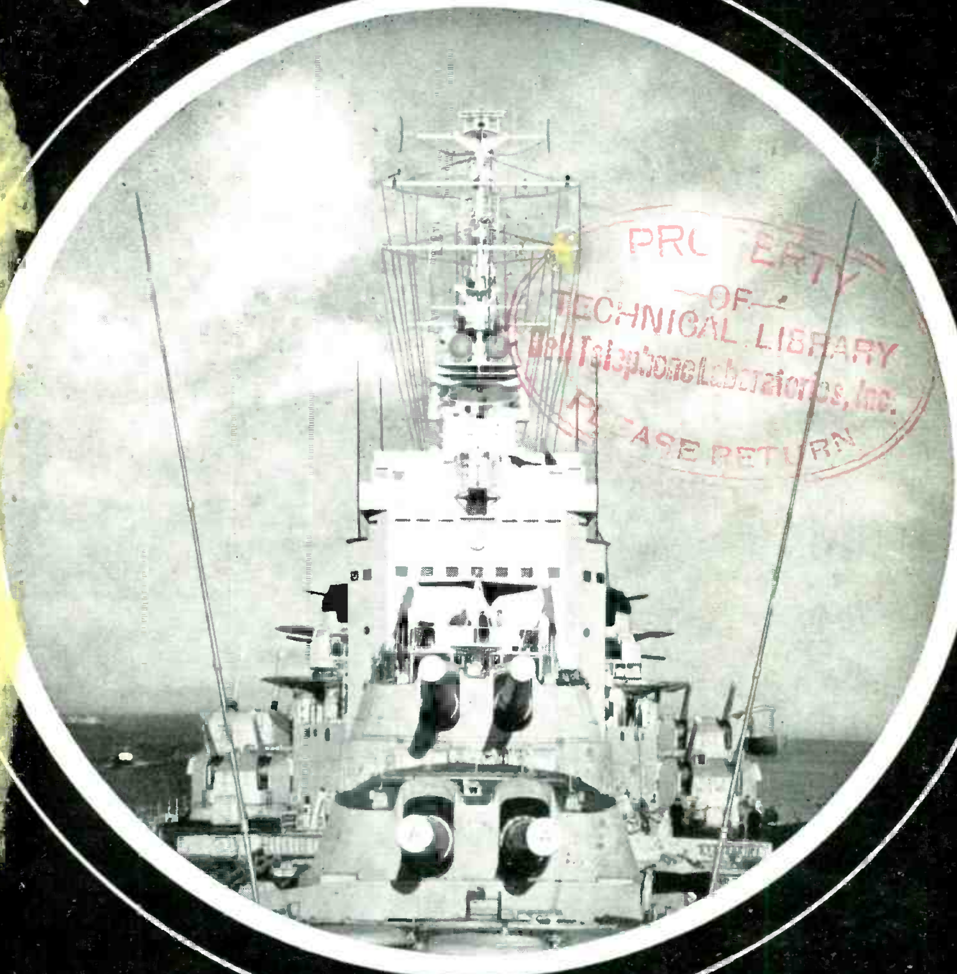
Wireless World

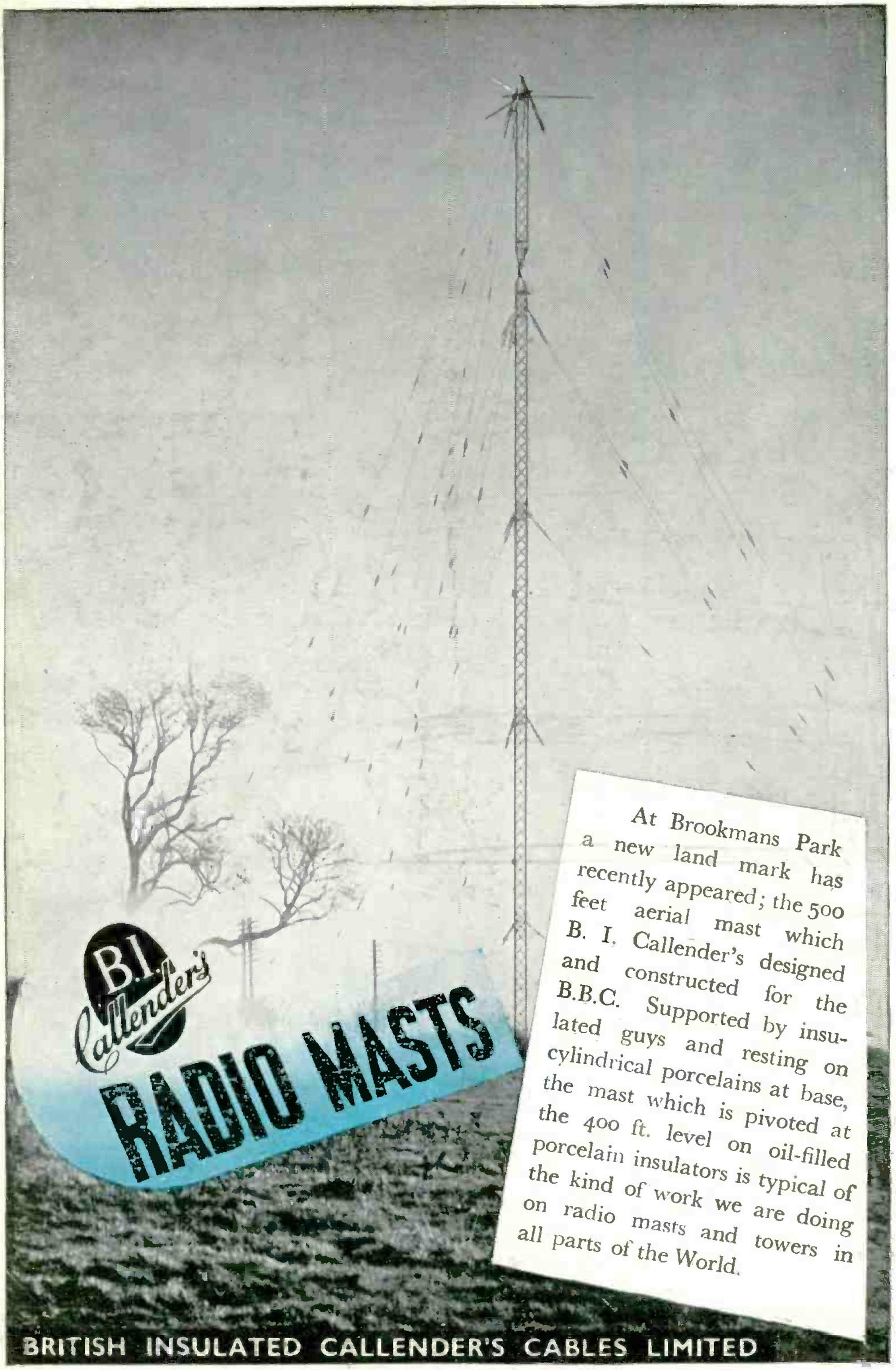
RADIO AND ELECTRONICS



MAR. 1947
1/6

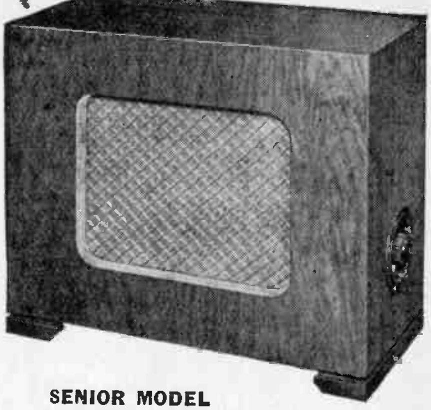
IN THIS ISSUE: RADIO EQUIPMENT IN H.M.S. "VANGUARD"

Vol. LIII. No. 3


B.I. Callender's
RADIO MASTS
At Brookmans Park a new land mark has recently appeared; the 500 feet aerial mast which B. I. Callender's designed and constructed for the B.B.C. Supported by insulated guys and resting on cylindrical porcelains at base, the mast which is pivoted at the 400 ft. level on oil-filled porcelain insulators is typical of the kind of work we are doing on radio masts and towers in all parts of the World.
BRITISH INSULATED CALLENDER'S CABLES LIMITED


AVO
REGD TRADE MARK
AVOMETER
MODEL 7
UNIVERSAL
AVOMETER
MODEL 40
UNIVERSAL
AVOMETER
THE "AVO"
TEST
BRIDGE
THE "AVO"
VALVE TESTER
THE
ALL WAVE
"AVO" OSCILLATOR

Radio in every room
with these
NEW & BETTER
Extension Speakers . . . .



Have you joined that ever-increasing number of listeners who enjoy the pleasure and convenience of "radio in every room" with the NEW and BETTER Stentorian Extension Speaker?

Though moderately priced, the Senior and Junior models with their handsome walnut veneered cabinets offer you a marked improvement in reproduction and are an acquisition to any furniture scheme.

ASK your local dealer to demonstrate—you will be convinced of the outstanding quality of these new Stentorian speakers.

SENIOR MODEL

Type SC (with Universal Transformer) .. **£5.15.6**
Type SX (less ,, ,,) .. **£5. 2.6**
Cabinet dimensions 14⅞"x12 9/16"x7". P.M. Unit. 9" diameter, handling capacity 7 watts. Magnet, flux density 12,000 lines/sq. cm. Volume control, constant impedance type.

JUNIOR MODEL

Type JC (with Universal Transformer) .. **£5. 0.0**
Type JX (less ,, ,,) .. **£4.10.6**
Cabinet dimensions 13½"x11¼"x6⅝". P.M. Unit, 8" diameter, handling capacity 6 watts. Magnet, flux density 10,000 lines/sq. cm. Volume control, constant impedance type.

WB **Stentorian**
THE FINEST *EXTRA* SPEAKER FOR ANY SET

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

The
PIFCO
ALL·IN·ONE RADIOMETER

tests everything electrical

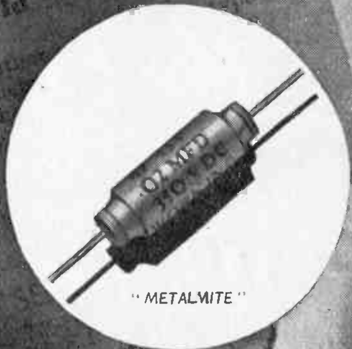
RADIO, HOUSEHOLD APPLIANCES & MOTOR CAR LIGHTING ETC!

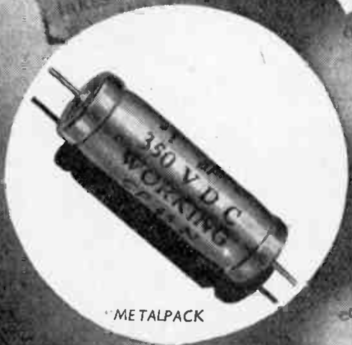
25/-

Ask your local Factor to show you one of these remarkable instruments and to put your name down on his waiting list.

TCC

PAPER DIELECTRIC
Tropical
TUBULAR CAPACITORS





FOR the ever-increasing applications where the maintenance of a high value of insulation resistance is of paramount importance, the T.C.C. "METALPACK" Tropical and "METALMITE" Miniature Tropical types are indispensable. By virtue of the aluminium tube, hermetically sealed construction, the initial insulation is maintained, even under the most arduous climatic conditions.

"METALMITE" (Miniature) TUBULAR PAPER CAPACITORS

Capacitance mFds.	Working Voltage D.C.		Dimensions Inches		Type No.	List Price Each
	at 71°C.	at 100°C.	Lgth.	Dia.		
.001	500	350	1	.2	CP30S	1/9d.
.002	500	350	1	.2	CP30S	1/9d.
.005	500	350	1	.25	CP32S	1/10d.
.01	500	350	1	.34	CP33S	1/10d.
.02	500	350	1¼	.34	CP34S	1/10d.
.05	500	350	1½	⅜	CP36S	2/1d.
.005	350	200	1	.22	CP31N	1/8d.
.01	350	200	1	.25	CP32N	1/8d.
.02	350	200	1	.34	CP33N	1/9d.
.05	350	200	1¼	⅜	CP35N	2/-
.1	350	200	1½	7/16	CP37N	2/3d.
.05	200	120	1¼	.34	CP34H	1/11d.
.1	200	120	1½	⅜	CP36H	2/2d.

"METALPACK" TUBULAR PAPER CAPACITORS

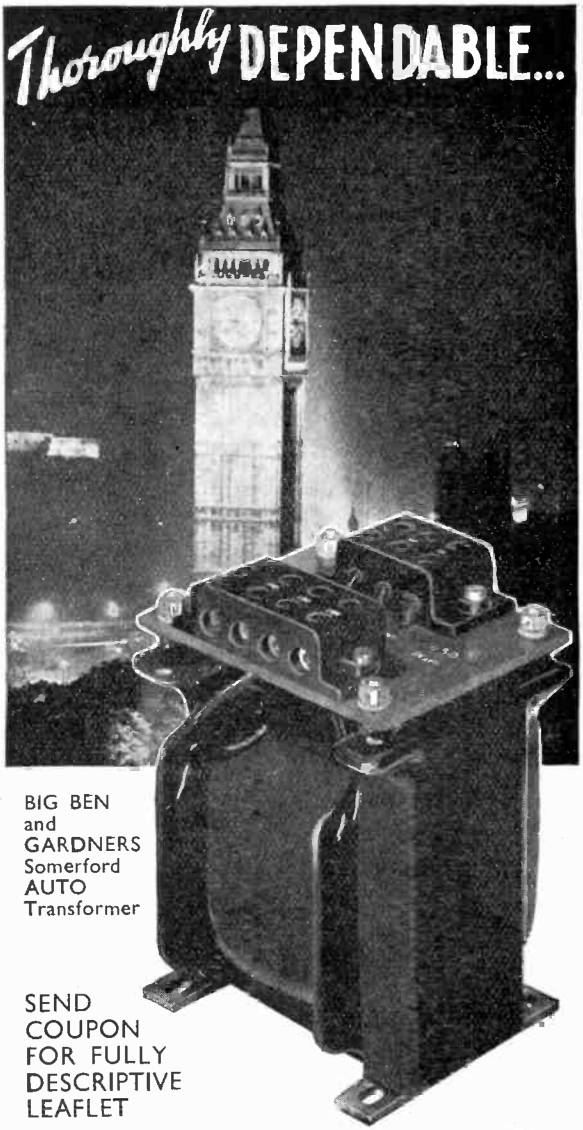
Capacitance mFds.	Working Voltage D.C.		Dimensions Inches		Type No.	List Price Each
	at 71°C.	at 100°C.	Lgth.	Dia.		
.001	1000	750	1⅝	⅜	CP49W	1/10d.
.002	1000	750	1⅝	⅜	CP49W	1/10d.
.005	1000	750	1⅝	½	CP45W	1/10d.
.01	1000	750	1⅝	½	CP45W	1/10d.
.02	750	500	1⅝	½	CP45U	1/10d.
.05	500	350	1⅝	½	CP45S	2/1d.
.1	350	200	1⅝	½	CP45N	2/1d.
.1	500	350	2⅞	½	CP46S	2/2d.
.1	1000	750	2⅜	¾	CP47W	2/6d.
.25	350	200	2⅞	¾	CP48N	2/8d.
.25	500	350	2⅞	¾	CP47S	2/10d.
.5	350	200	2⅜	¾	CP47N	3/-
.5	500	350	2¼	1	CP91S	3/10d.
1	350	200	2¼	1	CP91N	4/-

THE TELEGRAPH CONDENSER CO., LTD.

RADIO DIVISION

NORTH ACTON · LONDON · W·3 Telephone, ACORN 0061


THIS IS
THE B.B.C HOME
SERVICE...
SATURDAY NIGHT
Theatre Presents.


Thoroughly DEPENDABLE...

WEBB'S *Radio*

TWO OF THE INSTRUMENTS DESCRIBED IN THE NEW "EDDYSTONE" SHORT-WAVE MANUAL

are now available from Webb's as complete and tested Equipment ....

1
5 & 10 METRE CONVERTER

The converter can be used in conjunction with any good super-het or "straight" receiver, *and will improve the ten metre reception of even the finest communication receiver.* On five metres tests have shown results equal to specialised high-frequency receivers. The three Mullard Valves were developed during the war for H.F. work and have only recently become commercially available. Service personnel will recognise the EF54 and EC52 as specialised high-frequency valves known previously as the RL7 and RL16—and this applies also to the EF50.

Uses Valve Types:
R.F. EF54
MIXER EF50
OSCILLATOR EC52
Recommended I.F. 1.6 Mc/s.(187.5 Metres)

No power pack is incorporated; an external source of power is necessary giving 6.3 volts 1 amp. and 200/250 volts 30 milliamps. The main receiver will often provide this small additional power; batteries or a separate pack can be utilised if desired. Actual frequency coverage of converter is 51.4 to 60.5 mc/s and 26.4 to 33.4 mc/s by plug-in coils. Simplicity of coil design makes other interesting H.F. ranges available by experiment.

5 & 10 METRE CONVERTER UNIT

Assembled and tested (less valves)	£10 10 0
VALVES. Types: EC52, 18/3; EF50, 21/4; EF54, 21/4	3 0 11
	£13 10 11

AVAILABLE FROM IMMEDIATE STOCK. The inclusive price of £13 10s. 11d. includes a copy of the Eddystone Short Wave Manual with full operating details.

2
TWO VALVE PRE-SELECTOR

An efficient two-stage radio-frequency amplifier for use with any straight or super-heterodyne communication receiver. Gives considerable improvement in signal to noise ratio, adjacent channel selectivity and reduces image interference. Built in the Eddystone No. 644 black-crackle cabinet, size $10\frac{5}{8}'' \times 6'' \times 7''$ high, as illustrated, for 5/10 metre converter above. Valves used are two Mullard EF39, giving high-gain with low noise level. Supplied with four pairs of Eddystone coils giving coverage 32 to 3.5 megacycles. External source of power is necessary, though in most cases both filament and high-tension may be drawn from the existing receiver.

TWO-VALVE PRE-SELECTOR

Assembled and tested (less valves)	£10 10 0
VALVES: Two type EF39 at 12/10	1 5 8
	£11 15 8

WEBB'S POWER PACK (Type 230/30)

Built in black-crackle case $6'' \times 6'' \times 4''$ high to meet supply demands of either the 5/10 metre Converter or the Two-Valve Pre-Selector. Tapped input 200, 220 and 240 volts. A.C. output 230 volts 30 m/a D.C. and 6.3 volts 1 amp. A.C. Useful for many other purposes where a compact source of D.C. and filament power is required. Price complete **£4 10 0**

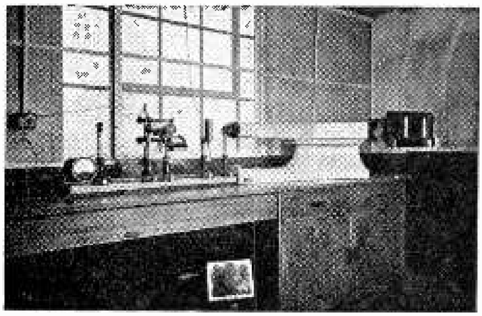
If you prefer to build your own equipment, full constructional details of the 5/10 metre Converter and the two-valve Pre-selector will be found in the new Eddystone Short Wave Manual. (Supplies of this book are limited, and we are forced to say *callers only, please.*)

Price 2/6

WEBB'S RADIO, 14, SOHO ST., LONDON, W.1. 'Phone: GERrard 2089. Shop hours: 9 a.m.—5.30 p.m. Sats. 9 a.m.—1 p.m.

The operation of SPECTROGRAPHIC APPARATUS

direct from an A.C. supply



Steadiness of output and absolute dependability are but two reasons why Messrs. Evered & Company, Smethwick (by whose permission the photograph is reproduced), use a Westinghouse metal rectifier to supply the D.C. for the arc of their Laboratory spectrographic equipment.

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WESTALITE RECTIFIERS

for a reliable D.C. Supply

Send your rectification problems to Dept. W.W.

WESTINGHOUSE BRAKE & SIGNAL CO. LTD.

82 York Way, King's Cross, London, N.1

JUST RECEIVED !!!

BRAND NEW AMER'CAN SINGLE BUTTON CARBON BREAST ASSEMBLY

Beautiful job. Ribbed aluminium diaphragm. Bakelite case. Complete with 3 position switch. PRICE **9/6**

Extra 3-position control switch with 10 ft. length 3-core flexible T.R.S. cable for above. PRICE 3/6

Both the above items still in maker's sealed cartons.

MOVING COIL MICROPHONE & HEADPHONE ASSEMBLY (Approx. Impedance of each unit 48 ohms) Microphone has "Press to talk" switch; worth £8. Complete **15/6**

Moving Coil Hand Mike with switch. PRICE 6/6

Moving Coil Assembly in bakelite case with 3" grill. Can be used as midget speaker. PRICE 4/6

(All above units have genuine Alni magnets.)

STRATTON MICRODENSERS (Eddystone)

Code E18. 18 mmfd triple spaced, 3,9. E40. 40 mmfd double spaced, 4/3

Code E60. 60 mmfd single spaced, 4/3. E100. 100 mmfd single spaced, 4,6

YAXLEY TYPE SWITCHES

Double pole 6-Way. Ideal meter or multi band switches - - - 2/6

Three pole 3-Way. 2 Wafer 3,6 Double pole 4-Way. 3 Wafer 3/6

SEND S.A.E. FOR DETAILS OF NUMEROUS OTHER INTERESTING BARGAIN LINES.

RADIOMART G5NI (B'HAM) LTD.

ASK FOR LIST No. 4

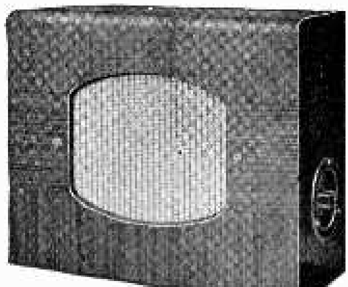
Telephone: Midland 3254

48 HOLLOWAY HEAD, BIRMINGHAM, 1

Wharfedale BIJOU

Extension Speaker

With Standard 8-in. Unit **70/-**



$12\frac{1}{2}'' \times 10'' \times 5\frac{1}{2}''$

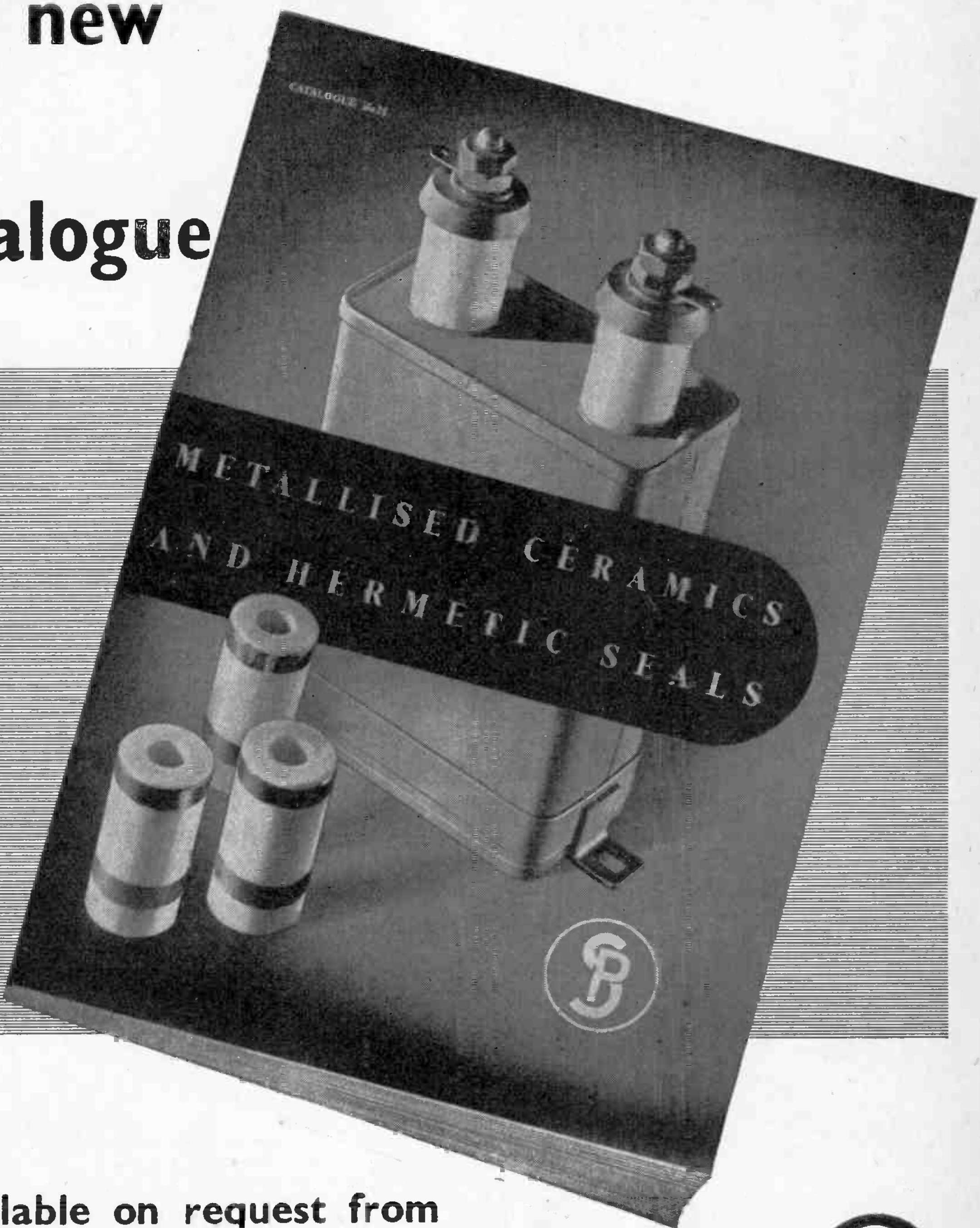
The production of Wharfedale cabinet Speakers in still restricted, but the Quality and Finish are up to the highest standards. The BIJOU is outstanding in appearance and performance.

WHARFEDALE WIRELESS WORKS

BRADFORD, ROAD, IDLE, BRADFORD

Telephone: IDLE 461. Telegrams: Wharfdel, Idle Bradford.

The new S.P. Catalogue



is available on request from

STEATITE & PORCELAIN PRODUCTS LTD.

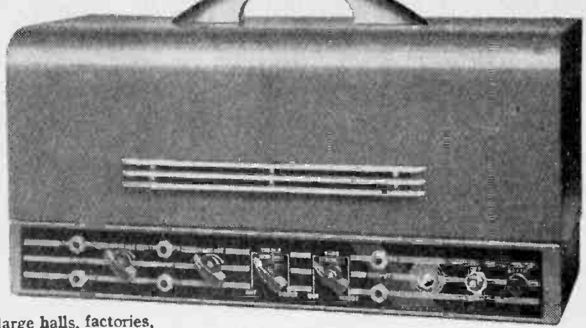
Stourport on Severn, Worcs. Telephone: Stourport 111. Telegrams: Steatain, Stourport.

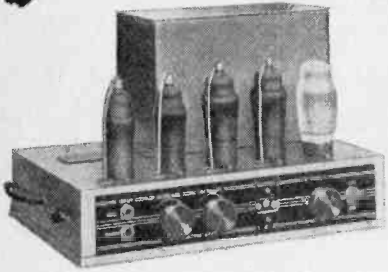
S.P.48

B

Something new—Something better...

Two Models available *now*





MODEL T.40 DE LUXE AMPLIFIER

For outdoor meetings, large halls, factories, etc. Superior in appearance, design and performance. 40 watts undistorted output. 4 separate matched inputs. Separate volume controls, electronic mixing, unique treble or bass tone control system.

Overall dimensions 18¼in. long, 11in. high, 8¾in. wide.

Guaranteed for 12 months, valves for 3 months.

PRICE COMPLETE, ready to operate **27 GNS.**

MODEL T.10 AMPLIFIER

Ideal for small or medium halls, cafes, clubrooms, etc. AC or DC mains. 8/10 watts undistorted output. Separate inputs for Moving Coil microphone (matching transformer built into amplifier) and Crystal or Moving Iron gramophone pick-ups, separate MIC. and GRAM. volume controls. Overall dimensions 12½in. long, 7½in. high, 9in. wide.

Guaranteed for 12 months, valves for 3 months.

PRICE COMPLETE ready to operate **12 GNS.**

AVAILABLE SHORTLY

AMPLIFIERS—IN STREAMLINED CASES.

Model T.12 for AC/DC mains 12/15 watts output ....**12 GNS.**

MODEL T.25 for AC mains 200/250 volts 25 watts output ....**18 GNS.**

TABLE MODEL RADIO RECEIVER S63 AD. for AC/DC mains ....**22 GNS.**

"CRYSTATONE," DEAF AID UNIT

Brings great enjoyment to those afflicted with hearing troubles. Genuine quality and value. Streamlined and pleasing in appearance, fits bag or pocket. Unbreakable plastic case.

Complete ready for use...............**10½ GNS.**

Full details on request.

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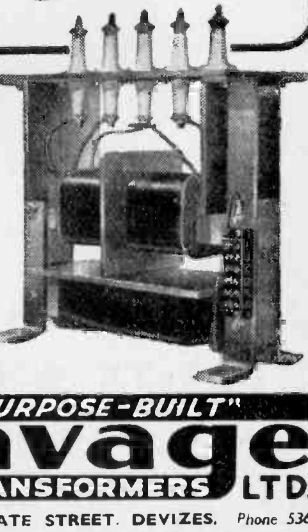
Transformers aren't clothes pegs.



Clothes pegs work just as well on any line. Transformers are only completely efficient when built for the job they have to do. That's why we specialise in building transformers for special industrial purposes. If you want transformers designed and built to do a definite job, we can help you.

"PURPOSE-BUILT"

Savage

TRANSFORMERS LTD.

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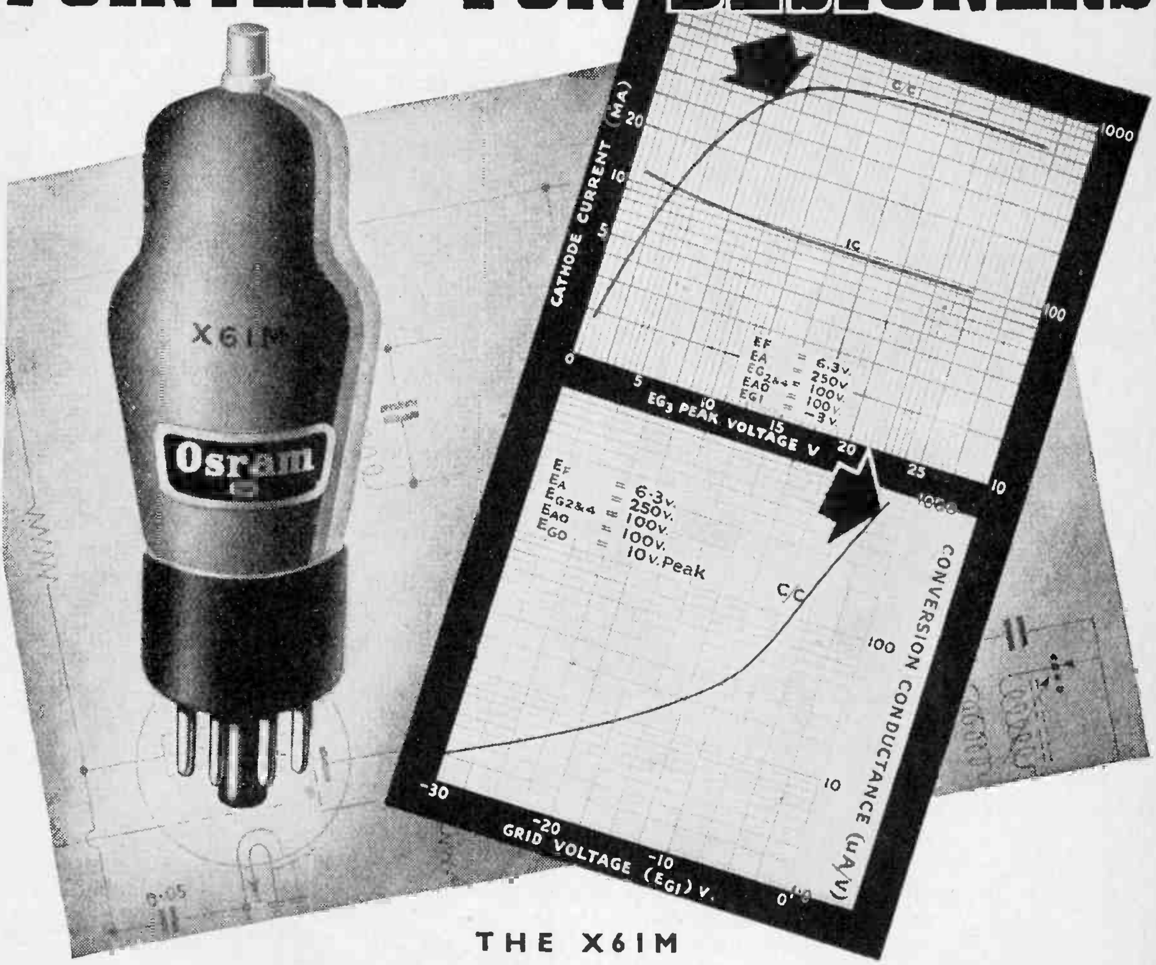
POINTERS FOR DESIGNERS



THE X61M

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

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

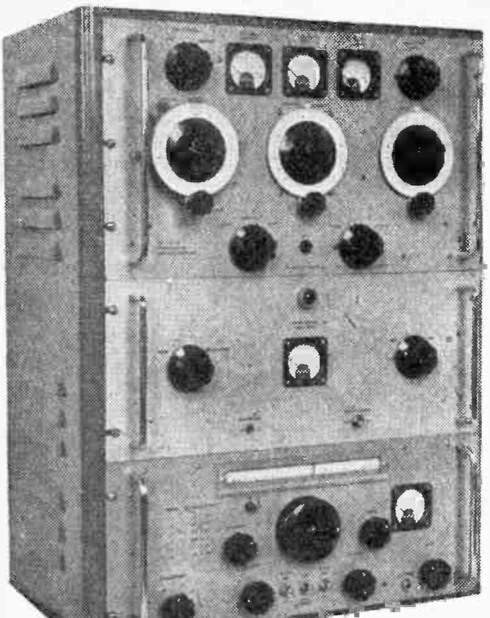
A detailed technical data sheet is available on request.

Osram PHOTO CELLS

G.E.C. CATHODE RAY TUBES

Osram VALVES

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



Redifon G.32 Transmitter/receiver for C.W., M.C.W., telephony and telegraphy.

The new Redifon G32 transmitter/receiver

Ideal General Purpose Communications Unit

THE REDIFON G.32, a compact 50-watt mobile transmitter/receiver, is already giving excellent service to Colonial Governments in civil administration and police duties, and it has now been redesigned to give even simpler and better operation as well as an improved appearance.

The transmitter covers 4.0 to 15.0 mc/s (75 to 20 metres) and the receiver 150 kc/s to 20 mc/s (2,000 to 15 metres).

The complete unit, which is ideal for general communications use, whether installed in small airfields, oil-field or harbour communications, or geographical research equipment, is 28 ins. high by 21 ins. wide by 12 ins. deep, finished to tropical specification.

It fits easily into a truck and can be operated from 250v. A.C. supply or 24v. accumulators for which a special supply unit is provided.

The Redifon G.32 is available now for almost *immediate delivery*, and further details can be supplied by our Communications Sales Division.

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Designers and Manufacturers of Radio Communication and Industrial Electronic Equipment

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M.R. SUPPLIES Ltd.

offer only brand new and guaranteed material, with immediate delivery from stock. All prices nett.

"FUZIT" WIRE JOINTERS. A large purchase enables us to present this opportunity. This very useful S.T.C. product electrically welds all gauges of wire from 50 to 30 s.w.g. (copper and resistance) instantly. No solder or flux, no dry joints. Operation 200/250 v. A.C. Equipment comprises well-housed portable transformer, hand-tool with carbon electrodes and trigger, leads, ready for use. Further details, if required, but supply limited. **78/6** complete (des. 2/6).

MINIATURE COMMUNICATION RECEIVERS (M.C.R.1). **An unbeatable M.R. offer.** The 5-valve superhet in metal case approx. 9in. by 3in. by 2in., A.C./D.C. Power Pack in same size case, two H.T./L.T. Batteries (one spare), four coil units, headphones, aerial and earth, complete, universal and mobile, brand new in hermetically sealed container, **£10** (carr. 4/6). (The tuning ranges are: 188/3000 metres, 60/120 metres, 38/67 metres, 20/38 metres.)

G.E.C. OMNI-DIFFUSION SPEAKERS. Efficient central suspension type with octagonal flare 21in. dia., handling 12 watts at good quality. Fitted multi-match line transformer, ideal for dance-halls, public rooms, etc., limited number for callers, at **£9/17/6** each.

SPECIAL MULTI-LINE STROBOSCOPES (cardboard) A. 200/3000 r.p.m. in 15 steps, B. 206/6000 r.p.m. in 14 steps, C. 60/1200 r.p.m. in 20 steps, all 50 c. viewing. Each strobo. with stator and table, **2/9**, or set of three **7/6**.

MINIATURE PIEZO-CRYSTAL MICROPHONES (Rothermel-Brush). Only 1⅜ inches diameter, with 5 megohm loading incorporated, made for deaf-aids but suitable for all mic. purposes, **29/6**.

POWER TRANSFORMERS, prim. 200/220/240 v. Sec:—350/0/350 v. 150 m.a., 4 v. 5 a., 4 v. 3 a., in cast brackets with terminal board, **35/-**. Also 450/0/450 v. 150 m.a., 6.3 v. 4 a., 6.3 v. 2 a., 5 v. 3 a., in brackets with loose leads, **45/-**. Also 260/0/260 v. 75 m.a., 6.3 v. 3 a., 5 v. 2 a., **27/6**. **Special offer** ex Admiralty, Prim. 230 v. Sec:—500/0/500 v. 170 m.a. (250 m.a. can be safely drawn) 4.4 a. CT., **35/-** (des. 2/6).

L.F. CHOKES:—5 henries with 200 m.a. passing, in cast brackets with terminal board, 75 ohms, **32/6**. 30 henries 100 m.a., 500 ohms, fully shrouded, **21/-**.

ROTHERMEL PIEZO-CRYSTAL PICKUPS. Replacement Heads for Garrard and Collaro arms, giving much improved performance and minimum record wear, **46/11**.

ROTHERMEL SAPPHIRE GRAMO-NEEDLES, the best permanent needle for any pickup, **12/6** each.

HEAVY DUTY OUTPUT TRANSFORMERS. The improved "W.W." model handling up to 25-watts. 11 ratios from 12/1 to 75/1 with c.t. for P.P. Tapped prim. and sec. Weight 9½ lbs. Undoubtedly the best for high fidelity work. **59/6** (desp. 1/6).

RECTIFIERS (L.T. for charging, etc.). All for charging up to 12 v. All FW. 1.5 amp, **12/6** (A), 4 amps, **22/6** (B), 6 amps, **39/6** (C), 10 amps, **49/6** (D). The letters refer to appropriate Transformers—below. Also 26 v. 5 amps, **62/6** (desp. 1/6), and 30 v. 8 amps, **£4/17/6** (desp. 2/-). All of the above rectifiers are the latest products of Standard Telephones and Cables, Ltd.

STEP-DOWN MAINS TRANSFORMERS. All primaries tapped 200/220/240 v. Sec:—7, 11 and 15 v. at 2 amps (A), **22/-**. 6, 8 and 14 v. at 4 amps (B), **32/6**. 5, 12 and 17 v. at 6 amps (C), **51/6** (des. 1/6), 7 and 15 v. at 10 amps (D), **77/6** (des. 2/-). **HEATER TRANSFORMERS,** Prim. 200/240 v. (tapped), sec. 6.3 v. 5 a., CT and 5 v. 3 amps, **29/6**.

ROTARY RHEOSTATS. Space saving, front of panel mtg. (3-holes). Large range. Examples:—5 ohms 3 amps, **22/-**. 4 ohms 4.5 amps, **23/6**. 1,500 ohms 0.25 amp, **25/6**. 115 ohms 1 amp, **25/6**. Also double former type (same mtg.), 10 ohms 8 amps, **28/6**. 230 ohms 1 amp, **33/6**. 920 ohms 0.4 amp, **31/6**. These are exceptionally well constructed, with 2½in. control knob, continuously rated.

Please include sufficient for packing and despatch.

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PORTABLE ELECTRIC GRAMOPHONE TYPE A.G.4

BSR

The amplifier of this instrument provides an output of 10 watts from built in gramophone unit or separate microphone. It is ideal for Hotels, Dancing Schools, educational purposes and in the home. The unit is compact, portable, has excellent reproduction and is robust in design. Full particulars including details of loudspeakers and microphones are available on request.

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M-W.73

The remarkable accuracy of the DUBILIER PRECISION WIRE WOUND RESISTOR is due to its scientific construction. A slotted high insulation ceramic former is wound with enamelled resistance wire of not less than 0.0014″ diameter. During winding the wire is subjected to tests to eliminate accidentally shorted turns and to ensure the essential high standard of insulation between turns. Contact between resistance element and terminals is by the exclusive DUBILIER moulded metal method which removes the possibility of weak, non positive or noisy connections. All units are suitable for use up to 50 Kc/s. *Full technical details on request.*

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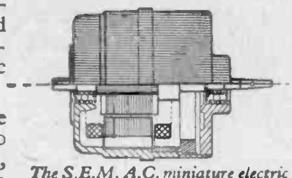

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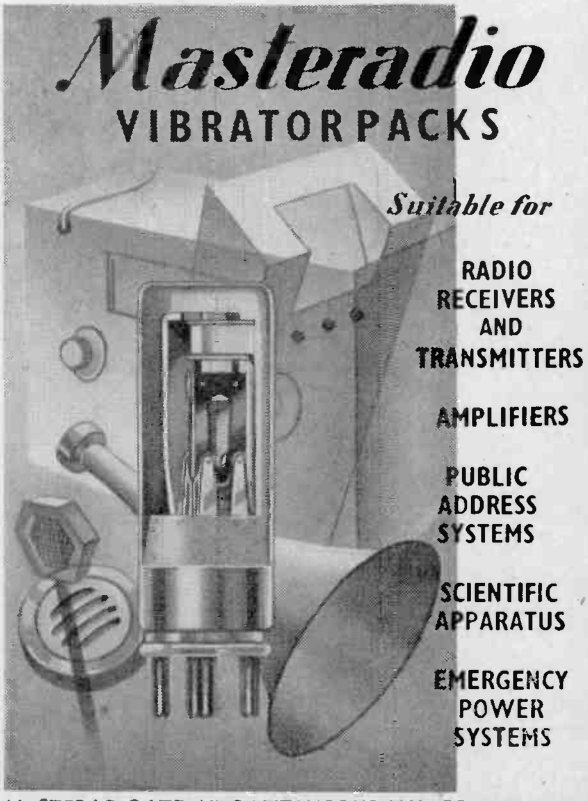

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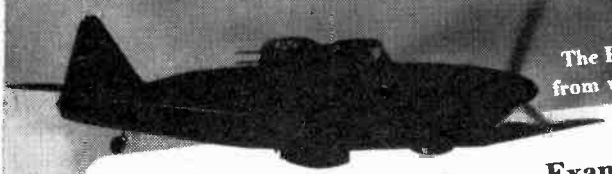

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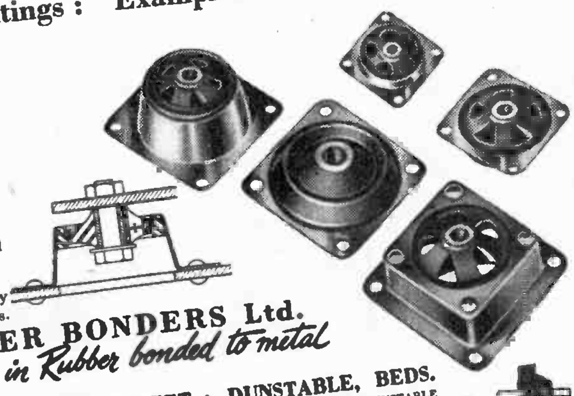

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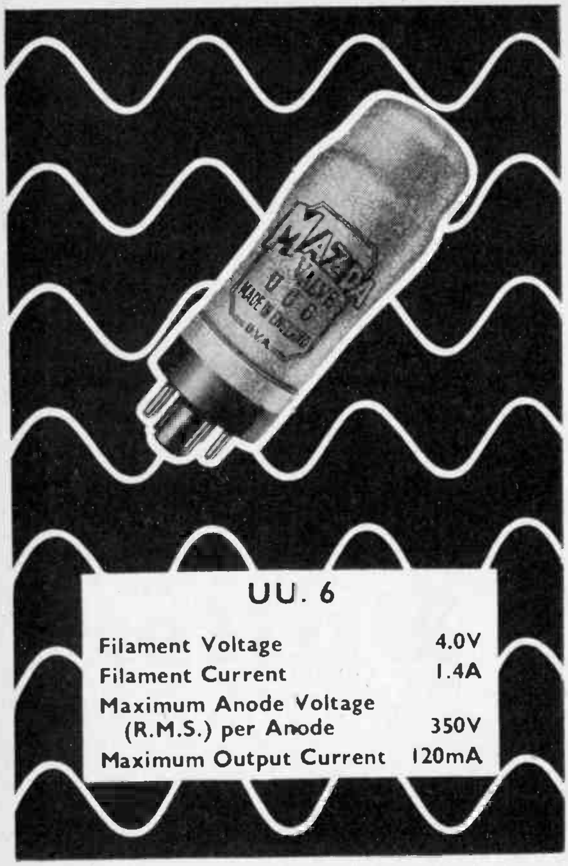

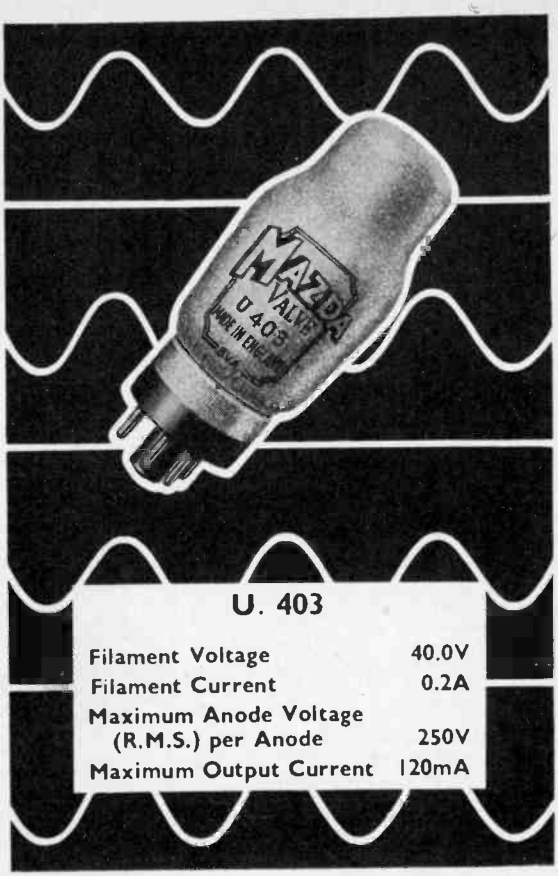

The UU.6 is an indirectly heated full wave rectifier for use in A. C. Mains Receivers, whilst the U.403 is a half wave rectifier for use in A.C./D.C. Receivers.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

VALVES AND THEIR APPLICATIONS

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

No. 3: Mullard SINGLE-ENDED SHORT WAVE TRIODE EC52

THE EC52 is the companion triode to the EF54 pentode discussed last month. You will remember that the great point about the EF54 is that it works at frequencies up to 300Mc/s or so, formerly the preserve of the costly and fragile acorn. Nearly all receivers for such frequencies are superhets or super-regeneratives; and both require an oscillator.

As with the EF54, one has to realise that near the limiting frequency a large part of the tuned circuits is inside the bulb. For example, in seeing how high in frequency I could make the EC52 go, my oscillator circuit ended up (close on 400Mc/s) as Fig. 1. Until re-drawn as Fig. 2, to show the inductance of the leads and the inter-electrode capacitances, it is not easy to recognise it as a Colpitts circuit. The 10pF was a ceramic disc condenser bridged straight across the anode and grid tags, and the choke a dozen or so turns of fine wire ¼" dia. For frequencies in the region of 300Mc/s a small tuning coil can be inserted on the anode side of the condenser, and the choke preferably tapped to its centre. At still lower frequencies — say for the oscillator in a television superhet — almost any conventional circuit can be used.

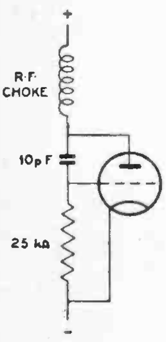

FIG. 1

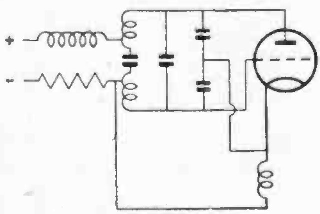

FIG. 2

With very slight modification (Fig. 3) an oscillator can be converted into an extremely simple super-regenerative receiver. The aerial may be a half-wave piece of wire with one end near an end of the coil. As the anode rating of the EC52 is 7.5 watts at 400 volts, it makes quite an effective VHF sender. And, of course, a triode with a slope of over 6.5 mA/V is quite useful for other than VHF applications.

NOTE: The EC52 should *not* be used as an earthed-grid amplifier. For that purpose there is a special valve having exceptionally low anode-cathode capacitance — the EC54.

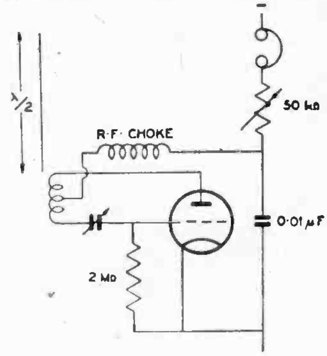

FIG. 3

Mullard

This is the third of a series of articles written by M. G. Scroggie, B.Sc., A.M.I.E.E., the well-known Consulting Radio Engineer. Reprints for schools and technical colleges may be obtained free of charge from:

THE MULLARD WIRELESS SERVICE CO., LTD., TECHNICAL PUBLICATIONS DEPARTMENT, CENTURY HOUSE, SHAFTESBURY AVE., W.C.2

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Monthly Commentary

Wire versus *Wireless*

THOUGH some of us may sigh for the "good old days" of intense and embittered rivalry between wire and wireless, it is all to the good that co-operation has largely replaced competition. The more sane and realistic modern attitude towards this old controversy was well brought out at a recent discussion meeting of the Institution of Electrical Engineers, where the conclusion was reached that the two systems of communication are largely complementary and that both have wide fields of usefulness. And, in any case, there is no longer a clear-cut line of demarcation between the two; most line systems use electronic techniques to some extent, and the most highly developed—with R.F. cables—may fairly though rather inelegantly be described as non-radiating radio.

In the I.E.E. discussion no time was wasted in profitless reiteration of the old arguments for and against radio in simple point-to-point communications. For such purposes, and indeed in most borderline cases, the deciding factor is now generally recognized as an economic one; the principle is more or less that, where the alternatives are available the use of radio is unjustified where the wire would serve at reasonable cost. Most of the discussion was concerned with the relative merits of V.H.F. radio relay systems and R.F. cables for large-scale internal communications. It would seem that precise data on the general functioning—and, above all, on the reliability—of radio links of this kind is not yet available, but a good case was made for their use, particularly on economic grounds. The main objections, apart from the unknown factor of reliability, were on the score of lack of secrecy and susceptibility to interference.

If data on the functioning of radio relays is in fact so scarce as would appear, we suggest that experimental stations, operating at or about maximum ranges, should be set up without delay in order that propagation and other problems may be studied intensively under all meteorological conditions. Data obtained from a few experimental links should give the industry a chance to cater for the communication needs of those overseas countries in which the attractions of radio relay systems are perhaps greater than in Britain. In the national interest, co-operation between the Post Office and industry would seem to be indicated.

In the Air

WIRELESS made its first great contribution to humanity by saving life at sea. In the early days, even before direction-finding came as an additional safeguard to the mariner, impressive totals were given each year of those owing their lives directly to radio. We should like to think that it is making equally notable contributions to the safety of flying. No doubt, civil aviation as it is to-day could not possibly be conducted without the help of radio, but it is also certain that recent developments that contribute to safety in the air are not yet being used to full advantage.

For this state of affairs there are many causes. The general dislocation of post-war life has resulted in unexpected delays in beating our swords into ploughshares in most spheres of activity. Failure to secure international agreement and standardization of radio aids is another important factor. A civil aircraft that may fly over aerodromes controlled by half a dozen national authorities in almost the same number of hours cannot possibly carry the gear that may be needed to take advantage of all the different types of ground equipment that may be encountered. The problem is technically not very difficult in regard to the broad essentials; most of the answers are already known. But a good deal of detail work has to be done in adapting war-time methods to civilian needs. Close and sympathetic collaboration with those who fly the aircraft is needed; we must find what they want, and give it to them in an attractive form. As we see it, there is a tendency towards over-complication; wireless men tend to regard an aircraft as a flying platform for radio equipment, ignoring the requirements of pay-load and crew psychology. Radio can and must help to reduce the present deplorable loss of life.

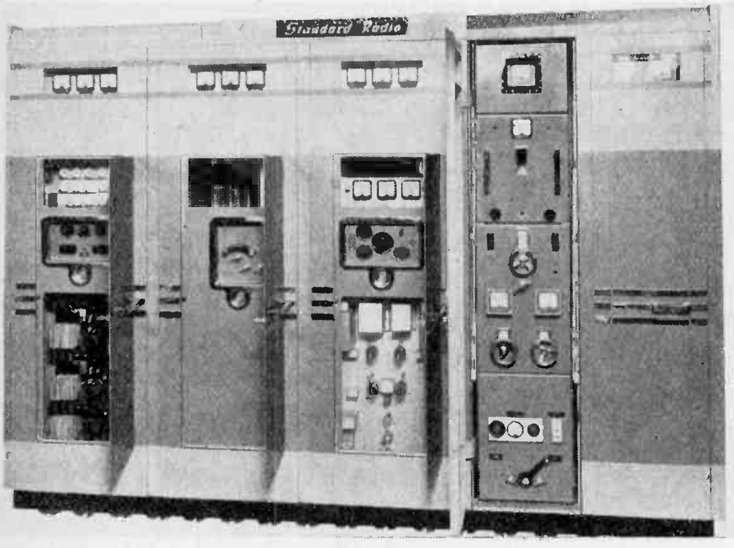
H.M.S. "VANGUARD"

Radio Communication Arrangements for the Royal Cruise

By G. M. BENNETT

THE radio communication equipment of a modern warship is normally limited to that needed for morse transmission and reception at both hand and automatic high speed over any distance, and *short*-range R.T. on V.H.F. H.M.S. *Vanguard,* Britain's newest battleship, was so fitted when she was completed early last year. When, however, this great vessel was selected to convey the King and Queen and the two Princesses to South Africa and back it was decided to augment her normal radio communication facilities. The large amount of radio traffic expected to be handled, including both official messages and "copy" from the two Press correspondents, called for duplex automatic telegraphy (A.T.), i.e., two-way radio teleprinter. The second requirement was for *long*-range duplex R.T., comparable with that provided in Atlantic passenger liners, permitting telephonic communication between the ship and telephone exchanges in Britain or South Africa. This was also needed so that programmes could be transmitted from the ship for re-transmission by the B.B.C. and the South African Broadcasting Corporation. It was also decided to provide facilities for the transmission of Press photographs from the ship. And lastly, satisfactory reception of broadcast programmes throughout the compartments occupied by the Royal Party and their suite was required.

The last item, being the simplest and independent of the other three, is best dealt with first. Installation of separate broadcast receivers in all the cabins concerned was ruled out owing to the difficulty of providing satisfactory aerials. It was also doubtful whether such sets could be operated successfully in the face of the interference to be expected from the ship's high-power transmitters. A rediffusion system was, therefore, decided on, similar to that already feeding the whole ship, but with the difference that three programmes were to be available instead of one. Three standard Naval broadcast receivers were installed in the special radio control room (described later). These are connected by feeders to receiving aerials separated as far as possible from the ship's transmitting aerials. The output from these sets is fed to Vitavox loudspeakers in every required compartment, each having a volume control and programme selector switch. In addition individual Murphy radio-gramophones have been installed in the King's day cabin and the equerries smoking-room, whilst a Decola record reproducer is available for use wherever it may be required.



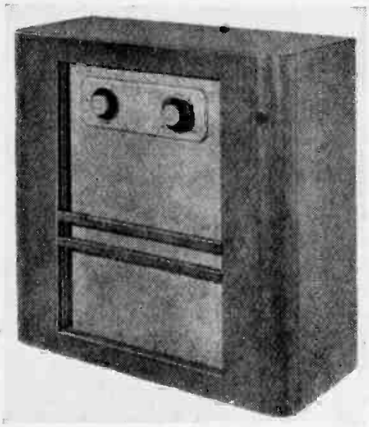
Standard Telephones & Cables DS10 transmitter as installed in the *Vanguard* for long-range duplex radio-telephony. The units are, left to right two power units, modulator and two R.F. units.

All the other special facilities—automatic telegraphy, long-range radio-telephony and facsimile[1]—have one thing in common; for satisfactory operation they need a higher radiated power on the H.F. bands than any existing transmitter in the ship could give. Theoretical calculations demanded 4 kW for R.T. and 1 kW for A.T. The rated power of the ship's single high-power H.F. transmitter was approximately 3 kW on telegraphy but only 500 watts on telephony. But, to meet the normal naval requirement of continuous tuning from 1.5 to 25 Mc/s, it was provided with a simple single-wire aerial system, so the radiated power was considerably less. The first decision taken, therefore, was to install a higher-powered transmitter; the second, to provide it with a more efficient aerial system.

The solution to the first problem was not as easy as would seem at first sight. As there was no time to develop a transmitter for the purpose, one had to be found amongst the products of commercial firms. But the demand for transmitters of such power is in general limited to

[1] The term facsimile is used by the Navy for all systems employed for the transmission of still pictures.

shore stations where the limitation of space is not a governing factor as in a warship. Only one suitable transmitter was found; the DS10



A programme selection switch and volume control are incorporated in the Vitavox loudspeakers installed in the battleship. The speakers, designed for bulkhead mounting, are cellulose sprayed to match the decorations in the Royal suite. The fret covering is perforated white P.V.C. sheeting.

which had just been designed by Standard Telephone and Cables especially for use afloat. The prototype was lent to the Admiralty for installation in the *Vanguard*.

This transmitter employs a unit system of construction, whereby up to six radio-frequency units may be added to a multiple power unit. This enables up to three of six spot frequencies to be selected for simultaneous operation. A modulator unit may also be added for M.C.W. and R.T. operation. The transmitter is capable of providing:—

(*a*) 2 C.W. channels at 5 kW each, or 3 C.W. channels at 3 kW each, with independent keying;

or (*b*) 2 C.W. channels at 3 kW each, with common keying;

or (*c*) 1 C.W. channel at 3 kW plus 1 R.T. channel at 3 kW.

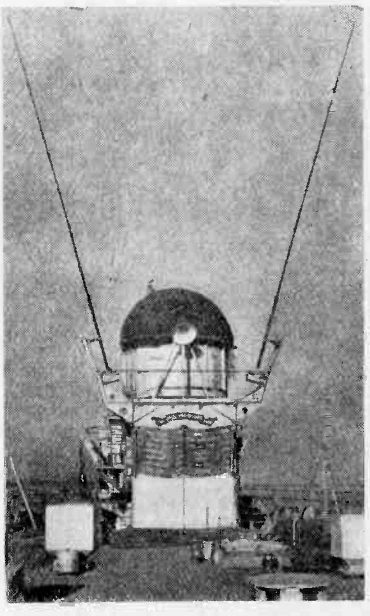
Both (*b*) and (*c*) permit simultaneous transmission on two different frequencies. The frequency coverage is from 2.5 to 22 Mc/s. An electronic keying unit is incorporated in the set permitting operation at keying speeds up to 600 w.p.m.

The transmitter as fitted in H.M.S. *Vanguard* consists of two R.F. units, a modulator and a twin power unit bolted together to form a remarkably compact set. The overall dimensions are only 6ft 6½in high, 9ft 3in long, and 3ft 2in deep. Individual units can be withdrawn for maintenance. The R.F. circuits consist of a crystal or master oscillator, selected at will, followed by two amplifier-doubler stages and a driver stage. The output circuit employs a pi-network and is calibrated directly in frequency. The exciter tuning stages are ganged together and also calibrated directly in frequency. By this means tuning is simplified. Beam tetrodes are employed as exciter valves, and pentodes for the driver and output valves: the latter have a 5 kW rating and are air-cooled. No neutralizing is necessary. The final stage feeds into a splitting circuit for balanced feeders, with a line reactor to provide exact matching, or simply into the line reactor in the case of an unbalanced feeder.

The modulator consists of two pentode pre-amplifiers, a phase splitter, two beam-tetrode push-pull amplifiers, and a push-pull cathode-follower driver for the Class "B" final modulator. The final stage uses two airblast cooled triode valves capable of modulating fully the final R.F. stage. Automatic gain control is obtained by rectifying part of the output of the first push-pull amplifier and feeding back the D.C. as bias to the first pentode stage. The final R.F. stage is modulated on screen as well as anode, thus giving substantially complete modulation.

The power equipment is split into two units and includes the main 6,000-volt rectifier, the intermediate 1,500-volt rectifier and two 500-volt rectifiers for low-power circuits and bias. Mercury vapour rectifiers are used for the 6,000 and 1,500-volt supplies and selenium rectifiers for lower voltages. The transmitter operates from a three-phase 50/60 c/s supply on a three-wire circuit, with 400 volts between phases, which is the normal system used for radio equipment in the larger warships. It is designed for operation in tropical conditions, three air blowers being provided for air-blast cooling of the valves while a fourth blower is employed for ventilation.

The aerial problem in H.M.S. *Vanguard* was simplified, in comparison with that normally met in a warship, because the special transmitter was only required for communication with the U.K. and South Africa during given periods. The optimum frequencies could, therefore, be predicted and as a result one was chosen in each of the six following bands: 3, 5, 7, 14, 19 and 22 Mc/s. For 3 Mc/s a two-wire vertical $\lambda/4$ aerial was rigged. For 5 and 7 Mc/s there are two sloping two-wire aerials $3\lambda/4$ each folded at the lower ends to suppress radiation from the bottom $\lambda/4$. Two $\lambda/2$ two-wire omni-directional dipoles are provided for the 14 and 19 Mc/s bands. The last are also used on 22 Mc/s. All five special aerials are on the mainmast and are connected by Pyrotenax feeders to the DS10 transmitter which is installed in a compartment on the port side of the superstructure.



The quarter-deck of H.M.S. *Vanguard* looking aft showing two of the whip receiving aerials.

Another compartment, simi-

H.M.S. "Vanguard"—

larly situated on the other side of the ship was selected as a control room for all the special radio facilities. For automatic telegraphy, standard G.P.O. type teleprinters (one for transmission, one for reception and one spare) are installed here, together with the necessary tape perforators and Creed relays, providing for either direct or re-perforated transmission and reception, the latter being a requirement for high-speed working.

The R.T. equipment fitted in the radio control room includes:—

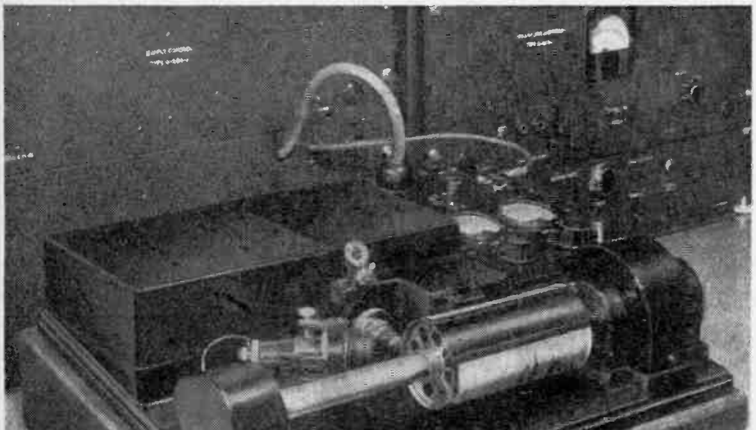
(*a*) A switchboard to connect the transmitter and receiver to the handsets in the Royal apartments and other selected positions in the ship. The latter include plug-in points forward and aft for the high-grade moving-coil microphones used for broadcast commentaries.

(*b*) Speech privacy equipment to prevent interception by casual eavesdroppers.

B.B.C. disc recording equipment is fitted on the benches to the left and in the background in this view of the ship's recording room. On the right-hand bench is a naval type recorder carried as a stand-by and one of the new Murphy naval receivers for monitoring purposes.

(*c*) Electronic Voice Operated Switching (EVOS)—a device for suppressing the transmitter carrier during reception, to provide interference-free duplex working.

(*d*) A Voice Operated Gain Adjusting Device (VOGAD) to give a constant "speech voltage" output for large variations in "speech voltage" input.



One of the two Muirhead picture transmitting units installed in the battleship. The system employs sub-carrier frequency modulation and the output from the equipment is fed into the ship's A.M. transmitter. To send a picture 8in by 5in it takes approximately 12 minutes.

The above mentioned switchboard is fitted at the technical operator's position and serves also to connect the automatic telegraphy and facsimile apparatus to the transmitter. The latter is a high-quality type recently developed by Muirhead & Co. who, at the Admiralty's request, lent and installed the first available model. It employs photo-electric scanning at the transmitter, the variations in light intensity modulating the frequency of an audio-frequency tone of constant amplitude, which tone is used to modulate the amplitude of the radio-frequency carrier wave. The drum on which the material to be transmitted is clipped rotates at a speed of one revolution per second and is traversed by the scanning spot-light to give 135 lines per inch. At the receiver the frequency-modulated tone modulates a beam of light projecting on to a photographic film. H.M.S. *Vanguard* is provided with facsimile transmitting equipment only. A second transmitter is installed as a stand-by, and it has been adapted to serve also as a monitor.

All communication receivers are of the new naval type manufactured by Murphy and described in last December's issue of *Wireless World*. Apart from the monitoring receivers in the transmitter room and the control room, all receivers are installed in the ship's receiving room sited in the forward superstructure just below the bridge. This separation from the transmitters (the ship's other transmitters are, like the DS10, installed aft) is necessary to avoid mutual interference. The aerials, both single wire and vertical whips, are rigged on and around the foremast. But since this provides a separation of only 100 feet (the masts are only this distance apart although the ship is 800 ft long) two whips have been fitted right aft on the quarter-deck and two right forward on the forecastle (clearly seen in our cover illustration) with matched feeders leading to the receiving room in order to provide the maximum possible freedom from interference from the ship's transmitters.

The B.B.C. has provided disc recording equipment which is installed in a recording room in the bridge structure which has the necessary connections to the control room and thence to the DS10 transmitter.

All the special equipment is duplicated to ensure continuous operation in case of breakdowns and when the gear is taken out of service for maintenance. The ship's normal naval high-power set is used as a standby for the DS10, switching arrangements being provided in the control room for connecting the A.T., R.T. and facsimile equipment to it if the need arises.

The automatic telegraphy service to and from the *Vanguard* is operated with existing naval shore stations in the U.K. and South Africa. Other special facilities are, however, being worked with G.P.O. stations in the U.K. and the Capetown terminal of Cable and Wireless (Overseas), Ltd. And in the U.K. the *Vanguard* circuit is connected from the G.P.O. Overseas Terminal in London as requisite by line to private subscribers' telephones,[2] to the B.B.C. or, in the case of facsimile, to Electra House, the headquarters of Cable and Wireless who are the operators of this system in the U.K. Daily schedules for working A.T., R.T. and facsimile in turn with both the U.K. and South African terminals are necessary since only one can be satisfactorily operated at a time from the ship. The ship's shakedown cruise in December provided an opportunity for extensive trials.

Apart from meeting the operational requirements for automatic telegraphy, long-range R.T. and facsimile for this particular cruise, invaluable experience will be gained towards the solution of the many problems involved in providing such facilities in other warships. It is believed to be the first occasion on which both facsimile and automatic telegraphy have been used in a British ship.

The installation of all this special equipment has been arranged by the Admiralty Signal Establishment who, in conjunction with Admiralty departments, were responsible for the overall scheme and the solution of the many novel problems involved. It is only fair to add that the G.P.O., the B.B.C., Cable and Wireless and the manufacturers of the equipment used, gave unstinted help throughout.

[Readers will have noted the quality of the B.B.C. transmissions from the *Vanguard* and also the high definition attained in the transmission of pictures as exemplified by the illustrations in the lay Press.—ED.]

[2] This service is *not* open to the public.

BOOK REVIEW

An Introduction to Transmission Lines. By C. J. Mitchell, A.M.I.E.E. Pp. 64, with 30 diagrams. George G. Harrap and Co., Ltd., 182, High Holborn, London, W.C.1. Price 3s 6d.

THIS book falls into two halves, each of three chapters, the first half elucidates the behaviour of variously terminated lines by supposing them to be connected to D.C. sources (continuous and pulsed); the second is devoted to A.C. performance, ending with impedance matching by means of stubs and quarter-wave sections.

Being, as the author declares, a simple approach to the subject, the treatment excludes the complication of line losses, and makes the minimum demands on the reader. In the D.C. half, only an elementary knowledge of the fundamental laws of inductance and capacitance, and the simplest algebra, are assumed. The formula for characteristic impedance is derived by considering the energy stored in L and C at various stages after connecting the source. By tracing the process a step at a time, with numerical examples, and not evading the matter of reflection, the author builds up a very clear and complete picture. Except for the formulæ for inductance and capacitance of twin-wire and coaxial lines, everything is derived from first principles. Incidentally, this section would be a very helpful preliminary to study of the line discharge pulse generator in radar.

Pleased with his steady and sure progress under this painstaking guidance, the reader may be a little disconcerted on entering the A.C. half to find the pace has quickened considerably, over a road surface that has not been quite so carefully smoothed and graded as before. The speed-up was perhaps inevitable in order to get everything into the allotted space; but the book as a whole is so good and so much needed that the reviewer hopes that for the second edition the author will take as much care in the A.C. half as in the D.C. to make the way comfortable for the less sure-footed students. For example, after following 17 diagrams all showing the start of the line on the left, one is apt to be caught by Fig. 20 where for no obvious reason it is on the right. And on the last two pages *y* is suddenly substituted for what was previously called *l*.

None the less, even in the A.C. half, using only elementary trigonometry, and leaving in and explaining every step, it is remarkable how the author has succeeded in deriving all the main results without ever falling back on "it can be shown." The book can be thoroughly recommended. M. G. S.

"RADIO VALVE VADE MECUM"

WE understand that the first supplement to the 1947 edition of this Belgian valve data book is now available and will be sent to subscribers in return for the coupon contained in the main book. The British agents, Ritchie Vincent and Telford, Ltd., 136a, Kenton Road, Harrow, Middlesex, inform us that they will be pleased to forward coupons; alternatively, subscribers applying to Antwerp direct are reminded that the postage to Belgium is 3d per ounce.

C

METAL LENSES FOR RADIO

Latest Aids to Narrower Beaming

By "CATHODE RAY"

DAY by day, radio gets more and more like it was in 1888. That was when Hertz revealed his experiments with centimetre waves, showing how like light they were in regard to mirrors, lenses, prisms and so forth. For decades all this was of historical and theoretical interest only. Now we are right back in this optical kind of radio; with improvements, of course. There are magnetrons to provide far more R.F. power than Hertz could get out of his sparks, and valves to amplify the received waves, so they can be put to practical use. But basically it is the same thing.

Most of the time between 1888 and to-day it appeared as if the only radio waves that were really useful were those that are enormously longer than light waves. The sizes of reflectors, lenses, etc., have to be in proportion to the waves they handle. So the fact that radio and light waves are identical, except for wavelength, was less obvious than it might have been; optical devices large enough for the radio waves in common use were too immense to construct.

Now that effective generators of very short waves have been produced, the optical paraphernalia are with us once more. Why? Well, except for broadcasting, it is extraordinarily wasteful to radiate and receive waves to and from all directions. For purposes such as radar and D.F. it is worse than wasteful; it is useless. Concentrating the radiation into a narrow beam is a much more effective and economical way of providing a strong signal than increasing the power of the transmitter. One practical example of the beam-forming device I am going to describe is equivalent to multiplying the power of an omni-directional transmitter by 12,000. And how much more cheaply! And think of how much less interference! The same step-up can be obtained again by using a similar device at the receiver, strengthening the incoming signal more than any U.H.F. amplifier could, and cutting out all but a negligible risk of interference.

For point-to-point communication, navigational aids, radar and D.F., then, beaming is indubitably the thing. The most popular means for doing it has hitherto been the parabolic reflector. That is true both of radio and light. In one case the radiator is an electric lamp and in the other it may be a dipole fed by a coaxial line or a horn fed by a wave-guide. The horn is itself directional, like a megaphone, and confers the advantage of directing practically all the radio energy into the parabolic mirror. The dipole is usually made somewhat directional by means of a parallel-rod reflector (as in the usual form of television aerial) but is not nearly so effective in this respect as the horn. This initial directiveness into the mirror corresponds to that rather high class of motor headlight that has a small reflector around the front of the bulb to make sure that all the light goes into the main reflector and is beamed.

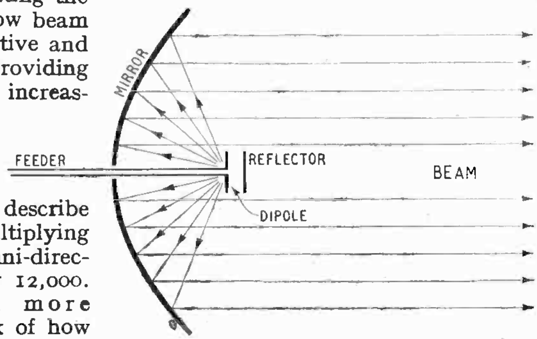


Fig. 1. Beam-forming action of a parabolic reflector for light or radio waves.

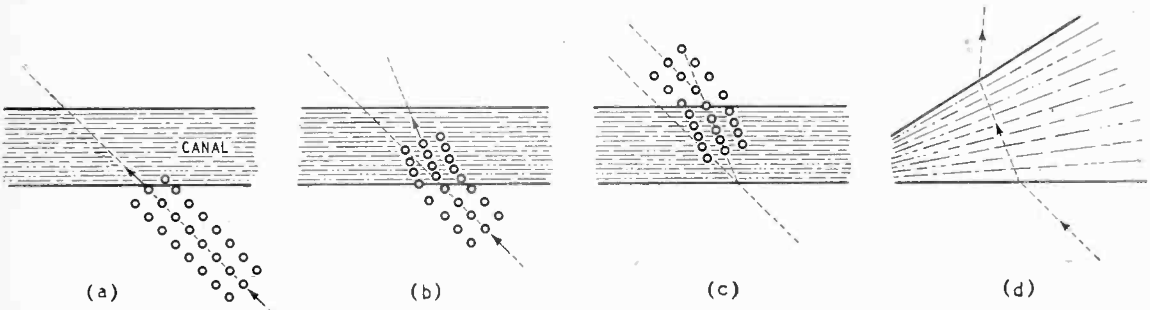
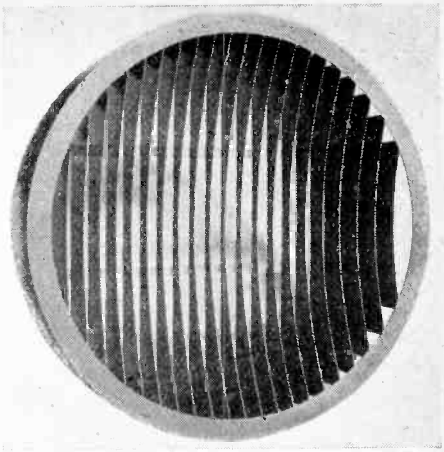


Fig. 2. When a column of troops enters a canal as shown (*a*), the right-hand front-rank man is slowed; and to preserve the front line the column has to bend inwards (*b*). This is refraction. On emerging on a parallel bank (*c*) it is refracted back into the original direction. But if the farther bank were as shown at *d*, the effort of keeping the front level would cause a second inclination to the right.

Incidentally, the commonly adopted device of a wave-guide horn playing into a parabolic reflector may seem rather an entertaining mixture of acoustical and optical analogy.

The principle on which the reflector beam-former works is, of course, that celebrated one: "the angle of reflection is equal to the angle of incidence." The only shape of reflector surface that can redirect all the rays diverging from a point source into a parallel beam is the paraboloid—the surface generated by a parabola revolving on its axis. An obvious defect of this system is that the radiator is in the way of the beam (Fig. 1). An advantage is the enormous range of wavelengths covered by a single size of reflector. So much so, in fact, that the same reflector will do for both radio and light. As long as the wavelength is less than about a quarter of the diameter of the mirror and greater than several times the diameter of the graininess of the surface, there is no need to worry. That is why a light mirror should be highly polished, whereas a radio mirror need not even have a continuous metal surface.



Courtesy Proc. I.R.E. and Bell Telephone Labs.

Plano-concave metal lens with an aperture of 14 wavelengths.

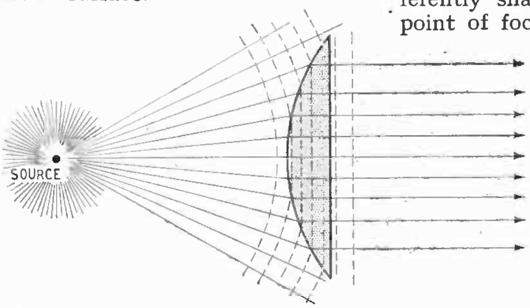


Fig. 3. Diverging rays of light reaching a suitably shaped lens are refracted into a parallel beam. Dotted lines indicate typical wave-fronts; the slower speed of the waves in the lens material is shown by the closer spacing.

The other main optical device is the lens. The working of a lens depends on refraction—caused by the fact that light (and radio) waves travel more slowly in the material of which the lens is composed. If a column of troops on the march, having got beyond earshot of the sergeant, were to find themselves entering a canal at an oblique angle, as in Fig. 2, the right-hand man at the head would enter the water first, and his pace would be retarded thereby. If the column continued in the same straight line, the right-hand side of it would drop behind, which would never do; so, preserving perfect discipline, the column would swing slightly to the right to keep its front rank level. Emerging on the farther bank of the canal, assumed parallel to the first, the column would have to swing back to its original direction to allow for the left-hand man remaining later in the water. But if the canal were wedge-shaped, so that the right-hand man would emerge last, the column would have to swing rightwards a second time. It would be permanently bent.

Rays of light or radio approaching a lens along the axis strike it at right angles, and emerge likewise, so are not refracted at all. Other rays are bent back towards the axis; and if the lens is suitably shaped they emerge parallel (Fig. 3), or, with a differently shaped lens, meet at a point of focus. Another way of looking at it is that the axial ray has the shortest journey to the focus, so is retarded by the maximum thickness of solid matter; the longest rays have least to traverse. By this equalization policy it is possible to bring them all into step along a straight front.

Radio waves are retarded by having to pass through dielectrics. Hertz used more than half a ton of pitch to demonstrate refraction. Dielectric lenses for radio are rather clumsy; but in 1941 the Admiralty Signal Establishment and Marconi's[1] experimented with a new type of lens which seems a more practical job, besides being very interesting theoretically. It depends on speeding the waves up instead of slowing them down, so the middle of the lens is the thinnest. Compare Fig. 4 with Fig. 3.

As you probably know, the basic fact of the universe nowadays is that nothing can travel faster than light (or radio) in space, so how the Einstein *can* one speed up radio waves that are already doing maximum knots? This is the question that is asked by sceptical students of waveguide theory when they encounter the formula for phase velocity:

$$V_p = V_0\,[1-(\lambda/2a)^2]^{-1/2}$$

in which V_0 is the velocity in space, λ is the wavelength, and a is the distance between the walls of the guide. Whatever the sizes of λ and a, the phase velocity V_p is either imaginary or greater than V_0 ("which is impossible," mutters the zealous but raw follower of Einstein).

[1] N. M. Rust, *Journal I.E.E.*, Part III A, No. 1 (1946), p. 50.

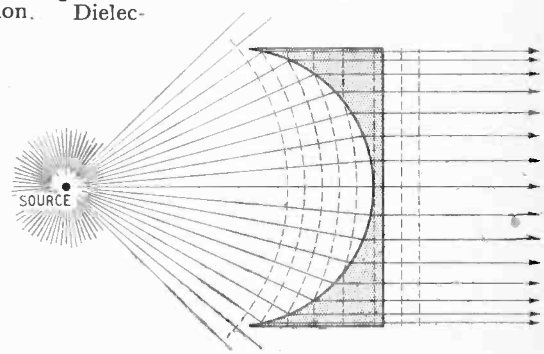


Fig. 4. Section of a metal lens. The increased speed in the lens shows as an increased spacing of wave-fronts.

Metal Lenses for Radio—

Neither is it possible for sea waves to travel at 100 miles an hour; yet if a wave-front strikes a sea wall almost but not quite parallel to it (Fig. 5), the splash

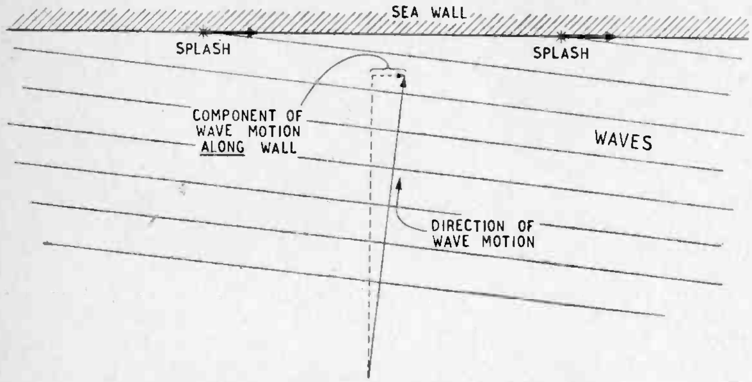
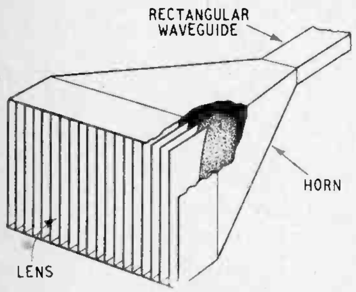


Fig. 5. The more nearly parallel a sea wall is to approaching waves, the faster the splash along the wall, and the slower the waves themselves move in that direction. These two speeds correspond respectively to phase and group velocities in radio wave guides. When the sea wall is exactly parallel (or the wave guide is exactly $\lambda/2$ wide) the splash (and phase) velocity is infinite and the wave (and group) velocity along the wall is zero.

travels along the wall far faster than the waves themselves. There is, in fact, no limit to the speed of the splash, because it is not a material thing like a bullet, or energy like an air or radio wave; it is just a phase—a relative arrangement of events in time.

In a similar way, radio waves passing between two conducting walls set up a wavelike pattern along their path. The waves themselves are actually slowed by the walls on each side, but the pattern moves faster, just like the splash on the sea wall. And just as the splash of one wave at a point on the wall can be made (by adjusting the angle of the wall) to



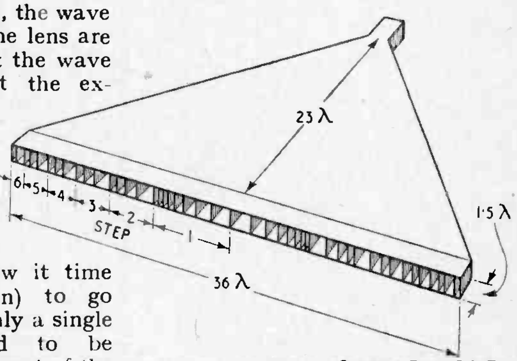
Courtesy Proc. I.R.E.

Fig. 6. Combination of metal lens and horn feed.

synchronize at any distance—say 300 yards away—with the splash due to the next wave (only perhaps 10 yards behind the first), so the length of width of a waveguide can be adjusted so that radio waves at two widely different points are in phase.

So, referring to Fig. 4, the wave fronts emerging from the lens are in phase as shown, but the wave *energy* coming out at the extremities of the lens did not start from the source at the same time as that coming out of the centre; it was actually radiated a few wavelengths ahead, to allow it time (according to Einstein) to go "the long way." If only a single wave were imagined to be radiated, it would come out of the middle of the lens first, and progressively later towards the circumference, so the focusing idea would break down completely. But in practice it is all right, because one generates a continuous stream of waves, all alike, or changing only very slowly due to modulation; and the waves are not called on to show their birth certificates, correct to the nearest microsecond, so one is as good as another.

To pass from these philosophical musings to the constructional details of metal lenses, the waveguide formula given above shows that if the sides are closer together than half a wavelength the phase velocity is imaginary. In practical terms that means that the waves are so rapidly attenuated that quite a short length of guide acts as a screen. (We all know that a piece of chicken netting, even, screens waves that are much longer than the mesh diameter.) When the sides are very slightly more than half a wavelength apart, the energy flow is very slow and the phase velocity is much greater than the speed of light. So quite a short length of guide gives a considerable phase advance. But the advance is very critical with wavelength, and there is also excessive reflection at the guide mouth. As the guide is widened, the effect becomes less and less, until when infinitely wide it — obviously! — has no effect at all. The greater the width the greater the length required; and it is inconvenient to go too far in that direction. A suitable compromise between length of guide needed and sensitivity to wavelength is a velocity step-up of about 65 per cent,

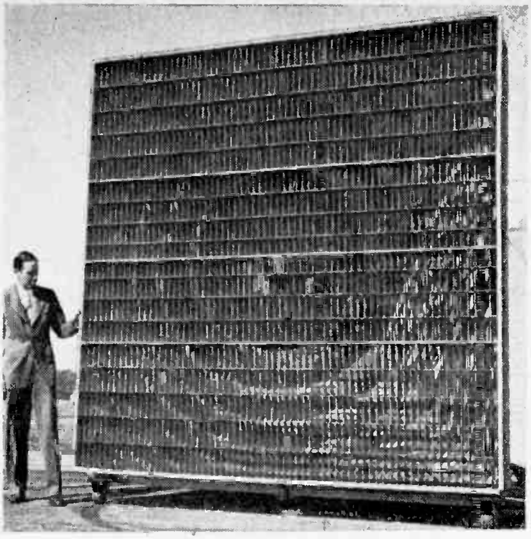


Courtesy Proc. I.R.E.

Fig. 7. Sectoral horn with wave guide lens for radiating fan-shaped beam.

given by a guide width of about 0.6λ.

This width, by the way, is at right angles to the electric field. The other dimension, parallel to the electric field, is not very important, but ought to be large compared with the width. The length, which is the thickness of the lens, controls the phase advance and hence the beaming effect. So the lens consists of a number of parallel slats, vertical for vertically polarized waves, cut out into shapes like Fig. 4. A very clean design results when the lens is fed by a wave guide horn having a mouth large enough to



Courtesy Proc. I.R.E. and Bell Telephone Labs.
Lens aerial system for a 4,000-Mc/s repeater station.

enclose the lens, shown in Fig. 6.

For some purposes, notably marine radar, a fan-shaped beam is wanted, and can be obtained by a horn and lens shaped as in Fig. 7. It looks as if in the near future one will have difficulty in distinguishing beam radio sets from vacuum cleaners; both will have a range of similarly shaped interchangeable nozzles.

As with other aerial systems, the beam is made narrower by making the "aperture" larger. A lens aerial designed at the Bell Telephone Laboratories (where this type of aerial has been extensively developed[1]), 48 by 480 wavelengths in area, gives a radio beam claimed to be the sharpest ever produced—only one-tenth of a degree wide.

There is no point in having more than one whole wavelength phase-advance in the lens—it requires more material and is liable to reduce accuracy of beaming. So the superfluous thicknesses are cut away, giving a stepped construction (Fig. 8). In a complete lens, these steps are concentric, and the whole thing reminds one of the prismatic glass lenses used in lighthouses.

Since a given phase advance can be obtained either by controlling the distance over which a given speed-up is effective; or alternatively by controlling the rate of speed-up over a given distance, an alternative to the variable-thickness lens in a variable-spacing lens of constant thickness. Or both can be varied, with the object of matching the impedance of the source.

Still another alternative is to replace the solid metal slats by an array of parallel wires. The slat construction is convenient enough for centimetre waves, but would offer rather extensive wind resistance and weight if made in metre-wave sizes. A wire curtain would be more practicable, adapting methods of construction that have been used for short-wave aerial arrays for years.

To sum up the advantages of the metal lens type of aerial: It is a sound mechanical job, and has been proved to be not too

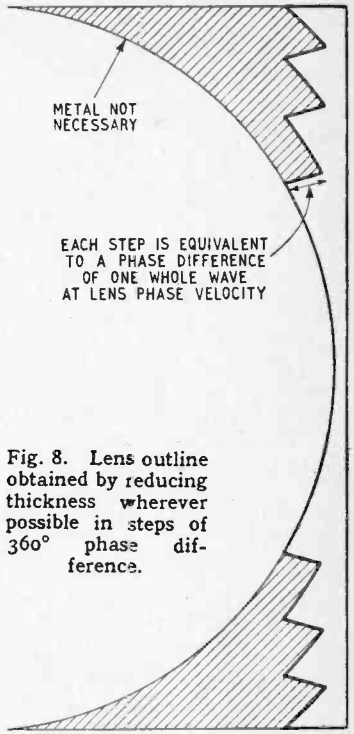


Fig. 8. Lens outline obtained by reducing thickness wherever possible in steps of 360° phase difference.

[1] W. E. Kock, *Proc. I.R.E.*, 34 (Nov. 1946), pp. 828-836.

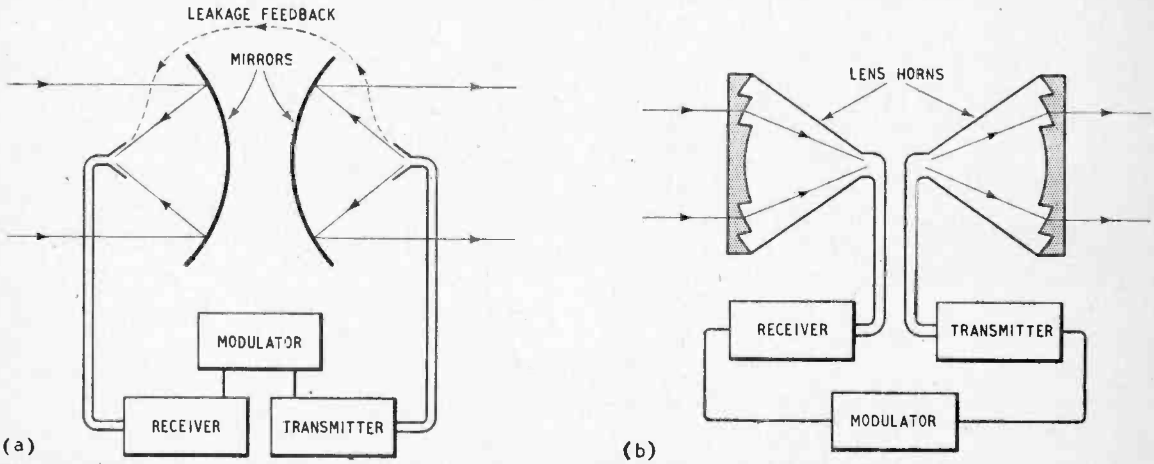


Fig. 9. Using reflector systems at a microwave repeater station, there is a likelihood that some of the transmitter output will feed back to the receiver on the same wavelength (*a*). This risk is far less with lenses (*b*).

Metal Lenses for Radio—

sensitive to tolerances in manufacture and deformations due to wind, etc.; it can be made for any wavelengths from 5 metres downwards; it can easily be designed to produce almost any desired shape of beam; it fits in well with feed systems, which do not get in the way of the beam; and when used for repeater stations—likely to be very important in the future for extending the limited range of micro-waves—they not only give the desired narrow point-to-point beam, but, as shown in Fig. 9, avoid the feed-back difficulty that occurs with reflectors.

Against this there is one possible drawback as compared with reflectors. We have already noted that a reflector treats all wavelengths so much alike that the same one could be used for, say, 10-cm radio and 0.00004-cm light. Metal lenses, on the other hand, have to be tailored to suit the working wavelength, and a comparatively slight variation either way causes the waves to be refracted too much or too little, causing the beam to be diffused. It is easy to see that this effect is worse the thicker the lens—another advantage of the stepped construction, which cuts out unnecessary thickness. Incidentally, the same is true of solid lenses; with the simple types, light of different wavelength (i.e., colour) focuses at slightly different distances, so a multi-coloured image is never properly in focus. This is called chromatic aberration, and lenses corrected for it are acromatic. But to get back to our radio: in practice it is not difficult to preserve even a fairly sharp beam over a bandwith of ±10 per cent, which is generally more than enough for television. So the disadvantage does not amount to much.

SHORT-WAVE CONDITIONS

Expectations for March

By T. W. BENNINGTON

(Engineering Division, B.B.C.)

DURING January maximum usable frequencies for this latitude decreased a little by daytime and increased by a small amount during the night, as compared with those of the previous month. The small daytime decrease occurred mainly during the first two weeks of the month—during the last two weeks the daytime M.U.F. was beginning to increase again from the mid-winter low value. On most days, however, conditions were such that communication to most parts of the world was possible on the higher frequencies for good periods, whilst at night 7 Mc/s was the lowest frequency usually really necessary.

Short-wave conditions were not unduly disturbed during the month, though one ionosphere storm of severe intensity did take place—during the period 25th-27th. Disturbances of minor intensity occurred on 3rd-4th, 5th-7th, 9th, 16th-17th and 31st.

Forecast.—It is expected that during March there will be an appreciable increase in the daytime M.U.F.s and a considerable increase in the night-time M.U.F.s, as compared with those for February, the seasonal and sunspot cycle effects taken together tending to produce this result. Due to the lengthening hours of daylight in the Northern Hemisphere daytime frequencies will remain operative for considerably longer periods than during February. Communication on very high frequencies should therefore be good for considerable periods on undisturbed days, and frequencies as high as 15 Mc/s should remain regularly usable on certain circuits until well after midnight. Frequencies lower than 11 Mc/s should not be really necessary at any time during the night over many circuits, though on those that traverse high latitudes frequencies of the order of 9 Mc/s will be required for limited periods.

March is a month during which a considerable amount of ionosphere storminess usually occurs, so we must anticipate that short-wave communication will sometimes be interrupted. At the time of writing it would appear that ionosphere storms are more likely to occur during the periods 1st-3rd, 11th-12th, 20th-22nd and 26th-30th, than on the other days of the month.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during March for four long-distance circuits running in different directions from this country. In addition a figure i brackets is given for the use of those whose primary interest is th exploitation of certain frequency bands, and this indicates the high st frequency likely to be usable for bout 25 per cent of the time duri the month for communication by way of the regular layers:—

Montreal:	0000	11 Mc/s		(17 Mc/s)
	0400	9 ,,		(15 ,,)
	0800	11 ,,		(17 ,,)
	1000	17 ,,		(23 ,,)
	1100	21 ,,		(29 ,,)
	1300	26 ,,		(36 ,,)
	1900	21 ,,		(30 ,,)
	2100	17 ,,		(25 ,,)
	2200	15 ,,		(21 ,,
Buenos Aires:	0000	15 Mc/s		(21 Mc/s)
	0200	11 ,,		(16 ,,)
	0800	17 ,,		(23 ,,)
	0900	21 ,,		(29 ,,)
	1000	26 ,,		(42 ,,)
	2000	21 ,,		(30 ,,)
	2100	17 ,,		(24 ,,)
	2300	15 ,,		(22 ,,
Cape Town:	0000	15 Mc/s		(21 Mc/s)
	0200	11 ,,		(18 ,,)
	0500	15 ,,		(22 ,,)
	0600	21 ,,		(30 ,,)
	0700	26 ,,		(42 ,,)
	1900	21 ,,		(32 ,,)
	2000	17 ,,		(25 ,,)
	2200	15 ,,		(22 ,,)
Chungking:	0000	9 Mc/s		(15 Mc/s)
	0300	11 ,,		(17 ,,)
	0500	17 ,,	or [illegible] Mc/s	(24 ,,)
	0800	26 ,,		(34 ,,)
	1300	21 ,,	or [illegible]7 Mc/s	(24 ,,)
	1600	15 ,,		(20 ,,)
	1800	11 ,,		(17 ,,)
	2200	9 ,,		(15 ,,)

NEW MAGNETIC ECORDER

A RECORDING ma hine using paper tape painted with "Hyflux," a finely divid d metallic powder of high coercivi , has been developed by The India Steel Products Co., 6, No. Michi n Avenue, Chicago, Ill., U.S.A., nd is described in the Jan., 19 7, issue of *Tele-Tech*.

The paper used is ¼i wide and 0.002in thick and wil withstand breaking stresses up t 6lb. It is stated that the dimensio al stability is better than existing p stic tapes. A high signal-to-nois ratio is claimed on the basis the high coercive force of th magnetic material which has p perties in bulk similar to those of Alnico III. A specially designed rec rding head has been developed fo use with this tape and it canno be used in existing tape recorders.

A compact machine which has been developed is fitte in a flat drawer which can be sed as a pedestal for a table mo l radio receiver. Half-an-hour's p ying time is given by a standard 7 nch 8-mm film reel of the tape at a ape speed of 8in per second, giv ng a frequency response up to oo c/s.

Stuck for a 12A7? —then *BRIMARIZE!

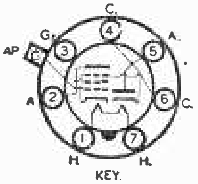
12A7

Any of the valve types listed below together with a metal rectifier makes a good substitution for the 12A7.

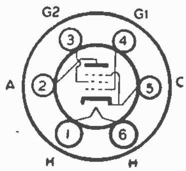
TYPE 18 *One of the U.X. types which can often be obtained. Its characteristics at low voltages are identical with those of the 12A7 pentode section. The rectifier section is conveniently replaced by a small SenTerCel selenium rectifier which is easily fixed to chassis or cabinet.*

TYPE 43 *Another U.X. type which is still being made and whose characteristics, if self bias is employed, are similar to those of the 18. It is advisable to make a small adjustment to the line cord when using type 43.*

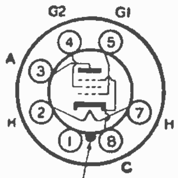
TYPE 25A6G *The International Octal version of the 43, but more readily available at the moment.*



TYPE 12A7



TYPE 18 & 43



TYPE / 25A6G
LOCATING KEY

TYPE	Change Socket From	Change Socket To	Change Connections From Old Socket	Change Connections To New Socket	Other Work Necessary	Rectifier
18	U X 7 pin	U X 6 pin	Pin No. 1 „ „ 2 „ „ 3 „ „ 4 „ „ 5 „ „ 6 „ „ 7 Top Cap	Pin No. 1 „ „ 2 „ „ 3 Rect. + ve Rect. — ve Pin No. 5 „ „ 6 „ „ 4	NIL	SenTerCel miniature Selenium Rectifier Type H18/12/1/B2 (2¼" x ¾" overall) may be fitted to chassis or cabinet in all three cases.
43	U X 7 pin	U X 6 pin	AS ABOVE		Reduce line cord by 40 ohms SEE NOTE	Supplies are obtainable from :—
25A6G	U X 7 pin	Int. Octal	Pin No. 1 „ „ 2 „ „ 3 „ „ 4 „ „ 5 „ „ 6 „ „ 7 Top Cap	Pin No. 2 „ „ 3 „ „ 4 Rect. + ve Rect. — ve Pin No. 8 „ „ 7 „ „ 5	Reduce line cord by 40 ohms SEE NOTE	S. T. & C. Ltd. Rectifier Division, Oakleigh Rd., New Southgate, N. 11. PRICE 7/10 List.

NOTE—When fixed Bias is used in the receiver it is necessary to insert a 33,000 ohm ½ watt resistor in series with the lead to the screen grid (Pin 3 of type 43 or Pin 4 of type 25A6G) together with a 2 mfd 150 V.W. condenser from screen grid to chassis.

BRIMAR
• RADIO VALVES

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

THE NEXT OF THE SERIES WILL DEAL WITH TYPE 25A7G

← PUNCH HOLES HERE →

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

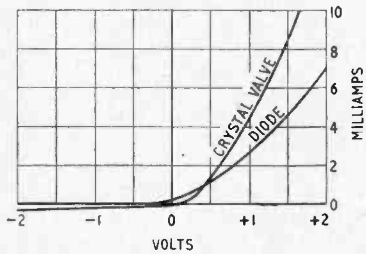
1

CRYSTAL VALVES

Modern Crystal Detectors of High Mechanical and Electrical Stability

FOR the detection of signals on centimetre wavelengths the crystal rectifier is still unrivalled. It was introduced in the earlier stages of development of centimetric radar as an expedient, pending the possible substitution at a later date of special diode valves, but so far no rival has appeared.

The transit time of electrons from cathode to anode in a diode limits its efficiency at high frequencies. To be effective on a wavelength of 10 cm the anode-cathode path would have to be of the order of 0.1 mm, at which spacing the capacitance would offer an impedance of only a few ohms and it would be impossible to develop a sufficient voltage from a resonant circuit. The crystal detector, on the other hand, has an electron path through the barrier layer of the order of 0.0001 mm and a capacitance of only 0.1 $\mu\mu$F.



Comparison of crystal valve and diode characteristics.

Compared with a diode, the ratio of slopes for positive and negative voltages is greater for a crystal, and when used as a mixer with a superimposed local oscillator voltage adjusted to operate on the linear portions of the rectifier characteristic the loss of signal power in frequency conversion is less than 10 db.

The principal disadvantage of a crystal rectifier has, hitherto, been its instability under mechanical or electrical shock. This has been overcome in the crystal valve capsules used in radar receivers[1] and some interesting details of the method of manufacture are given in a recent paper.[2]

Tests of a wide variety of contacts soon established the superiority of silicon-tungsten for use in radar receivers. Impurities present in commercial silicon were found to have a profound influence on performance and it was necessary first to prepare pure silicon powder by chemical treatment. The melting of this powder in vacuo to form ingots presented difficulties owing to the affinity of silicon for oxygen in the usual refractory materials. Best results were obtained with beryllia crucibles as it was found that a trace of beryllium, and also about 0.25 per cent aluminium conferred greater resistance to electrical burn-out. It is thought that these elements, which have a greater free energy of oxide formation, tend to form preferred oxide layers when the silicon surface temperature is raised in an oxidizing atmosphere.

The silicon ingot, with controlled additions of aluminium and beryllium is cut into slices which are ground and polished. The heterogeneous surface layer is dissolved with hydrofluoric acid and a new layer produced by oxidation at 1,000° C for half an hour. This is too thick and would have a high resistance, so it is again etched with hydrofluoric acid until the required characteristics are obtained.

In the early stages of development the crystal was adjusted after assembly by a "tapping" process. A complete theory to account for the improvement resulting from controlled mechanical shock has not so far been evolved, but it is thought that relative movement at the very small contact area generates high local temperatures which remove surface irregularities and build up progressively a new oxide barrier layer. Evidence in support of this view is provided by experiments made by the G.E.C. with etched crystals and hardened whiskers with very sharp tungsten carbide tips. Relatively light contact pressures destroyed the rectifying properties of the contact, suggesting that the point was driven through the barrier layer into the silicon. "Tapping" gradually reformed a barrier layer and restored the non-linear characteristic.

Later experience showed that silicon reduced from silicon-aluminium alloy to form a coarse grain instead of powder resulted in less oxidation of silicon in melting; also that an unpolished surface, lightly etched gave a uniformly sensitive contact area. The use of molybdenum-tungsten alloy for the whisker gave a higher back/front resistance ratio than tungsten. The addition of boron of the order of 0.002 per cent reduces the resistivity of the crystal from 5 to 0.05 ohm/cm^3 but destroys its resistance to burn-out.

Although designed primarily as a mixer for use with a local oscillator in a superheterodyne circuit, the crystal has applications as a straight detector in wide-band receivers on centimetre waves, and also as an indicator in wavemeters, standing-wave detectors, monitoring and other auxiliary apparatus.

[1] *Wireless World*, May, 1946, p.150.
[2] "Crystal Valves," by B. Bleaney, J. W. Ryde and T. H. Kinman, *J.I.E.E.* Vol. 93, Part IIIA, No. 5.

"TELEVISION RECEIVING EQUIPMENT"

TELEVISION SYNCHRONIZING

A Survey of Some of the Problems

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

FOR the attainment of a high standard of reproduction in television it is not sufficient merely to ensure a satisfactory response from the receiver proper and to obtain adequate linearity of output from the saw-tooth oscillators. It is also necessary very accurately to synchronize those oscillators with the signal waveform.

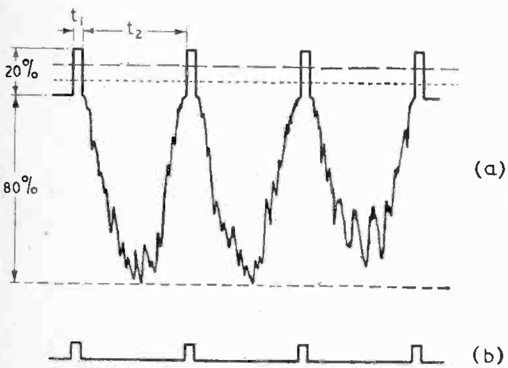


Fig. 1. The signal waveform as applied to the cathode of the C.R. tube is shown at (*a*) with the "slicing" levels indicated by broken horizontal lines. The separated waveform appears at (*b*).

Quite a high degree of precision of timing is needed in the starting of successive scanning lines if the full picture definition is to be secured. Imperfect synchronization is not often cited as a cause of poor definition and one is inclined to think of its results in terms only of its more obvious manifestations, such as, tearing and pulling on whites. However, when one thinks about the matter it is clear that quite small horizontal variations of line position will cause a raggedness of outline which will reduce the definition appreciably. It is even more obvious that if successive pictures are not almost exactly superimposed, in either the horizontal or vertical directions, there is likely to be a noticeable blurring of the image.

In an area of high field strength the requirements for good synchronizing are not unduly difficult to meet but even then they demand much more care and attention than they are often given. When the field strength of the signal is low the problem is much more difficult, chiefly because noise voltages on the edges of the sync pulses affect the timing of the oscillators. Very careful design of the sync circuits is then needed for the best results and perfection, by the nature of the problem, is hardly to be attained.

To clarify ideas on the subject, it will be examined in some detail and the particular case of the V.F. signal being fed directly to the cathode of the C.R. tube will be considered. This is a method which is becoming increasingly adopted because of its convenience.

The signal voltage existing at the cathode of the tube has the form sketched in Fig. 1 (*a*); the signals of three typical lines are shown but no frame pulses. The picture signal is negative-going with an amplitude range of 80 per cent of the total and the sync pulses are positive-going with an amplitude range of 20 per cent. In the transmission the figures are 70 per cent and 30 per cent, but they become altered in the receiver because of non-linearity in the detector and V.F. stage. The figures given are of the right order of magnitude for a typical practical case. The actual total signal amplitude is about 30 volts peak-to-peak, so that the sync pulse amplitude is some 6 volts p-p.

The first essential is to remove as completely as possible all trace of the picture signal. This can be done in the ideal case by a limiter which cuts off all signals applied to it which are more negative than a certain figure, say, −4 volts. The effect of this is to remove everything below the dotted line in Fig. 1 (*a*) and to make its output waveform like (*b*).

Here any phase reversal in the limiter has been ignored and the output pulses are shown as occurring regularly. All pulses are also identical in shape and have vertical sides. This is the ideal case not found in practice.

There are two factors which make it desirable to adopt a double limiter, one like the one just described, and another set to be irresponsive to signals more positive than, say, −2 volt. This has the effect of cutting off everything more positive than the dash line in Fig. 1 (*a*). It so prevents any irregularities in the heights of the pulses from appearing in the output, which is still of the form (*b*) but reduced in amplitude. Because such a double limiter virtually selects a horizontal slice through the waveform of Fig. 1 (*a*) it is frequently, and

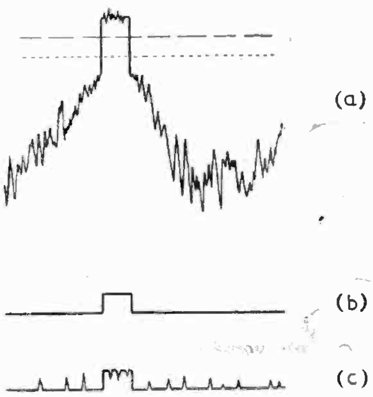


Fig. 2. The signal waveform with a moderate amount of noise superimposed is shown at (*a*) together with the slicing levels. A clean output pulse (*b*) is obtained, but when the noise is severe there is some break through (*c*).

very conveniently, termed a slicer.

The first need of a slicer arises because it is rarely possible to use direct coupling between the sync separator and the V.F. circuits. The coupling nearly always removes the D.C. component of the signal and D.C. restoration is needed. This is never quite perfect and as a result the tops of the pulses in Fig. 1 (*a*) are not all exactly at the same level, but

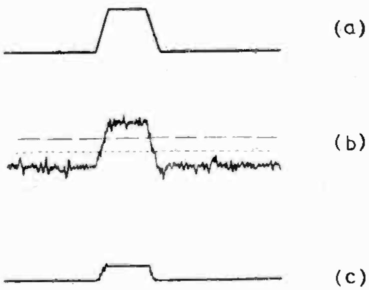


Fig. 3. A pulse with sloping sides is indicated at (*a*) and with superimposed noise at (*b*). The noise on the sloping edges passes the slicer and appears as at (*c*).

vary a little according to the picture content. The slicer removes this variation and provides output pulses all of the same amplitude.

The second need is much more important. When noise is present it is superimposed on the signal waveform, much as shown in Fig. 2 (*a*). Provided that the noise amplitude is not too great it does not break into the slicer levels and its output is consequently free from noise and as clean as if the signal itself were perfect. This is indicated at (*b*). However, if the noise level is too great, it may break into the slicing levels and the output is then imperfect and of the form shown at (*c*).

Even under less severe conditions than this the slicer does not completely remove the effects of noise because the sides of the pulses are not quite vertical. The voltage changes corresponding to the sides take a finite time to pass through the slicing range and noise occurring during these times is passed.

A single sync pulse is shown in Fig. 3 with sloping sides, and for clarity the slope is greatly exaggerated. The same pulse with a small amount of noise added appears in (*b*) and at (*c*) the output of the slicer operating between the lines shown in (*b*).

When the pulse sides are sloping, a variation of the input pulse amplitude affects the timing of the output pulses if the slicing levels are fixed. Fig. 4 (*a*) shows pulses of small (1) and large (2) amplitude and in (*b*) is given the slicer output. A large amplitude pulse (2) clearly cuts through the slicing levels earlier at the start, and later at the end, and so provides an output pulse of longer duration. In television this is not in itself important in most cases, for the time-bases are usually fired by the leading edges of the pulses. The fact that a large amplitude pulse sweeps through the slicing range earlier than one of small amplitude, however, does mean that there will be a variation of relative timing of scanning lines when the sync pulse amplitude changes.

In practice, this effect is not of major importance in the main sync separator of a television receiver, for it is not usual for the sync pulse amplitude to change to

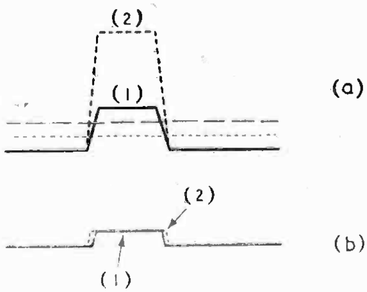


Fig. 4. With pulses having sloping edges, the effective output pulse duration and timing is dependent on its input amplitude. The input pulses are shown exaggerated at (*a*) and a large amplitude can be seen to cross the slicing levels earlier and later than a small one. The output pulses are thus of the form (*b*).

any great extent. Slow changes which might occur on a fading signal are unimportant.

From all this two facts emerge. The sync separator should be of the "slicing" type rather than a simple limiter and the leading edges of the sync pulses should be

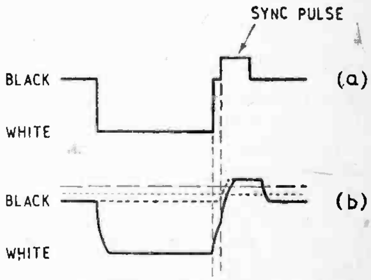


Fig. 5. The waveform (*a*) depicts the end of a line having a white object on the extreme right of the picture. An excessive time constant prior to the sync separator distorts the waveform to (*b*) and causes a displacement of the separated pulse.

kept as sharp as possible, at least until after the slicer. They have the sharpest edges at the input to the C.R. tube, for here the waveform is preserved as far as possible in the interests of picture quality. Practically speaking one cannot do better than to feed the slicer from this point also.

Of course, the waveform would be still better at an earlier point, such as the detector, but its amplitude would be lower and it is necessary to have sufficient amplitude for operating the slicer. What this is depends on the characteristics of the slicer, but in general the larger its input the better.

Pulling on Whites

It may be as well at this stage to point out that the preservation of the sharp edges of the pulses is also very important for another reason. It is necessary to avoid the very obvious defect of pulling on whites. This is a displacement of the scanning lines following a white object on the extreme right-hand side of the picture.

The waveform of one scanning line having a white object immediately prior to the end of the line is shown in Fig. 5 (*a*). Following this there is a small interval—0.5 μsec—at black level before the sync pulse. This is a guard interval in the transmission and is always present between the

Television Synchronizing

picture content and the sync pulse.

Now if the response of the circuits before the sync separator is inadequate the change from the white to black levels cannot be completed in the 0.5-μsec guard interval and the waveform on a white line is of the nature indicated by the solid line in Fig. 5 (*b*). When the sync pulse occurs, the signal has not reached black level. However, this does not happen on a black line, for the signal is at black level at the start of the pulse.

The slicing range is indicated in Fig. 5 (*b*) by the two horizontal dash lines, and it will be clear that the effect of the inadequate response is to introduce a delay in the leading edge of the separated sync pulse which depends on the picture content immediately prior to the guard interval. Relative to the pulse time for black, the delay increases as the signal becomes whiter.

The effect of this is to cause the line time-base to trip later after a white line than after a black. That scanning line is consequently longer. As a result of this, there is often, but not always, depending on the characteristics of the scanning oscillator, a shift of the following line to the right. If the scanning oscillator is such that it can discharge a fixed amount only in the flyback period, then the delayed pulse results in the next line starting a bit to the right. However, if the oscillator always discharges to the same level this effect is absent.

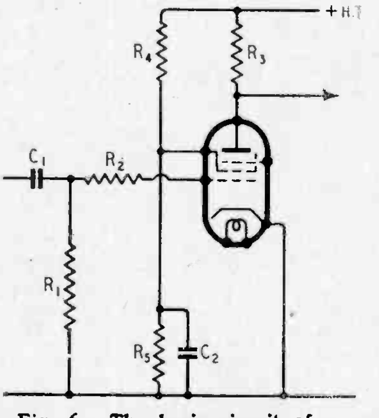


Fig. 6. The basic circuit of a sync separator which can function as a slicer, but is often better as a simple limiter.

In practice, the performance lies between these extremes in most cases, and there is some shift of the following line. When the picture contains a series of black and white squares arranged vertically on the extreme right-hand side, as in one of the B.B.C. test patterns, the effect shows up as a displacement of the lines to the right opposite the white squares. Because the lines are so displaced any vertical line in any part of the picture has a similarly stepped edge.

It is, however, to be noted that even when the amount of pulling on whites seems intolerable on the test pattern, it is often unnoticeable on an ordinary picture. The reason is that the average picture does not contain black and white objects on the extreme right. Where it does, of course, the pulling occurs.

If the grid of the valve used for sync separation is fed from the V.F. stage with the same signal as the cathode-ray tube, its input waveform will be as good as that supplied to the tube, and there is no fear of pulling on whites. This connection is usually the most satisfactory, and the basic circuit of a limiter is shown in Fig. 6. The signal waveform of Fig. 1 (*a*) is applied to the grid of the valve through C_1. For the moment, assume that R_2 is zero. D.C. restoration is effected in the grid circuit, since the tips of the sync pulses drive the valve into grid current. This charges C_1, and the charge leaks away through R_1 in the intervals between pulses. The equilibrium condition is such that the loss of charge during the interval is very small, and the valve is only just driven into grid current on the sync pulses.

As the grid current cut-off is around −1.3 volt for most modern valves, we can say that the "zero" level of the signal (that is, the grid-cathode voltage corresponding to the tops of the sync pulses) is about −1 volt. The signal thus always drives the grid negatively from this point.

Now the signal level is of the order of 30 volts p-p of which the first 6 volts is sync pulse. It is clear that if a short grid-base valve is used it will soon be driven beyond anode current cut-off, and this is how the main limiting action, represented by the dotted line of Fig. 1 (*a*), is obtained. To separate the sync pulses completely from the vision signal it is necessary for cut-off to be reached for a grid potential less negative than black level in the signal. This occurs for a signal of 6 volts negative from the zero level. A factor of safety of at least 1 volt should be allowed, which makes the cut-off point −5 volts from the zero level.

However, the full signal level may not always be wanted on the C.R. tube, and to allow for this and for some fading in the signal, the limiter should be designed for operation with a minimum signal of certainly not more than one-half the normal. This means only 3 volts amplitude of sync pulse on the limiter, and, with the 1-volt factor of safety, cut-off must occur at −2 volts from zero level. Since zero level is −1 volt grid-cathode potential, cut-off must be at −3 volts.

This is achieved by choosing a suitable screen voltage for the valve. In practice, this means selecting the values of R_4 and R_5 so that cut-off occurs at the right place. As valves vary considerably in their characteristics in the region of the cut-off point, as resistance values usually have only a 20-per cent tolerance, and as the H.T. supply voltage will vary somewhat from one set to another, it will often be necessary to make R_4 or R_5 adjustable in order to be sure of obtaining the right limiting level.

This is because the conditions are rather tight. With fixed values the cut-off point might easily vary by ±1 volt or even more, and we have only allowed 1 volt safety factor. Matters would be very different if the input signal were larger; thus if the minimum signal of sync pulse were 20 volts instead of 3 volts we could set the cut-off point at −10 volts, and no likely variation of limiter characteristics would affect the operation. All that would happen would be that the output amplitude would change somewhat.

So far nothing has been said

about obtaining the double-limiting or slicing action. This can be done by including R_2, and the higher the value given to this resistance the better, so far as limiting is concerned. What happens is that this resistance and the grid-cathode resistance of the valve, when it is driven into grid current,

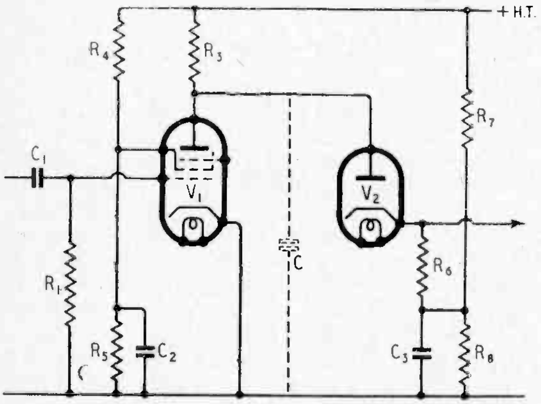


Fig. 7. The addition of a diode to the circuit of Fig. 6 turns it into a slicer or double limiter of great effectiveness.

form a voltage divider across R_1, and only the fraction of the full voltage developed across the grid-cathode resistance is actually effective in operating the valve.

However, a high value for R_2 cannot be used for two reasons. In the first place, it reduces the efficiency of the D.C. restoration, and in the second, in conjunction with the grid-cathode capacitance of the valve, it reduces the steepness of the edges of the pulses. From the second point of view, a value of 10kΩ is probably the maximum desirable, but this would give but a poor limiting action. For good limiting R_2 should be 0.5 MΩ or more, but this distorts the pulse far too much. A compromise value around 50 kΩ is often used and is reasonably satisfactory. One advantage of using R_2 is that it does tend to relieve the V.F. stage of the input capacitance of the limiter and so improves matters at this point.

When double limiting is necessary, however, it is often better achieved by adding a diode in the anode circuit. When this is done R_2 may be omitted entirely or can be retained to help the diode by giving some further limiting action.

One way of connecting a diode is shown in Fig. 7. The circuit of the main sync separator is identical with that of Fig. 6, but the diode V_2, its output load resistance R_6, and its bias circuit R_7, R_8, have been added. The whole forms a slicer. Except during sync pulses V_1 is cut-off. Its anode is thus at at the potential of the H.T. line, as is also the diode anode. The diode cathode is biased negatively with respect to positive H.T., since it is returned to the voltage-divider R_7, R_8 across the H.T. supply. The diode is thus conductive and there is some current through R_3, R_6 and the diode. In fact, therefore, the anode of V_1 is slightly below + H.T. by the voltage drop across R_3; this is usually very small, however.

When V_1 conducts on a sync pulse the current through R_3 drops its anode potential considerably and the anode of V_2 is carried with it. The change of voltage across R_3 is made greater than the voltage drop across R_7, consequently the anode of V_2 becomes more negative than its cathode and this valve becomes non-conductive. The cathode potential of V_2 is then equal to the potential of the junction of R_7 and R_8.

With the 2 volts of sync pulse amplitude which we have previously allowed to run V_1 to cut-off, we might well obtain 20 volts change across R_3. If R_6 is large compared with R_3 and the junction of R_7 and R_8 is made about 10 volts less than + H.T., the cathode of V_2 will vary in potential from very nearly that of + H.T., when V_1 is cut off, to nearly 10 volts below + H.T. on a sync pulse when V_2 is cut off.

Before values can be selected it is necessary to consider the effect of stray capacitance on the pulse shape. We are fortunate here in two things; we are not greatly concerned with the shape of the trailing edge of the pulse so far as line synchronizing is concerned, only the leading edge, and the leading edge occurs for the "turning on" of current in V_1. We are fortunate because the effective time constant of the circuit can be lower when V_1 turns on current than when it turns it off.

Assuming R_6 to be large compared with R_3, the time constant effective when V_1 is cut-off at the end of a sync pulse is simply R_3C, where C is the total shunt capacitance to earth from the anode of V_1. This might be 20-30 pF. The anode of V_1 is E volts negative with respect to +H.T. and the voltage e below +H.T. at any instant after the end of a sync pulse is $e = E\epsilon^{-t/CR_3}$.

When $t/CR_3 = 4.5$, e is about 1 per cent only of E and is thus substantially zero. The decay of the pulse thus takes $t = 4.5CR_3/1{,}000$ with t in microseconds, C in pF, and R_3 in kΩ. Thus if $R_3 = 20$ kΩ and $C = 30$ pF, $t = 2.7$ μsec.

At the start of a pulse, however, the voltage can rise much more rapidly if V_1 takes a large current. Whether or not it does depends on the operating conditions of V_1. The matter is of some importance and deserves consideration.

In Fig. 8 is sketched the general form of the anode volts—anode-current characteristics of a pen-

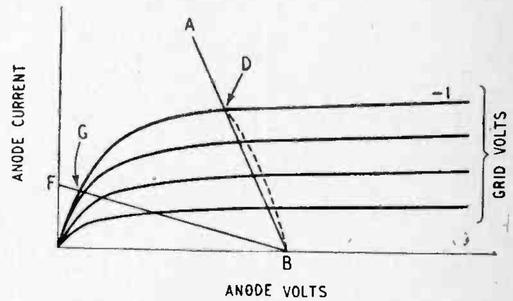


Fig. 8. The general form of the characteristics of a pentode is shown here. With a low load-resistance load AB, the time constant is the same for voltage changes in either direction. With a high load FB the time constant for a falling anode voltage (rising current) is shorter than for a rising voltage.

tode together with a load-line AB. This represents R_3 of Figs. 6

Television Synchronizing

and 7. The slope shown is for a fairly low resistance, say 20 kΩ, and a fairly high anode voltage of the order of 100 volts or more. We take the output pulse amplitude to be 20V, so that the anode current corresponding to a grid potential of −1 volt is 1 mA. Just prior to a sync pulse the anode current is zero and the anode voltage corresponds to point B. On the pulse the anode current jumps to 1 mA and the anode voltage falls to D, but not immediately. The circuit capacitance draws current and therefore robs R_3; the full current can only flow through R_3 and bring the operating point to D when the capacitance is charged. The actual operating path is thus not the load line but a curve something like that shown dotted in Fig 8.

Assuming that the A.C. resistance of the valve is very large compared with R_3 the time constant is CR_3 and is the same on charge as on discharge. The voltage acting is i_aR_3 which is 20 volts in this case—the same on charge and discharge. In this case the distortion of leading and trailing edges is the same.

Suppose now that we make R_3 of very high resistance—say, 0.2 MΩ. The load line will be FB, crossing the −1 grid volt curve at G, for a current of perhaps 0.4 mA. The final output pulse amplitude will be 0.4×200=80 volts, but the change of output on the pulse will still start off by charging the same capacitance and the initial rate of rise will be the same as with the lower resistance.

If the current on the flat top of the −1 volt curve is i_1, the voltage starts to rise at the rate i_1t/C and it rises linearly at this rate as long as the current taken by R_3 is negligibly small. This is so only for a small rise in voltage, and as long as the current supplied by the valve is constant the voltage rise is actually following an exponential law and is i_1R_3 $(1-\epsilon^{-t/CR_3})$. For values up to about 10 per cent of i_1R_3, this is nearly linear and nearly i_1t/C.

In our example this nearly linear rise of voltage covers the first 2 volts of output for R_3=20 kΩ, but the first 8 volts for R_3= 200 kΩ.

The exponential voltage change continues as long as the valve supplies constant current. When R_3 is low it does this until the final state is reached, but when R_3 is high the valve current starts to fall when the output voltage rises beyond a certain point. This reduces the rate of rise of voltage and the net result is to give a waveform like B of Fig. 9. There A shows the output pulse when R_3 is small—both leading and trailing edges show the same distortion. With B, the effective time constant is much less on the leading than on the trailing edge.

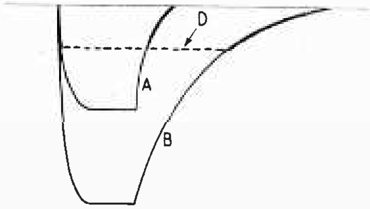


Fig. 9. Pulse A indicates the use of a low load resistance for the limiter without a diode and B the effect of a high load. When a diode is added to form a slicer the output is limited to the level D on both so that it follows the solid curve until it reaches the level of the dotted line and stays there until the decay again reaches this level.

If the diode of Fig. 6 is used to catch the anode voltage at 10 volts, say, then the waveform of B is altered to something like D. The leading edge is virtually independent of R_3, not quite but nearly, but the trailing edge is greatly dependent on it.

The advantage of this scheme is that one can make V_1 of Fig. 6 itself act as a slicer independently of V_2, for if R_3 is made large and the H.T. voltage is fairly low the point G in Fig. 8 can be brought down to the point where the valve curves coalesce. In general, this action is not perfect enough to enable the diode to be dispensed with, but the action considerably assists the diode. The two together lead to almost perfect slicing and a constant amplitude of output pulse.

In some applications the long discharge time constant may be disadvantageous, but usually one can tolerate a discharge time of several microseconds.

If i_1=1 mA and 10 volts output is required with C=20 pF it is not difficult to calculate how long it takes for the output voltage to fall by this amount for different values of R_3. Assuming i_1 to be constant over the range of voltage concerned, $t=2{,}300\ CR_3 \log_{10} [1/(1-e/i_1R_3)]$ with time in microseconds, capacitance in pF, R_3 in kΩ, and i_1 in mA.

With the above values, t=0.28 μsec for R_3=20 kΩ and t=0.2 μsec for R_3=200 kΩ. This seems surprising for the higher time constant gives a sharper leading edge to the pulse than the lower. The reason is that the output amplitude is limited to the same value in both cases by the diode and with the higher resistance the effective voltage (i_1R_3) acting in the circuit is greater.

The improvement, which is small, is paid for by the much longer decay of the pulse. Whether or not this is important depends on the type of time-base oscillator and upon the method of separating the frame sync pulses. In general, with a blocking oscillator and an integrator for frame pulse separation the lengthening of the pulse is of no importance. However, when the rear edge of the first frame pulse is used in one method of pulse separation, then any considerable lengthening cannot be tolerated.

NEW CAR RADIO

THE post-war Philco car radio receiver (Model K526) is a four-valve superheterodyne, with built-in loudspeaker and a separate control head operating through flexible-shaft drives. The weight of the receiver is under 12 lb and the price is £21, plus £4 18s 3d purchase tax. Models are available for 6- and 12-volt supplies.

"MAINS TRANSFORMER PROTECTION": A Correction

In the formula in this article on p. 52 of the February, 1947, issue, R_0 was omitted from the denominator. The formula should read, $T = \dfrac{R_T - R_0}{\alpha R_0}$

World of Wireless

B.B.C. AND F.M.

IT is learned from the B.B.C. that it has invited tenders for a frequency-modulation transmitter which it is stated will be used in the first instance for experimental transmissions. It is understood no contract has yet been placed neither has the site for the station been acquired.

It is stated that although plans are under consideration no decision has yet been made regarding the building of F.M. stations in other parts of the country.

F.M. transmissions are at present being radiated experimentally each evening from 6-12 on 90.3 Mc/s from the Alexandra Palace station.

I.E.E. CONVENTION

A RADIOCOMMUNICATION convention, with particular reference to wartime activities and their possible influence on peacetime development, has been arranged by the Institution of Electrical Engineers for March 25th-28th at Savoy Place.

The convention will be opened by Sir Stafford Cripps, P.C., K.C., M.P., President of the Board of Trade, on March 25th at 5.30, when an address on "Telecommunications in War" will be delivered by Col. Sir Stanley Angwin.

On each of the three following days there will be three sessions: 9.45-12.45, 2.30-5 and 6-8, and the subjects to be covered at these sessions are, respectively,

March 26th: Long-distance point-to-point and naval communication. Military and aeronautical communication. Pulse communication.

March 27th: Short-distance communication. Direction finding. Broadcasting.

March 28th: Propagation. Components. A review of the convention and future trends by Sir Clifford Paterson.

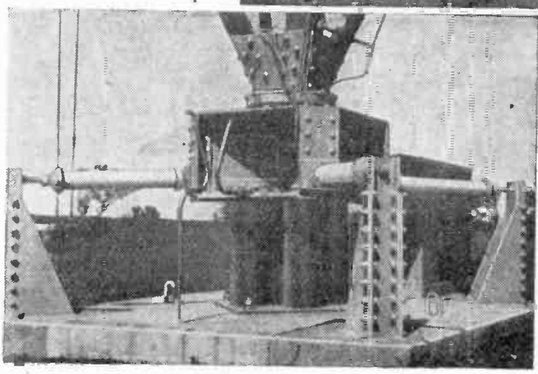
There will also be an additional meeting on April 2nd at 5.30 covering C.W. navigational aids.

RECORDING CONFERENCE

A CONFERENCE organized by the British Sound Recording Association on Jan. 25th was opened by M. J. L. Pulling, Superintendent Engineer (Recording), B.B.C., who gave a comprehensive survey of the use of disc recording for war reporting and the preservation of typical war noises for posterity. An interesting paper on the recording of aircraft noise for simulating flying conditions as part of the training of air crews was read by R. W. Lowden, of the Royal Aircraft Establishment. Wartime experiences were also recounted by W. S. Barrell (E.M.I. Studios) and C. E. Watts (M.S.S. Recording).

In the evening the Association held its first annual dinner and the speeches were recorded on discs to commemorate the first important landmark in the history of the Association.

CONSOL. One of the two transmitters at the Bushmills, Ulster, Consol station, which, as mentioned last month, has been handed over to the Ministry of Civil Aviation by the Air Ministry and now operates under the civil call sign MWN



The centre unit is the transmitter — a Rediffusion G12 (R.A.F. Type T 1412)—with (left) the control unit and (right) the power rack. The lower photograph shows the insulated base of one of the three 300-ft vertical radiators which are arranged in line about two miles apart.

SALE BY AUCTION

A SERIES of sales by auction of radio and radar equipment is being held by Goddard and Smith on behalf of the Ministry of Supply.

The next two sales will be on March 19th and April 9th, at the Ministry's stores at Aldenham on the Watford By-pass Road just past the junction with the Edgware and Elstree Roads. Catalogues are not issued but the equipment will be on view each sale day from 9-11 when the auction will commence.

It is stated that if these experimental sales prove a satisfactory means of disposal they may be continued at fortnightly intervals.

WHITHER TELEVISION?

CRITICISM of the Government's attitude towards the B.B.C. television service, the development of which it is "doing very little to encourage," was recently voiced in the House of Commons. Points stressed by J. Lewis, M.P. for Bolton, were:—

"There is little hope of the television service developing on a nation-wide scale unless the Government is prepared to put millions into it. . . .

"The service must not be regarded as a branch office of the B.B.C. . . .

"Much closer co-operation with the film industry must be secured. . .

"Film industry should be encouraged to develop television programmes for cinemas. . . ."

Another M.P. stressed the im-

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portance from the export point of view of the British technique being ahead of every other nation so that when a country is installing a television system British apparatus will be used.

In his reply the Assistant Postmaster-General, W. A. Burke, stated that "arrangements have been made to run a two-way link between London and Birmingham so that programmes can be sent in either direction by cable or radio. That does away with the necessity of having to look too far ahead and discover which of the two methods will be found the better."

Referring to the definition of the proposed service from Birmingham he said "we have provided for both eventualities [405 and 1,000 lines] in a way which justifies the B.B.C. being entitled to a good deal of credit instead of criticism."

RADIO TRANSLATION

WHEREAS the simultaneous translation of speeches in a number of languages at the Nuremberg trials of German war criminals was by a wired distribution system, that being used at Lake Success, New York, for the addresses at the United Nations General Assembly is by radio.

Six low-power transmitters are used on frequencies of the order of 120 Mc/s, which radiate the original speech and translations in the five major working languages, viz., English, French, Russian, Spanish and Chinese.

The delegates are provided with small battery-operated receivers (about the size of a cigar-box) slung from the neck, feeding earphones, and by a simple dialling arrangement any of the translations can be obtained. Thus the delegates are no longer restricted to their seats and have mobility in or outside the building up to 200 yards.

MANUFACTURING CONTROL

THE powers of control over the manufacture and supply of radio-gramophones and wireless receivers (including television sets) have been transferred from the Board of Trade to the Ministry of Supply. The Order (Wireless Receivers and Radio-Gramophones (No. 1)—S.R. & O., 1947, No. 226) gives power to the Minister of Supply to prevent the diversion by dealers into the home market of goods, the manufacture of which was licensed on condition that they would be exported.

Under a second Order (Musical Instruments and Wireless Receivers (No. 2)—S.R. & O., 1947, No. 225) gramophones, gramophone motors and needles are deleted from the list of goods controlled under a previous Order (S.R. & O., 1944, No. 658) and may now be manufactured and supplied without a licence. A licence is still required for the manufacture and supply of gramophone records.

INTERNATIONAL TELECOMMUNICATIONS

IT was agreed at the Five Power Telecommunications Conference in Moscow last September to recommend to the United Nations Organization that it convened a meeting of the Administrative Radiocommunications Conference in May to revise the radio regulations, redistribute frequencies and set up a central frequency registration board.

It is understood invitations have been sent out to some sixty nations to attend the conference at Atlantic City on May 15th.

Preparatory to this conference a meeting was held in Paris early in February for an exchange of views between the U.K., U.S.S.R., and France on the allocation of some radio-frequency bands which might be susceptible to regional agreement.

A plenipotentiary conference for the purpose of revising the International Telecommunications Convention and the reorganization of the International Telecommunications Union is planned for July 1st.

The first world conference for the allocation of high frequencies to broadcasting stations is planned to follow the Atlantic City conference.

RADAR TECHNOLOGY

A COMPLETE 3cm radar installation, Type 268, has been acquired by the University College, Southampton, for the radar technology (marine) course in the School of Radio. The course is designed primarily to meet the demand for men to operate and maintain Merchant Navy radar installations.

Applicants for the 12-week course must not be under 16 years of age, must have attained a standard of education not lower than School Certificate, or have not less than four years' practical experience in an approved branch of radio or electrical engineering or telecommunications, and hold the P.M.G.'s First-Class Certificate or other approved certificate or diploma in radio or electrical engineering.

Priority is at present being given to approved members of the Merchant Navy.

EMPIRE RADIO LIAISON

THE converted Halifax bomber *Mercury*, which, as reported in our November, 1946, issue, had been fitted out by the Empire Radio School at Debden, Essex, with all the latest airborne radio and radar equipment used in the Royal Air Force for a liaison flight to the Antipodes, recently took off again on another liaison trip, this time to the Union of South Africa.

The purpose of the mission is the same as on the first occasion: to discuss the current practices and policy of radio training in the R.A.F.; explain and demonstrate the latest equipment carried in the aircraft, as some of it is not yet in general use, and to collect material of interest in the formulation of unified systems of radio instruction throughout the British Commonwealth air forces.

Mercury also has on board a cinema projector and a selection of radio training films.

PERSONALITIES

Dr. R. C. G. Williams, Ph.D., B.Sc., formerly of Murphy Radio, who went to the United States in May last year to gain experience of technical and industrial aspects of radio and electrical engineering in that country, has joined the North American Philips Company, Inc., as an executive engineer.

A. McVie, B.Sc.(Eng.), relinquishes his position as general manager of Kolster-Brandes on his appointment as commercial director of Standard Telephones and Cables in succession to **C. W. Eve,** who is retiring. Mr. McVie, who is also chairman of the council of the British Radio Equipment Manufacturers' Association, remains a director of Kolster-Brandes.

IN BRIEF

Broadcast Licences.—An increase of 791,000 receiving licences during last year is recorded in the figures just issued by the G.P.O. At the end of December a record total of approximately 10,778,000 were in force, including 7,450 television licences. This latter figure does not represent the total number of television sets in use as holders of unexpired 10s broadcast receiving licences are permitted to operate television sets.

Radio engineering comes within the purview of the Engineering Advisory Council which has been set up by the Minister of Supply to provide "a means of consultation with employers and workers in the industry on matters of general concern in the engineering field." G. Darnley-Smith, managing director of Bush Radio and director of Cinema Television, is representing the radio industry on the Council.

F.M. in the States.—According to figures issued by the Federal Communications Commission in the middle of January a total of 142 F.M. stations were at that date operating in 33 States. This is an increase of 53 in two months. According to the figures published by *Broadcasting* some 20-25 per cent of this year's receiver output in the U.S.A. will be F.M. sets, which means the total may reach 18,000,000.

5XX.—After nearly twenty-two years' service the B.B.C.'s long-wave broadcasting station 5XX at Daventry has finally closed down. It was originally taken out of service in 1934 when the high-power Droitwich transmitter came into operation. During the early part of the war, however, it was converted for operation on medium waves (391 m) but reverted to its old wavelength in 1941 when it was used for the European service.

Civil Aviation.—The Radio Industry Council is represented on the recently formed National Civil Aviation Consultative Council by C. O. Stanley, of Pye, Ltd. The Council's terms of reference are "to be a forum for the review of developments in civil aviation generally and to assist the Minister of Civil Aviation in the examination of questions relating thereto."

"They're Called Electrons."—This is the title of an instructional film just produced by The Edison Swan Electric Company, with collaboration from G. Parr, Editor, of *Electronic Engineering*. It succeeds in explaining valve action in the simplest possible terms. The film, which runs for about 30 mins, will be available for schools and training centres, etc.

A Correction.—In the article on "Hum in High-Gain Amplifiers" in the February issue the last sentence of the middle column on p. 57 should read: ". . . the right layout of the *external* circuit . . ." Also on p. 60, middle column, six lines from the bottom, the response should, of course, be "30 c/s to 20,000 c/s."

Shipwrights' Exhibition.—The only two marine radio manufacturers exhibiting at the recent Shipwrights' Exhibition were Marconi International Marine Communication Co. and the International Marine Radio Co. In addition to the company's latest communication equipment Marconi's were showing new depth-sounding equipment—combining visual and recorded readings, and harbour approach radar gear on which the display can be concentrated on any one of four sectors—ahead, astern, port or starboard. I.M.R.C. was showing a number of transmitters and receivers and a combined R.T./C.W. outfit with a loud-hailer.

"Wireless Servicing Manual."—New stocks of the seventh edition of this useful book by W. T. Cocking, editor of our sister journal *Wireless Engineer*, are now available from our Publisher, price 10s 6d, postage 4d.

INDUSTRIAL NEWS

Halicrafters Great Britain, Ltd., has been formed to produce Halicrafter communication equipment in this country. The registered office is at 56, Kingsway, London, W.C.2, and the factory will probably be at Dagenham, Essex.

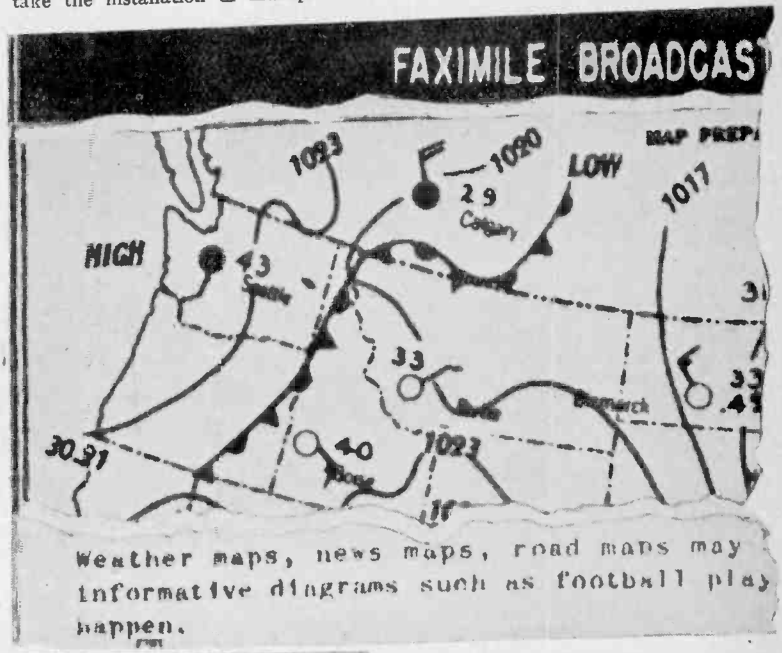
Television Retailers' Development Co., Ltd., has been formed to undertake the installation of multiple television aerials in blocks of flats and other communal buildings which cannot readily be done by individual retailers. The present address of the company is 18, Woburn Square, London, W.C.1.

DELAY IN PUBLICATION

We apologise to readers for delay, brought about by the fuel crisis, in the appearance of this issue of "Wireless World"

Marconi's announce that its associated company Marconi Espanola has obtained a contract worth approximately £270,000 to supply four 100-kW short-wave broadcasting stations to the Spanish State Broadcasting Service. They are Type TBS802, which is used by the B.B.C.

Stentorian cabinet extension speakers are again in production. There are two models, Senior and Junior, with permanent-magnet units housed in walnut veneer cabinets and fitted with



FACSIMILE NEWSPAPERS are to be produced regularly by a group of American broadcasting stations and newspapers. Pieces from *Fax News* are reproduced above (actual size) without any retouching. Pages measuring 9in by 12in are reproduced at the rate of four in fifteen minutes. 400-foot rolls of paper—about a month's domestic supply—at present cost about £1. The system, which has been developed by John V. Hogan, shown standing in the photograph, employs a wire helix which presses on the damp chemically impregnated paper as it passes over the cylinder. The scanning is 150 lines to an inch. Duplicate transmitting equipment is shown in the photograph.

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constant-impedance volume controls incorporating a push-button switch for use with the "Long Arm" remote control. Made by Whitely Electrical Radio, Mansfield, Notts, the Senior model costs £5 15s 6d with universal transformer and the Junior model £5. Without transformer (3 ohms impedance) the prices are £5 2s 6d and £4 10s 6d, respectively. The 9-inch Senior model has a power-handling capacity of 7 watts and the Junior model, with an 8-inch diaphragm, handles up to 6 watts.

E. K. Cole, Ltd., is to erect a new branch factory at Rutherglen, Scotland. The sod-cutting ceremony was performed by Mr. Tom Fraser, the Under-Secretary of State for Scotland.

Southern Instruments, Ltd., has now restarted production at Fernhill, Hawley, Camberley, Surrey ('Phone Camberley 1741). They will be producing C. R. oscilloscopes and associated equipment designed on the miniature rack system, with a comprehensive range of recording cameras and amplifiers for special purposes.

E.M.A.—At the recent annual general meeting of the Electronic Manufacturers' Association, Major W. H. Berriedale-Johnson (R.A.P. Manufacturing) was appointed its first president. The council member-firms are:—British Tungsram, Dulci Co., Felgate Radio, Magneta Time Co., New Era Industries (Tottenham), R.F. Equipment, and J. and H. Walter. It was announced that the association had been granted full recognition by the Ministries.

B.R.E.M.A.—At the first meeting of the new council of the British Radio Equipment Manufacturers' Association, A. McVie, of Kolster-Brandes, was re-elected chairman and F. W. Perks, of the Gramophone Co., elected vice-chairman.

R.G.D.—A showroom and dealers' service depot has been opened by the Radio Gramophone Development Co. at 187, Corporation Street, Birmingham, 4. Tel.: Birmingham Central 2403.

Extension Loudspeaker.—A new 6-inch permanent-magnet extension speaker housed in a plastic cabinet with moulded grille back and front has been produced by British Rola, Georgian House, Bury Street, London, S.W.1. The unit is omni-directional and holes are provided for screwing to roof beams, etc. At present the standard impedance is 3 ohms; models with matching transformers and volume control will be available later. The price is £2 14s.

Grampian Microphone.—The price of the Grampian MCR microphone is £5, and not £4 4s as given in an advertisement in our February issue.

CLUBS

Aberdeen.—Meetings of the Aberdeen Amateur Radio Society are now held in the Forsyth Hotel, 102, Union Street, Aberdeen, on Fridays at 7.30. Sec.: A. D. J. Westland, 17, Beaconsfield Place, Aberdeen.

Ashton-under-Lyne Amateur Radio Society meets on Thursdays at 7.30 at its headquarters, Astral House, Stalybridge Sec.: N. H. Brown, B.Sc., 63, Corporation Street, Audenshaw, nr. Manchester, Cheshire.

Birmingham.—Slade Radio now meets fortnightly at its headquarters, Broomfield Road, Slade Road, Erdington. The subject for the meeting on March 21st is "Police Radio." Sec.: L. A. Griffiths, 34, Florence Road, Sutton Coldfield.

Cheadle.—The official opening of the headquarters of the recently formed Cheadle (Staffs) and District Amateur Radio Society at Wolver House, Rakeway, Cheadle, was performed by the Chairman of the Rural District Council on January 4th. Details of membership are obtainable from V. Hughes, G3AVG, Abbots-Haye, Cheadle, Stoke-on-Trent, Staffs.

City of London Phonograph and Radio Society has recently resumed its meetings, which are held on the first Thursday in the month at 6.30 at "The Flying Horse," 52, Wilson Street, E.C.2. Sec.: R. H. Clarke, 12, Grove Road, North Finchley, N.12.

Exeter.—The inaugural meeting of the Exeter and District Amateur Short-wave Radio Society was held on February 6th. Details of the meetings, which are held on Thursdays at 7.0, are obtainable from the secretary, E. G. Wheatcroft, 7, Mount Pleasant Road, Exeter, Devon.

Holloway. — The Grafton Radio Society, which meets at the Grafton L.C.C. School, Eburne Road, Holloway, London, N.7, is now publishing a monthly magazine called *QTH Grafton*. A library has been started and a new section for V.H.F. enthusiasts formed. Secretary, W. H. C. Jennings, G2AHB, 82, Craven Park Road, London, N.15.

Kingston.—Meetings of the Kingston & District Amateur Radio Society are held on the second and fourth Thursday in the month at 8.0 at the "Three Fishes," near Kingston Southern Railway Station. Secretary, J. J. Hughes, 12, Hillingdon Avenue, Ashford, Middlesex.

London.—At the meeting of the London Chapter of the International Short-Wave Club on March 14th our contributor T. W. Bennington will speak on the propagation of short waves. Meetings are held every Friday at 8.0 at the Buckingham Gate School, Castle Lane, Palace Street, London, S.W.1. Sec.: A. E. Bear, 100, Adams Gardens Estate, London, S.E.16.

Southport Amateur Transmitters' Association is now producing its own bulletin, "QSO." Meetings are held on the first and third Thursdays in the month at 8.0 at Thorp's Restaurant, Nevill Street, Southport. Sec.: J. R. Fennessy, G5ZI, 65, Balmoral Drive, Southport, Lancs.

Stroud and District Amateur Radio Club meets every Tuesday at 7.30 in the Labour Club, Cainscross Road, Stroud. It is stressed that the club is non-political. Sec.: K. D. Ayers, G2FRG, Victoria Villas, Whiteshill, Stroud, Glos.

West Bromwich.—A U.H.F. section and a technical library have been formed by the West Bromwich and District Radio Society which meets fortnightly at the Gough Arms Hotel, Jowetts Lane, West Bromwich. The new secretary is R. G. Cousens, 38, Collins Road, Wednesbury.

MEETINGS

Institution of Electrical Engineers

Radiocommunication Convention, March 25th-28th—see separate note.

Radio Section.—"Velocity Modulation Valves," by L. F. Broadway, B.Sc., Ph.D., C. J. Milner, M.A., Ph.D., D. R. Petrie, W. J. Scott and G. P. Wright, on March 19th.

Measurements Section.—"The Design and Construction of a new Electron Microscope" by M. E. Haine, B.Sc., on March 21st.

All the above meetings will be held at 5.30 at the I.E.E., Savoy Place, London, W.C.2.

Cambridge Radio Section.—"U.H.F. Triodes and Velocity Modulation Tubes" by G. W. Warren, B.Sc., on March 11th at 6.0 at the Cambridgeshire Technical College.

North-Eastern Centre.—"Industrial Applications of Electronic Techniques" by H. A. Thomas, D.Sc., on March 24th at 6.15 at the Neville Hall, Westgate Road, Newcastle-on-Tyne.

North-Western Centre.—"Colonial Telecommunication Systems" by C. Lawton and V. H. Winson, B.Sc.(Eng.), on March 18th at 6.0 at the Engineers' Club, Albert Square, Manchester. Joint meeting with the Institution of Post Office Electrical Engineers.

Scottish Centre.—"Industrial Applications of Electronic Techniques" by H. A. Thomas, D.Sc., on March 12th at 6.0 at the Heriot-Watt College, Edinburgh, 1; and on March 14th at 7.30 at the Caledonian Hotel, Aberdeen.

"Colonial Telecommunication Systems," by C. Lawton and V. H. Winson, B.Sc.(Eng.), on March 25th at 6.15 at The Royal Technical College, George Street, Glasgow. Joint meeting with the Institution of Post Office Electrical Engineers.

South Midland Group.—"The Elements of Wave Propagation using the Impedance Concept" by H. G. Booker, M.A. Ph.D., on March 24th at 4.0 at the James Watt Memorial Institute, Great Charles Street, Birmingham.

Radio Society of Great Britain

"Ex-enemy Radio Equipment," by A. A. Jones, G3RU, on March 14th at 6.30 at the I.E.E., Savoy Place, London, W.C.2.

British Sound Recording Association

"Developments in Magnetic Wire Recording," by P. T. Hobson, on March 27th at 7.0 at the Royal Society of Arts, John Adam Street, London, W.C.2.

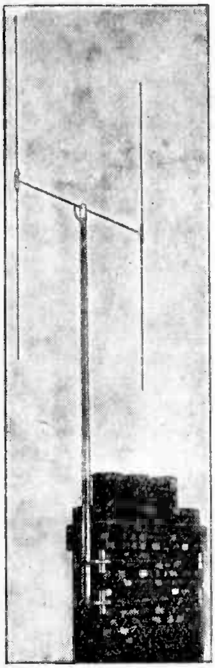
British Institution of Radio Engineers

Scottish Section.—"The Boundary between Sinusoidal and Relaxation Oscillation," by Emrys Williams, Ph.D., B.Eng., on March 19th at 6.30 at the Heriot-Watt College, Edinburgh, 1.

BELLING-LEE QUIZ (No. 9)

Answers to questions we are often asked by letter and telephone

Q. 35. *Why is it that in the *1 Belling-Lee television aerial, the reflector elements are the same length as those of the dipole? Should they not be longer, as is customary in such V.H.F. aerials?*



*1 *The Illustration shows a Belling-Lee "Viewrod" Television dipole and reflector. Type L.502/L.*

A. 35. It is generally forgotten that a television aerial is called upon to do a double job, to handle two wavelengths at once, and also to possess wide band characteristics for the faithful retention of the video component of the transmission. If the aerial is designed to handle only one component of the transmission, then it is true to state that the reflector will be longer than the dipole. But this will cause the other channel to be unfairly attenuated and will considerably alter the azimuthal (horizontal) polar diagram.

The proportioning of the reflector and dipole lengths in the Belling-Lee L.502 aerial has been arrived at by extensive tests directed at providing the best average signal strength from both the sound and vision channels, having regard to the preservation of adequate bandwidth and comparable polar diagrams from both. It is only incidental that all the elements are about the same length. It is a pity that the mechanics of the job preclude their being interchangeable.

Some manufacturers have paid us the compliment of following us: we *were* the first. Others go their own way.

Many people in all walks of life have asked us why we dimension our aerials in this way. Now they know. It has taken a letter from a person at Southampton to bring this question on to our quiz page, and we would like to hear of his success. Incidentally we have many successful installations still further afield.

Any other questions, please? We like to hear from our readers.

Q. 36. *Can an "Eliminoise" receiver transformer be "burnt out"?*

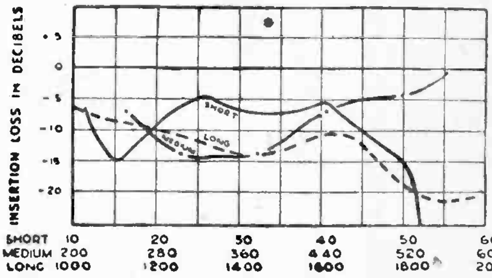
A. 36. It is surprising how many people in the trade—and out of it—do not realise that this can happen until the possibility is pointed out to them—then the reason seems obvious. It invariably happens with AC–DC sets, in which the design allows the chassis to be alive at mains voltage, with respect to earth. If an earth terminal is fitted, it should be connected to chassis via a capacitor, thereby isolating the chassis. Unfortunately, some manufacturers omit the earth connection altogether; in other cases the earth capacitor breaks down.

When an *2 "Eliminoise" aerial is used in these circumstances, the receiver "Eliminoise" transformer is earthed. If there is no capacitor (or one that has broken down) between earth and chassis, or between aerial and chassis, current from the chassis flows through the "Eliminoise" coil and may burn it out.

Unfortunately, there are AC–DC sets where the aerial becomes alive through the same cause, and should the aerial fall down on a garden or metal clothes line, the results might be disastrous.

Q. 37. *What is the recognised method of making a comparison between different types of anti-interference aerials?*

A. 37. The mode of procedure is laid down in B.S.S. 905. The original "Eliminoise" curves were prepared by the National Physical Laboratory and have been published frequently and are shown in our literature. We are satisfied that the



WAVELENGTH IN METRES

*2 *The above curves are reproductions of those obtained by the National Physical Laboratories for the "Eliminoise" Aerial.*

"Eliminoise" has not yet been beaten on any generally useful frequency.

ERRATUM.—In the January issue of this publication we stated the capacitance of L.604 coaxial plug *and socket* as being 1.3 mfd. This should read 3 pF.

TO BE CONTINUED . .

We hope you will come and visit us at the Exhibition being organised by the Radio Component Manufacturers Federation. to be held at the new Horticultural Hall, Vincent Square on March 10-13 inclusive, Stand No. 82. We will be showing a comprehensive range of components and aerials—many of them available for the first time, and we will have engineers on site to answer tricky questions.

*1 **Viewrod** (*Regd. Trade Mark*). Dipole, reflector and cross arm with chimney lashings, **L.502/L.** each **£5 12 6**

Supplied also without reflector and/or chimney lashing ...... from **£2 7 6**

*2 **"Eliminoise"** (*Regd. Trade Mark*). Anti-Interference Aerials. (*U.K. Patents 477218, 479118.*)

L.307/T. Receiver Transformer Price **£2 0 0**

***L.306/T.** Aerial Transformer Price **£2 10 0**

***L/308/T.** Pair of Transformers Price **£4 10 0**

***L/308/K.** Complete kit with 60′ Aerial, 50′ screened feeder. **L.1221** Price **£6 6 0**

L.1221 screened feeder per yard **1 9**

* Complete with **L350** lightning arrester.

BELLING & LEE LTD
CAMBRIDGE ARTERIAL ROAD, ENFIELD, MIDDX

SHORTHAND CIRCUIT SYMBOLS

Rapid Method of Circuit Representation

By A. W. KEEN, M.I.R.E.
(Sobell Industries Ltd.)

IN the course of several years' development and teaching experience of multi-valve television and radar circuit systems, the writer continually felt the need for a more speedy technique of circuit representation than is possible by conventional graphical methods. The simple solution evolved has proved satisfactory over a long period of continuous use.

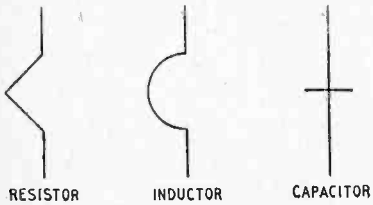


Fig. 1. "Shorthand" symbols for common basic components.

Preliminary Considerations —Analysis of typical circuit systems reveals that, while a wide variety of component types exists, only a very restricted class occurs in considerable numbers, viz., resistors, capacitors, inductors, and valves (in descending sequence); other types are comparatively few. Accordingly, rapid representation requires simple symbols for the common types of component; it is less essential (and more difficult) to achieve simple representation of the rarer types.

Detailed study of conventionally drawn circuits shows also that of the total line length employed, by far the greater part is taken up by connections. If these could be reduced in length without loss of information or clarity, the saving of drawing time would be considerable. The American practice of omitting leads common to several stages takes recognition of this fact.

Further reduction necessitates improved component layout.

Again, it is generally recognized that conventional valve symbols are most unsatisfactory, particularly from the present point of view. The use of closely parallel dashed lines for grids easily leads to errors and confusion and results in overlapping of the circuits associated with the various electrodes. Drastic simplification and radical change of form are in this case most necessary.

It is strongly emphasized that the symbols and arrangements to be described are derived from, and are supplementary to, existing conventional practice and are preferred to the latter only when the time factor so dictates.

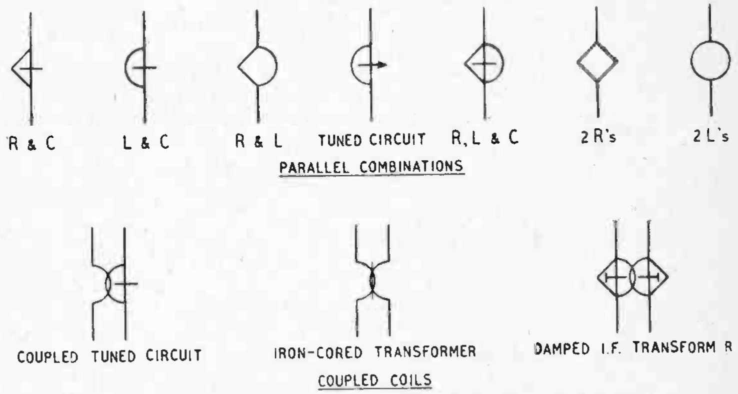
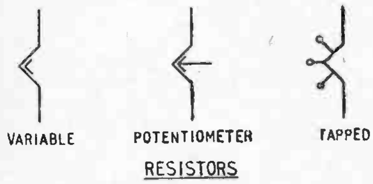
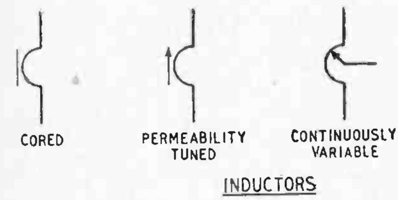


Fig. 3. Commonly occurring combinations of basic symbols.





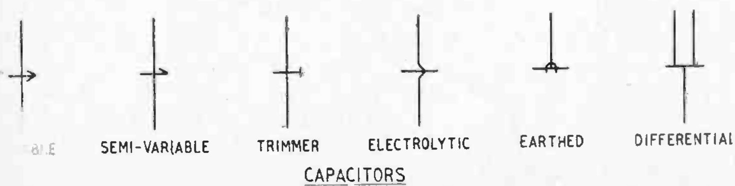


Fig. 2. Special forms derived from basic symbols of Fig. 1.

Simplification of Normal Symbols.—In the case of resistors, capacitors, and inductors, extreme simplicity of representation and ease of drawing are achieved without introduction of new types of symbols by reducing the normal symbols to the extent shown in Fig. 1. Variants of the basic component (e.g., tapped, continuously variable, etc.) are given at Fig. 2. It will be noted that despite this drastic reduction the symbols retain their characteristic form and appearance.

More complex components are

treated in the same manner but to a lesser degree, the mains transformer of Fig. 6 being a good example.

A feature of these simplified symbols is the facility with which they combine to represent common component combinations; examples are given in Fig. 3.

An ambiguity arises in the case of the resistor and inductor symbols in that they may be drawn left-hand or right-hand. The writer has at times made use of this property in various ways (for example, to distinguish signal-carrying components from those employed purely for feed purposes) but normally chooses the orientation giving the neatest appearance (usually away from the associated components).

New Valve Symbols.—A great deal of thought and experiment has been expended on the development of improved valve symbols; the method finally adopted evolved in the following manner:—

1. Only electrodes having external connections need be represented; thus the envelope symbol is quite superfluous and it is unnecessary to indicate the fact that a valve is enclosed within a grounded shield, or that it is fitted with certain types of secondary-emission suppressor, provided the (essential) valve type number is stated.

2. The simplest way of representing an electrode is by a short bar (—). The complete n-electrode tube should, therefore, contain only n bars. The connecting lead is best rendered distinct by drawing it out to meet the bar normally at its mid-point, thus $\perp$.

3. Next, it is necessary to identify the various electrode bars. If the latter are arranged in the logical manner, that is, in the same sequence as the corres-

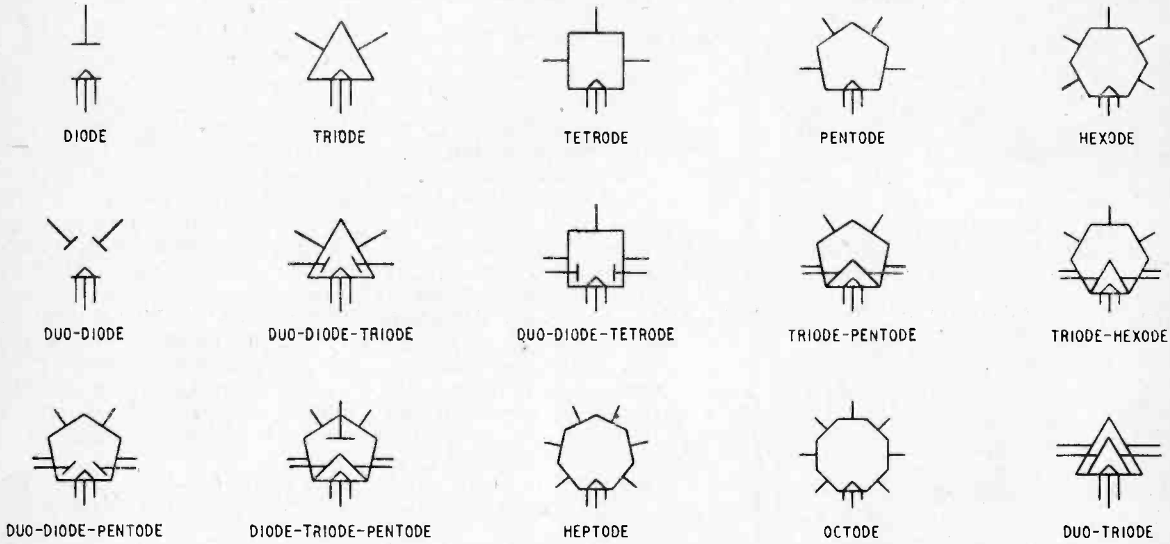


Fig. 4. **Proposed valve symbols.**

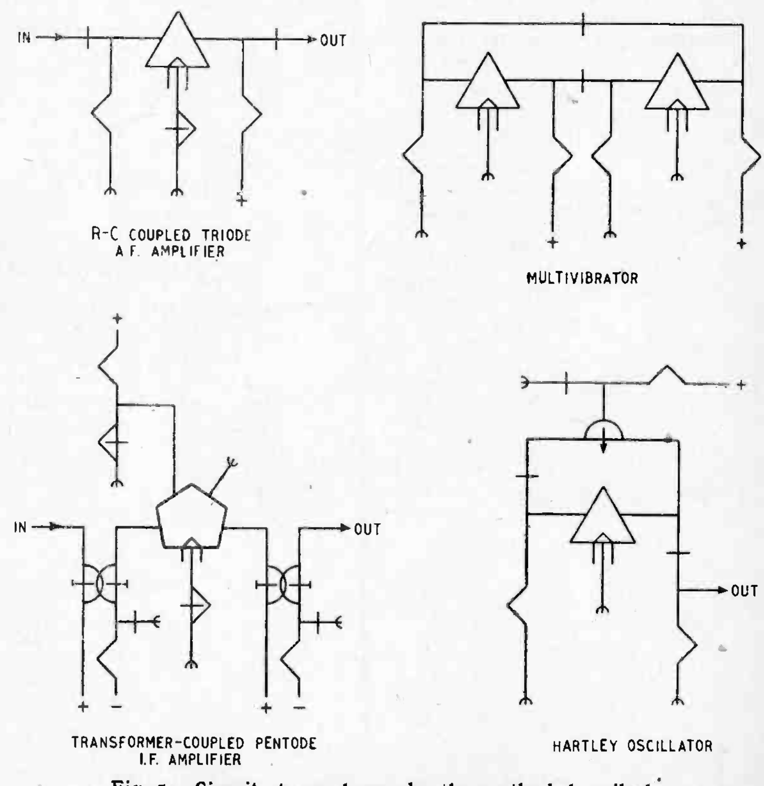


Fig. 5. **Circuit stages drawn by the method described.**

Shorthand Circuit Symbols—

ponding electrodes occur in the electron stream, they need not all be rendered distinctive. In fact, provided the sequence in which the remainder follow is indicated, only one electrode need be distinguished. It was finally decided to make a special case of the heater by representing it in the same manner as a resistor and superimposing it on the cathode bar, thus .

4. Two kinds of sequential arrangement of the *n*-bars are possible: cyclical and linear. The method finally chosen, having the bars arranged end-to-end to form a regular closed polygon was found to have the most advantages (enumerated later). In the common base without difficulty or adverse results.

7. No distinction need be made between directly heated and indirectly heated valves except that in the case of the former no external connection is taken from the cathode bar which then represents the emitting surface only.

The symbols thus derived are illustrated by Fig. 4.

Advantages of Proposed Valve Symbols.—As a result of their irreducible simplicity and elementary geometrical form the new valve symbols are readily drawn and possess a pleasing, finished, and easily recognizable (e.g., pentagon for pentode) appearance.

Moreover, a number of advantages accrue from the adoption of two separate junctions to avoid confusion, thus .

4. Input and output circuits of successive stages are rendered adjacent.

5. For a given degree of clarity, component spacing (and length of connecting leads) may be reduced.

Complete Circuits.—A selection of single-stage circuits employing the new symbols and arrangements is shown in Fig. 5. Fig. 6 shows a complete broadcast receiver drawn in the new manner. No difficulty arises from the interruption of long inter-stage connections provided the broken ends are systematically annotated, as shown, but the saving of time is considerable. It will be

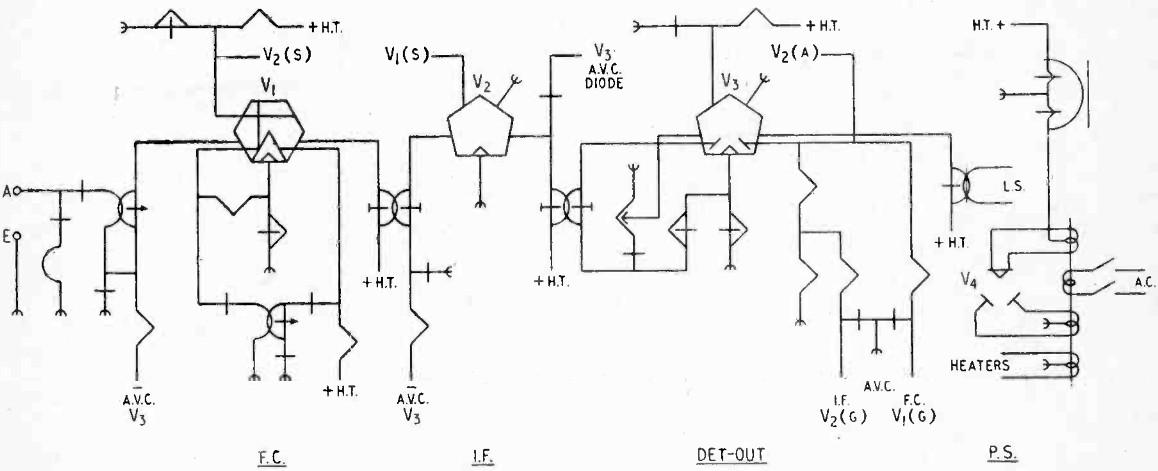


Fig. 6. Simple superhet broadcast receiver in "shorthand" symbols.

special case of the diode the resultant symbol closely resembles that of the equivalent cold-metal rectifier.

5. The grid and anode electrodes are taken in clockwise order from the cathode (which is usually made the base of the polygon) rather than in the reverse direction, in order to correspond to the conventional direction of signal flow (i.e., left to right).

6. In the case of multiple valves a section is taken between those which have separate cathodes and are, therefore, electrically independent and those which make use of a common cathode. The former class are best treated as separate valves; the latter may be drawn on a the cyclical electrode arrangement:—

1. The valve circuit as a whole is "opened out" by the radially disposed connecting leads, thus reducing the "lumping" of associated components which inevitably occurs with normal symbols. A more even component distribution throughout the entire circuit results.

2. The circuits associated with the various electrodes are separated, thus eliminating overlaps, and the signal circuits are thrown clear of the auxiliary feed circuits.

3. Crossovers and right-angle bends occur much less frequently. The writer distinguishes between crossed leads and four-wire junctions by separating the latter into noted that chassis connections are denoted by letter C superimposed on the lead to form letter E (for earthy).

Conclusion.—The foregoing description and examples are sufficient to allow immediate adoption of the method. It will be noted that very few new symbols are introduced; of these, the valve symbols are easily remembered. As already stated, the new method is presented as supplementary to existing practice for use when time is short. In conclusion, however, it is suggested that the simplified L, C, R symbols are most suitable for use in equivalent circuits and would render the latter distinct from actual circuit representations.

UNBIASED

By FREE GRID

Slaves of the Lamp

A QUARTER of a century ago, when regular broadcasting first started in this country, more emphasis was laid on the technical achievement of distributing music and speech than on the entertainment value of it. Its stars, whose photographs appeared in all the papers, were not the stars of the entertainment world but those of the technical world whose scientific achievements made this new wonder possible. In addition to their photographs we had biographical details of Captain this and Captain that—for after the 1914-18 war we technical men imitated the lion tamer and the seaside diver and were all permanent Captains without portfolio. But alas! how are the mighty fallen, for no longer does the engineer or the scientist hold the centre of the stage but is regarded as merely a humble slave of the lamp who is tiresomely necessary in order to put over the Great Magic of the Medicine Men of the Microphone.

No clearer proof of this attitude toward the professional engineer could be had than that provided by the B.B.C. itself on the occasion of a broadcast from the Bishop Rock Lighthouse in January. Two B.B.C. men, one a humble engineer and the other a great white chief of the microphone, were despatched to this lonely fastness to add to our Christmas entertainment. They did their stuff, but, it will be remembered, were prevented from making their scheduled getaway with the result that a further broadcast was arranged in which the broadcasting member of the team told us all about it.

"Captains without portfolio."

From his remarks it was quite clear that he at least was free of any superiority complex and regarded the engineer, whom he mentioned by name, as in no way inferior to himself. When, however, we were switched back to Broadcasting House, the cold official tones of a very superior kind of Medicine Man let it be clearly understood, by the manner in which—after affectionately referring to the broadcaster—he added the words "and his engineer companion," that the individual concerned and all his tribe were altogether beneath the salt.

The incident reminded me, in fact, of the contrast between the manner in which Counsel and Judges of the High Court refer to each other and the manner in which they refer to the man in the dock, forgetting as they do that he is, in effect, their real employer, as without his efforts they would be deprived of comfortable jobs.

I am sorry to say that I do not consider *Wireless World* itself is altogether free from this worms-of-earth attitude to the engineer but in this case it is not the Microphone Medicine Men who are placed in the seats of the mighty but the machine which is exalted above its master. Thus in the otherwise excellent account of the *Queen Elizabeth's* radio gear in the November issue we were told nothing about the numbers and qualifications of the staff needed to run it but from a reference to the engineer's control desk it can be gathered that these low fellows are still needed.

[Sorry we offended your strong sense of justice, Free Grid. We did state the number of radio officers carried—originally ten, but now increased to thirteen—although we did not state their actual duties. They are all fully qualified operators, holding either the P.M.G.'s first- or second-class certificate, but some have, in addition, received special training in maintenance, and, in some cases, in the operation of particular equipment, such as the radar and P.A. gear.—ED.]

Uxoricution

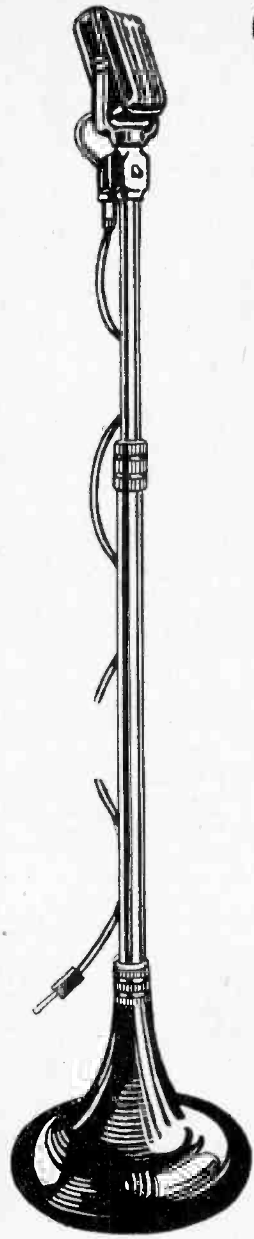
AS many of the less highbrow of my readers will know, the B.B.C. has been running a series of horror broadcasts designed to make our flesh creep, although, speaking as one who has spent a night in a South American calaboose, they are a very poor second to *Pulex Irritans* in this respect. For the most part these flesh-creeping broadcasts dabble in technical matters of a psychic nature on which I cannot claim the same professional qualifications as in things radio and electrical. Recently, however, I chanced to switch over in the middle of a hair-raiser which not only touched on an electrical matter but also touched me on the raw as I have seldom heard such nauseating nonsense.

The plot dealt with a man's successful effort to commit "uxoricide" by electrocuting his wife in her bath. Now I have no wish to be a spoilsport, but a man who sets out to electrocute his wife, or even his mother-in-law, without calling in the expert services of an electrical engineer deserves all he gets and more. First of all, so the story ran, he scraped some of the enamel off the bottom of the bath in order to get better electrical contact with the water. Even a schoolboy would have told him that he merely gave himself needless labour as excellent contact is already provided by the metal surround of the waste pipe.

"Some women are tough."

The idea was that the lady sitting in the earthed bath would receive the necessary shock when she stretched out her hand to switch on the electric fire, the switch of which was faulty and, contrary to all the best modern practice, was fixed within reach of the bath. The thing which stuck in my gullet was that the killer decided to replace the 15-amp fuses by thick copper strips to ensure that they would not "blow" before the current through the lady's body reached a sufficiently high value to kill her.

Now some women are tough, as I know full well from experience, but I doubt if even Mrs. Free Grid with her robust constitution could "take it" when a 15-amp fuse couldn't. According to figures published by the Warden of Sing-Sing Prison, New York, and discussed by me in these columns (August, 1943), approximately ten amps is the value of the current used in the electric chair and it requires five thousand volts to push it through, even with the large wet surface contact area provided at each end of the victim. No doubt some expert calculator like "Cathode Ray" or "Diallist" could give a pretty shrewd guess at the value of current resulting from a mere 240 volts; a matter of milliamps I should imagine, but there is little doubt that it would be fatal.



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TELEVISION RECEIVER CONSTRUCTION

3.—Frame Coil Winding and Deflection Yoke Assembly

DETAILS of the line deflector-coil construction appeared last month and it will be remembered that because of the moderate number of turns it is practicable to wind the coils directly to their final shape. In the case of the frame coils the number of turns is much larger and this form of construction is far too laborious. They are consequently wound as plain slab coils and subsequently bent to shape. This necessitates a bending jig as well as a winding former. Details of the latter are shown in Fig. 1; it consists of two brass plates (b) separated by a core piece (a) of $\frac{3}{8}$-in thickness. After fitting, but, of course, before assembly, and when the construction is otherwise complete the core is cut into four segments, so that it can easily be removed from the finished coil. Saw-cuts are put in the brass cheeks and carried down a little way into the core piece so that the coil can be bound by passing a needle and thread under the winding.

Each segment on the cheeks is given a very slight twist with a pair of pliers so that they are as shown greatly exaggerated in Fig. 1 (d). This is necessary to prevent the wire from catching against the leading edges.

The former is conveniently mounted for winding on a length of 2B.A. rod held in the chuck of a hand drill as shown in Fig. 2 (a), which is itself mounted horizontally in a vice. It is desirable, but not essential to arrange a second bearing for the rod and time spent in seeing that the former runs true is well spent. It is important to avoid any wobble, for this will cause the wire to pile up at diagonal ends of the straight sides to the coil and the finished coil will not have the right dimensions.

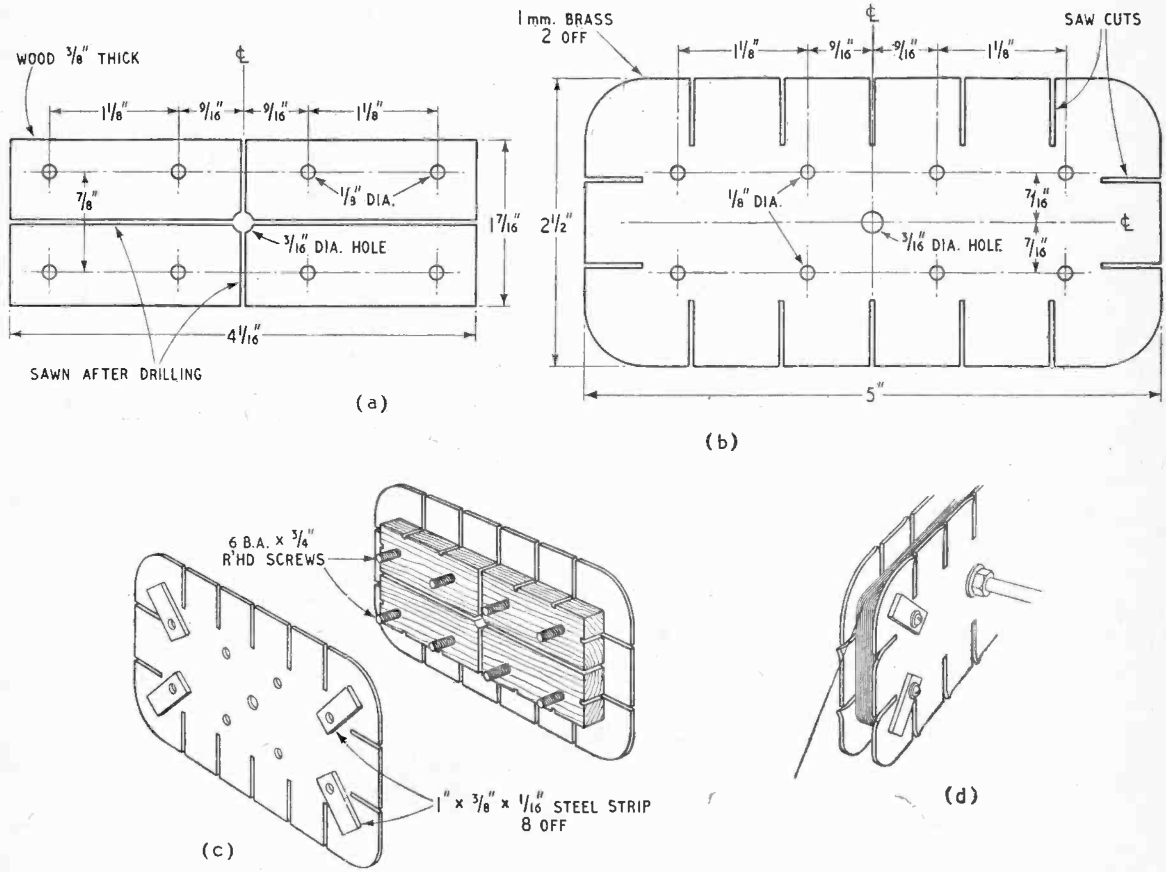
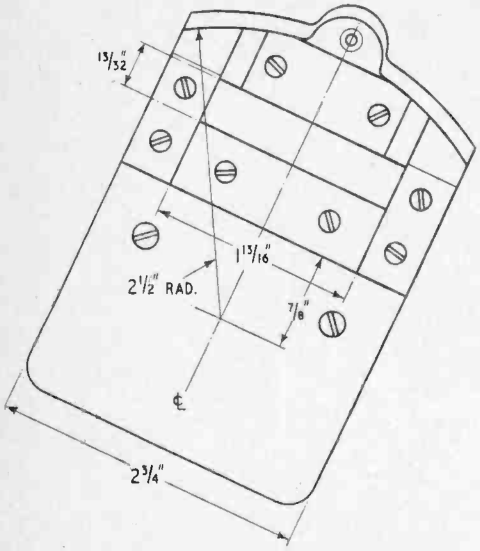


Fig. 1. Details of the core of the winding former are shown at (a) and of the end cheeks at (b). The assembly is sketched at (c) and the way in which the segments in the cheeks are twisted is indicated at (d).

The reel of wire must be mounted

Television Receiver Construction— to run freely and a revolution counter attached to the end of the coil spindle is a great help.

The winding process itself is simple and a total of 2,000 turns



of No. 40 enamelled wire* is run on each coil; some $1\frac{3}{4}$oz is needed per coil. No attempt at layer winding need be made, but care should be taken to see that the coil builds up evenly. Any irregularities should be smoothed out as they occur. Every few hundred turns insert a piece of $\frac{3}{8}$-in wood and press down the winding, since there is always a tendency for its outer turns to become elliptical instead of rectangular.

Having wound the coil, bind it with needle and thread, passing the needle through the slot in the core beneath the former and looping the thread up the side slots. The photo of Fig. 2 (b) will make this clear. Now take out the spindle and take the former to pieces, Fig. 2 (c). The core will drop out, and the coil will be left quite free, Fig. 2 (d).

Line the clamps of the bending jig, constructional details of which are given in Fig. 3, with waxed paper to protect the coil and to prevent subsequent shellacing from sticking the coil to them [Fig. 2 (e)]. Place the ends of the coil in the clamps and apply shellac liberally over the parts of the coil in them only.

Cover the clamping pieces with waxed paper, put them in place and tighten them up so that the ends of the coil are now firmly gripped as shown in Fig. 2 (f), and held in the correct shape for subsequent operations. These should be carried out straight away before the shellac hardens. Cut the binding at the centre of each of the exposed sides and undo it right back to the end clamps, leaving the four ends for the subsequent attachment of a fresh binding thread.

Now take one clamp in one hand, and with the palm of the other hand held flat against the exposed part of the coil bend it at right angles where it comes out of the clamp. Then do the same at the other end. The windings between the clamps will bunch horribly, as shown in Fig. 2 (g). They will probably spread so much that one may overlap the other; it is as well to slip a piece of paper between them to prevent the turns intermingling.

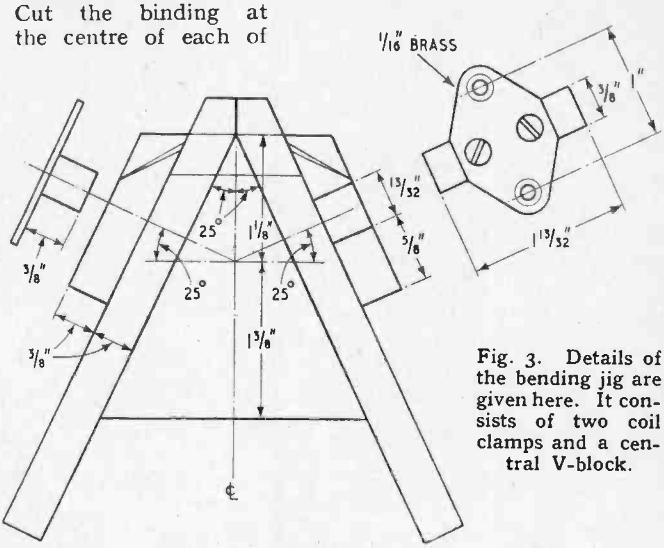


Fig. 3. Details of the bending jig are given here. It consists of two coil clamps and a central V-block.

The next step is to attach the clamps to the central V-block. Fig. 2 (h). This brings the two ends of the coils, which are held in the clamps, to their correct relative positions. Now take the flat spread of one of the sides and bend it upwards so that the wire lies above the lower turns instead of at the side of them. Attach a thread to one of the old ends of the binding and bind this side firmly tying off the thread on the other old end for that side. Then do the same with the other side. The coil then has the form shown in Fig. 2 (i).

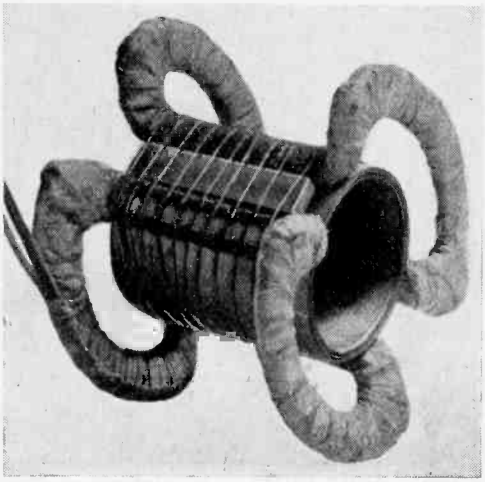


Fig. 4. A pair of line coils assembled on a former.

At this stage distinctively coloured leading-out wires should be fitted. The insulated wires should be bound firmly to the top or inside of one of the sides of the coil, so that any external pull on the

* The use of No. 41 gauge wire as an alternative is permissible, but No. 40 is preferred.

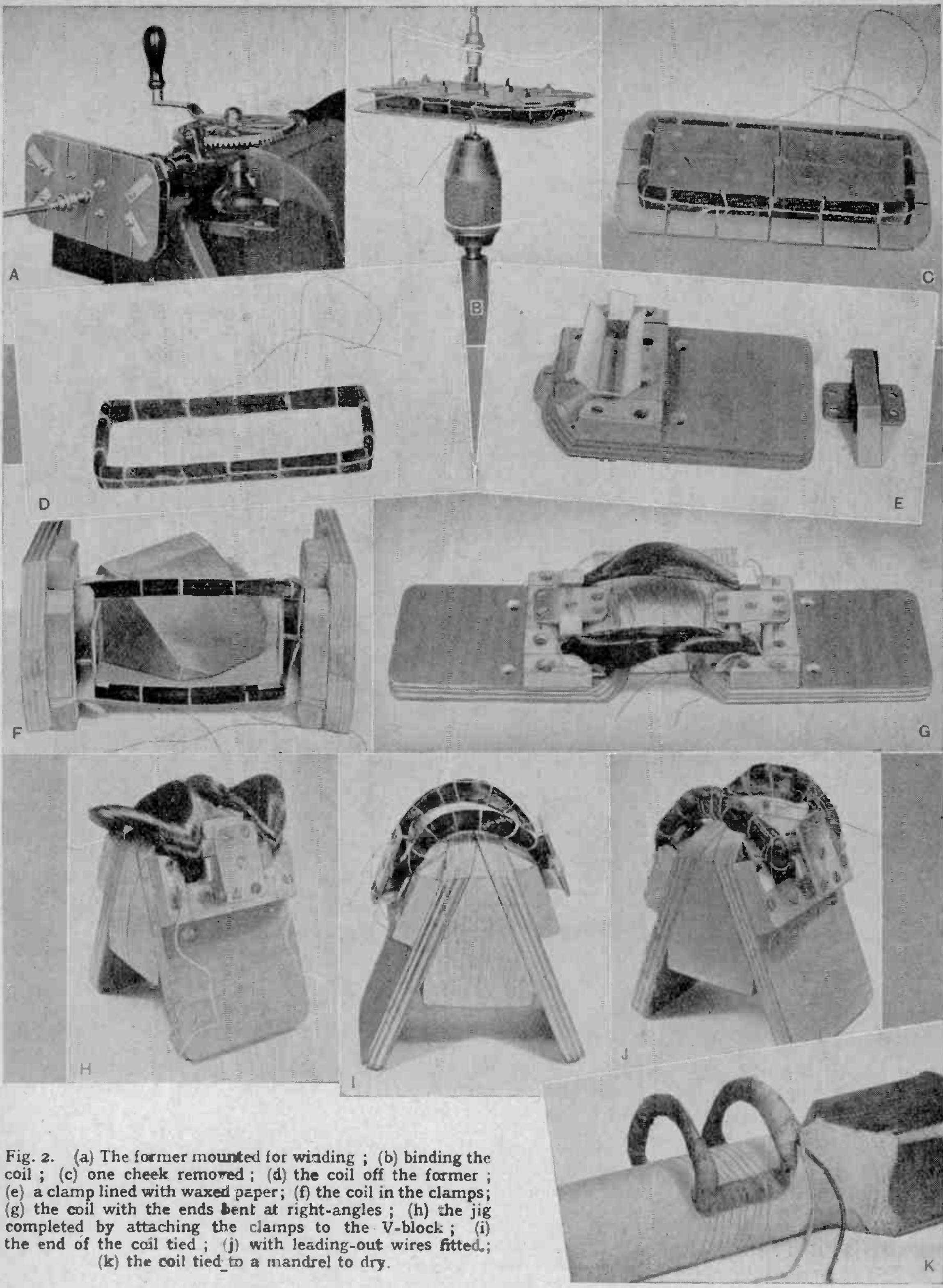


Fig. 2. (a) The former mounted for winding ; (b) binding the coil ; (c) one cheek removed ; (d) the coil off the former ; (e) a clamp lined with waxed paper; (f) the coil in the clamps; (g) the coil with the ends bent at right-angles ; (h) the jig completed by attaching the clamps to the V-block ; (i) the end of the coil tied ; (j) with leading-out wires fitted ; (k) the coil tied to a mandrel to dry.

wire comes on the binding. The ends of the windings should be soldered to the leading-out wire and the junctions covered with thin tape. The appearance of the coil at this stage is shown in Fig. 2 (j).

The coil is now in its finished shape. The sides should be shellaced, and it should be put aside until the shellac is nearly dry but not hard. The clamps should then be removed from the core piece, the clamping covers taken off, and the coil removed. The coil should now be taped and shellaced again for its protection.

The wax paper prevents the shellac from sticking the coil into the clamps, but as it is difficult to be certain of getting a complete covering of paper at the corners there may be a slight tendency to stick here. In view of this, it is wise to remove the coil before the shellac is hard, but after it has become surface dry. The coil will then be somewhat malleable, and may be distorted a little during the taping. As a last thing, therefore, the coils can be tied to a round rod, Fig. 2 (k), and manipulated to final shape just as in the case of the line coils (see part 2). They are left on this until the shellac is bone hard.

For the coil assembly a 2-in length of $\frac{3}{32}$-in wall, $1\frac{1}{2}$-in inside diameter tubing is needed. Paxolin tube is suitable, but a former can easily be made by winding 2-in gummed brown-paper strip on a $1\frac{1}{2}$-in rod. When quite dry it sets surprisingly hard and with a couple of coats of shellac, makes a very good former.

Take the pair of line coils and two spacers. The latter can be of Paxolin or wood, $\frac{3}{8}$in $\times$ $\frac{3}{16}$in $\times$ $1\frac{3}{4}$in. It is convenient but not essential to slip the former over a length of $1\frac{1}{2}$-in diameter rod which is held in a vice. Attach a length of thread to one end of one of the line coils at a point where it rests against the former. Place the two coils round the tube with the leading-out wires at the same end, drop the spacers between the straight sides so that the sides are separated by $\frac{3}{8}$in and hold the assembly temporarily in place with a rubber band. Now carefully line up the coils so that the sides lie parallel with the axis of the former and the ends coincide, and then bind them on to the former tightly with the thread already attached to the coil, finishing it off on one of the coil ends. A binding of about six turns per inch is adequate.

Remove the rubber band, cutting it if necessary, check that the coils are in their correct positions, for slight adjustment is still possible. Then give the surface of the former, the thread and the sides of the coils a coat of shellac. The pair of coils thus assembled is shown in Fig. 4.

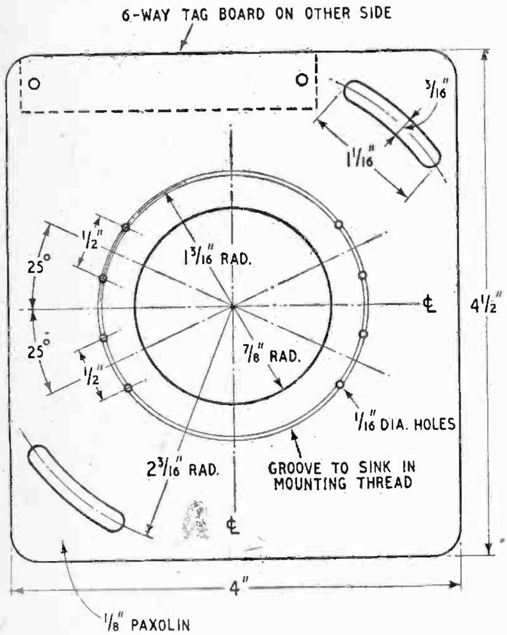


Fig. 5. Details of the mounting board which is bound to the coil assembly and which carries the tag-board for the connections.

When the shellac is dry, the frame coils are fitted in exactly the same manner, using another pair of identical spacers to separate their sides. They are, of course, mounted with the gaps between them at right angles to the gaps between the line coils. An imaginary line drawn across the end of the former and bisecting the spacers is a diameter of the former in the case of both pairs of coils. It is necessary that these imaginary lines for the line and frame coils should be at right angles otherwise the horizontal and vertical sides of the picture will not be at right angles. Slight final adjustment can be made after tying but before shellacing.

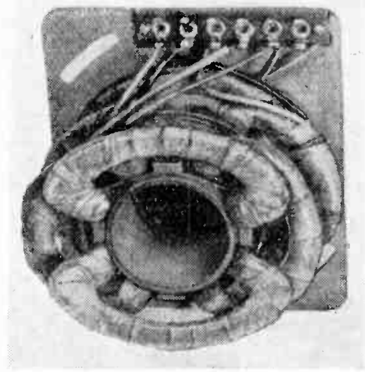


Fig. 6. An end view of the deflection yoke. The ends of the spacers between the side limbs of each pair of coils can be seen.

When the shellac is hard a turn or two of tape should be placed around the whole to protect the winding from the outer iron ring. This ring is by no means critical and can be built up from strips cut from old transformer laminations. The iron must extend for the full distance permitted by the frame coils otherwise the efficiency of the line scan will suffer. If iron of this width is available well and good, if not narrower strips must be used and cut so that a pair side by side will fill the space.

If long strips are available, again well and good, but if not shorter overlapping strips must be used. It will be rare for more than eight strips to be needed to form a single iron ring with half-inch overlaps. Two thicknesses of iron are desirable, so that not more than 16 pieces are needed. They are assembled round the middle and tied on with string.

In order to hold the assembly a Paxolin board, shown in Fig. 5,

Television Receiver Construction— is tied to the four corners of the line coils. This carries the tagboard for the connections and has two slots. These pass over bolts on the focus coil mounting and the assembly is retained by two knurled nuts. The purpose of the slots is to permit the deflector assembly to be rotated slightly about the tube neck, to bring the picture vertical.

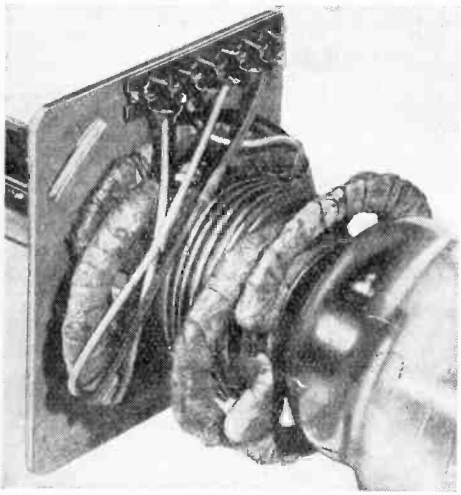


Fig. 7. Another view of the assembly. The string holding on the iron ring is clearly visible.

There are six tags on the board, three for line and three for frame, one of each being used for the junctions between the two coils of each pair. When the two coils of a pair are identical, the two outer ends (or the two inner ends) of each are joined together, the remaining two leads connecting to the time base. No difficulty arises in the case of the line coils for if the coils are both wound in the same direction they are necessarily alike. In the case of the frame coils, however, it is necessary not only to wind them in the same direction but to bend them the same way also.

The matter is not very important, however, for if a mistake is made and little or no deflection is obtained, it can be remedied merely by reversing the connections to one coil of a pair. Similarly it is not worth while to try to get the time-base connections right from the start for it is simpler to determine them by trial. If the picture is upside down or reversed left to right, it means merely that the connections to the pair of frame or line coils must be reversed. Two views of the complete coil assembly are given in Figs. 6 and 7. In the former the ends of the spacers between the sides of each pair of coils can just be seen, and in the latter the string binding the iron ring around the assembly is clearly visible.

The line coils have an inductance of 8.9 mH with a resistance of 15Ω, while the frame coils an inductance of 1 H and a resistance of 1.7 kΩ (2 kΩ with No. 41 wire).

Details of the time-bases and other associated equipment for use with the coils will appear in subsequent articles in this series.

MANUFACTURERS' LITERATURE

"MAGNET Steels and High-performance Magnet Alloys," a brochure giving technical specifications and performance curves of Jessop-Saville magnet steels, from William Jessop and Sons, Brightside Works, Sheffield, 1.

Illustrated leaflets describing Type B601 radio-frequency bridge (15 kc/s to 5 Mc/s), and Type B101 component bridge (50 c/s) for resistance, inductance and capacitance (including electrolytic condensers), from Wayne Kerr Laboratories, Sycamore Grove, New Malden, Surrey.

Leaflets giving technical details of oscilloscopes designed on the unit system, from Lydiate Ash Laboratories, Nr. Bromsgrove, Worcs.

"Marine Sound Equipment," an illustrated booklet describing complete ships' intercommunication and loudspeaker broadcast systems, and also "Diverphone" equipment for "diver-to-diver" and "diver-to-surface" communication, from Ardente Acoustic Laboratories, Compton, Nr. Guildford, Surrey.

Audio equipment by S.T.C. used in Radio House, Copenhagen, is described in an illustrated leaflet issued by Standard Telephones and Cables, Connaught House, Aldwych, London, W.C.2.

IONOSPHERE REVIEW

Sunspots and Short Waves : Long "H.F." Spell Predicted

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

DURING 1946 the solar activity continued its rapid increase and the critical frequencies of the ionosphere layers—and hence the Maximum Usable Frequencies for short-wave communication—increased in sympathy with it. In fact, it is possible but not certain that we may already be over halfway through the "rising" period of the present cycle, and that the maximum itself may be reached during the present year.

It is both interesting and informative, at the end of a year, to make a brief analysis of the sunspot and ionospheric data which is available for that year, with a view to finding out what changes have actually taken place, and how they have affected short-wave communication. With this knowledge at hand it is then advantageous to glance—though such a glance will necessarily be clouded by some uncertainty—towards the future. This is a practice which has been followed by *Wireless World* for some years past.

First, for the benefit of readers new to this subject, a few words about the nature of the data to be examined. One convenient way of obtaining evidence about the sun's activity, upon which the ionisation in the upper atmosphere depends, is to examine the sunspots which appear upon it. This is regularly done at many astronomical observatories, and the information published in the form of "relative sunspot numbers." These are arrived at by taking the sum of the total number of sunspots observed plus ten times the number of spot groups, this sum being multiplied by a factor depending upon the telescope used and the seeing conditions. The observations from the different observatories are correlated by that at Zurich and the final "number" published from there. Records of this index of the solar activity go back for many years, though, so far as 1946 is concerned, since they are not yet available, we have used those obtained by the Royal Observatory at Greenwich alone, and these are provisional numbers only. Measurements of the atmospheric ionisation are also regularly made in many parts of the world, and are usually published in the form of hourly values of the critical frequency of the various layers. This critical frequency is the highest frequency on which an echo is returned from a given layer when the exploring wave is sent vertically upwards. The Maximum Usable Frequency for communication over any distance depends upon the ionisation existing in the reflecting layer, and is related to its critical frequency at vertical incidence. As

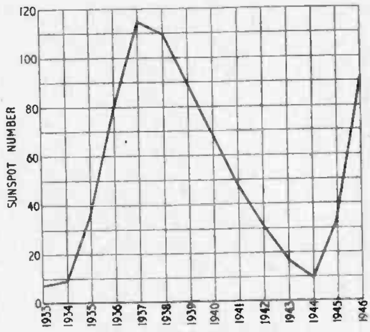


Fig. 1. **Annual means of relative sunspot numbers.**

a rough guide we could assume that the M.U.F. for the maximum distance it is possible to cover in one hop is about 3.5 times the critical frequency.

Course of the Sunspot Cycle.—In Fig. 1 are plotted the annual means of the relative sunspot numbers for some years past, in order to show the general course of the last and present sunspot cycles. So far as the present cycle is concerned we see that the solar activity has increased exceptionally quickly since the minimum year of 1944, and that during 1946 the increase was so rapid that the annual mean was somewhat greater than that for 1936, the year preceding that of the last solar maximum. Which naturally leads us to speculate about the future. Will the activity continue to increase during 1947? Will it reach a maximum during that year? If so, will this be higher or lower than the last maximum? All these are questions to which we should like to know the answer, but this is one, in point of fact, which only time can supply. We shall, however, later examine the predictions made by an authority on this subject. We may here remark on two points of interest about the present cycle. Firstly the activity has increased much more rapidly from the epoch of minimum activity than has been the case during most—though not all—preceding cycles; and secondly, if the coming maximum is to be a high one it will break the "high-low" sequence for maxima which has persisted since the maximum of 1848, and in which the maximum of 1937 was a high one.

Effects on the Ionosphere.—In Fig. 2 are plotted (bottom curve) the monthly means of the relative sunspot numbers since the time of the last sunspot minimum, and (top curve) the monthly means of the noon critical frequencies of the F2 layer over the same period, as measured in England.

So far as the sunspot activity is concerned it is seen that there are very considerable fluctuations from month to month, but also a general increase in activity since April, 1944. In 1946 February, July and November were months when solar activity underwent considerable increases. In the top curve we have the critical frequency variations due to seasonal effects superimposed on those due to the solar cycle. As will be seen, these seasonal effects are such as to produce low values of critical frequency in the summer and high values towards the winter, with the exception that there is, at each *mid* winter period, a secondary decrease. This mid-winter effect in the Northern Hemisphere occurs almost every year and was exceptionally pronounced during the winter of 1945-46. What interests us now, however, is not the seasonal fluctuations, but the general rise in the atmospheric ionization in sympathy with the variation in the activity of its producing agent, the sun. This is clearly evident and during 1946 was especially marked and of a large order. Compare the monthly mean for November, 1945 (8.3 Mc/s), with that for November, 1946 (12.1 Mc/s), an increase in critical frequency during the year of 3.8 Mc/s and a corresponding increase in M.U.F. for longest distance working of 10.5 Mc/s. The mean M.U.F. for working over a distance of 2,500 miles during November, 1946, in these latitudes come out at 40.7 Mc/s, a remarkably high value. This implies that on half the days of the month the M.U.F. at noon reached or exceeded this figure! On individual days it was often much higher, an example being November 21st, when it was 47.5 Mc/s. This gives some idea of the very high frequencies which could now be used, especially when one remembers that to the south of this country the M.U.F. will be still higher, because there the sun is more directly overhead.

These high theoretical values of M.U.F., obtained from the measured critical frequencies, seem to have been well borne out by practical results. During November, for example, signals from an American amateur transmitter in the 50-Mc/s band were well received in this country, and there is no occasion to doubt that the received wave travelled by way of the regular F2 layer of the ionosphere. Again, reception of British transmitters on frequencies above 40 Mc/s were several times reported from the West Indies and from South Africa. These results lead one to speculate as to what the high limit in frequency for regular long-distance communication during the next few years may be, and also to wonder whether plans already made are adequate for the exploitation of the higher frequencies in order that efficient communication may be maintained. There is evidence, in this connection, that frequencies as high as 17 Mc/s are becoming subject to undue ionospheric absorption over certain daylight routes, so that the use of higher frequencies than this seems necessary in the interests of efficiency.

It is interesting also to note, from these two curves, the effects of the erratic fluctuations in solar activity upon the critical frequency, though these are, in

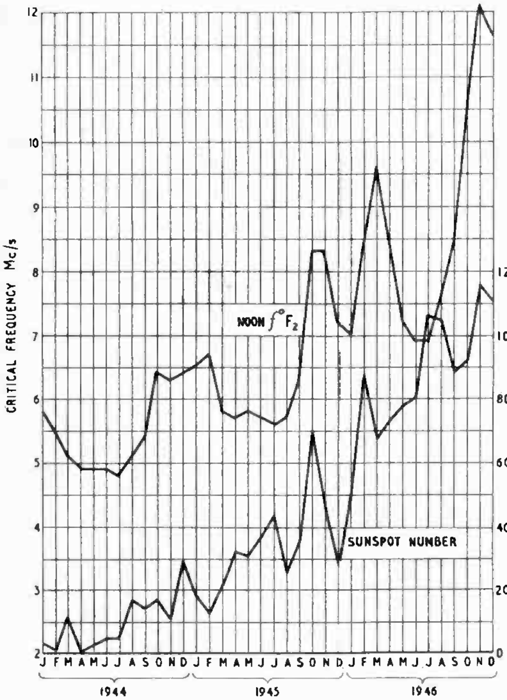


Fig. 2. Monthly means of relative sunspot numbers and of F_2 critical frequencies for noon for the past three years.

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many cases, obscured by the seasonal effects in the latter. Often, however, there is a retardation or enhancement in the seasonal variation in critical frequency which is clearly due to the suddenly changing sunspot activity. This shows that, apart from the long-period influence of the sun on the atmospheric ionization, this also responds to the relatively sudden outbursts and declines in solar activity.

Detailed Correlation and Future Prospects.—In Fig. 3 are given (full line curves) the twelve-month running average values of noon critical frequency in England, and of relative sunspot numbers. The object of taking twelve-month running averages is to smooth out the temporary fluctuations in the sunspot numbers and the seasonal effects in the critical frequency values, so that the long-period effects in both quantities may be more clearly seen. It is done by taking for the mean for the epoch at the centre of any month the average of the twelve monthly means having that month as the centre. The two curves show that there is exceptionally good correlation between the sunspot activity and the noon critical frequency when considered on a long-term basis, and that the latter follows the former according to a *substantially* linear relationship. However, there is some indication that the increase in critical frequency is now beginning to lag behind that in sunspot numbers. Between the epochs June/July, 1944, and June/July, 1945, for example, there was an increase in the sunspot number of 23.5 and in the critical frequency of 1.1 Mc/s, whilst the corresponding values for the period between the epochs June/July, 1945, and June/July, 1946, was 54.3 in sunspot numbers and 2.2 Mc/s in critical frequency. So that, although the sunspot number change more than doubled itself during the latter period as compared with the former the critical frequency change was only just twice as great. This slight departure from a linear relationship may not be of significance but it seems worth noting, having regard to the future. The good correlation between twelve-month running averages of sunspot numbers and of critical frequencies applies to all the ionosphere layers and for other times of day than noon, though the magnitude of the critical frequency change varies with the layer and time of day, being less for the E layer than the F and less at other times of day than at noon.

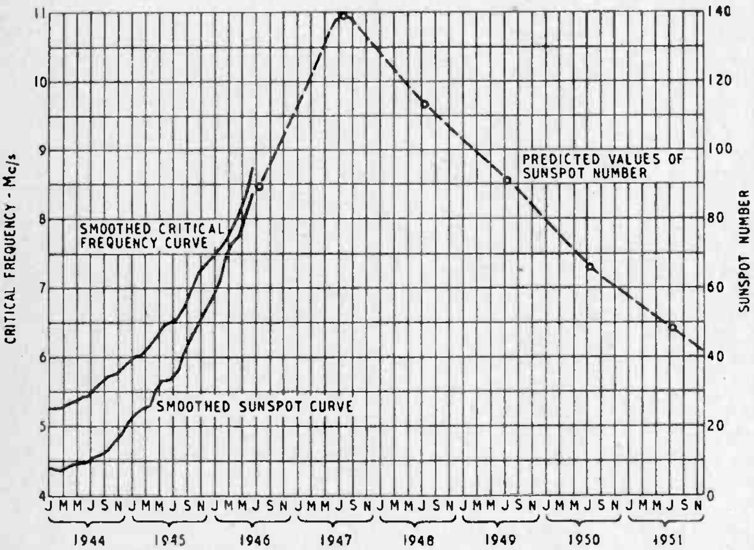

Fig. 3. Twelve-month running average of noon F_2 critical frequencies and of sunspot numbers, together with Waldmeier's predicted values of smoothed sunspot numbers.

We may now attempt to see what effect the increasing sunspot activity may have upon the critical frequencies during the coming year. Though, as has been said before, attempts to forecast the variations in sunspot activity some years ahead are not always successful, the predictions made by M. Waldmeier, of Zurich Observatory have, up to the present, been very accurate indeed. The twelve-month running averages as forecast by him for certain epochs in the cycle are shown by the encircled points in Fig. 3 up to the year 1951, and we may take the dashed curve as representing the coming trend in the twelve-month running average of sunspot numbers. It is seen that the maximum may occur in 1947, that it may be higher than that of 1937 and that, for the next five or six years thereafter the activity will most likely be decreasing. The running average for the middle of the present year may, therefore, have increased to 139, or about 50 above what it was at the same epoch in 1946, and, if the critical frequency should continue to follow in a similar manner to that which it has pursued in the past year, then we might expect its noon value to increase during the period by about 2.0 Mc/s to about 10.7 Mc/s.

But, for practical purposes, what we wish to arrive at is not the highest running average of critical frequency but the highest monthly mean we are likely to reach. It is not, of course, in the middle of the year that we should expect the highest daytime critical frequencies, but in early winter months. And it is not possible to deduce, from the twelve-month running average what the monthly mean for any one month will be, owing to the erratic month-to-month variations in solar activity. But, from a comparison of Figs. 2 and 3 we might hazard a guess that the highest daytime critical frequencies of the present cycle will occur about October or November of 1947, and that during the latter month the noon mean is likely to be of the order of 14.0 Mc/s. This implies that the mean noon M.U.F. for longest distance working in these latitudes next November should be

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of the order of 49.5 Mc/s, whilst on certain individual days it should be very considerably higher.

Working Frequencies during 1947.—There are several reasons, however, why frequencies as high as this are unlikely to be put to use during 1947 for regular short-wave communication. To mention only one—the working frequency for a particular transmission path depends, not upon conditions at one point in the ionosphere only, but upon conditions over a very large section of it. And since ionosphere conditions vary greatly with time of day, season of the year, and geographical and geomagnetic latitude and longitude it is unlikely that all these factors will combine at once so as to permit the propagation of such high frequencies on a regular day-to-day basis. But occasions when such results can be achieved should, of course, be much more frequent than at present.

But what of the frequencies likely to be of use for regular long-distance communication this year? Well, the detailed specification of such frequencies for all distances and directions over the world's surface is an extremely complex business, so all that can be given here are a few indications for a few long-distance circuits from this country, it being understood that these refer to frequencies regularly workable and not to freak results occurring on exceptional days.

For daytime transmission towards Africa frequencies as high as 29 Mc/s should be regularly workable during the daytime in the early part of 1947. These will probably decrease but slightly during the summer, and should increase to about 34 Mc/s next Autumn. The lowest frequency necessary for night-time working should be about 10 Mc/s during the early part of the year and by Summer 15 Mc/s should be usable the night through, whilst by next winter frequencies below about 14 Mc/s should seldom be really necessary.

For communication with South America very similar frequencies to those mentioned above should be usable, and the seasonal variations should also be similar.

Frequencies up to 26 Mc/s should be usable during the daytime for communication with the U.S.A. in the early part of the year, falling to about 22 Mc/s during the Summer and increasing to over 30 Mc/s next winter. For night-time use 9 Mc/s should be the lowest frequency required at first, whilst in the summer 15 Mc/s should last the night through, and 12 Mc/s be the lowest frequency really necessary next winter.

Communication with the Far East and India should be possible on frequencies up to 25 Mc/s during the early part of the year, on those up to 22 Mc/s during the summer and those up to 30 Mc/s next winter. During the night 8 Mc/s should be the lowest frequency required at first, rising to about 14 Mc/s during the summer, whilst next winter frequencies lower than about 11 Mc/s should not often be necessary.

As has been indicated, frequencies considerably in excess of those given should become usable on certain days, and we may expect that there will be considerable activity and some achievement by the amateur fraternity upon certain of these, such for example as 50 or 56 Mc/s.

As to the coming years the "falling" part of the sunspot cycle is practically always of longer duration than the "rising" part, so we may expect the higher frequencies to hold their own for some time to come. M. Waldmeier's prediction does not place the sunspot activity back to the level which now prevails till about the middle of 1949, so, all things considered, we may confidently expect "high frequency" conditions to prevail—at least during periods when the ionosphere is undisturbed—until at least the summer of 1950.

WODEN AMPLIFIERS

THE "Junior" and "Classic" amplifiers made by the Woden Transformer Co., Moxley Road, Bilston, Staffs, have been redesigned and the undistorted power outputs available are now 20 watts and 60 watts respectively. The price of the "Junior" amplifier is £27 10s and of the "Senior," £47 10s.

LETTERS TO THE EDITOR

Choosing Frequencies for Television ♦ "Functionalism" in Design ♦ B.B.C. Transmission Quality

Frequencies for Television

AN early statement should be made as to what band of frequencies in the radio spectrum broadcasting authorities propose ultimately to adopt for television; an early international agreement should be reached in this respect.

Whilst the present single London station on 45 Mc/s is giving satisfactory performance, disadvantages in the general use of frequencies as low as this are: (a) interference from widely separated stations in other countries by ionospheric reflection (this occurs quite frequently at sunspot maximum years), and (b) lack of sufficient channels (on an international basis) within the convenient tuning range of a receiver, especially bearing in mind that future television will require greater bandwidth.

To avoid (a) frequencies used should exceed 60 Mc/s. There is then no possibility of interference taking place on an international scale (except by tropospheric bending up to a limit of, say, 300 miles under best (or worst!) conditions).

Even considering the use of the present 40-50 Mc/s range so far as the establishment of a national service is concerned, immediate problems are apparent. Stations even 100 miles apart can interfere (by tropospheric propagation) with one another.

The French vision on 46 Mc/s, over 200 miles from here, is frequently a good signal, and it is understood that the Netherlands will shortly have 10-kW vision on 45 Mcs, which will probably cause trouble with the London station at times.

Recently the American F.M. stations around 44 Mc/s (particularly WGTR Boston 44.3 Mc/s) have provided signals here, at times, greater in strength than those of the London television signal, and the interference has been such as to completely spoil vision reception. It is understood that these F.M. stations have been directed to move to higher frequencies, but they represent only one example of what may be expected with the more general use of these frequencies. In the summer months the sporadic E layer will cause strong signals, up to 60 Mc/s, to be received from Europe, even in the evenings.

There would be some advantages in the use of frequencies over 100 Mc/s, particularly from the aspects of aerial size and wide channels.

There is an increased tendency to use pre-tuned straight receivers (admittedly an admirable arrangement in most respects) for the reception of the Alexandra Palace transmissions. One visualizes, however, difficulties with this arrangement when further stations come into operation in other parts of the country—a set for the London station would be of no use in Birmingham.

Presumably one possible way of overcoming this difficulty would be to put a mixer in front of a 45 Mc/s straight receiver and turn it into a variably tuned set for higher frequencies. D. W. HEIGHTMAN.

Clacton-on-Sea, Essex.

"Symmetry or Circuitry?"

I DISAGREE with your February Editorial; of course we should buy our broadcast receivers on their external appearance. So long as no performance figures are published we must assume that the manufacturer who hires the best designer hires the best engineers. And, anyway, the plumbing should be out of sight in the bathroom, not exposed in the drawing-room. Even for more serious radio engineering a dignified and balanced appearance may be regarded as a sign of a planned and unified design while a collection of miscellaneous panels on a rack is more than a suggestion of an equally haphazard design.

J. H.

B.B.C. Transmissions

IN your January issue H. A. Hartley writes with considerable emphasis on the subject of quality of B.B.C. transmissions. It would be almost as gross an exaggeration on my part to say that the quality of B.B.C. transmission is always impeccable and distortionless as it is for Mr. Hartley to make some of the statements in his letter. It is always difficult and frequently impossible to reply to or to refute charges of such a general nature, and I would ask Mr. Hartley, and for that matter any other of your readers who may wish to criticise B.B.C. quality, to get directly into touch with us and to refer to specific items.

I would agree with Mr. Hartley that the quality of B.B.C. transmission nowadays is not always of the uniform high standard which we were able to secure before the war and to which we are gradually trying to return. On the other hand, it is, I suggest, quite untrue to say that "there is no audible improvement whatever since the war." The replacement of temporary studios and improvements in studio acoustics need materials either in short supply or not obtainable at all, and the work is costly in skilled labour. Some delay is inevitable in our programme of acoustical work to catch up the years lost in the war.

Mr. Hartley dismisses recorded programmes with a sweep of the pen. The fact is that much of the B.B.C.'s output which finds enthusiastic approval from millions of listeners could not be achieved without the aid of recording. It is therefore our job to transmit these programmes at the highest possible quality, a task which is being considerably helped by our taking into service during the past year the first model of the B.B.C.'s own design of disc recording equipment, which is agreed by all who have seen it to be a considerable advance on any other disc recording equipment.

While it is our desire always to put out quality which will satisfy even the most "quality-conscious" of our listeners, it is, in my view, even more important to secure a generally higher standard of reception by the majority of listeners throughout the country. Unfortunately, the two are not always compatible, at any rate at present, when transmission is confined to the medium- and long-wave bands which are so congested that they do not provide sufficient space for our needs. H. BISHOP,

Chief Engineer, B.B.C.

Universal Transformer

WHILST reading A. S. E. Ackermann's "Scientific Paradoxes and Problems" recently, it occurred to me that the solution to the grocer's problem of weighing integral weights of material up to 40lb with the minimum number of weights is also a solution to the perennial problem of designing a really universal transformer for heater voltages, etc., for experimental work. The solution to the problem is see the fact that by suitable additions and subtractions the required integral numbers may be obtained from 1, 3, 9 and 27. The solution is general and may be extended for higher values. Thus, if a transformer is designed with the usual primary tappings and a number of secondary windings giving 1, 3, 9 and 27 volts respectively, by suitably combining the windings (with the aid of a chart) a very useful range of voltages up to 40 volts is available. The addition of an 81-V winding extends the range to 0-121-V in steps of 1-V, and so on. The transformer should be suitably marked so that the windings may be connected to give "phase assistance" or "phase opposition."

I do not know whether this principle is commonly known or used, but I do not recall having seen it applied or recommended anywhere However, in these days, when testing apparatus must be extremely versatile, it might profitably be given publicity. A. E. BROWN.
London, W.3.

Technical Assistants

W. H. CAZALY (your February issue) is wrong; the technical assistant is usually recruited from the local grammar school and does not realize until too late that he is in a dead-end job. He could acquire professional status, but no one tells him that until he is too old to start to do so.

As an academic specialist (or Head Wizard) I can assure Mr. Cazaly that I always come out of the clouds to say where the valve holders are to go; after all, the engineer is responsible for the job and its appearance. If he can't look after the practical side too he should retire to the sheltered cloisters of a Government Department.

THOMAS RODDAM.
London, S.W.

THE CUSTOMER IS ALWAYS RIGHT

"I DID not then have that high regard for the ability of our scientists that I subsequently acquired as the war progressed and as I saw their inventions pull us time and again out of a mess."

This statement by Marshal of the Royal Air Force Sir Arthur Harris[1] is a satisfying tribute from one of radio's best customers. At the beginning of the war "we had no conceivable means of identifying . . . an average-sized town"; towards the end of 1944 "we could hope to hit so small a target as the banks of a canal whenever we wanted to, in any weather. . . ." This advance was entirely due to radar. Every stage in the offensive war followed a new advance on the radar front: it is clear that without the aid of Gee, Oboe, H_2S, G-H and Window the war would certainly have been lost. Without the attitude of mind which assumed that the scientist was worth listening to, either on navigational aids or on operational research problems, the war would have limped on as inconclusively as the peace.

"Bomber Offensive" is the first clear account of just how the many scientific aids to warfare were used. The multiplicity of radio devices fall into a natural perspective in terms of the techniques and strategy of their period. We see the wood at last, with each tree making its contribution. Gee, first used seriously on the night of March 8th-9th, 1942, for a raid on Essen, begins the history rather unsuccessfully, for eleven major attacks during three months did no serious damage. Oboe was first used in December, 1942, and H_2S on January 30th-31st, 1943: on March 5th-6th, 1943, Oboe was used for its first major attack, on Essen, and now at last both Berlin and the Ruhr became vulnerable. With the dropping of Window on July 24th-25th, 1943, the radar war settled into its stride.

Of our bombing policy, the author writes: "there was nothing to be ashamed of, except in the sense that everybody might be ashamed of the sort of thing that has to be done in every war, as of war itself." Radio technicians who condemn "Bomber Command" must condemn themselves, for it was their work which helped to produce the fire-storms which wrecked Hamburg. Application of the same techniques to peacetime prosperity and stability might help to ease our consciences. T. R.

[1] *Bomber Offensive* by Sir Arthur Harris. Collins; 21s.

"TESTGEAR" MAINS RESISTOR

A NEAT wire-wound mains resistor measuring 3in × 1¼in overall has been produced by Morton & Dismore, 52c, Old Church Road, Chingford, London, E.4. The resistor which is available in two types, 1,000Ω at 0.2A and 600Ω at 0.3A, is space-wound with nickel-chrome wire on a cylindrical ceramic former and is provided with a tapping contact and 4BA one-hole fixing. The price is 4s 9d.

RANDOM RADIATIONS

By "DIALLIST"

An Ingenious Scheme

THE masthead photograph on the cover of the December *Wireless World*, showing the new Brookmans Park "anti-near-fading" radiator, probably made some of you feel a bit dizzy. Those of you who could study it without nausea probably wondered how the vertical radiator was adjusted to do its stuff. What was required was a circular horizontal polar diagram with the greatest possible non-fading radius. That means maximum ground-wave and minimum sky-wave. No doubt you grasped that the purpose of the adjustable booms at the top and of the variable inductor on the 400ft platform was to enable the current distribution in the radiator to be so regulated that this desirable state of affairs would be achieved. The coil is connected across the two sections of the mast and it was used for the final adjustments. Here's the way in which these were carried out. The transmitter was arranged to radiate square pulses. These were fed alternately to the mast and to a short aerial. The ground-wave range of the latter was short and observers were posted at places beyond its skip distance. Their receivers thus picked up one pulse from the sky-wave of the short aerial and the next from the mast ground-wave. The output of each receiver was fed to a double-beam cathode-ray tube, one display pulse-form being locked to the radiation from each radiator. There was thus no confusion owing to changing conditions in the ionosphere and the results of adjusting the loading coil could be observed immediately.

Some Coil!

The loading coil itself, by the the way, consists of turns of 4-core cable with a mineral insulation. But the cores don't form the coil. One pair carries the circuits for aircraft warning lights and the other that of a telephone to the masthead. The cable is sheathed in copper and it is that sheathing which constitutes the actual coil. The results achieved have come up to all expectations. To the south the soil conductivity is bad and here fading has been severe in the fringe region. The non-fading range was distinctly poor. With the new vertical radiator this has been increased by 35 per cent. To the north, where soil conditions are good, the range of the genuine service area has been lengthened by almost 75 per cent. There can't be much doubt that the new Brookmans Park vertical radiator is the most efficient anti-fading aerial in the world to-day.

□ □ □

The "Tron" Problem

MY colleague "Free Grid" asks "How did the suffix 'tron' originate?" Some "scolard," he suggests, may be able to provide the answer. Well, I don't never claim to be no scolard, but I think I can help. It all goes back to our old friend *electron*, the Greek word for amber (little did the first coiner of that word realize that amber was indeed to be forever!), which actually means "the shiny stuff." In the early days of wireless certain Americans, realizing that valve operation depended on a stream of ejected electrons (meaning electrons this time and not amber) thought it would be a good idea to make the termination -tron denote any piece of apparatus which functioned on these lines. Lee de Forest is not guilty, for he called the first three-electrode valve an audion. I rather suspect that Hull was the culprit with the dynatron. The man who first used electron as an English word was, I believe, Johnston-Stoney; he, therefore, is the founder and "onelie begetter" of the whole "tron" tribe.

How Many?

Toute la Radio produced some time ago a glossary containing the best part of a hundred trons. Last month it had to add a supplement, containing a further thirty. Some of these are mere trade names, but the majority have some kind of text-book authority behind them.

□ □ □

Aircraft and Ghosts

HAVE you noticed when watching a television screen the curious effect that may be caused by a passing aircraft? You see it best of all if a test pattern happens to be on the screen. "Ghosts" of the lines appear, sometimes considerably displaced from the originals. This effect is due to the arrival of the signals by two different paths, one direct and the other by reflection from the aircraft. I am told that it is something more than a nuisance when reception takes place near busy airdromes. Before the days of radar G.P.O. engineers had remarked on the interference which aircraft could cause with the reception of telephony *via* a U.S.W. radio link. An eminent television man with whom I was talking the other day told me that he thought that interference from aircraft would make the use of radio relays for television impracticable. I haven't enough experience of the effects of this type of interference to be able to express an opinion. Perhaps some readers who suffer from it will tell us whether or not they regard it as really serious.

□ □ □

Tuning Drives

IT beats me to understand why so many manufacturers of wireless sets still stick to detestable and unreliable tuning drives depending on loops of string and systems of pulleys. I am assured that there are good and dependable drives of this kind and I don't deny the possibility of the existence of such. My fate, though, is to encounter not such as these, but drives for which it is difficult to find printable descriptive adjectives. The pulleys become loose on their spindles in those that I try; the strings stretch or break. To set matters right you may have almost to disembowel the set and when you've done the job there's no guarantee that it won't have to be done all over again in the not-so-distant future. Servicemen, I find, share fully my hatred of these Heath Robinson contraptions, declaring roundly that they give them more unnecessary and uncongenial work than anything else in the make-up of wireless receivers.

BROADCAST RECEIVERS

PARTICULARS have been received of the first post-war radiogramophone to be produced by E. K. Cole, Southend-on-Sea. It is a four-valve (plus rectifier) superhet with a power output of 2 watts and, in addition to the usual short, medium and long wavebands, has provision for the reception of television sound. Five stations (three on medium and two on long waves) can be selected by push buttons. A spring-suspended Garrard turntable and pick-up is used and the four-position tone control is effective on both radio and gramophone. The price is £52 10s, plus £11 5s 9d purchase tax.

Ekco also announce that it is hoped to deliver substantial quantities of their Model CR32 car radio receiver before Easter. Five medium-wave and one long-wave station are now available for push-button control and a moulded pip is incorporated on the station-selector control to permit tuning by touch, thus avoiding distraction while driving. A Model CR60 with larger output has been designed for large saloons, coaches, etc. Telescopic and under-car aerials will be available.

A new "Cameo" universal receiver, Type EL80, has been introduced by Rees Mace Manufacturing Co., 40, Welbeck Street, London, W.1. This supersedes the Model U54A and consists of a four-valve (plus rectifier) superhet for 100-250 volts, with three wavebands and provision for pick-up and external loudspeaker. The dimensions of the plastic-fronted wood cabinet are 15in×9in×7½in and the price is £15 15s, plus £3 8s 6d purchase tax.

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

VELOCITY MODULATION

AN electron stream is velocity-modulated by passing it through a hollow resonator in the ordinary way. The "bunched" stream is then projected against a secondary-emission electrode, where each "bunch" liberates corresponding pulses of secondary electrons, though the effect is much more intense. The new electrons are released instantaneously, so that the frequency, or relative spacing of the amplified bunches, is not affected, whilst the output from the tube, whether used as an amplifier or oscillator, is greatly increased.

In a tube of the klystron type, the secondary-emission electrode is situated at the entrance to the second resonator, facing the collecting anode. A high potential of the order of 8,000 volts is required on the anode, though the other operating potentials need not exceed 400-600 volts.

Standard Telephones and Cables, Ltd.; J. H. Fremlin; and R. N. Hall. Application date May 24th, 1940. No. 577278.

BEAM SIGNALLING

ONE or more gas-discharge tubes are placed close in front of a short-wave beam transmitter, the longitudinal axis of each tube being set at right angles to the plane of polarization of the radiated waves. A glow-discharge is maintained through each tube by a steady D.C. voltage, on which a signalling voltage is superposed through a transformer in series with the supply.

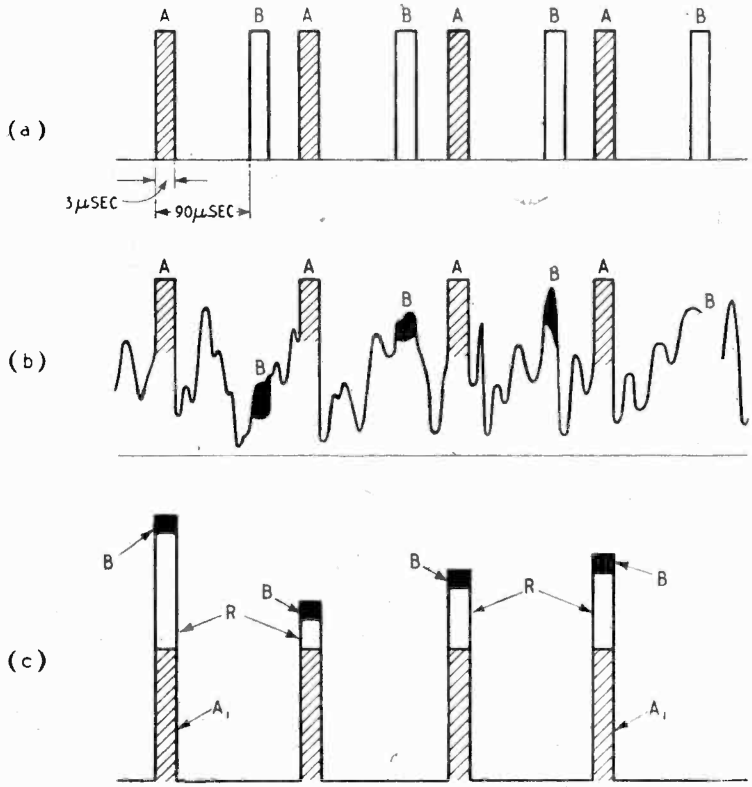
A narrow central zone of signals is thus created along the axis of the existing beam, and may be used either for the blind landing of aircraft, or for the remote control of mobile craft, or for point-to-point signalling, with a high degree of secrecy, and with little risk of unauthorized interception or of deliberate jamming. If the main beam is radiated from a horn-shaped aerial, the length of the cylindrical discharge tube should be about one-third the diameter of the horn.

H. Hughes and Son, Ltd.; A. H. W. Beck; and A. J. Hughes. Application date January 10th, 1941. No. 577458.

RADAR

THE effect of interference on the reception of pulsed signals, such as are used in radar, is minimized by utilizing the fact that whilst the signal recurs at constant intervals, the disturbance is random. In diagram (a), the echo signals B from exploring pulses A are shown under ideal conditions, whilst (b) illustrates the obscuring effect of interference.

According to the invention, the mixed output from the receiver is rectified and fed to one end of a time-delay line, whilst impulses A1 in diagram (c) (having the same frequency as the exploring signals A) are applied to the opposite end of the same line. Tapped off at equal distances along the line are a number of valves, each biased to respond only to voltages greater than those applied by the A1 impulses alone. Each valve is coupled to a condenser, which thus serves to integrate the combined effect of the echo signal B and the interference R, when these coincide with the passage of the timed impulses A1. The resulting indications, shown in diagram (c), can be identified with the position of the corresponding valve along the delay line, thus allowing the time interval between the original exploring pulse and its echo signal to be ascertained.



Reduction of interference with radar signals.

W. S. Percival. Application date November 30th, 1939. No. 577275.

TELEVISION AMPLIFIERS

AN amplifier is designed to give substantially linear results over the wide band of frequencies delivered by a television pick-up tube. In order to offset the increasing attenuation of the signals with frequency, across the resistance-capacity load circuit of the C.R. tube, there is included in the cathode circuit of the amplifier a degenerative resistance-capacity coupling having a time-constant equal to that of the load circuit, and a resistance which is determined by the impedance ratio between zero and the cut-off frequency of the signals to be amplified.

In a typical case, where the load circuit of the television tube was one megohm shunted by a capacitance of 25 μμF, a back-coupling resistance of 250,000 ohms, shunted by 100 μμF, was found to give linear amplification over a signal-band of 12 Mc/s. In practice, to avoid the necessity of applying large biasing voltages to the amplifier, the large ohmic resistance in the cathode circuit is replaced by the high anode impedance of a pentode valve.

Marconi's Wireless Telegraph Co., Ltd. (assignees of O. H. Schade). Convention date (U.S.A.), January 20th, 1943. No. 576277.

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WESTON 0.4in 0-250 micro amp meters, 57/6; selector relays, 4-bank 25 contact 37.5 ohms, 22/6; I.F. coils, 100 kc/s, ironed cored, 5/6 each; wire wound resistors, 1watt, 100, 5,000, 7,000, 35,000 ohms, 6d each; wire wound, 5watt, 100, 150, 200, 250, 400, 500, 600, 50 ohms, 1/6 each; transformers, 230 input, 350-0-350 90ma, 5v 2a, 6.3v 4amp, 3 times, 35/- each; 200-250 input, 540v, 4v, 6.3v, 22/6 each; 7/22 heavy duty hard twin rubber cable, 60/- per 100 yds.; Tannoy hand microphones, multi cell service type with switch in handle, 7/6 each; Sil mica con., 500, 440, 100, 80, 50, 40, 25, 15 p.f., 4d each, 3/- per doz.; chassis, 10½×6×3, 2/- each; 2mfd 250v, 1/6, 2mfd 400v 1/9; 0.1 1,000v, 0.25 2,500v 3/6 each; 0.25 3,000v, 0.1 3,000v 4/- each; 0.25 8,000 volt, 7/6; 0.1 10,000v 0.02 10,000 10/- each; sleeving 1mm, 2d per yd.; Westinghouse meter rectifiers, 5ma, 7/6 each; air spaced I.F. trimming condensers, 2/- each; screening cans, 3×2½×2½, 1/3 each; short reach jack plugs, 1/6 each; single headphones, low resistance, 3/- each; 1-1 intervalve transformers, 2/- each; mica discs, various sizes, very useful for condenser and insulating purposes, 2/- 250 mixed sizes; plus postage.
G. W. SMITH & Co. (RADIO), Ltd., 2, Cecil Rd., Southgate, London, N.14. Enterprise 5463. [7038

MILNS H.T. units, 2×120 volt, brand new units; offers over £5.—Box 6526. [7032

CHARLES BRITAIN RADIO.—A few selected lines from our latest list.
TRF coils, with reaction, medium, long wave, with diagram, 8/6 pr; superhet coils, all-wave, Ae. and Osc. with diagram, 10/6 pr; i.f. transformers, 465 kc. 12/6 pr; 2-gang condensers, 0.0005, less feet and trims, 9/- ea.
SPECIAL offers.—Moving coil mikes, undamaged, with metal grille, 5/- ea. damaged 1/6 ea; parcel of 36 assorted tubular condensers from 0.0001 to 0-5 mfd, all new, 10/6; parcel of 72 new assorted restistors, 1, ½ and ¼-watt, from 100 ohms to 1 meg, 12/6; special parcel of new and used goods, exceptional value, £1; money refunded if not satisfied.
Charles Britain (Radio), Ltd., Radio House, 2, Wilson St., London, E.C.2. Tel. Bis. 2966.

UNIVERSAL ELECTRONIC PRODUCTS (G8UQ), 36, Marylebone High St., London, W.1. Tel. Wel. 4058.
SLOW motion drives: Precision built gear boxes giving 2 ratios of 4½ and 40-1, free from backlash, ideal for receivers, instruments, etc.; few left at 15/6, postage 6d.
BFO screened coil units, 465kc/s i.f.; at 5/6, postage 3d.; send s.a.e. for lists.
R1155: If you are disappointed with the results from your existing set let us convert it into a really efficient communications type receiver; power packs supplied to order.
OUR works are available for the construction of all types of radio and electronic equipment, from an extension spindle to a complete 500-watt transmitter. As practical people with a wide knowledge of the amateur's requirement we may be able to help you. [6986

G. J. BUSH, manufacturer of transformers and chokes; price list sent on request; trade supplied.—13, Sunland Av., Bexleyheath.

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INDUCTOR ALTERNATORS. 400 watts single or 3-phase 50 cycles 230 volts. Separate 12 volt excitation, speed 2,800 r.p.m. 4 poles, ball bearings, totally enclosed, made to Government specification; as new, **£8/10/-.**

D.C. DYNAMOS. 6 volts 10 amps., **£4.** 12 volts 10 amps., **£4/10/-.** 24 volts 40 amps., **£10.** All 1,000 r.p.m. 30 volts 5 amps., **£7/10/-**, 1,500 r.p.m. 50 volts 10 amps., 1,000 r.p.m., **£10.** 100 volts 4 amps., 2,800 r.p.m., **£10.** All in good condition and running order.

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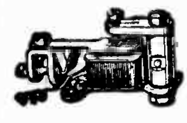

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DOUBLE WOUND TRANSFORMERS. 230/12 volts 21 amps., totally enclosed, **75/-**, 230/20 volts 2 amps., **30/-**, 230/12 volts 3 amps., **32/6**, 230 v./3-5-8 volts, **7/6** bell type.

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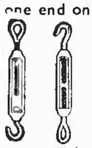
SMALL A.C./D.C. MOTORS. 1/27th h.p. 230 volts 4,000 r.p.m., with shaft extension at one end only, **70/-.**



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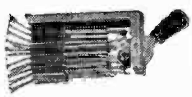

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ELECTRADIX RADIOS
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Telephone: MACaulay 2159

CONDENSERS, 3-gang, .0005 with trimmers, 10/6 each; c.o.d. only.—Write Radio Service Co., Baker St., Gorleston. [6954

ALIGNED INSTRUMENTS SERVICES, 1, Colworth Road, Leytonstone, E.11.—40 COIL PACK: A superhet coil pack with an H.F. stage. Uses 9 iron cored coils in a 16-50, 200-500 and 800-2,000 metres circuit for 465kc/s. I.F.; complete with circuit diagram, aligned and gain tested, this coil pack enables the amateur with no signal generator to construct a 1st class all-wave receiver; price £3/10. Circuit diagram only, 2/6 post free.
30 COIL PACK SERIES: A famous series of precision made coil packs now too well known to need description. Superhet types: Model 30, 16-50, 200-550, 800-2,000, at 42/-; 30A, 12-30, 30-75, 75-200, at 42/-; 30B, 16-50, 200-550, at 30/-; 30C, 200-550, 800-2,000, at 30/-; 30S, 12-30, 30-75, 200-550, at 42/-. TRF types: Model 30D, 16-50, 200-550, 800-2,000, at 35/-; 30E, 12-30, 30-75, 75-200, at 35/-; 30F, 16-50, 200-550, at 27/6; 30G, 200-550, 800-2,000, at 27/6. Each is complete with circuit. Circuits only 2/6.
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TUNING CONDENSERS: 2-gang matched to all our 30 coil pack series, price 15/-; 3-gang matched to our 40 coil pack, price 17/6. These condensers ensure that correct alignment and waveband coverage is maintained. Many other interesting A.I.S. products available. Send stamp for new price list. Terms: Cash with order or C.O.D. No C.O.D. under £2. Over £5 post free. [7023

COULPHONE RADIO, 58, Derby St., Ormskirk, Lancs.—The return of post mail order service. New goods only, C.w.o. or c.o.d. post free over 5/-. Tungsram, B.V.A. and American valves, Barretters C9266, K55H, K52H and K52B, 8/6 ea.; mains transformers, primaries 200/230/250, (a) 300v 60ma with 6.3 and 5v or 4v l.t.s, 19/6; (b) 350v 100 ma l.t.s as (a), 25/-; 450v 200ma, 4v 8a, 4v 4a, 4v 4a, 42/6; 450v 200ma, 6.3v 4a, 6.3v 4a, 5v 3a, 42/6; 450v 200ma, 6.3v 6a, 4v 2a, 4v 2a, 5v 3a, 45/-; filament 6.3v or 4v, 15/6; auto 4v to 6.3v, 12/6; smoothing chokes, midget 360Ω, 5/-; 60ma 425Ω, 6/-; 90ma 340Ω, 7/-; 100ma 425Ω, 12/6; 200ma 150Ω, 21/6; fluorescent 80w, 25/-; twin suppressor, 2/9; output transformers, midget pow/pen, 5/6; std. univ. p/p, 6/6; large univ. p/p, 10/6; H.D. univ. 80ma, 21/-; ex-H.D. univ. 100ma, 32/6; spec. p/p PX4s, 22/6; Belling Lee type B insulated terminals, 8d.; kits with construction manual, complete with valves, 4v t.r.f., £8/10; 5v 3W.B. superhet a.c/d.c., £12; a.c., £12/10; prices include P. Tax; B3 tuning units, 3W.B., with r.f. stage, £8/15; kit of parts, £6/12/6; speaker fret material, 14in×12in, 3/-; B.P.L. test meters, £8/17/6; Avominor universal, £8/10; Qualrad signal generators, £15/15; Qualrad resis. and cap. bridge, £12/10; send 2½d. stamp for 18-page catalogue with useful formulæ.

ROTARY transformers, brand new, ex-Govt. stock, with 6v input, output 200v at 50ma continuous, or 150v at 80ma up to three hours, with 12v input, output 480v at 40ma continuous or 400v at 80ma up to three hours, size, length 7½in, height 3¾in, weight 6¼lb, ideal for car radios, mobile amplifiers, etc., original price £7/7, each 25/-; midget m. wave, t.r.f. coils, high gain, 5/-; m.l. wave, with reaction, circuit, 7/6; m.l. wave, iron cored, adjustable cores, circuit, 10/6; s.m.l. aer. and osc. coils, circuit, 10/6; Weymouth midget i.f.s. iron core, 465 kc/s, per pr. 18/9; standard i.f.s. 465 kc/s, per pr. 15/-; Weymouth all-wave coil pack 36/6; 2-gang condensers, 0.0005mfd, 12/6; Tiny Tim ditto, fitted trimmers and perspex dust cover, 2in×1½in×1½in, 17/6; speakers, miuus tran., p.m., 5in, 21/-; ditto p.m., 6in, 27/-; speaker fabric, heavy quality, 8in squares, 1/-; volume controls with switch, long spindle, 10,000 ohms, 25,000 ohms, ¼, ½, 1 meg. 6/-; wire-wound pots., 2,000 ohms and 50,000 ohms, 4/-; Paxolin valveholders, English-America, all types, 9d each, 8/- doz; screened valve top caps, English and octal, 9d each; moulded octal holders, 1/-; coloured ivorine dials, s.m.l. wave, 4×3½in, 2/-; 5×5½in, 2/6; 6×5in m.l wave, 1/6; slow motion drum drive, 3/-; epicycle drives, 3/3; Rothermél Senior piezo crystal pick-ups, 56/3; car aerials, roof mounting, chromed, screened lead-in, 30/-; midget cabinets, cream and green, 13in×7in ×6in, 40/-.
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Once again we can make a limited quantity of Radiogram Cabinets, at first only for manufacturers holding a timber permit, but soon we hope to deal with some of the many individual enquiries received.

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We believe this cabinet to be exclusive and with acoustic features not found in ordinary commercial cabinets. Like all good things it will be expensive, but we would rather produce something good or not manufacture at all.

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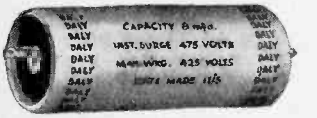

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SANGAMO Synchronous Motors, self-starting, exceptionally good torque, rotor speed 200 r.p.m.; 200-250v A.C., 50c, consumption 2½ watts, size 2¾x2, geared 1 rev 60 min, can be reset to zero by friction drive from front or back, shaft ⅝inx1/10 to run clockwise, ideal movements for making electric clocks, time switches, etc., nickel-plated finish; price 22/6 each; 12-to-1 dial trains to fit above spindle, per set 2/6.

CHAMBERLAIN & Hookham synchronous motors (enclosed type), self-starting, exceptionally good torque, rotor speed 200 r.p.m., 200-250v A.C., 50c, consumption 3 watts, size 2¾x2, geared 1 rev 60 min, can be reset to zero by friction drive from front or back, shaft ⅝inx1/10, to run clockwise, ideal movements for making electric clocks, time-switches, etc., nickel-plated finish; price 25/- each; 12-to-1 dial trains to fit above spindle, per set 2/6.

MOVING coil headphones, P.M., energised by Alni magnets, 45 ohms, ½in coil, ideal for mikes, miniature loudspeakers, etc., 1½in overall, in bakelite cases, with 3in front flange; 6/6 each.

MOVING coil microphones, fitted as hand mic. with switch in handle, 45 ohms speech coil, 10/- each; throat microphones, fitted with elastic bands, 'phone, plug 15 ohms speech coils, etc., 7/6 each; respirator carbon microphones, fitted, 'phone plug, lead, etc.; 5/6 each.

15 AMP mercury switches, enclosed bakelite tubular cases, 2½inx¾in, fitted swivel saddle, connector block, etc.; 5/6 each.

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REMOTE contactor units, 6-24 volts D.C., fitted with relay and gears, etc.; 10/- each.

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6-VOLT vibrator units, complete with vibrator, smoothed output 150-volt, 30 ma D.C., ideal for car radios; 25/- each.

PRE-SET lamp-holders, suitable up to 500 watts, sturdy construction; 3/- each.

MANGIN mirrors, 2½in, hole in centre ¾in dia; 3/6 each. Relays, 110-volt, 1,600-ohm coils, makes ideal 200-250v A.C. mains buzzers, 3/6 each.

DIMMERS, 220-volt, 2,700-ohm .27 amps, stud control, in brass cases 7x7x4, 30/- each.

CASH with order, post paid on all above goods. To callers only; a comprehensive stock of scientific instruments, meters, gears, relays, etc.

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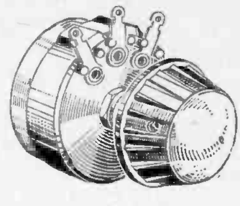

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Continuous Wire-Wound

(as illustrated)

Rating: 5 watts (linear)
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Ranges: 10-100,000 Ω linear Max
100-50,000 Ω graded ,,
100-10,000 Ω Non-Inductive

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W.W.57

HENRY'S RADIO.—A few more items from our comprehensive stock of components; send stamp for list.
SPECIAL.—Midget I.F. unit, in aluminium can. 4¼×2⅝×1in. comp. 1T4 valve, iron-cored midget, I.F. trans., 465 kc/s, and 8 midget resistors and condensers, 15/-; B.F.O. unit, as above, comp. 1S5 valve and oscillator coil, 12/6; regret other units previously advertised now sold; H.T. metal rectifiers, 260v, 60 ma 10/-, 280v 120 ma 15/-, 600v 300 ma 30/-; headphones, moving coil, 100 ohms, 7/6 pr.; carbon mikes, with switch, 9/6; electrolytics, 4 mfd, 150 vw micropack. 2/9; 4 mfd 200 vw, 2/-; 500 mfd 12 vw block, 4/-; 15 mfd 200 vw, 3/6 mainsbridge 1 mfd 1,000 vw. 3/- (small), 2 mfd 1,500 vw, 6/-; 4 mfd 1,000 vw, 7/6; tuning condensers, 2-gang, 0.0005, trimmers 12/6; less trimmers, 10/- extra special. Midget 2-gang 0.0005, with trimmers, vanes, covered Perspex, 2×1½×1½in, 14/6; speakers, 5in P.M., less trans., 19/-; 6½in P.M., w/trans., Rola, Plessey, Goodmans, 27/6; 8in P.M. w/trans., Celestion, 27/6; I.F. trans., Standard, 465 kc/s, 15/- pair; 110 kc/s. 12/6 pair; Midget, Weymouth 18/9 pair, Wearite 10/6 each; Epicyclic drives, 2/6; valveholders, Amphenol, all types British and U.S., 9d each, 7/6 doz; button type, 1/-, Loctal 1/- each, Ceramic EA50. 1/6; chassis, strong, well finished, drilled 4-valve holders, standard T.R.F. A.C./D.C., speaker cut-out, 11×4½×2in, 4/6; also chassis for Weymouth circuit, drilled completely, 6/6; C.R. tube holders, 12-pin, 2/-; car radio components, vibrators, 6 or 12v, 4-pin, 9/6; 6v transformers, 15/-; voltage dropper, 12v to 6v, 7/6; special, 6v supply unit, 5½×5×5in, 200v 60 ma, completely smoothed, ready for working, brand new, 75/- each; gram motors, Garrard, single-spring, 10in turntable, new, 35/-; over 6,000 new valves in stock; many more unparalleled lines.
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TRANSFORMERS for every purpose, highest grade workmanship, competitive prices, immed. delivery; test gear trans for bridges, oscilloscopes, valve testers, etc.; list.—Radio Services, Field St. Works, Blackpool. Tel. 1250.

OSMOR Radio Heart equals complete first class 5-valve superhet, positively only small condensers and resistances to find, super efficient components, building instructions: £5/16; cabinets; trade invited.—Morgan Osborne, Ltd., Southview Rd., Upper Warlingham 2560, Surrey. [6226

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RESISTANCES, assorted 1watt, ½watt, ¼watt, all useful standard sizes from 82ohms to 2meg, our assortment only, 40 for 5/-; also special offers 1,800 wire wound, 1/- dozen; 2,000ohm non-insulated, 1/- dozen; 33,000 3watt, 3/- dozen; vitreous 20watt, 2/- each; also 2watt 150,000, 220,000, 36,000, 470,000, 820,000, all 3/- dozen; panels with screened 0.1mf and 12 ½watt resistances, 2/3 each; twin trimmers, 30mm, separate connections, 3 2/- (6); octal plugs with metal caps and chassis type sockets, 3 2/6; with solder tags, 3 3/-; valve holders, U.S.A. 4-5-6-pin chassis types, first class make, to clear at special price of 3/- dozen; Mansbridge 4mf 250v, will work O.K. on 350v, made for A.M., 1/6 each; volume controls, less switches, short spindles, ¼meg metal cased, ¼meg bakelite, 1meg bakelite, all 1/6 each; bakelite 300ohm pre-set, 1/6; Yaxley type short spindle switches, 9-way, 2/6; special type 3-bank, 4-way, with middle screen, 2-pole, 3/9 postage 8d. on singles; double type mike and phone transformers secondaries, 175, 45, 10ohms, 5/-, postage 9d.; power microphones, work direct into speaker, unissued stores, 20/- each; Yaxley switches, some require alteration, single and double bank, 12/- dozen to clear; Paxolin strips, polished, Govt. quality, about 4ft long, 2in to 4in wide, about ⅜in thick, prices 2in 3/9, 4in 4/9, both post free; panels of standard quality Paxolin, 4ft×2ft, ¼in, 30/- each, carr. extra. [6980

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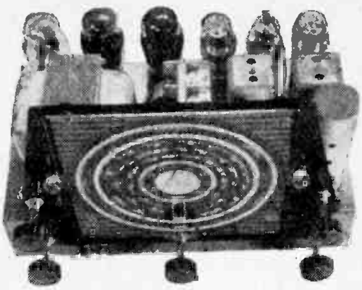

Model EXP83

As announced in November, we have developed an 8-valve Universal Chassis on the lines of our now popular EXP83. This was in response to many requests for a good quality receiver for use on either D.C. or A.C. mains. This new chassis is our

Model UNI-83

ALL-WAVE 8-VALVE SUPERHET CHASSIS incorporating wave-band expansion, e.g. the 16-50 m. band covers just over 20 inches on the large glass scale, treble boost control, gram switching, all controls work on both radio and gram, high quality push-pull output giving 6 watts audio. For 200-250 v. D.C. or A.C. mains.

Provisional Price **14 gns.** *plus tax.*

Model EXP83

ALL-WAVE 8-VALVE SUPERHET CHASSIS incorporating wave band expansion. Large glass scale treble boost control. Gram. switching. High quality push-pull output gives 10 watts audio. For 100-250 v. A.C. mains.

Price **14 gns.** *plus tax*

Model EXP53

ALL-WAVE 7-STAGE RADIOGRAM CHASSIS This new radiogram chassis incorporates wave-band expansion on all bands. Volume and tone controls work on both Radio and Gram. 4½ watts R.C. coupled output. **Supplied complete with full size loudspeaker.** This chassis has a lively performance, good quality reproduction, and represents excellent value. For 200-250 v. A.C. mains.

Price, with speaker **£13** *plus tax.*

Model EXP43

ALL-WAVE SUPERHET FEEDER UNIT incorporating wave band expansion manual I.F. gain control, etc.

Price **11 gns.** *plus tax.*

● We very much regret that, owing to the continual rise in cost of materials, it may be necessary to increase the above prices slightly by the time this advertisement appears.

Demonstration Sets are now available for interested callers to hear and illustrated technical specifications are now ready.

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ALSO all types of English and American valves, mains transformers, chokes, condensers, line cord, and test gear by Avo, Weston, Hunts, and Evershed and Vignoles, all at B.o.T. list prices, and many other lines; 1d. stamp brings list and replies; no order too large or too small.—15, Little Newport St., W.C.2. Tel. Ger. 6794. Hours 9-6, Sat. 9-2.

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LAMINATED bakelite panels, ⅛in thick, 6in ×4in, 1/6; 6in×6in, 2/-; 8in×6in, 2/6; 10in×6in. 3/-; 10in×8in, 3/9; 12in×8in, 4/6; ditto 1/16in thick, same sizes, 1/-, 1/4, 1/8, 2/-, 2/6, 3/-; polished ebonite panels, 3/16in thick, sizes as above, 2/-, 3/-, 3/9, 5/-, 6/6, 7/6 respectively; B.A. screws, gross useful sizes, 2/6; ditto, nuts, 2/6 gr.; assorted gross screws and nuts, 2/6; brass washers, 1/6 gr.; fibre washers, 1/6 gr.; assorted soldering tags, 2/- gr.; assorted small eyelets and rivets, 1/3 gr.; finest quality stranded and single push-back wire, 12 yds, 2/3; resin-cored solder, ¼lb 1/-; new ex-G.P.O. hand telephone with microphone, switch and cord, 12/6; used ex-R.A.F. low resistance earphone with switch, bargain, 2/6; all postage extra; trade supplied.—Post Radio Supplies, 33, Bourne Gdns, London, E.4 [6760

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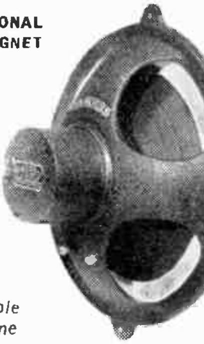

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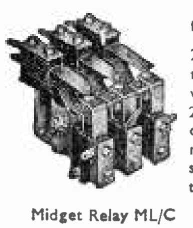

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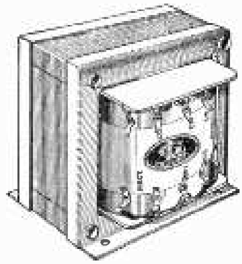

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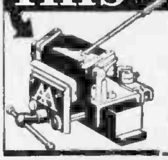

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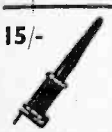

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