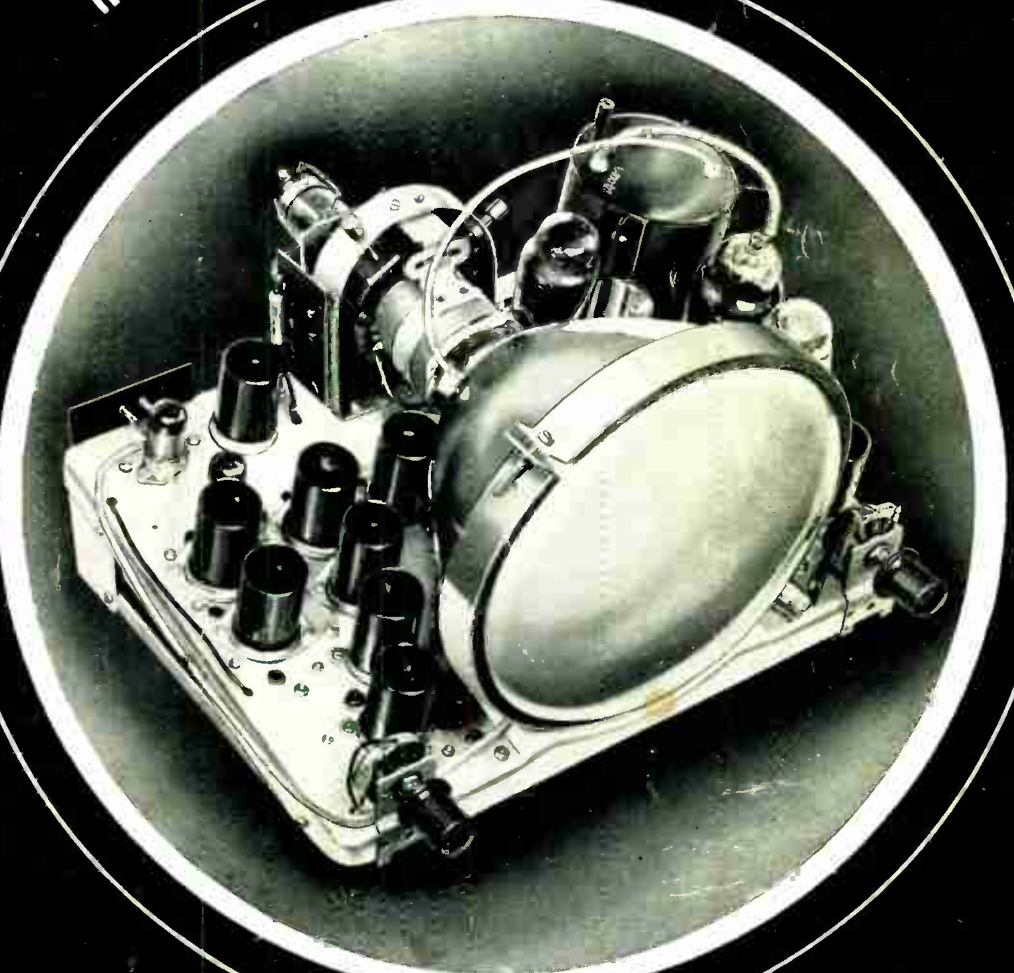
Wireless World

RADIO AND ELECTRONICS



DEC. 1948

1/6

Vol. LIV. No. 12

IN THIS ISSUE: BUILDING AN OSCILLOSCOPE

Interference? never heard of it!

Never had your favourite programmes spoilt by a background of hissing, crackling and spluttering noises? No? Lucky you! But for thousands living in towns and cities near industrial electrical apparatus, near trolley-bus routes or in the vicinity of high-frequency equipment such interference is only too common.

B.I.Callender's Anti-Interference Aerial when properly erected, will give you better listening nd reveal many stations you never heard before.

The aerial is a 60ft. polyethylene insulated dipole type with suspension insulator and matching transformer. The 80ft. down lead is a fully screened coaxial cable with polyethylene plugs moulded to each end; it is matched to the receiver by a transformer with easily fixed suction mounting.

It acts as a "T" type aerial on long and medium waves and as a true dipole on short waves.

Write to-day for descriptive folder No. 221S on "Anti-Interference Aerial."

Licensed under Amy Aceves & King, Inc. Patents Nos. 413917, 424239, and 491220.

B.I. Callender's *All-Wave* ANTI-INTERFERENCE **AERIAL**

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

AVO
REGD TRADE MARK

Precision
ELECTRICAL TESTING INSTRUMENTS

The Model 7 Universal AVOMETER

The world's most widely used combination electrical measuring instrument. It provides 50 ranges of readings on a 5-inch hand-calibrated scale fitted with an anti-parallax mirror, and is guaranteed accurate to B.S. first grade limits on D.C. and A.C. from 25c/s to 2Kc/s.

The meter will differentiate between A.C. and D.C. supply, the switching being electrically interlocked. The total resistance of the meter is 500,000 ohms.

CURRENT: A.C. and D.C. 0 to 10 amps.
VOLTAGE: A.C. and D.C. 0 to 1,000 volts.
RESISTANCE: Up to 40 megohms.
AUDIO-FREQUENCY POWER OUTPUT: 0—4 watts.
DECIBELS: —25Db. to +16Db.

BRITISH MADE

The instrument is self-contained, compact and portable, simple to operate and almost impossible to damage electrically. It is protected by an automatic cut-out against damage through severe overload.

PRICE
£19 : 10s.

Various accessories are available for extending the wide ranges of measurements quoted above.

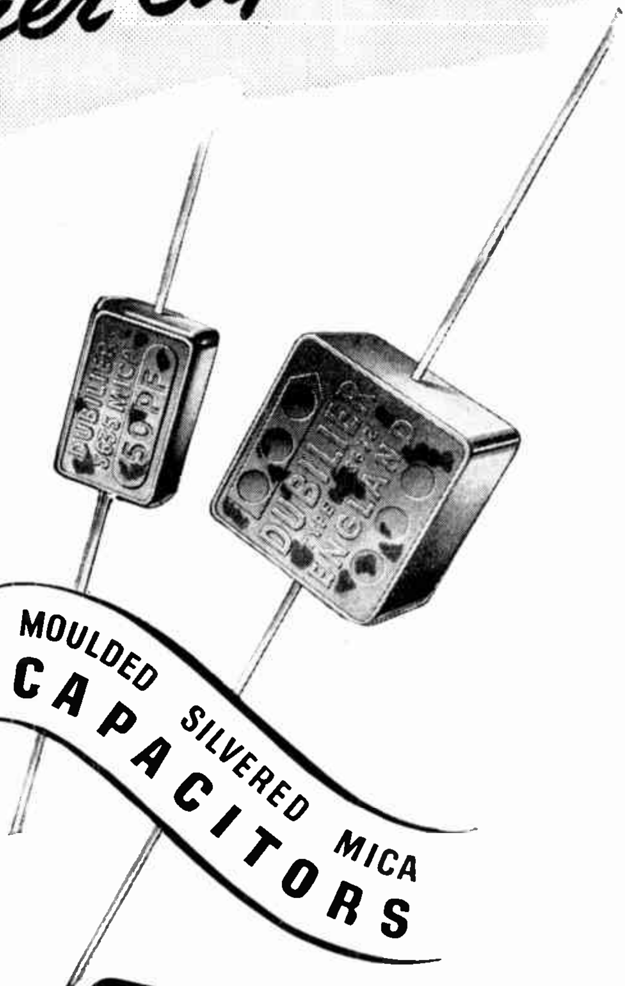
Size: 8" x 7¼" x 4½".
Weight: 6¾ lbs. (including leads).

Fully descriptive pamphlet available on application.

Sole Proprietors and Manufacturers:—

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

Another New Dubilier Capacitor



- Moulded in special bakelite and treated to resist humidity.
- Exceptional stability is obtained by the design and method of manufacture of the silvered mica plates.
- Engineering features provide for compactness, robustness and lightness of weight.

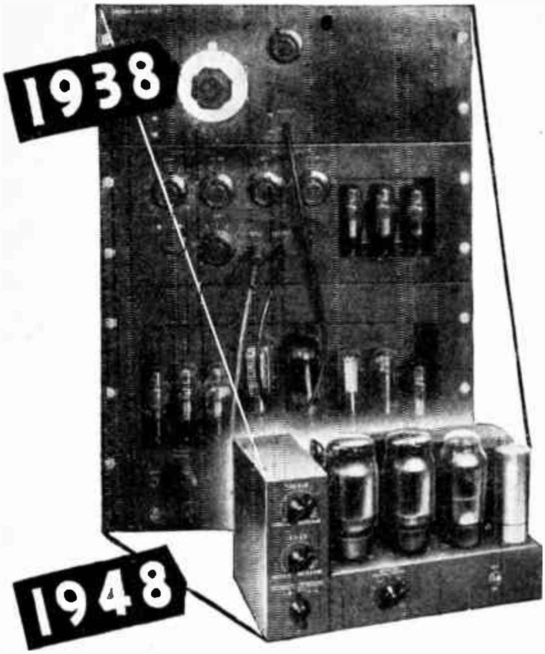
These capacitors are available in two types, in compact form, and cover the capacitance ranges detailed below.

S635	5 pF to 1,500 pF	350 V.D.C. Wkg.
S635	50 pF to 300 pF	750 V.D.C. Wkg.
S672	1,800 pF to 10,000 pF	350 V.D.C. Wkg.

DUBILIER
CONDENSER CO. (1925) LTD.

DUBILIER CONDENSER CO. (1925) LTD., DUCON WORKS, VICTORIA ROAD, NORTH ACTON, W.3
Telephone: Acorn 2241 (5 lines) Telegrams: Hivoltcon, Phone, London Cables: Hivoltcon, London. Marconi International Code

D13



Evidence of PROGRESS

The illustration above shows an ACOUSTICAL product of ten years ago—an amplifier designed for high quality reproduction of records and radio programmes.
Using push-pull triodes throughout—RC coupled throughout—independent treble, middle and bass controls etc., it was considered about the best that could then be obtained. Indeed the circuit is often specified today for high quality reproduction.
A comparison of the performance with that of the QA12/P reveals the extent of recent developments.

	Pre-War	QA12/P	Improvement achieved
Output deviation within 20-20,000 c.p.s. range ...	3 db	0.3 db	7 times better (% power change).
Frequency range within ± 1 db ...	30–15,000 c.p.s.	15–30,000 c.p.s.	Increase of two octaves.
Total distortion at 10 watts (Both models rated 10–12 watts).	2%	0.1%	20 times less distortion.
Sensitivity (r.m.s. for full output) ...	0.2 v	0.0015 v	120 times more gain with no background increase.
Background noise (equivalent r.m.s. at input)	120 microvolts	1 microvolt	
Background for equal (low) gain	—65 db	—80 db	15 db lower background.
Load impedance / Internal Impedance	2	12	Better damping.
Treble and bass controls	variable extent of boosts and cuts.	variable slope of boosts and cuts.	Wider range of control and slopes of controls more accurately designed for small room listening conditions.
PRICE ...	£60	£30	50% less cost.

ACOUSTICAL

Acoustical Manufacturing Co., Ltd., HUNTINGDON. *Tele.: Huntingdon 361.*

PORTABLE V.H.F. COMMUNICATIONS EQUIPMENT *by* B.C.C.

THE new Model L45 "Walkie Talkie" is specially designed to provide reliable and efficient two-way communication over 1-5 miles between sets. This range is greatly increased when used between a mobile or central station and distances of 15-20 miles have been obtained with a clear audible signal.
The model L45 is but one of the many items of V.H.F. equipment, developed and manufactured by B.C.C. It is the result of many years' experience in the design of Miniature Transportable Communications Equipment.
Other outstanding achievements by B.C.C. in this field are the new Low Power Consumption 4-watt Mobile and "Handie Talkie."

PRINCIPAL FEATURES OF THE MODEL L 45.

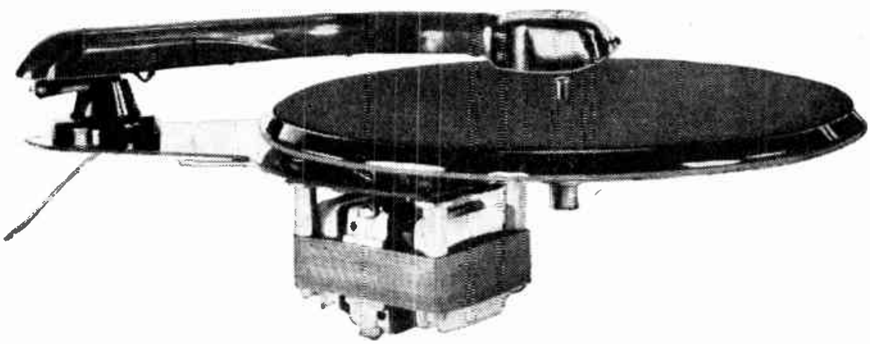
Size 9½ in. by 4 in. by 11 in. Weight 16 lb.
Crystal controlled transmitter and receiver.
Operates on any spot frequency in the range of 75-100 Mc/s. A.M.
On/off and send/receive switches mounted on microphone.
Patented flexible aerial ensuring full mobility to user.
Strong, sturdy, watertight case.
Approved by the G.P.O. and now in use by the Police and Fire Service.
We develop and design special V.H.F. systems to your specification.
Write for full information and catalogues to:

BRITISH COMMUNICATIONS CORPORATION LIMITED
GORDON AVENUE, STANMORE, MIDDLESEX.
Tel.: Grimsdyke 1455
Electronic Development and Research Engineers, Contractors to H.M. Government, A.I.D. approved.

'A NEW DRIVE'

for Perfect Performance

featuring SIMPLICITY LIGHTNESS & LOW COST



The new Collaro R.P.49 Rim-Drive Gramophone Unit is an extremely simple and practical design, beautifully made and finished to the usual high Collaro standard, yet it is available at surprisingly low cost. The powerful induction type Motor is suitable for 100/130 and 200/250 volts, and is fitted with a cooling fan . . . the AUTOMATIC STOP is independent of length of playing surface —is fully automatic . . . four types of PICKUP HEAD are available—all fitted with ball-bearing bases . . . the complete unit, including baseplate, turntable and some types of pickup, finished in a hard scratch-proof enamel. Write to-day for trade terms and free leaflet which fully describes the new Collaro R.P.49 Rim-Drive Gramophone Unit.

The COLLARO R.P.49

RIM-DRIVE GRAMOPHONE UNIT

COLLARO LIMITED
Ripple Works, By-Pass Road,
Barking, Essex.

Telephones: RIPPLEWAY 3333
Telegrams: "KORLLARO, BARKING"

MAKERS OF FINE QUALITY GRAMOPHONE COMPONENTS, INCLUDING:— COLLARO AUTOMATIC RECORD CHANGERS, GRAMOPHONE UNITS, INDUCTION MOTORS, DE LUXE MICROGRAM PORTABLE ELECTRIC GRAMOPHONES.

MAZDA VALVES

For SPECIAL PURPOSES

6F32
SCREENED R.F. PENTODE

The 6.F.32 has a short cut off Suppressor Grid characteristic which makes it particularly suitable for use in Modulator, Variable Reactance and Timing Circuits.

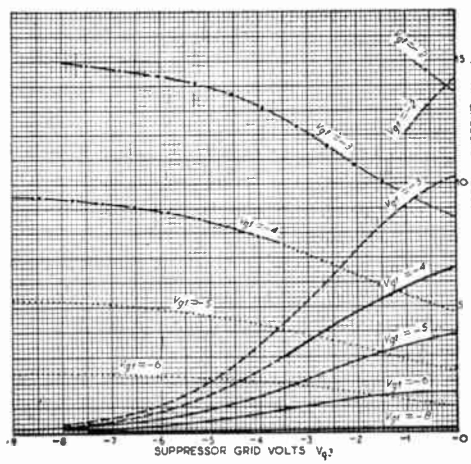
TYPICAL OPERATION

Anode Voltage (volts) - - - - -	V_a	200	200
Screen Voltage (volts) - - - - -	V_{g2}	200	200
Control Grid Bias Voltage (volts) -	V_{g1}	—4.5	—4.5
Suppressor Grid Bias Voltage (volts)	V_{g3}	0	—3.3
Anode Current (mA) - - - - - -	I_a	5.1	2.5
Screen Current (mA) - - - - - -	I_{g2}	3.45	5.5
Mutual Conductance - - - - - -	g_m	3.0	1.4
Approximate Suppressor Grid Bias volts for 50µA/V with V_{g1} = —4.5v.		—8.0	—8.0

CHARACTERISTIC CURVES OF AVERAGE
MAZDA VALVE 6.F.32
Curves taken at $V_a = V_{g2} = 200V$

Key

———Anode Current
...... Screen Current
—— ——Anode Current
—— . —— Screen Current
In these regions a dissipation limit is exceeded.



Other curves available on request

RATING

Heater Voltage (volts) - - - - - -	V_h	6.3
Heater Current (amps) - - - - - -	I_h	0.63
Maximum Anode Voltage (volts) - -	V_a (max)	250
Maximum Screen Voltage (volts) - -	V_{g2} (max)	200
Mutual Conductance (mA/V) - - -	g_m	* 3.35
Inner µ ℄ - - - - - - - - - -	$\mu_{g1} - \mu_{g2}$	* 38
Maximum Anode Dissipation (watts) -	P_a (max)	†4.5
Maximum Screen Dissipation (watts) -	P_{g2} (max)	1.5
Maximum Potential Heater / Cathode (volts DC) - - - - - - -	$V_{h\text{-}k(max)}$	150

* Taken at $V_a = V_{g2} = 200V$; $V_{g1} = —4V$; $V_{g3} = 0V$.

℄ i.e. $\frac{\delta V_{g2}}{\delta V_{g1}}$ with I_a constant

† Low grid resistance should be employed, particularly when running at maximum dissipation.

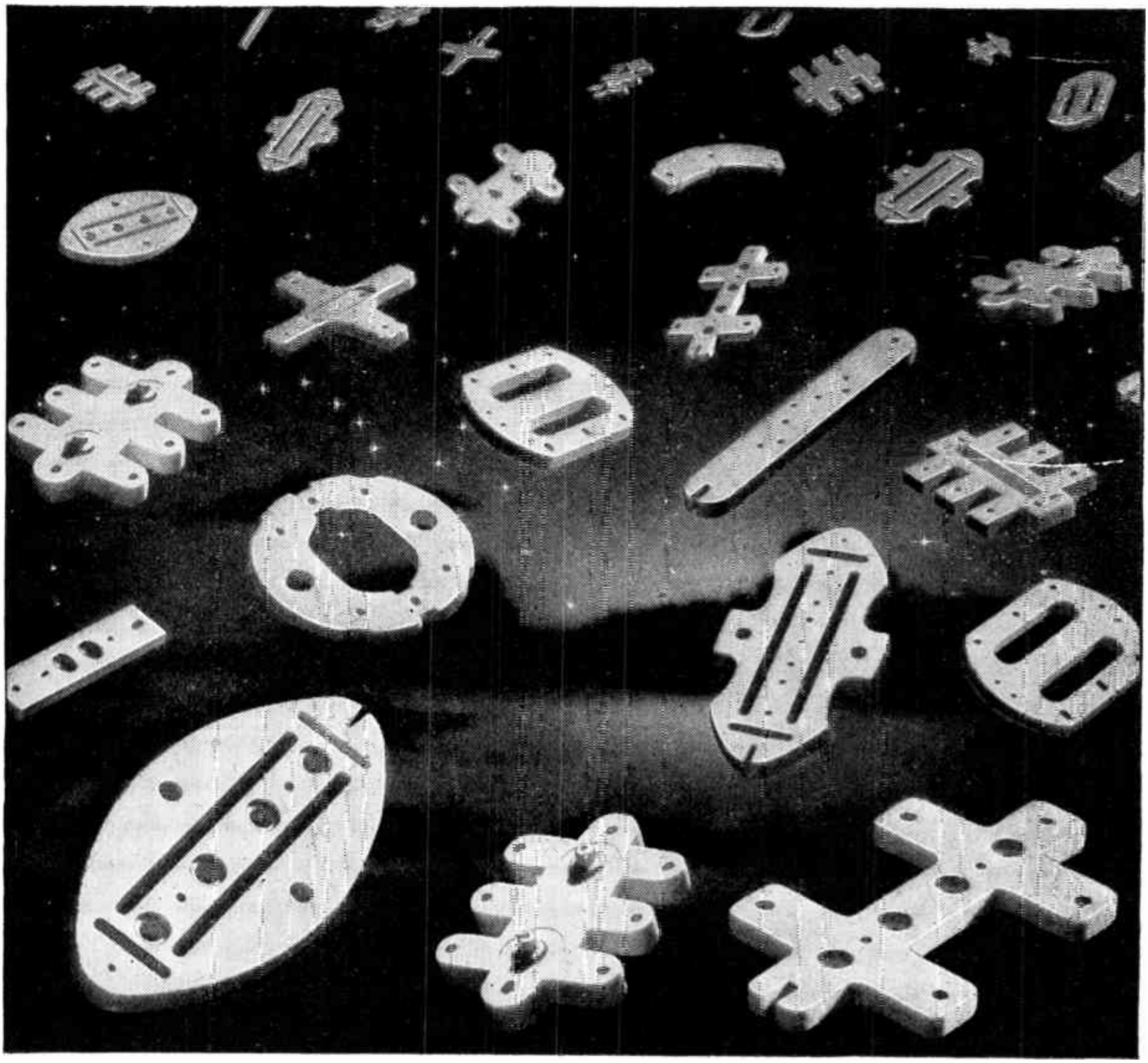
LIST PRICE 10/6 *Further details on request.*

EDISWAN
MAZDA

RADIO VALVES AND CATHODE RAY TUBES

V81

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



WEBB'S *Radio*

Webb's

NEW RADIO GLOBE

An improved and enlarged version of our famous pre-war globe brought right up-to-date with new continental boundaries and 1948 Amateur Radio Prefixes. The enlarged diameter (13½") greatly increases map area and a compass fitted in the base makes correct orientation simple. Invaluable for quick location of unfamiliar calls and a handsome adjunct to receiver or transmitter. Price 47/6 to callers. 50/- by rail.

VALVES!

No experimenter should miss this opportunity; even if not of immediate use the:e valves represent a sound investment for future experimental work. **You will never buy cheaper.** All are new and boxed—please do not confuse them with valves culled from broken down service equipment.

9003 UHF "button base" R.F. Pentode **4/6**	**957** Acorn Triode (1.25V,0.05A) **4/-**	**801** Ceramic base 20 watts dissipation **8/3**
7193 As 6J5GT with anode and grid at top **3/6**	**832** UHF double Pentode **25/-**	**8012** UHF Triode for 500 Mc/s. **18/6**
807 R.F. and A.F. general purpose **7/3**	**NEONS** Assortment of 4 standard type Neons 2 miniature types, two 2" Neons for **2/-**	**100th** Popular "EIMAC" Triode **35/-**

Webb's Radio, 14, Soho St., Oxford St., London, W.1

Phone: GERrard 2089. Shop hours: 9 a.m.—5.30 p.m. Sats. 9 a.m.—1 p.m.

SPHERE INSTRUMENTS
NOW AVAILABLE!
The new "75" Range
TESTGEAR

Brief Specification of Item I

SIGNAL GENERATOR "75"
Model I

Frequency Range. 110 to 50 Megacycles. With calibrated extension covering London, and Midland Television frequencies, at over 60 Megacycles.
Modulation. 400 C.p.s. sinusoidal.
Attenuator. 5-step ladder, with fine control.
Output. Switched via single test-lead. RF. and AF. 1 volt Max.
External Radiation. Less than 1 microvolt.
For AC. mains operation. Complete with Standard Dummy Aerial.

EXCELLENT PERFORMANCE ATTRACTIVE APPEARANCE LOW PRICE

LIST **12½** GNS. *Subject*

LOW COST EFFICIENCY

INQUIRIES INVITED

SPHERE RADIO LIMITED
HEATH LANE, WEST BROMWICH, ENGLAND

Measuring Electrolytic Leakage

The generally accepted maximum permissible leakage current after forming is given by I (in μ amps) = 0·15 x C x V. wkg. This bridge measures leakage direct at voltages of 6, 12, 25, 50, 150, 250, 350 and 450. Capacity can be measured up to 500 mfds.

COMPONENT BRIDGE B101
C: 5 pfd. to 500 mfd.—8 ranges.
R: 5 ohms to 500 MΩ—8 ranges.
L: 0·1 Hy. to 5000 Hys.—4 ranges.
Leakage 0 to 1·5 m/a. Q: 0 to 30.

Wayne Kerr

WAYNE KERR LABORATORIES LIMITED, NEW MALDEN, SURREY

Serve – with a sprinkling of nuts – to engineers who say that *all* small power tools get too hot to handle. Point out that some power tools – no names mentioned – are worked by little horses who keep cool even when running for hours on end at a perfectly furious pace. Remind discreetly – when presenting the bill – that bigger horses are known to get hot under the collar at the mere thought of such activity.

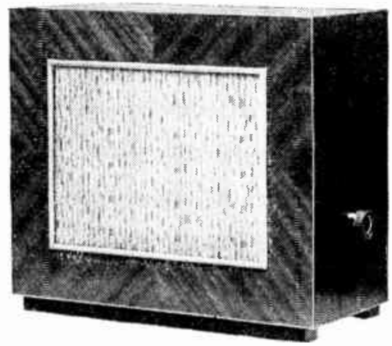
Specialists in Lightweight Pneumatic and Electric Portable Tools.

DESOUTTER

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

C.R.C.193

CELESTION



The quality of reproduction secured from Celestion Speakers greatly increases the pleasure of radio in the home.

The model illustrated has an attractively designed Cabinet with a special mahogany finish, it employs an 8″ speaker of high sensitivity and excellent response. It is fitted with a volume control and is one of the finest 8″ extension speakers available.

All interested in other Celestion Cabinet and Chassis models should write for Illustrated Brochure "W.W."

WHERE TO BUY CELESTION SPEAKERS

The Public are requested to order from their local Radio Dealer.

Wholesalers are supplied by the Sole Distributors: CYRIL FRENCH LTD., High Street, Hampton Wick, Middlesex. Phone: KINgston 2240.

Manufacturers should please communicate direct with:

STANDARD 8 CABINET MODEL

Mahogany finish

Size: Height 10″ Width 12″ Depth 5½″ **PRICE £3 : 18 : 0**

Price with Universal Transformer £4 : 4 : 0

Technical Details of Chassis Model for use with your own cabinet. Dia. 8″. Baffle opening 7¼″ Voice coil impedance at 400 cps., 2.3 ohms. Pole dia. 1″. Flux density gauss, 8,000. Total gap flux, 31,000. Peak power capacity 4 watts.

Price less transformer (Suitable for outputs 1-5 ohms.) **£1 : 17 : 6**

Price with Universal Transformer (Suitable for all Receivers) **£2 : 3 : 6**

CELESTION LIMITED, SUMMER RD., THAMES DITTON, SURREY. Telephone: EMBERBROOK 3402-5

HAVE YOU COMPARED

OTHER MINIATURE NEEDLE PICK-UPS WITH THIS?

SHEFI

Voigt Patent No. 538058

MOVING-COIL PICK-UP

It has many exceptional qualities. Try it now. Available from enterprising dealers or from distributors.

BROOKS & BOHM LTD

90, Victoria Street, London, S.W.1

Phone: VICtoria 9550/1441

"You're CERTAIN to get it at ARTHURS!"

★ **VALVES:** We have probably the largest Stock of valves in the Country. Send your enquiries. We will reply by return.

Ex-Govt. brand new **A.C. TEST BOARD** approx. 12 in. x 6 in., completely wired comprising :— A.C. voltmeter, 300 v. 15 amp. bridges and fuses, 15 amp. 2-pin surface sockets, 2 fuse wire holders. Complete £1 2 6

PERSONAL RADIO SETS IN STOCK

New Olympic Romac, Long and Medium Wave £17 16 11
Ever Ready £12 18 10
Marconi £15 19 5

REMINGTON FOURSOME SHAVERS
210-250 v. AC/DC £7 17 6

ALL AVO AND TAYLORS METERS. List on request.

PHILIPS CYCLE DYNAMO SET £2 1 6

ALSO STOCKISTS OF ALL DOMESTIC APPLIANCES.

London's Oldest Leading Radio Dealers.

Arthurs

EST. 1919

PROPS. ARTHUR GRAY. LTD.

Terms C.O.D. or cash with order.

Our Only Address: **Gray House, 150, Charing Cross Rd., London, W.C.2** *TEMple Bar 5833/4.*

ELECTRICAL, TELEVISION & RADIO ENGINEERS.

Osram
VALVES

TECHNICAL TOPICS

B65 DOUBLE TRIODE

The Osram valve B65 is a double triode designed for use in push-pull, parallel or cascade circuits. The valve is octal based, compact in design, and apart from the common 6.3 volt 0.6 amp. heater, the two sections are entirely independent.

A data sheet giving detailed information and typical curves may be had on request to :

THE OSRAM VALVE TECHNICAL DEPT., MAGNET HOUSE, KINGSWAY, W.C.2.

TYPICAL OPERATING CONDITIONS (*One Unit*)

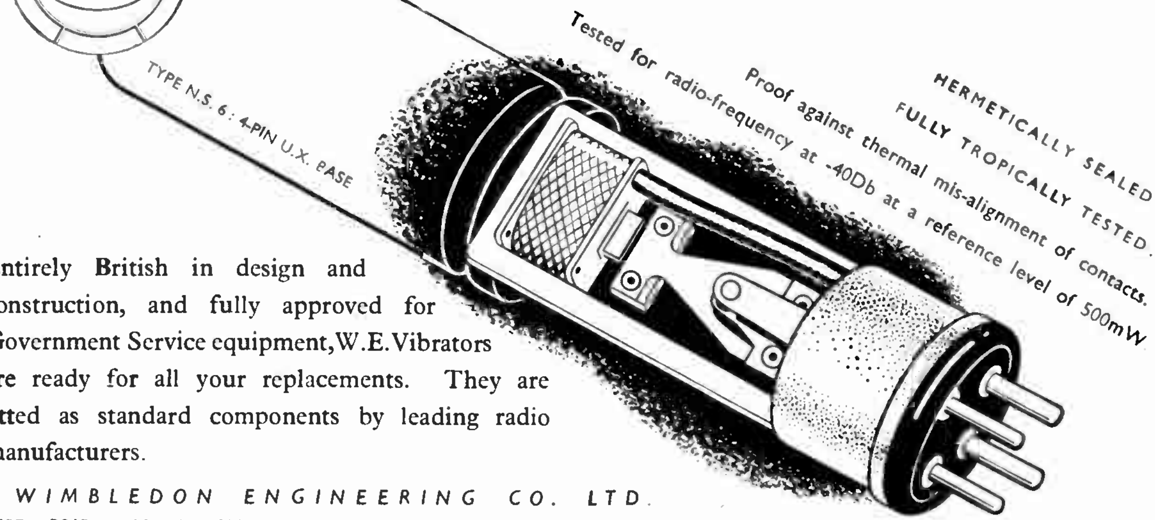
Anode Voltage	*250 volts.*
Control Grid Voltage	*—8 volts.*
Amplification Factor	*20*
Impedance	*7,700 ohms.*
Mutual conductance	*2.6 mA/volt.*

Price **15/-** *(Purchase Tax 3/3 extra)*

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

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

VIBRATORS FOR RELIABLE REPLACEMENTS



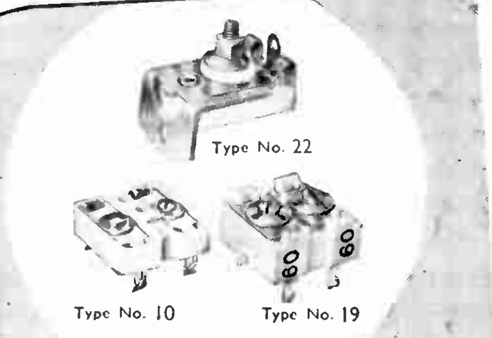
Entirely British in design and construction, and fully approved for Government Service equipment, W.E. Vibrators are ready for all your replacements. They are fitted as standard components by leading radio manufacturers.

WIMBLEDON ENGINEERING CO. LTD.
GARTH ROAD · LOWER MORDEN · SURREY · TELEPHONE: DERWENT 4814, 5010.

C.R.C. 2

"Cyldon"

MICA DIELECTRIC TRIMMER *Capacitors*



Type No. 22

Type No. 10

Type No. 19

SYDNEY S. BIRD *& Sons, Ltd.*
CAMBRIDGE ARTERIAL ROAD, ENFIELD, MIDDX.
Phone Enfield 2071-2 'Grams: Capacity, Enfield.

A NEW **B.P.L.** INSTRUMENT

THE VOLTASCOPE—A combined valve-voltmeter and oscilloscope. VALVE-VOLTMETER—Infinite Input Resistance for D.C. ranges 0 to 300 volts. A.C. ranges 0 to 150 volts in 5 ranges. 3½ inch scale meter. OSCILLOSCOPE—3 inch screen tube provided with balanced amplifiers for Y and X plates giving a 5 times trace expansion. Maximum sensitivity 150mV cm. Response from D.C. to 100 kcs.

Limited quantity available for early delivery.

BRITISH PHYSICAL LABORATORIES
HOUSEBOAT WORKS, RADLETT, HERTS.
Tel: Radlett 5674-5-6

PREMIER RADIO COMPANY

MORRIS & CO. (RADIO) LTD

NOW OPEN—COMMODIOUS NEW PREMISES AT

152-153, FLEET STREET, E.C.4

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

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

WESTINGHOUSE J50 RECTIFIERS, 400 volts at 2 ma. **3/6.**

PHOENIX GLASS INSULATORS. 7in. long, 2in. diameter, suitable for the heaviest aerial. **3/-** each.

100 MICROAMP METERS, thermetically sealed in polystyrene case. 3½in. diameter. **39/6.**

DISTRIBUTION BOARDS. An ebonite board 12in. × 6in. with mounting clips, fitted with a 300 v. A.C. Meter, 2-5 amp. Porcelain Fuses. 3-15 amp. Power Sockets, with 3-pin mains input socket with plug. Useful for the shack or workshop. **21/-** each.

POLYSTYRENE STAND-OFF OR FEED-THROUGH INSULATORS. 1⅝in. high × 1⅜in. base, 2BA screw. **6d.** each.

SPECIAL OFFER OF ELECTROLYTIC CONDENSERS.

16+16 mf. 500 v.	working,	Cardboard	**4/11**
8+8 mf. 500 v.	,,	,,	**4/11**
32+32 mf. 350 v.	,,	Ali. Cans	**5/11**
32 mf. 350 v.	,,	,,	**2/6**
16 mf. 350 v.	,,	,,	**2/6**
16 mf. 450 v.	,,	Cardboard	**3/9**
8 mf. 450 v.	,,	,,	**3/-**
4 mf. 500 v.	,,	,,	**2/-**
16+8 mf. 450 v.	,,	Ali. Cans	**4/11**

STANDARD LOUDSPEAKER OUTPUT TRANSFORMERS, 2/11. MULTI RATIO, 5/11.

GOVERNMENT SURPLUS MAINS TRANSFORMERS. All are for use on 230 volt 50 cycle Mains. These are all new and very conservatively rated.

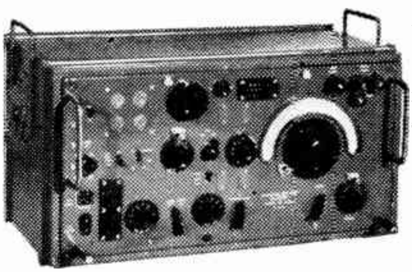
Type		
3	500-0-500 v. 150 ma. 4 v. 2-5 a., 4 v. 1 a., 4 v. 5 a.	**35/-**
31	40 v. 3 a., 104 v. 1½ a. Auto Wound	**21/-**
32	650-0-650 v. 150 ma. and 1,000 v. at 30 ma.	**40/-**
33	38 v. 2 a. Tapped at 32, 34, 36 v.	**15/-**
34	1500-0-1500 v. 120 ma. 4 v. 2-3 a. 4 v. 2-3 a. L.T. Trans. is separate on Base Plate	**55/-**
42	500-0-500 v. 170 ma. 4 v. 4 a.	**35/-**
43	4 v. 20 a.	**25/-**
44	10 v. 5 a. 10 v. 5 a. 10 v. 5 a.	**35/-**
46	Auto 50 v. 100 v. 150 v. 230 v. 100 w.	**12/6**
47	Output Trans. Ratios 43.5-1 and 51.5-1 Secs. 2.1 ohms and 4.2 ohms.	**45/-**
49	275-0-275 v. 120 ma. 5 v. 2 a. 6.3 v. 2.5 a. 6.3 v. 0.3 a. C.T.	**29/-**
50	12 v. 70 a. An ideal Transformer for ground heating or welding	**60/-**
51	350-0-350 v. 60 ma. 6.3 v. 1 a. 6.3 v. 2-5 a.	**12/6**
52	250-0-250 v. 65 ma. 4 v. 1.5 a. 6.3 v. 2 a.	**12/6**

C.R. TUBES. VCR97, 6in. diameter, green screen, 4 v. 1 a. Heater, 2,500 v. max. H.T. Complete with socket, in maker's original cartons. A large new purchase enables us to reduce the price to **35/-.**

OSCILLOGRAPH POWER UNITS. Input 230 volts. Consists of Kit of Parts incorporating Mains Transformer, metal rectifier, voltage doubling condensers.

Type		
408	Output 800 v.	**25/-**
409	Output 1800 v.	**30/-**
25	Output 2,500 v. at 3 ma. and 4 v. 2 a. C.T. For use with 2 or 4 v. C.R. Tubes	**49/6**
55	Output 5,500 v. at 3 ma. and 4 v. 2 a. C.T. For use with 2 or 4 v. C.R. Tubes	**81/-**

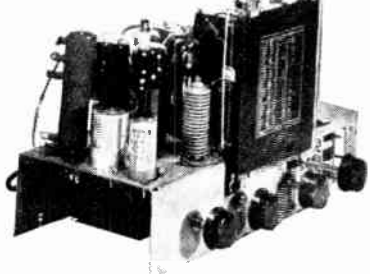
We have a fine selection of Radiogram Cabinets, Electric Gramophone Motors and Auto Changers on show at Fleet Street.



R107. ONE OF THE ARMY'S FINEST COMMUNICATIONS RECEIVERS. (See "W.W.," August, 1945.) 9 valves. R.F. amp. osc. Frequency Changer, 2 I.F.'s (465 kc.), 2nd Detector, AVC. Af. amp. B.F.O. A.C. mains, 100-250 v, or 12 v. accum. Frequency range 17.5 to 7.25 mc/s, 7.25 mc/s to 2.9 mc/s, 3.0 to 1.2 mc/s Monitor L.S. built in. Complete. Write for full details. **£16/16/-.** Carriage paid.

We require additional staff for our new **Fleet Street** premises. Also for our new premises at **207 Edgware Road, W.2** which will be open by December 1st 1948.

PREMIER KITS AT REDUCED PRICES



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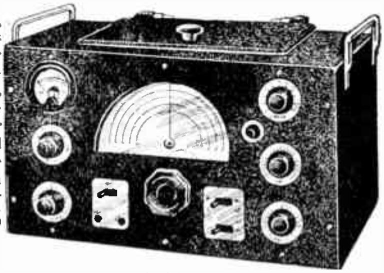

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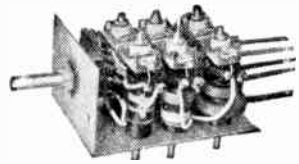

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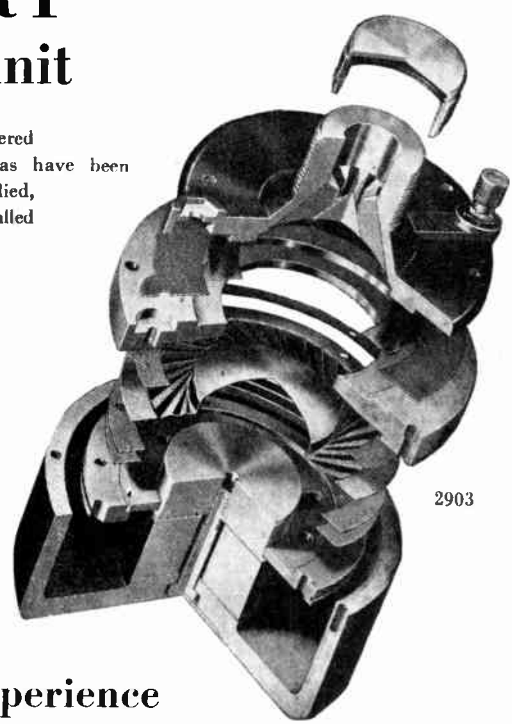

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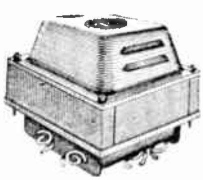

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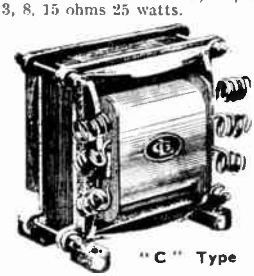

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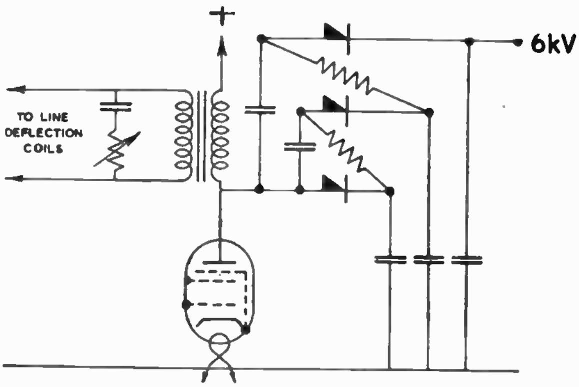

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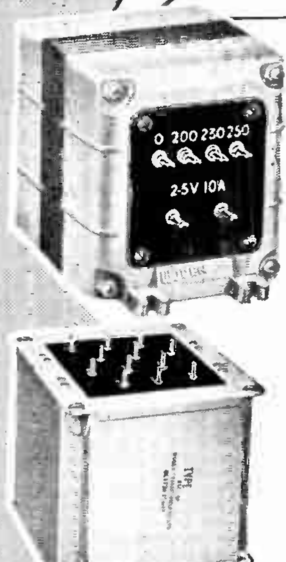

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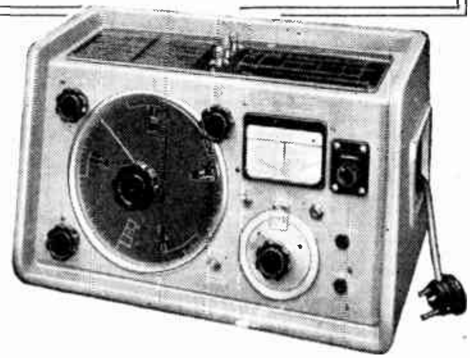

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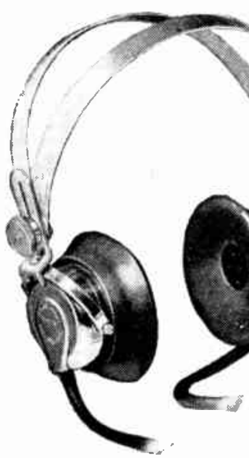

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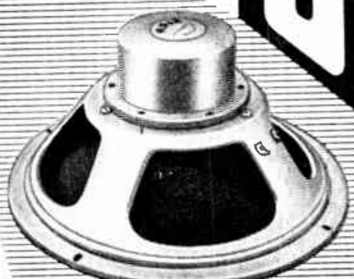

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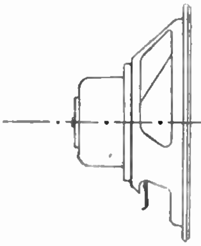

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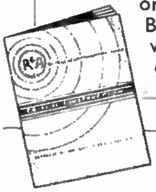

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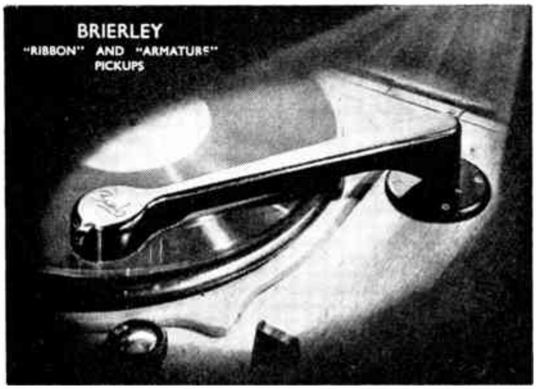

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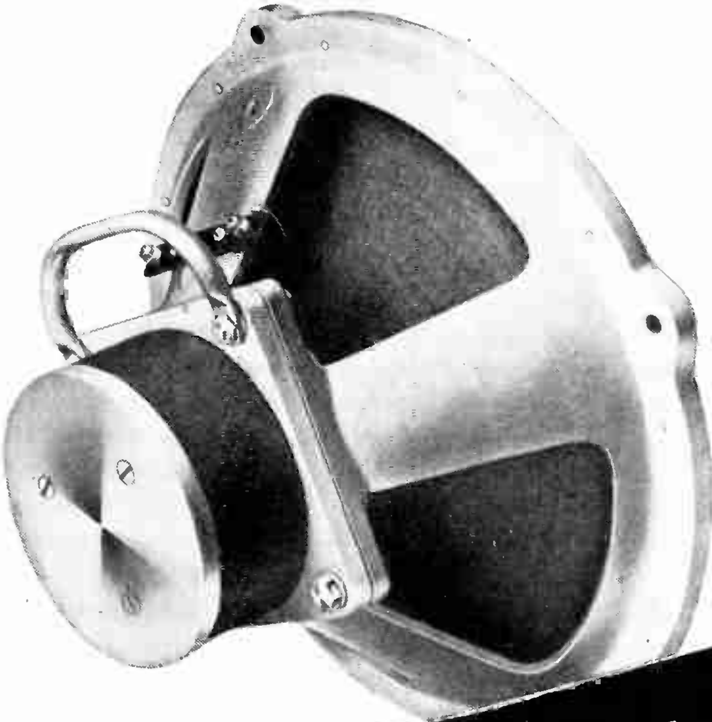

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T.X.39

Wireless World

RADIO AND ELECTRONICS

38th YEAR OF PUBLICATION

DECEMBER 1948

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In this Issue

OUR COVER; Pye B18T Chassis (See Page 458)

Valves and their applications

85A1 NEON STABILISER TUBE

In the design of many types of equipment it frequently happens that a stable D.C. supply is required. To take a practical example, local oscillator drift in a F.M. receiver may necessitate frequent retuning to eliminate distortion in a narrow band discriminator. The use of temperature compensated circuits in highly stable oscillators is, of course, a necessity but the performance can be still further improved by the use of a stabilised D.C. supply.

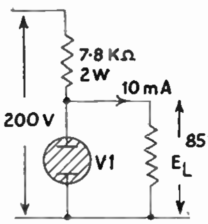


Fig. 1(a)

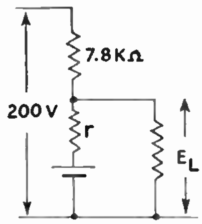


Fig. 1(b)

The simplest voltage stabilising circuit is that shown in Fig. 1(a) and its action may be explained by reference to Fig. 1(b). The stabiliser tube V1 behaves in a similar manner to a battery with a small but finite internal resistance r; the voltage appearing across the load E_L will be the sum of the burning voltage of V1 and the voltage drop across r. With the circuit values given in Fig. 1(a), the change in E_L will not be greater than 2V for load changes between 7 and 14mA or input voltage changes between 170 and 220V.

When a very much higher degree of stability is required the circuit of Fig. 2 may be employed. Its stabilising action is as follows: (1) An increase in E_1 causes a corresponding increase in E_L. (2) A fraction of the change in E_L is fed back to the grid of V2 which causes a fall in the anode voltage of V2 and the grid of V3 (3) This increases the voltage drop across V3 and tends to keep E_L constant.

It will be seen that the function of V1 is to provide a stable reference voltage for the cathode of V2. Changes in voltage across V1 due to its internal resistance are automatically compensated by the circuit but any irregular changes in this voltage may cause considerable changes in E_L. These irregular changes in voltage stabiliser tubes arise mainly from (1) Discontinuities in the I/V characteristic and (2) Variations in burning voltage with temperature. Provided that the 85A1 is operated with a current of at least 4.5mA no discontinuities occur in its I/V characteristic; its temperature coefficient is −3.25mV per C deg. and temperature effects will therefore be negligible in all normal applications.

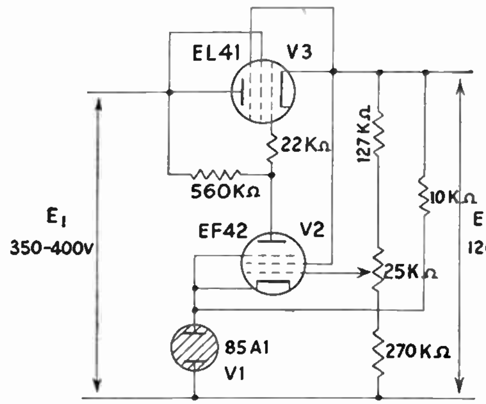


Fig. 2

With the circuit values of Fig. 2. the change in E_L for a change in E_1 of 10%. or a change in load from 0 to 40mA, will be less than 0.05V.

Characteristics of 85A1

Mean burning voltage	85V
Maximum current	8mA
Minimum current	1mA
Optimum current range	4.3 to 4.7mA
Internal resistance.	290 Ohms at I = 4.5mA
Temperature coefficient of burning voltage	− 3.25mV/°C.

Mullard

Reprints of this report from the Mullard Laboratories together with additional circuit notes can be obtained free of charge from the address below,

MULLARD ELECTRONIC PRODUCTS LTD., TECHNICAL PUBLICATIONS DEPARTMENT, CENTURY HOUSE, SHAFTESBURY AVE., W.C.2

(MVM79)

VOL. LIV. NO. 12

Wireless World

DECEMBER 1948

RADIO AND ELECTRONICS

The Wireless Telegraphy Bill

Establishing a New Principle

UP to the present time radio in Great Britain has been controlled by the Postmaster-General under the powers conferred on him by the Wireless Telegraphy Act of 1904. It is a high tribute to the foresight of those who drafted the Act that it has provided a workable basis for regulating such a rapidly growing art for 44 years. In strict justice, perhaps still greater tribute should be paid to the Post Office for the generally benevolent and effective manner in which it has exercised its powers. This is all the more remarkable because our legislation has been on a foundation that, to most lay minds at least, seems inherently unsure. The Act of 1904 was concerned with establishing the Postmaster-General's monopoly, rather than with the good governance of the art. In spite of that, cases of restrictive action likely to hamper development have been remarkably few, and, so far as this journal is concerned, the Post Office has generally lent a sympathetic ear to any protests we have been impelled to make.

With the passage of time the Postmaster-General has gradually assumed control of the various offshoots of wireless telegraphy. The main part of the Bill now before Parliament will merely confirm his powers. Such things as radiolocation (in the widest sense) as well as radio control of machinery are to become, legally speaking, "wireless telegraphy."

Undoubtedly, the most important part of the Bill is the section dealing with interference. *Wireless World* has long contended that a situation where there is no legal barrier to the radiation of interference is intolerable, and we welcome the principle that power will be given to the Post Office to prevent with force of law the use of apparatus likely to cause undue interference.

It is not intended here to discuss in detail the methods proposed for putting into effect the principle of compulsory interference suppression. Unfortunately, criticism of this part of the Bill has been largely on emotional and party-political grounds with which we are not concerned. Exception has been taken to the conferring on the P.M.G. of right of entry in the enforcement of the anti-interference clauses, but it seems to have been forgotten that for many years he has possessed a legal right of entry to homes licensed for broadcast reception—about 90 per cent of all those in the country. Other and more useful grounds of criticism present themselves. For instance, the appointment of an advisory committee to advise the P.M.G. on such matters as permissible levels of interference may possibly cause interminable delays through failure to reach agreement. Earlier proposals for compulsory suppression have been bedevilled by delays through this cause. But that is a small matter compared with the broad principle, which will be readily conceded in all radio technical circles, that there should be unified control of all man-made radiation, deliberate or fortuitous, within our part of the frequency spectrum. That principle is now to be established, and at last the P.M.G. will have power to give his licensees the protection to which they should be entitled. Not only radiation, but "deliberate reflection of electro-magnetic energy" up to three million Mc/s is covered.

Wireless World Overseas Issues

Starting with this issue, copies of *Wireless World* going abroad will be printed on heavier paper, and, periodically, will include extra pages. This has been made possible by a modification of Board of Trade regulations; these changes cannot apply to copies for home readers.

CATHODE-RAY

General Purpose Design with Wobbulator

By S. A. KNIGHT

WITH large numbers of small ex - Govt. cathode - ray tubes available on the radio market, the home construction of oscilloscopes seems to be the vogue. While this natural desire to make oneself the owner of such an attractive and versatile instrument has much to recommend it, yet there is the serious error into which many intending constructors fall of believing that the tube itself is the be-all and the end-all of the equipment's design. This is far from the truth, for the purchase of a tube, even if it happens to be perfectly suitable for inclusion in an oscilloscope, is only the first small step towards the final aim—a well-constructed and attractive instrument that really will be a valuable piece of test equipment.

In the instrument to be described everything is built up from scratch. The tube employed at present is a 3-in Emiscope 4/1 (Marconi), used on visual-indication equipments (V.I.E.) in the early stages of the war, operating at 750–800 volts on the final anode. This type of tube is eminently suitable for oscilloscope work and is preferable to many larger types now available requiring considerably higher working voltages. Any small tube (about 3-in to 4-in screen diameter), operating at about 750–1,000 volts, is, however, suitable for the present design, since the only small modifications required to the full circuit of Fig. 1 are those involving the tube supply network, and these will be fully

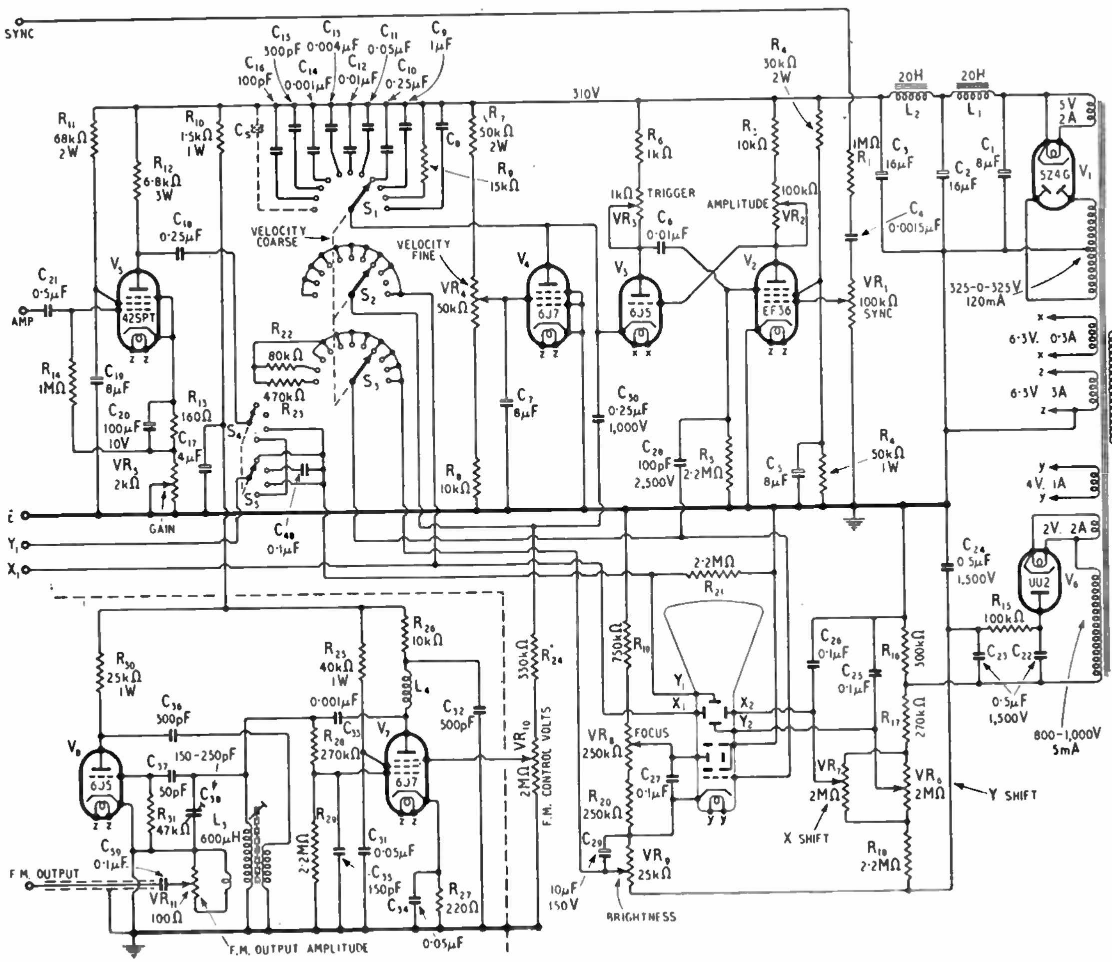


Fig. 1. The complete circuit diagram of the oscilloscope. A three-valve time base is used and a single-valve signal amplifier. The wobbulator has two valves—an oscillator and a reactor. All resistors are ½-watt types except those otherwise marked and variable types which should be of 3-W nominal rating. Capacitors should be generally of 450-V rating except where otherwise marked.

OSCILLOSCOPE

Time Base	Three hard valves generating continuously variable sweep frequencies, 5–200,000 c/s.
Y Amplifier	Response flat 60–550,000 c/s, 3 db down at 1 Mc/s. Useful range (with care) extending beyond 2 Mc/s. Input resistance 1 MΩ, capacitance 20 pF.
Frequency Modulator	465 kc/s ± 12 kc/s for I.F. circuit alignment. Entirely optional attachment which can be omitted without any other alteration.

described later on. All other circuit details are suitable as designed, and no alterations are necessary for a change of tube.

Briefly, the complete design incorporates:

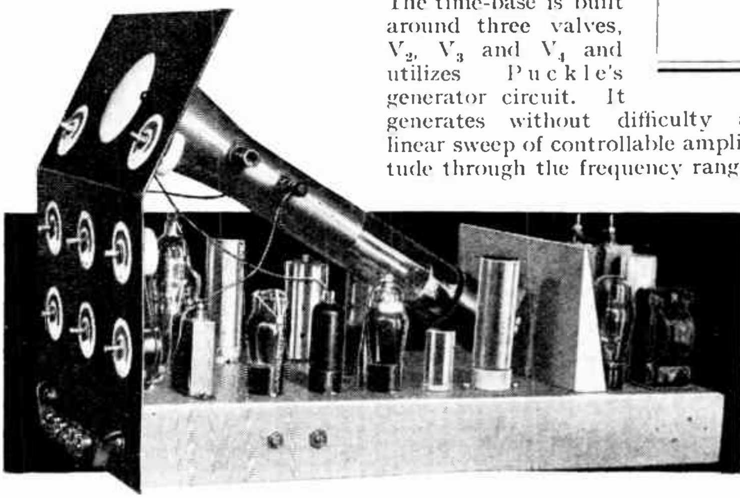
(i) a time-base circuit (3 hard valves), generating a linear saw-tooth waveform of controllable amplitude and covering the frequency range 5–200,000 c/s approximately. This extremely high upper-frequency limit enables individual wave analysis and examination to be undertaken on the work source up to several megacycles per second in frequency, and is an important aspect in the design of any oscilloscope.

(ii) a single-valve amplifier for vertical deflection giving a gain of some 50 times over the frequency range 60–550,000 c/s with a useful amplification up to 2 Mc/s, thus making it suitable for work on pulsing circuits and television, a further important feature;

(iii) an entirely optional frequency - modulation circuit (2 valves), controlled by the time-base, giving a variable amplitude output of 445–480 kc/s ± 12 kc/s, for I.F. circuit alignment on receivers employing a frequency in this band.

These individual sections will be dealt with in more detail in the following paragraphs.

In the design considerations of the time-base a hard-valve circuit was decided upon immediately on account of the difficulties experienced with gas dischargers on frequencies above about 25 kc/s. The time-base is built around three valves, V_2, V_3 and V_4 and utilizes P u c k l e's generator circuit. It generates without difficulty a linear sweep of controllable amplitude through the frequency range



General view of the completed oscilloscope.

5–200,000 c/s in 9 steps, each of these being continuously variable.

Referring to the circuit diagram, the time-base charging capacitor (C_9 to C_{16}) is selected by S_1, the high-frequency contact being dependent upon the circuit strays C_s. The selected capacitor charges linearly through V_4 which is an R.F. pentode (6J7) connected as a constant-current valve, the time of charge being controllable by VR_1 feeding the screen. VR_1 is thus a fine frequency (velocity) control and permits smooth control of all sweep frequencies between the extremes set by the selection of S_1. As the selected capacitor charges through V_4 the cathode of the triode discharger (6J5) falls towards earth, and thus approaches the voltage present upon its grid due to the drop across VR_2 and R_3 in the anode of V_2 (EF36). The extent to which this grid is held negative with respect to the H.T. line depends upon the setting of VR_2. As soon as the cathode has fallen to the potential level of the control grid, V_3 conducts and a drop is present across VR_3 which appears as a negative pulse on the suppressor of V_2. V_2 thus swings towards cut-off, and the consequent voltage rise present at the anode carries V_3 into saturation, thus discharging the time-base capacitor through VR_3 and the valve internal resistance (both low). When the capacitor is discharged the cathode of V_3 again rises to H.T. level and the valve is non-conducting, after which the cycle repeats.

The setting of VR_3 determines the amplitude of the pulse applied to the suppressor of V_2 and should consequently be as high in value, consistent with proper working of the valve, as possible. At the same time this component is in series with the discharge path of the capacitor and cannot, therefore, be too large in value without seriously lengthening the fly-back time. With a total value of 2,000 Ω given in the present circuit a compromise setting is easily found where the lowest value consistent with good triggering action is the aim in view. For very low settings the time-base will collapse. In general, a higher value is required for the upper frequency end of the time-base range, and to avoid the 1,000-Ω preset control, a 2,000-Ω fixed resistor *may* be inserted in this anode lead.

VR_2 determines the amount by which the grid of the discharger V_3 is held negative with respect to the H.T. line and its cathode at the commencement of the charging cycle. It therefore controls the amplitude of the generated saw-tooth and enables the sweep length to be adjusted within very wide limits The

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maximum setting of this control does not, however, necessarily give the maximum length of time-base, and also, as for the action of VR_3, very low settings of VR_2 may cause the time-base to collapse. This control is very useful as a velocity vernier since changes in its value do affect the time-base frequency slightly.

When S_1 is set to either of the two highest frequency time-base capacitors (C_{16} and C_8) a negative impulse is developed across either R_{22} or R_{23} respectively by the application of a negative pulse from the suppressor of V_2 during the fly-back period, via C_{28}, which momentarily reduces the tube brilliance during the return trace. Similarly, there is some brightening effect during the forward sweep on these switch positions when the suppressor of V_2 swings positive, and the brilliancy of the trace thus tends to constancy as the spot velocity increases up to the maximum frequency of some 200 kc/s. On these latter two switch positions the brightness control (VR_9) has very little effect on spot brilliancy. It will be noticed, also, that on the 2nd position of S_1 (reading anticlockwise on the diagram) the charging capacitor is replaced by a resistance (R_9 = 15 kΩ). On this position the time-base becomes inoperative and the X_1 plate of the tube is released by S_2 from the time-base circuit. Only the spot then appears on the screen, a useful point for certain D.C. and amplitude test work. Since the X_1 plate is completely 'floating' in this position, a high-resistance D.C. path must be provided for it to return to earth or inaccuracies will result due to spot drift. A suitable value is 2 MΩ. An external time-base may, of course, be applied at this switch setting, through X_1 terminal.

Synchronizing

The time-base sweep may be synchronized to the work input by simply connecting the SYNC terminal to the Y_1 input. This has an input impedance sufficiently high to have no effect on the work voltage source and is isolated from the time-base circuit proper by its connection to the control grid of V_1 through the Sync control VR_1. Normally, this control should always be set fully anticlockwise (slider to earth), and for effective synchronizing should only be advanced as little as possible consistent with effective locking. Too much of this control will destroy linearity of the trace and produce excessive X distortion. When using the amplifier

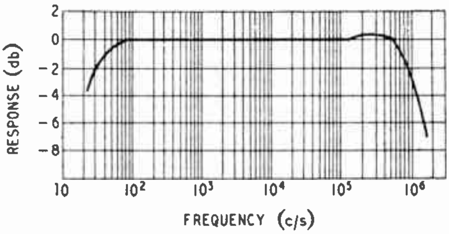


Fig. 2. Frequency response curve of the signal amplifier.

it is essential that the SYNC terminal be connected to the Y_1 terminal and *not* to the AMP input.

The amplifier used in this circuit is a single-valve stage designed as for television video-frequency amplification with an eye to frequency response rather than high gain. To be of any real value an oscilloscope amplifier should give substantially level amplification over the range 50 to 500,000 c/s with a useful range up to at least 1 Mc/s. The present stage adequately fulfils these conditions by making use of a high-slope power pentode (42SPT), and a gain of some 50 times is obtained over the above mentioned frequency range. At first, various types of R.F. pentode such as the SP61 and EF50 were tried in this position without a great deal of success, and finally the power pentode was employed in order to obtain the voltage swing required without distortion.

The problem of gain control necessitated something better than the ordinary grid potentiometer. With this latter system the input impedance of the stage is different at different settings of the control and for very low settings the input capacitance of the valve offers a serious shorting effect to high frequencies. The only useful method of overcoming this is to employ a tapped input potentiometer with a small capacitor connected permanently across the upper half to compensate for the valve capacitance. This circuit was tried out, using a normal potentiometer with a suitable capacitor from the slider to the hot terminal, but the H.F. response suffered on account of the cumulative error in the correction as the slider approached earth. In the end, on account of the complication of a tapped input potentiometer, the whole system was scrapped in favour of a feedback control such as is used on some commercial amplifiers.

This circuit makes use of the current in the bias control VR_5 to develop a feedback voltage and thus vary the gain of the stage. This feedback system of control tends to stabilize the output current rather than the output voltage developed and there is thus a tendency for a sharp falling off in response at high and low frequencies for a constant alternating current in the anode load. This form of feedback, considered as such, therefore, does little to improve the frequency response of the amplifier (though there is some improvement at low gain), but it tends to minimize amplitude distortion and it does away with the evils of the input potentiometer. A further important point in connection with this form of control is that of the input resistance which is virtually constant throughout the range of gain control setting, and any tendency to phase distortion at low frequencies is minimized by working at a deliberately reduced level. In actual use, this form of gain control is apt to appear 'rough'; that is, the trace is liable to jump violently while the control is actually being rotated. This is not a fault, however, and once set, the trace is perfectly stable.

Some experiments were conducted with inductance compensation in the anode circuit to improve the H.F. response of the amplifier, but with little effect. As it stands the response is substantially flat from 60 to 550,000 c/s with a drop of 3 db at 1 Mc/s. Considerable gain remains up to

2 Mc/s, making the amplifier useful even at this frequency. The response curve of Fig. 2 was taken at half gain and for smaller settings there is some improvement in both the high- and low-frequency response, a useful point to bear in mind when using the amplifier.

Tube Circuit and Controls

Little explanation is needed for the tube circuit and controls as they stand in the present design, but there are several points worthy of attention with regard to possible modification of this part of the circuit to utilize a different make of tube. Since this is the only section requiring alteration on this account, some little space will be given to the problem.

Referring to the main circuit, the actual tube network from

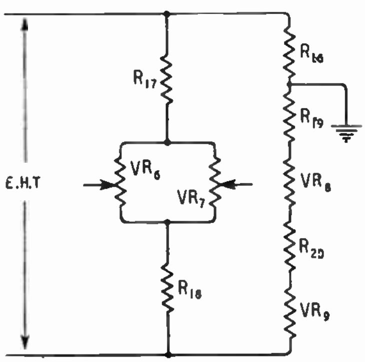


Fig. 3. The tube voltage-supply network, which may need alteration with different tubes, is shown here.

which Brightness and Focus control is obtained, consists of R_{19}, VR_8, R_{20} and VR_9 in series between earth (final anode) and the negative pole of the E.H.T. rectified by V_6 and smoothed by C_{22} and C_{23} and R_{15} in the conventional way. The positive pole of this supply is itself returned to earth through R_{16} which is of such a value (300 kΩ) in proportion to the sum of R_{19}, VR_8, R_{20} and VR_9 all in series (1,275 kΩ) that a drop of approximately 1/5th of the total available voltage on C_{23} is developed across it. This voltage is used for the purpose of applying shift potentials to the X_2 and Y_2 plates. From the simple diagram of Fig. 3 it will be seen that the X and Y Shift controls are paralleled (VR_7, VR_8) and are in series with R_{17} and R_{18} across the total E.H.T. supply. By the choice of suitable values of R_{17} and R_{18} it is possible to ensure that the control sliders pass through earth from a positive to a negative potential (or vice versa), and hence the potential of the deflectors can be varied above or below that present upon the X_1 or Y_1. In the present design, which will probably be suitable for most 3-in to 4-in tubes requiring 750–1,000 volts H.T. values are calculated on the basis that the current through both networks, including beam current, is so small that voltages developed are proportional to the resistance values. Hence, taking E.H.T. across C_{23} to be 1,000 volts, the voltage across R_{16}

$$= \frac{R_{16} \times 1000}{R_{16} + R_{19} + VR_8 + R_{20} + VR_9}$$

$$= \frac{300 \times 1000}{1575} = 200 \text{ V approx.}$$

leaving a total of 800 volts on the tube anode. The shift sliders now have to pass through earth approximately at the centres of their travel, therefore, from Fig. 4—

$$R_b : R_c :: 1 : 4 \text{ or } R_c = 4R_b$$

Bearing in mind the necessity for keeping the total current down to a minimum, a suitable total value for $R_b + R_c$ is 3.5 MΩ, whence $R_b = 0.7$ MΩ and $R_c = 2.8$ MΩ. But each resistance includes 0.5 MΩ of the joint shift potentiometers resistance, assuming the sliders to be central, and both at earth, and so final suitable values for R_{17} and R_{18} are 270 kΩ and 2.2 MΩ respectively.

The smoothing capacitors C_{22}, C_{23} and C_{24} are not critical in value and those indicated in the table are perfectly adequate. The only point requiring attention is that of working voltage which must be adequate for the voltage applied, itself depending upon the tube used.

This two-valve circuit was included in the design simply to extend the range of usefulness of the instrument without increasing the number of panel controls which already numbered ten. Some readers may wish to omit this part of the circuit entirely, and this is easily accomplished by the simple procedure of replacing R_{24} and VR_{10} by a single 2.2 MΩ resistor.

The circuit is designed to cover only the 465-kc/s I.F. band, and throughout this range 'wobbulation' is effected over a range of about ± 12 kc/s on either side of resonance. The circuit is very simple and consists of a tuned-grid oscillator, back coupled from the anode through C_{36} and a coupling coil, and a variable-reactance valve V_7 (6J7) is connected across the tuned circuit C_{38} and L_3. The important components in this part of the circuit are R_{28} and C_{35}; these are connected in series across the triode tuned circuit, their junction being returned to the control grid of V_7. C_{33} is simply a blocking capacitor and R_{29} provides grid circuit continuity. The value of R_{28} is 0.27 MΩ and is consequently very high compared with the reactance of C_{35} (150 pF) at frequencies around 465 kc/s. Hence, when the oscillator is functioning the current through R_{28} and C_{35} is very nearly in phase with the oscillator voltage, and the voltage on the control grid of V_7, developed across C_{35}, is 90° lagging on the oscillator voltage. The valve anode current is in phase with the grid voltage and is consequently lagging 90° on the oscillator voltage. From the point of view of the oscillator, therefore, V_7 and its associated components draw a lagging current and hence behave as an inductance. This 'inductance' is in parallel with the oscillator tuned circuit and thus modifies the tuning of the latter by an amount depending upon the value of the

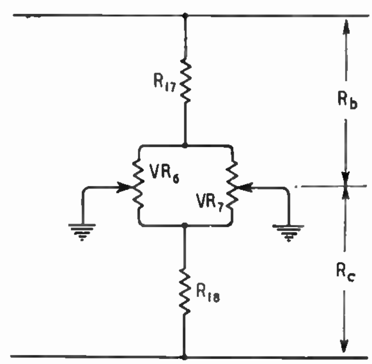


Fig. 4. This diagram is used in computing the values for the shift network.

Cathode-ray Oscilloscope—

former. This value is adjustable by the amount the slope (g_m) of the valve is adjustable, and is given by $C_{35}.R_{28}/g_m$ for a particular value of g_m.

Control voltage is applied to the suppressor grid of V_7 from the time-base saw-tooth supply and modifies the slope of the valve by an amount dependent upon the setting of VR_{10}. The slider of this control falls from a positive value to earth during the charging cycle of the time-base and hence changes g_m from a large to a small value as the charge proceeds. Since the spot on the screen is moving across the screen during this period, its position at any instant is a function of the slope of the valve and hence the frequency generated by V_8.

The output from the frequency modulator is adjustable by the setting of VR_{11}, and is normally applied, through a low-capacitance screened line, to the I.F. or F.C. valve in the receiver under test. This receiver output is generally best taken directly from the diode load through the oscilloscope amplifier which has an adequate response to cope with the frequencies concerned. The correct setting of VR_{10} to 'fit' the receiver I.F. response curve on to the screen (i.e., to give the correct amount of frequency change) is quickly found in practice (it is fairly high up VR_{10}), and the trace can be centred by adjustment of the core of L_3. The setting of VR_{11} and the Amp. Gain can be set to give the best amplitude of the image. As the frequency modulation and the horizontal sweep of the spot are both controlled from the time-base, synchronism is automatic and a steady response curve is readily obtained. It is best, however, to lock the time-base to the mains frequency to avoid any possibilities of hum pick-up affecting the trace and this is best done by choosing the lowest time-base speed (capacitor C_9 position of S_1) and adjusting the velocity control VR_4 to give a steady image. The actual time-base frequency is fairly important and it cannot be high (a maximum limit is 100 c/s) without the possibility of distorting the trace. Capacitor C_8 (2 μF) is specially included in the circuit diagram to allow a very slow sweep to be obtained from the time-base if required, but in general it is not needed and this switch contact may be connected across to the C_9 contact or ignored altogether.

Construction

The photograph shows a general view of the complete instrument, the nearest valves being the time-base components. The amplifier and the frequency-modulator valves are on the far side, and the whole power unit is behind the dividing screen at the rear. This layout, together with careful screening below chassis, gives a trace free from hum troubles, though a mu-metal tube screen may be included if one is available.

A mains transformer with all windings may be difficult to obtain and two separate items may, of course, be employed. Particularly note that the 42SPT is a 4-volt valve and is run from the 6-volt heater winding. A series resistance of about 1 Ω is included in its heater path and is not shown in Fig. 1; this is best found experimentally.

Other points to note are: C_{29} should not be metal cased, or if it is the case must be insulated from earth; the spindles of VR_8 and VR_9 should be insulated from chassis as an extra precaution against breakdown. Switches S_4 and S_5 are ganged and select the inputs: (a) D.C. to Y_1—position shown in the diagram, (b) A.C. to Y_1, (c) Amplifier to Y_1 plate, and amplifier output available at Y_1 terminal, (d) Amplifier available at Y_1 terminal freed from internal circuits.

APPENDIX

Frequency Modulator

Oscillator tuning capacitance = 200 pF, and therefore the effective L for 455 and 475 kc/s (assuming a 20-kc/s swing) is 605 μH and 555 μH respectively. This effective L is made up of L_3 and the reactor valve V_7 (L_r) in parallel, and L_v is variable by the amount g_m is variable. If g_m varies from 0.5×10^{-3} A/volt to 2×10^{-3} A/volt, then the larger value becomes 20.5 mH, whence L_3 must be 625 μH. Hence for $g_m = 2 \times 10^{-3}$ A/volt

$$C_{35}\,R_{28} = 41 \times 10^{-6}$$

so that making $R_{28} = 0.27$ MΩ, $C_{35} = 150 \times 10^{-12}$ F = 150 pF.

"NUCLEONIC" EQUIPMENT

MANY of the electronic measuring instruments associated with Government research in nuclear physics were developed by the Ministry of Supply in conjunction with Dynatron Radio, of Maidenhead, who are now free to offer these products to approved research organizations.

The use of radioactive tracer elements in medicine is well known, and the technique is being applied in industry to the investigation of chemical and metallurgical problems. For the detection of radioactivity the most sensitive device is the Geiger-Muller counter which produces pulses of current, due to the ionization of the gas forming the dielectric between polarized electrodes in a sealed glass tube. The rate of production of pulses is a measure of the radioactivity, and electronic counters (scalers) have been devised for this purpose.

In the Dynatron Type SC.200 scaling unit, indications up to 100 are given by a series of miniature neon lights, and multiples of 100 up to 1,000,000 by a Post Office relay counter. The instrument operates with a pulse separation of 6 microseconds or, alternatively, with a "paralysis" time up to 1 millisecond.

Auxiliary equipment includes a probe unit (Type PR200), stabilized power unit (Type P200) and a test oscilloscope monitor (Type M.200).

Dynatron Type 200 scaling unit for counting ionization pulses.

Cabinet racks for housing these and similar units, made to the Post Office standard panel width of 19 inches, are available in heights of 3, 4 and 6ft.

CIRCUIT SYMBOLS

Notes on the New British Standard

By L. H. BAINBRIDGE-BELL

(Royal Naval Scientific Service)

In radio, the circuit diagram is something more than a convenient graphical representation of electrical connections. As "Cathode Ray" points out on p. 459 of this issue, it is to most of us an indispenable aid to thought. The choice of symbols used in such diagrams is thus of importance, and so the recent appearance of a revised book of standardized symbols is a matter of some interest.

THE appearance of a revision of "Graphical Symbols for Telecommunications"* (briefly recorded in last month's *Wireless World*) after a lapse of eleven years will be welcomed particularly by workers in the short-wave and microwave techniques and in the complicated circuits which have made such strides during this interval.

The book deals with symbols for "block schematics" and plans as well as the type of graphical symbol for use in circuit diagrams with which we are here concerned. A circuit diagram is defined as: "a diagram which depicts in simple form, by means of symbols, the essential components and the interconnections required to provide the information necessary to show the operation of the circuit. A circuit diagram will usually be drawn so as to show this as clearly as possible and therefore will not necessarily depict the various items and their connections in their actual spatial relationship."

The last sentence should be a warning to those who spoil a circuit diagram by trying to combine it with a layout drawing and end by producing something which is suitable for neither purpose.

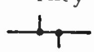
Guiding Principles

The pages dealing with "Guiding principles to be observed in using the symbols and in preparing diagrams" are, in the writer's opinion, the most important additions. To borrow a term from Frederick Bodmer's "The Loom of Language" they might well be called the "table-manners" of circuit drawing. The following "principles" are selected in order to give an idea of the field covered.

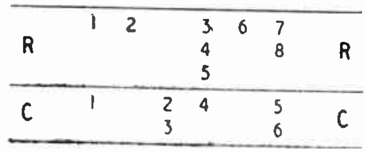
"Diagrams should be drawn so that the main sequence of cause to effect goes from left to right, and from top to bottom." (The writer would prefer "*or* from top to bottom.") "When this is impracticable, the direction should be shown by an arrow."

"Frequently occurring groups of symbols should be drawn in standard recognized forms." The groups shown include multivibrators, rectifier circuits, filter-network and bridges.

The applications of these principles are illustrated in two of the diagrams at the end of the book. It should be emphasized that these two diagrams are *not* intended as examples of complete drawings but are intended only for the above purpose. With this end in view, they have been distorted so as to include as many "principles" as possible. The diagrams referred to are: page 88 "Modulator and Master Oscillator" and page 89 "Oscilloscope."

On page 8 we read "Of wires meeting at a connecting point, not more than two should be collinear. They should be drawn thus  and not thus ." The writer considers that the observance of these "Staggered cross-roads" would contribute more than any other rule to the avoidance of "accidents" in the shape of mistakes in drawing or in careless tracing. He would respectfully draw the attention of the *Wireless World* drawing office to this rule, which has had a rather unnoticed existence in this British Standard for fourteen years.

Before leaving these pages one other recommendation (on page 15) is worthy of mention. We read "It is frequently necessary to locate [why not "find"?] in a circuit diagram . . . some particular component . . . by the coded reference only. One method of facilitating such location is illustrated below. This indication extends along the length of a diagram." [See also diagrams on pp. 88, 89 of the book.]



The writer believes that this system was invented by the Royal Air Force. With the increasing complicity of apparatus, this aid is becoming more and more necessary.

Too Many Symbols?

There are shown nearly three hundred circuit symbols. The writer often hears the opinion expressed that there are far too many symbols, and that there is an unwise tendency to distinguish by different symbols the differing method of construction or differing materials of devices which perform the same electrical operation (for example, different types of transformer cores) and also to indicate mechanical details (for example, direction of rotation of control knobs).

In defence of this large number of symbols, the writer produces the following arguments:—

(1) Many of the 300 are variants of about 100 basic symbols and illustrations of combinations of these. For example, No. 25 (resistor) plus No. 20 (sliding control) gives No. 25.11 (potential divider, variable).

* B.S. 530; British Standards Institution, 28, Victoria Street, London, S.W.1. 10s 6d, post free.

Circuit Symbols—

(2) If all technical manuals contained diagrams showing mechanical details in addition to the essential circuit diagram, many of these extra symbols would be unnecessary. Often only one diagram (the circuit diagram) is provided; this, then, is the only place where these apparently irrelevant details can be shown.

(3) The writer is constantly being asked by rather unimaginative people, who have perused the nine symbols for valve elements (grid, anode, etc.) and the twenty examples of their combinations (diode, pentode, etc.). "How do you draw, say, a double-diode octode?" The 200 variants are useful to such people.

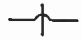
Criticism would be disarmed if B.S.I. or some other body were to produce "Basic Circuit Symbols"—much as the B.S.I. has produced a card containing extracts from its standard on proof-correcting.

The adjoining symbols, which have not appeared in previous editions, are worthy of attention.

The above review has tried to show that an important new aid to standardization and interpretation has been produced; it should find its way into the hands of those who want their diagrams to "be understanded of the people." Readers who have been (or are still) in the fighting services may be glad to know that items which are common to B.S. 530 and to the "Services" book (B.R. 1079—Tels. A. 301—A.P. 2867 to give the Navy, Army and Air Force references) are represented by the same symbols in the two publications, except for trivial differences a satisfactory example of combined operations between the services and industry.

NEW SYMBOLS

No. 4.1.
Crossing of conductors without connection:

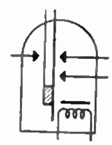
The bridge  is included as an alternative but it is associated with a note "The bridge is deprecated unless considered essential." The writer hopes that *Wireless World* will continue to consider it "essential" in the type of circuit which it illustrates so clearly.*

No. 19.1.
Pre-set adjustment

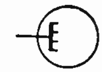
No. 25.4.
Thermistor

(the full disc indicates a negative resistance temperature characteristic: positive characteristic is indicated by an open circle.)

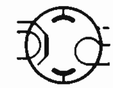
No. 43.
Vibrator as used for power supply



No. 79.6.
Secondary emission electrode

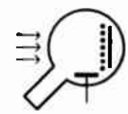


No. 94.
Magnetron: concentric line output

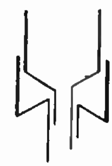


(this symbol was devised when the insides of a magnetron were still "secret.")

No. 95.
Vision pick-up tube: storage type (Iconoscope)



No. 801.41.
Adcock aerial



No. 801.5.
Rhombic aerial

* *Wireless World* drawing office says "Mr. Bainbridge-Bell's approval of our practice in the matter of bridge cross-overs seems to cancel out his disapproval of our use of colinear connections (see previous page). When bridges are used, the risk of errors through this cause automatically disappears."—Ed.

NEWS FROM THE CLUBS

Birmingham.—On December 10th members of the Slade Radio Society will be given demonstrations of home recording by D. O'C. Roe, of Birmingham Sound Reproducers. Meetings are held fortnightly at 8.0 at the Parochial Hall, Slade Road, Erdington. Sec.: C. N. Smart, 110, Woolmore Road, Birmingham, 23.

Croydon.—The normal monthly meeting of the Surrey Radio Contact Club will not be held in December as the club's annual social gathering has been fixed for December 14th at the Purley Hall, Banstead Road, Purley. The next meeting will be on January 11th at 7.30 at the "Blacksmith's Arms," Southend, Croydon. Sec.: L. C. Blanchard, 122, St. Andrew's Road, Coulsdon, Surrey.

Derby.—A series of television lectures is being given to members of the Derby and District Amateur Radio Society which meets on alternate Wednesdays at 67B, London Road, Derby. Sec.: F. C. Ward, G2CVV, 5, Uplands Avenue, Littleover, Derby.

Edinburgh.—Meetings of the Lothians Radio Society are held on the last Thursday in each month at 7.30 in the Chamber of Commerce Rooms, Charlotte Square, Edinburgh. Sec.: I. Mackenzie, 41, Easter Drylaw Drive, Edinburgh, 4.

Enfield.—It has been decided to restart the Enfield Radio Society and the inaugural meeting will be held on January 12th at 8.0 at the King's Head Hotel, Enfield Town. Acting Sec.: B. C. Lowing, G2FDO, 98, Myddleton Road, Hornsey, London, N.8.

Harrow.—Members of the Radio Society of Harrow will compete for the Club Constructors' Challenge Cup on December 7th. The Club's transmitter is now licensed under the call G3EFX and will soon be operating on all bands from 10 to 80 metres. Sec.: J. R. Pikett, 93, Whitmore Road, Harrow, Middx.

Liverpool.—The November programme of the Liverpool and District S.W. Club includes a lecture demonstration on capacitor testing by H. B. Morgan, chief engineer of Wingrove and Rogers. Meetings are held on Tuesdays at 7.30 in St. Barnabas Hall, Penny Lane, Liverpool, 15. Sec.: W. G. Andrews, G3DVW, 17, Lingfield Road, Broadgreen, Liverpool, 14.

Southall.—The West Middlesex Amateur Radio Club has been unable to find a suitable building for a clubroom and workshop and has, therefore, started a fund for the purchase of a hut. Meetings continue to be held at the Labour Hall, Uxbridge Road, Southall, on the second and fourth Wednesdays of each month at 7.30. Sec.: C. Alabaster, 34, Lothian Avenue, Hayes, Middx.

Southend.—At the meeting of the Southend and District Radio Society at 7.45 on December 10th in the Municipal College, Victoria Circus, R. Ritchie, of E. K. Cole, will speak on pulse modulation. Sec.: J. H. Barrance, M.B.E., 49, Swanage Road, Southend-on-Sea, Essex.

Walworth.—Meetings of the Walworth (Men's Institute) Radio Club have restarted on Wednesdays and Fridays at 7.0 at the Avenue School, John Ruskin Street, London, S.E.5. Sec.: B. E. Symons, 100, East Dulwich Grove, London, S.E.22.

TELEVISION WAVEFORMS

Some Comparisons Between British and American Standards

ALL television systems now in use have a fundamental likeness in spite of a number of surface dissimilarities. The number of scanning lines used may vary and the synchronizing signals may be somewhat different in form; some systems may use positive modulation and others negative, while again vertical polarization of the radiated wave may be adopted in some cases and horizontal in others.

Through all these minor differences the broad principles of line scanning, interlacing, and synchronization by pulses transmitted as 'blacker than black' signals remain the same in all systems. Some of the differences are not always well understood, with the result that unjustifiable claims are not infrequently made by their supporters. As will appear later, it turns out in some cases, at least, that there is very little to choose between the alternatives on technical grounds. This being so, it is unfortunate that one or other of the alternatives has not been universally adopted.

Two of these points of difference only will be discussed here, the sense of modulation and the inclusion, or otherwise, of equalizing pulses in the synchronizing signals. In Britain, positive modulation has been adopted with peak-white corresponding to full carrier amplitude, black to 30 per cent of full amplitude and the tips of the synchronizing pulses to zero carrier. In America negative modulation is used; with this the tips of the sync pulses correspond to the full carrier amplitude, black to 75 per cent of the full amplitude and white to 15 per cent. In both systems the duration of a line sync pulse is 10 per cent of the full line period.

Because the peak power with negative modulation is radiated for only 10 per cent of the time as compared with 85 per cent for positive modulation with a white picture, the ratio of peak/mean powers is greater with it. This is often claimed to mean that higher power can be obtained from the same transmitter output valve with negative modulation than with positive. This is not necessarily true, however.

	White		Black		Sync	
	+	−	+	−	+	−
Relative Carrier Amplitude ...	1.0	0.15	0.3	0.75	0	1.0
Relative Instantaneous Power						
Output	1.0	0.022	0.09	0.562	0	1.0
Anode Dissipation ...	1.0	0.27	0.5	0.94	0	1.0
Grid Dissipation	1.0	0	0	0.32	0	1.0
Occupance	0.85	0	0.05	0.9	0.1	0.1
Relative Average Power						
Output	0.85	0	0.005	0.506	0	0.1
Anode Dissipation ...	0.85	0	0.025	0.845	0	0.1
Grid Dissipation	0.85	0	0	0.29	0	0.1

	Modulation	
	+	−
Total Relative Average Power		
Output W_a...	0.855	0.606
Anode Dissipation D_a ...	0.875	0.945
Grid Dissipation G_a ...	0.85	0.39
Relative Peak Power W_m ...	1.0	1.0
Useful Picture Signal (= change from black to white)	0.7	0.6
Figures of Merit		
$E_u/\sqrt{W_m}$	0.7	0.6
$E_u/\sqrt{W_a}$	0.76	0.77
$E_u/\sqrt{D_a}$	0.75	0.62
$E_u/\sqrt{G_a}$	0.76	0.96

The matter is not as simple as it seems at first sight, however, and in a recent paper L. H. Bedford[1] has analysed the position in some detail. He compares the two systems under the highest mean power conditions for each; these are the transmission of a white picture with positive modulation and a black picture with negative. The results are summarized in the Table above which may need a little explanation.

In each column the left-hand set of figures refers to positive modulation and the right-hand to negative. The first line gives the relative carrier amplitudes for the three different signal conditions, and the next the relative instantaneous power output. The relative instantaneous anode power dissipation is then calculated on the assumption that the efficiency is constant at 50 per cent, and that the grid power dissipation is proportional to the fourth power of the carrier amplitude.

The line 'Occupance' shows the fraction of time allotted to each quantity and is used in computing the relative average powers given in the three following lines. The appropriate figures are then summed to give the total relative average powers.

Since the changes of carrier amplitude between black and white are not the same in the two systems, this must be taken into account and is represented in the table by E_u. The figures of merit for the two systems are then computed as the ratios of E_u to the square roots of the various powers.

When peak power is the limitation positive modulation is superior in the ratio $0.7/0.6 = 1.16$; it is also better when the limit is set by anode dissipation and in the ratio $0.75/0.62 = 1.2$. However, when grid dissipation forms the limit negative modulation is superior and the difference is then rather greater, the ratio being $0.96/0.76 = 1.26$.

The greatest difference between the two systems is no more than 2db, and occurs with negative modulation in the rather unlikely event of grid dissipation being a limiting factor. In the more likely event of anode dissipation providing the limit the advantage is with positive modulation but only to a little less than 1.5 db.

Interference

The differences between the two systems affect matters much more at the receiver. In the paper already referred to Bedford[1] has pointed out that there are three main differences to be considered—the effects of ignition interference of greater peak amplitude than the full carrier on the picture and on the synchronizing, and the possibilities of A.G.C.

Ignition interference causes white spots on the picture with positive modulation but black spots with negative. With a simple limiter circuit the spots can be prevented from spreading in the former case and there is little to choose between the two systems. The advantage does lie with negative modulation, however, as it needs no limiter.

Matters are very different when the effect of interference on synchronizing is considered. With negative modulation a large interference peak may trip the line time base at any time and cause 'tearing of lines,' but with positive modulation it cannot produce false sync signals and can affect the synchronizing only by obliterating a genuine sync pulse. It can do this only when an interference peak coincides with the leading edge of a sync pulse.

This is quite a big point in favour of positive modulation, and it is worth noting that in America it has become necessary to adopt 'flywheel sync' circuits whereas they have not been adopted in any British commercial receiver to date.

The problem of A.G.C. is not an easy one in television in spite of the claims made for negative modulation in connection with it. It has never been considered as important in Britain as in the U.S.A., probably because the provision of a number of alternative programmes was considered from the outset in that country.

The simple A.G.C. system originally envisaged for use with negative modulation has proved rather a failure, for it is affected by interference. As a result, the use of A.G.C. has been abandoned in most American receivers. With both methods of modulation it is necessary to adopt 'strobing' if a satisfactory A.G.C. system is to be secured. Nevertheless, there is probably still some advantage in negative modulation.

One practical point which is not mentioned in Bedford's paper is that with negative modulation it is hardly practicable to use direct coupling between detector and V.F. stage and between the V.F. stage and the C.R. tube, as is the almost universal British practice. Since 15 per cent carrier level corresponds to peak white the cessation of a signal will send the tube into the 'whiter than white' region, and it will be underbiased. With positive modulation black level corresponds to 30 per cent modulation, and the cessation of the signal only drives the tube into 'blacker than black' beyond cut-off and does no harm. Because of this it is usual in American sets to use A.C. couplings with D.C. restoration. This means slightly more equipment.

Equalizing Pulses

On balance it will be seen that there is not a great deal of difference between the two systems. The advantage would seem to lie generally with positive modulation because synchronizing is less affected by interference and direct coupling can be used with some simplification of the receiver. This outbalances the need for a limiter.

Turning now to the synchronizing waveforms, British and American practice is very similar. Both adopt the elegant concept of odd-line interlacing with a frame signal slotted at twice the line frequency. The only significant difference lies in the provision of equalizing pulses before and after the frame pulses in the American system.

When an integrator is used for separating the frame pulses there is an error in interlacing. Bedford works out the timing error as

$$\frac{\delta t_1}{T} = \frac{t_s}{t_1} e^{(t_e - t_s/2)/T} \frac{1 - e^{-t_1/2T}}{1 - e^{-t_1/T}}$$

where

δt_1 = timing error of the frame time base firing point

T = integrating time constant

t_s = duration of line sync pulse

t_1 = duration of whole line

The error can be as great as 20 per cent of the line period when reasonable values of the integrating time constant are used, and this is sufficient to cause severe pairing.

When equalizing pulses are used, however, the error is reduced by the factor $e^{-t_e/T}$ where t_e is the interval between the first equalizing and the first frame pulses. This is a considerable reduction.

It is, however, quite easy to secure a much better performance still and without the use of equalizing pulses, by adopting an alternative to integration. One method due to H. A. Fairhurst[2] depends on passing the wave through a suitably short time constant circuit which gives a partial differentiation. This makes the *trailing* edge of the first frame pulse stand out so that it is separable by a limiter and can be used for synchronizing.

This method gives as sharp an edge to the pulse as in the case of the line pulses, and so leads to very precise synchronizing. However, even perfect precision does not necessarily result in perfect interlacing because only the firing point of the time base is controlled. Careful design is needed to secure perfect interlace, but as long as there are sufficient frame pulses to cover the whole firing time of the frame saw-tooth generator, the presence or absence of equalizing pulses has no bearing on it.

It will thus be seen that while equalizing pulses are beneficial when frame pulse separation by an integrator is adopted, they are unnecessary when other methods are used, and these other methods are usually advisable for an accurate interlace.

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[1] "Comparison of British and American Television Standards", by L. H. Bedford (Marconi's W. T. Company) International Television Convention, Zurich. To be published in a special edition of the *Bulletin de l'Association Suisse des Electriciens.*

[2] *J. Instn Elect. Engrs*, December 1938, Vol. 83, p. 797.

See also *Journal of the Television Society*. December 1937; "Interlacing," by W. T. Cocking, *Wireless World*, April 1947, p. 124, and "Television Receiving Equipment," by W. T. Cocking (2nd Ed.), p. 268.

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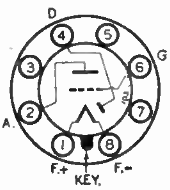
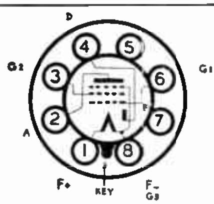
BATTERY diode-triode type 1LH4 may be conveniently replaced by type 1LD5, stocks of which are now available.

Type 1LD5 is a diode-pentode and it is therefore necessary to fit a screen series re istor together with a decoupling condenser to chassis.

Substitution by type 1LD5 will give increased gain and if this is excessive, the anode load may be reduced to give the desired gain as shown in the table below.



TYPE ILH4



TYPE ILD5

CHARACTERISTICS

	ILH4	ILD5	
Filament Voltage	1.4	1.4	Volts
Filament Current	0.05	0.05	amp.
Anode Voltage	90	90	Volts
Screen Voltage	—	45	Volts
Anode Current	0.15	0.6	mA
Mutual Conductance	0.3	0.6	mA/V
Grid Bias	0	0	Volts

RESISTANCE COUPLED OPERATION (Supply Voltage 90 Volts)

	Type ILH4		Type ILD5			
Anode Load Resistance	0.47	1.0	0.27	0.47	1.0	Meg.
Screen Series Resistor	–	–	1.5	2.7	5.6	Meg.
Voltage Gain	34	40	57	84	100	–

CHANGE VALVE		SOCKET	CONNECTIONS	OTHER WORK NECESSARY	PERFORMANCE CHANGE
FROM	TO				
ILH4	ILD5	LOCTAL NO CHANGE	Remove any connections to Pin 3.	Insert Screen Resistor between Pin No. 3 and HT+. Fit 0.1 condenser between Pin No. 3 and chassis. See table above for correct values.	Increased gain. (Reduce Anode load if necessary as given in table above.)

← PUNCH HOLES HERE →

ILH4

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.

21

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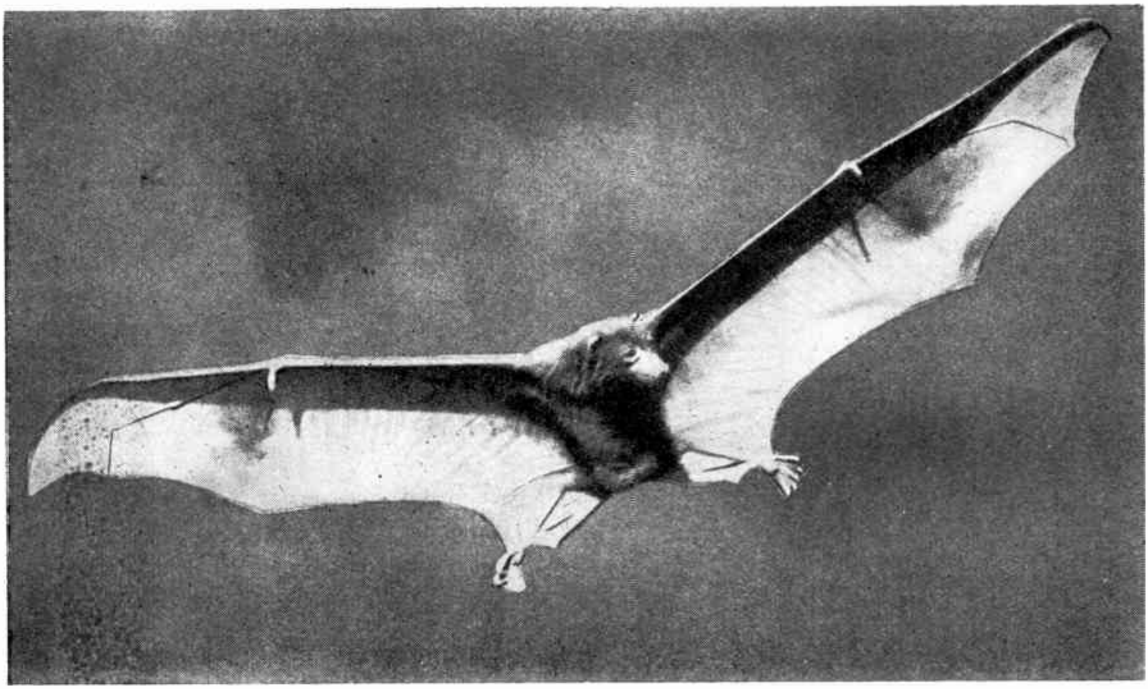

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AERIAL CORONA INTERFERENCE

Its Cause and Cure

By F. R. W. STRAFFORD, A.M.I.E.E. (Technical Manager, Belling & Lee)

THE increasing use of vertical rod-type aerials for broadcast and television reception has made evident a particularly troublesome form of interference which, although sporadic, is usually of very great intensity.

The experienced gained by the writer's observations over the last twelve months, with the help of observers' reports, has resulted in the adoption of a device which will effect a permanent cure in the majority of cases. The few cases in which complete suppression is not realized can be explained, and the further steps required to complete the cure are outlined.

It has been customary to refer to the form of interference to be discussed as "precipitation static," and it is believed that the term was originally used to describe atmospheric electricity phenomena in connection with operational aircraft.[1]

It is well known that when aircraft fly through water vapour, sleet, or snow carrying electrical charges, these charges are precipitated upon the surface of the aircraft so that it gradually attains a potential and ultimately causes corona (brush) discharges from the most exposed tips. Such discharges will naturally radiate electromagnetic impulses and, as with all discontinuous electrical phenomena, will interfere with radio reception.

Since it requires a discontinuous electric current to create an electromagnetic wave the use of the word static is hardly the correct label to attach to the phenomenon.

There would now appear to be at least two phenomena, associated with atmospheric electricity, which can disturb radio reception. First, there are atmospherics due to the radiation of electromagnetic energy from the electric discharge from cloud to cloud or to earth, visible as lightning.

Secondly, there is the interference radiated (or conducted) when conductive objects are caused to corona (brush discharge) when they are situated in a sufficiently intense electric field created by atmospheric conditions.

It is this second form of interference which is amenable to treatment and cure, and it is proposed to refer to it here as aerial corona interference.

Nature of Interference

The conditions necessary to produce this interference are invariably those obtaining in thundery weather. There are usually heavy and low rain clouds accompanied generally by heavy and sudden showers of rain, sleet or hail. There may be no thunder or normal lightning discharge atmospherics at the time. The interference usually commences abruptly with a series of slow clicks rising in repetition frequency to a few hundred per second. Sometimes the frequency is much higher and musical or squealing effects are produced. A burst of such interference can last between a few seconds and as many minutes and usually ceases as abruptly as it commences. If lightning discharges are occurring substantially overhead the burst will cease at the instant of the discharge, due to the sudden reduction of the electric intensity in the vicinity of the aerial.

It is not the intention of this article to consider in any detail the physics of atmospheric electricity, for we are concerned only with one of the annoying effects it can produce, but briefly it must be realized that, in perfectly clear weather, an electric field exists in the atmosphere. This field, which is perpendicular to the earth, attains a maximum of about 1 volt/cm at the earth's surface, falling off with increasing height to negligible value in the tropospheric region.

During a thunderstorm, or under thundery conditions, the intensity of the field (usually reversed in polarity) increases a hundredfold or more.

The voltage gradient which will exist at the tip of an aerial will depend, apart from its position in the electric field, upon the sharpness of the tip. The gradient reduces as the tip is made blunter and rounder, and continues to reduce if a conductive sphere is fitted to it, the reduction increasing with diameter of the sphere. Irrespective of the size or shape of the aerial tip there may, at times, exist a sufficiently intense field to provide gradients at the surface of the aerial capable of causing electrical breakdown of the air which initiates the corona discharge and the intense radio interference which accompanies it.

Vertical Rod Aerials

Naturally the more elevated and "spiky" the aerial becomes the greater the voltage gradient at its tip. It is for this reason that the more extensive use of chimney-mounted rod-type aerials has been followed by more widespread complaints of corona interference.

It is not necessary for the listener's aerial to corona in order to observe the interference. Neighbouring objects, particularly lightning arrestors or nearby rod type aerials, may be in a state of

[1] Army-Navy Precipitation Static Project, Part 4: *Proc. I.R.E.*, May, 1946, pp. 234-240.

Aerial Corona Interference—

corona and radiate their interference to the listener's aerial.

Observations on this aspect of the problem have proved that the radiated interference from an 18-ft vertical spike aerial located approximately ten feet from, and at the same height as, an identical receiving aerial produced an interfering level at least one hundred times lower than when the receiving aerial was itself in a state of corona.

The reader may justifiably ask how such an experiment was carried out in view of the identical character and elevation of the two aerials.

It should be stated that the tip of the receiving aerial was, in the first place, fitted with a spherical conductive ball of approximately 2 inches diameter. During the test the gradients at the aerial tips were such that the unprotected aerial was just in a state of corona so that the protected receiving aerial was below the corona threshold.

The sphere was then removed quickly and the increased level of interference observed. Several observations were made in all.

It can be stated with moderate assurance that re-radiated corona interference is not likely to be very serious, and at the worst can be reduced to negligible proportions by removing the aerial from the more likely neighbouring sources of corona.

So far as corona at the tip of the receiving aerial is concerned it does not require much thought to appreciate the intensity of the interference caused by the passage of the impulsive corona current through the input impedance of the receiver. It is quite usual for a broadcast signal of 100 mV/m to be rendered unintelligible by this form of interference.

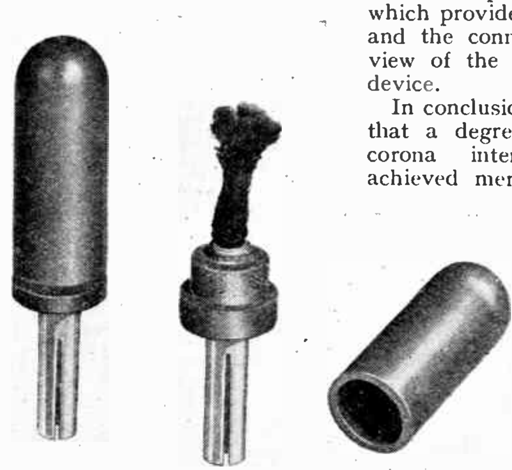
Partial Cure

The fitting of a conductive sphere to the tip of the aerial will naturally reduce the occurrence of the interference as compared with the unprotected tip. Since the atmospheric electric intensity varies over wide limits during thundery conditions, there will be times when the unprotected aerial will just attain a state of corona while the protected aerial will remain unaffected.

It must be realized that the interference does not come on gradually as the gradient increases. There is very little interference until the critical threshold gradient is attained and then intense interference immediately results.

Thus the greater the diameter of the sphere fitted to the aerial the less are the chances of interference arising during thundery weather, but complete immunity cannot be expected.

A far better method of removing the interference, however, is to make use of a device[2] which does not in itself prevent corona but splits up the corona currents through a multitude of highly resistive paths.



Complete "silent discharger" and, (right) the wick with protective cover removed

Under these conditions the capacitance of the aerial in series with each high-resistance path reduces, very considerably at the receiver input, the proportion of interfering energy lying within the broadcasting and communication frequency spectrum. In other words, the steepness of the wave front of the corona discharge impulses is greatly reduced.

The "silent discharger," as the writer prefers to call it, consists of a short length of soft lamp wick, one end of which is teased out into a fluffy brush. The wick is impregnated with a rapid-drying partially conductive solution, so that each fibre has a resultant high resistance. The wick is suitably mounted on a conductor and arranged for attachment to the aerial tip, and is protected by a plastic cap to preventive deterioration by the weather. Also wetting of the wick during rain will completely destroy the silent discharge properties, so that in this respect the protective cap is also necessary. The attenuation of interference on the medium waveband has in all observations exceeeded 40 db, while at times no level could be recorded although over 100 mV of noise was generated by the unprotected control aerial.

An example of a silent discharger[3] for rod aerials is shown in the accompanying photographs, which provide a view of the wick and the connecting plug, and a view of the completely enclosed device.

In conclusion, it must be stated that a degree of freedom from corona interference may be achieved merely by coating the aerial with a good insulating compound of low permittivity and high dielectric strength. It is essential, however, that the compound be closely adherent to the aerial rod. Slipping a jacket of insulating material over the rod is unsatisfactory because the small air gap thereby provided breaks down and the corona at the interfaces is as severe as that produced in the absence of the jacket!

Even if a good quality and adherent coating is employed it is only necessary for it to be punctured on one occasion by an unduly high surface voltage gradient for it to be quite useless thereafter.

Probably some form of bitumastic compound, or some sub-

[2] J. R. Clement, Jr.; Seventh Partial Report on Precipitation Static Problems; U.S. Naval Laboratory Report No. 0-2309. June, 1944.

[3] Patent applied for.

stance possessing sufficient cold flow to heal such punctures might prove to be satisfactory, but further evidence is required in this respect. It is only necessary for such an aerial to be severely scratched during erection to vitiate completely the inhibiting effects of the covering.

Finally, it is known that corona discharge can cause very severe interference with the vision channel of television, although the interference to the sound channel would not appear to be so serious as to the lower frequency spectrum. The interference as viewed upon the screen appears as very large white splashes, presumably due to defocusing of the electron spo because of the abnormally hig intensity of the individual pulses

Unfortunately no opportunit has yet arisen to enable a test o the silent discharger to be mad on television aerials, but there would appear to be no reason why the same, or possibly better results should not be achieved.

BRITISH COMPONENTS IN SWEDEN

Local Reactions to the R.C.M.F. Show

(FROM A CORRESPONDENT)

STOCKHOLM has been the scene of a concentrated drive by the British radio industry—components, television and lectures. The exhibition, organized by the Radio Components Manufacturers' Federation, was the most important event. In spite of the minor faults which I shall discuss below, it was a really good show, and it has done a lot of good. It was a small show, with only 36 stands, but nearly all the major firms were represented, and the layout was attractive.

The Swedish visitors were both surprised and impressed. German propaganda and American publicity have combined to make Swedes think that Great Britain, the industrial heart of a community of 550 million people, survives by copying such bright ideas as magnetrons and jet engines. This exhibition made them think. One feature which gave a great deal of satisfaction was the fact that most stands had someone there who knew the answers. This was especially important in Stockholm, because whereas in the U.K. we simply say "Type approved?", in Stockholm they ask all the questions which type approval implies.

More Data Wanted

The chief criticism is an old friend, and dates back to before the war. There were not enough detailed technical catalogues, though the exhibition was planned long enough ago to allow of their preparation. I should also prefer to see the R.C.M.F. emulate the Physical Society, and provide a single volume, for which they would be paid. In Stockholm information about British components is hard to get. The other main criticism is a question: Why aren't valves components? Sweden needs valves of American RMA types, because Sweden's foreign customers demand this. Cannot just one British firm make these and exhibit them? Perhaps British designers would find their overseas markets prefer a single standard, too.

The immediate results of the exhibition may be depressing; trade quotas are still being negotiated as though they were ends in themselves, instead of operating on a sliding scale as devices for increasing trade. It is, however, most desirable to sell as many different kinds of components as possible to Sweden, to pave the way for expansion on a broad front. Many of these components are re-exported, serving as samples of British components in Eastern European countries. This exhibition must become an annual affair, and could, to my mind, be supplemented by a "Little Show"; a showcase of new components which could tour European factories, spending, say, one week at each. Publicity for the BS/RC specifications would help, too, especially if they could be printed decently in book form. If the publicity people and the politicians can do as well as the component industry, Europe is wide open.

Pye television put up a very good show, too, though for reasons outside their control, the arrangements discouraged quite a few visiting engineers. I was fortunate enough to see a programme from the control van when a valve failure took place. The radiated programme showed no trace of this at all, except that there was a rather static quality in the production, as only one camera was in use. This episode provided a convincing proof of the efficiency of the production control system, for friends who saw only the broadcast programme were not aware of any failure. Picture quality was very good, and the actual equipment itself was, to my mind, extraordinarily well constructed. Until we have colour, I see no need for technical improvements, at least on the electrical side.

Lectures

Dr. Smith-Rose's lectures marked an important change in the attitude of the British Council, which is under new management in Stockholm. Physics and mathematics are part of our civilization, just as they were part of that of Leonardo da Vinci. The concentration of side issues, like theatre scenery and book printing, is wrong; the play and the contents of the book are the important things. British life is now based on a scientific background. The lectures themselves, for some reason, were not those announced, but were of the semi-popular class. Unfortunately the audience had not been warned.

Looking back on the six days, I feel that it was all much better than I expected, and that it produced much more effect than I had hoped. There really is a market in Scandinavia, but it must be cracked open. If the industry and the British Council hang together they should be able to double their present trade.

ELECTRONIC CIRCUITRY

Selection from a Designer's Notebook

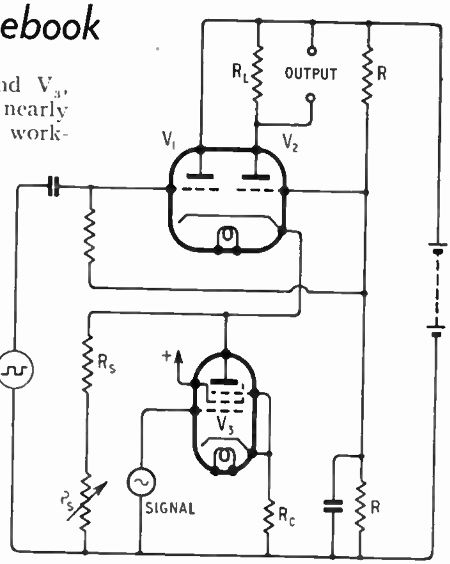


Fig. 2. High-speed gate circuit.

More Notes on Beam Switches

LAST month two gate circuits were described, the second of which was a cathode-coupled arrangement. Another cathode-coupled arrangement suggested by the writer's colleague, Mr. T. C. Nuttall, is shown in Fig. 1. This circuit has the advantage that the output is derived in push-pull across the equal resistances R_{L_1} and R_{L_2} and there is no loss of gain due to R_c. The mode of operation is an extension of the simpler cathode-coupled circuit.

On the positive half-cycle of the switching wave form V_2 and V_3 are cut off by the positive excursion of the common cathode potential. On the negative half-cycle V_1 is cut off, leaving V_2 and V_3 operating as a cathode-coupled phase splitter as described by Mr. Cocking in a recent article. V_2 and V_3 may be used with either single-ended input or in push-pull as required, and in either case a push-pull output is obtained. This is very convenient as most modern cathode ray tubes are intended for symmetrical deflection. Another obvious advantage is that R_c now introduces no loss of gain, and the larger R_c is made the better balanced will be the output voltages across R_{L_1} and R_{L_2}.

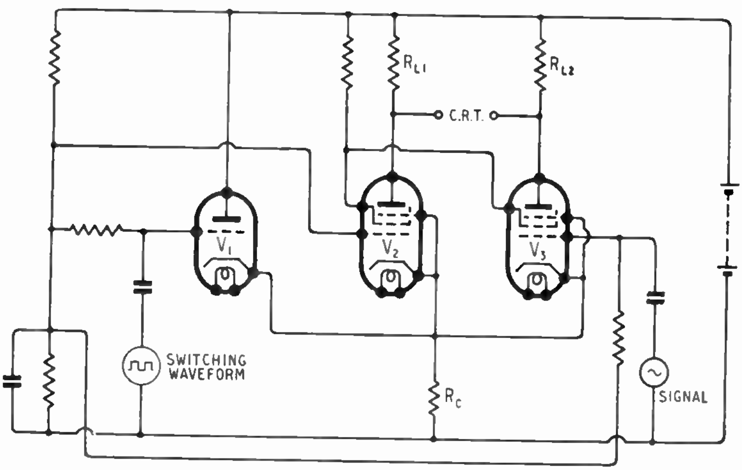


Fig. 1. Push-pull cathode-coupled gate.

The overall gain of V_2 and V_3, when conducting, will be nearly g_mR_L; g_m is, of course, the working mutual conductance of one valve.

As before, the grid-cathode capacitances of V_2 and V_3 are charged or discharged at each switching operation through whatever grid impedance there may be—in the case of one valve at least this will be the signal source impedance. Generally speaking a high switching frequency can be satisfactorily obtained only when either a low-impedance signal source (e.g., a cathode follower) is provided, or when the circuit is entirely symmetrical. Under these latter conditions any effects of switching appear at the anodes of V_2 and V_3 in push-pull and so leave the C.R.T. unaffected.

In a two-beam switch, two such gates are used, and the V_2 anodes of each channel are connected in parallel, as are the V_3 anodes. Each signal can be given its own "shift" by arranging for a manually controlled unbalance of the standing anode currents in V_2 and V_3 and by direct coupling to the C.R.T. deflection plates.

The last of the gate circuits to be described* is shown in Fig. 2. Here the switching waveform is applied to the double triode so that on positive half-cycles V_1 is conducting and V_2 cut off, and on negative half-cycles the reverse is true. The cathode current of the double triode is continuously modulated by the signal applied to V_3, and when V_2 is conducting the signal voltage appears across R_L. The gain from input to output is approximately $g_mR_L/(g_mR_c+1)$ where g_m is the mutual conductance of V_3.

The main limitation to rapidity of switching is the stray capacitance between the anode of V_3 and earth, which has to be charged or discharged at each switching operation. This capacitance is the sum of the anode-earth (V_3), the cathode-earth (V_1, V_2) and grid-cathode (V_2) capacitances. By the use of miniature valves these can be kept to a minimum. This total capacitance has to be charged through the cathode of V_2, V_1, and this is fortunately a low impedance point (V_1 is a cathode follower, and V_2 a grounded-grid stage). If in addition the mutual conductance of V_1, V_2 is made high, conditions are very favourable for rapid

* Patent applied for.

switching. To obtain a "shift" associated with each signal V_s may be shunted by R_s and P_s as shown, so that by variation of P_s the standing current in R_L may be varied.

This last circuit has most of the advantages of the previous circuits and is capable of being switched extremely rapidly. Using a 6J6 for V_1, V_2, and an EF91 for V_3 it was not found difficult to make a beam switch with a switching frequency of 100 kc/s. By arranging to "blank" the C.R.T. for a period of about 0.15μsec at each switching operation, a beam switch with a switching frequency of 1 Mc/s was found to be practicable.

Direct-coupled Amplification for Photocells

THE photocell is now widely used in a variety of applications, and in many of these a very short response time is unnecessary. It is not always realized that many of the difficulties of direct-coupled amplifiers can be avoided by using a high-resistance load for the photocell — provided it is not gas-filled. In a normal vacuum photocell it is necessary to provide a sufficient anode potential to achieve saturation (i.e. collect at the anode all electrons emitted by the cathode), and this potential is generally 20-70 volts according to the cell construction. As long as this potential is always available the cell current is independent of external resistance, so that it is possible to detect minute photo-currents by developing a relatively large potential across a resistance of large value.

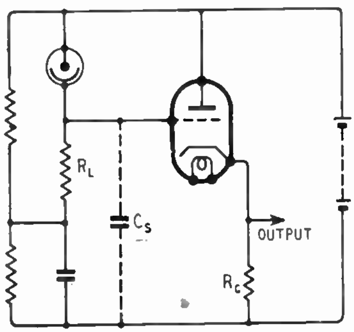


Fig. 3. Photocell amplifier Cs is the stray capacitance

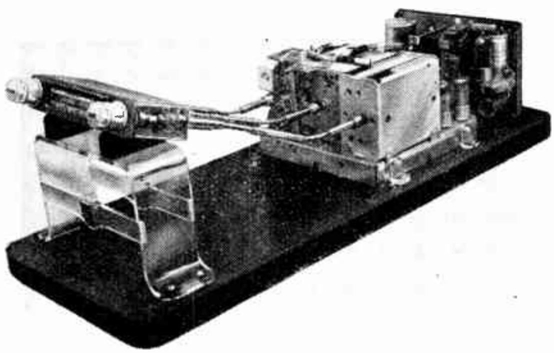
A simple circuit frequently used by the writer with success is shown in Fig. 3. With a photo-cell load (R_L) of 100 MΩ, then obviously one volt output will be obtained with 1/100μA cell current—corresponding to the light resulting from a 100 watt lamp about 150 ft away from a cell of average size and sensitivity. Because the "amplifier" is only a cathode follower, considerable freedom from instability can be expected. The speed of response is, however, limited by the time constant formed by the capacitance at the valve grid and the load resistance. If R_L = 100MΩ and the stray capacitance is 20 pF the time constant is 0.2 millisecond.

One word of warning. When using such high resistances (10-1,000 MΩ) care must be taken to eliminate stray leakages. The use of guard rings is sometimes desirable, and these may conveniently be connected to the cathode of the cathode follower. The cathode load, R_c, should be large.

—J. McG. S.

HIGHLIGHTS OF CAR RADIO

New Models for Cars, Coaches and Motor Launches



This view shows the three units of the EKCO model CR61 car radio.

BECAUSE the bulk of motor car production in this country is ear-marked for export it is perhaps not surprising that the car radio sets that were shown at this year's Motor Show should cater more for overseas than for home users.

The latest Ekco production is the Model CR61 and it provides five manual tuning ranges covering 0.515 to 1.64 Mc/s, 3.3 to 7.4 Mc/s, 9.3 to 10 Mc/s, 11.5 to 12.1 Mc/s and 15 to 15.5 Mc/s. The last three it will be seen are the 31-, 25- and 19-metre bands expanded to cover the full scale. In addition there is switch selection of four pre-set stations, three in the medium and one in the long-wave band.

The receiver is a 7-valve plus rectifier superhet with permeability tuning throughout. It has an R.F. stage, push-pull output and a noise limiter. Miniature valves are used and overall size of the receiver is 7 × 7 × 4½in only. The power unit is separate and so is the control head but this only takes up 6½ × 1½ × 3⅜in. One or more external loudspeakers can be fitted.

The CR61 is available in the home market and costs £31 10s plus tax and excluding aerial. There is a home version with medium- and long-wave facilities only at £28 7s, plus tax. It is the Model 84.

A number of circuit improvements have been made to the H.M.V. car radio sets shown by Radiomobile in addition to which a new model, the 4020, has been developed for large limousine cars. Designed primarily for the Humber Pullman the set is divided into two parts, control head and main unit, respectively. The former is designed to fit into an ash-tray receptacle just below the off-side rear window and contains the R.F. and frequency changer valves, push-button and manual tuning, on-off and wave change controls. The volume control is separate.

The pre-selection mechanism is similar to that used in the Model 100 and the remainder of the set is basically the same. Separate loudspeakers are, however, employed. The price is £48, plus £12 tax, including installation and aerial.

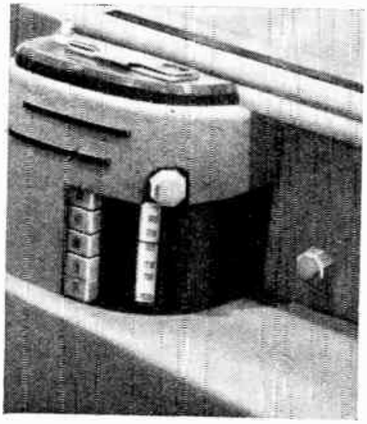
Other firms showing home and export models include Delco-Remy-Hyatt, Masteradio, Philco, Romac and World Radio (Motorola).

A new application for car radio is appearing in the form of special equipment for motor coaches. Included are facilities for making announcements through a microphone, using the audio stages of the re-

Highlights of Car Radio—

ceiver as a small public-address amplifier.

Basically the set is a normal car



The new H.M.V. set for limousine cars has a separate control head and loud speakers with the remainder of the set stowed in the boot.

radio with a larger output stage, and provision is made to operate several loudspeakers in the body of the coach. It is fitted in the driver's cab.

Sets of this kind are also being fitted to some of the large motor cruisers, while normal car radio sets were seen in the smaller motor launches and in caravans.

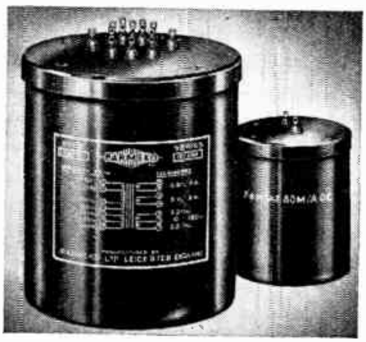
CAR RADIO MANUFACTURERS AT EARLS COURT MOTOR SHOW

Delco-Remy-Hyatt (Delco) (Division of General Motors Ltd.), 111, Grosvenor Road, London, S.W.1.
E. K. Cole Ltd. (Ekco), Ekco Works, Southend-on-Sea, Essex.
Masteradio Ltd., Fitzroy Place, London, N.W.1.
Philco Radio and Television Corporation of Great Britain, Ltd., Wadsworth Road, Perivale, Greenford, Middlesex.
Romac Industries Ltd. (Mellow Truth), The Hyde, Hendon, London, N.W.9.
Radiomobile Ltd. (His Master's Voice), Cricklewood Works, London, N.W.2.
World Radio Ltd. (Motorola), Edgware Road, Cricklewood, London, N.W.2.

MANUFACTURERS' PRODUCTS

"Mercury" Transformers and Chokes

THIS is a new range of iron-cored components, including mains and A.F. types, introduced by



The new "Mercury" series of iron-cored components, showing a mains transformer and a small A.F. choke.

Parmeko Ltd., Percy Road, Leicester. All are vacuum impregnated and hermetically sealed in drawn copper containers with connections brought out through glass seals.

Fixing bushes are provided in both the top and the base of the container so that upright or inverted mounting can be employed to suit surface or under-chassis wiring.

A comprehensive range of transformers and chokes, from miniatures with internal mu-metal shields, to power transformers of 170 VA, audio transformers up to 60 watts rating and smoothing chokes up to 20 H at 250 mA are now available in seven different sizes of container.

The form of construction adopted protects the components against all climatic effects, from extreme cold to extreme heat and high humidity. Corrosion fungus and fumes are excluded and they are particularly well suited for use in aircraft at high altitudes and in land mobile equipment.

New Valves

FIVE new A.C./D.C. valves with 0.1A heaters have been introduced by Mullard Electronic Products, Century House, Shaftesbury Avenue, London, W.C.2. They are mounted on B8A bases and their type numbers and functions are as follows:—

UCH42 (14-V heater). Triode-hexode frequency changer.

UAF41/UAF42 (12.6-V heater). Var.-mu pentodes with single diodes.

UL42 (45-V heater). Output pentode, 4.2W at 10 per cent with 165V H.T.

UY41 (31-V heater). Half-wave rectifier, 90mA.

A change in the nomenclature of two R.F. power double tetrodes is announced. In future the QVO4-20 and QV07-40 types will be known as QQV04-20 and QQV07-40 respectively.

Portable Record Player

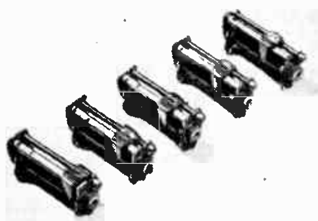
A BATTERY-OPERATED record player with carrying capacity for nine records has been introduced by Vidor, Ltd., Erith, Kent. The

Vidor Record Player

3-valve amplifier works from a combined L.T. and H.T. dry battery and the whole outfit weighs only 17lb. The price is £14 14s inclusive of tax.

Pre-set Resistors

A SERIES of miniature pre-set resistors for circuit balancing and matching has been introduced by Electro Methods, 220, The Vale, London, N.W.11. The range of maximum values is from 5 ohms to 1,800 ohms and the rating is between 3 and 4 watts. Silver contacts are used and the slide is adjusted by means of a screw thread. The dimensions are $1\frac{7}{8}$in × $\frac{15}{16}$in × $\frac{1}{2}$in.



A selection of Electro Methods pre-set resistors.

THE SEE-SAW CIRCUIT *Again*

Applications as a Stable Wide-band Voltage Amplifier

By J. McG. SOWERBY, B.A., Grad.I.E.E.

(Cinema Television, Ltd.)

PARTLY as a result of its use in war-time radar, but also because it is being realized that it can be used as a versatile feedback amplifier stage the see-saw or anode follower circuit is becoming more and more popular. It has been well described in several journals[1-6], but these descriptions have usually been confined to the discussion of the conditions required for a gain of unity, for use as a phase reversal stage in push-pull amplifiers. By analogy with the cathode follower the circuit is sometimes called the anode follower—a name to be deprecated as the anode potential does *not* follow that of the grid; they are, in fact, reversed in phase.

A gain of unity is by no means essential to the see-saw circuit, and a gain of anything less than the gain of the stage alone (without the see-saw attachments) can be obtained, as will be seen from the following notes.

There are two ways in which the see-saw circuit may be connected. In Fig. 1, is shown a common arrangement which is quite suitable for low-frequency work—up to 10 kc/s, say. This connection is, however, unsuitable for the higher frequencies because as soon as the reactance of the grid—earth capacitance C_g (shown dotted) becomes comparable with R_i or R_f, the gain begins to change with frequency. Although an improvement may be effected by the introduction of additional capacitances C_i, C_f (shown dotted) across R_i and R_f respectively, a feedback independent of frequency cannot be obtained. This is obvious when it is remembered that R_g, R_i, R_f, and R_a in parallel with the impedance of the valve form a π circuit, and the capacitances C_i, C_g, C_f, and C_a (the stray anode capacitance) form a loaded T circuit.

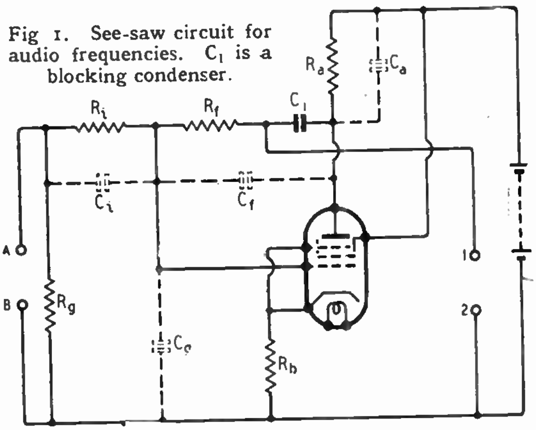


Fig 1. See-saw circuit for audio frequencies. C_1 is a blocking condenser.

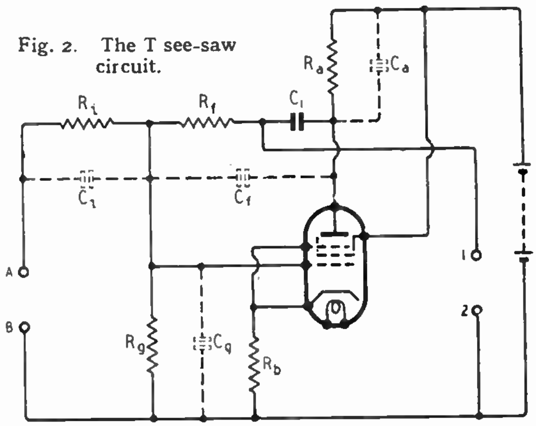


Fig. 2. The T see-saw circuit.

If the use of frequencies above the audio range is contemplated, it is preferable to arrange the see-saw as in Fig. 2. It is obvious that the network now forms a loaded T circuit composed of three impedances Z_i, Z_f and Z_g, each of which is of the same character being composed of a resistance shunted by a capacitance. By making the time constants of the three arms equal (i.e. $R_iC_i = R_gC_g = R_fC_f$) the T network becomes independent of frequency, and the only capacitance which plays any great part in the attenuation of high frequencies is C_a—to which must be added the apparent capacitance C_t, presented to the anode of the valve by the T network.

Design of the T See-Saw.—If the see-saw is to be designed for a fairly wide bandwidth, as in an oscilloscope amplifier for example, it is usually necessary to make R_a relatively small, and it is then easy to arrange that the resistance looking back into the T from the anode of the valve is large compared with R_a. Hence it will be sufficiently accurate for most practical purposes to assume that the anode load resistance is unmodified by the introduction of the T, but that the capacitance C_t must be added to C_a in calculating the high-frequency performance.

The overall gain $E_{12}/E_{AB} = A$ can be expressed in terms of three parameters: the gain without feedback $A_0 = E_{12}/E_{gc}$, the attenuation α through the T alone from terminals AB to the grid of the valve, and the feedback factor β which is the attenuation of the T alone from terminals 1, 2, to the grid. A short-circuited termination is assumed in each case. The overall gain is thus

$$A = \frac{\alpha A_0}{1 + \beta A_0}.$$

We may proportion α and β more or less as we please to yield the required overall gain. We could, for example make β approach zero (by making R_f exceedingly large) and then simply choose α to give the required

The See-Saw Circuit *Again*—

overall gain. But by doing this we should have thrown away the possibility of reducing the distortion and output impedance by feedback. If we go to the opposite extreme and make α approach unity (by making R_i very small and control the gain almost entirely by feedback, then the input impedance becomes very small and the stage is consequently difficult to drive. Another assumption has to be made before useful design data can be derived. The assumption has been made here that $(R_i + R_f) = R_g$ as this represents a reasonable compromise in most practical cases between too little feedback, and too low an input impedance.

As will be seen from the Appendix (equation 5), the analytical results are not very convenient to handle, and the design of a see-saw stage is more easily tackled graphically with the aid of the curves of Fig. 3. These show A (over the range 1 to 100) for various values of R_f/R_i for gains without feedback (A_0) between 5 and 500. A curve has been drawn for A_0 infinitely high so the results with values of A_0 exceeding 500 may be estimated.

Having found a suitable value of R_f/R_i from the curves—by interpolation if necessary—and assumed a convenient and reasonable value for R_g, it is a simple matter to find R_f and R_i from $R_i = R_g/(1 + R_f/R_i)$ and $R_f = R_g - R_i$. Trimmer condensers may then be added to make the time constants equal in all the arms of the T network. The input resistance is then virtually R_i, and the input capacitance C_i is given by equations (9) and (10) of the Appendix.

The output resistance is modified by the feedback, and this is conveniently described as a low resistance R_0 in parallel with R_a, so that the total output resistance $R' = R_0R_a/(R_0+R_a)$. From the Appendix we may take the result $R_0 = \left(\frac{1}{g_m} + R_b\right)F$ and the factor F may be taken from the curve so labelled in Fig. 3.

The high-frequency response of the stage is determined by the stray capacitance across R', and this is composed of C_a and C_t. Calling this total capacitance $C' = (C_a + C_t)$, the frequency at which the response is three decibels down is

$$f_c = \frac{160}{C'R'} \quad \begin{matrix} C' \text{ in } \mu\mu F \\ R' \text{ in } k\Omega \end{matrix} \quad f_c \text{ in Mc/s}$$

For most purposes it is sufficiently accurate to assume that $C_t = C_f$: see equation (10a) in the Appendix.

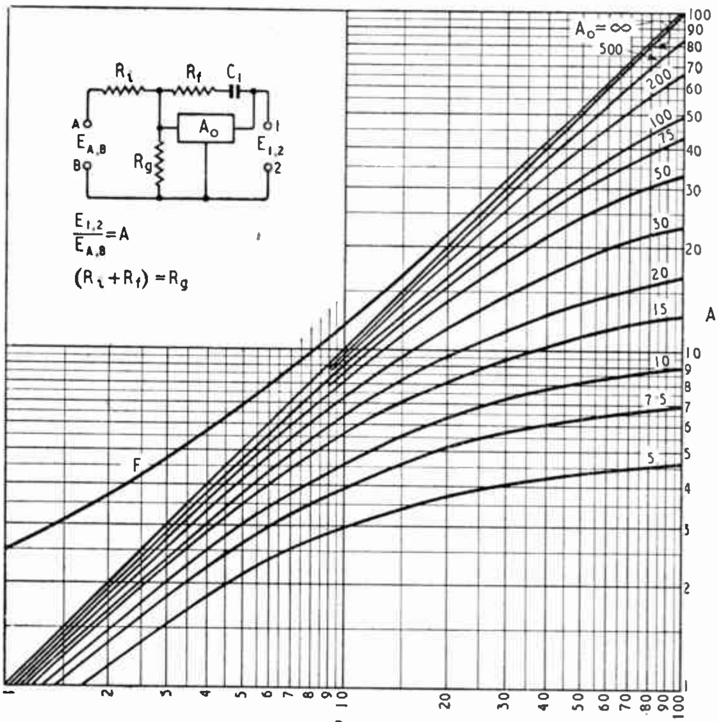


Fig. 3. Curves connecting A and F with R_f R_i for see-saw circuit, T connection.

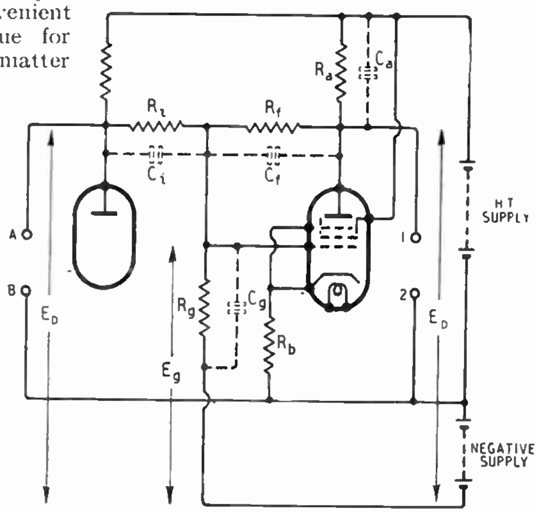


Fig. 4. Direct coupled see-saw circuit.

Direct Coupled See-Saw.—The L.F. response of the circuit of Fig. 2, is limited by the blocking condenser C_1, and if a response down to zero frequency is required, the direct-coupled see-saw of Fig. 4 may be adopted. The arrangement is not generally suitable for an input stage, because it has a relatively low input resistance and the gain is partially dependent on the internal impedance of the signal source. The circuit is however suitable for subsequent stages.

It will be remembered that for the circuit of Fig. 2, we make the reasonable assumption that $(R_i + R_f) = R_g$ thus fixing the relative values of feedback and attenuation for a given overall gain. In the circuit of Fig. 4 we need to make no such assumption, as the conditions are already fixed by the required distribution of standing potentials. These may be almost anything within reason, each leading to different results. It seems reasonable, therefore, to present the conditions for the particular case when the standing potentials at input and output are equal. This case is particularly useful as stages may be cascaded without further trouble; always provided, of course, that R_a is low compared with the resistance of the T network. Except for the extension of the frequency response to zero frequency, the circuit behaviour of Fig. 4 is the same as that of Fig. 2.

APPENDIX

A = Stage gain
A_0 = Gain of valve alone $= g_m Z_a\ (g_m R_b + 1)$
g_m = Mutual conductance of valve.

To find the overall gain of Fig. 2.
We may write:

$$A = \frac{\alpha A_0}{1 + \beta A_0} \quad \ldots \quad \ldots \quad (1)$$

Where

$$\alpha = \frac{R_f R_g}{R_i(R_f + R_g) + R_f R_g} \quad (2)$$

and

$$\beta = \frac{R_i R_g}{R_f(R_i R_g) + R_i R_g} \quad (3)$$

Substituting for α and β in (1)

$$A = \frac{R_f R_g A_0}{R_f(R_i + R_g) + R_i R_g(A_0 + 1)} \quad (4)$$

or

$$A = \frac{A_0\ R_f/R_i}{\frac{R_f}{R_i}\left[1 + \frac{1}{\frac{R_f}{R_i} + 1}\right] + A_0 + 1} \quad (5)$$

when $(R_i + R_f) = R_g$

To find the input impedance
The signal potential across R_g is

$$E_{gr} = \frac{AE_{AB}}{A_0} \quad \ldots \quad (6)$$

But the signal potential across R_i is

$$E_{AB} - E_{gr} = E_{AB}(1 - A/A_0) \quad (7)$$

and the signal input current is

$$I_{in} = \frac{E_{AB}(1 - A/A_0)}{R_i} \quad \ldots \quad (8)$$

Hence the input resistance is

$$R_{in} = \frac{E_{AB}}{I_{in}} = \frac{R_i}{1 - A/A_0} \quad (9)$$

Similarly the input capacitance is

$$C_{in} = C_i(1 - A/A_0) \quad \ldots \quad (10)$$

And in the same way the input capacitance, C_t, looking back into the T network from the anode is given by

$$C_t = C_f(1 - 1/A_0) \quad \ldots \quad (10a)$$

To find the apparent anode resistance R_0 of the valve.
Let a potential V_{12} be applied to the anode of the valve and let the consequent potential at the grid be v_g.

$$v_g = \beta V_{12} \quad \ldots \quad (11)$$

The resultant valve anode current is

$$i_a = g_m(\beta V_{12} - i_a R_b)$$

or

$$i_a = \frac{g_m \beta V_{12}}{1 + g_m R_b} \quad \ldots \quad (12)$$

Hence the apparent anode resistance is

$$R_0 = \frac{V_{12}}{i_a} = \frac{1}{\beta}\,\frac{1 + g_m R_b}{g_m}$$

or

$$R_0 = \left(\frac{1}{g_m} + R_b\right)F, \quad \ldots \quad (13)$$

where $F = \frac{1}{\beta}$

From (3), when $(R_i + R_f) = R_g$,

$$\frac{1}{\beta} = F = \frac{R_f}{R_i}\left[1 + \frac{1}{\frac{R_f}{R_i} + 1}\right] + 1 \quad (14)$$

Referring to Fig. 4
To find R_f and R_i for a given overall gain, A.

$$(\alpha - \beta) = \frac{E_g}{E_D} = E \text{ and } \alpha \text{ and } \beta$$

are defined by (2) and (3).

Hence

$$\alpha + \beta = \frac{R_f R_g + R_i R_g}{R_i(R_f + R_g) + R_f R_g} = E$$

Whence

$$R_i = \frac{R_f(1 - E)}{E\left(\frac{R_f}{R_g} + 1\right) - 1} \quad \ldots \quad (15)$$

From (4),

$$R_i = \frac{1}{A}\,\frac{R_f R_g A_0 - AR_f R_g}{R_f + R_g(A_0 + 1)} \quad (16)$$

Equating (15) and (16).

$$R_f = \frac{(1 - E)(A + 1)}{E - A/A_0} R_g \quad (17)$$

Substituting (17) in (15) we find

$$R_i = \frac{(1 - E)(A + 1)}{A(E + 1/A_0)} R_g \quad (18)$$

To find the apparent anode resistance, R_0, of the valve.
From (13),

$$R_0 = \frac{1}{\beta}\left(\frac{1}{g_m} + R_b\right) \quad \ldots \quad (19)$$

Substituting (17) and (18) in (3), and substituting the result for $\frac{1}{\beta}$ in (19)

$$R_0 = \frac{A + 1}{E - A/A_0}\left(\frac{1}{g_m} + R_b\right) \quad (20)$$

Extracting the relevant results from the Appendix:

$$R_i = \frac{(1 - E)\ (A + 1)}{A\ (E + 1/A_0)} R_g$$

where $E = \frac{E_g}{E_D}$

and $R_f = \frac{(1 - E)\ (A + 1)}{E - A/A_0} R_g$

As before, the output resistance $R' = R_0 R_a/(R_0 + R_a)$, and

$$R_0 = \frac{A + 1}{E - A/A_0}\left(\frac{1}{g_m} + R_b\right)$$

The calculations of H.F. performance are exactly as before.

It is hoped that the foregoing notes will facilitate the design of see-saw circuits. They can be used in standard laboratory amplifiers, oscilloscope amplifiers, and in fact whenever a stable voltage amplifier of low output impedance is required. The writer has found the circuit of particular use in oscilloscope amplifiers when a wide-band frequency response (e.g. 0 c/s — 5 Mc/s) is needed, the effective load capacitance is liable to variation according to the conditions of use, and adequate inductive compensation is consequently difficult of satisfactory realisation. Occasionally the see-saw circuit might be useful as a low gain phase-inverting video amplifier.

Thanks are due to the writer's colleague, Mr. T. C. Nuttall, for helpful discussion on the applications of see-saw circuits.

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[2] M. G. Scroggie, *Wireless World*, July 1945, p. 194.
[3] R. E. H. Carpenter, *Wireless World* Sept. 1945, p. 263.
[4] F. C. Williams, *J.I.E.E.* Vo . 93, Part IIIA No. 1, p. 289 (1946).
[5] F. C. Williams, F. J. U. Ritson and T. Kilburn, *J.I.E.E.* Part IIIA, No. 7 p. 1275 (1946).
[6] W. T. Cocking, *Wireless World*, Apr., 1948, p. 126.

NEW TELEVISION RECEIVERS

THREE new television receivers have been added to the range made by Ultra Electric, Western Avenue, London, W.3. The Model D570, costing £141 15s 6d, is of the superheterodyne type with 21 valves and has automatic frequency control as well as A.V.C. on the sound channel. The 12in tube gives a black-and-white picture 10in × 8in.

Model W570 is technically similar to the D570 but has a less expensive cabinet and costs £90 4s 6d, while the W470 with 20 valves and a picture 7¾in × 6¼in costs £77 6s 8d, including tax.

WORLD OF WIRELESS

Set Manufacture ✦ Television News ✦ Naval Recruiting ✦ U.N. Radio

Relaxation of Controls

THE Government Order (S.R. & O. 226/47) controlling the manufacture and supply of broadcast and television receivers and radio-gramophones has been revoked. Under this Order, which was designed to limit production for the home market and encourage export, licences were issued yearly for definite quotas for sets for this country, while for export, licences were issued against firm orders, or, in the case of manufacturers with a well-established export trade, for an export production programme.

Among the many other products and materials on which control has been withdrawn are gramophone records and accumulators.

U.S. Television Standstill

THE mushroom-like growth of American television has been stopped. The F.C.C. has decided not to issue further licences for the building of television stations to operate in twelve of the thirteen channels until a decision has been reached on the question of possible changes in television engineering standards. This may take six or nine months.

There are at the moment about forty stations on the air and some eighty in the process of building. It is, however, the number of pending applications for licences which is significant—some 300.

The position has apparently been reached where the number of proposed television stations has outgrown the accommodation of the thirteen channels available. These channels range from 44-216 Mc/s and the decision effects all but the lowest—44-50 Mc/s.

Our Washington contemporary, *Broadcasting*, states that the F.C.C. made it clear that it intends to provide more space for television in the 475-890 Mc/s band.

Télévision Française

THE note in our November issue on the provision of high-definition television equipment for France was a little ambiguous.

The position is that the Paris 455-line television system is to continue until 1956, but during this period experiments with higher definition systems are to be carried out by the broadcasting authority, Radiodiffusion Française. To this end it has accepted from the Compagnie Radio-Industrie the 819-line equipment referred to. R.D.F. has also asked the Compagnie Française Thomson-Houston to provide equipment for 729 lines, and still higher definition gear (1029 lines) is being supplied by the Compagnie des Compteurs.

A new transmitter is to be erected at Lille, which it is anticipated will provide a higher definition service. The decision on this is expected to be delayed until the three experimental systems have been tested. The station is planned to be in service toward the end of 1949.

Naval Radio Officers

THE Admiralty has announced a scheme for Short Service Commissions in the Electrical Branch of the Royal Navy to former officers of the Royal Naval Volunteer Reserve who were employed on technical duties connected with radar, wireless and air radio.

Candidates, who must have completed one year's mobilized service as an officer, and be under the age of 35 on January 1st, 1949, will be entered in the substantive rank, and with the relative seniority in that rank, which they held at the time of their release. They will be eligible for promotion under the normal rules. Service will be for five years on the Active List and four years on the Emergency List.

Applications should be made to the Director of Naval Electrical Department, Admiralty, Queen Anne's Mansions, London, S.W.1, from whom further details are obtainable.

R.N.V.(W.)R.

WITH the object of training telegraphists to serve in the fleet in a national emergency until the ordinary mobilized men have been trained for the task, the Admiralty re-constituted some months ago the Royal Naval Volunteer (Wireless) Reserve. The prescribed strength is 39 officers and 1,200 telegraphists.

So far only 200 ratings have been enrolled at the training centres established in London, Grimsby, Hove and Northampton. Twenty-five other training centres will be equipped. Training is essentially operational. When a trainee has reached a sufficiently advanced stage in his training he is lent a naval transmitter and receiver for home use, and is granted an allowance of £3 a year for maintenance and operation costs.

Trainees must be between 17 and 26, unless they have served in the Navy, when they are eligible up to 45. Period of service is five years.

Details of benefits, bonuses, periods of training, etc., are obtainable from Naval Reserves, Admiralty, Queen Anne's Mansions, London, S.W.1.

Long-Distance Television

ALL records for long-distance television reception were broken recently when a transmission from Alexandra Palace was resolved in Cape Town—nearly 6,000 miles.

Having picked up on occasions the television sound channel, an amateur, H. Reider, secured from this country a standard Pye B16T receiver in the hope of receiving a picture. This set was used successfully without pre-amplification.

It had been predicted (*see* "Short-wave Conditions," October issue) that long-distance working on very high frequencies would frequently be possible during the month.

Australian Broadcasting

FOR some time there has been agitation in Australia for the whole of radio administration to be taken out of the hands of the Postmaster-General and placed under the control of a communications board as is done in the U.S.A.

A step in this direction has now been taken by the Federal Government which proposes the transfer of the control of broadcasting from the P.M.G. to a board of three members having no financial interest in broadcasting or associated industries. This board will not replace the Australian Broadcasting Commission which will continue to operate the thirty national stations. The hundred or so commercial stations are operated by individual companies or organizations. The activities of these stations are co-ordinated by the Federation of Commercial Broadcasting Stations.

United Nations Radio

AT very short notice, the French broadcasting organization, aided by the French radio industry, has installed an exceptionally complete equipment for the broadcasting and recording of speeches at the Paris session of the United Nations Organization. About 28 hours daily of short-wave broadcast transmissions can be effected, and facilities are provided for up to 35 simultaneous commentaries in duplex. Links with the broadcasting systems of many countries allow of direct or delayed recorded re-broadcasts. Some 16,000 disc recordings are expected to be made during the session.

In addition to the facilities provided by R.D.F. the technical services of the U.N. organization have installed in the Palais de Chaillot equipment enabling delegates to hear speeches simultaneously translated into any one of the five official languages.

Amateur Licences

THE present arrangement whereby Service experience is accepted by the P.M.G. as giving exemption from parts of the examination for an amateur transmitting licence will be slightly modified from January 1st. From that date the exemption will be granted only if applicants have been engaged in the specified Service trades or duties within two years of the date of the application for a licence.

OBITUARY

It is with regret we record the death on November 3rd of **H. Bevan Swift,** who was past president of the R.S.G.B. He was 74 years old. Following his presidency of the society from 1931 to 1933 he was honorary editor of the *R.S.G.B. Bulletin* until 1940. In recognition of his work for the society, which went back to the pre-broadcasting days, he was elected an honorary member in 1939. He will be remembered by many as a chairman of the old T. & R. Section.

PERSONALITIES

C. G. Allen, the well-known radio amateur (G8IG) and sales manager of McMichael Radio, has been appointed to the company's Board of Directors. It was in 1923 that he joined McMichael's, prior to which he was a radio operator with the Marconi International Marine Communication Co. Radio is his business and hobby! Another appointment to the Board is that of **J. A. Klein,** who is export manager.

H. Bishop, C.B.E., B.Sc.(Eng.), chief engineer of the B.B.C., has been elected a vice-president of the I.E.E. He was chairman of the Radio Section for the 1941-42 session.

Dr. E. H. Colpitts, who is known throughout the radio world because of the circuit which bears his name, has been awarded the Cresson Medal of the Franklin Institute, New York, for his work in the development of long-distance radio communication.

P. R. Coursey, B.Sc.(Eng.), technical director of Dubilier, gave a lecture on the standardization of components to 150 technical officers of the Swedish Armed Forces during the recent exhibition of British radio components in Stockholm.

H. J. Denham, C.B.E., M.A., D.Sc., who served as a member of the Ordnance Board with the rank of Colonel from 1944 until 1946, has been re-appointed as a civilian member of the Board which is the inter-Service authority on armaments. Dr. Denham has also been appointed Head of the Electronics Division of the Board.

H. Faulkner, Deputy Engineer-in-Chief, G.P.O., has gone to Mexico as joint leader of the British delegation to the International Administrative High-Frequency Broadcasting Conference which opened on October 22nd. The delegation also includes **L. W. Hayes, F. Axon** and **R. A. Craig** of the B.B.C. and **P. W. Fryer** and **P. N. Parker** of the G.P.O.

L. W. Hayes, who is head of the B.B.C. Overseas Engineering Information Dept., is resigning from the service of the Corporation at the end of the year in order to take up his recent appointment to the International Radio Consultative Committee (C.C.I.R.) as vice-director for broadcasting. The C.C.I.R. is one of the constituent bodies of the International Telecommunication Union. Mr. Hayes, who has been with the B.B.C. for over 23 years, is at present in Mexico for the H.F. Broadcasting Conference. When he takes up his new appointment in January he will reside in Switzerland.

IN BRIEF

Licences.—Despite the increase of 4,900 in the number of television licences issued during September, bringing the total to 66,600, the total number of receiving licences had decreased during the month by approximately 13,000. The only apparent reason for this is the tardiness of listeners in renewing expired licences. The comparative figures are: August, 11,324,000; September, 11,311,200.

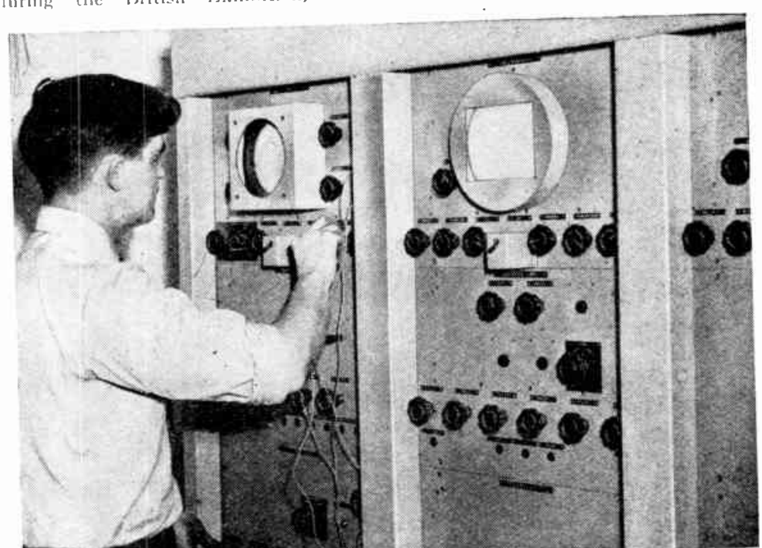
Danish Television.—A correspondent points out that, in spite of the enthusiasm with which the public received the television demonstrations during the British Exhibition, the attitude in official circles is "wait and see what is adopted as a European standard." No decision is likely to be taken, however, until the attitude of Norway and Sweden is known. Opinion is sharply divided on the question of definition. It is understood the offer, at a nominal price, of the Pye equipment used for the demonstrations has not been accepted.

Navigation.—H.R.H. the Duke of Edinburgh will open the exhibition "Navigation through the Ages," which is being organized jointly by the Institute of Navigation and the Royal Geographical Society, on December 17th. It will be open free to the public from December 18th to January 20th at the R.G.S., 1, Kensington Gore, London, S.W.7. Radio aids will be a feature of the exhibition.

Radiolympia.—The Radio Industry Council has appointed an organizing committee for the Sixteenth National Radio Exhibition which it is planned to hold at Olympia next autumn. The chairman of the Committee is F. W. Perks (E.M.I.) and the vice-chairman V. M. Roberts (B.T.H.). The remaining seven members are R. Arbib (Multicore), B. J. Axten (S.T.C.), A. F. Bulgin, H. J. Dyer (Philips), F. V. Green (S.T.C.), F. Jones (Marconiphone) and W. M. York (Ekco).

Components Exhibition.—The sixth annual private exhibition of radio components, materials and test gear, organized by the Radio Component Manufacturers' Federation, will be held at Grosvenor House, Park Lane, London, W.C.1, from March 1st to 3rd.

E.M.I. Evening Courses.—Three evening courses, each of three months' duration, dealing respectively with Practical Television, Television Principles and Practical Radio, are to be introduced by E.M.I. Institutes. Details of the courses, which are planned for students with some knowledge of the fundamentals, are obtainable from



SOBELL INDUSTRIES installed a specially built television transmitter at the recent Ideal Homes Exhibition in Birmingham in order to demonstrate their receivers on a closed circuit.

World of Wireless—

the Principal, E.M.I. Institutes, Ltd., Grove Road, Chiswick, London, W.4.

Brit.I.R.E. Officers.—As previously announced, the new president of the Brit.I.R.E. for 1948-49 is L. H. Bedford, who succeeds the Earl Mountbatten, who is now vice-patron. W. E. Miller, Editor of our associated journal *The Wireless & Electrical Trader*, who has been chairman of the council since 1946, was elected a vice-president. The new ordinary members of the council are Prof. H. M. Barlow, H. A. Brooks, Cdr. A. J. B. Naish, L. H. Paddle and Dr. W. J. Thomas. J. W. Ridgeway was re-elected on the council.

Outward Form.—Various stages in the development of the Ekco "Radiotime" receiver and the Murphy V116 television set are illustrated and described at the exhibition of "Design at Work" at Burlington House, Piccadilly, London, W.1.

Europe's New Wavelengths.—The list of Copenhagen Frequency Allocations, published in the November *Wireless World*, is now available from our Publishing Office as a reprint, price 6d post free.

Great Circle Map.—Many reprints of the *Wireless World* Great Circle Projection Map have been issued since it was first drawn by the late J. St. Vincent Pletts at the time when worldwide radio communication was beginning. A new edition, containing extra tabulated information on standard times and geographical positions, has just been issued. This map, giving the true bearing and "radio" distance to any part of the world from London, is obtainable from our Publisher, price 2s 6d, plus 3d postage and packing.

"W.W. Diary."—All copies of the *Wireless World* Diary, 1949, have now been distributed to stationers and booksellers. The eighty reference pages contain information, mostly technical, of the kind so often needed by radio men but seldom memorized. The price, including P.T., is 3s 4½d.

INDUSTRIAL NEWS

Pye Australasia, Ltd., is the name under which a new company, formed in Australia jointly by Pye, Ltd., of Cambridge, and Electronic Industries, of Australia, will operate.

Chilian Agency for valves and condensers is sought by John Cameron Reid e Hijos, Agustinas 1070, Of.131, Santiago. Information regarding the company may be obtained from the Export Promotion Department, Board of Trade, Thames House North, Millbank, London, S.W.1, quoting ref. 41024/48.

P.E.R.A.—The official opening of the Production Engineering Research Association of Great Britain at Staveley Lodge, Melton Mowbray, which has actually been established for some months, took place on October 26th. P.E.R.A. has been established to "assist the engineering industry in improving its efficiency of production."

PRESS - BUTTON RECORD PLAYER—In this new single-record player introduced by the Plessey Co., Ilford, Essex, the pickup is automatically lifted and placed at the start of 10-in. or 12-in. records by pressing the appropriately marked operating lever. A moving-iron pickup is standard and the turntable is rim-driven by a constant speed A.C. motor.

It is assisted financially by the Government, which donates £1,000 p.a. for every £1,000 subscribed by industry, and recently granted £25,000 for the purchase of equipment.

Iron-cored Components. — Samples and prototypes, as well as long-production runs, of power and A.F. transformers and inductors, can be handled by a new firm, the Transformer Equipment Co., Ltd., St. Mark's Road, Bromley, Kent. The range of sizes extends from miniature communications components to units of 10 kVA capacity.

Wright & Weaire point out that although restrictions prevent the import of coils and coil products complete to certain countries it is possible to supply the mechanical parts of a coil pack, leaving the manufacturer to assemble his own coils. The company's three-coil unit, with pre-formed wiring and built-in wave-change switches, which is totally enclosed and measures $4\frac{1}{2} \times 4 \times 1\frac{1}{2}$in, can be supplied without coils.

Plastics "Hall Mark."—A scheme has been launched jointly by the British Plastics Federation and the British Standards Institution for the certification of plastic materials and products. At present the certification mark, which is in the form of a circle with the initials B.S. in the centre and B.P.F. on the left-hand side, is only applicable to moulding powders made from phenol formaldehyde and urea formaldehyde resins and certain mouldings made from these.

MEETINGS

Institution of Electrical Engineers

Radio Section.—"Fixed Resistors for use in Communications Equipment, with special reference to High Stability Resistors" by P. R. Coursey, B.Sc. (Eng.), at 5.30 on December 1st.

Discussion on "V.H.F. Mobile Radio-Telephone Services" opened by D. H. Hughes, at 5.30 on December 14th.

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

Cambridge Radio Group.—"Three-Dimensional Cathode-Ray Tube Displays," by E. Parker, M.A., and P. R. Wallis, B.Sc. (Eng.), at 8.15 on December 7th at the Cavendish Laboratory, Cambridge.

North-Eastern Radio and Measurements Group.—"Three-Dimensional Cathode-Ray Tube Displays," by E. Parker, M.A., and P. R. Wallis, B.Sc. (Eng.), at 6.15 on December 20th at King's College, Newcastle-on-Tyne.

Northern Ireland Centre.—"Analysis-Synthesis Telephony, with special reference to the Vocoder," by R. J. Halsey, B.Sc. (Eng.), and J. Swaffield, Ph.D., at 6.45, on December 14th, at Queen's University, Belfast.

British Institution of Radio Engineers

London Section.—"Physical Applications of Microwaves," by J. B. Birks, B.A., at 6.0, on December 16th, at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

South Midlands Section.—"Heating by Centimetric Power," by R. Keitley, B.Sc., at 7.0, on December 16th, at the Technical College (Room A5), The Butts, Coventry.

Merseyside Section. — "Negative Feedback," by J. Durnford, at 6.45, on December 15th, at the Incorporated Accountants' Hall, Derby Square, Liverpool, 2.

Radio Society of Great Britain

London Meeting.—"Equipment for the 144 Mc/s Band," by E. A. Dedman, at 6.30, on November 26th, at the I.E.E., Savoy Place, London, W.C.2.

Television Society

Midlands Centre.—"Studio Technique in Television," by D. C. Birkinshaw, M.B.E., M.D., at 7.0, on December 1st, at the Chamber of Commerce, New Street, Birmingham.

Institute of Physics

Electronics Group.—"Gas Discharge Tubes," by G. F. Heymann, M.Sc., at 7.0, on December 7th, at the University, Glasgow.

British Sound Recording Association

London Meeting.—"Some Physiological Factors in Quality Appreciation," by E. A. Vetter, at 7.0 on December 17th at the Royal Society of Arts, John Adam Street, London, W.C.2.

Institute of Navigation

"Radio and Position," by Sir Robert Watson-Watt, C.B., F.R.S., at 5.0 on December 17th at the Royal Geographical Society, 1, Kensington Gore, London, S.W.7.

Royal Society of Arts

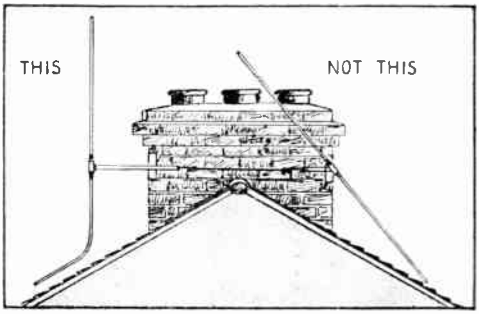
"Television and Education," by Mrs. Mary Adams, at 8.0 on November 29th at the R.S.A., John Adam Street, London, W.C.2.

Junior Institution of Engineers

"New Developments in Broadcasting," by Sir Noel Ashbridge, President, at 6.30 on December 10th at the R.S.A., John Adam Street, London, W.C.2.

THE "BELLING-LEE" PAGE

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



This trouble is generally only met with in terrace houses. In detached or semi-detached houses where a simple dipole is all that is required, the easiest location is generally on the gable end, as high up as practicable. The illustration shows most of the story. It is only the idea that is required, and the assurance that the bending of the lower element will not make any perceptible difference to reception. If the whole dipole is mounted at an angle, it will be in a most suitable position to pick up "flutter" due to aircraft that may be in the vicinity. Before the war, most chimneys were high enough to allow the single dipole to be so mounted, but modern building generally means low chimneys and low - angle roofs and these physical features do not suit the London television frequencies.

To prevent unnecessary damage to the insulator, remove the element before bending and examine it carefully.

The holes to take the fixing and contact screws (or the slot in some types) must be on the opposite side of the tube to the bend, and do try and bend the tube so that the "line" is maintained, otherwise the installation will look untidy.

Connecting the Feeder the Right and Wrong Way

Most television receivers have their aerial input terminals marked "A" and "E." "A" should be connected to the top element of the dipole, and "E" to the lower. When using coaxial*1, the inner conductor should connect the top element of "A" and the screen should connect the lower element to "E." There is a noticeable improvement in most cases when this connection is carried out correctly.

When balanced feeder L.336*2 is used it is easy to tell one lead from the other as one is bare copper. With other present types a continuity test is necessary to ensure correct connection, but we have no doubt that within a reasonable time all makers will arrange for the leads to be distinguished. L.336 type of balanced feeder was originally made to a 1938 specification issued by "Belling-Lee," and for years was the only 80-ohm feeder of its kind, but lately other manufacturers have paid us the compliment of producing something similar.

Attic or Loft Television Aerial

Whereas this indoor aerial*4 was designed to conform with the shape of the average roof and so enable the user to take full advantage of available height, it *will* function if mounted upside down, i.e. with its legs in the air. If used like this it may be unnecessary to enter the loft, just lift the flap, coax the assembly through, and fix it to a joist within reach *after* having satisfied yourself that the tips are not close to the water tank or some run of conduit or other metal. The farther they are away from such conductors the better. The easy way is seldom the best.

Midland Television Frequencies

The "Belling-Lee" television aerials*3 already sold or installed in this area were produced before the decisions of the Copenhagen Wavelength Conference, which necessitated a slight reduction in the frequencies allocated for the Midland television service, and before the decision to use asymmetric side bands for the vision transmission. These changes were made by the B.B.C. after consulting the Radio Industry when we, and other manufacturers, assured them that the effect of these small changes would be negligible as regards sensitivity, bandwidth and the polar diagrams of the aerials.

When on this subject, we have had to disillusion some correspondents who thought that by cutting down the elements they could convert a dipole and reflector made for London, to one suitable for the Midland transmitter. Quite a number of people had overlooked the fact that the length of the cross arm between the dipole and its reflector is also critical.

Skyrod Dimensions

When we first introduced the L.638 range of eighteen-foot *5 "Skyrods" for direct chimney mounting (without pole) we had a number of perfectly logical enquiries as to their relative performance as anti-interference aerials compared with the old - twelve foot collector on a twelve - foot pole. When we were faced with the present difficulties in getting just the material we required, and with the high prices of everything, our research department were set the fresh problem. After a lot of work, and a great many measurements it was found that *in most cases* the sacrifice of the pole was not so important provided we *increased* the length of the collector.

Faulty Parts

The other day the writer of these notes had the misfortune to have a serious fault develop in a new car. The maker was prompt in authorising a free replacement of the faulty part, but the account from the garage for carrying out the work was far in excess of the value of the part. "Belling-Lee" adopt the same procedure as the motor manufacturer. We will replace faulty goods under guarantee but we cannot contribute towards any installation charges which may be incurred.

Incidentally, the new car mentioned above cost between four and five hundred pounds and is rusting in places within a few months of delivery, and underneath it *is* rusty. The makers will not do anything about it. It's a good car for all that. Though our aerials cost but a fraction of the cost of a car, we do give them the best rust prevention available at the moment, but we must admit that we have not yet been able to return to our pre-war standard.

*1. Coaxial feeder. **L.600 1/6** yd.
*2. Balanced twin. **L.336 7½**d. yd.
*3. **"VIEWROD"** aerials.
For Birmingham frequencies, **L.634**
For London frequencies, **L.502/L, £6/6/-.**
*4. Television attic aerial, **L.605, £2/12/6.**
*5. **"SKYROD"** vertical anti-interference aerial for chimney mounting. **L.638/K, £10/-/-.**

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STABILIZED POWER SUPPLIES

3.—Extension of Output Voltage Range

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

WE come lastly to the problem of extra-wide ranges of output voltage. Maximum V_o can be extended in the upward direction by increasing the supply voltage and the maximum value of R_1; but, as the working-out of a design with the aid of Fig. 4 showed, unless the minimum V_o is raised equally it is necessary to provide series valves capable of greater anode dissipation. Alternatively, and more economically, the full range of control can be split up into two or more bands by means of a switch controlling E_t (the source voltage) and R_{1a} simultaneously in steps (footnote reference 4, Part 2). The value of R_{6a}, if used, ought also to be changed; but in practice it will be found that when R_{1a} considerably exceeds R_2 the error due to omitting R_{6a} altogether is unimportant.

Lowering the minimum V_o is less straightforward. As we saw in Part I, the limiting condition with the circuit considered until now is that V_o must be sufficient to supply V_{N1}, V_{2a} and V_{1g1} (max) in series. The lowest available V_{N1} is about 50 V; V_{2a} can hardly be reduced below 20 V, and in our example V_{1g1} (max) was 66 V, making 140 V about the lowest practicable V_o. Further reduction, down to perhaps 100 V, could be obtained at the expense of range of V_o control.

For some purposes, however, it may be desirable to extend the range down to zero volts. This can be done by providing a source of negative potential for V2. Such a source can conveniently be made to add still further to the facilities of the unit by providing an external grid bias supply.

Although the modification to the circuit is fairly obvious in principle, there are a number of practical details that require care and attention. These will be discussed with reference to Fig. 13, an extension of the previous design, to cover 0-500 V in two equal bands.

Since N1 cannot be fed from the main stabilized output it is necessary to consider very carefully the effects of its A.C. resistance. Any voltage variations across it are amplified perhaps 2,000 times and injected into the main supply, and are not reduced by feedback. The most effective way

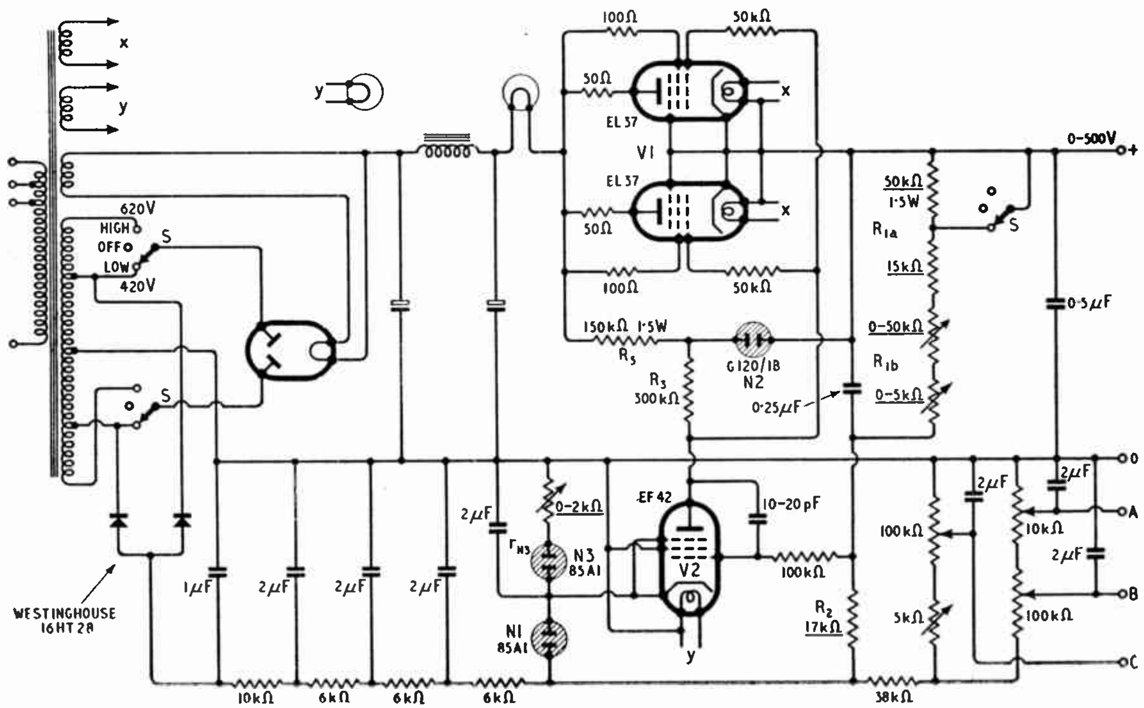


Fig. 13. Modification of Fig. 7 to provide output voltage variable over the range 0-500 V. The resistors underlined at least, should be wire-wound. The outputs obtainable from the negative terminals are:—A, 0 to −9 V, or fine control of B if shorted to 0; B, −9 to −100 V, or 0 to −100 V with fine control if A shorted to 0; C, 0 to −100 V with fine control.

Stabilized Power Supplies—

of avoiding them is to stabilize the auxiliary negative supply; but this is somewhat elaborate, necessitating a separate transformer H.T. winding, valves, etc.

The alternative is to smooth the negative supply very thoroughly. It should be noted that while hum can be reduced by reactances, slow fluctuations in mains voltage are reduced only by series resistance. It is therefore necessary for this resistance to be high. The supply in Fig. 13 is taken from 420 V tappings on the mains transformer, using a pair of Westinghouse 16HT28 metal rectifiers. The 620 V tappings, with appropriately rated components, would be better still. Current in this supply should be kept as small as possible, the requirement for large smoothing resistance overriding the rectifier maximum rating of 15 mA. The reservoir capacitance is limited by the rectifier rating to 1 μF.

The effect of the resistance between screen grid and cathode of V2 is quite different in this circuit. It forms one arm of a bridge, the others being r_{N1}, R_2 and R_1 (completed by the negligible R_o). V2 (grid to cathode) is the detector, and the negative supply is the signal source. To eliminate the effect of slow fluctuations in the latter completely, therefore, it is only necessary to make $R_{g2-k} = r_{N1}R_1/R_2$. Such a resistance, being quite insufficient to supply V_{2g2}, must be supplementary to a tube N3; 0–2kΩ would usually do.

Unfortunately the value of R_{g2-k}, alias r_{N3}, needed to balance the bridge varies directly with R_1, which in this type of unit obviously varies a lot. It can be ganged with R_{1b} and the voltage range switch; a rather elaborate device which may incline one more favourably to a stabilized negative source. This balance is rendered ineffective for hum and other rapid fluctuations by the capacitor across R_1. A balancing capacitor across r_{N3} would have to be very large, and in practice it has been found better to apply most of the available capacitance in the hum filter. Some is useful across N3, however, to suppress random noise.

Since the fluctations in the unstabilized negative source correspond only partially with those in the main supply, adjustment of r_{N3} is not very effective for neutralizing R_i and still less r_{1a}. Fig. 10 can be applied successfully, but Figs. 11 and 12 (Part 2) are not directly applicable. Hogg has suggested a modified form in which R_7 is inserted in the negative main supply as before, while in place of R_2 there is a potential divider across the negative source. The parallel resistance of the two resistors composing it must be equal to R_2, and their individual values such as to apply the correct standing V_{2g1}. Changes of V_{R7} are thus passed to the control grid, but R_7 has to be several times greater than in Fig. 11 to allow for the step-down in potential. Moreover the current to be supplied by the negative source is considerably increased. It was considered that these drawbacks were not outweighed by the advantage of separate current feedback, especially as Fig. 10 can be adjusted to do the same thing more simply, though at some slight loss of mains voltage stabilization.

Connecting the heater of V2 to cathode was found to introduce about 10 mV of hum, which could be avoided by transferring it to the zero volts line. If N3 has a tendency to go out when V_o is adjusted towards zero it is because the anode of V2 is "bottoming," causing I_{2g2} to increase sharply. The tendency can be reduced by increasing I_{N3} or preferably by removing the cause such as by reducing V_i or increasing R_5.

The procedure for calculating resistance values, etc., is the same as for Fig. 7. The grid bias scheme calls for no comment, except to point out that the outlets are not to be used for supplying appreciable current.

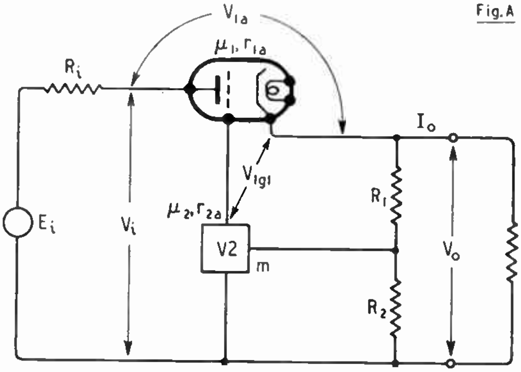
The voltage range switch ought, of course, to be capable of safely handling the high voltages, up to about 1750 V peak, across the transformer outers. One of the old-fashioned "anti-capacity" types, slightly modified to increase the leakage paths, has been found satisfactory.

It can be seen from all this that the facility of voltage control below 100–200 V necessitates considerable elaboration of the unit and reduces the possibilities of obtaining a high degree of stabilization. By accepting some restriction on the output current and the regulation, one or more output voltages, variable down to zero, can be obtained quite simply as additions to the main highly-stabilized output. This device is the subject of an article to follow.

APPENDIX

Fig. A shows the theoretical circuit of a stabilizing unit of the type considered, and Fig. B relates the quantities shown to a current/voltage diagram such as Fig. 4. Increments of these voltages and currents are denoted by the prefix Δ; and it must be borne in mind that r_{1a}, m, etc., are by no means constant, and their

Fig. A



values must be related to the particular working points considered, while if the increments are not infinitesimal the valve parameters must be mean values.

It is assumed that the voltage and current changes are slow enough for reactance to be neglected. Of course the system could be considered more generally by substituting complex impedances for resistances. The results given here do not apply to hum, etc.

Although the sign of equality is used in all the following equations, they are subject to the approximations stated.

The interesting performance characteristics are:

(i) The stabilization ratio, as regards variations in E_i, which may be defined as

$$S' = \frac{\Delta E_i}{\Delta V_0} \quad (R_L \text{ constant}) \quad .. \quad .. \quad (1)$$

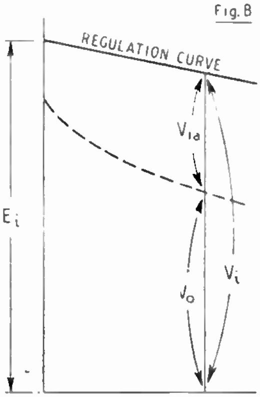


Fig. B

but for practical purposes it is more useful to consider

$$S = \frac{\Delta E_i}{E_i} \bigg/ \frac{\Delta V_0}{V_0} = S' \frac{V_0}{E_i} \quad (R_L \text{ constant}) \quad (1a)$$

If R_i is assumed to comprise all causes of regulation, including mains transformer resistance, and E_i is rectified voltage on no load, S represents the ratio by which percentage mains fluctuations are reduced.

(ii) R_0, the output resistance, defined as

$$R_0 = -\frac{\Delta V_0}{\Delta I_0} \quad (E_i \text{ constant}) \quad .. \quad (2)$$

In the following, all current increments through R_i other than ΔI_0 are neglected.

From valve theory

$$\Delta I_0 r_{1a} = \Delta V_{1a} + \mu_1 \Delta V_{1g1}$$

Also $\quad \Delta V_{1a} = \Delta E_i - \Delta I_0 R_i - \Delta V_0$

Hence $\Delta I_0(r_{1a} + R_i) + \Delta V_0 = \Delta E_i + \mu_1 \Delta V_{1g1} \quad (3)$

Assuming V2 is a pentode, whose anode current, I_{2a}, is virtually independent of V_{2a},

$$\Delta V_{1g1} = \Delta V_{2a(b)} - m(\Delta V_{2g1} - \Delta V_{2k}) - m_2 \Delta V_{2g2} \quad (4)$$

where $V_{2a(b)}$ is the anode feed voltage for V2, relative to $+V_0$,

m is the voltage gain of V2 via its control grid,

m_2 is the voltage gain of V2 via its screen grid.

By defining the voltage variations of the V2 electrodes in (4), in terms of E_i, V_0 and I_0, according to the circuit conditions, and substituting in (3), S' and R_0 can be evaluated.

In the circuit of Fig. 6 and Fig. 7, neglecting r_{n2} in comparison with R_5,

$\Delta V_{2a(b)} = 0$

$\Delta V_{2g1} = p_0 \Delta V_0 \qquad$ where $p_0 = R_2/(R_1 + R_2)$

$\Delta V_{2k} = (\Delta E_i - R_i \Delta I_0) r_{n1}/R_1 \qquad (r_{n1} \ll R_{4a}$ and $R_{4b})$

$\Delta V_{2g2} = (\Delta E_i - R_i \Delta I_0) R_{4b}/R_4$

Substituting in (3) and (4),

$$\Delta I_0(r_{1a} + qR_i) + \Delta V_0(\mu_1 m p_0) = E_i q \quad .. \quad .. \quad (5a)$$

where $q = 1 + \dfrac{\mu_1 m}{R_1}\left(r_{n1} - \dfrac{R_{4b}}{\mu_2 g_2}\right)$

$\mu_{2g^2} = \dfrac{m}{m_2}$ = amplification factor of V2, control grid to screen grid, and 1 is neglected in comparison with $\mu_1 m p_0$.

Substituting this and (1) in (5a), and neglecting $(r_{1a} + qR_i)/R_L$ in comparison with $\mu_1 m p_0$,

$$S' = \frac{\mu_1 m p_0}{q} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (6a)$$

If the cathode and screen-grid potentials of V2 are constant, $q = 1$, and

$$S' = \mu_1 m p_0 \quad .. \quad .. \quad .. \quad .. \quad .. \quad (7a)$$

i.e., the stabilization ratio as defined by (1) is equal to the overall gain in the feedback loop.

q can also be made equal to 1 by making

$$R_{4b} = \mu_{2g2} r_{n1} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (8a)$$

S' can be made infinitely great by putting $q = 0$, i.e.,

$$R_{4b} = \mu_{2g2}\left(\frac{R_4}{\mu_1 m} + r_{n1}\right) \quad .. \quad .. \quad .. \quad (9a)$$

Also from (2) and (5a), if E_i is constant, so that $\Delta E_i = 0$,

$$R_0 = \frac{r_{1a} + qR_i}{\mu_1 m p_0} \quad .. \quad .. \quad .. \quad .. \quad (10a)$$

If $q = 1$ for either of the reasons given above for (7a) or (8a),

$$R_0 = \frac{r_{1a} + R_i}{\mu_1 m p_0} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (11a)$$

i.e., the internal resistance of the unit is divided by the stabilization ratio.

If S' is made infinite, as in (9a),

$$R_0 = \frac{r_{1a}}{\mu_1 m p_0} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (12a)$$

i.e., the source resistance R_i is cancelled by input feedback.

To cancel the valve resistance too and make $R_0 = 0$, put $r_{1a} + qR_1 = 0$, i.e.,

$$R_{4b} = \mu_{2g2}\left(\frac{R_1}{\mu_1 m} \cdot \frac{(r_{1a} + R_i)}{R_i} + r_{n1}\right) \quad .. \quad .. \quad (13a)$$

in which case

$$S' = -\mu_1 m p_0 \cdot \frac{R_i}{r_{1a}} \quad .. \quad .. \quad .. \quad .. \quad (14a)$$

If V2 anode is fed from the anode side of V1, so that $\Delta V_{2a(b)} = \Delta V_i$ is written in (4), the equations (5a) to (14a) are modified thus, respectively,

$$\Delta I_0[r_{1a} + (q + \mu_1)R_i] + \Delta V_0(\mu_1 m p_0 + \mu_1) = \Delta E_i(q + \mu_1) \quad .. \quad .. \quad .. \quad .. \quad (5b)$$

Assuming $mp_0 \gg 1$,

$$S' = \frac{\mu_1 m p_0}{q + \mu_1} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (6b)$$

$$(V_{2g2} \text{ and } V_{2k} \text{ constant}) \qquad S' = \frac{\mu_1 m p_0}{1 + \mu_1} \quad .. \quad (7b)$$

i.e., the anode feed condition worsens the stabilization ratio by the divisor $(\mu_1 + 1)$.

$(q + \mu_1)$ can be made equal to 1, restoring the basic stabilization (7a) if

$$R_{4b} = \mu_{2g2}\left(\frac{R_1}{m} + r_{n1}\right) \quad .. \quad .. \quad .. \quad .. \quad (8b)$$

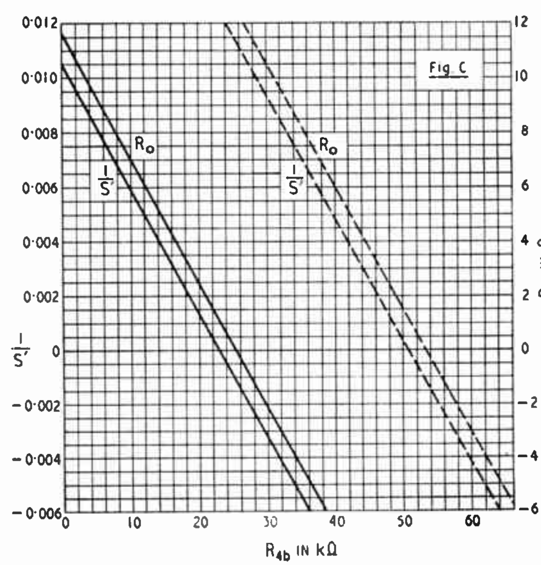
$$(S' = \infty) \qquad R_{4b} = \mu_{2g2}\left(\frac{R_1(\mu_1 + 1)}{\mu_1 m} + r_{n1}\right) \quad (9b)$$

$$R_0 = \frac{r_{1a} + (q + \mu_1)R_i}{\mu_1 m p_0} \quad .. \quad .. \quad .. \quad (10b)$$

If $q = 1$,

$$R_0 = \frac{r_{1a} + (\mu_1 + 1)R_i}{\mu_1 m p_0} \quad .. \quad .. \quad .. \quad (11b)$$

i.e., the anode feed condition multiplies the apparent source resistance by $(\mu_1 + 1)$.



Stabilized Power Supplies—

$$(S' = \infty) \qquad R_0 = \frac{r_{1a}}{\mu_1 m p_0} \quad \ldots \quad \ldots \quad \ldots \quad (12b)$$

which is the same as (12a).

$$(R_0 = 0) \quad R_{4b} = \mu_{2g2}\left[\frac{R_1}{\mu_1 m} \cdot \frac{[r_{1a} + R_i(\mu_1 + 1)]}{R_i} + r_{n1}\right] \quad \ldots \quad \ldots \quad \ldots \quad (13b)$$

In practice this may be excessively large.

$$(R_0 = 0) \qquad S' = -\mu_1 m p_0 \frac{R_i}{r_{1a}} \quad \ldots \quad \ldots \quad (14b)$$

as in (14a).

In Fig. C, R_0 and $1/S'$ are plotted against R_{4b} for the following typical circuit values, similar to those in Fig. 7:

$R_i = 1k\Omega$ $\quad \mu_1 = 8$
$r_{1a} = 0.7k\Omega$ $\quad \mu_{2g2}$ (effective) $= 65$
$r_{n1} = 0.3k\Omega$ $\quad m = 280$
$R_1 = 120k\Omega$ $\quad p_0 = 0.28$

With the anode of V2 fed from a constant-potential point as in Fig. 7, the following results are shown:

Value of R_{4b}	R_0	S′
0 kΩ	4.3 times normal, due to r_{n1}	0.15 times normal, due to r_{n1}
19.5	*Normal* (2.7Ω); r_{n1} neutralized.	*Normal* (630); r_{n1} neutralized.
23.0	0.41 times normal; R_i neutralized.	∞ Perfect stabn. against ΔE_i
24.0	0.23 times normal; r_{1a} partly neutralized.	− 3.2 times normal; slightly over-stbd.
25.5	0; $(r_{1a} + R_i)$ neutd.	− 1.43 times normal
26.5	− 0.185 times normal	− 1 times normal
31.2	− 1 times normal	− 0.42 times normal
With the anode of V2 fed from V_i (dotted lines):		
0	9 times normal	0.068 times normal
19.5	5.7 times normal	0.011 times normal
50.7	0.41 times normal	∞
53.2	0	− 1.43 times normal

Input Voltage Compensation

The relevant part of Fig. 9 can be represented by the network Fig. D.

Assuming $R_6 \gg R_2$

$$\Delta V_{2g1} = p_0 \Delta V_0 + p_0 \frac{R_1}{R_6} \Delta V_i = p_0 \Delta V_0 + p_i \Delta V_i \quad (15)$$

where $p_i = \dfrac{R_1 R_2}{R_1 + R_2} \Big/ R_6$

Regarding $V_{2a(b)}$, V_{2k} and V_{2g2} in Fig. 9 as constant, so that $\Delta V_{1g1} = -m\Delta V_{2g1}$, and substituting in (3) and neglecting 1 in comparison with $\mu_1 m p_0$,

$$\Delta I_0(r_{1a} + tR_i) + \Delta V_0(\mu_1 m p_0) = \Delta E_i t \quad \ldots \quad \ldots \quad (5c)$$

of the same form as (5a) except that $t = (1 - \mu_1 m p_i)$ takes the place of q, $1/R_8$ appearing in a similar role to R_{4b}, but the influence of r_{n1} is of course absent. Results corresponding to (6a), etc., follow, thus

$$S' = \frac{\mu_1 m p_0}{t} \quad \ldots \quad \ldots \quad \ldots \quad (6c)$$

$$\begin{matrix}(S' = \infty \\ t = 0)\end{matrix} \quad R_6 = \mu_1 m p_0 R_1 \quad \ldots \quad \ldots \quad \ldots \quad (9c)$$

$$R_0 = \frac{r_{1a} + tR_i}{\mu_1 m p_0} \quad \ldots \quad \ldots \quad \ldots \quad (10c)$$

$$(S' = \infty) \quad R_0 = \frac{r_{1a}}{\mu_1 m p_0} \quad \ldots \quad (12c), \text{ same as } (12a)$$

$$(R_0 = 0) \quad R_6 = \mu_1 m p_0 R_1 \frac{R_i}{r_{1a} + R_i} \quad \ldots \quad (13c)$$

$$(R_0 = 0) \quad S' = -\mu_1 m p_0 \frac{R_i}{r_{1a}} \quad (14c), \text{ same as } (14a)$$

Output Current Compensation

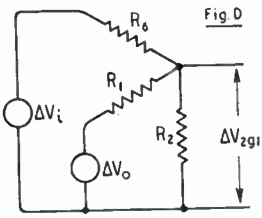
In Fig. 11, V_i is reduced by the amount $I_0 R_7$ and V_{2g1} by $I_0 R_7 \dfrac{R_1}{R_1 + R_2}$.

Extending (5c) accordingly,

$$\Delta I_0\left[r_{1a} + tR_i + R_7\left(t - \mu_1 m \frac{R_1}{R_1 + R_2}\right)\right] + \Delta V_0(\mu_1 m p_0) = \Delta E_i t \quad \ldots \quad (5d)$$

Putting $t = 0$ for optimum voltage compensation ($S' = \infty$).

$$R_0 = \frac{r_{1a}}{\mu_1 m p_0} - R_7 \frac{R_1}{R_2} \quad \ldots \quad \ldots \quad (12d)$$



So R_0 can be made zero at the same time as $S' = \infty$ by

$$R_7 = \frac{r_{1a}}{\mu_1 m p_0} \cdot \frac{R_2}{R_1} = \frac{R_1 + R_2}{g_{1m} m R_1} \quad (16)$$

If no voltage compensation, so $t = 1$, R_0 is made zero (but S′ negative) by

$$R_7 = \frac{(r_{1a} + R_i)}{\mu_1 m p_0} \cdot \frac{R_2}{R_1} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (13d)$$

Equalization of Compensation

In Fig. 10, to fulfil the required conditions,

$$\text{(i)} \quad \frac{R_{6a} R_{6b}}{R_{6a} + R_{6b}} = R_6 = \mu_1 m p_0 R_1$$

$$\text{(ii)} \quad \frac{R_{6a}}{R_{6b}} = \frac{R_{1a}}{R_2}$$

Solving, with $R_{1b} = 0$,

$$\left.\begin{matrix} R_{8a} = \mu_1 m R_{1a} \\ R_{6b} = \mu_1 m R_2 \end{matrix}\right\} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (17)$$

Condition (ii) ensures condition (i) for any value of R_{1b}. In Fig. 12, conditions are similar to those in Fig. 10 except that feedback is taken from across R_7 instead of across r_{1a}.

The values of R_{8a} and R_{8b} are therefore

$$\left.\begin{matrix} R_{8a} = \mu_1 m R_{1a} \dfrac{R_7}{r_{1a}} = g_{1m} m R_{1a} R_7 \\ R_{8b} = \mu_1 m R_2 \dfrac{R_7}{r_{1a}} = g_{1m} m R_2 R_7 \end{matrix}\right| \quad \ldots \quad \ldots \quad (18)$$

"NOTES ON SOLDERING"

THIS new 88-page edition of the Tin Research Institute's handbook is intended primarily for industrial users of solders of various kinds but is useful to many others. Mass-production soldering methods are dealt with at some length and special emphasis is laid on an important point that is too often overlooked: parts that are to be joined by soldering should be so designed as to facilitate the making of good, sound joints. The book describes both the theory and the practice of many kinds of soldering. There is a most useful section (illustrated by 8 good photographs) on wiped joints in lead pipes, the successful making of which is perhaps the most satisfying of soldering achievements. Another section shows how to solder such "difficult" metals as stainless steel, cast iron and aluminium. The best fluxes for use on both straightforward and difficult metals are given and the writer is careful to state which of them are or are not permissible in electrical work. Altogether, this is an extremely valuable little book; it is obtainable free of charge from The Tin Research Institute, Fraser Rd., Greenford, Middlesex. R. W. H.

ECONOMICAL 50-WATT AMPLIFIER

Taking Advantage of New Ratings for the KT66 Valve

By G. R. WOODVILLE (M.-O. Valve Company)

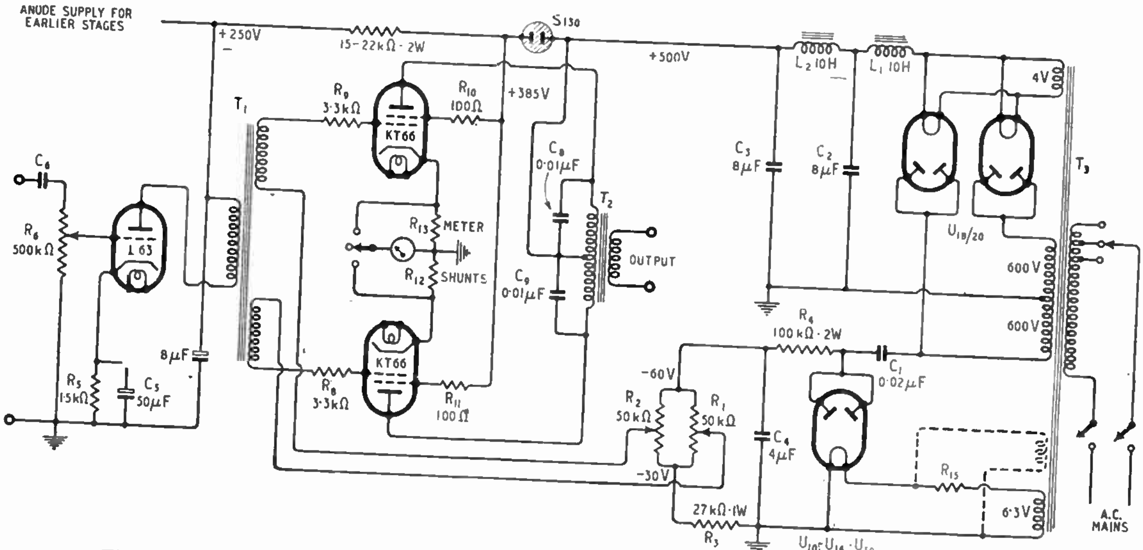


Fig. 1. Complete circuit diagram of 50-watt amplifier using KT66 output valves with fixed bias.

WHEN the KT66 valve was first introduced in 1937 it was given maximum anode and screen voltage ratings of 400 and 300 respectively. At these voltages a pair of valves will provide an output of 30 watts with quiescent anode and screen dissipations of 21.5 and 0.75 watts.

Recent investigations have shown that it is permissible to increase the anode and screen voltages to 500 and 400 respectively and the anode dissipation to 25 watts. These new limits permit the design of an economical 50-watt amplifier. This output represents an increase of nearly 70%, which is obtained with an anode *supply* voltage only 20% greater than that required for the 30-watt amplifier.

Under the quiescent condition the dissipation is below the permitted maximum, though, due to the regulation of the supply, the voltages are slightly higher than the normal working limit. No ill effects will be experienced from this cause.

The comparative operating conditions per pair of valves unless otherwise stated are :

		Auto Bias.	Fixed Bias.
H.T. supply voltage	Q	450	535 V
	FO	425	500 V
Anode voltage	Q	415	525 V
	FO	390	480 V
Screen voltage	Q	300	420 V
	FO	275	385 V
Anode current	Q	104	80 mA
	FO	125	175 mA
Screen current	Q	5	3 mA
	FO	18	21 mA
Grid bias per valve	—	500 ohms	−45 V (appx.)
Power output	—	30	50 W
Anode load resistance	—	8,000	6,000 Ω
Anode dissipation per valve ...	Q	21.5	21 W
	FO	9.5	17 W
Screen dissipation per valve ...	Q	0.75	0.6 W
	FO	2.5	4 W
Peak input voltage approx. ...	FO	35+35	45+45 V
R.M.S. voltage to rectifier (approx.)	FO	525+525	600+600 V
Efficiency*	—	49%	52%

Q = Quiescent or no signal condition. FO = Full output.

$$* \text{ Efficiency} = \frac{\text{Watts output}}{\text{Watts input to anode and screen}} \times 100$$

Some small differences from the above data are to be expected with various pairs of valves.

The circuit used to obtain 50 watts output is shown in Fig. 1, the two KT66 valves being driven from a low-impedance triode via a push-pull transformer T_1. The

1

Economical 50-watt Amplifier—
latter is not essential since the KT66 valves are not driven into the positive grid current region, and any of the recognized phase-splitting arrangements are suitable, but the D.C. resistance from each KT66 control grid to earth should not greatly exceed 100,000 ohms under the fixed bias conditions.

Independently adjustable bias controls, R_1, R_2, provide a bias supply variable from 30 to 60 volts. The bias circuit is somewhat unorthodox in that it is taken from the anode supply transformer T_3 via a small condenser C_1 of high working voltage. The maximum bias voltage obtainable is determined by the capacitance of C_1 and the resistance of R_1, R_2, R_3 and R_4. This arrangement has the advantage that no special bias transformer is required and that a comparatively low bias voltage (of 60 volts) is obtainable from a high-voltage transformer without the use of resistances dissipating considerable power. This arrangement is suitable whenever a low-impedance bias supply is not required, i.e. when the output valves are not driven into the positive grid current region. The value of the condenser C_1 may be increased or decreased to provide higher or lower voltages for use with other types of valves. It will be noticed that the rectifier filament is earthed and may be run from the 6.3-volt amplifier heater supply with a resistance R5 dropping the voltage to 4 or 5 for the rectifier. Suitable resistances values are U10—2.3 ohms, U14—0.9 ohms, and U50—0.65 ohms.

A considerable increase in anode and screen currents takes place with increasing signal input and a low-impedance H.T. supply is required. A choke input filter circuit using two low-resistance chokes L_1, L_2, provides a hum-free supply of good regulation. When a small amount of hum can be tolerated at full output, the second choke and condenser L_2, C_3 may be omitted.

Due to the large variation in screen current between the quiescent and the full output conditions, a gas-filled cold-cathode diode, type S130, must be used to supply the screen voltage. As the voltage drop across this diode does not change materially with varying current, the screens are maintained at approximately 115 volts below the anode supply under all conditions of operation. This reduced voltage is also used to supply the earlier valves. The screen grids must not be connected directly to the 500 volt supply.

The meter shunts R_{12}, R_{13} are permanently connected in the cathode circuits of the KT66 valves and the meter measures the total cathode current of each output valve. The quiescent screen current (approx. 1.5 mA) is small compared to the anode current (approx. 40 mA), and may be safely ignored when adjusting the bias voltages by means of the resistances R_1, R_2. The actual quiescent current is not important and any value between 30 and 40 mA may be used. At lower currents "crossover" distortion becomes evident and at higher currents the anode dissipation is increased unnecessarily. Both valves must of course be set to identical quiescent currents. A meter having a full-scale deflection with its shunts, of 100/150 mA is suitable.

The performance of the amplifier is illustrated by the curves of Fig. 2, and is suitable for small public address equipment and also makes an economical modulator for low power transmitters, being capable of providing 100% modulation for a 100-watt carrier. It has a high efficiency and a lower quiescent dissipation than many other 50-watt amplifiers. The use of fixed grid bias instead of the more usual cathode bias arrangement renders the amplifier rather less foolproof, and a meter is essential for adjusting the anode current and should preferably be built into the equipment. However, it is not essential that it should have a high accuracy and one of the miniature type is suitable.

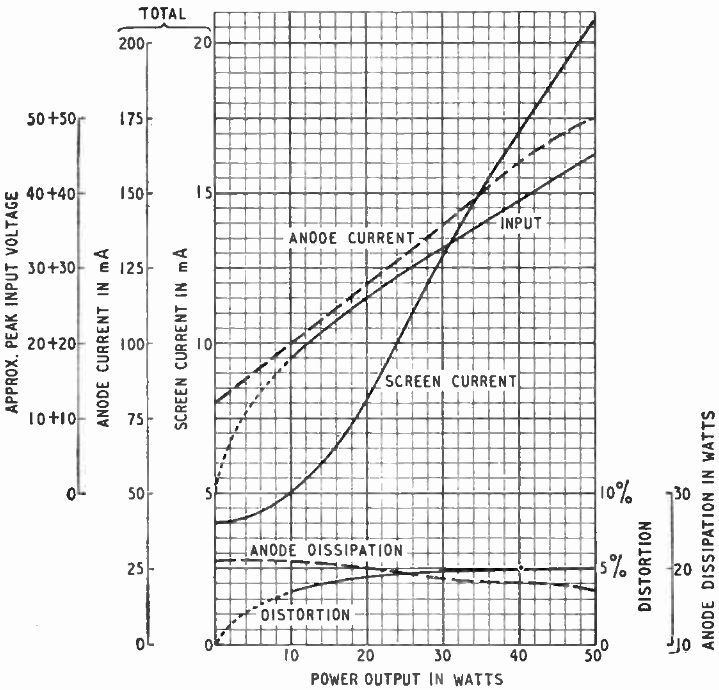
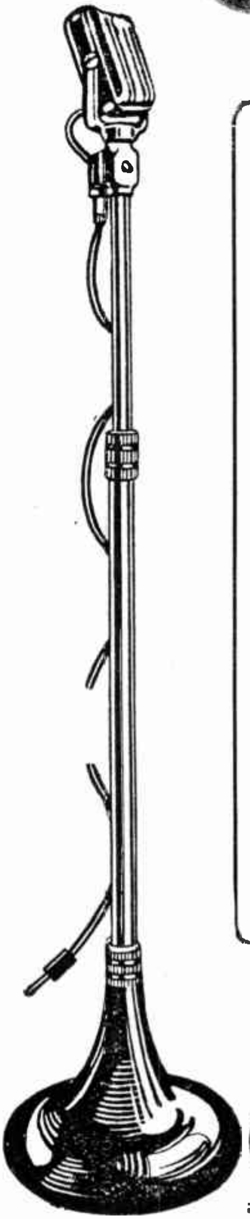


Fig. 2. Performance curves of the amplifier operated in class AB, with V_a=480, V_{g2}=385, V_{g1}=−45, and an anode-to-anode load of 6,000 ohms.

OUR COVER

The overall size of the chassis of the Pye B18T television receiver, in which the makers have dispensed with a mains transformer, is little bigger than a standard broadcast set. By using an inclined chassis the 9-in C.R.T. has been accommodated in a minimum of space.



"SUPER FIFTY WATT" AMPLIFIER

This AMPLIFIER has a response of 30 c/s. to 25,000 c/s. within ½db, under 2 per cent. distortion at 40 watts and 1 per cent. at 15 watts, including noise and distortion of pre-amplifier and microphone transformer. Electronic mixing for microphone and gramophone of either high or low impedance with top and bass controls. Output for 15/250 ohms with generous voice coil feedback to minimise speaker distortion. New style easy access steel case gives recessed controls, making transport safe and easy. Exceedingly well ventilated for long life. Amplifier complete in steel case, with built-in 15 ohm mu-metal shielded microphone transformer, tropical finish. *As illustrated*, Price **36½ Gns.**

All types of MICROPHONES, STANDS and SPEAKERS available from stock including 12 in. GOODMAN P.M. SPEAKER

●

30-Watt RECORD REPRODUCER in metal case
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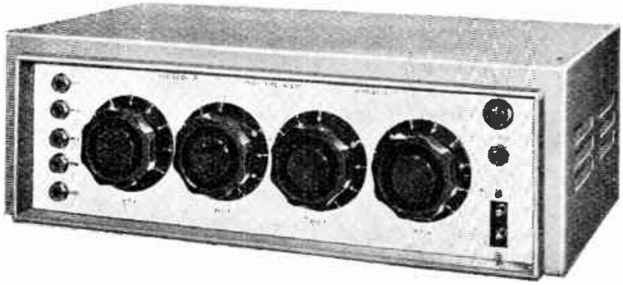

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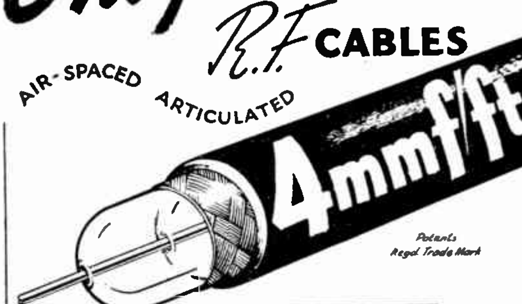

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C22	5.5	184	2.8	0.44
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C33	4.8	220	2.4	0.64
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INVISIBLE COMPONENTS

What the Circuit Diagram Fails to Show

By "CATHODE RAY"

THE ability to think out intricate problems mentally, without external aids such as written or drawn symbols, is given to only a few great intellects. Most of us are obliged to lean rather heavily on such aids, though perhaps we do not always realize how well they serve us. If you want to get some idea of how much you owe to our system of numerals, for example, try working out a simple little "sum" in Roman figures, say, dividing MCMXI by XCI.

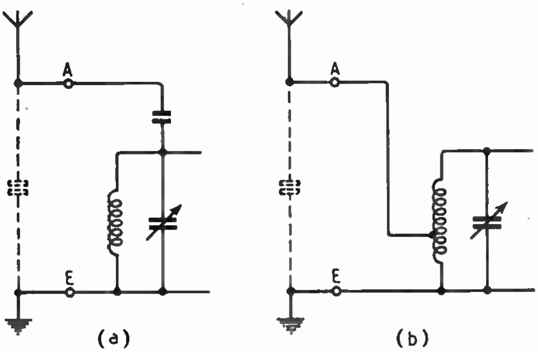


Fig. 1. General rules about "lead-in capacity" that apply to the customary receiver input circuit (a) may not hold good with the alternative arrangement, (b).

The circuit diagram is another example of a practically indispensable aid to thought; simple and effective. But the very effectiveness of such aids creates a danger; the danger of handing over to them too much of our reasoning powers.

When some piece of circuitry behaves unexpectedly, it is usual to place the circuit dagram on the desk in front of us and gaze at it intently, trying to arrive at a plausible explanation of the action in terms of what we see. But it is a great mistake to assume that because a correctly drawn diagram, complete with values of components and any other necessary data, tells the truth, it tells the whole truth and nothing but the truth.

Workers in megacycles are, of course, familiar with the importance of such unrevealed details as inter-electrode capacitances. Sometimes they dot them into the diagram. A year or so ago* I showed how circuits that appear to be unorthodox or even inexplicable can be accounted for in this way. Many—perhaps most—of the snags that so often crop up in new arrangements or modifications can be traced to the "invisible components." Out of sight, out of mind.

Even when aware of their existence, one is often tempted to regard them vaguely as "capacity effects," and either fail to adopt suitable precautions in the right places or go to a lot of trouble to apply them in unnecessary places.

One of the first places where "capacity effects" became well known was at the aerial lead-in. As long as a quarter of a century ago books and articles for wireless amateurs were emphasizing the importance of keeping the aerial lead-in well away from walls—and still more from pipes and gutters—and as short as possible, to prevent a large stray capacity to earth bypassing away the precious R.F. currents that were so much needed in those days of low-power transmitters and crystal detectors. With the type of input circuit commonly used (Fig. 1a), that was sound advice. One had only to grasp the aerial lead and notice how signal strength fell off to demonstrate its truth. But it was one of those generalizations which, if accepted blindly, might mislead. Some receivers used the tapped-down input connection (Fig. 1b), sometimes with only a turn or two between aerial and earth terminals; and such sets are almost immune from "capacity effects." The aeral lead can be wired all over the house in lead-covered cable, even, without much loss of signal. The explanation, of course, lies in the impedance across which the stray capacitance occurs. A "stray" amounting to 100 pF, at 1 Mc/s, is a reactance of about 1600Ω. In Fig. 1(a) the input impedance of the receiver is probably tens of kilohms; in (b) perhaps only a few tens of ohms. So the effect of shunting 1600Ω across is likely to be disastrous to (a) and unnoticeable with (b).

As interest developed in the direction of higher frequencies, amateurs naturally became more conscious of "capacity effects" than ever. And rightly so, seeing that the shunting effect of a capacitance is directly proportional to frequency. It would never have occurred to those who rely on second-hand generalizations, therefore, to invent the coaxial cable, with its many pF per foot, for these very high frequencies. "A little knowledge" would have rejected such a proposal scornfully, as obviously having far too much "stray capacty." Fuller knowledge took account of another hidden component—distributed inductance—and found that this exactly neutralized the effect of the distributed capacitance.

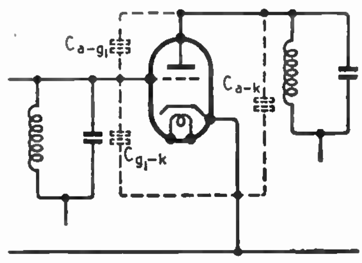


Fig. 2. In a R.F. amplifier the "hidden components" (dotted) are quite as important as many of those shown in the usual circuit diagram.

A valuable accomplishment, then, is the ability to estimate

* "Tuning Circuits—Obvious and Otherwise." Wireless World, November, 1947.

Invisible Components—

the values of the uncharted quantities and calculate their probable effects in the circuit. In a stage of tuned R.F. amplification one would not normally connect a capacitor between the "live" sides of the input and output.

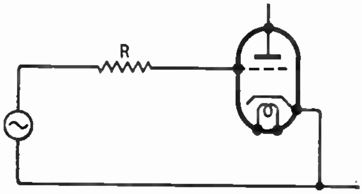


Fig. 3. Another circuit in which valve capacitance may play an important part.

But it has long been common knowledge that one exists, in the form of the anode-to-grid capacitance of the valve (denoted by C_{a-g1}; Fig. 2). The screen-grid valve was invented to reduce it to a minimum; and then it became necessary to look carefully to the capacitance of the valve holder and the wiring. Even 0.01pF could make all the difference. At the same time, much larger capacitances can be tolerated *across* input and output (namely, C_{g1-k} and C_{a-k}), because they are neutralized by the tuning inductance and simply necessitate a reduction in tuning capacitance. Ultimately, however, the possible gain at a given frequency—especially a very high frequency—is limited by these input and output capacitances; gain is approximately proportional to coupling impedance, which in a tuned circuit is $\frac{L}{rC}$ so inversely proportional to C.

It is quite wrong to suppose that such effects are confined to radio frequencies. The "invisible components" can sometimes dominate the situation at audio or even power frequencies. It is well known that when a high resistance (R in Fig. 3) is used in a grid circuit, the fact that the valve is biased and operated to avoid grid current does not exclude voltage drop in R. One must take account of the valve input capacitance, which combines with R to form a potential divider that progressively reduces the overall gain of the stage as signal frequency is increased.

Part of this hidden capacitance is doubly hidden; because in addition to the fairly straightforward C_{g1-k} there is C_{a-g1}, which is by no means straightforward, for the "geometrical" or "cold" capacitance is multiplied by the gain of the valve ("Miller effect"), and in a high-μ triode may amount to several hundred pF.

An interesting example of how stray capacitance can cause serious trouble, even at the lowest frequencies, occurred in a piece of apparatus where the cathode potential of a cathode-follower valve was adjustable over a range of several hundred volts. The valve makers generally refuse to answer for the consequences if the potential between cathode and heater is increased beyond 100 V; sometimes even less. At the same time they recommend that the resistance between them should not exceed, say, 20,000Ω. So the heater could neither be joined to a fixed potential nor left floating, and it was therefore necessary to connect the heater to cathode. Since the

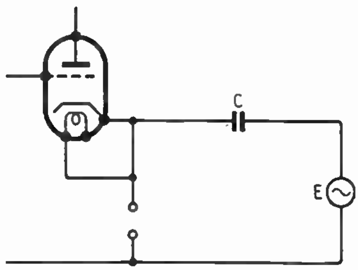


Fig. 4. Example in which a stray capacitance may be vital even in a zero-frequency power unit.

apparatus was designed to give only a D.C. output at the cathode, it might have been supposed that "capacity effects" could be ignored, and precautions confined to making sure that the separate heater winding for this valve was well insulated to stand the full range of voltage. In practice, however, a very unsatisfactory result might have been obtained. The power transformer had another winding supplying about 700V. If the heater winding had been laid on top of it, the circuit would have been equivalent to Fig. 4, where E is 700V, 50 c/s, and C is the capacitance between the two transformer windings. Being a cathode follower, the valve would have an output resistance something less than $1/g_m$; assuming g_m to be in the region of 5 mA/V, that would be 200Ω. C might be in the region of 100pF; at 50 c/s, 100pF is about 30 MΩ, which seems large enough to be harmless. Yet assuming these figures, the hum voltage in the output would be about 5 mV, which is more than five times larger than there was reason to expect it to be from other causes.

But the position was likely to be very much worse. If the output terminals were open-circuited, g_m would be zero, and there would be little to stop the "hum" rocketing up to hundreds of volts!

A capacitor across the output terminals would have to be 50μF or more to be much good; excessively bulky and expensive for up to 500 V working! The proper solution, of course, was to cut out C by carefully screening the winding. An alternative—to balance out the hum by capacitance to a point in opposite phase—is in principle and in practice less satisfactory. It is better to avoid undesirable effects by getting rid of the cause than by balancing them out with arrangements that require critical adjustment and may leave substantial "residuals."

The term "residuals" is a cue to dilate on the extreme importance of the invisible components in A.C. bridges. But dealing with them is a special art and far too long a story to tell here. So I go on to say a few words about the more relevant problem of "earthing," in the sense of "tying down" parts of the circuit that one wants to have at constant potential. Decoupling, and such like. This too can be made quite a long story, and I only give an example of the sort of thing.

Suppose you have a high-gain amplifier. One of the most important requirements in its design is to prevent it from picking up stray fields. The usual methods are either to build it on a metal chassis, with suitable metal screens for the more vulnerable parts, or to enclose the whole amplifier in a screen; in either case the metalwork is intended to be earthed. If the common negative lines of the circuit can be connected to this metalwork it simplifies matters to do so. But sometimes it is not; perhaps because there is a necessity to connect it to a point at a different potential to earth. If so, there may be trouble. Fig. 5 represents, say, the input to the first stage, which, of course, is the most sensitive part of the amplifier, so the grid lead has a screen round it (shown dotted) connected to the earthed chassis. Suppose now the common negative lead is connected to some other equipment. Even if the other equipment is also earthed, the leads between the two units or between them and earth may pick up a trace of hum or other interference. This can be represented as a small alternating voltage between the two terminals in Fig. 5; and it is easy to see that it is applied, *via* the capacitance between grid lead and screen, across the grid resistor, and therefore right in at the front door of the amplifier.

So one often has to think rather hard to decide whether screens should be connected to the "earthy" side of the circuit, or to chassis, or what.

Up to now we have been concentrating mainly on the effects of hidden capacitors. But the possibility of stray "pick-up," just referred to, is a reminder that transformers, too, are hidden in most circuits; often in unsuspected places. One is apt to assume that the alternating magnetic field in a mains or audio transformer is confined to the iron core; but that is very far from true, especially of those chokes and output transformers whose cores are interrupted by gaps.

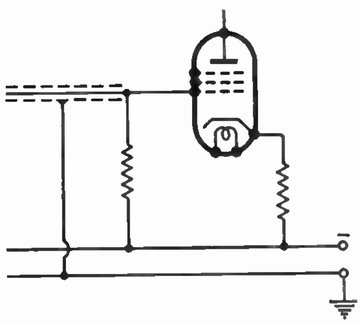


Fig. 5. A common dilemma; should the screening be joined to chassis or 'common negative'? Similar problems are particularly prominent in bridge design.

Any leads within a foot or two must be regarded as loosely-coupled turns on the transformer, and although the voltage generated in them may be small it can be very troublesome when highly amplified. P. J. Baxandall showed, in the February, 1947, issue, how careful one has to be about the loop formed by the input lead to an amplifier, the valve itself, and the return.

Another thing one tends to forget when studying a circuit diagram is that there is no perfect insulator, so there is a conduct-

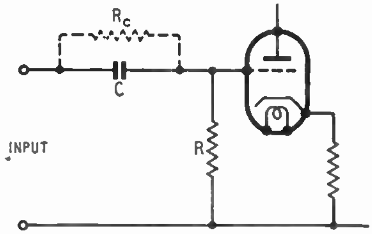


Fig. 6. The leakage, shown here as R_c, may be serious in a valve voltmeter or amplifier.

ance between every pair of points in the circuit! In most places the unintentional conductance is so small as to have no appreciable effect; for example, it may come across a relatively low intentional conductance. Or the effect may be appreciable—for example, the leakage of electrolytic capacitors—but harmless or even slightly beneficial. There are some danger points to look out for, however; one of the most important is a coupling or blocking capacitor in front of a high-resistance circuit. Consider the input to a valve voltmeter (Fig. 6). In order to avoid loading the circuit being measured, R may be made very large, perhaps 50 MΩ; but call it only 10 MΩ. C will generally have to be fairly large in order to cause no appreciable error in reading at low frequencies, say 25 c/s. And it may be there for the purpose of enabling alternating voltages to be measured in the presence of a relatively large direct voltage, say up to 1,000. Even if the instrument is only moderately sensitive it may well be desirable to limit leakage of this unidirectional voltage to, say, 0.01 V Considering R and the leakage of C (call it R_c) as a resistive potential-divider, then, R_c must be not less

Invisible Components—

than a million megohms. Which means that no ordinary capacitor will do.

Although this effect is generally less acute in an ordinary amplifier, neglect of it may lead to unexpectedly large anode currents and distortion.

We have seen that small stray mutual inductances may be important even at the lowest frequencies. Self-inductances can generally be neglected at audio frequencies, but not at very high radio frequencies. It is easy to draw a bypass capacitor in a circuit diagram and think you have "earthed" that part of the circuit; but what about the inductance of the leads? What you really have is not Fig. 7(a), as in the diagram, but Fig. 7(b), which is a low impedance at only one frequency. Increasing the capacitance may actually increase the impedance at the working frequency. The best policy is to reduce L as much as possible; the "bushing" types of bypass capacitor are the most familiar expression of that policy. A good deal of ingenuity has been used in devising still more nearly perfect E.H.F. "seals."*

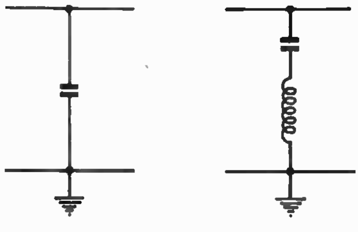


Fig. 7. What is shown as (a) on a E.H.F. circuit diagram is likely to behave more like what would be represented as (b).

Another place where invisible "coils" are a major problem is inside a valve. The inductance of the connections is a principal factor limiting the frequency at which the valve can be effectively used. While the usual simple symbol for a valve is good enough for most audio and moderate radio frequency purposes, it is seriously misleading at E.H.F. unless replaced by quite a complicated "circuit diagram."

The general conclusion, then, is a resolve to cultivate the habit of considering what "hidden components" may have to be taken into account under the conditions that apply. This may not always be easy, especially when the quantities in question are distributed around the circuit instead of being conveniently localized or lumped as the standard circuit symbols represent. On the other hand, some problems of this kind that seem at first sight vague or difficult can often be successfully treated as an "equivalent circuit." The common "transmission line" is a classical example. The intervalve transformer is another; Terman in his "Radio Engineering" shows very clearly how it can be treated as three simple equivalent circuits, valid respectively at low, middle, and high audio frequencies. And there are plenty of other examples "in the literature."

* *e.g.*: "The Duct Capacitor," Alan Watton, Jr., *Proc. I.R.E.*, April, 1948, p. 550.

NEW DOMESTIC RECEIVERS

A NEW "Ambassador" radio-gramophone Model 4756, Type S, with storage space for 150 records has been introduced by R. N. Fitton, Hutchinson Lane, Brighouse, Yorks. The A.C./D.C. superhet (4 valves+rectifier) covers six wavebands with bandspread tuning between 9.4 and 50 metres. The walnut cabinet measures 33in × 18in × 15½in and the price is £59 15s including tax.

A built-in loop aerial designed for efficient short-wave reception is a feature of the new Ekco "Consolette" A.C./D.C. transportable. The four-valve plus rectifier superhet circuit is housed in a two-colour plastic cabinet with finger-tip side controls for tuning and volume. The price is £17 17s including tax, and the makers are E. K. Cole, Southend-on-Sea.

In the new Model 91G radiogramophone made by Invicta Radio, Parkhurst Road, London, N.7, a seven-valve circuit (plus C.R. tuning indicator) covers short waves (with bandspread tuning) from 11 to 60 metres in addition to the usual medium and long waves. Individual calibrated bandspread tuning scales are provided for the 16, 19, 25 and 31 metre bands. A push-pull output stage delivers 6 watts undistorted. There is an automatic record changer and storage space for records in the cabinet which measures 40in × 30in × 21in. The instrument is designed for A.C. mains 110-250V, 40-100 c/s, and the price is £120 2s 5d, including tax.

Bandspread tuning on short-waves and a C.R. tuning indicator are features of the K.B. Model DR20 receiver. This is a superhet with four valve and a rectifier. The output valve is rated at 4 watts and there is an 8-inch P.M. loudspeaker. The price is £26 2s 6d including tax and an A.C./D.C. version including a barretter is also available.

The K.B. Model DR10

Negative feedback on the pickup circuit is an unusual feature of the K.B. Models DR10 and DR15 which are A.C. and universal mains versions of a new superhet using an 8-inch speaker in a shallow large-area cabinet. The price is £19 10s including tax and the makers are Kolster Brandes, Footscray, Sidcup, Kent.

The Model 848 "Town and Country" receiver made by Rainbow Radio, Mincing Lane, Blackburn, Lancs, can be operated either from A.C. mains, or from a 6-volt accumulator, H.T. being provided through the medium of a vibrator. The set covers medium waves and 9.8 to 98 metres in three short-wave ranges. An R.F. stage precedes the frequency changer and a separate electron-coupled oscillator is employed. The 10-inch loudspeaker is fed by a push-pull output stage; with mains operations the output is 7 watts and on batteries, 4 watts. Power consumption is 42 watts on mains or 27 watts (4.5 A at 6 V) from batteries.

SHORT-WAVE CONDITIONS

October in Retrospect : Forecast for December

By T. W. BENNINGTON and L. J. PRECHNER (Engineering Division, B.B.C.)

DURING October, in accordance with the seasonal trend for these latitudes, the average daytime maximum usable frequencies increased very considerably, while the average night-time M.U.F.s decreased somewhat.

Owing to the exceptional amount of ionosphere storminess, daytime working frequencies were rather lower than expected, particularly in the second half of the month. However, long-range working on the 28-Mc/s band was quite frequent, for example with New Zealand, and many contacts were made occasionally on higher frequencies. As is well known, Alexandra Palace television transmissions were received in Cape Town towards the end of October. That this is a long-distance record is due probably to installation of a test television receiver in South Africa, as otherwise it is by no means an unusual distance for propagation of signals of this frequency at the epoch of maximum sunspot activity. Indeed, such results were anticipated in this column's forecasts for October and November. Night-time working frequencies were fairly high for the time of the year.

Sunspot activity in October was less than in September. Two fairly large groups were observed, which crossed the central meridian of the sun on the 17th and 27th.

The month was exceptionally disturbed, particularly so in the last two weeks. Ionospheric storms were observed on 1st-6th, 15th-16th, 18th-24th, 26th-31st, those occurring on 1st, 15th, 19th-21st, 26th-29th and 31st being very violent.

Not very many "Dellinger" fade-outs have been recorded in October, but those on the 9th and 11th were fairly severe.

Forecast.—Daytime M.U.F.s will be probably rather lower in December than in November because of the "midwinter" effect in the Northern Hemisphere. However, daytime working frequencies will be still relatively high, and long-distance communication on very high frequencies should therefore be possible in all directions from this country. The 28-Mc/s amateur band should be regularly usable at siutable times of the day, but conditions on higher frequencies for long-distance contacts will not be as favourable as in November. The night-time M.U.F.s will fall to their lowest values for the winter, so that the night-time working frequencies will be as low as 7 Mc/s over many long-distance circuits, and they will be in use over longer periods than in November.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during December for four long-distance circuits running in different directions from this country. (All times are G.M.T.) In addition, a figure in brackets is given for the use of those whose primary interest is the exploitation of certain frequency bands, and this indicates the highest frequency likely to be usable for about 25% of the time.

Montreal :	0000	7Mc/s	(11Mc/s)
	1000	9 ,,	(12 ,,)
	1100	11 ,,	(15 ,,)
	1200	17 ,,	(23 ,,)
	1300	21 ,,	(27 ,,)
	1400	26 ,,	(33 ,,)
	1700	21 ,,	(28 ,,)
	1800	17 ,,	(24 ,,)
	1900	15 ,,	(22 ,,)
	2000	11 ,,	(17 ,,)
	2100	9 ,,	(14 ,,)
	2300	7 ,,	(10 ,,)
Buenos Aires :	0000	9Mc/s	(13Mc/s)
	0400	7 ,,	(11 ,,)
	0700	9 ,,	(16 ,,)
	0800	15 ,,	(20 ,,)
	0900	21 ,,	(28 ,,)
	1000	26 ,,	(32 ,,)
	1900	17 ,,	(25 ,,)
	2000	15 ,,	(20 ,,)
	2200	11 ,,	(16 ,,)
	2300	9 ,,	(13 ,,)
Cape Town :	0000	9Mc/s	(13Mc/s)
	0200	7 ,,	(11 ,,)
	0600	15 ,,	(20 ,,)
	0700	21 ,,	(32 ,,)
	0800	26 ,,	(34 ,,)
	1500	21 ,,	(29 ,,)
	1800	17 ,,	(25 ,,)
	2000	15 ,,	(22 ,,)
	2100	11 ,,	(16 ,,)
	2300	9 ,,	(13 ,,)
Chunking :	0000	7Mc/s	(10Mc/s)
	0500	9 ,,	(14 ,,)
	0600	15 ,,	(21 ,,)
	0700	17 ,,	(24 ,,)
	0800	21 ,,	(29 ,,)
	0900	26 ,,	(33 ,,)
	1100	21 ,,	(27 ,,)
	1200	15 ,,	(19 ,,)
	1300	11 ,,	(15 ,,)
	1500	9 ,,	(12 ,,)
	1700	7 ,,	(10 ,,)

Ionosphere storms are not very frequent in December, but if they do occur during periods of darkness they are very troublesome on account of the already very low ionization prevailing during the winter night. At the time of writing it would appear that such disturbances are more likely to occur within the periods 4th-5th, 8th-12th, 16th-17th, 19th-21st, 27th-28th and 31st, than on the other days of the month.

Unbiased By FREE GRID

English as She is Spoke

RADAR is, without doubt, one of the major developments of radio and, apart from its wartime uses, has already proved itself a very present help in trouble to the

Technical phraseology.

fog-encompassed mariner nosing his way cautiously along a crowded estuary amid the raucous bellowings of other ships under way and the bell-ringing bedlam of those lying uneasily at anchor. But it needed a visit to the radar research station at the end of Southend pier to convince me of the real marvels of this new application of radio science. I knew, of course, that I should be able to see on the screen the luminous representation of ships moving over the face of the waters in densest fog, but I little thought that radar would also enable me to see the ghostly forms of stationary and firmly anchored buoys silently and eerily passing up and down on the broad bosom of old Father Thames.

This sort of thing must surely be very bewildering and disconcerting to sailors of the old school, accustomed, as they are, to placing firm reliance on these invaluable aids to navigation to show them the fairway and keep them off the treacherous shoals and sandbanks. Yet they must learn that in this atomic age staid and stately buoys do move up and down stream with all the careless abandon of a woman driver on an arterial road; for one cannot cast doubt upon the categorical statement of a beautifully prepared and elaborately framed series of notices which attempt to instruct the unlettered masses concerning the wonders that they will see when they peer into the what-the-butler-saw type of viewer.

I must confess that I was so incredulous when I first saw the notice that I called the attention of a passing sailor to it. He uttered an astonished "blimey" and followed it up with a graphic description of his opinion couched in phraseology which would, I fear, be too technical to reproduce here. As it is I can only quote the actual words of the notice and leave it to you radar experts to explain matters gently to me: "Additional bright lights that you see on the screen and which do not appear on the [adjoining] chart are ships, buoys and other traffic moving up and down the Thames."

I cannot help thinking that A. P. Herbert, who is an old sailor himself and has written such an excellent account of the wartime history of Southend pier, might have realized what a dreadful shock this new idea of moving buoys would be to us old shellbacks and have broken it to us in a less brusque manner. Perhaps, too, he might have felt the same irritation as I did at the use of the totally unnecessary word "sited" used in another notice which refers to the apparatus "sited on the roof." What a word! even if it *was* used by Herbert Spencer and so is in the *O.E.D.*

Things to Come

THE Editor and I have always set our faces against the adoption by the authorities of any systems of broadcasting, such as the so-called wired-wireless or carrier-current methods, whereby listeners would be denied the freedom of the ether and be compelled to listen to piped programmes, no matter whether they were to their liking or not. I am sorry, therefore, to see a writer in a prominent newspaper talking of the possibility of high-level deliberations on, among other things, "the control of the receiving range of [television] sets manufactured for sale to the public."

Such a control of receiver range would, of course, be impossible unless the public were compelled to buy a television *volksempfänger* in a sealed box which it would be *verboten* to open. If such a thing did happen, let me say at once that I should immediately take to the Cave of Adullam and proceed to make "maquis" receivers with joyous abandon. I hope many *W.W.* readers would join me, not with the idea of making money (perish the thought!) but of preserving the nation's freedom to listen to and look at anything that was ether-borne.

Apparently all the fuss has arisen because the old idea of using a central cinema to feed programmes to a chain of satellites equipped with big-screen television is a stage nearer practical realization. This newspaper correspondent seems to think that pirate cinemas not belonging to the chain might pick up the programmes and profit thereby. Surely, however, the big cinema interests have enough money and technical talent at their disposal to obviate this sort of thing by means of an efficient "scrambling" system.

The next thing which apparently disturbs the same writer is the thought that home viewers might attempt to pick up the programmes. In this case he is not only disturbed by the thought that they might pirate the cinema transmissions but that the programmes which they filched might not be in good taste. So our moral rectitude, which is not sufficient to prevent our stealing entertainment, is to be protected against being offended by picking up a film of doubtful moral tone. He overlooks the fact that we could in any case see it at the local cinema. The price of this protection is to be a restricted-range receiver, or in other words, a Hitlerian *volksempfänger*.

As for the idea of distributing films by television, I personally look forward to the day when they will be sent out from a central transmitter, not for local cinemas, but for the home viewer. I would much prefer to see a film from the comfort of my fireside armchair than to

The local Amatorium.

turn out on a wet night and queue in the rain in the hope of securing a seat, which may or may not be at a suitable viewing angle, in the local Amatorium.

LETTERS TO THE EDITOR

Controversy on Quality Receivers ◆ Distortion and Inter-modulation ◆ Resistor Ratings

High-Level Detection

IN querying the power handling capabilities of the stages in my high-level detection set your correspondent E. F. Good (your Nov. issue) puts forward suggestions that were actually tried by myself and others as long ago as 1934 when you published the first H.L.D. set. At that time I preferred the transformer coupling between the final R.F. stage and the diode because it simplified the design, provided a very convenient means of permitting paraphasing from a single diode, and seemed to admit of greater stability on the R.F. side. During the intervening years I have not found that there is anything to be gained by varying my original circuit.

I have not tried an EF55 in the third R.F. stage and use the Osram KT61 because I have found it entirely satisfactory. If instruments are adequate indicators, this valve is more than capable of fully loading the PX25s but I agree that 120 volts RF is on the high side. Normally the output demanded from the KTT61 is not more than 30 to 50 volts as, operating the PX25s with 400V on the anodes and 600 ohm bias resistors, the maximum input (grid to grid) is 76V for the full 15 watts output.

It is pertinent to say here that the set on which I am now working is more in line with standardized practice in that six-volt Osram KT66s (triode connected) are in the output stage. The operating conditions for these are almost identical with those of the PX25s.

Concerning feedback. I quite agree with Mr. Good. In using a small amount of negative feedback I was bowing to the conventions of some of my friends who ought to know more about it than I do. When trying out a new speaker and using an output transformer without a feedback winding I found that there was some increase in the top note response and, as is well known, there was a decrease in the required voltage across the grids of the output valves which would naturally result in lessening the danger of overloading the KT61.

Kensington. W. MacLANACHAN.

Direct-coupled Amplifiers

I SHOULD be most grateful if you could find sufficient space in an early issue of the *Wireless World* to publish this reply to P. J. Baxandall's letter in your October, 1948, issue.

I am in a position to answer P. J. Baxandall's query as to the conditions of comparison between N. Bonavia Hunt's direct-coupled amplifier and other modern P.P. amplifiers.

Comparisons have been made by me (on a twin L.S. system using a folded bass horn and high-note diffuser for which the makers claim a smooth response from 40 c/s to 20,000 c/s) with a P.P. amplifier using tetrodes with feedback on the lines of P. J. B.'s amplifier (*W.W.*, Jan., 1948) and a Williamson amplifier (*W.W.*, May, 1947). Both these were preceded by a tone control circuit of similar characteristics to N.B.H.'s.

A quick switch over was arranged and several enthusiasts have all agreed that for complete absence of any form of distortion, separation of parts, and extreme clarity, the N. B. H. amplifier could be picked out every time.

The potentiometer referred to is not, as pointed out, part of the tone control network, but used as a preset load in connection with the 5kΩ resistor in the cathode of the MKT4 to ensure that the correct current is passed. Although as a matter of convenience I am using an amplifier of P. J. B. pattern, I think it is most unfair to try to deter enthusiasts who are prepared to go to any lengths to obtain the best possible solution to this complex business of Hi-Fidelity. F. ASTIN.

Chorley, Lancs.

N. BONAVIA HUNT'S direct-coupled amplifier is only a link at the end of a long chain of amplifiers used by the B.B.C. from microphone to transmitting aerial. He would do well to ponder the fact that as far as he is concerned the only D.C. amplifier in the complete chain to his loudspeaker is Mr. Hunt's.

I have no desire, nor is there need, to prove theoretically that a capacitance can deal with alternating currents of complex wave-form with adequate fidelity; but, if capacitors have not this property, the B.B.C. are transmitting sounds of inferior quality, which of course they sometimes do, due I am sure entirely to other considerations.

Perhaps Mr. Hunt would be kind enough to divulge the secrets of his loudspeaker system which can with

Letters to the Editor—

so much accuracy reveal on the one hand the perfection of his D.C. amplifier and on the other the defects of a well-designed R.C. coupled amplifier with feedback.

In all fairness it could be argued that even distorted programmes should be reproduced with the utmost fidelity, and no doubt Mr. Hunt will continue to use his wasteful D.C. amplifier regardless.

But Sir, is it worth it?

ALEXANDER SHACKMAN.

New Barnet,
Herts.

MAY I be allowed to put forward the following points in reference to Mr. P. J. Baxandall's letter criticizing my amplifier?

(1) The circuit published in the July issue gave only one form of the amplifier, mainly intended for gramophone work.

(2) The potentiometer connected in the grid circuit of the second A.F. valve does not form part of the variable tone control network but is intended to be pre-set to the optimum point and not altered.

(3) A later circuit incorporates a fixed resistance with a choke in series between grid and earth.

(4) A big undistorted wattage output cannot alone guarantee good quality reproduction of orchestral music; this amplifier can do so when using PX4s in the output stage.

(5) Two or three watts is not really a sufficient output for reproducing the lower frequencies without distortion even in a small room.

(6) There is no question as to the excellence of the Williamson and the Baxandall push-pull amplifiers recently described in *Wireless World*. But if used in the average home, tone control filters are desirable for correcting at the lower volume levels.

(7) Following orchestral performances with an orchestral score quickly shows a musical listener like myself how much of the actual playing is lost even with the best amplifiers and loudspeakers. My amplifier was designed for the express purpose of picking up these missing parts, one of the essential conditions of success being the elimination as far as possible of the blocking condenser. On this latter principle I take my stand against all criticism.

N. BONAVIA HUNT.

Stagsden, Bedford.

The correspondence on "High-level Detection" and "Direct-Coupled Amplifiers" must now be closed.—Ed.

Assessing Distortion

IT is remarkable, indeed, what harm one single wrong article can do. In your August issue (p. 299) H. S. Casey advocates the use of A.F. amplifiers with very poor low-frequency performances. I have followed up the sources of this clear disagreement between theory and practice, and your readers may be interested in what I found.

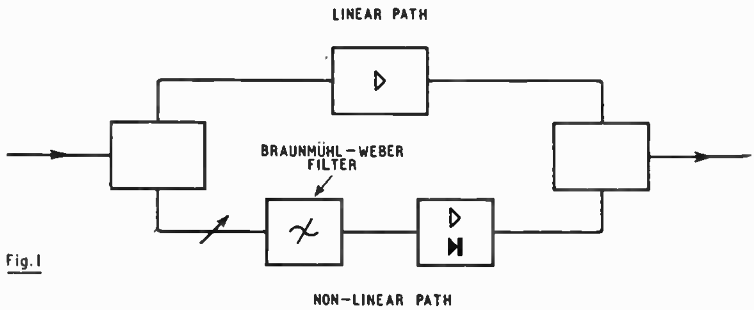


Fig. 1

Back in 1936 Dr. Fritz G. Lüchen wrote about "Die nichtlineare Verzerrung in langen Fernsprechkabeln und ihr Einfluss auf die Verständlichkeit der Sprache" (*Telegraphen- und Fernsprechtechnik*, Feb., 1936, p. 27). He used a distorting network consisting of two paths, one linear, and one non-linear, and mixed their outputs to get different amounts of non-linearity. Both paths *were independent of frequencies* (Fig. 1).

This apparatus is used by Hans Joachim von Braunmühl and Walter Weber. ("Ueber die Störfähigkeit nichtlinearen Verzerrungen," *Akustische Zeitschrift*, May, 1937; p. 135) for the production of distortion dependent of frequency. This is done by inserting octave filters in the non-linear path in advance of the distorting network. However, such an artificial distortion bears almost no correlation to the distortion encountered in an ordinary amplifier. If, for instance, the band 70-140 c/s is passed through the non-linear path, intermodulation will occur only between frequencies within this band. But we all know that the most disturbing effect of low frequency non-linearity (e.g., in a transformer core) is the modulation of middle and high frequencies by low frequencies. A distortion test by the intermodulation method (e.g., 100 and 2,000 c/s) would measure practically no distortion in an artificial network of Braunmühl and Weber even if it is set for very high non-linearity.

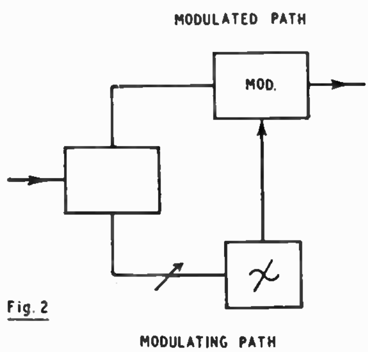


Fig. 2

Incidentally this phenomena is taken use of for expanders (Audio Noise Reduction Circuits, Harry F. Olson, *Electronics*, Dec., 1947; p. 118).

So Braunmühl und Weber are wrong, and so is R. E. Jones. (Non-linear Distortion of Music Channels with Particular Reference to the Bristol-Plymouth System, *Post Office Electrical Engineers' Journal*, April, 1939; p. 45); and H. S. Casey seems to be misled by them.

If one wishes to synthesize frequency-dependent non-linearity of the kind encountered in ordinary amplifiers there is another more realistic method (Fig. 2).

Like Braunmühl and Weber we have two paths, one frequency independent and one path with filters that pass frequencies in the band that we want to make non-linear. These frequencies then are caused to *modulate* the whole complex in the other path. The distortion thus obtained has a good correlation to the second-order distortion encountered in most kinds of AF apparatus. For the production of third and higher order distortion, non-linear circuits must be inserted in the modulating path.

K. SMITH.

Lidingö, Stockholm,
Sweden.

Resistor Ratings

AS a footnote to the above article in your November issue, the following points may be of interest.

In commercial use a life expectation of some 10,000 hours has to be envisaged, whereas Service requirements merely call for a minimum of 1,000 hours at the present time, which has a large bearing on the relatively high wattage ratings at

71°C. assigned to the resistors by the Services.

In addition, it is understood that tests recently carried out indicate that some increase in maximum voltage ratings is possible in the case of the high-stability type.

A. E. BENNETT,
Chief Engineer,
Dubilier Condenser Company.
London, W.3.

Reducing Heater Hum

THE method of reducing heater hum described by Dr. K. G. Britten in your October issue may be satisfactory for a high-gain laboratory amplifier, but has disadvantages for ordinary practical purposes.

For perfect cancellation the hum neutralizing voltage must be in exact antiphase to the hum and of the same amplitude. If the hum which is to be removed is at all large a slight unbalance in either respect will cause a serious increase. In addition the hum introduced by most valves is far from sinusoidal, so that the hum-neutralizing voltage should properly be of a similar waveform, which is difficult to achieve in practice. I would also expect the setting of the controls to alter as the amplifier warmed up.

An alternative to D.C. heating of the early stages, not mentioned in the article, is to supply the heaters from a small R.F. oscillator. As only a few watts are required, this can easily be obtained from a KT61 or KT66 valve in a Hartley circuit, with only a few additional components, compared with the bulky equipment of a D.C. power supply. The oscillator can be supplied from the main H.T. line of the amplifier without the necessity for extra rectifiers, chokes and smoothing condensers. The regulation of the oscillator output may not be very good, and if one valve is removed, the heater volts will rise on the remaining valves, but this is not usually a serious objection.

However, with a suitable type of valve in the early stages, and care in the method of earthing, it should be possible to keep the hum in the neighbourhood of the level of the valve and circuit noise without resorting to complications.

Wembley Park, R. TOWNSEND.
Middlesex.

Mercury for Dry Cells

I WOULD like to correct an erroneous impression in the last paragraph of the article "Fresh Progress in Dry Batteries" in your October issue. First, mercury is not scarce; in fact is is very readily available. Secondly, comparatively speaking, mercury is cheap, being the only metal that is today cheaper than pre-war. Mercury in 1939 was £17 per bottle of 76lb, whereas today it is only £15 per bottle.

Of course, red oxide of mercury in a dry battery is not necessarily a cheap raw material.

W. J. TUFFIN,
Manager, Mercury Dept.,
F. W. Berk and Co., Ltd.
London, W.C.

MANUFACTURERS' LITERATURE

Illustrated leaflets giving technical details of the Type 412A pulse generator, Type 1210A frequency meter and photo-electric pick-up, and Type 1250A dynamic balancing machine from Dawe Instruments, 130, Uxbridge Road, Hanwell, London, W.7.

Application Data Book, Issue 3, giving technical details of Type 100 high-stability resistors, etc., from Erie Resistor, Ltd., Carlisle Road, Hendon, London, N.W.9.

Catalogue of W.B. loudspeakers and components, including radio sonde apparatus, from Whitely Electrical Radio, Victoria Street, Mansfield, Notts.

New leaflets dealing with the following products: Ref. SP7/2, Transmitting Valves; Ref. SP8/2, Receiving Valves; Ref. A8, Valve Type DET17; Ref. SL.1/2, Receiver Type CR.100/2; Ref. SL.4/2, Receiver Type CR.300; Ref. SL.17/2, Transmitters: Types TGS and TGM.571; Ref. SL.35. Transmitter Type TGM.651; Ref. SL.36, AXBT Microphone; Ref. SL.37, Airborne Receiver Type AD.86 from Marconi's Wireless Telegraph Co., Marconi House, Chelmsford.

Leaflet giving technical details and dimensions of the Type "A" automatic record changer made by the Plessey Co., Ilford, Essex.

Descriptive lists of transmitters, accessories and components, from Radiocraft, Ltd., 11, Church Road, London, S.E.19.

Standard stock size list of aluminium, brass, copper and other non-ferrous metals from H. Rollett & Co., 6, Chesham Place, London, S.W.1.

Leaflet B/10 describing electronic balancing machines from Scophony, Ltd., Wells, Somerset.

Illustrated catalogue of "Minirack" oscillograph equipment and recording camera, from Southern Instruments, Fernhill, Hawley, Camberley, Surrey.

Illustrated lists of sound amplifying equipment from the Trix Electrical Co., 1-5, Maple Place, Tottenham Court Road, London, W.1.

Illustrated leaflet describing the Hughes supersonic flaw detector, from Henry Hughes & Son, New North Road, Barkingside, Ilford.

RANDOM RADIATIONS

By "DIALLIST"

A Poser

A WHILE AGO I received from an editor (*not* of this journal) a request for "a short account of the Vipuri tube." Completely floored but feeling that it might be something I ought to know about, I spent a busy morning in searching through text books, encyclopædias and even catalogues and in ringing up erudite friends, all without the slightest success. I was convinced at length that "their ain't no sech thing" (though it looks quite a likely name or doesn't it?—for something in the electronic line) and that the Vipuri tube which had given me so much hard work was in fact nothing more substantial than a typist's or printer's error; my correspondent had, so to speak, drawn a bow at a Venturi. The "short account," however, must certainly be sent and this is the form it took:

The Vipuri tube, I wrote, was invented by the famous Finnish physicist Konstant Labilius and named by him in honour of his native town, Viipuri. The omission of the second "i" in the name was deliberate and is believed to be a covert allusion to the coccide nature of the invention. The apparatus consists of a glass envelope, 2.00625 metres in length and of inverted-O section, which contains a cathode, an anode, a hyrode, a byrode and eighteen grids, connected in series—paranoia, in a high-pressure vacuum. A length of hoaxial cable, attached to the eastern end of the envelope is provided to form the connection with a source of uni-directional A.C. The purpose which the Vipuri tube is intended to serve is not known.

The Big Black-Out

THE RADIO BLACK-OUT on the evening of November 2nd seems to have been one of the most complete that has ever happened. The North American short-wave stations were just wiped right out and not even the most powerful transmitters could get their messages across to this country. It must have been an exasperating time for those who were trying to get the latest election news from the States. These things so often happen at times when you'd give anything for clear reception. I recall the day when Hitler was carrying out his greatest pre-war purge and all communication with Germany was cut off. During the day the only German radio stations working were medium-wavers of moderate power, which were sending out short news bulletins at intervals. I had a communication receiver in use at the time with which I could normally get intelligible daytime reception from one or two of them. But on that day atmospherics were simply maddening.

At Last

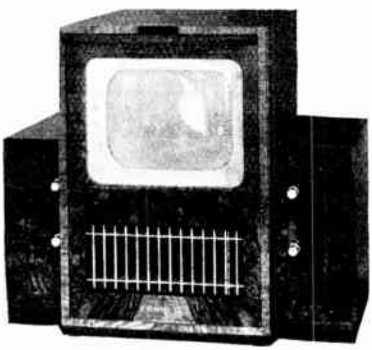
THE PROVISIONS OF the new Wireless Telegraphy Bill regarding interference with broadcasting and television reception seem to be just what the doctor ordered so long ago that he must almost have forgotten writing the original prescription. For about a quarter of a century *W.W.* has been urging that the Postmaster General should be given authority to exercise something more than his powers of persuasion on those who operated commercial or domestic electrical apparatus which marred (or even completely wrecked) reception in neighbouring homes. When the bill has become an act, as no doubt it will, the P.M.G. will be able to serve notice on offenders to abate the nuisance within 28 days. He's no longer tied down to polite requests, which too often proved ineffective. Now he can up and at 'em And that's what I hope he will do. The user of apparatus capable of radiating interference will at last be compelled to make sure that it does not in fact do so. But I've always contended that the real fault probably lay less with the user than with the manufacturer of the apparatus. The ordinary man or woman, for example, who bought an electrical gadget for the home could not be expected to think about its interference-radiating powers. That was an aspect which seldom occurred to his or her non-technical mind. But the manufacturers jolly well did know and one of the queer things is that some firms making and selling radio or television receivers also made and sold other kinds of domestic apparatus certain to spoil the enjoyment obtainable from these. I profoundly hope that before long people will insure themselves against trouble by refusing to buy apparatus that is not guaranteed to conform to the P.M.G.'s requirements.

Television in the U.S.A.

FROM AMERICAN INDUSTRIAL sources comes the information that the number of television sets now in use in the U.S.A. is over half a million and that it is confidently expected that three times as many as that will be working by the end of next year. I'm told that television is not getting so much into private homes as into bars, hot dog stands, restaurant lounges and so on. The reason given is that the programmes are not often of the kind likely to make a strong appeal to the fireside viewer, but consist too largely of prize fights, race meetings and so on. As there is no receiving licence in the States, and therefore no direct revenue from listeners, all programmes must be provided ultimately by proceeds from advertising. The system works fairly well on the whole so far as "sound" broadcasting is concerned; but there is something of an impasse at the moment in television. Business concerns won't buy "time on the air" from owners of television transmitters until they feel that there are sufficient televisors in the homes of the service area. The owners of these homes, on the other hand, say that they won't buy receivers until they are guaranteed the right kind of programmes. Matters will probably sort themselves out in time.

Metering Programme Appeal

Talking of programmes and their popularity or otherwise reminds me of an account I read recently of a remarkable new method developed in Denmark for ascertaining the number of sets in use in a particular area at any moment. At first blush the method used appears to have a distinctly Heath Robinson touch; but its genuineness and the fact that it works are vouched for by the Journal of the International Broadcasting Organization. The principle is this. The switching on of a radio receiver connected to an A.C. supply circuit causes a minute distortion of the waveform in the circuit to occur owing to the action of the rectifier in the set. The harmonics resulting from such distortion can be selected and made to appear as a voltage proportional to the number of sets in use. Apply this to a recording voltmeter of suitable type and the result is a graph showing pretty accurately the amount of listening that was being done at any moment. Graphs covering the period from the fourth to the eighth of August this year show, amongst other things, that Copenhagen listeners switched on in large numbers when commentaries on the Olympic Games were being sent out. The system has a good few limitations. It can be used only on A.C. mains and a separate recorder is needed to keep account of events in the circuit served by the output of each transformer station. It does not indicate to what station the sets are tuned. At the same time it should give some very useful information when the records are carefully analysed. One interesting point is that the fact that each recorder deals with only one supply circuit is not altogether a drawback. Such a circuit is likely to serve an area the majority of whose inhabitants are of much the same social type.



HAYNES RADIO HR88 table-model television receiver with 12-in. tube. The vision channel has six R.F. stages while in the sound channel there is a push-pull triode output stage. An E.H.T. supply of 7 kV is used and the deflector coils, both line and frame, are fed from the time bases without transformers. A table is supplied with the set which together cost £120, plus £26 P.T.

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

Large-scale Television

TO avoid restricting the size of the received picture to that of the C.R. tube, it has already been suggested to replace the ordinary fluorescent screen by one having a point-to-point transparency which is controlled by the electron scanning stream. Such a screen could be used to modulate the light passed through it from a powerful lamp, and so project the picture directly upon an external viewing screen.

A screen intended for this purpose is prepared by depositing a thin layer of potassium bromide crystals upon a normally transparent surface in closely set parallel lines to form a diffraction grating, preferable through a wire mask which is subsequently removed. By the so-called Toepler-Schlieren effect, a beam of light projected on to the screen will then suffer diffraction to an extent that varies from zero to a maximum in accordance with the intensity of the scanning stream of electrons. The screen is stated to give a high contrast of light and shade in the projected picture, and to have a sufficiently quick rate of recovery to cope with normal scanning speeds.

Scophony, Ltd.; G. Wikkenhauser; and F. Okolicsanyi. Application date, January 16th, 1945. No. 597580.

Short-wave Aerials

THE so-called slot aerial is formed by cutting out from a conducting sheet or plate an aperture having a length and width determined by the wavelength it is intended to handle. One of its properties is that of polarizing a wave passing in or out of it, so that the electric field of the wave is at right angles to the length of the slot. Conversely, the slot aerial is opaque to waves where the electric field lies parallel with the slot length.

The invention consists in combining these characteristics of the slot aerial with the directional properties of other aerials, such as the wave-guide horn. Various specific aerial embodiments are described showing how the invention can be applied to controlling the frequency and polarization, as well as the relative phase relation and power distribution over the cross-sectional area of a beam of short-wave energy.

H. G. Booker. Application date, October 31st, 1945. No. 600433.

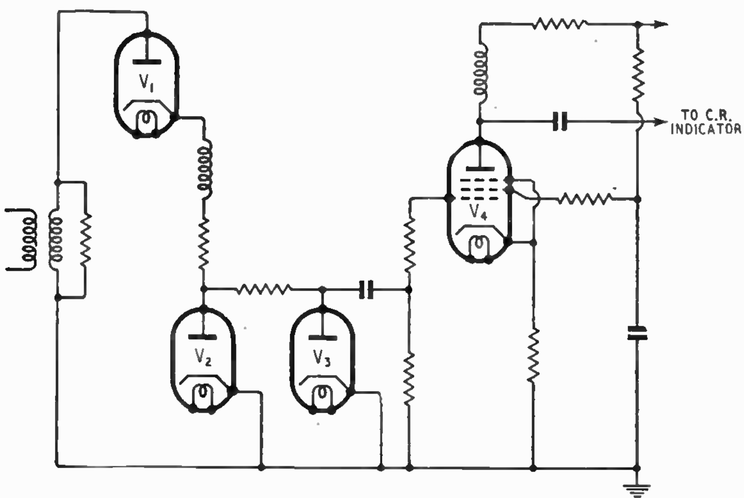
Radar Indicators

THE echo signals returned to a ground observation post by local obstructions, such as buildings and hills, are of large amplitude and wide base. They serve only to clutter-up the near-range end of the time base, and may thus mask the signals from an aircraft that it is desired to detect.

According to the invention, this source of error is reduced by passing the incoming signals through a circuit which acts as a potentiometer having a logarithmic characteristic, so that the amplitude of strong signals is diminished, whilst that of weak signals is not appreciably affected. As shown, when the strength of the signal applied to the diode V1 does not exceed 0.3 volts, the impedance of the diode V2 is so high that the signal is passed, without loss, to the grid of the phasing valve V4, and thence to the C.R. indicator. For stronger signals, the impedance of the diode V2 decreases logarithmically, and the signal voltage is correspondingly attenuated. The diode V3 is arranged to come into action, as and when V2 passes beyond the logarithmic portion of its characteristic curve.

R. H. A. Carter and G. Bradfield. Application date, August 10th, 1945. No. 597912.

"Clutter" suppression circuit.



Super-regenerative Receivers

THIS type of circuit is very liable to cause interference with neighbouring sets by radiating parasitic oscillations, particularly during the intervals when it is not actually receiving signals.

According to the present invention, the receiver is coupled only intermittently to the aerial, the make-and-break periods being substantially in step with the quenching frequency, though slightly de-phased from it. Preferably the aerial coupling is established at the instant when the oscillations in the regenerative circuits start to build up, and is maintained until their amplitude is almost equal to that of the incoming signal. The coupling is then broken, and is kept open until the local oscillations are damped out by the quenching valve. In effect, the switching cycle maintains a one-way path, which allows signals from the aerial to reach the receiver, but prevents re-radiation of the locally generated oscillations. The switching is performed by a valve which is controlled by blocking voltages derived from the quenching oscillator through a phasing device.

"Patelhold" Patentverwertungs-und Elektroholding A.G. Convention date (Switzerland), September 11th, 1944. No. 598807.

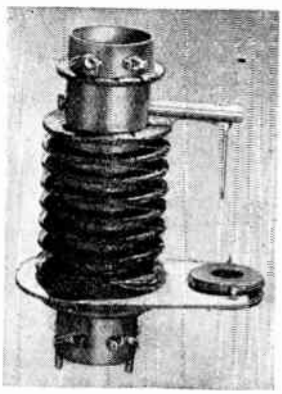
Panel Mountings

THE usual circular hole bored through the panel of a wireless set to take the spindle of a rheostat or similar control unit is replaced by a slot which is expanded at one end into an aperture of sufficient size to allow the internal component to be withdrawn bodily, after the external fixing screw for the spindle has first been slackened to permit the necessary sliding movement.

This enables the unit to be conveniently renewed or repaired from outside the panel, and avoids any necessity, say, for inverting a soldering iron inside the chassis. Where two or more similar units are mounted on the same panel, the respective fixing slots should all extend into a common removal aperture.

D. Jackson and Pye, Ltd. Application date, September 27th, 1945. No 599985.

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



NEW LOW COST HIGH VOLTAGE
R.F. POWER UNITS

Designed for use in equipment requiring a high voltage at low current, this type of power unit consists of an H.F. oscillator and transformer. Fully screened units are now available for outputs between 5KV and 25KV, the illustration being of the 8KV transformer, 5 in. high.

Amongst the more obvious applications are :
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Full design and production facilities are at the service of the Trade, from whom enquiries are welcomed.

HAZLEHURST DESIGNS LTD.
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'Phone KENsington 7793

AN UNSOLICITED LETTER

Highcliffe-on-Sea,
Hants.
Oct. 18th, 1948.

Dear Sirs.

Regarding the "£15 Television Receiver" for which I obtained data from you I thought you might be interested to know that I have made up a receiver exactly to the instructions and the results are to say the least amazing.

I have had the set working now for about three weeks and have had quite worth-while entertainment every night, which considering the distance from London (90 to 100 miles) I think is pretty good.

You are quite at liberty to quote this or refer anyone to me who may be in doubt as to whether the set is a practical job as I can assure them that it is really worth while.

Yours faithfully,
M. Coundley.

Constructional data for the improved **MARK 2.** version is now ready, price 7/6 post free. All necessary parts are available ex-stock but we advise you to order the three main items (Radar Receiver Radar Indicator and Mains Transformer combined h.t. & E.H.T.) immediately as these may become unobtainable later, and in any case you should get started now if you want your T.V. Receiver finished by Xmas. The price of the three main items is £11 10s., plus 12/6 carriage plus 7/6 (returnable) packing case. A list of the other additional items is included with the data.

A made-up receiver can be seen working during transmitting times. We are open on Sats. until 5 p.m. Hire purchase terms available on these and other goods. Send for our winter list.

BULL'S EX-GOVERNMENT DEPOT,
42-46 WINDMILL HILL, RUISLIP MANOR, MIDDX.

Success through constant research—can we help you?

LOW LOSS CERAMICS

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TAYLOR TUNNICLIFF

TAYLOR TUNNICLIFF (REFRACTORIES) LTD.

Head Office: Eastwood, Hanley, Staffs. London: 125, High Holborn, W.C.1.

Phones: Holborn 1951-2 & Stoke-on-Trent 5272-4.

TAS/TT 68.

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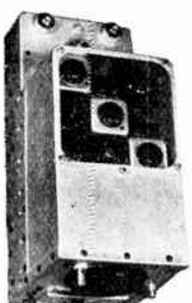
THE MOST OUTSTANDING BARGAIN OF THE YEAR



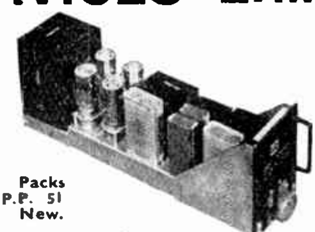
NEW BC454B. 6-valve Superhet complete with valves. Line-up: 3 12SK7's, 1 12SR7, 1 12K8, 1 12A6. All GT Types. Frequency range 3-6 Mc/s I.F. Valve 1415 kcs.

NEW BC455. Same specification but Frequency range 6-9.1 mc/s. I.F. 2830 kcs.

ALL 25/- EACH. Owing to very low price please add postage 1/3d.

THE DOUBLE SUPERHET FOUNDATION AT A SENSATIONALLY LOW PRICE. Plan of basic connections free with each order. Special press-in tuning spindle and knob, 2/6 (precision medium wave coil assembly for the 453, price 10/- not suitable for 454B or 455B).

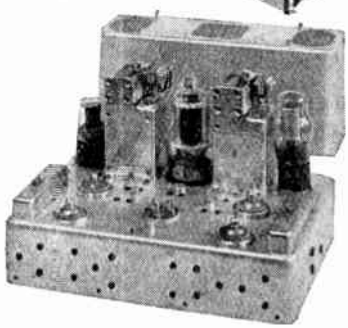
(SPECIAL NOTE. Regret all BC453B now sold.)



Power Packs Type P.P. 51 Brand New.

Black Crackle Cabinet. Size 20" × 8" × 8" Input 115 v., 400-2,600 c/s. Output 730 v.-380 mA., 935 v.-370 mA., 370 v.-130 mA., 6-3 v.-2 amps. Fitted four 5RG (similar U50) Rectifying Valves. Power Transformer makes fine multi-ratio 200 watt Modulation Transformer Oil Filled 1,000 v. 4 mfd. Condensers. 1,500 v. 1 mfd. Condensers. Heavy Duty Chokes, etc. In original wooden unopened crates, 30/-.

Carriage paid per rail (state name of nearest railway station). Available in Gt. Britain only.



BC456B 40 watt Modulator Unit contains 1625 (same as an 807 with 12 v. heater), 12J5 Triode and VT150 Neon Stabiliser. 3 Super-sensitive relays. Modulation Transformer. Driver Transformer. Output Transformer. Precision Resistors, Condensers, etc. Brand New in original cartons.

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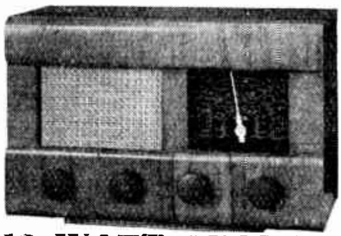

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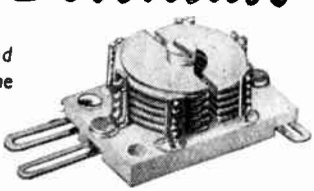

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Standard Model—3 Input Channels. 4 and 5 Channel models available. Details on request from the makers.

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Readers are warned that Government surplus components which may be offered for sale through our columns carry no manufacturer's guarantee. Many of these components will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such components purchased.

NEW RECEIVERS AND AMPLIFIERS

WAKE the easy way with the Reveille clock-radio; £12/12 retail plus tax; stamp for leaflet.—Thames Valley Products, 28, Camden Ave., Feltham. [1947

1949 feeder units with R.F. stage and ban-spread, completely aligned; send 2½d stamp for illustrated brochure to: Couphone Radio, Ormskirk, Lancs. [2340

BC456B modulator, 12J5, 1625, VR150/30, easily converted into high-power audio amplifier, instructions supplied; brand new, 21/- each.—Steadman, 250, Chellaston Rd., Derby.

AMPLIFIERS, new 60-watt heavy duty P.A. models, built for continuous rating and rack mounting; £45; early delivery; send for spec.—Broadcast and Acoustic Equipment Co., Ltd., Tombland, Norwich. [1855

HIGH quality amplifier and radio tuner units, 15 valve, 12 watts, 30 D.B. bass and treble lift; send for specification.—Broadcast & Acoustic Equipment Co., Ltd., Broadcast House, Tombland, Norwich 26970. [9382

TELEVISION sound or vision units, 2Hr' stages, 1 detector and 1 video amplifier employing 3 EF50, 1 EA50, and adjustable iron cored coils, brand new, only 45/- each, carriage paid.—L. Wilkinson, 204, Lower Addiscombe Rd., Croydon. [2317

SPECIAL 6v6 A.C. amplifier for pick-up, etc., 4 watts output with NFB, tone control, modern style chassis, £4/15 complete; introductory offer for one month, 8.n P.M. L.S., free; write for full catalogue coil packs, etc.—Midco Radio, 19, Newcomen Rd., Wellingborough.

POST-WAR radio at pre-war price! The N.R.S. Fidelity 5-valve a.c./d.c. superhet, neg. feedback, attractive 2-colour cabinet; medium and shortwave model, 9½gns; medium and long, 10gns., incl. tax and carr; leaflet —N.R.S., 102, Parkhill Rd., London, N.W.3.

BC453, the Q5 er, brand new in makers' packing, 42/- each; BC603, FM AM 10-valve receivers, £7/10; 1154 Tx., £8; H.R. headphones, 8/6; S130 V/s., 5/- each, dust iron cores for the RF27 units, 6d each; 0.25mfd, 2 kvw, 1/3; many other bargains in our 12-page catalogue; write for your free copy to-day.—Torbay Electric, 43, Colley End Park, Paignton, S. Devon.

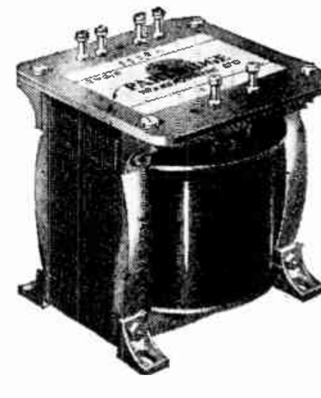
ABK1 spares kit, including 32 valves individually boxed, 18×6sn7, 6×6H6, 28×7193, also many useful relays, resistors, condensers, and a dynamotor with extended spindle which will work as a powerful motor on 200/250 a.c. mains without alteration, 145 items in all, brand new, properly packed; special bargain price 70/-, carriage paid.—L. Wilkinson, 204, Lower Addiscombe Rd., Croydon. [2316

RADAR receiver indicator units, R-31 APS-2E. Brand new American equipment employing 40 useful valves, 2 cathode ray tubes Nos. 2AP1 2in. and 5FP7 6in, power pack, motor blower, milliameters, etc. The following are the valves: 13-6SN7GT, 8-6AC7, 2-6L6, 6-6L6G, 3-VR150-30, 1-2×2, 3-5U4G, 2-6×5G, 2-6H6; special bargain price, £20, carriage 15/-.—L. Wilkinson, 204, Lower Addiscombe Rd., Croydon. [2318

ASTOUNDING year end offer, to clear stocks. Complete mains receiver kit, everything, including valves, beautiful cabinet, all components, assembly drawing, etc., right down to the last nut and bolt; not an odd kit set, but a first-class commercial 2-waveband receiver, ideally suitable for resale; offered for one month only at £9/10, carr. paid; never again.—Radio Constructors, 28, Spital Hill, Sheffield, 4.

C.J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd., Hubert St., Birmingham, 6 (Aston Cross 2440), the Midlands specialist manufacturers of high fidelity equipment, for "W.W. Williamson," "Electronola," and other quality amplifiers built strictly to specification with finest components available; also tone control stages, loudspeaker cross over units, contrast expanders and radio feeders; send 2½d stamp for full details and prices. [2233

CONNOISSEUR'S receiver—world-wide results on highly sensitive 10-valve communication receiver or, by change of switch, very high quality reception of local stations on non-superhet high fidelity receiver; basis rebuilt R1155, 9-1,500 metres, P×4 push-pull quality amplifier, bass and treble controls (boost and cut), gram input, new panel, and other refinements; write for details, or call for demonstration; R1155 specialists, receivers repaired and re-aligned, also modified as above, or to your requirements; R1155 circuit and values, 2/- post free.—R.T.S., Ltd., 5, Gladstone Rd., Wimbledon, S.W.19. Tel. Lib. 3303 [1266



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LOCAL station high fidelity tuner units, £5/5; 6-watt push-pull high fidelity amplifier, £12/12; 12-watt ditto, £18/18; tone control unit, will work with any amplifier, bass and treble boost and cut, £6/6; all complete with valves; technical details on request.—E. A. D., 13, Bence Lane, Darton, Barnsley. [2183

A SPENCER-WEST television preamplifier will generally effect a considerable improvement in reception for users on the fringe of the service area. This unit, which is completely self-contained and can be used in conjunction with any television receiver, enjoys great popularity. Several of these installed before the war are still giving first-class results. The latest model employs advanced circuit technique to ensure the viewer consistent reception in regions of low field strength; list price 10gns., complete with accessories; ask for leaflet SWTP, which gives full technical details.—Spencer-West, Quay Works, North Quay, Gt. Yarmouth. [2041

BARTONS.—Brand new American B.C.728C, superhet push-button portable receivers, complete with accumulator (2-volt), vibrators, spare valves, etc., uses latest 1.5v valves, with built-in speaker, ideal for car radio or use as domestic portables, £10/10; B.C.342S., brand new, in carrying cases, £18/10; R.A.34, power supply 200-250v, 50 cycles input, 800-1200v, at 350 mas and 5-14v, 14a, L.T., complete with meters and variable control, £8/10, plus carr.; T.U.6B, tuning units, 10/-, carr. 2/4 Please send for latest list with details of these and many other items.—Barton, 41, Bedminster Down Rd., Bristol, 3. [2097

THE now famous Williamson amplifier as manufactured by Radio Trades Manufacturing Co. (Ealing), Ltd., is definitely acknowledged as the world's finest amplifier at a reasonable price (vide numerous testimonials from famous critics), built to specification from real quality components on extra heavy gauge chassis with cover, this amplifier constitutes the finest product in the trade to-day; if you are genuinely searching for quality reproduction your search is ended as we can supply what you want; price complete with cover £27/10; gram. motors, tuners, pre-amplifiers, speakers and pick-ups supplied; trade enquiries invited.—Write or call, R.T.M.C. (Ealing), Ltd., Laurel House, 141, Little Ealing Lane, W.5. Eal. 6962. [2025

UNIVERSAL ELECTRONIC PRODUCTS, 36, Marylebone High St., W.1. Welbeck 4058. Specialists in the design and manufacture of high grade fidelity gramophone reproducers and radio units. If you are interested in obtaining the finest possible reproduction from recorded music we invite you to hear our equipment demonstrated in conjunction with the Wilkins and Wright coil pick-up and the Wharfedale corner cabinet speaker. We will gladly give you a quotation for the conversion of your existing radio gramophone into a first-class reproducing instrument, or for the design and construction of equipment to your own special requirements. Write for descriptive leaflets of our range of fidelity amplifiers and radio tuning units.

GOODSELL, Ltd., 40, Gardner St., Brighton, Sx.—Send 6d for our new booklet giving a few views on high fidelity and full details of the Williamson amplifiers with K.T.66 and PX.25 output, together with particulars of tone control units and high fidelity tuners, PX.4, version, at £17/17/6; also included are kit prices and a complete range of components for the Williamson, plus a general range of useful mains transformers, chokes and condensers, etc.; high fidelity superhet, two-band only, with four-position variable selectivity (see *W.W.*, Sept., 1942), R.F., F.C., I.F. and special detector, with glass scale 9in×4¾in slide rule pattern pointer, full details now available; the quality of this unit is equal to any straight feeder. Five useful books: "The Brimar Valve Manual," 2/6; "Loudspeakers," by G. A. Briggs (Wharfedale), 5/-; "Partridge Manual," 5/-; Denco Bulletins, 3/- each; DBT.1 (Practical Design of Receivers using Maxi-Q Coils), DBT.2 (Design and Layout for Turrets, including new C.T.7 with 5 wavebands and R.F. stage); postage 3d; Denco C.T.6, £4/19/6; C.T.7, £7/2/6; C.T.4, £10/10 ex-stock [1917

RECEIVERS, AMPLIFIERS—SECOND-HAND

HARTLEY latest T.R.F. tuner, unused, perfect; £12.—Box 2318. [2200

M.C.R.1 com. rec., 20-3,000 metres, 97-250v, a.c., d.c., £7/10.—Box 2608. [2291

WILLIAMSON P.X.4 amp'r., with 1 R.F. tuner in cabinet; £18.—Box 2641. [2367

FOR sale, Hallicrafters Sky Champion.—Offers to Maynard, Burnside, East Meon, Hants.

C.R.100 Marconi receiver, 60 kc/s-30 mc/s, excellent cond.; £30 or offer.—Box 2637.

NATIONAL H.R.O. receiver, power pack, coils, spare valves, spkr., exc. cond.; £45. Box 2609.

10-100 M. S.W. 2v battery set, valves, copper chassis, complete working, £3/5.—Harris, 29, Bank St., Braintree. [2216

M.C.R.1 19/2,000 metres, complete with power pack, two sets headphones, £6.—Savage, 69, Yewtree Drive, Chesterfield. [2295

PYE Invicta television receiver, T.L.5, complete with stand to match, good working order; £40 or near offer.—Box 2392. [2222

AS new, Bendix R.A.10 8-valve aircraft receivers, 3 waveband, 2-10 mcs, 200-1,100 kc/s, £4; converted 1155, £8.—Box 2235. [2153

PEERLESS 1148 £52 receiver, perfect cond., complete; offers? elect. gram. motor with p.u., £6.—Booker, Oakenshaw Rd., Walton, Wakefield. [2003

THE IDEA BEHIND THE PERFORMANCE

Some recent letters of appreciation have suggested to us that we don't say much about our attitude to the job we are doing and our relations with our customers. We have never thought of doing so because these things are traditional with us.

The equipment we design, make, and sell is intended to give the best possible musical quality of reproduction. We are constantly being told that we succeed to quite an exceptional degree. So far, so good ; but the thing doesn't rest there, for it is, to our way of thinking, a silly sort of procedure to sell a man some goods and then forget about him until he wants some more goods. The mechanised way of avoiding this is to send out "sales letters," "brochures," " mailing pieces " and whatever else the advertising experts think of. We, however, are allergic to mechanisation, because we are convinced that you can't mechanise what is virtually a fine art. So when you make contact with Hartley-Turner you meet a new idea—the idea that the manufacturer and the customer are partners in an adventure, where each party makes his intelligent contribution to a joint effort.

The apparatus involved is only the (necessary) means to an end ; the end is pleasure to the customer through music in his home, and pleasure to us because we have pleased him. We should like to please you.

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The Hartley-Turner 215 Speaker **£9.**
The T.R.F. Unit **£19/10/-** (Purchase tax in Britain **£4/4/6).**
The 25-watt Amplifier **£39.**
Complete catalogue of data sheets free on request.
Home construction of the T.R.F. unit and amplifier is quite easy with the aid of our Technical Bulletins (**10/-** each) and a complete understanding of the subject of high-fidelity will be found, as its thousands of purchasers will tell you, in " New Notes in Radio." Cheap reprint now available at **2/8**, post free anywhere.

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The Hartley-Turner Selected Record Catalogue, the final answer to the problem " Which records shall I buy ? " Price about 25/-. You cannot afford to be without it.

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G. W. SMITH & Co. (RADIO), Ltd., offers the following sound and guaranteed:—TELEVISION, ex-R.A.F. R.3585 receivers, brand new in sealed boxes, a complete 45mc/s T/V strip using 5T.R.F. stages (E.F. 50s), 1 diode stage (E.A.50), and video stage (E.F.50) in addition to the above there are some 17 other valves, including EF50, VR54, 55, 56 and 65, together with dozens of condensers and resistors, all of useful values, supplied complete with circuit, £5/10; ex-R.A.F. R.1355 receivers for use with type 24, 25, 26 and 27 U.H.F. units, complete with valves, 52/6, make an ideal television line-up; ex-Admiralty Responcer units, type W4790 B, brand new in sealed boxes complete with valves, very little modification needed for a complete vision and sound pack, 52/6 each; television Polythene ½in slugged coil formers with dust cores, 6d, 4/9 dozen; wavemeters, ex-R.A.F., W.1191, brand new in sealed boxes with spare set of valves, coverage 100kc/20mc/s can be used as signal generators, £7; ex-Admiralty wavemeters (Marconi), type G.93 very limited number, less valves, 39/6 each; American crystal multipliers, brand new in sealed boxes complete with 2 807 valves and fitted with 0-10ma meter, 49/6 each; meters, 0-20v a.c., 0-20amp a.c., 0-.5amp thermo, 0-1amp thermo., 0-1.5amp thermo., 0-3amp thermo., 0-6amp thermo., 0-5amp d.c., 7/6 each; 0-20v 0-5ma, 4/9 each; 2-speed S/M dials as fitted to the 27 U.H.F. units, 5/- each; silver mica condensers and resistors, assorted values, 3/- doz.; ex-R.A.F. aerial coupling units, type 39, with 0-3 and 0-6amp thermo. meters and 100-watt dummy aerial, brand new, 7/6 each; rectifiers, 250v 60ma, 3/6 each; 250v 100ma, 4/6 each; 400v 100ma, 5/4; Westectors W.6, 1/- each; G. W. SMITH & Co. (RADIO), Ltd., 3, Lisle St., London, W.C.2. Tel. Gerrard 8204. Open 6 p.m. Saturday. [2255

WIRELESS World 2 R.F. 3 valve quality tuner for use with quality amplifier; £6/10 including valves; new and unused.—Box 1384.

50-watt amplifier, unused, as new, 30gns, offer; speakers, microphones, etc., available.—11, Allandale Cres., Potters Bar, Middx.

SOUND Sales D.X. Plus tuner, six watt quality amplifier, tone control; £30; passed " as new " by makers.—112, Chase Cross Rd., Romford, Essex. [2071

EKCO portable, 4-valve, 2 waveband (1937 model), new H.T. batt., and 2 accumulators, £7.—White, 15, Brunswick Sq., W.C.1 (no callers). [2320a

PYE television chassis with diagrams and parts lists, almost complete with valves; best offer over £12.—H. Sparrow, Ltd., Dept. M., Bishop's Stortford, Herts. [2285

WEBBS W.W. amplifier and radio unit in cabinets, B.T.H. speaker on baffle gram motor and pick-up; £25.—36, Mymms Drive, Brookmans Park, Hatfield. [2257

R1155E 8-valve a.c./d.c. KT33C, modified, £18; Universal radiogram with 8-valve Armstrong chassis, new 1948, £55.—244, Ballards Lane, North Finchley, London. [2096

GRAMPIAN amplifier, A.C.-D.C., complete with pick-up, motor, 2 speakers and microphone, output 12¼ watts, excellent condition; £30.—Redman, 47, Royal College St., N.W.1.

HALLICRAFTERS S36A AM/FM receiver, 27-143mc/s, 145mc/s obtainable, excellent condition, laboratory aligned, offers £40 or exchange SX 28A or AR88.—T. Knight, Caxton House, High St., Hoddesdon. [2294

14 watt quality amplifier (Jeffery circuit, W.W., Aug., 1947), £15; W.W.Q.A. (P.X.4s) with spares, £12/10; Philco 4-v ac/dc portable, £6; Rola G.12, £5; Ferranti P.M. speaker, with P.P.O./T, £4.—Box 2553. [2273

HALLICRAFTERS S-38 a.c./d.c. communications receiver, 6 valves, 540kc/s to 32mc/s, bandspread dial, 18gns; Eddystone " 640 " communications receiver, 31mc/s to 1.7mc/s, 9 valves, latest model, £22/10.—City Sale & Exchange (1929), Ltd., 90-94, Fleet St., E.C.4.

24-TUBE Midwest radio, twin chassis, 3 speakers, 4½-3,000 metres, superb quality, specially trimmed for ultra shortwave reception (beat oscillator built in), £30; fitted in de luxe giant console cabinet with auto record changer, record space and cocktail cabinet, £110.—Parsons, 12, Laings Corner, Mitcham 4296.

1124D R.A.F. receivers with 6 valves, easy to convert for television-sound; complete diagram and gen for conversion, 25/-, carr. pd.; 1224A comm. receivers, brand new, £4/10, carr. pd.; 1155F latest, brand new receivers, £12, carr. pd.; 24-volt motor generators and rotary transformers, 10/- each.—J. Rae, 39, Penn Rd., Wolverhampton. [2342

TELEVISION, H.M.V. model 900, radio and vision, in beautiful condition, 12in tube, £70; television, Murphy model A56V console, in tip-top order, £45; National NC120 receiver, 0.54 to 30 megs, noise limiter and S meter, the National opposite of the AR88, complete, £30; Eddystone 5 and 10 convertor, as new, with valves and coils for 5 and 10, £8.—A. V. Spray, Ninfield Rd., Bexhill-on-Sea. [2138

A.R.88 receiver with spare valves, £65; B.C. 348Q converted mains, modified triode audio stage and 6v6 amplifier, £30, both with S meters, heterodyne signal generator, converted mains, 125kc/s-20,000kc/s, crystal controlled, £15; Radar Monitor, type 25, time cases 2μs and 25μs and R.F. frequency, 150-260mc/s, with spare 4in cathode ray tube, suitable for convertion to oscillograph, £10; circuit diagrams for all; offers considered.—Box 2493. [2245

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U.S.A. make re-entrant horn public address speakers, brand new, with built-in transformer 0-250-500-1,000-2,500 Ω, complete with collapsible 8ft super tripod and universal fitting bracket, nearest equivalent on home market over £20, our price £8/8 c.p. These can also be supplied in sets of four in special fitted transit case for £30 per set, inc case, c.p. FRITH RADIOCRAFT, Ltd. 69-71, Church Gate, Leicester. [2123

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12in R.K. 6v field, with mains energising unit; £5.—67, Dalmally Rd., Croydon.

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VOIGT corner reflector cabinet, twin diaphragm unit, rectifier, like new; best offer over £45.—Box 2499. [2266

HARTLEY-TURNER model 215, almost unused; nearest £8.—Dr. Baldwin, 13, Raleigh Villas, Exmouth, Devon. [2268

VITAVOX K12/10, used one week; £6 or offers.—Hill, "South Berryclose," Doulting, Shepton Mallet, Somerset. [2290

VOIGT domestic speaker, light twin, £50; W. W. Williamson amplifier, £20; dem. given.—5, Gloucester Ave., Slough 22052. [2137

VOIGT light coil twin, Lowther valve rectified power supply, H.C. corner horn and bass chamber by Voigt; all post-war, mint condition; £37/10 plus carriage.—Redington, 101, High St., Barnstaple. [2048

VOIGT domestic corner horn, with cabinet-makers' polished oak facing, complete with Voigt speaker unit and large metal rectifier unit; £65 or close offer.—Servome, 10, St. James' Parade, Muswell Hill, N.10. [2198

BAKER super quality 12in triple cone speaker with Ticonal magnet, complete with infinite baffle cabinet in veneered walnut, 15ohms speech coil; £7/10; new and unused, half original price.—Box 1383. [1764

VOIGT corner horn, special model, in natural light oak veneer, with horn mouth cover, twin light-coil diaphragm, perfect, £55 or offers; another, in dark walnut, French polished, £40.—Brewer, Bethcar St., Ebbw Vale. [2098

B.A.E.C. dynamic corner deflector, £4; 4-station pre-set panel, T.R.F. tuner, £4; Lexington Senior pick-up head for collaro, with Nu-Metal transformer sapphire, £3; all as new. —Trees, Lissoms Rd., Chipstead, Surrey. [2281

WHARFEDALE corner cabinet, nat. oak, dual speakers, crossover 1,000 c.p.s., £35; Rogers reflector type corner cabinet, walnut, less speaker, £26; Goodmans Axiom 12, £6/10; Connoisseur p.u., with trans., £3.—Seymour, 19, Parkhurst Court, N.7. [2058

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E.D.C. convertor, 50 volts D.C. input, output 230 volts 50 cs 400 watts, in cabinet, 230-volt mains rect. for recharging storage accs. for latter.—Aspinwall Radio Service, Windermere.

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D.C. to A.C. motor alternators, 200-250 volts D.C. input, 200-250 volts 50 cyc. 1 ph A.C. output at 200 watts, ball bearings, new; £12/10 each; also new rotary converters with special smoothing equipment up to 500 watts output for television, radiograms, etc.; prices on application.—Johnson Engineering, 319, Kennington Rd., London, S.E.11. Reliance 1412-3. [2191

SANGAMO synchronous motors, self-starting, 200-250v A.C. 50 cycle, consumption 2½ watts, size 2¼in diam, 2in deep, geared 1 rev 60 mins, can be reset to zero by friction drive from front or back, to run clockwise, ideal movements for making electric clocks, time switches, etc., nickel plated finish, complete with 12 to 1 dial train, price 25/- ea, postage 6d; Sangamo as above, final speed, one rev per min, less dial train ideal for darkroom, process timing, etc. price 22/6 each, postage 6d; hour meters, fitted Sangamo synchronous motor, with gear train, one rev 1/10 hours to 10,000 hours' recording, in bakelite cases, ideal for process timing, etc price 35/- each, postage 1/-; large quantities of surplus Naval, Army and Air Force radar, transmitting and receiving apparatus, rotary converters, rectifiers, power units, cathode ray units, relays, meters, motors, etc., etc.; a visit to our premises will not be in vain; s.a.e. for lists. H. FRANKS, Scientific Stores, 58, New Oxford St., London, W.C.1. Tel. Museum 9594. [2243

97/6. charging switchboards, 12v-32v 500 and 1,260 watts, volts, amps, cut-outs, fuses, resistances, etc., 4 take-offs, superb unit, in case, or send £5 carriage paid; 75/-, dynamos, 24 volts, 1,000 watts, 9in×7in, ¾in spindle, or send 80/- carriage paid; 75/- 230v/1/50, ⅓hp electric motors, incorporating 1,260 cycle converter, or send 80/- carriage paid; 58/-, mains transformer switchboards, 230v ac to 12v, 5 separate take-offs, complete distribution panel, all switches, fuses, amps, etc., brand new, or send 60/- carriage paid; 55/-, electric motors, 12v and 24v, ¼hp, 4in×4in, with ½in spindle for drive, beautiful job, or send 60/- carriage paid; 45/-, dynamotor units, containing 12v, 24v, 130v and 300v dc dynamo, or suitable as 6v, 12v or 24v motor, approx. ¼hp, 11in×5in, with spindle to take small grindstone, mop etc., also contain adjustable 24v cut-out automatic voltage control, smoothing condenser, resistances, and many other extremely useful fittings, beautifully made or send 50/- carriage paid; 38/-, radio wavemeters, adustment dial 350-370 Mc/s, beautiful instrument in case or send 40/- carriage paid; host other valuable equipment; lists free.—Benmotors, Summerley St., Earlsfield, S.W.18. Wim. 3833. (100 yds S. Rly. Electric Line; 10 minutes Waterloo.)

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TAYLOR 65B sig. generators, almost new; £12.—Hawkins, 88, Inderwick Rd., N.8.

MARCONI TF144 signal generator, almost new, complete in case; £65.—Box 2617.

AVO R. & C. bridge and D.C. Avo Minor; £8.—Dawson, 101, Harwood Rd., Rishton, Lancs.

COSSOR double beam C.R.O., almost new, £48 or offer; seen Esher, Surrey.—Box 2422.

OSCILLOSCOPE, Taylor 30, brand new; £25—61, Broadstone Rd., Yardley, B'gham, 26.

WEE Megger, 250v, leather case, as new; £. —Lynas, Tunstall Rectory, Sittingbourne

EKCO television pattern generator; £10.—Lash, 17, Westhurst Drive, Chislehurst. Imp. 1243. [2234

SALE, test equipment, Avometers, Avominors, testers, signal generators, big reductions; list s.a.e.—Young, 134, Old Shoreham Rd., Southwick, Sussex [1931

COSSOR D.B. Oscillograph 339 (new), best offer over £40; also ganging oscillator 343, best offer over £35.—Meldrum White Lodge, Fyling Hall, Whitby. [2236

E.M.I. 20,000 O.P.V. analyser, complete with case and booklet, £17; special crystal controlled beat frequency audio oscillator, £45; details, s.a.e.; 2 unused 12volt 2½amp F.W rectifiers, 15/- each.—Box 2554. [2276

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SIGNAL generator Model 999, 100 kcs-50 mcs, large scale 10×5¼ inches new type attenuator, special internal filtering individual calibration, better than 1%, £13/17/6, hire purchase available; stamp for details.—Radio Development Co., Moretonhampstead, Devon. [2034

FOR sale. Lexington Senior P.U. with transformer, 75/-; 10 2mfd. 2,000v Dubilier type 951, 9/- each; 2 E.D.C. rotary converters in cases. 50v d.c. and 100v d.c. inputs, both 230v a.c., 180 watt output. £9 each; P.A. outfit with 8 speakers, details on request, £20.—Macrae & Dick, Ltd., Academy St., Inverness. [2236

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A.C. gram. motors, 200-250v 9in t.t., 75/-; Collaro ditto with 12in t.t. and variable speed, 118/4d; Collaro ditto but with universal autostop, £7/6/3; Collaro combined unit-motor/mag. pickup/autostop a.c., £9; a.c./d.c. £12/18/9; ditto with crystal pickup (a.c.), £10/7/10; Plesey new model super quick-action a.c. mixed record changer with magnetic pickup, £18/9/6; Collaro ditto, £22; 4watt audio amplifiers, pickup and tuner inputs, volume, tone and neg. feedback controls, £5/19/6; bargain list, 2½d.—N.R.S., 102, Parkhill Rd., London, N.W.3. Gulliver 1453. [2392

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A DIAMOND stylus finished to such fine limits is necessarily expensive and, in actual fact, accounts for three-quarters of the price of £29/5 for the Enock Pick-up (Patent No. 538058, others pending).

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COMPONENTS—SECOND-HAND, SURPLUS

12V OAK vibrators, UX4, base, V6612; 5/- ea. post pd.—Electron Wks., 92, East Ham, E.6.

AIRBORNE radar T.X. inc H.P. pulse magnetron, £5; 3 core 0.3A line cord, 1/2 yd.—Mort, 42, Barn Lane, Golborne, Lancs. [2388

SUPPRESSORS cont. 8 .1μf 350v condensers, 1/- post free; quantities at reduced rates.—Smith, Highworth Rd., Faringdon, Berks. [1850

50 ½ resistors, 5/6; 0.1μf, 3/- doz.; octal holders, 3d.; mains volts panels and fuse, 9d.—J. Sparrow, 28, Lancaster Gdns., Clacton.

CHASSIS, undrilled dural, 2½in. deep, 9in.×7in. 6/6, 12in.×8in. 8/-, 14in.×9in. 9/-, 20in.×10in. 10/6, post free.—"Vincent's," 22, Pine Grove, Sheringham, Norfolk. [2088

MAKERS' surplus.—New t.r.f. coil assemblies, aerial and HFT, 100-2,000 metres, selective, 10/- pair; h.f. chokes, 3/-.—Schooner Marine, 51, St. Mary St., Bridgwater. [2169

OUTPUT transformer, mains transformer and smoothing chokes for Williamson amplifier to exact specification, full standard range.—Send for details to Dupley Electronics, Ltd., Cranmer Av., W.13. Ealing 5688. [1934

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CLEARANCE offer, rotary converters, 7/6 post free; brand new boxed, ex-Govt. 12v input 250v and 6v output, or can be reversed. limited quantity. cannot repeat.—Joslin 97, Southsea Ave., Leigh-on-Sea, Essex. [2171

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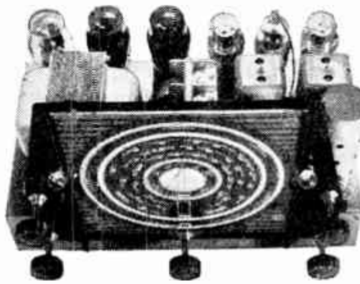

ADDITIONAL REFINEMENTS

have been incorporated in *Armstrong Model RF103* for the Coming Season as under.

2 stages of I.F. amplification with variable selectivity, a remodelled coil pack with permeability iron cored coils and a tuning indicator of the cathode ray type. The chassis in future will be known as :

Model RF103 Type 2. 10-VALVE ALL WAVE CHASSIS WITH VARIABLE SELECTIVITY. 10-valve (including C.R. valve) circuit R.F. Pre-amplifier, 2 stages I.F. with variable selectivity, Wave band expansion (short wave band covers over 20"), large glass scale. 10 watts push-pull output. For 200-250 v. A.C. mains. Price 19 gns. plus tax.

SPECIAL NOTICE

MODELS EXP83 and UNI83 briefly described hereunder now incorporate a remodelled coil pack with permeability iron cored coils giving increased selectivity and sensitivity and a new tone compensating circuit to still further increase quality of reproduction

Model EXP83. 8-VALVE ALL-WAVE RADIO CHASSIS incorporating waveband expansion. Large glass scale. Treble boost control. High quality push-pull output gives 10 watts audio. For 200-250 v. A.C. mains. Price £15. 8. 8. Plus Tax.

Model UNI-83. 8-VALVE ALL-WAVE RADIO CHASSIS incorporating waveband expansion, e.g. the 16-50 m. band covers just over 20 inches on the large glass scale, treble boost control, high quality push-pull output giving 6 watts audio. For 200-250 v. D.C. or A.C. mains. Price £15. 8. 8. Plus Tax.

Model EXP125. 14-VALVE ALL-WAVE RADIO CHASSIS giving continuous waveband coverage from 11.9 m. upwards. Waveband expansion. R.F. Pre-amplifier. Two I.F. stages with variable selectivity. Electronic bass and treble lift controls. 15 watt push-pull output. For 200-250 v. A.C. mains.

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A limited number of the above is available to our friends at home, and we shall be glad to send details and to give demonstrations at ourshowrooms

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WARLTERS ROAD, HOLLOWAY, LONDON, N.7
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WONDERFUL opportunity; moving coil microphone inserts, brand new, 2/- each; cash with order; limited number available.—Write now to Douglas Benjamin, 1, White Conduit St., N.1.

E.H.T. transformers, mains transformers and chokes for electronic engineering home-built televisor; delivery ex-stock.—Metropolitan Radio Service Co., 1021, Finchley Rd., N.W.11. Tel. Speedwell 3000. [1678A

TELEVISION scanning coil assemblies, as used in our own equipment, suitable for "Wireless World" receiver design, high impedance frame coils, low impedance line coils; 32/- ex-works.—Clive Courtenay & Co., Ltd., 5, Horsham Rd., Dorking, Surrey. [1579

COIL sets in container to plug into Model RU19 U.S.A. aircraft receiver; 65 sets, 850-1,330 kc, 9/6 each; 34 sets, 9,050-13,575 kc, 4/6 each; 20 sets, with switch, 540-830 kc, and 5,200-7,700 ks, 6/- each; cash with order.—Bush, 14, Leigh Rd., Worthing, Sussex. [2182

150 transformers (real), primary 200/250, secondary 47/51v; at 1.2 amps, screen primary and shrouded, price 5/- each, postage and packing 1/-; in lots of 12, 4/- each.—South Wales Engineering Supply Co., Pembroke Buildings, Cambrian Place, Swansea. [2241

THE pioneer manufacturers of the Williamson amplifier offer finest quality set of transformers and chokes at £8 15. inc. car.; fully shrouded, beautifully made and guaranteed.—R.T.M.C., Ltd., 141, Little Ealing Lane, W.5. (See advert. under Amplifiers.) [2370

AMAZING bargain.—9/6, complete kit of parts for 3 W.B. superhet coil pack, including Yaxley type, coils chassis, trimmers, etc., i.f.t.s 465, 7/6 pr; droppers, 2/9; send for cheapest list in England.—Sussex Electronics, Ltd. (G.), Bevendean, Brighton, 7. Tel. 4446. [2143

PANEL indicator lamps, blue or red, 9d; toggle switches, 3amp 250v, 1/-; unspillable accumulators, 2v, 9/6; rotary uniselector switches, 12/6; telescopic masts, 15ft, 10/6; control panel of 16 switches, 5/6; post extra; list available.—Stansfield, Aireworth Terrace, Keighley. [2298

LITTLEWOODS.—Filament transformers, 6-volt 1½ amps, 8/6; selenium rectifiers, 250v 40 mA, 3/6; both ideal for t.r.f. set; t.r.f. coils, combined m.w. and l.w., 4/6 pair; i.f. transformers, high gain, 465 kc/s, 9/- pair.—G. Henson, Littlewood & Co., 27, Ballards Lane, Finchley, London, N.3. Fin. 3060. [2145

SELSYN motors for remote control of beams, etc., wt 4lb, torque 1½in lb, as brand new, in sealed tins, with instructions; set of 3 motors to work direct from 230v a.c. (in series), £3/10/6; moving coil microphones, each with 1 pr m.c. headphones, brand new, boxed, 4/6, post 9d.—Logan, 1, West Alley, Hitchin, Herts. [2060

G.L.G. RADIO offer high-class metalwork at competitive prices; aluminium chassis, panels, etc., plain or punched, bright, plain grey, or black crackle finish; single or repetition; trade supplied; large stocks new and surplus components; lists ready; send stamp; Woden components from stk.—15, Halcyon Rd., Newton Abbot.

SALE of surplus stock; valve-holders, moulded, 25/6 100; Paxolin, 16/8 100; multicore sheathed cable, 5 to 9 core, from £7 1,000 yds; 1,000 yds; 7/36 P.B., £1/10; 1,000 yds; 4-pole, 2-way switches, 6/- doz; 1-pole, 12-way switches, 12/- doz; special 9-pin plugs and sockets, £1 per 100 pr.; sleeving, chokes, resistors, etc.—Apply 40, South Molton Lane, W.1. Tel. May. 5833. [2253

TRANSFORMERS, special quality, tropicalised, 6½in×6½in×7in, 230v primaries, secondary 350-0-350v at 300ma, 20-0-20v, 2×6.3v, 5v, 37/6; secondary, 2×350-0-350v at 200ma, 2×6.3v C.T., 2×5v, 6.3v, 55/-, carriage 5/-; primary tapped 200-250v, secondary 500-0-500v at 120ma, 3×4v C.T., 10v, 32/6; 350ma L.F. chokes, 20 -; many other items, s.a.e. list.—Cross, Skerries, Cross Lane, Grange, West Kirby, Cheshire.

COMPONENTS for West Country amateurs: Eddyston 640 Ham receiver, cash £27/10, or terms; meters, 1ma mc 2in Rd. Fl. Weston, 9/6; 5ma Sq. Fl. Weston, 10/-; 100ma do., 10/-; holders, Br. 5-pin amph., 6d; Int. oct. pax., 4d; int. oct. amph., 6d.; condensers, .01-350v, 7d; .1-350v, do., 8d; Solar oil-filled blocks, 0.1 or 0.25-600v, 1/3; 25pF ceramic A/S trimmers, 9d.; 50 pF ceramic tuning, 1/-; c.w.o. only; add postage on orders under 30/-; s.a.e. for lists.—G. N. Pill & Partners, 49, Cobourg St., Plymouth.

TELRAD ELECTRONICS, 70, Church Rd., Upper Norwood, London, S.E.19.—Brand new 2-gang condensers, 0.0005mfd, 8/-; midget with trim, 15/-; J.B. with trim, 13/3; 3-gang 0.00016 mfd with trim, 17/6; 4-gang 0.00036 or 0.0005mfd with trim, 26/6; loudspeakers, less trans., 3½in, 12/6; Rola 4in, 18/-; 5in, 23/6; 6in, 23/6; 6½in, 27/6; Rola 8in, 24/-; 10in, 30/-; Celestion 8in, 30/-; 10in, 45/-; 12in P44, 75/-; M.E. with pen. trans., 8in, 1,500 or 2,000ohms field, 36/-; 10in, 2,000ohms field, 54/-.

NEW ex-Govt. bargains! Send 1d s.a.e. for our list before buying! A few examples: Headphones, double, Bal. Armature units, Reed driven alumn. diaphragms, adjustable double headbands with 8ft cords and jack-plug, d.c. resistance 60 ohms, but ideal for Xtal sets, note these are brand new, boxed, super-sensitive instruments worth 2 guineas! Our price, 5/6 pr, 2 pairs 10/-; trade: 10 prs. @ 3/6, 100 prs. @ 3/-, 1,000 prs. @ 2/6; rectifiers, metal, 12 volt 1 amp, brand new, 2 for 10/-, or 10 for £2; vibrators, 6 volt, non-synchronous 629C, 5/6 ea, 48/- doz, £21 gross.—A. C., Ltd., 15, Lawrence St., Northampton. [1912

RAYMAX are your suppliers for radio television and gramophone equipment, components kits and chassis; all at prices you can afford; all necessary items, including cabinets, for player or auto table radiograms; stamp for general list or state your requirements.—Raymax Elec. Co., Ltd., 126, Norwood Rd., S.E.24.

TELEVISION pre-amplifiers, R.F.1 6F.12, 2 tuned stages coaxial coupled, 40-48mc/s. flying leads, 6.3 heater, 200 h.t., £2/12/6; R.F.2 6 F.12s, 3 tuned stages, £3/12/6; E.H.T. transformers, pri. 200-250sec, 2-4-6volt taps, 5,000v d.c., 5m.a., £3/6; power trans., 350×350v, 280m.a., 6v 6a., 4v 8a, £3/18/6; choke 1, 250m.a. 5h, £2/5; choke 2, 80m.a. 10h, £1/5; coax. cable B.1 television, 1/3 per yd.; anti-static coax. ⅜in diameter neoprene with copper braiding, 1/2 per yd.—Boscombe Radio & Electric, 595, Christchurch Rd., Boscombe. [2341

AMATEUR has surplus to requirements.—Genuine B2 ceramic coil formers, 1/6; 0.0001 V/condensers with long spindles, ideal C.O. or buffer, 3/6; R.F. meters, lamp, 4/6; E.F.50 valve holders, micalex, 6d; 5-core metal shielded maroon cotton covered cable, 1/6 yd; h.t. cable, as used sparking plugs, 6d yd; 250ohm 25w vitreous resisters, 6d; round jack plugs, 3d; Nife batteries, 11 units delivering 26 volts at 125amps, weight about 2cwt, £26; small single units delivering 1.3 volts, size 6in×1⅜in sq, weight about 1lb, 2/6 each; please add little for carriage; large batteries to be collected by purchaser.—G2FXK, 82, Walsall Rd., Aldridge.

HARRY JAMES PRODUCTIONS, 270, Leith Walk, Edinburgh, 6.—Mail order specialists, c.o.d. or cash with order; electrolytics, new, not W.D. surplus, 8mfds 3/2, 16mfds 5/3, 16+8mfds 6/3, 8-8mfds 6/-, 4mfds 2/9, 25mfds 25v 2/-, 50mfds 50v 2/9; T.R.F. chassis, 3/6; T.R.F. coils, M. & L., 7/9 pair; condensers, 0.1, 0.01, 0.05, 500v 8d each; variable 2 gang, 0.0005, 12/-, with trimmers, 13/6; loudspeakers, 5in P.M., 19/6; 6½in energised 1,000 ohms, 29/6; 8in P.M., 25/-; volume controls, long spindle, W/S, 5/6; L/S, 3/6; mains transformers, 350-0-350 6.3v and 5v or 4v heaters, 30/-; output multi ratio, 9/-; valve holders, 5-pin, 7 and octal, 7d each; amphenol type, 9d each; voltage droppers, 0.2 amp 1,000 ohms, 3/9; 0.3 amp 800 ohms, 4/9; line cord, best quality, 0.3 amp 3-core, 9d per ft; special offer, 0-1 milliamp, metres, suitable for multi meters, etc., price 12/6; enquire for anything in radio; s.a.e. for lists. [1553

SELENIUM rectifiers, charger kits, etc., new goods, not surplus; add 7d. postage up to 15/-, 1/4 above; latest type selenium rectifiers for L.T. packs, chargers, etc., data sheet supplied with each rectifier; 15v 1amp 10/6, 15v 2amp 12/6, 15v 3amp 21/-, 15v 4amp 25/-, 24v 2.5a 35/6, 24v 5a 45/-; also trickle charger types, 6v 0.5amp 5/6, 6v 2amp 9/6, 15v 0.5amp 7/6; giant finned type rectifiers, 15v 6amp 33/-, 6v 10amp 26/-; H.T. types, 250v 60ma, small space selenium for a.c., d.c. sets, 7/-; ditto 110v 60ma for U.S.A. midgets, 7/-; 120v 20ma eliminator rects., 7/-; 350-0-350 80ma, 13/6; 250v 100ma, full wave bridge type, 13/6; de luxe, high quality charger kits, data sheet supplied, fully guaranteed standard kit, 15v 3amp S.T.C. rectifier with 50-watt interleaved and impregnated transformer and ballast bulb for 2v to 12v charger, 45/-, or with specially manufactured, black crackled, louvred, steel case and all small hardware, 62/-; ditto but 12v 2amp rectifier, 40-watt trans. and ballast bulb, 36/6, with case and hardware 52/-; ditto 6v 2a rectifier, with trans. and ballast bulb, 35/-, or with case and hardware, 50/-; medium duty kit, 15v 4a rectifier, with 75-watt transformer and ballast bulb for 6v 12v charger, 62/-, or with handsome steel case and all small parts, 80/-; heavy duty transformer, 140 watts with 15v 6amp rectifier for 6v, 12v charger, 75/-, or with slider resistance and high-grade 0-6 ammeter, £5.—Champion, 43, Uplands Way, London, N.21. Tel. Lab. 4457. [2384

AERIAL insulators, 2 link, 4d, 3/- doz; 3 link 6d, 4/6 doz; Pyrex 1/- ea., 9/- doz; crystals, 3.780, 3.720, 3.760, 4/6 ea.; 8+16 electrolytics, 450/350 V.W., 2/6, 24/- doz; lead acid hydrometers, 1/6, 12/- doz; condensers, 0.01 tubular, 2/- doz, 18/- gross; 0.01 mica, 4d, 3/6 doz; 1mfd, 1/- doz.; 0.5mfd, 2mfd, 1/6 doz.; 0.1 350 V.W., American metal tubulars, 5 for 2/6, 5/- doz.; ditto 200 V.W., 3/6 doz.; 10mfd, 600 V.W. compact American oil filled, 5/-; 2mfd, 4,000 V.W. ditto, 7/6; 2mfd, 2,000 volt ditto, 3/9; ceramic variables, 75 p.f., long spindle, 1/9; 5 p.f., 15 p.f. split stator, 1/9; rectifiers, 12v 1½a, 6/-; transformers, 100-250 volt in, 1 to 26v out, 7 amps, 25/-; iron selenium rectifiers, 12v 6a, 15/-; bakelite enclosed M.E.S. panel lamps, 4/- doz., 36/- gross; S.P.S.T. toggle switches, 1/-; U.S.W. chokes, 3d; boxed meters, 5 m.a., 2½in, 5/-; 9 amp 3½in, 4/-; E.F.50 holders, 4d; pots 50K w. wound, 500K long spindle, 2/6 ea.; co-ax. plugs and sockets, 9d pr.; 2p 6-way miniature Yaxley types, 1/3; 524G, GTIC, 5R4G (selected 5U4), 6/- ea.; VR137, EFSD, 4/6; 2¾in vernier dials, 0-100, chromed, 2/6; multi-purpose 50 cy. transformers, 220v, 45v, 6.3v, 5v windings, bargain price, 4/6; 6 new assorted tag panels, approx. 30 useful components, 3/6; new ½-2 watt resistors, our assortment, 2/- doz.; ditto, good used, 1/3 doz.; condensers including 0.1mfd, etc., new assorted, 2/- doz.; condensers, good used, 1/3 doz.; Westectors, W6, WX6, 6/- doz.; 2½in voltmeters, 9-16v, scaled for 12v acc. charging, moving coil, 2/-, 18/- doz.; money refunded if not satisfied; include postage under 10/-.—The Amateurs Den, 181, Lake Rd., Portsmouth. [2264

EX-GOVT. switchboxes, 7×4×2, with 16 on/off snap toggles, mes. holder, etc., 4/9; control panels, U.S.A., black crackle, contain 2 high-grade on/off plus 6-way switch, 5 multi-way sockets, complete with plugs, 3/9; heavy duty 3-position rotary switches, pointer knob, 7/6 dozen; miniature 12volt electric motors, a.c.-d.c., roller bearings, 7/6; lampholders, 1/6 dozen; 6.2v 0.3a bulbs, 4/6 dozen; Mk III reflector gunsights, contains 3 lenses, lamphouse with rheostat S.B.C. lampholder, 4/6; no lists.—Passingham (Dept. W.W.), North St., Keighley.

CERAMIC condensers, most sizes, 2 pf to 350 pf, silver and standard mica most sizes to 6,000 pf., all at 2/3 per doz; type 577 0.01/2,000v mica plated cases, metal case electrolytics, 50mf/25v 20mf/50v micropacks, 10mf/25v, all at 9d, 7/6 doz; U.S.A. metal tubulars 0.1/350 0.01/1,000 waxed, 0.15/450, all at 3/- doz; 0.1/1,000, 4/- doz; wafer switches, silvered double contacts, 2p 4w 4b 2/6, rotary DPST, 1/6, group boards, 21 way, 1/3, 4-way 3/6 doz; Mansbridge condensers, 2mf/400, 12/- doz, 4mf/700v, 8mf/400v, 2/6. Please add postage.—J.E.L. Postal Supplies, 133, St. James Rd., Blackburn.

WHY convert surplus gear? 30volt primary tapping with selenium bridge rectifier gives 24volts d.c.; any bridge assembly possible at 2d. per watt. Examples: 24v 1a 4/-, 10a 40/-, ¼a 600v 25/-, 1,200v 50/-. New vitreous resistors, 1 to 75k ohms: 30watts 1/3, 75w 1/6, 100w 1/9, 200w 2/-, 300w 2/3. Type 4 power buzzer and suppressors, 3/6; junction boxes, 8×3×2in, 9d.; brass side entry terminals, 1½d.; modulators, type 16, 100w, 5KT44, etc., £3; switchboard, 10 line, £3; B.S.R. P.A.10 amplifier, as new, £15; 24v 6a charger, 2 meters, etc., £6, c.f.; control panels, type 363, 7/6; Fairylite sets, 25/-; mains suppressors, 4 section cast case, dust iron cores, 16s.w.g., 4 conds., 5/- ea.; 10×8mf 750 wkg. oil conds., 3/-; 30v bias packs for AB2 modulators, 55/-; no c.o.d.—69, Allerton grange Way, Leeds, 7. Tel. 66146. [2369

RADIOELECTRON, 22, Frances St., Scunthorpe, Lincs.—New goods only, no W.D. surplus goods; Belling Winrod aerials, 19/6; condensers tub, up to .0005 7d, up to .005 8d, up to .1 11d, 1mfd 2/2, 2 mfd 2/9, 4mfd 3/4; electrolytic, 8mfd 3/9, 8-8mfd 5/9, 7-16mfd 6/3; 5OX50V, 2/9; 25X25V, 2/2; tuning conds, 1 gang 4/3, 2-gang 11/-; drum drives with spring and cord, 3/-; epicyclic drives, 3/-; volume controls, lg spdls, L/s 3/3, W/s 5/-; resistances, carbon, ½-watt 5d, 1-watt 8d; mains droppers, .2 amp, 1,000KΩ, 4/4; .3 amp, 800Ω, 4/11, all with ft and 2 sliders; loudspeakers, P.M., 5in 14/-, 8in 17/-, 10in 25/-; mains transformers, interleaved and impregnated, 200/230/250v mains, 250-0-250v of 350-0-350v, 100ma, 6.3v and 5v or 4v heaters, 29/6; output triode and pen, 5/6; universal, 7/3; valve holders, Eng 5- and 7-pin, 6d; Oct 7d, U.X. 4-, 5-, 6-, 7-pin 6d, Mazda Oct 6d, side cont 1/-; Nylon drive cord, 7d yd; Westinghouse 1ma rectifiers, 10/6; Pifco all-in-one test meters, 25/-; terms, cash with order; orders over 10/- post free, under add 4d c.o.d. extra; 2½d stamp will bring you a copy of our latest list. [2035

SELENIUM rectifiers, 600v 40ma, 3/3 ea., 30/- doz.; 500v 80ma, 5/6 ea., 52/- doz.; 250v 50ma, 3/6 ea., 33/- doz.; 90ma, 5/3 ea., 49/6 doz.; 100ma, 5/6 ea.; 6-12v ½amp, 1/6 ea., 14/- doz.; electrolytics, 32mfd, 350v, cans 3/3 ea., 33/- doz; 8-16mfd 450v, cans 5/- ea., 47/- doz.; 8-8mfd 500v, cans 4/3 ea., 43/- doz.; 8mfd 500v tubulars 2/9 ea., 27/- doz, 12mfd 50v tubulars 12/- doz.; 25-25v micropack, 1/4 ea., 11/9 doz.; tubular condensers, .01mfd 350v, 3/- doz., 32/- gross; 1mfd 500v, 4/6 doz.; vibrators, 6 and 12v 4-pin, 4/6 ea., 42/- doz.; smoothing chokes, 60-70ma 350ohms, 4/3 ea., 43/- doz.; midget pentode output transformers, 40:1 35ma, 3/- ea., 30/- doz.; mains transformers (fully shrouded), screened primary, 200-250v, secs., 350-0-350v 100ma 6.3v, 3a, 5v 2a, 22/9 ea.; half-shrouded, 275-0-275v 6.3v 3a, 5v 2a, 18/11 ea.; mains droppers, .2a 950ohms, 3/6 ea., 33/6 doz.; metway fully shrouded, .3a 750ohms, 3/11 ea.; P.M. speakers, 2-3ohms, l.t. 5in, 10/11, 8in 15/-, 10in 18/9; all best makes; c.w.o. or c.o.d.; postage extra under £2; send 2½d stamp for bargain list; trade supplied.—Radio Supply Co., 15 Queen Sq., Leeds, 2. [2319

RODING LABORATORIES (ELECTRONICS). —Following numerous requests for coil packs, I.F.T.s, gangs, dials, etc., to be aligned and matched, we are offering the famous range of L.T.C. products either (a) wired and tested, or (b) completely aligned and gain tested (465 Kc I.F.); Model 30.3 wave s'het coil pack, 21/- or 24/-, aligned and gain tested; PB30—same with pushbuttons incl. gram. switching, 30/- or 35/- a. and g.t.; Model 40 as 30 but with r.f. stage, 2gns or 49/6 a. and g.t.; the new midget pack (1½in cube!) 2-wave with gram., 21/- or 24/- a. and g.t.; I.F.T.s, 5/- ea or 5/6 a. and g.t.; 0.0005 2 gang (matched), 8/6; 3 colour dials, 3/6; whether beginner or "old sweat" you will find something of use in the famous "Home Constructor's Handbook"—the 2/6 book we are offering for only four 2½d stamps! Contains valuable circuits, data, hints and tips, etc. Special offer manufacturers' surplus, as new, cannot repeat! 5in Truvax P.M., 10/-; 6½in Plessey P.M. with T., 12/6; 8in M.E. (1,250 ohms), with T. 15/-; 10in Plessey M.E. (1,250 ohms) with T. 21/-; horiz. glass dials, 10/- doz; L.F. trans., 11/6 doz; etc., etc., hundreds of items; send stamp for list; pl. incl. postage under £2; mail order only.—Roding Laboratories, Dept. W, 70, Lord Ave., Ilford. [2380

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FRITH RADIOCRAFT, Ltd., Leicester, offer: HRO coils, complete sets covering 50kc/s to 30 mc/s, with bandspread ham bands, £15; general coverage all coils, £12, c. pd.; U.S.A. field telephones complete with streamline mike/tel handset, 35/- plus 1/3 post; I.F. transformers dust cores, 455kc/s, 7/6 pair, plus 6d post; 4-gang tuning condensers, .0005 small size, 5/- plus 9d post; 2-gang ditto, .0005 midget for personal sets, 12/6, plus 6d post; Thordarson chokes, 12H 175ma, weight 11lb, 21/-, plus 1/6 post; ditto, 12H 400ma, weight 28lb, 30/-, plus 4/6 carriage; R.C.A. chokes, 50H, 670ma, weight 200lb, £5, carr. for.; Universal selector switch, 16 pole, 16 ways on each pole, similar to AVO valve-tester switch, 16 independent roller switches will make any combination, 5/-, plus 9d post; 8mfd 600vw paper condensers, metal can type 4in×2in×4½in high, 5/-, plus 6d post; miniature tubular electrolytics, all one size, 2¾in×1in, 8/450vw, 4/6; 16/450vw, 5/9; 8+8/450vw, 6/-; 16+16/350vw, 7/-; 32+32/250vw 7/6; post 3d each or dozen lots, asstd., post free; latest lists free on request; satisfaction guaranteed or cash refunded without question. FRITH RADIOCRAFT, Ltd., 69-71, Churchgate, Leicester. [2389

TELEVISION branded components exact to E.E. designers specifications, vision chassis fitted valveholders, coil formers, 22/6; sound ditto chassis, 18/6; time base ditto, 18/6; power ditto chassis, 25/-; set Gantrys, clips, control panel, 10/-; complete chassis assembly with gantrys, etc., £4/14/6; Aden deflector coil assembly, 32/6; line transformer, 32/6; focus coil, 32/6; set 8 coils, fully wound, 15/-; Hunts 0.1 mfd tubular condenser with clip, 7,000 v.w. 14,000v test, 19/6; rubber mask for 9in tube, 11/-; Magnavista screen enlarger, 6gns; co-axial cable, 1/3 per yard; Ultra midget 2-gang variable condenser for personal portables, 10/-; glass, s.m.l. dial, 6×8in 4/6, pan 4/6, escutcheon 5/6; 8in P.M., less trans., 17/6; 6½in P.M., with trans., 22/6; P.P. output heavy duty trans. for 6L6 valves, tapped output 15 and 7.5 and ditto for 6V6 valves at 21/- each; American throat microphones, boxed, 3/- each; condensers, 8 mfd 450v at 2/6, 8 mfd 350v 2/-, 8 plus 16 mfd 450v 5/6; trimmer kit in smart case, 17 tools Qualrad, 45/-; heavy duty variable resistance, 300 ohms, lamp, 15/-; rotary trans. in 6-12v, out, 200-480v 50 Ma, or as motor d.c. mains, 15/-; Collaro a.c./d.c. gram. motor and P.U. on plate, £12/17/6; 4-pin vibrators, 6v, 6/-; switches, Yaxley type 3-pole 2-way 2/-, 4-pole 3-way 3/-, 4-pole 4-way 3/6, 6-pole 4-way 4/6; 14-pole 3-way 7/6; midget switches 4-pole 3-way 3/-; 4-pole 2-way 3/-; enamelled copper wire, various gauges in ¼lb reels; tinned copper wire, 18, 20, 22 at 1/6 per ¼lb reel; full list at 2½d postage all orders.—O. Greenlick, Ltd., 265, Whitechapel Rd., London, E.1. Bis. 5079. [2377

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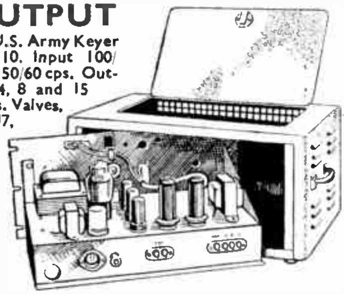

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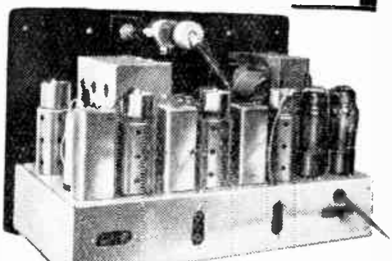

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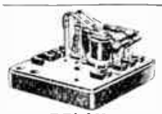

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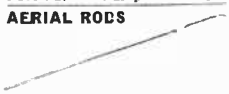

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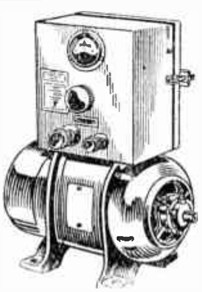

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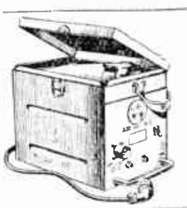

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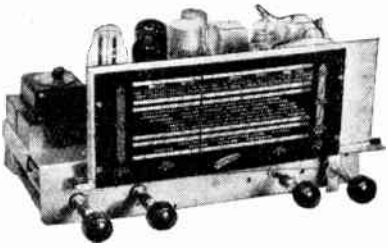

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TIME switches, partly used, 14-day, 5-amp. 0 to 250 volts a.c., clockwork time switches, excellent condition, £2; mercury sealed tube 10-amp type, £2/10; cash with order.—J. Donohoe, 2, Upper Norfolk St., North Shields [1172

"PROCEEDINGS I.R.E." (N.Y.), 1941-47, £14; "Electronics" (N.Y.), March, 1943, to December, 1947, £9/10. Of interest as a record of tel. development; "Television," later "Electronics and Television," 1934-40, £7; "Practical Television," 1934-35 (only 15 numbers), 15/-; "Journal Television Society," 1939, Vol. 3 to Vol. 5, No. 3 (current), £4/10, unbound.—31, Wilmington Way, Brighton, 6, Sussex. [2089

TELEVISION hams make a neat job of that VCR97 receiver; we offer VCR97/1 chassis size 16×12×2½ fitted 6 EF50 valveholders with space for tube and strip type vision and sound panels, price 17/6; VCR97/2, as above, but for use with separate receiver size, 16×12×2½, 15/-; send for our lists of television and radio components.—Television and Radio Developments, 3, Saracens Head, Newark, Notts. [2372

TECHNICAL information and advice.—Enquiries are invited from those requiring information or advice on technical matters relating to radio and light electrical engineering; bibliographies, abstracts and reports prepared on all technical subjects; recommendations made to those wishing to obtain standard or non-standard equipment and components; overseas enquiries are particularly invited.—Michael C. Johnson, Assoc. Brit. I.R.E., 110, Norbiton Hall, Kingston-on-Thames, Surrey. [2254

SITUATIONS VACANT

Vacancies advertised are restricted to persons or employments excepted from the provisions of the Control of Engagements Order, 1947.

RADIO and television service engineer required; good salary and permanency to capable man.—Killbourn, Abingdon, Berks.

RADIO and television service engineer, age 20 to 25 yrs., able to drive, required for London S.W. area; state qualifications and salary.—Box 2320. [2204

REQUIRED for S.W. England, engineer for design and production of electronic apparatus; wide knowledge of C.R.T. practice essential.—Box 2498. [2262

ENGINEERS required, with experience in all branches of television transmission and reception; specialisation in some of the following subjects is essential:—
(1) Wide-bandwith, medium and low power transmission.
(2) Video amplifier design.
(3) Sync and scanning generators.
APPLICANTS should have had some years' laboratory experience in the subjects outlined, and preference will be given to those holding recognised academic qualifications; London area.—Apply in confidence, giving age, details of education and experience, and salary required, to Box 1375. [1738

A SALES engineer required with experience of modern air radio technical and operational practice and a sound knowledge of I.C.A.O. reqs.—Write, quoting Ref. 148, to Box 2388.

RADIO service engineer required for N.W. London, television experience, able to drive, must have considerable experience of servicing domestic receivers.—Give full details in reply to Box 2239. [2164

A SENIOR electronic engineer required for circuit work on industrial equipment in the Midlands; salary range £600-£1,000.—Send details of age, qualifications and experience, quoting ref. 144, to Box 2234. [2151

ELECTRICAL engineer, with a good degree or equivalent and experience in design and development of electronic equipment, required by N.E. London firm; salary according to ability and experience.—Box 2557. [2282

BATTERY charger designer/engineer required on development work for production and special types, both valve and metal.—Apply, Personnel Manager, Edison Swan Electric Co., Ltd., Ponders End, Enfield, Middx. [2336

SENIOR design draughtsman required for radio and television, previous experience on advanced development and design work essential.—Apply Personnel Manager, Dynatron Radio, Ltd., Ray Lea Rd., Maidenhead, Berks. [2176

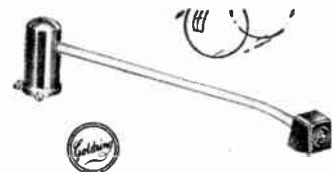
BUSH RADIO, Ltd., require engineers for development work in their test gear dept.; applications in writing only, stating experience, qualifications, salary, etc., to Labour Manager, Bush Radio, Ltd., Power Rd., Chiswick, W.4.

RADIO draughtsmen required by large light engineering company, North London; applicants with knowledge of electronics equipment design preferred, but practical shop and drawing office experience essential.—Write Box 2229.

SENIOR mechanical designer with experience of electro-mechanisms for work on industrial electronic equipment in the Midlands; salary range £600-£1,000.—Details of age, qualifications and exp. quoting ref. D.O.23, to Box 2233.

TESTERS required, experienced in receiver, transmitter or electronic instrument testing, for work in S.W. London area; commencing salary according to experience and ability.—Apply to Box WW823, L.P.E., 110, St. Martin's Lane, W.C.2. [2152

A LARGE engineering group requires draughtsmen of senior and junior grades in several parts of the country.—Men with sound electrical or mechanical drawing office experience should apply to Box 1933. All replies are acknowledged. [1960



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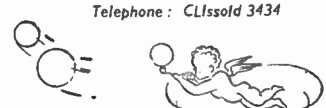

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SENIOR design draughtsman required for work in connection with commercial radio receivers and electronic equipment.—Write, giving full particulars of experience, salary, etc., to the Labour Manager, Bush Radio, Ltd., Power Rd., Chiswick, W.4. [2005

ELECTRONIC engineer.—A vacancy exists in the West Country for an engineer having good technical knowledge and considerable experience in the television and general electronic development fields; salary according to experience.—Box 2244. [2189

DRAUGHTSMEN required for work on electrical and radio test instruments; excellent opportunities and good rates of pay.—Write, giving full particulars of experience, to Taylor Electrical Instruments, Ltd., 419-424, Montrose Ave., Slough, Bucks. [2263

MALE technical assistant required for examination and analysis of reject cathode ray tubes, previous experience essential, London area.—Applicants should include details of qualifications experience and salary required, and be addressed to Box 2241. [2173

TECHNICAL sales assistant required by London marine radio manufacturers, work includes preparation of installation schedules, estimates, contract specifications, correspondence; young ex-operator with some office experience suitable.—Write Box 2558. [2287

THE MORGAN CRUCIBLE Co., Ltd., Battersea, S.W.11, require a technical assistant aged approximately 25, with B.Sc.(Eng.); should have some experience of electronic development work.—Write, giving details of age, quals., exp. and salary req., to the Staff Manager.

LARGE manufacturers in North London require radio engineer for service department. —Details of education (not below School Certificate standard), technical training and experience, age and salary required, to Box 321, c/o Era Publicity, Ltd., 7, Fitzroy Sq., London, W.1.

QUALIFIED engineer required for leading firm in London area; must have had several years' electro-mechanical design experience in electronics; salary minimum £650, or more, depending on experience.—Write Box S.5273, A.K. Advg., 212a, Shaftesbury Avenue, W.C.2.

SENIOR and junior experienced development, research engineers and draughtsmen required for radio, television, electronics, speakers, preference those with B.Sc. (EL.): radio/television testers, inspectors, repairers service required. —Technical Employment Agency 179, Clapham Rd., S.W.9. (Brixton 3487.) [2272

ELECTRONIC circuit development engineer, 25 to 30 years, B.Sc. standard; previous laboratory experience essential; knowledge of servo systems desirable; must be practical and capable of bringing projects right up to the production stage.—Write or Tel. Furzehill Laboratories, Ltd., Boreham Wood, Herts. Elstree 1137. [2297

TWO senior development engineers required by well-known company in Essex; considerable experience on theory and design of V.H.F. transmitters up to powers of 200 watts or on V.H.F. receivers is an essential requirement.—Applications, giving age, qualifications, experience and salary required, quoting Ref. No. 133, to Box 1392. [1782

ELECTRICAL inspector, fully qualified, urgently required for progressive light electrical engineering company in South Wales, must have experience in inspection and testing of small fractional horse-power motors, transformers, etc., excellent conditions.—Please reply, stating fully previous experience, age, salary required, to Box 2236. [2154

RADIO engineer required for test gear development and maintenance. Vacancies also exist for technical investigation on radio and radar production. Sound theoretical knowledge required and practical experience essential.—Apply in first instance by letter only, to Personnel Department, C/S., E.M.I., Ltd., Blyth Rd., Hayes Middlesex. [2227

ELECTRONIC engineer required as head of department engaged on the design and manufacture of special purpose electronic test gear; a suitable applicant must have an Honours Degree in Electrical Engineering or Applied Physics and wide experience of electronic engineering.—State age, qualifications, experience and salary required, to Box 2494. [2246

RADAR engineers required to operate from London headquarters for installation and maintenance of marine installations home and overseas; the essential qualifications are: practical knowledge of electronic circuits and equipment, ability to work without supervision after training, and resourcefulness; initial salary according to experience.—Box 1377. [1751

DEVELOPMENT engineer required for work on experimental types of cathode ray tubes; applicants should possess a physics degree and have had practical experience in the design, development and manufacture of cathode ray tubes; London area.—Applications should include details of qualifications, experience and salary required, and should be addressed to Box 2242.

A LARGE corporation requires an electronics engineer to take charge of new project; applicant should have a good degree in physics with laboratory or Government establishment research experience in television or, preferably, radar; must be good organiser capable of controlling staff and, in particular must have practical experience of making circuits work; should not be over 35 years of age; substantial salary according to ability, age and exp.—Box 2555.

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ELECTRONIC engineer or physicist for development or microwave radio required by large company in the East London area; suitable applicant should have technical education to degree standard and experience in development of electronics.—Full details, including age and salary required, to Box 2395. [2225

ELECTRONIC draughtsman required by large manufacturer of radio and allied equipment situated in the East London area; suitable applicants should have previous experience of this work and technical qualifications to National Certificate or equivalent.—State age, experience and salary required, to Box 2497. [2259

ELECTRONIC engineers are required by works situated on the Treforest Trading Estate, near Cardiff, preferably with factory experience; men with service training will be considered, but knowledge of the basic principles of design is essential.—Applicants should give full details of training and experience to Box 2228. [2134

QUALIFIED electrical engineer or physicist required for leading radio firm in the London area; must have had several years in responsible position on design of radar equipment; salary minimum £800 per annum, or more according to experience.—Write Box S5266, A.K. Advg., 212a, Shaftesbury Avenue, W.C.2. [2211

LECTURER in telecommunications and mathematics to City and Guilds Final standard for radio engineering school; qualifications: degree in telecommunications or similar; preference to recent graduate with teaching ability; salary according to qualifications and experience, on scale from £450 per annum.—Applications to Commandant, Air Service Training, Hamble, Southampton. [2165

SENIOR development engineers required, must have good technical training, preferably with Hons Degree in Physics or Engineering and radio laboratory experience; able to carry through development, with assistants, to production stage; salary up to £800 according to qualifications.—Apply in writing to Personnel Department, Murphy Radio, Ltd., Welwyn Garden City, Herts. [2105

GRADUATE in electrical engineering or physics with radio required by company in S.E. London to take charge of a small section designing and building electronic equipment for specialised high-frequency measurements; experience with circuit techniques for frequencies above 100 mc/s essential; salary £500-700, according to age and experience.—Full particulars to Box 2391. [2220

DESIGN draughtsmen are required by the English Electric Co., Ltd., Stafford, for research and development work on electronic equipment; applicants must have higher national certificate or equivalent, and shop experience; salary according to experience.—Send full details to Central Personnel Services, English Electric Co., Ltd., Queens House, Kingsway, W.C.2, quoting Ref. DO.25. [2192

DEVELOPMENT engineer with experience in design of audio frequency equipment, transformers and kindred apparatus; experience in telecommunication equipment an advantage, engineering degree an advantage.—Apply in writing, stating full details of experience, age and salary required, to Truvox Engineering Co., Ltd. (Ref. FC/4), Hirwaun Trading Estate, Aberdare, Glamorganshire, South Wales [2278

GRADUATE in electrical engineering required by company in S.E. London to take charge of work, mainly on cable accessories; no previous experience in this field necessary, but a knowledge of high-frequency phenomena and workshop methods desirable; salary £500-700, according to age and experience; candidates with experience in an industrial electrical laboratory will have preference.—Particulars to Box 2390. [2217

DRAUGHTSMEN, electrical (experienced and also trained junior) for layout of radio installations, previous drawing office work essential, experience of installation planning, switchgear, power distribution and wiring required; radio knowledge not vital; applicants of Nat. Cert. grade preferred.—Apply to the Secretary, Marconi's Wireless Telegraph Co., Ltd., New St., Chelmsford stating age, education, experience and salary required. [2163

TWO electronic engineers, technical qualifications equal to City and Guild Final (Radio Communication), preferably with manufacturing experience of audio and/or recording apparatus, required for large organisation with overseas branches; position calls for executive ability and involves control of specialist staff; operational bases in England and Canada; substantial salary in accordance with qualifications and experience.—Reply to Box 2389. [2218

VALVE engineer, well-known London firm has a vacancy for an engineer in the transmitting valve department; successful applicant must have had practical experience in all branches of the manufacture of valves up to 20kw of anode dissipation, and must be capable of conducting and supervising development of new types; some experience of circuitry an asset.—Write, with full details of qualifications and experience, to Box 2635. [2335

REQUIRED immediately by a company in the East London area, an engineer experienced in the design of inductances for radio communication work; only applicants having considerable experience of the design of R.F. tuned circuits, I.F. transformers, wave filters and similar devices will be considered; this vacancy is in connection with a long-term project for the development of high-grade communication equipment.—State full details to Box 2394. [2224

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THE MORGAN CRUCIBLE Co., Ltd., Battersea, S.W.11, require maintenance engineers, aged approximately 21; successful applicants should have higher national certificate or equivalent and some experience in service and maintenance of electrical control equipment, with particular reference to programme controllers and general electrical furnace control equipment. Write, giving details of age, quals., exp. and salary req., to the Staff Manager.

ELECTRONIC engineers with honours degree or equivalent are required for research and advanced development work by the Nelson Research Laboratories, English Electric Co., Ltd., Stafford; preference will be given to men with sound electrical engineering experience; salary according to qualifications.—Apply by letter to Chief, Administration, Nelson Research Laboratories, English Electric Co., Ltd., Stafford, stating age, experience and academic qualifications.

REQUIRED as technical assistant to chartered patent agent in patent department of the General Electric Co., Ltd., at Research Laboratories, Wembley, Middx., a young man with an Honours degree or similar qualifications and preferably with some experience or knowledge of radio engineering and electronics; the assistant would receive training for qualification as a chartered patent agent.—Apply by letter to the Director, stating age, academic qualifications and experience. [2172

LARGE electrical organisation requires an assistant engineer, capable of writing specifications, dealing with tenders and contracts for sound installations; design work on special amplifier and electronic circuits; successful applicant would be required to assist in special surveys of factories, etc.; some general experience of office routine; B.Sc. and/or A.M.I.E.E. qualifications preferred, but not essential.—Write, giving full details as to age, previous experience and salary required, to Box 2231. [2142

ELECTRONIC engineering.—The S.W. Division of leading radio company invites applications for post in development laboratories engaged on radar and allied equipment; candidates should have at least 3 years' industrial experience in this type of work and show educational qualifications equivalent to A.M.I.E.E. examination standard; the post offers considerable opportunity for advancement; commencing salary will be commensurate with qualifications and experience; forms of application may be obtained on request.—Box 2238. [2162

MECHANICAL designer with production engineering experience required as deputy chief of a development department in a well-established company employing 2,000 people; applicant must have experience of the design of small semi-precision mechanical assemblies and have had adequate technical training; an engineer with outstanding drive, experience and initiative will obtain a permanent and progressive position; our own staff have knowledge of this vacancy.—Write, stating age, details of experience and qualifications, to Box 2245. [2190

DRAUGHTSMEN required in design department for laying out small electro-mechanical equipment, capable of preparing detail drawings in development stage and final manufacturing drawings for production, experience in telecommunications or small electrical equipment an advantage; vacancies exist for mechanical and electrical draughtsmen with design experience, also juniors.—Apply in writing, stating full details of experience, age and salary required, to Truvox Engineering Co., Ltd. (Ref. FC/3), Hirwaun Trading Estate, Aberdare, Glamorganshire, South Wales. [2279

B.B.C. invites applications for an engineering post in the Acoustics Section of the Research Department based initially at Balham, S.W.12, and later at Kingswood, Surrey. Candidates must possess a University degree in Physics or Electrical Engineering, or equivalent qualifications, such as graduate membership of the Institution of Electrical Engineers. The duties consist of research on acoustic design of studios and involve investigation into acustical properties of materials and structures. A knowledge of physics and of electronics is necessary. A good knowledge of music and some workshops' experience would be an advantage. The salary is in a grade with annual increments of £25 rising to a maximum of £580 per annum.—Applications, stating age, qualifications and experience, should reach the Engineering Establishment Officer, Broadcasting House, London, W.1, within 7 days of the appearance of this advertisement. [2247

CROWN Agents for the Colonies.—Applications from qualified candidates are invited for the following post: Wireless technicians (aeradio) required by Hong Kong Government for 3 years; salary $600 a month, rising to $800 a month, plus expatriation pay $166.67 a month, cost of living allowance between $216 and $360 a month, according to dependants ($1—1s. 3d.), free passages; candidates, under 35, must hold P.M.G. 1st or 2nd class certificate of competency or air operator's certificate with appropriate ground operating experience; they must be competent to maintain modern ground communications, transmitters and receivers; radar experience essential; merchant service operating experience an advantage; R.A.F. type maintenance experience desirable.—Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience and mentioning this paper, to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting M/N/23617(3B) on both letter and envelope. [2175

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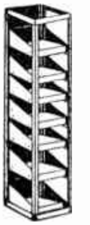


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