PUBLISHED IN CONJUNCTION WITH

THE

RADIO CONSTRUCTOR

★ ***Data Book Series***

★ ***Radio Reprint Series***

★ ***Panel Signs Transfers***

Send stamped addressed envelope for latest

BROCHURE

giving details of ALL PUBLICATIONS

DATA PUBLICATIONS LTD

57 MAIDA VALE LONDON W9

Telegrams **Databux London** *Telephone* **CUNningham 6141/2**

Published in Great Britain by the Proprietors and Publishers
Data Publications Ltd 57 Maida Vale London W9
Printed by A. Quick & Co. (Printers) Ltd 125 High Holborn London WC1 England *also at* Clacton-on-Sea
Obtainable abroad through the following Collets Subscription Service Continental Publishers & Distributors Ltd William Dawson & Sons Ltd *Australia and New Zealand* Gordon & Gotch Ltd *South Africa* Central News Agency *Holland* "Radio Electronica"
Registered for transmission by Magazine Post to Canada (including Newfoundland)

LOW-POWER TRANSMITTER MODULATOR

VOLUME 14
NUMBER 1
AUGUST
1960

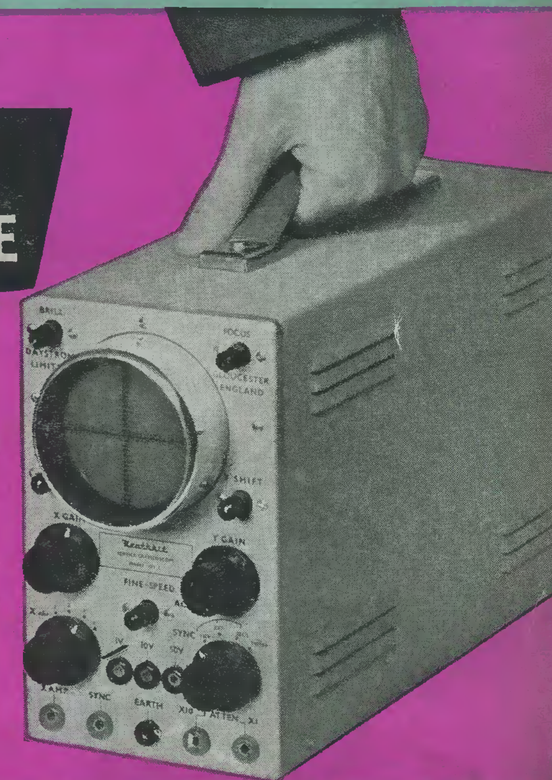
The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS

A PORTABLE OSCILLOSCOPE

The HEATHKIT OS-1

by
G. J. Stone

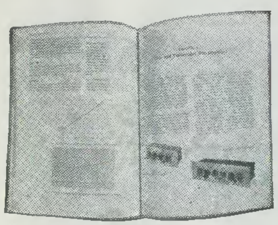


Included in this issue

DATA Publications 1/9

Mullard

CIRCUITS FOR AUDIO AMPLIFIERS



-a book every enthusiast will want!

This new Mullard publication is a practical manual for every audio enthusiast. In addition to describing twelve of the most popular Mullard circuits, it has introductory chapters on many of the theoretical and aspects of high quality sound reproduction.

Whether you are interested in disc or tape, monaural or stereo, you will find that "Circuits for Audio Amplifiers" gives just the sort of information you need.

This informative book costs only 8/6d. The demand for it is high, so get your copy now from your local radio dealer.

MULLARD LTD · MULLARD HOUSE · TORRINGTON PLACE · LONDON · W.C.1

MVM 422A

Technical training in radio television and electronics engineering with

ICS

The decision is YOURS. To be a success in your chosen career; to qualify for the highest paid job . . . to control a profitable business of your own. I C S home-study courses put your plans on a practical basis; teach you theory and practice; give you the knowledge and experience to take you, at your own pace, to the top.

Choose the RIGHT course,

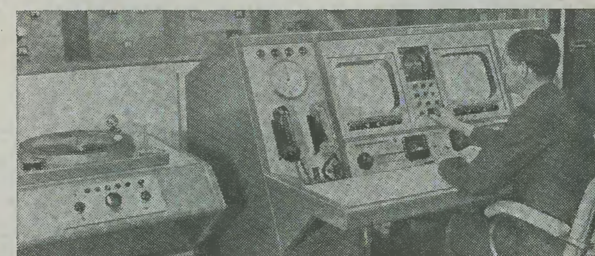
RADIO AND TELEVISION ENGINEERING . INDUSTRIAL TELEVISION . RADIO AND TV SERVICING . RADIO SERVICE AND SALES . ELECTRONICS . VHF/FM ENGINEERING . COMPUTORS AND PROGRAMMING

I C S provides thorough coaching for professional examinations: A M BRIT. I R E, City and Guilds Telecommunications, C. & G. Radio and TV Servicing, C. & G. Radio Amateurs.

LEARN AS YOU BUILD

Practical Radio Course

Gain a sound up-to-professional-standards knowledge of Radio and Television as you build YOUR OWN 4 valve T R F and 5 valve superhet radio receivers, signal generator and high-quality multi-tester. At the end of the course you have three pieces of permanent and practical equipment and a fund of personal knowledge and skill . . . I C S Practical Radio courses open a new world to the keen radio amateur.



THERE ARE ICS COURSES TO MEET YOUR NEEDS AT EVERY STAGE OF YOUR CAREER.

Post this coupon today: In return you will receive the FREE 60-page I C S Prospectus listing technical examinations and their appropriate I C S courses PLUS details of over 150 specialised subjects.

Other I C S courses include: MECHANICAL, MOTOR, FIRE, CHEMICAL, ELECTRICAL AND CIVIL ENGINEERING, ETC. SELLING AND MANAGEMENT, ARCHITECTURE, WOODWORKING, FARMING, GARDENING, ART, PHOTOGRAPHY.

Please state subject on coupon

INTERNATIONAL CORRESPONDENCE SCHOOL
(Dept. 248) Intertext House Parkgate Road London SW11

NAME........................ AGE ....
ADDRESS ....
....
OCCUPATION ....
SUBJECT ....
SUBJECT........................8.60

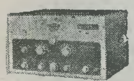
See the whole Heathkit range at STAND 112 RADIO SHOW

For the Discerning who require the Best Performance at Minimum Price

HI-FI FM TUNER

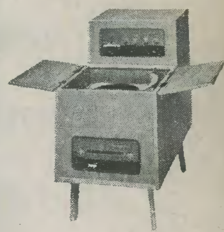
This model is available as two units which, for your convenience, are sold separately. They comprise a Tuner Unit, Model FMT-4U (**£3.2.0** including Purchase Tax) with I.F. output of 10.7 mc/s and an Amplifier Unit complete with attractively styled cabinet, power supply and valves. Model FMA-4U (**£10.10.6**) making a total cost for the equipment of **£13.12.6.**

AMATEUR TRANSMITTER Model DX-100U



This is the most popular Amateur transmitter in the world and requires no introduction to "Hams" the world over. Covers all bands from 160–10 metres. Self-contained, including power supply, Modulator and V.F.O. **£78.10.0**

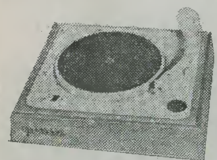
THE "CHEPSTOW".



This cabinet has specially been developed for those who require to house their equipment in as small a floor area as possible. Overall dimensions are 35″ x 18″ x 33″ high.

It will accommodate Record Player, FM Tuner, Stereo Amplifier and where a Stereo Control Unit is used, one or more power amplifiers as well. An upper deck is available for the self-powered stereo amplifiers to ensure maximum heat dissipation. Left in the white, veneered for finishing to personal taste. **£10.10.0**

TRANSCRIPTION RECORD PLAYER

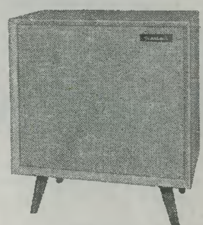


TRANSCRIPTION RECORD PLAYER, Model RP-1U. This new RP594 Collaro Transcription Unit has a Ronette Stereo Pick-up, giving excellent results on stereo or mono (33, 45, or 78 r.p.m.) discs. Complete with furniture-grade wooden plinth. **£12.10.0**

The "GLOUCESTER". It will house Tape Deck and/or Record Player—as well as FM Tuner and Stereo Amplifier, and storage space is provided for records, tapes and power amplifiers. Furthermore to meet the needs of those with whom room-space is an overriding consideration, provision is made in the cabinet ends for matched Hi-Fi Stereo Speaker Systems.

Mk. 1. Tape Deck or Record Player. **£15.18.6**

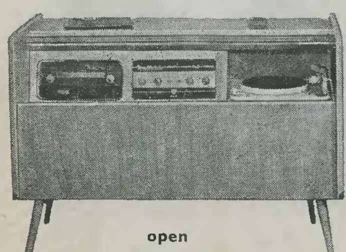
Mk. 2. Tape Deck and Record Player. **£17.8.6**



THE "COTSWOLD"

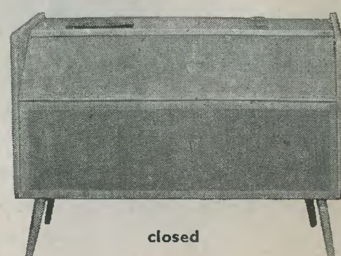
THE "COTSWOLD". This is an acoustically designed enclosure 26″ x 23″ x 15⅛″ housing a 12″ bass speaker with 2″ speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 32–20,000 c/s. capable of doing justice to the finest programme source, its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, crossover unit, level control, Tygan grille cloth, etc. All parts pre-cut and drilled for ease of assembly and left "in the white" for finish to personal taste. **£19.18.6**

BUY YOUR HI-FI EQUIPMENT ALL TOGETHER AS ONE OF OUR "PACKAGED DEALS" AND SAVE YOURSELF MORE MONEY!



open

THE "GLOUCESTER"

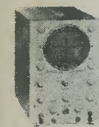


closed

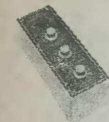
DAYSTROM LTD DEPT. RC7 GLOUCESTER ENGLAND

Easily-built Equipment Heathkit of excellent quality

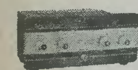
at much lower cost



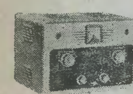
O-12U



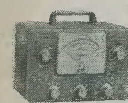
DC-1U



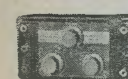
S-33



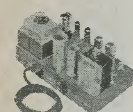
DX-40U



AG-9U



UJR-1



MA-12

5″ OSCILLOSCOPE: O-12U. "Y" sensitivity 10mV/ cm., 3 c/s to over 5 Mc/s. Rise time, 0.08 μsecs. or less. Sweep, 10 c/s to 500 kc/s. Electronically stabilised. **£34.15.0**

2½″ PORTABLE SERVICE OSCILLOSCOPE: OS-1. Ideal instrument for service and portable use. Size 5″ x 8″ x 14″. Wt. 10½lb. **£18.19.6**

DECADE CAPACITANCE BOX: DC-1U. Provides capacity values from 100 mmf to 0.11 mfd. in 100 mmf. steps. Ideal for experimental, development and design work. **£5.18.6**

VALVE VOLTMETER: V-7A. The World's largest-selling VVM. Measures Volts to 1,500 (DC & RMS) and 4,000 pk. to pk.; Resistance 0.1Ω to 1,000MΩ D.C. Sensitivity: 7,333,333 ohms per volt. **£13.0.0**

HI-FI STEREO 6 WATT AMPLIFIER: S-33. Low-priced but high quality; less than 0.3% distn at 2½ watts per channel. **£11.8.0**

HI-FI STEREO 16 WATT AMPLIFIER: S-88. Superb reproduction for the man who wants the best in Hi-Fi. Only 0.1% distortion at 6 W/chnl. Many special features. **£25.5.6**

"HAM" TRANSMITTER: DX-40U. 75 W. CW; 60 W. pk. c/s phone; 40 W. into Aerial. **£29.10.0**

HI-FI SPEAKER SYSTEM: SSU 1. Ideal twin speaker/ducted-reflex cabinet for stereo/mono. in average room (left "in the white"). Legs £1.7.0 extra. **£10.5.6**

AUDIO GENERATOR: AG-9U. 10 volts, 10 c/s to 100 kc/s pure sine-wave. Switch-selected frequencies attenuation. **£19.3.0**

JUNIOR PERSONAL TRANSISTOR RADIO: UJR-1. Youngsters are not excluded from our kit programme. This special single transistor set is an excellent introduction to radio and an instructive present. **£2.16.6**

TRANSISTOR PORTABLE RADIO: UXR-1. In elegant solid hide case, with golden relief. Six transistors, dual-wave, fine reproduction, very easy to build. **£15.18.6**

SINGLE CHANNEL 12 WATT HI-FI AMPLIFIER: MA-12. Ideal for stereo conversions, etc. Generous auxiliary power provided. **£9.19.6**

COLLARO "STUDIO" TAPE DECK. This extremely attractive and compact 3-speed monaural tape deck features digital counter, pause control and piano-key switches. **£17.10.0**

(Following models not illustrated)

CAPACITANCE/RESISTANCE BRIDGE: C-3U. Measures capacity, 10pF to 1,000μF. Resistance 100Ω to 5MΩ; Pwr. Factor. **£7.19.6**

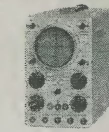
VARIABLE FREQUENCY OSCILLATOR: VF-1U. 10V output; covers 10 to 160 metres. **£10.12.0**

AUDIO WATTMETER: AW-1U. Up to 25 W. continuous, 50 W. intermittent. **£13.18.6**

AUDIO VALVE-MILLIVOLTMETER: AV-3U. 1mV to 300V A.C. 10 c/s to 400 kc/s. **£13.18.6**

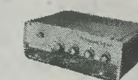
ELECTRONIC SWITCH: S-3U. This extremely useful device extends your single-beam "scope" for double-beam uses. **£9.18.6**

DIRECT READING CAPACITANCE METER: CM-1U. Full-scale ranges of 0–100 mmf., 1,000 mmf., 0.01 mfd. and 0.1 mfd. **£14.10.0**

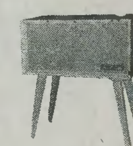


OS-1

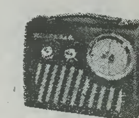
V-7A



S-88



SSU-1



UXR-1

"STUDIO"

Money Saving "Packaged Deals" of Complete Stereo Equipment from £42.10.0

All prices include free delivery in U.K.
Deferred terms available on orders above £10

★ SEND THIS COUPON NOW FOR FURTHER INFORMATION

(Please write in BLOCK CAPITALS)

NAME ....

ADDRESS ....

Without obligation please send me (Tick here)

BRITISH HEATHKIT CATALOGUE .... ☐

FULL DETAILS OF MODEL(S) .... ☐

DAYSTROM LTD DEPT. RC7 GLOUCESTER · ENGLAND

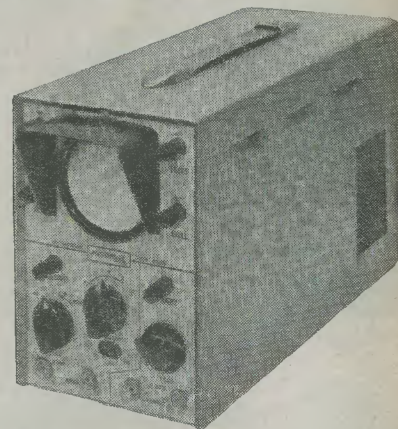
A member of the Daystrom Group, manufacturers of the **WORLD'S LARGEST-SELLING ELECTRONIC KITS**

BUILD THE OG.10 OSCILLOSCOPE

with an authentic **Jason kit**

Britain's Finest kits

For absolute assured results, build this excellent Oscilloscope with an authentic Jason kit. All parts exact to author's specification. Amongst the many uses to which this instrument may be put, TV servicing and audio amplifier checking are important examples. Sensitivity—10mV/cm with a bandwidth of 2 c/s to 1.5 Mc/s. Complete with case, Mullard C.R.T. and all valves as specified.



£22.10.0 *with tube*

OTHER KITS IN THE JASON PROGRAMME

AUDIO GENERATOR AG.10

Excellent stability with output held constant over entire band. Tunes from 10 c/s to 100 kc/s over four switched stages and two scales. Switch for square or sine wave. Square wave rise time less than 2 microsecs. at all frequencies. Min. calibrated output 100mV. With case, valves and calibrated scale **£14.5.0** (*Built* £17.10.0)

WOBBULATOR W.11

Enables FM signals, IF signals for AM sets and TV sound and vision channels to be correctly aligned. RF circuits may also be aligned from the 40–70 Mc/s output, the second and third harmonics of which serve for Bands II and III respectively. Return trace is blanked when using a 50 c/s sine wave sweep frequency to provide a reference base line not found on most commercial instruments. **£14.19.0** (*Built* £19.19.0)

CRYSTAL CALIBRATOR CC.10

Enables the exact frequency of a generator to be found between 10 kc/s and 250 Mc/s. A basic accuracy of 0.01% is achieved from a 1 Mc/s crystal. Self-powered unit complete with valves, crystal oscillator, speaker and case. **£16.19.0** (*Built* £21.0.0)

STABILISED POWER PACK PP.10M

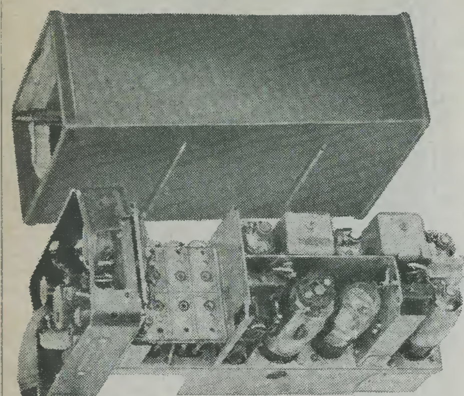
175mA at 300V mains variation of ±10% produces output change of less than 0.15%. Ripple less than one millivolt. Available with or without meter. Polarity change switch. With valves, meter and case. **£19.0.0**

Details of the above instruments and others in the Jason range, including audio and radio units gladly sent on request. Please quote this journal when writing.

THE JASON MOTOR & ELECTRONIC COMPANY

3-4(E) GREAT CHAPEL ST. OXFORD ST. LONDON W1 *Telephone* GERrard 0273/4

FANTASTIC UNREPEATABLE OFFER!



No. 46 TRANSCEIVER CHASSIS AND 2 PAIRS DLR 5 MOVING COIL HEADPHONES AND 2 THROAT MIKES. ALL NEW AND UNUSED. WORTH AT LEAST £4.10.0.

OUR PRICE 35/- THE LOT

CARRIAGE PAID G.B.

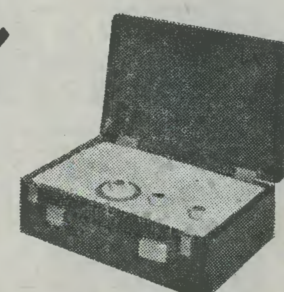
We challenge you to beat this this offer for price !

Cheap enough for the expert, the youngster or anybody to play with. Note Gentlemen. The No. 46 transceiver chassis contains 6 valves. Two VP23, ATP25, HL23, DD., QP25, A.T.P.4. Two 3-pole 2-way Yaxley switches, one 3-pole 3-way Yaxley switch, output and mic. transformers, 50 p.F. tuning capacitors and numerous useful resistors and capacitators. Build up this superhet circuit I.F. 470 kc/s, 3 channel switching, crystal controlled. One switch, removed to comply with Ministry regulations, no crystals.

BUSHELL'S 46-52 Brearley Street Birmingham 19 Aston Cross 3556-7

RCS "REGENT"
4-Valve Portable Superhet

Plans 9d. or details S.A.E. (as featured in June issue)



- ★ Economy "96" Range Valves
- ★ Medium and Long Waves
- ★ 6″ High Flux Speaker
- ★ T.C.C. Printed Circuit and Condensers
- ★ Osmor Ferrite Aerial and Coils
- ★ Attache Case Cabinet 12″x 8″x 4″ Rexine-covered
- ★ Ready-made Mains Unit available. Price **39/6**
- ★ All components identified and of finest quality

Special Reduced Price (*for limited period*) if all components are purchased at one time.

£6.6.0

Carriage 4/–

Batteries extra **10/– set**

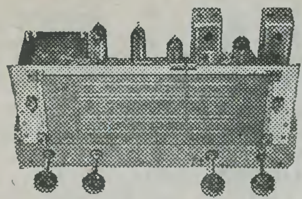
CHAMPION VHF (FM) TUNER 88 to 96 Mc/s. 5 Mullard valves and superhet tuning heart.

Features: This is a self-powered 200/250V a.c. VHF (FM) adaptor with operating and servicing data and a screened lead for connection to pick-up sockets of any radio, radiogram or amplifier. Brand new. Ready for use. 12 months guarantee. List price 16 gns.

Our price £9 10. carr. 4/6

Maroon and cream receiver styled cabinet 6″ x 12″ x 6″. 20/- extra.

RADIO COMPONENT SPECIALISTS **337 WHITEHORSE ROAD WEST CROYDON** *Telephone* THO 1665



1960 RADIOGRAM CHASSIS

THREE WAVEBANDS — FIVE VALVES
S.W. 16 m.–50 m. — LATEST MULLARD
M.W. 200 m.–550 m. — ECH81, EF89, EBC81,
L.W. 800 m.–2,000 m. — EL84, EZ80

12 month Guarantee. A.C. 200/250V, 4-way switch. Short-Medium-Long-Gram. A.V.C. and negative feed-back. 4.2 watts. Chassis 13½" x 5½" x 2¼". Glass dial, horizontal or vertical, size 10" x 4½". 2 pilot lamps. Four knobs, walnut or ivory, aligned and calibrated. Chassis isolated from mains. Leaflet S.A.E.

BRAND NEW £9.10.0 Carr. 4/6
TERMS: Deposit £5.5.0 and 5 monthly payments of £1
MATCHED SPEAKERS: 8" 17/6. 10" 25/–. 12" 30/–.

LATEST "E.M.I." 4 SPEED SINGLE RECORD PLAYER

Acos 73 Hi-Fi Pick-up for LP, 78 and Stereo 7", 10" and 12" records. Silent motor, heavy turntable, auto stop. Special offer **£6.19.6** post free

BUILD THIS REPRODUCER BARGAIN
SPECIAL SINGLE PLAYER KIT

COLLARO 4-speed Gram-Pick-up Unit — £3.15.0
Handsome portable case 17½" x 13½" x 7" with room to play 12" records — £2. 5.0
Ready built 3-watt amplifier with two valves and 7" elip. speaker, printed circuit — £3.12.6

or £9.9.0 complete kit post free

I.F. TRANSFORMERS 7/6 pair
465 kc/s slug tuning miniature can 2½" x 1" x 1". High Q and good band width. By Pye Radio. Data sheet supplied.
Wearite M800 Midget 465 kc/s 1¾" x ¾" sq. **12/6** pair
Weyrad Standard Size 465 kc/s 3½" x 1½" sq. **12/6** pair

New boxed VALVES 90-day Guarantee

1R5	7/6	6K8G	7/6	EA50	1/6	EZ80	7/6
1S5	7/6	6L6G	10/6	EABC80	8/6	E1148	1/6
1T4	6/–	6N7M	6/6	EB91	6/–	HABC80	12/6
2X2	3/6	6Q7G	8/6	EBC33	8/6	HVR2A	6/6
3S4	7/6	6SA7	6/–	EBC41	8/6	MU14	9/–
3V4	7/6	6SJ7M	6/6	EBF80	10/–	P61	3/6
5U4	7/6	6SN7	6/6	ECC84	9/6	PCC84	9/6
5Y3	7/6	6V6G	6/6	ECF80	9/6	PCF80	9/6
5Z4	9/6	6X4	7/6	ECH42	10/6	PCL82	11/6
6AM6	5/–	6X5	6/6	ECL80	10/6	PEN25	6/6
6B8	5/–	12A6	7/6	ECL82	10/6	PL81	12/6
6BE6	7/6	12AT7	8/–	EF39	5/6	PL82	10/6
6BH6	9/6	12AU7	8/–	EF41	9/6	PY80	7/6
6BW6	9/6	12AX7	8/–	EF50	5/6	PY81	9/6
6D6	6/–	12BE6	8/6	EF80	8/–	PY82	7/6
6F6	7/6	12K7	6/6	EF86	12/6	SP61	3/6
6H6	3/6	12Q7	6/6	EF92	5/6	UBC41	9/6
6J5	5/6	35L6	9/6	EL32	5/6	UCH42	9/6
6J6	5/6	35Z4	7/6	EL41	9/6	UF41	9/6
6J7G	6/6	80	9/6	EL84	8/6	UL41	9/6
6K6GT	6/6	807	5/6	EY51	9/6	UY41	8/–
6K7G	5/–	954	1/6	EZ40	7/6	U22	8/–

DK96, DF96, DAF96, DL96, 8/6 ea. or 30/- set.

B.B.C. Pocket Transistor. M.W. and L.W. Radio Kit 32/6. Phones 7/6, or deaf aid earpiece 15/–.

C.R.T. ISOLATION TRANSFORMERS
For Cathode Ray Tubes having heater cathode short circuit and for C.R. Tubes with falling emission, full instructions supplied. **Type A.** Low leakage windings. **Optional 25% and 50%** boost on secondary: 2V, or 4V, or 6.3V, or 10.3V, or 13.3V, with mains primaries, **12/6. Our Latest Superior Product. Mains Input Type A2. High quality low capacity 10-15pF. Optional boost** 25%, 50%, 75%, **16/6** each.
Type B. Mains input. Low capacity. Multi output 2, 4, 6.3, 10 and 13V. Boost 25% and 50%. This transformer is suitable for all TV tubes. **21/–** each.

RESISTORS. Preferred values. 20% 10 ohms to 10 meg, ¼W **4d.**, ½W **4d.**, 1W **6d.**, 1½W **8d.**, 2W **1/–**. **HIGH STABILITY.** ½W 1%, **2/–**. All preferred values 100Ω–10MΩ. Ditto 5% 100Ω–5MΩ **9d.** each.

5 watt / 10 watt / 15 watt — **WIRE-WOUND RESISTORS** 25 ohms–10,000 ohms — 1/3 / 1/6 / 2/–

WIRE-WOUND POTS Pre-set min. TV type. Knurled slotted knob. All values 25 ohms to 25k, 3/– each, 30k, 50k, 4/–. Ditto ½W Carbon Track 30k to 2 Meg, 3/–.
3W Lab. Colvern, etc. Standard size Pots, 2¼" Spindle, high grade. All values, 100 ohms to 50k, 6/6; 100k, 7/6. W/W EXT. SPEAKER CONTROL 10Ω, 3/–.

MAINS TRANSFORMERS—200/250 AC

STANDARD 250-0-250, 80mA, 6.3V tapped 4V 4A, Rectifier 6.3V 1A tapped 5V 2A and 4V 2A	22/6
Ditto 350-0-350	22/6
MINIATURE. 200V 20mA, 6.3V 1A	10/6
MIDGET. 220V 45mA, 6.3V 2A	15/6
SMALL. 220-0-220V 50mA, 6.3V 2A	17/6
STANDARD. 250-0-250, 65mA, 6.3V 3.5A	17/6

HEATER TRANS. 6.3V 1½A **7/6.** Ditto, sec. 6.3V 3A **10/6.** Ditto, tapped sec. 2, 4, 6.3V 1½A, **8/6.**
Mullard "510" Osram "912" 300-0-300, 120mA, 6.3V 4A c.t., 6.3V 2A tapped 5V — **38/6**
General Purpose Low Voltage. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V. at 2A — **22/6**

O/P TRANSFORMERS. Heavy duty 50mA, **4/6.** Multi-ratio push-pull, **7/6.** Miniature 3V4, etc., **4/6.** Small pentode, **4/6.** Hygrade push-pull 7 watts, **15/6.** Goodmans heavy duty 10/20W 6k or 8k c.t., **30/–.**
L.F. CHOKES 15/10H 60/65mA, **5/–**; 10H, 85mA, **10/6**; 10H 150mA, **14/–.**

CRYSTAL MIKE INSERT by Acos **6/6**
Precision engineered. Size only ¾" x 5/16".
ACOS CRYSTAL HAND or DESK MIKE, 27/6

ALADDIN FORMERS and cores. ¼" **8d.**, ⅜" **10d.** 0.3" **FORMERS** 5937 or 8 and cans TV1 or 2. ¾" sq. x 2¼" or ⅜" sq. x 1¾", **2/–** with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6-1, **2/3.**
REMPLOY INSTRUMENT IRON, 230V 25W, **17/6.**
MAINS DROPPERS. 3" x 1¼". With adj. sliders, 0.3A, 1,000 ohms, **4/3**; 0.2A 1,000 ohms, **4/3.**
LINE CORD. 0.3A 60 ohms per foot, 0.2A 100 ohms per foot, 2-way, **6d.** per foot; 3-way, **7d.** per foot.
MIKE TRANS. 50:1, **3/9**; 100:1, potted, **10/6.**
LOUDSPEAKERS. P.M. 3 ohm. 5", Rola, **17/6**; 6" x 4" Rola, **18/–**; 4" Hi-Fi Tweeter, **25/–**; 8" Plessey, **19/6**; 6½" Goodmans, **18/6**; 10" R.A., **30/–**; 12" Plessey, **30/–**; 10" x 6" R.A., **27/6**; 12" Baker 15W 3 ohm or 15 ohm models, **90/–**; Stentorian HF1012 10", **95/–.**
CRYSTAL DIODES. G.E.C., **2/–**; GEX34, **4/–.**
40 CIRCUITS FOR GERMANIUM DIODES, 3/–.
H.R. HEADPHONES 4,000 ohms, brand new, **15/-** pr.
SWITCH CLEANER FLUID, squirt spout, **4/3** tin.
TWIN GANG CONDENSERS. 365pF, miniature. 1⅜" x 1½" x 1¾", **10/–**; 0.0005 standard with trimmers, **9/–**; less trimmers, **8/–**; midget, **7/6**; 50pF single, **2/6.**
SHORT WAVE Single 75pF, 100pF, 160pF, **7/–** each.
TUNING AND REACTION CONDENSERS. 100pF, 300pF, 500pF, **3/6** each, solid dielectric.
RADIO & TV SERVICE SHEETS 2/6 plus S.A.E.

HIGH GAIN TV PRE-AMPLIFIERS
BAND I B.B.C.
Tuneable channels 1 to 5. Gain 18dB. ECC84 valve. Kit price **29/6** or **49/6** with power pack. Details **6d.** (PCC84 valves if preferred.)
BAND III I.T.A.—Same prices
Tuneable channels 8 to 13. Gain 17dB. ECC84 valve

Volume Controls
Midget size. Long spindles. Guaranteed 1 year. All values 5,000 ohms to 2 Meg.
No Switch 3/– — D.P. Switch 4/9
Linear or Log Tracks

80Ω Coaxial Cable
Post 1d. per yard extra
Semi-air spaced Polythene
Ideal Band III
Losses cut 50% — **6**d. yd.
FRINGE QUALITY
Air spaced Coaxial — **1/–**yd.

Coaxial Plugs 1/– — **Lead Socket** 2/–
Panel Sockets 1/– — **Outlet Boxes** 4/6
Balanced Twin Feeder, per yd **6d.**, 80Ω or 300Ω.
Twin Screened Balanced Feeder, **1/6** yd, 80 ohms.
Trimmers. Ceramic 30, 50, 70pF, **9d.**; 100pF, 150pF, **1/3**; 250pF, **1/6**; 600pF 750pF, **1/9**; Philips, **1/–** each.
BLACK CRACKLE PAINT. Air drying, **3/–** tin.
P.V.C. CONN. WIRE, 8 colours, single or stranded, **2d.** yd. Sleeving 1, 2mm, **2d.** 2, 3mm, **3d.**, 6mm, **5d.** yd.
NEON MAINS TESTER SCREWDRIVERS, 5/–.
SOLDER RADIOGRADE, 4d. yd, ½lb **2/6.**

Aluminium Chassis. 18 s.w.g. Plain, undrilled, 4 sides, riveted corners, lattice fixing holes, 2½" sides. 7" x 4", **4/6**; 9" x 7", **5/9**; 11" x 7", **6/9**; 13" x 9", **8/6**; 14" x 11", **10/6**; 15" x 14", **12/6**; 18" x 16" x 3", **16/6.**

Miniature Contact Cooled Rectifiers. 250V 50mA, **7/6**; 250V 85mA, **9/6.** **Selenium Rect.** 300V 85mA, **7/6.**
Coils. Wearite "P" type, **3/–** each. Osmor Midget "Q" type, adj. dust core, from **4/–** each. All ranges.
Teletron D.W.R. L. & Med. T.R.F. with reaction, **3/6.**
Ferrite Rod Aerials. M.W., **8/9**; M. & L., **12/6.**
Ferrite Rods 8" x ⅜"—**2/6**
T.R.F. Coils A/HF, **7/–** pair. **H.F. Chokes, 2/6.**
Speaker Fret. Gold cloth, **17" x 25", 5/–; 25" x 35", 10/–.** **Tygan,** 4' 6" wide, **10/–**; 2' 3" wide, **5/–** ft. Samples, S.A.E.
Condensers. 0.001μF 7kV T.C.C., **5/6**; ditto 20kV, **9/6**; 0.1μF 7kV, **9/6**; 100pF to 500pF Micas, **6d.**; Tubular 500V 0.001 to 0.05, **9d.**; 0.1, **1/–**; 0.25, **1/6**; 0.1/350V, **9d.**; 0.5/350V, **1/9**; 0.01/2,000V, **1/9**; 0.1/2,000V, **3/6.**
Ceramic Condensers. 500V 0.3pF to 0.01μF, **9d.**
Silver Mica. 10% 5pF to 500pF, **1/–**; 600pF to 3,000pF, **1/3**; close tolerance (plus or minus 1pF), 1.5pF to 47pF, **1/6**; ditto 1% 50pF to 815pF, **1/9**; 1,000pF to 5,000pF, **2/–.**

NEW ELECTROLYTICS — FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350V	2/–	50/350V	5/6	8/500V	3/–
2/350V	2/3	100/25V	3/–	16/500V	4/–
4/450V	2/3	250/25V	3/–	32/350V	4/–
8/450V	2/3	500/12V	3/–	100/270V	5/6
8/500V	2/9	8+8/450V	4/6	2,500/3V	4/–
16/450V	3/6	8+8/500V	5/–	5,000/6V	5/–
16/500V	4/–	8+16/450V	5/–	32+32/450V	6/6
32/450V	5/6	8+16/500V	5/6	32+32+32/350V	7/-
25/25V	1/9	16+16/450V	5/6	50+50/350V	7/–
50/25V	2/–	16+16/500V	6/–	64+120/350V	11/6
50/50V	2/–	32+32/350V	4/6	100+200/275V	12/6

Full Wave Bridge Selenium Rectifiers. 2, 6 or 12V 1½A, **8/9**; 2A, **11/3**; 4A, **17/6.** Free charger circuit.
Charger Transformers. Tapped input 200/250V for charging at 2, 6 or 12V 1½A, **15/6**; 2A, **17/6**; 4A, **22/6.**

P.V.C. PLASTIC RECORDING TAPE

Long Play			Standard Play		
7" reel, 1,700ft		32/6	7" reel, 1,200ft		21/–
5¾" reel, 1,200ft		22/6	5¾" reel 850ft		17/6
5" reel, 850ft		19/6	5" reel, 600ft		15/–
3" reel, 225ft		7/6			

Spare Plastic Reels all sizes **3/-**. Metal Reels 7" only **2/-**. "Instant" Bulk Tape Eraser and Head Defluxer, 200/250V A.C., **27/6.** Leaflet, S.A.E.

BRAND NEW AND BOXED
Model UA8
OUR PRICE
£6.15.0

STEREO MODELS
UA8 — £7.19.6.
UA14 — £10.10.0.

★ **COLLARO** ★
HI-FI AUTOCHANGER £7.19.6
4 SPEEDS—10 RECORDS
or with Cabinet, Amplifier and Speaker
OUR PRICE £11.19.6 Carr. 5/6

★ **GARRARD 4-SPEED RECORD CHANGERS MODEL 210** ★
With Plug-in Head for Monaural **£10.10.0**
Stereo Heads £2 extra

AUTOCHANGER ACCESSORIES
Suitable player cabinets (uncut boards) — 49/6
Amplifier player cabinets with cut boards — 63/–
2-valve amplifier and 6½" speaker for above — 79/6
3-valve amplifier and 6½" speaker for above — 95/–
Wired and tested ready for use

★ **GARRARD 4-SPEED SINGLE RECORD PLAYER TA MK II** ★
£8.8.0 — **AUDIO PERFECTION** — Stereo wired
with plug-in GC8 Normal Heads — Stereo Heads £2 extra
MODEL 4 HF £18

Wavechange Switches. 2 p. 2-way, 3p. 2-way, short spindle, **2/6**; 5p. 4-way 2 wafer, long spindle, **6/6**; 2 p. 6-way, 4 p. 2-way, 4 p. 3-way, long spindle, **3/6**; 3 p. 4-way, 1 p. 2-way, long spindle, **3/6**; wavechange "MAKITS," 1 wafer, **8/6**; 2 wafer, **12/6**; 3 wafer, **16/–**; 4 wafer, **19/6**; 5 wafer, **23/–**; 6 wafer, **26/6.**
Toggle Switches, s.p., **2/–**; d.p., **3/6**; d.p.d.t., **4/–.**

JASON FM TUNER COIL SET, 26/–. H.F. coil, aerial coil, oscillator coil, two i.f. transformers 10.7 Mc/s, detector transformer and heater choke. Circuit and component book using four 6AM6, **2/6.** **Complete Jason FMT.1. Kit,** and Jason chassis with calibrated dial, **5gns.** 4 valves **20/–**

Valveholders. Pax. int. oct., **4d.** EA50, EF50, **6d.** B12A, CRT **1/3.** Eng. and Amer. 4, 5, 6 and 7 pin, **1/–.** MOULDED Mazda and int. oct., **6d.**, B7G, B8A, B8G, B9A, **9d.** B7G with can, **1/6.** B9A with can, **1/9.**
Ceramic, EF50, B7G, B9A, int. oct., **1/–.** B7G, B9A cans, **1/–** each. **Valve and TV Tube** equivalents **9/6**
TV Fault Finding, 5/–. Quality Amplifiers, 4/6.
Radio Valve Guide. Books 1, 2 or 3, **5/–** each.
TRANSISTORS. Ediswan Audio XB112, **10/–**, R.F. 2 Mc/s XA103, **15/–**; R.F. 4 Mc/s XA104, **18/–**. Red Spot **5/–**; White Spot **7/6.**
Sub-miniature Electrolytics (15V) 1μF, 2μF, 4μF, 5μF, 8μF, 25μF, 50μF, 100μF, **3/–.**

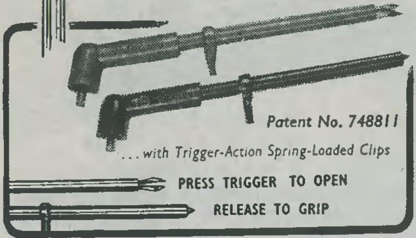
TELETRON POCKET RADIO KIT
Transidyne Superhet Six 6" x 4" x 1¾"
T.C.C. Printed Circuit, internal Ferrite aerial, Rola loudspeaker push-pull output. All parts, cabinet, 6 Ediswan transistors, GEX34 diode, **£9.9.0** Details **9d.**

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD WEST CROYDON — *Telephone* **THO 1665**

Our written guarantee with every purchase — Buses 133 or 68 pass door. S.R. Stn. Selhurst. — *Post and packing charge 1/–, over £2 post free. C.O.D. 1/6* — *(Export welcome. Send remittance and extra postage)*

For Safety's Sake use **AVO Prodclips**



Safety first every time with these patented spring-loaded AVO Prodclips.

Cleverly designed for use as insulated prods, they are invaluable for reaching and holding test points which are difficult of access.

Suitable for use with AvoMeter, Multiminor and Avo Electronic Test Meter Leads Post Free **15/–** per pair

AVO LTD AVOCET HOUSE
92-96 VAUXHALL BRIDGE RD., LONDON, SW1
VICtoria 3404 (12 lines)
A Member of the Metal Industries Group of Companies

2PC

ERSIN MULTICORE SOLDERS

Wherever precision soldering is essential, manufacturers, engineers and handymen rely on MULTICORE. There's a MULTICORE SOLDER just made for the job you have in hand. Here are some of them.

SAVBIT TYPE 1 ALLOY

A specially formulated alloy to reduce the wear of soldering iron bits. Contains 5 cores of non-corrosive Ersin Flux and is ideal for all soldering purposes.

SIZE 1 CARTON 5/-
Available in three specifications.

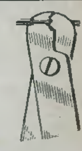
ERSIN MULTICORE

Contains 5 cores of extra-active non-corrosive Ersin Flux. Prevents oxidation and cleans surface oxides.

SIZE 1 CARTON 5/-

Bib WIRE STRIPPER AND CUTTER

Strips insulation without nicking wire, cuts wire cleanly, splits extruded flex **3/6 each**



The Home Constructors Pack, containing 19 ft. of 18 s.w.g. 60/40 alloy is available at 2/6d.

MULTICORE SOLDERS LTD.,
MULTICORE WORKS, HEMEL HEMPSTEAD, HERTS.
(BOXMOOR 3636)

★ VALVES NEW TESTED AND GUARANTEED

1R5	6/6	6X4	7/6	DK92	7/6	EL84	10/6
1S5	6/6	6X5GT	6/6	DK96	8/–	EL91	7/6
1T4	4/6	12AH8	10/6	DL92	6/9	EY51	9/6
3S4	6/9	12AT7	7/6	DL94	7/6	EZ40	6/6
3V4	7/6	12AU7	7/6	DL96	8/–	EZ80	6/6
5U4G	6/–	12AX7	9/–	EB91	4/6	EZ81	7/–
5Y3GT	7/6	12BH7	10/6	EBC41	9/6	PL81	13/6
5Z4G	9/–	12K7GT	8/6	EBF80	10/6	PL82	10/6
6AK6	6/6	12K8GT	13/6	ECC81	7/6	PY81	8/–
6AL5	4/6	12Q7GT	6/6	ECC82	7/6	PY82	7/–
6AM6	4/–	25A6G	10/6	ECC83	7/6	PCC84	9/6
6AT6	7/6	25L6GT	9/–	ECC84	9/–	PCF80	9/–
6BA6	8/6	35Z4GT	8/6	ECF82	11/–	PCF82	11/–
6BE6	7/6	35L6GT	9/6	ECH81	10/6	PCL82	7/6
6BR7	10/6	5763	10/6	ECH42	8/6	R19	12/6
6BW6	8/6	DAF91	6/6	ECL80	9/6	U76	8/6
6J7GT	8/6	DAF96	8/–	EF41	8/6	UBC41	10/–
6K7G	7/6	DF91	4/6	EF80	8/–	UCH42	10/6
6Q7G	7/6	DF96	8/–	EF86	9/6	UF41	10/–
6SL7GT	8/–	DH76	8/6	EF91	4/–	UL41	8/–
6SN7GT	8/6	DH77	7/6	EF92	5/6	UY41	8/–
6V6G	7/6	DK91	6/6	EL41	9/–	W76	8/6

Matched Pairs. EL84, **23/–**; EL85, **25/–**; 6V6G, **17/–**; 6BW6, **18/–**; KT33C, **19/6**; 807 **14/6** pair

SETS OF VALVES

DK96, DF96, DAF96, DL96, "REGENT"	**29/6** per set
DK91, DF91, DAF91, DL92, or DL94	**21/–** per set
1R5, 1T4, 1S5, 3S4, or 3V4	**21/–** per set
6K8, 6K7, 6Q7, 6V6, 5Z4, "G Types	**27/6** per set
12K8, 12K7, 12Q7, 35L6, 35Z4, GT Types	**35/–** per set
ECH42, EF41, EBC41, EL41, EZ40	**37/6** per set
UCH42, UF41, UBC41, UL41, UY41	**35/–** per set

P.P. Op. Transformers. MR 3–15 ohms for EL84, 6V6, 6BW6, etc., **13/6**; Op. Pen. 50mA, **5/6**; 30mA, **4/6**

★ **Volume Controls.** All values, long spindle. L/S **2/9**, s.p. **3/9**, d.p. 4/3; ext. spkr. control **3/–**

P.M. Speakers. 3 ohm 5" **16/6**, $6\frac{1}{2}$" **17/6**, 8" **21/–**, 10" **25/–**; 12" **30/–**, Bakers 12" 15 ohm 15W, **90/–**

Coaxial Plugs 1/– each; **Sockets 1/–** each

C.R.T. Isolation Transformers with nil, 25% and 50% boost, low capacity a.c. mains 200/250V for 2V 4V, 6.3V and 13V tubes. All **10/6** each. P. & P. 1/6

Valveholders. 4, 5, 7 pin English and U.S.A. B7G, 59A, 10, M0, B8G, **9d.** each; B7G, B9A with screening can, **1/6**; B12A, **1/3**; Aladdin formers $\frac{1}{4}$" with core, **8d.** each

Jack Plugs. Miniature standard **3/–**; **Sockets 3/–**

Capacitors. Small mica, 5% 1pF to 100pF, **8d.**; 120pF to 1,000pF, **9d.**; 1,000V wkg. .01, .0015, .0025, .004, .005µF, **1/–** each

Crystal Diodes. G.E.C., **1/6** each

Ceramic Capacitors. Close tol. 500V for V.H.F., **9d.**

Paper Tubular. .001–.1 500V, **9d.**; .25. **1/–**; .5, **1/6**; .01 1,000V, **1/–**

Paper Blocks. 4µF, 1,000 wkg., **3/6**; 4µF 250V, **2/6**

Rectifiers. Contact cooled, 250V 50mA, **7/6**; 85mA, **9/6**

Reaction Condensers. .0001, .0003, .0005µF **4/6** each

Heater Trans. 200/240V, 6.3V, 1.5A, **7/6**, 3A **10/6.**

Resistors. $\frac{1}{4}$ and $\frac{1}{2}$W, insulated, **4d.** and **6d.**; 1W, **8d.**; 6W W.W., **1/–**; 10W, **2/–**

Electrolytics. Wire ends. 25/25V, **1/6**; 50/50V, **2/–**; 12/50V, **9d.**; 8/450V, **2/–**; 16/450V, **2/9**; 16/500V, **3/6**; 32/450V, **4/–**; 8+8/450V, **4/6**; 8+16/450V, **4/6**; can types: 16/450V, **3/6**; 16+16/500V, **6/–**; 32/500V, **6/6**; 32/450V, **6/6**; 20+20/450V, **4/6**; 64+120/275V, **7/6**

Wavechange Switches. Midget: 1p 12W, 2p 6W, 3p 4W, 4p 3W, 4p 2W, long spindles, **4/6**

Toggle Switches. QMB, s.p.s.t., **2/–**; s.p.d.t., **3/3**; d.p.s.t., **3/6**; d.p.d.t., **4/–**; rotary s.p., **3/–**

Chokes. 65mA 10H, **5/6**; 80mA 15H, **8/6**; 100mA 10H, **10/6**; 150mA 10H **14/6** ★

P. & P. 6d., over £1 post paid. C.O.D. 2/6

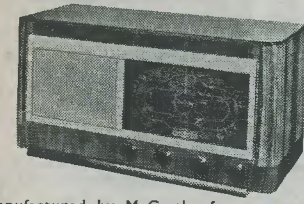
R. COOPER G8BX 32 SOUTH END CROYDON SURREY CROYDON 9186

CLYNE RADIO LTD.

ALL POST ORDERS AND CORRESPONDENCE TO
162 HOLLOWAY ROAD · LONDON N7
NOR 6295/6/7
18 TOTTENHAM COURT RD. LONDON W1
MUS 5929/0095
99 CHEAPSIDE · LONDON EC2
MON 6860

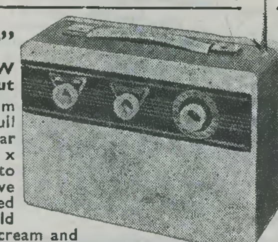
Specialists in Equipment for Home Construction (Send stamp for complete list)

FRUSTRATED EXPORT–Not Repeatable!
LONG, MEDIUM AND SHORT WAVES
SUPERHET RECEIVER



Manufactured by McCarthy for export. At present for operation on 6 volts, but conversion details supplied free. Valve line-up: 6K8G, 6K7G, 6Q7G, 6F6G, 6X5G and 6 volt 4-pin non-synchronous vibrator. 8" P.M. speaker, 4 watts output, p.u. socket, ext. l.s. socket, etc. Tone control. Fitted in polished wood cabinet, size $21\frac{3}{4}$" x $10\frac{1}{2}$" x $10\frac{3}{4}$". These cabinets are slightly soiled owing to storage, but each is guaranteed unused, in serviceable condition, tested prior to despatch. Price **£5.19.6** only plus P. & P. 7/6, plus **27/6** for A.C. Mains Conversion Components if required. **OUTSTANDING BUY!**

NEW! NEW!
The "Wavemaster"
7-Transistor Luxury Portable **400 mW output**



To build yourself! Medium and Long Waves Push-Pull Superhet A.V.C. Perfect Car Radio reception. Size 10" x $6\frac{3}{4}$" x $4\frac{1}{2}$" at base tapering to 4" at top. Very attractive two-tone Vynide covered cabinet with cream and gold printed escutcheon plate, cream and gold knobs, handle and cabinet fittings. Weight complete with long-life $7\frac{1}{2}$ volt battery—$4\frac{1}{2}$ lb. Mazda high-grade transistors throughout, high-flux 7" x 4" elliptical speaker, slow motion tuning, co-axial socket at rear for direct connection to car radio aerial. Improved reception by use of seven-section plated telescopic aerial disappearing into cabinet when closed, 34" above cabinet when fully extended. Construction simplified by bakelite chassis board with the following components already mounted: i.f. transformers (3), oscillator coil, trimmer bank, output transformer, interstage transformer, aerial brackets and earth bar. SPECIAL INCLUSIVE PRICE for all required components, full assembly instructions—nothing more to buy—is **£10.19.6** plus 3/6 P. & .P Alignment service available. Full assembly instructions and individually priced parts list, all of which are available separately 2/6 post free.

Premier RADIO

23 TOTTENHAM COURT ROAD LONDON W1 *Telephone* MUSeum 3451/2
and **309 EDGWARE ROAD LONDON W2** *Telephone* PADdington 6963

Dramatic Price Reductions

AVANTIC SPA11 10 watt (per channel) combined Stereophonic Amplifier and Pre-amplifier. Dimensions: $14\frac{1}{2}$" x $8\frac{3}{4}$" x 4".
Original Price 28 gns. **OUR PRICE 19 gns.** P. & P. 7/6.

AVANTIC SP21 Stereophonic Pre-Amp. Control Unit designed for use with the DL7-35 Power Amplifier. Power requirements 6.3V at 1.3A A.C., 250V at 5mA D.C. Dimensions $14\frac{1}{2}$" x 9" x 4".
Original Price £28.10.0 **OUR PRICE 18 gns.** P. & P. 5/–.

AVANTIC PL621 20 watt monaural Amplifier, frequency response 10 c/s-30 Kc/s 1dB. L.S. impedance, 4, 8, or 16 ohms. Dimensions 14" x $8\frac{1}{2}$" x $7\frac{7}{8}$".
Original Price 29 gns. **OUR PRICE 19 gns.** P. & P. 7/6.

AVANTIC DL7-35 Power Amplifier, power output 54 watts peak, Valve line-up: GZ34, 2—EL34, ECC83, EF86. L.S. impedance 4, 8, or 16 ohms switch selected.
Original Price 30 gns. **OUR PRICE £24.0.0.** P. & P. 7/6.

AVANTIC SL12-21 Speaker System employing 12" dia. P.M. L.S. and high frequency pressure unit in an accoustically designed enclosure. Dimensions 38" x $18\frac{7}{8}$" x $15\frac{7}{8}$". Finish matt medium walnut with front and sides covered with fawn fabric, standing on small contemporary legs.
Original Price 22 gns. **OUR PRICE £21.0.0.** P. & P. 20/-.

THE EASY-SIX 6-Transistor Battery Portable

May be built for **£9.15.0** plus 3/– p.p. Ever-Ready PP7 Battery extra 3/3

STAR FEATURES: six 1st grade Mullard Transistors, internal Ferrite Rod Aerial, provision for Car Radio Aerial, 5" Loudspeaker printed circuit, with component positions indicated, pre-assembled Dial Assembly, 500 milliwatts output, full medium and long waveband coverage, attractive two-tone Blue/Cream Vynide covered Cabinet dimensions $8\frac{1}{2}$" x $6\frac{1}{2}$" x 3", full point-to-point instructions supplied, weight—3. lb. with Battery.

The "MID-FI"

A NEW DESIGN $4\frac{1}{2}$ WATT AMPLIFIER KIT
95/– plus 3/– P. & P.

Technical specifications: separate bass and treble controls. Valve line-up EF86, EL84, EZ80. Voltage adjustment for a.c. mains from 200/250 volts, 3 or 15 ohms impedance. Negative feedback. Size 7" x 5" x 2", overall height 5". Silver hammered finished chassis.

All this Equipment is Brand New and in Manufacturers' Original Sealed Cartons
Full Descriptive Literature Available

The
Radio Constructor

Incorporating THE RADIO AMATEUR

AUGUST 1960

Vol. 14, No. 1

Published Monthly

Annual Subscription 25/- *(including postage)*

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9

Telephone
CUNningham 6141 (2 lines)

Telegrams
Databux, London

CONTRIBUTIONS on constructional matters are invited, especially when they describe the construction of particular items of equipment. Articles should be written on one side of the sheet only and should preferably be typewritten, diagrams being on separate sheets. Whether hand-written or typewritten, lines should be double spaced. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but all relevant information should be included. Photographs should be clear and sharp. Details of topical ideas and techniques are also welcomed and, if the contributor so wishes, will be re-written by our staff into article form. All contributions must be accompanied by a stamped addressed envelope for reply or return, and should bear the sender's name and address. Payment is made for all material published.

OPINIONS expressed by contributors are not necessarily those of the Editor or the proprietors.

TRADE NEWS. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

TECHNICAL QUERIES must be submitted in writing. We regret that we are unable to answer queries, other than those arising from articles appearing in this magazine; nor can we advise on modifications to the equipment described in these articles.

CORRESPONDENCE should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers, as appropriate.

REMITTANCES should be made payable to "DATA PUBLICATIONS LTD."

suggested circuits

No. 117. A Touch-plate, or Proximity, Detector

The Circuits presented in this series have been designed by G. A. FRENCH, specially for the enthusiast who needs only the circuit and essential data

As is well known by anyone who has carried out servicing work, touching the grid of an early valve in an a.f. amplifier with the finger can cause a hum to be heard from the associated loudspeaker. The signal passed through the amplifier by the application of the finger usually has a very complex waveform (as may be shown by examining typical samples on the screen of an oscilloscope), its basic frequency being at 50 c/s. It would appear that the amplitude of the signal varies according to the amount of unscreened mains wiring which exists in the immediate vicinity, the capacity between the body and such wiring causing the pick-up of the signal which is passed to the grid. In country districts remote from mains supplies the hum effect is absent, although it is possible for local electrical "noises", such as vibrator hash or car ignition noise, to be fed into the amplifier via body capacity when an early grid is touched.

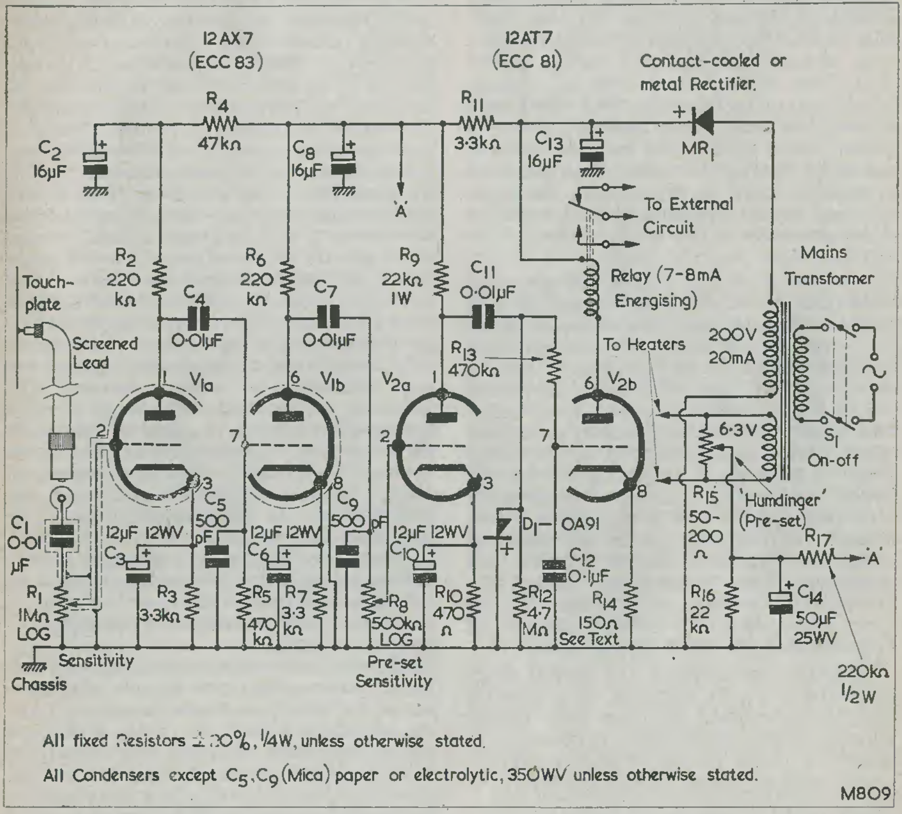
It occurs to the writer that this effect can be put to advantageous use for certain applications. Thus, if a small metal plate were connected to the grid of a sensitive a.f. amplifier whose output controlled a relay, it would be possible to operate that relay by merely touching the plate. Given sufficient gain in the amplifier, it would also be possible to operate the relay if the plate was closely approached, without actual contact being made. In the latter instance relay operation could conceivably be obtained when the distance between any part of the body and the touch-plate was as much as six inches. The practical applications of a device taking advantage of this effect fall, mainly, into a "novelty" classification; although serious uses can also be visualised. In the "novelty" category are such applications as the switching on of shop window displays when the hand of a person in the street is placed over a pick-up plate on the *inside* surface of the window; whilst, in the more serious class, are such uses as the switching on of warning devices when certain positions involving danger are inadvertantly approached. Other applications may be readily imagined.

The Circuit

The circuit of the device accompanies this article. The touch-plate, which causes operation of the relay when it is touched or approached, is connected, via screened cable and the isolating condenser C_1, to the sensitivity control R_1. The slider of R_1 connects to the grid of $V_{1(a)}$ whose anode, in its turn, couples, via C_4, to the grid of $V_{1(b)}$. $V_{1(a)}$ and (b) are the two high-mu triodes of a 12AX7 (ECC83) and, in cascade, provide a high degree of a.f. gain.

The anode of $V_{1(b)}$ couples, via C_7 and the pre-set sensitivity control R_8, to the grid of $V_{2(a)}$. The signal on the anode of $V_{2(a)}$ is applied to the shunt detector D_1, with the result that a negative potential, porportional to the peak amplitude of any a.f. signal on $V_{2(a)}$ anode, appears on the upper terminal of the diode. This negative potential is passed, via the filter R_{13}, C_{12}, to remove the a.f. component, to the grid of $V_{2(b)}$.

$V_{2(b)}$ is a relay energising valve and, in the absence of signal on the anode of $V_{2(a)}$, has a bias provided by the voltage dropped across cathode resistor R_{14}. In consequence, it passes an anode current of the order of 10mA, maintaining the relay in an energised condition. In the presence of signal of adequate amplitude at the anode of $V_{2(a)}$ the resultant negative voltage from diode D_1 causes $V_{2(b)}$ to cut-off, and the relay to de-energise. Thus, when the touch-plate is not touched or approached there is minimum signal at the anode of $V_{2(a)}$ and the relay remains energised. When the touch-plate is closely approached, or touched, the resultant amplified signal on the anode of $V_{2(a)}$ causes the relay to de-energise. Contacts of the relay then control the external circuit.



The valve employed in the V_2 position is a 12AT7 (ECC81), this type being chosen because it has a short grid-base, thereby enabling de-energising of the relay to occur for low signal level amplitudes at $V_{2(a)}$ anode. $V_{2(a)}$ is given cathode and anode resistor values which, whilst enabling it to function satisfactorily as an a.f. amplifier, are sufficiently low to cause it to pass a standing anode current of some 3 to 4mA. This standing current, together with the 1.5 to 2mA drawn by V_1 and the potentiometer R_{16}, R_{17}, provides a small, but helpful, degree of h.t. voltage stabilisation, catering for the instance when $V_{2(b)}$ anode current drops from 10mA to zero.

Due to the high degree of gain given by the amplifier stages of the circuit, and because inter-stage coupling components have values comparable with those employed for conventional a.f. applications, care has been taken to provide adequate decoupling and, thereby, prevent unwanted feedback. All cathodes are individually bypassed. At the same time, the h.t. supply is split into three sections: the section bypassed by C_2 which feeds the anode load of $V_{1(a)}$, the section bypassed by C_8 which supplies the anode loads of $V_{1(b)}$ and $V_{2(a)}$, and the section (providing an unsmoothed voltage immediately after h.t. rectification) which feeds the anode circuit of $V_{2(b)}$. In addition to providing adequate decoupling, it has been felt necessary to detect the signal voltage present on the anode of $V_{2(a)}$ with the aid of the separate diode, D_1, rather than to attempt leaky grid detection on the grid of $V_{2(b)}$ itself. In the circuit given here whatever detected signal is present on the anode of $V_{2(a)}$ is applied as a relatively steady direct voltage to the grid of $V_{2(b)}$, with the result that little a.f. voltage appears across the relay coil. If leaky grid detection on the grid of $V_{2(b)}$ were attempted, a high a.f. voltage would appear on its anode, with consequent risk of feedback. Such feedback could, of course, occur (and would be more likely to occur) for the condition when the touch-plate was not touched or approached, the signal on $V_{2(a)}$ anode consisting only of amplified noise generated in the early stages of the circuit.

In a device of this nature, self-generated noise can be troublesome because it may achieve sufficient amplitude at the anode of $V_{2(a)}$ for a constant and relatively high negative voltage to be permanently present on the grid of $V_{2(b)}$. This constant voltage would reduce the effectiveness of the circuit and might make relay operation unreliable. Much of the noise generated in the earlier stages is reduced in amplitude by the two 500pF condensers C_5 and C_9. Self-generated hum may also be a problem, and a "humdinger", R_{15}, is included in the design in order that hum level may be reduced to a minimum. The "humdinger" slider connects to the junction of R_{16} and R_{17}, at which point there is a positive potential of approximately 17 volts above chassis.

A final point concerns the crystal diode employed in the D_1 position. It is possible for this component to have high inverse voltages applied to it and it is necessary to specify a diode having a high maximum inverse voltage rating, such as the OA91.

Practical Points

The circuit should not cause any difficulties in construction provided that care is taken with layout. The stages should be positioned "in-line"; that is, the grid components of $V_{1(a)}$ should be at one end of the chassis and the mains transformer at the other, with the anode circuit of $V_{2(b)}$ next to it. Intermediate components in the circuit then take up intermediate positions on the chassis. Protection against hum pick-up from the heater wiring should be necessary in the V_1 stages only, and it would be very desirable to employ twisted wiring dressed close to the chassis in feeding the heater of this valve. Twisted heater wiring to V_2 and the "humdinger" should not be essential; but its use would be an added safeguard. All cathode bypass condensers should be mounted close to the valveholder tags to which they connect. The two electrolytic condensers, C_8 and C_{13}, may consist of a dual component mounted at the power unit end of the chassis. C_2, however, would preferably be a separate component mounted close to $V_{1(a)}$.

It will be noted that V_1 is screened as, also, is $V_{1(a)}$ grid circuit. It is especially important to keep heater wiring well away from $V_{1(a)}$ grid wiring. Provided care is taken in this respect it is probable that it will not be necessary to provide any screening around the sensitivity control, R_1, other than that given by connecting the metal work of this control to chassis, with its tags projecting outside the screening thereby provided. If a conventional coaxial socket is employed for the input connection it may be possible, here also, to dispense with any screening of the centre tag which projects back into the chassis. The series condenser, C_1, will, on the other hand, need to be completely screened, this being done either by putting it into a metal or foil tube or by using a metal cased component and connecting the case to chassis. The screening on the leads connecting together the compoents in the $V_{1(a)}$ grid circuit should extend close to the points to which their inner conductors connect. The grid circuit of $V_{1(b)}$ is liable also (but to a lesser extent) to pick up hum. In this case wiring should be short and kept well away from heater leads.

The diode D_1 has a maximum inverse voltage rating which increases as the ambient temperature around it reduces. It should, in consequence, be mounted in a relatively cool part of the chassis.

The relay in the anode circuit of $V_{2(b)}$ may be any conventional type capable of energising at the maximum anode current of $V_{2(b)}$. As calculated under the circuit conditions shown here (and assuming zero signal due to noise at the anode of $V_{2(a)}$) this current is of the order of 10mA. Such a current, for an anode voltage of 200, approaches the maximum rated dissipation of the valve; and it would be advisable to employ a relay capable of energising at some 7 to 8mA, rather than at 10mA, so that energising current is "in hand" without the risk of overrunning $V_{2(b)}$.

For most reliable operation, the chassis of the unit should be connected to earth.

Setting Up

After the device has been constructed it is necessary to test and set it up. The process of testing is carried out initially with no connection made to the input socket. A loudspeaker, connected via a conventional step down speaker transformer, is then coupled across R_9 so that initial performance may be checked aurally. The test loudspeaker should be fitted in a cabinet or on a baffle so that it gives adequate response at the lower frequencies.

The unit should be switched on and the sliders of R_1 and R_8 set to the tops of their tracks. Under this condition, background hiss with, perhaps, a trace of hum should be audible from the speaker. The slider of R_{15} should then be adjusted for minimum hum. Especial care should be taken to listen for hum at the fundamental frequency of 50 c/s. Some people find this frequency difficult to hear even when its presence can be *felt* by lightly resting the fingertips on the cone of the loudspeaker.

The centre contact of the input socket should now be approached by the finger. It should be possible, as the finger closely approaches the centre contact, to hear an obvious increase in hum. When the finger touches the contact, there should be a very obvious increase in hum level.

When the device has been checked in this manner and appears to be satisfactory, the test loudspeaker should be disconnected. It next becomes necessary to ensure that $V_{2(b)}$ is working under satisfactory conditions. This may be done by measuring its anode current, either by inserting a milliameter in its anode circuit or by measuring the voltage dropped across its cathode resistor or the relay coil and evaluating current by means of Ohms Law. With R_{12} short circuited the current drawn by $V_{2(b)}$ should be of the order of 10mA (differences from this figure being given by valve spread, and variations in h.t. voltage, coil resistance of the relay and, within the tolerance specified, value in R_{14}). The short circuit across R_{12} should next be removed whereupon the self generated noise and hum in the amplifier will be passed, in rectified form, to the grid of $V_{2(b)}$. Anode current in $V_{2(b)}$ may, in consequence, drop slightly. R_{15} should next be finally adjusted for maximum anode current in $V_{2(b)}$ (corresponding to minimum self-generated hum in the amplifying stages). If the drop in anode current after removing the short circuit from R_{12} is sufficiently high to prevent satisfactory relay energising, R_{14} should be reduced in value (to a minimum of 82Ω) until the desired anode current is obtained. If it is considered that noise (evident as hiss in the previous loudspeaker test) is being especially troublesome in reducing anode current in $V_{2(b)}$, its effectiveness may be reduced by fitting an additional condenser (having a value between 500pF and 0.01μF) between $V_{2(a)}$ anode and chassis. If, on the other hand, it is considered that self generated hum (again aurally evident in the previous loudspeaker test) is causing excessive reduction in $V_{2(b)}$ anode current, the efficiency of the screening in the input grid circuit, and other possible causes of hum, should be checked. It is possible to reduce the effect of hum and noise by adjustment of the pre-set sensitivity control R_8, but this step should only be taken when it is felt that no improvement can be effected elsewhere. Adjustment of R_8 at this stage causes a reduction in overall sensitivity. If R_8 *is* adjusted, it should be set to the position which causes the output valve to pass a satisfactory relay energising current with R_{14} reduced to 82Ω.

The Touch-Plate

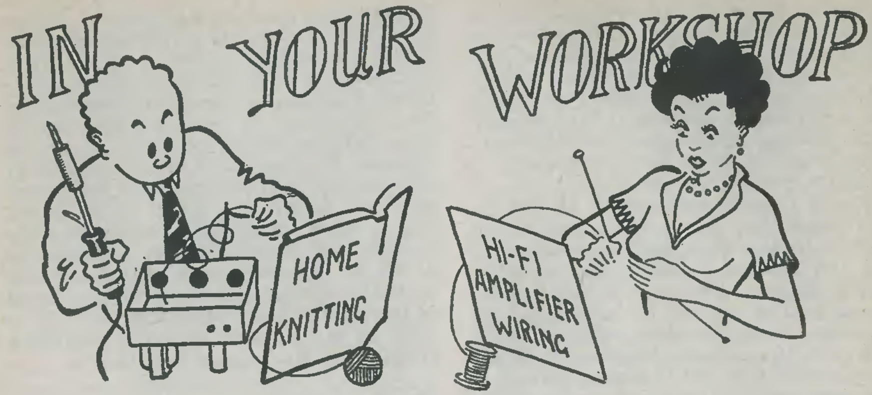
The touch-plate is connected to the input terminal of the device via good quality screened cable kept well away from unscreened mains wiring. It is difficult to specify a maximum length for the screened cable but it would be advisable to set a limit, during initial experiments, of some 10ft, this being increased later, if desired, in the light of experience. Some of the more inexpensive types of television coaxial cable may, incidentally, be unsatisfactory for this application due to coarse mesh in the outer braiding. A useful check of the efficiency of a particular type of cable consists of reconnecting the loudspeaker across R_9 and checking whether hum level increases when the outside insulation of the cable is firmly grasped by the hands. (The hands should not be allowed to make electrical contact to the screening during this test, as they will then become "earthed" and unable to pass any hum pick-up signal to the inner conductor.) A satisfactory cable will allow no increase in hum level to occur.

Provided that the touch-plate is kept well away from mains fields, and a satisfactory screened coupling cable is employed, their connection to the input socket of the detector should cause negligible increase in hum pick-up. *Slight* increases may be taken up by re-adjustment of R_8.

The touch-plate itself may consist of any metal plate having an area between 1 and 6 sq. ins. A touch-plate with too large an area will tend to pick up hum of its own accord. It should be well insulated from earth. (An alternative to a plate, which may be worthy of experiment, would be provided by a foot or two of thin gauge wire.) When the touch-plate has been connected the sensitivity control, R_1, is adjusted to give the desired degree of sensitivity according to whether the relay is to operate on touch or close proximity.

continued on page 24

IN YOUR WORKSHOP



This month Smithy the Serviceman and his able assistant, Dick, go through a complete servicing exercise clearing a fault in the flywheel sync circuits of a television receiver

"THERE ARE TIMES", SAID SMITHY, AS HE walked over to Dick's bench, "when I feel that sets with flywheel line sync circuits are something of a bore."

Dick looked a little startled. The greatest condemnation that Smithy ever expressed on any aspect of servicing was to call it a "bore".

"I'm awfully sorry, Smithy," he said meekly, "but I've done everything I can think of to do the repair myself."

"Not to worry, lad," said Smithy comfortingly. "I don't blame you at all. It's just that line flywheel sync circuits tend to have more obscure faults than do any other parts of a television set."

He looked with disfavour at the screen of the 17in receiver on Dick's bench. It presented an excellent picture which was marred only by a random horizontal jitter. For several seconds at a time the picture remained reasonably steady, after which it would suddenly jump sideways for half an inch or so and continue jittering horizontally with varying degrees of displacement until, after some further moments, the movement ceased and the picture again became reasonably steady.

"Irritating, isn't it?" said Dick.

"Well, at least", remarked Smithy philosophically, "it's an intermittent which seems to be present more or less all the time!"

Recapitulation

The Serviceman sat down heavily alongside his assistant.

"Right," he said. "Before going any further, let's recap on what has happened already. That'll help to get our minds clear."

"Okey-doke," replied Dick. "Here's the story up to date. The set came in with a customer complaint, which I thought very apt, of a 'flickering picture'. I hitched it on to the mains and found it gave exactly the same effect as we're seeing now. I recognised the set as a fairly recent model having flywheel sync and, before taking the chassis out of the cabinet, I substituted the valves in the flywheel sync and sync separator circuits for known good ones. There was no improvement so I put the old valves back. I wasn't going to lug out the chassis when it might have been a valve elsewhere, so I next tried swapping the line output valve and booster diode. But this gave no joy and I put the old ones back there, too."

"I think that's a very fair procedure," commented Smithy. "Any of the valves you mention could conceivably cause the jitter, and it would be silly to go to all the trouble of removing the chassis without exhausting the possibilities in that line."

"The story continues," said Dick, pleased with Smithy's approval, "and we next see the mad professor sitting quietly in his laboratory, pondering over the intricate equipment ranged about him."

Smithy cocked a suspicious eyebrow.

"I mean", continued Dick hastily, "that *I* was pondering. Now, although the set was giving this jitter all the time there were no flashes or changes of contrast, and no crackles or alterations in volume from the loudspeaker. So I ruled out, fairly confidently, that the power supply was O.K., and I didn't worry my head over the rectifier and its associated components. I did feel, though, that there was a faint risk that there might be a dicky connection to the deflection coils, and so I next waggled the leads which connected to these; but with no success. I finally bunged a yard or so of flexible wire into the centre connector of the coaxial aerial socket and held it near the chassis. I still got a picture capable of being recognised with this apology for an aerial, but I got no splashes on the screen which would indicate sparking in the line output stage. Including, especially, sparking in the line output transformer or deflector coils."

"Very good," commented Smithy. "You're really *inspired* this morning."

"This is one of my better days," said Dick, modestly, "when I am able to slough off the heavy domestic burdens and responsibilities which continually clatter about my slim and youthful shoulders, and am able to concentrate with undiminished power upon my work."

"The only domestic burden you've ever had", exploded the Serviceman, "has been the choice between green suede shoes with one inch or with one-and-a-half inch crepe soles."

"The one-and-a-half inch soles", Dick pointed out, "give better insulation. Anyway, having found that there were no splashes on the screen with my makeshift aerial—and having noticed incidentally that, even with such an aerial, the jitter was still present—I made my big decision of the day and, as the Americans put it, pulled the chassis."

Smithy nodded approvingly.

"I next", continued Dick, "lightly waggled the leads of the chassis components in the flywheel sync circuit to see if I could stumble on a cold joint type of fault but, once again, I had no luck." He paused, scratching his head. "Now what did I do next?"

"You called out for me," chuckled Smithy.

"So I did! Your first remark was to see whether the jitter existed on the other channel. Which it did. But I didn't understand why you asked me to make that particular check."

"Never mind," said Smithy, "Carry on."

"You next told me to do two things. First of all, to check any h.t. electrolytic which decoupled the line output stages or flywheel sync circuits or both. And this I did; but the jitter still remained."

"I heard you," interjected Smithy disapprovingly. "One of these days I'm going to impound that 100μF test-condenser-cum-detonator you so dearly love to splash across h.t. circuits. You know, 16μF or so is quite enough for that sort of thing."

"Secondly", Dick sailed on, "you suggested checking the line hold potentiometer for bad contact between the slider and the track, or for a worn track."

"Yes, that's right," confirmed Smithy. "Both bad decoupling electrolytics and crackly line hold pots have given me this sort of jitter in the past. How did you check the pot?"

"Well," said Dick, "I didn't go to the trouble of wiring in another as it was much easier to open up the existing one and examine its innards. Both the slider and track looked O.K. and I decided to put a spot of Electrolube on the latter just to make sure. I reasoned that if the connection between the slider and the track were poor the Electrolube mightn't effect a permanent repair, but it would at least give such an obvious immediate improvement that I could at once condemn the pot."

"That's a good idea," approved Smithy. "You *are* on form today!"

Logical Search

But, this time, Dick did not respond to the Serviceman's praise.

"Not really," he remarked disconsolately, "because I've come to the end of the story. I've tried all my own ideas, and I've tried your suggestions, and now we're up to the present time. And we've still got horizontal picture jitter."

He glared malevolently at the set.

"Don't take it too much to heart," said Smithy. "I said earlier that flywheel sync circuits became a bit of a bore every now and again, but that's only because it's so much more difficult to localise awkward faults in them than it is in other television circuits. There are two approaches now open to us. One consists of going mad and replacing every component in the whole circuit until we find the one which is causing the trouble. The other consists of putting our thinking caps on and attempting to track it down logically. I think we'll try the second approach. Hand me the service manual."

For once, Dick actually had the service manual for the receiver he was repairing in front of him; and he handed it over to Smithy without comment. Smithy studied it for a few moments.

"Well, it's not so bad," he remarked. "It uses a basic circuit arrangement common to practically all flywheel sync circuits which employ reactance valves, and it's of a type which was especially popular up to a year or two ago. The fundamentals of the circuit can, in fact, be drawn out quite easily in block form. (Fig. 1.) We have first of all a tuned circuit sine wave oscillator which, when all is working correctly, runs at line frequency. The output of this oscillator goes through a shaping circuit which gives it enough of a square wave or sawtooth characteristic to enable it to be fed to the grid of the line output valve. You will remember that the average line output valve only needs to become conductive about a third of the way along the scan so, provided the waveform allows this to happen *and* goes sharply negative at the end of the scan, it can have any old shape within reason you like. The shaping circuit, incidentally, can be in the oscillator valve itself: if you make the cathode and grid of a pentode act as an electron coupled oscillator and have a low-value anode load, limiting action will give you a square wave of sorts at that anode."

"Right!" continued Smithy. "Another output from the oscillator goes to a block which we'll call the 'comparator'. Also applied to the comparator are line sync pulses from the sync separator. The comparator compares the frequencies of the sync pulses and the sine wave oscillator, and generates a control voltage accordingly. If the sine wave oscillator is running at a higher frequency than the sync pulses, the comparator provides, say, a positive going control voltage, and if it is running at a lower frequency, a negative going control voltage."

"Or *vice-versa?*"

"Or *vice-versa*. Which way the control voltage goes depends on overall design and doesn't concern us here. Also fed into the comparator is a variable d.c. voltage from the line hold control. Adjusting the line hold control varies the centre control voltage from the comparator, and enables you to get the whole system on its correct operating point."

"It's getting a bit complicated now," complained Dick.

"Stay with it a little longer", grinned Smithy, "it gets easier from now on! I had better quickly add, before going any further, that I described the comparator as such since this part of the circuit is liable to vary in principle and design from set to set. Because of this, I used the blanket term 'comparator'."

"Well, I can understand *that!*" said Dick.

"Fair enough," chuckled Smithy. "Now we next apply the control voltage to a reactance valve. A reactance valve is one which has been made to function as a capacity or inductance by connecting a 90° phase-shift coupling between its anode and grid. Voltage and current in the anode circuit then flow 90° out of phase, just as they would do in a condenser or an inductance. A simple and cheap phase-shift coupling can be provided by connecting a condenser between anode and grid, whereupon the anode and cathode of the valve appear to an external circuit as a capacity. And you can vary that capacity by varying the bias on the grid."

A light of understanding was beginning to shine in Dick's eyes.

"You next", continued Smithy, "couple the variable capacity provided by the reactance valve across the sine wave oscillator tuned circuit, and you apply the control voltage from the comparator to its grid . . ."

"With the result", broke in Dick quickly, "that the whole thing becomes similar to an automatic frequency control system. If the sine wave oscillator runs faster than the sync pulse frequency, a control voltage is generated which varies the capacity provided by the reactance valve, and slows the oscillator down again. And if the sine wave oscillator runs slower than the sync pulses the control voltage brings it up again."

"You've got it," said Smithy. "And you set the whole business up initially by putting the line hold control in the middle of its travel and tuning the sine wave oscillator, with the aid of a slug in its coil, so that it's running exactly at line frequency. Minor deviations, caused by ageing and so on, can then be taken up by the line hold control potentiometer."

Dick's gleam of comprehension was replaced by a frown.

"But where does the flywheel business come in?"

"Ah," grinned Smithy. "The flywheel is provided by a resistor and a condenser! I've put them in my sketch but haven't drawn attention to them yet. The control voltage from the comparator passes through the filter given by the resistor and condenser with the result that there is a time delay, dictated by the time constant of the filter, before changes in control voltage affect the reactance valve. The filter provides the essential flywheel action because, if a spurious pulse caused by interference is passed to the comparator the resulting change in control voltage is not fed to the reactance valve immediately, and the sine wave oscillator runs on at the same speed. With direct sync the line time base would have been triggered by the spurious pulse and would have taken a line or two more to settle down again. With flywheel sync the sine wave oscillator presses serenely on at its own frequency, being capable of alteration at slow rates only."

Dick grimaced at the receiver on the bench which, during Smithy's explanation, had not ceased to exhibit its random line jitter.

"I wish", he remarked, "that the line

oscillator in *that* set was pressing serenely on!"

"We'll get down to the set in a jiffy," remarked Smith. "There are just two more points I want to deal with. Firstly, in many practical circuits you may find more than one resistance-capacity filter delaying the application of the control voltage to the reactance valve. However, the overall effect is just the same. The second point is that, in some circuits, a small flyback pulse from the line output stage is fed back, in a regenerative manner, to the grid or anode circuit of the sine wave oscillator in order to sharpen up the flyback pulse passed to the line output grid. Such a circuit is employed in the receiver we have here, and have I shown it in my sketch."

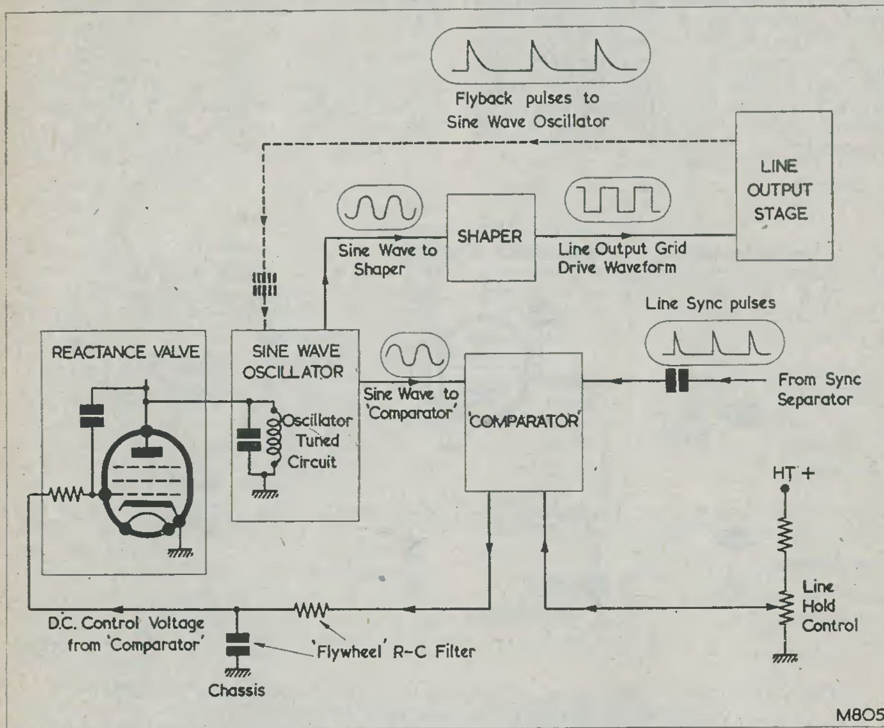


Fig. 1. A block diagram illustrating the operation of line flywheel sync circuits employing reactance valves. The flyback pulses from the line output stage to the oscillator are applied regeneratively to sharpen the line output grid waveform, the coupling being shown in dotted line since feedback of this type is not used in all receivers. Usually, the sine wave oscillator and shaper operations are carried out in one valve. In practice the anode of the reactance valve will carry an h.t. voltage, whereupon its connection to the oscillator tuned circuit will be via a blocking condenser. Alternatively, the earthy end of the oscillator tuned circuit may be connected to h.t. positive, being by-passed to chassis by a decoupling condenser

Fault-Finding

Smithy lit a cigarette.

"O.K.", he continued. "Having sorted the circuit out and spent a little time in explaining it, let's now get down to trouble shooting the line jitter in this particular set. I can think of no tool more useful to us at the present moment than a nice fat 0.5μF paper condenser with no leaks in it. Sort one out, Dicky boy!"

Smithy's assistant rummaged in the spares cupboard and produced a brand new component.

"That's what I like to see," approved the Serviceman. "A condenser with a nice clean wax overcoat which has been sullied only by your own grubby fingerprints!"

Now that he was actively coming to grips with the line jitter, Smithy's previous disgruntled mood had vanished as if by magic: he had become, indeed, positively jubilant.

"We must first assume", he announced, "that the jitter is being caused by an intermittent connection which may quite probably be in a component. Now, this intermittent connection *could* be in the sync separator circuits, whereupon it could cause such widely varying control voltages to be given by the comparator that even the time delay filter can't smooth them out. So, let us kill the sync! This we do by popping our 0.5μF condenser across the sync input to the comparator and chassis."

"No luck there," said Smithy. "The jitter isn't coming in from the sync separator. Incidentally, in some sets the application of my 0.5μF condenser might have so affected the sine wave oscillator that you wouldn't be able to get back on line frequency within the range of the line hold control. In such an instance you'd have had to open the circuit from the sync separator in order to kill the sync."

"What's the next step?"

"Well, we now know that the sync separator's above suspicion, so let's carry on to the comparator section. If there were a bad intermittent in this section this could also cause horizontal jitter despite the

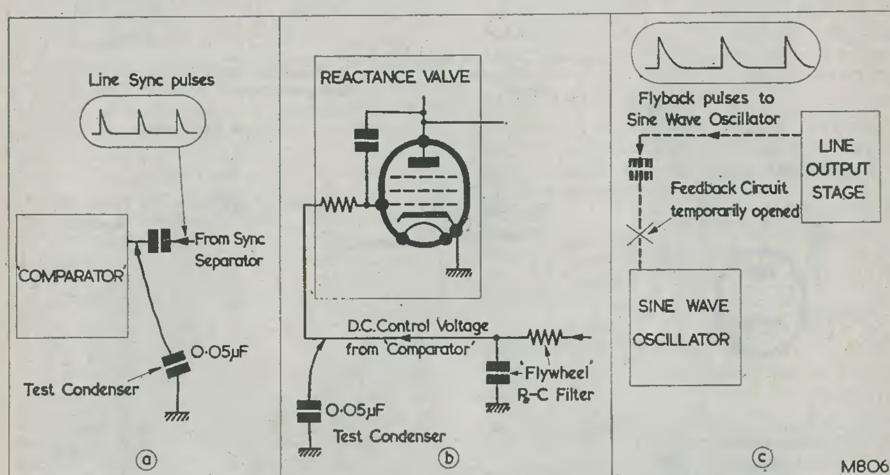


Fig. 2 (a) Smithy's first check, in clearing line jitter, consisted of temporarily by-passing to chassis the line sync input to the comparator
(b) Connecting the test condenser between chassis and the d.c. control voltage line checked for intermittents in the comparator circuits and the R–C filter
(c) Opening the flyback pulse feedback circuit ensured that jitter was not being fed back from the line output stage

Smithy applied his condenser (Fig. 2 (*a*)), whereupon the picture on the screen went immediately out of lock.

"If you carefully turn the line hold control a little", Smithy told his assistant, "you'll be able to get the sine wave oscillator running at line frequency."

Dick carefully adjusted the control and was able to resolve the unsynchronised picture fairly satisfactorily on the screen. Despite the fact that it was continually passing slightly in and out of true horizontal synchronism, both he and Smithy could see that the line jitter remained. Smithy removed his condenser, whereupon the picture jumped back to its previous condition.

smoothing action of the resistance-capacity filter. Alternatively, there might be a fault in the filter itself, with the result that it wasn't smoothing things out as well as it should do. We can check both of these eventualities by slapping our 0.5μF condenser between the smoothed control voltage and chassis."

Smithy re-applied his condenser, (Fig. 2 (*b*)), causing the picture to jump momentarily as the condenser charged to the control voltage. The picture reverted almost instantaneously to its original condition, and it still had the jitter.

"Well, that's not too bad," commented Smithy. "If the jitter had stopped or reduced

when I connected the condenser I would have started looking in the comparator circuits or in the resistance-capacity filter for intermittent connections. But as no change occurred we can continue to look elsewhere."

"What about the pulse fed back from the line output stage?"

"You know, *that's* not entirely above suspicion, either," remarked Smithy. "Unfortunately, I'd probably gum up the oscillator works if I tried to eliminate it with the 0.5μF condenser. In this case we'll have to open the circuit coupling the pulse back to the oscillator. Don't forget that this operation will cause us to lose the sharp flyback pulse on the line output grid."

Smithy switched off the receiver and disconnected one end of the condenser, coupling back the pulse from the line output stage. (Fig. 2 (*c*).) He switched on again, keeping his hand on the switch in case there was evidence of line output transformer overload. After a few moments a dim picture, indicative of low e.h.t., appeared on the screen. It was still accompanied by the line jitter. Smithy switched off quickly.

"Well, *that* didn't stop the jitter," he remarked as he re-soldered the coupling condenser into circuit. "By the way, I switched off quickly just to be on the safe side. I don't know what condition this particular line output stage operates in without proper drive, and I didn't want to take any risks."

Smithy switched the receiver on again and, as its screen displayed the same jittering picture as had appeared before his last experiment, he and Dick returned to the service manual.

"It's a pretty safe bet", said Smithy, "that due to our process of elimination we have now narrowed our search down to an intermittent in the reactance valve circuit or the sine wave oscillator circuit. There aren't all that many components to play about with here, and after a quick check for poor connections, we can start by substitution of components in order of unreliability. Rough check, this would put resistors of 1MΩ and up first, condensers second, and anything you like to follow."

"Well, the wiring seems O.K.", said Dick, making a careful visual check, "so perhaps we'd better start on components. To begin with, there's a 1MΩ grid leak to the oscillator."

"Fair enough," said Smithy. "Swop it."

Dick replaced the resistor and switched on again. The jitter remained.

"O.K.", commented Smithy. "What's next?"

"There are no more resistors of 1MΩ and up," said Dick. "So I suppose we'd better have a bash at the condensers."

"Righty-ho," said the Serviceman. 'Swap the easy ones first!"

"This one looks easiest," commented Dick, peering into the chassis. "It's a 50pF silver-mica connected between the anode and grid of the reactance valve. Which will, of course, be the phase-shift coupling for that valve."

"Take a stab at it then, boy," remarked Smithy grandiosely.

Dick wasted no time in removing the condenser.

"Will a ceramic 50pF do as a replacement?" he called out from the spares cupboard. "Otherwise it means two 25pF silver-micas in parallel."

"Use the silver-micas," replied Smithy. "They'll have a very low temperature coefficient and that's important in this particular circuit position."

Dick carefully connected the two 25pF condensers in parallel preparatory to inserting them in the chassis.

"What's the next component to try?" he remarked, as he soldered the condensers into circuit.

"The condenser across the oscillator tuned circuit would be worth trying," said Smithy. "It's a 0.003μF paper. You hunt one out while the set's warming up."

Smithy switched on and Dick returned to the spares cupboard.

"This means *three* condensers in parallel now!" he wailed after a moment. "We've only got 0.001's in stock."

"Forget it," grinned Smithy.

Dick rushed back to the bench and looked at his receiver. The picture it displayed was now as steady as a rock.

Transmitted Jitter ?

"Well, thank goodness for that," remarked Smithy's assistant, as he gazed happily at the set. "If you'd let me press on with that set on my own, it would still be there tomorrow! By the way, why *did* you ask me to check whether jitter was present on both channels?"

Smithy chuckled.

"You certainly never forget your questions," he laughed. "The point is that a lot of receivers with flywheel sync have long time constants in the flywheel filters, these extending to at least a frame or so. This set is one of them. I have a theory that, whilst such sets give perfectly steady pictures on camera and film programmes, they tend to suffer from jitter rather like that we've just seen when reproducing programmes which have been recorded on tape."

"I think I see what you're getting at," said Dick. "If the programmes are recorded on tape complete with sync pulses then mechanical shortcomings similar to 'wow' and 'flutter' in an audio tape deck will cause some of the sync pulses, together with the lines on either side of them, to be displaced out of their correct position in time."

"That's right," said Smithy. "If the receiver reproducing the picture has flywheel sync with a short time constant, say, twenty to forty lines or so, the discrepancies won't show up as badly as if the time constant is long. And, of course, they won't show up at all on receivers with direct sync."

Smithy paused.

"As I said," he concluded, "it's just a theory. Anyway, I think enough of it to suggest that if you ever start looking for line jitter on flywheel sync sets with long time constants it is a profitable exercise to ensure that it occurs with all programmes received instead of with some only. In your own particular case I assumed that the risk of having a taped programme on both channels at the same time was low."

Next Receiver

"I must remember that," said Dick, as he walked over to the rack and selected another television receiver for repair.

"This one's got flywheel sync as well," he added, as he plugged it into the bench socket and switched on. After some moments the set warmed up and exhibited a picture which was perfect except for one thing.

It had line jitter.

"Try the other channel," said Smithy, wearily. "You know, Dick, these sets with flywheel sync are *really* something of a bore."

In Your Workshop—June Issue

In the June issue, Smithy the Serviceman was incorrect in his calculations for resistance and capacity values for a three-section phase shift oscillator. These values should be found by: $f=\frac{1}{2\sqrt{6}\pi CR}$. Smithy's treatment would have been correct if the individual sections were isolated (say by valves); but in the circuit given each section is affected by the next.

Can Anyone Help?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

Radio Receiver Unit type 5019,: Ref. 110D/147.—G. M. King, 126a Portsmouth Road, Woolston, Southampton, Hants, would like to receive information, together with a circuit diagram, showing how this equipment may be converted into a Short wave communications receiver.

* * *

Hallicrafters Sky Buddy Receiver.—J. Parsons, 31 Cootes Lane, Middleton-on-Sea, Nr. Bognor Regis, Sussex, is urgently in need of the manual or circuit diagram of this receiver.

* * *

Signal Generator TF390G.—H. Lunson, 17 Tongdean Rise, Brighton, Sussex, would like to buy or borrow instruction manual and circuit diagram for this Marconi instrument.

Manuals and Circuits.—C. E. Woodrow, Haxted Mill, Edenbridge, Kent, would like to buy or borrow these for the following equipment—Bendix MN26 Radio Compass, RCA receiver CRV46151, a unit of aircraft radio equipment ARB. Mr. Woodrow has available manuals and circuits of the larger Bendix radio compass BC433 (SCR269) and of the DF circuits of the R1155—he would be pleased to lend these to any interested reader.

* * *

Ekco TV Model TU141 and TU142.—J. E. V. Henty, 24 Edward Way, Ashford, Middlesex, would be very grateful to receive, on loan or purchase, service sheets of these t.v. receivers to help solve problems which have arisen with both sets.

SUGGESTED CIRCUITS

(*continued from page* 17)

In some locations it may be found that the random radiated hum level due to mains wiring is low and that a low signal is, in consequence, passed to the detector when the touch-plate is approached or touched. The radiated hum level in such instances may be markedly increased by fitting an insulated wire connected to the live side of the mains some five feet or so away from the touch-plate.

UNDERSTANDING TELEVISION

PART 31

By **W. G. MORLEY**

The thirty-first in a series of articles which, starting from first principles, describes the basic theory and practice of television

In last month's issue we completed our examination of the deflection arrangements employed in television receivers. We shall now carry on to discuss the sync separator.

The Function of the Sync Separator

In order that the line and frame sawtooth generators of the television receiver may be kept in step with those employed at the transmitter it is necessary for the transmitted signal to carry synchronising information. This information is provided in the form of synchronising, or sync, pulses. It is the function of the sync separator in the reciever to remove the sync pulses from the transmitted signal, so treating them that line synchronising information is passed separately to the line sawtooth generator, the frame synchronising information being passed separately to the frame sawtooth generator. In *directly synchronised* receivers the line and frame synchronising information from the sync separator is presented to the sawtooth generators in the form of pulses and these initiate flyback. In receivers employing *flywheel sync* circuits the frame sawtooth generator, as in directly synchronised receivers, has its flyback initiated by the pulses passed to it by the sync separator; but the line sawtooth generator is synchronised in a different manner. Flywheel sync circuits are discussed later.

Fig. 13[1] illustrates the manner in which synchronising information is added to the transmitted signal employed in the British 405 line system. It will be seen that the synchronising pulses take up a position below blanking level. Picture information appears between white level and black level (the latter being 5% of full amplitude above blanking level). In consequence, all sync pulse information is at a lower level than black level and does not, therefore, enter the range of signal amplitudes which modulates the cathode ray tube beam.[2]

Fig. 13 is concerned mainly with the frame blanking period at the end of each frame, and the synchronising waveform occurring therein. The purpose of the latter is that of initiating flyback in the frame sawtooth generator. Fig. 13 also illustrates several line sync pulses before and after the frame blanking periods. Line sync pulses appear, between the frame blanking periods, at the end of each line of transmitted picture information, and a series of such pulses is shown in Fig. 186.[3]

Sync Clipping

Fig. 187 (*a*) illustrates a pentode to the grid of which a signal containing positive going sync pulses is applied by way of a series condenser and grid leak. The cathode of the pentode is connected to chassis and leaky-grid action takes place, the series

[1] Originally published in "Understanding Television", part 3, March 1958 issue.

[2] This assumes an "ideal" receiver. The possibility of sync pulse information interfering with the picture presented by practical receivers is discussed in a later article.

[3] A fully dimensioned waveform for the 405 line system sync pulse was given in Fig. 15 of "Understanding Television", part 3, March 1958 issue.

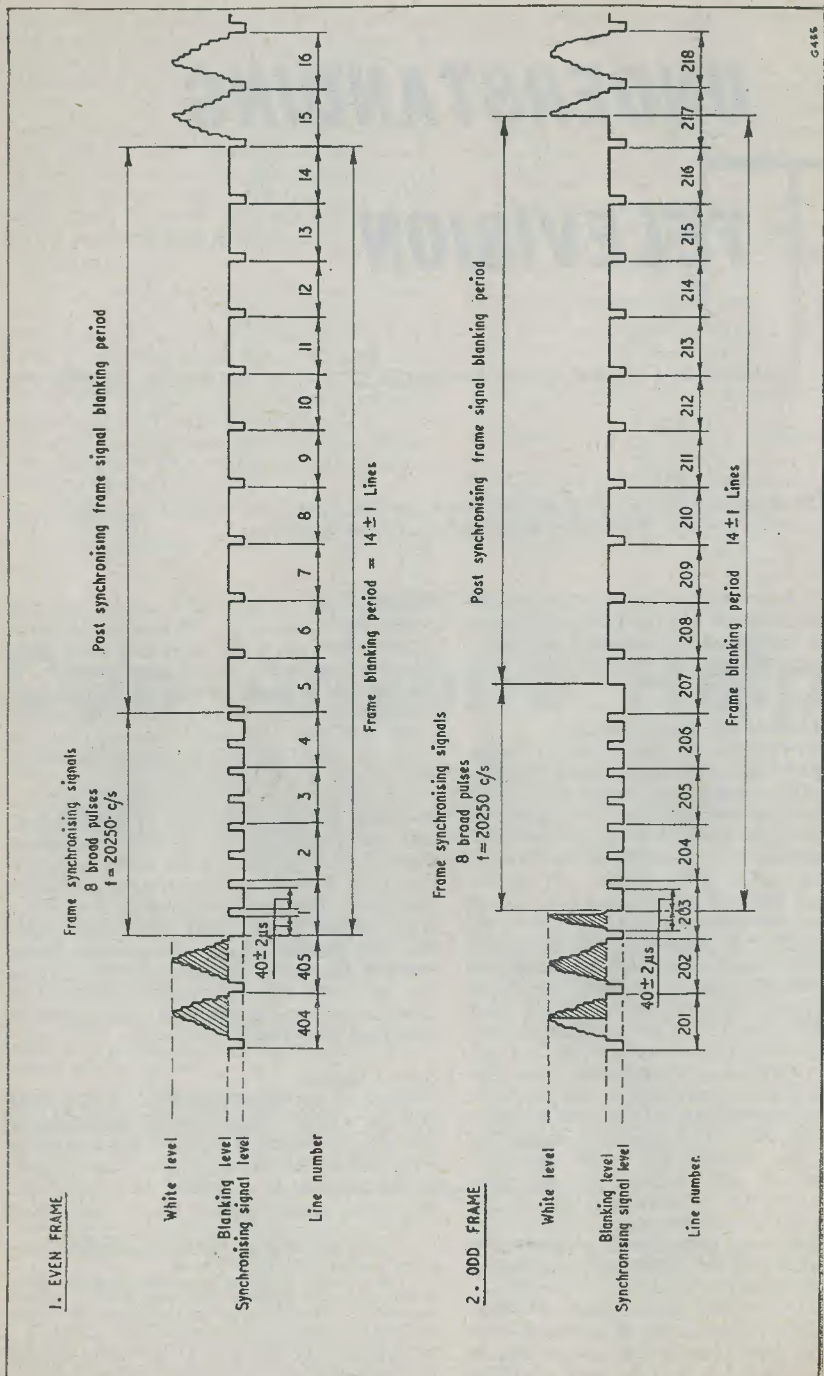


Fig. 13. Synchronising waveform of the 405 line system. The shaded part of the signal may consist either of picture information, as shown, or it may be occupied by a blanking period up to 2 lines in length

condenser taking up a charge such that the most positive parts of the input waveform (the sync pulse tips) assume a potential slightly positive of the pentode cathode. The pentode cuts off at a point approaching, but not exceeding, blanking level in the input signal, with the result that it handles no picture information. Inverted sync pulses then appear, on their own, at the anode of the pentode.

The clipping action is shown in more detail in Fig. 187 (*b*), wherein we see the video signal applied to the I_aV_g characteristic of the pentode. Since the picture information appears beyond cut-off point, the pentode anode current is varied only by the sync pulses.

A circuit arrangement of this nature is known as a *clipper*, the name being derived from the fact that it "clips" off, at a pre-determined level, part of the signal applied to it. In Fig. 187 (*b*) the grid cut-off point for the pentode is identified as *clipping level*, because it is at this point that clipping of the signal takes place.

It should be noted that, to obtain pulses at the anode of the clipper, clipping level need not necessarily extend right up to the blanking level of the input signal. Indeed, it might appear at first sight, that satisfactory sync pulses would be given at the clipper anode if clipping level were as close to the sync pulse tips as, say, point X in Fig. 187 (*b*). In practice, however, the sync pulses passed to the sync separator tend to be rounded, as in Fig. 187 (*c*), and it is desirable to clip reasonably close to blanking level in order that full advantage may be taken of the vertical edges of the pulses. Another complicating factor is that, in a practical receiver, the amplitude of the sync pulses applied to the clipper may vary; due to the fact that weak video signals will, naturally, carry pulses of lower amplitude than those given by strong video signals. If clipping level were, therefore, positioned close to blanking level for the sync pulses carried by strong signals it would extend beyond blanking level and into picture information for the sync pulses given by weak signals. Under normal working conditions, the weakest video signal likely to be encountered in the receiver is that which is capable of just resolving a picture of minimum entertainment value on the cathode ray tube screen; whilst the strongest video signal likely to be encountered is that resulting from maladjustment of the receiver contrast control whereby an over contrasted picture (one having excessive amplitude) is fed to the cathode ray tube modulating electrode. The best compromise to cover these conditions would consist of choosing a clipping level which closely approached blanking level for the weakest signal likely to be encountered, accepting the fact that only part of the sync pulse vertical edges would be handled for the strongest signal.

The circuit arrangement shown in Fig. 187 (*a*), wherein leaky-grid action with a pentode causes sync pulse information to be clipped from the composite video signal, is that which is most frequently employed in current television receivers. It has the advantage that few components are required and that sync pulses of good amplitude are available at the anode for further manipulation. The voltage at which grid cut-off occurs, i.e. the clipping level, is obviously important, and this is capable of being controlled (after the initial selection of a valve having suitable characteristics) by varying the potentials at the anode and screen-grid.

We have observed earlier[4] that it is desirable to feed a video signal with positive

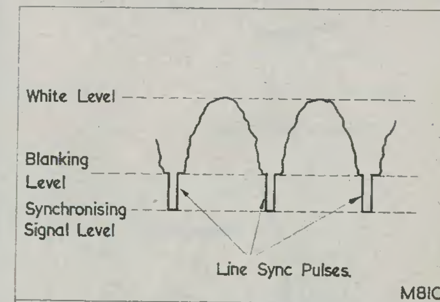


Fig. 186. Between frame blanking periods the line sync pulses appear at the end of each line as shown here

going sync pulses to the cathode ray tube modulating electrode, because this enables the associated sync separator circuit to be particularly simple and inexpensive. We may now see more clearly what that statement inferred: that feeding such a video signal to the cathode ray tube enables the simple clipping circuit of Fig. 187 (*a*) to be employed. If we combine the video amplifier anode circuit and the sync clipper input circuit we obtain the arrangement shown in Fig. 187 (*d*). This circuit arrangement is typical of current receiver practice. In Fig. 187 (*d*) the video signal on the anode of the video amplifier valve is applied to the cathode of the cathode ray tube and to the series grid condenser of the clipper, the negative going picture information in the signal having the polarity required for cathode modulation of the tube, and the positive going sync pulses having the

[4] In "Understanding Television", part 18, July 1959 issue.

polarity required for correct operation of the clipper. The series resistor shown in Fig. 187 (*d*) is almost always employed in practical applications, and it prevents the input capacity of the clipper valve from being applied directly across the video output load (whereupon video response at the higher frequencies might be reduced). The value of the series resistor is normally of the order of 5 to 10kΩ.

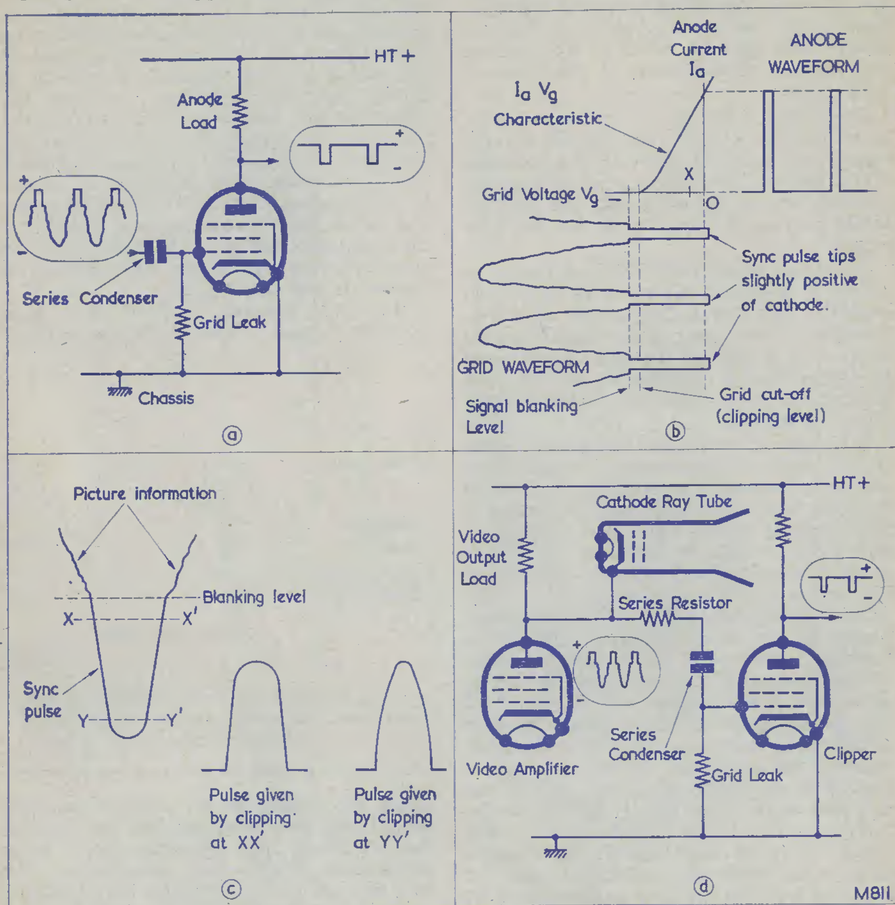


Fig. 187 (a) A sync clipping circuit. Due to the series condenser and grid leak the tips of the sync pulses take up a position on the pentode grid which is slightly positive of cathode. If the valve cuts off above blanking level the anode current is varied by sync pulses only

(b) Illustrating, with the aid of its I_aV_g characteristic, the action of the clipper valve. It may be seen that anode current is at maximum when sync pulses are present at the grid, and at zero when sync pulses are absent

(c) In practice, the sync pulses applied to the grid of the clipper tend to be rounded (as shown here in somewhat exaggerated form). It is desirable, therefore, to clip close to blanking level in order that a high proportion of the vertical edges appear at the anode of the clipper. The two pulses on the right represent those given at the clipper anode for different clipping levels

(d) When the video amplifier feeds negative going picture information to the cathode of the cathode ray tube, positive going sync pulses with good amplitude become available for the sync clipper

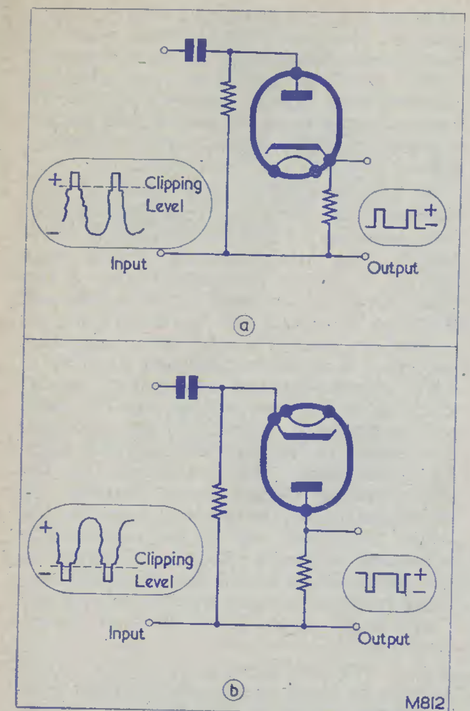


Fig. 188 (a) A simple diode clipper. If suitable values are provided for the condenser and resistors, the diode conducts in the presence of sync pulses only

(b) In this clipper circuit the polarity of the input signal and the diode of (a) are reversed

It is possible to provide clipping action by means of circuits other than that shown in Fig. 187 (*a*), and some of these may occasionally be encountered in practice. Fig. 188 illustrates two fairly typical examples. In Fig. 188 (*a*) we have a diode to whose anode is fed video information containing positive going sync pulses. In the same manner as occurred with the leaky-grid clipper, the series condenser becomes charged such that the most positive points of the waveform take up a position slightly positive of the diode cathode. In this case, however, the cathode is connected to chassis via a resistor instead of a direct connection. The result is that the cathode follows the more positive parts of the waveform applied to the anode. By judicious selection of component values in the circuit it is possible to cause the series condenser to take up a charge which allows the diode to conduct only when the input waveform is at a predetermined level above blanking level. In consequence only the sync pulses appear across the cathode resistor, and the function of a clipper is achieved. The circuit of Fig. 188 (*b*) functions in the same manner as that of Fig. 188 (*a*), the diode and the polarity of the input waveform being reversed. In both cases, the thermionic diodes shown may be replaced by germanium or silicon diodes.

It was stated above that the sync-separation clipper is usually fed from the anode of the video amplifier valve. The main advantage of this arrangement is that, under normal conditions, the sync pulses have greater amplitude at the video amplifier anode than anywhere else in the receiver; with the result that clipper stage design and component tolerances become eased accordingly. Nevertheless, instances wherein the sync separator circuits fed from points other than the video

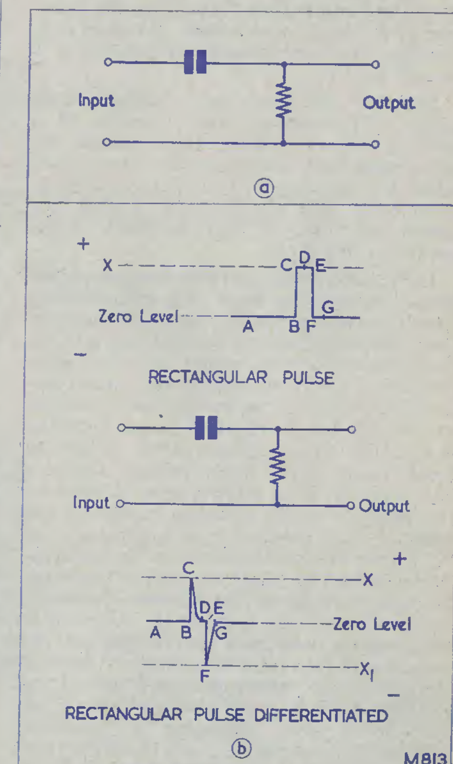


Fig. 189 (a) A differentiating circuit. The values of the condenser and the resistor are discussed in the text

(b) Differentiated pulses are given when a single rectangular pulse is applied to the input terminals of the circuit

amplifier anode may occasionally be encountered, a typical instance being where the sync clipper is fed from the video detector stage.

Differentiation

The transmitted synchronising information in the 405 line system has the waveform shown in Figs. 13 and 186, and it appears, divorced from the picture information, on the anode of the sync clipper. As it stands, this waveform cannot be passed directly to the line sawtooth generator because the latter would fall out of synchronism during the period when the broad frame synchronising pulses are being transmitted, with the result that a number of lines in the succeeding frame would be out of position until the line sawtooth generator fell into synchronism again. It is necessary, therefore, to so process the sync waveform that the line sawtooth generator receives suitable synchronising information throughout the duration of the frame sync pulses. We shall now consider how such waveform processing is carried out.

Fig. 189 (*a*) illustrates a *differentiating circuit*. This consists, quite simply, of a series condenser followed by a resistor, the two components being given values which allow the condenser to discharge partly or completely into the resistor during the length, in time, of any particular pulse applied to the input.

In Fig. 189 (*b*) we apply a simple rectangular shaped pulse to the input of a differentiating circuit whose component values are such that the condenser discharges completely into the resistor within the period of the pulse. Observing the input waveform, and commencing at point A, we see the input potential at a steady zero level. The output potential is similarly steady at zero level. When we reach point B the input voltage suddenly rises to point C, at positive level X. Due to the presence of the coupling condenser the output voltage similarly rises to positive level X. However, the condenser in the differentiating circuit at once commences to charge to pulse voltage via the resistor, becoming completely charged at point D. At point D the output is once more at zero level and the pulse has not yet come to an end. At point E the pulse ceases, whereupon the input voltage suddenly falls from positive level X to F, at zero level. The condenser is, however, charged to pulse voltage, with the result that, as its left hand plate drops suddenly to zero level, its right hand plate drops to negative level X_1. The condenser at once begins to discharge into the resistor with the consequence that, at point G, the output voltage is at zero level again. Summing up it may be seen that, by applying the rectangular pulse to the differentiating circuit we have obtained two spike shaped pulses, the first having the same polarity as the rectangular pulse and the second having opposite polarity. The leading edges of both spike shaped pulses have the same form as the leading and trailing edges of the rectangular pulse.

In the explanation just given it was assumed that, between rectangular pulses, both input and output voltages are at "zero level". The differentiating circuit will operate in exactly the same manner if the "zero level" of the input pulse is removed from the "zero level" of the output pulse by a fixed voltage. The only difference then occurring is that the condenser acquires a fixed charge between rectangular pulses, charging to the fixed voltage plus the pulse voltage during the duration of the pulse and discharging to the fixed voltage again after its termination. The condenser of the differentiating circuit could therefore be connected to, say, the anode of a sync clipper whilst the lower end of the resistor was connected to chassis. Rectangular pulses on the clipper anode would then cause differentiated pulses to appear across the resistor, the "zero level" of the latter being at chassis potential.

Fig. 189 (*b*) showed a positive going rectangular pulse. A negative going rectangular pulse would be differentiated by the circuit in just the same manner, the only dissimilarity being that the first spike shaped pulse would now be negative going and the second positive going.

Synchronising with Differentiated Pulses

Let us now examine the sequence of events when we apply differentiated line sync pulses to the line sawtooth generator of the receiver.

In Fig. 190 (*a*) we see a grid waveform typical of any unsynchronised line sawtooth generator. When, in Fig. 190 (*a*), the grid voltage reaches cut-off potential the scan period of the associated oscillator ceases and flyback commences. In Fig. 190 (*b*) we apply our differentiated line pulse to the oscillator such that the first spike shaped pulse is positive going. This pulse causes the grid to rise above cut-off level with the result that flyback is initiated. The second, negative going, spike shaped pulse arrives slightly before, or shortly after, the end of the flyback period and it has, generally, no effect on sawtooth generator performance.[5] Thus, the flyback period of the line sawtooth generator oscillator is initiated by the leading edge of the first differentiated pulse, this leading edge corresponding exactly, in shape and time, to the leading edge of the original rectangular line sync pulse accompanying the picture information. The differentiated pulse may, in consequence, be used for synchronising the line sawtooth generator.[6]

[5] This is true for a blocking oscillator. If the second spike shaped pulse of a differentiated rectangular pulse is fed to a multivibrator, before the end of the flyback period, it may initiate the scan period. If it is fed to a multivibrator after the flyback period, it has no effect. In consequence, it is desirable to design the multivibrator such that its flyback period is shorter than the length of the sync pulse. Occasionally, the second spike shaped pulses are clipped from the differentiated waveform.

[6] If the line sync pulse happens to be negative going, the first spike shaped pulse from the differentiating circuit will be similarly negative going. The line sawtooth generator may be synchronised by this negative going pulse if it is applied to a suitable point in its circuit. Synchronising with positive going and negative going pulses was discussed in "Understanding Television", parts 23 and 24, December 1959 and January 1960 issues.

ing signals shown in Fig. 13. Fig. 191 (*a*) illustrates the result of differentiation for even frames, and Fig. 191 (*b*) the result for odd frames. Commencing, in Fig. 191 (*a*), with the lines before the frame synchronising signals, we see that we obtain differentiated line sync pulses in the manner we have already discussed. In the diagram the leading edges of the line sync pulses are downward going, with the result that the first spike shaped pulse in each differentiated pair is also downward going. It is the downward going spike shaped pulses which will be used to initiate flyback in the line sawtooth generator, and the upward going spike shaped pulses can be ignored.

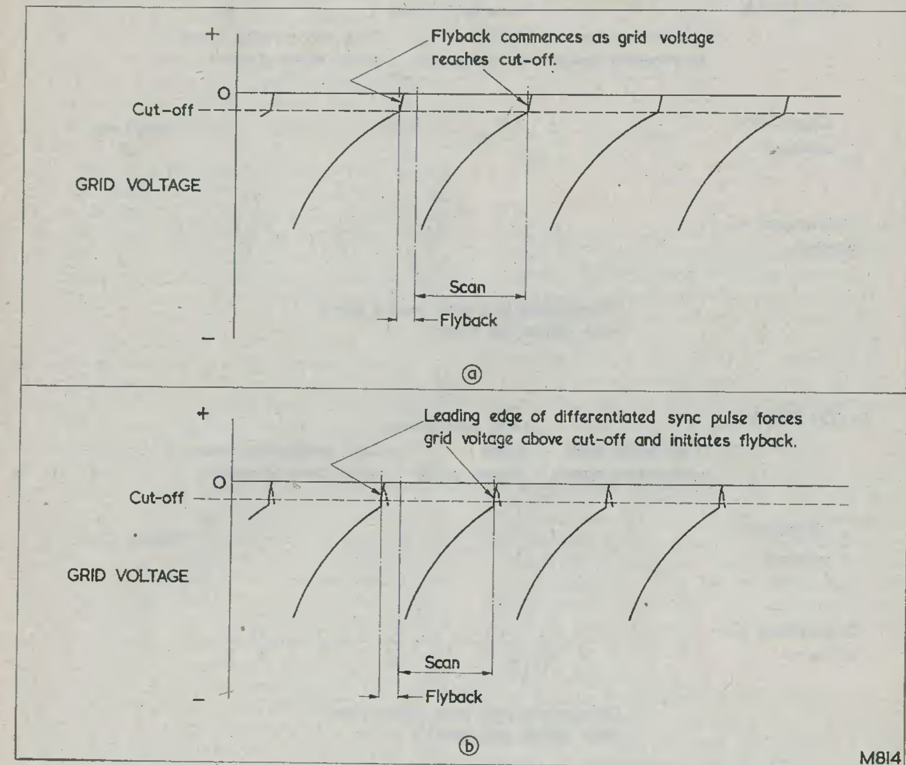


Fig. 190 (a) Typical grid waveform for the oscillator of a sawtooth generator. The flyback section is omitted in the diagram as this varies for different types of oscillator

(b) Illustrating how the leading edge of a differentiated sync pulse carries grid voltage above cut-off level, thereby initiating flyback

Differentiating the Frame Sync Pulses

Let us now differentiate the waveforms associated with the 405 line frame synchronis-

When, at A in Fig. 191 (*a*), we reach the first broad frame sync pulse we have a downward going leading edge, and we obtain a differentiated pulse which is similarly downward going. The transmitted frame sync pulse continues until we reach point B, whereupon the pulse ceases. At once, at this point, an upward going differentiated spike shaped pulse appears. At point C we have the leading edge of the next downward going frame sync pulse, with the formation of another downward going differentiated pulse. At point D, the end of the second frame sync pulse provides a further upward going differentiated pulse. This procedure is

At point P in this diagram we have the downward-going leading edge of the last line sync pulse before the frame sync pulses commence. A period equal to half a line follows point P, whereupon we have the leading edge, at Q, of the first frame sync pulse. A corresponding downward going differentiated pulse appears below. The end of the first frame pulse at R causes the next upward going differentiated pulse; to be

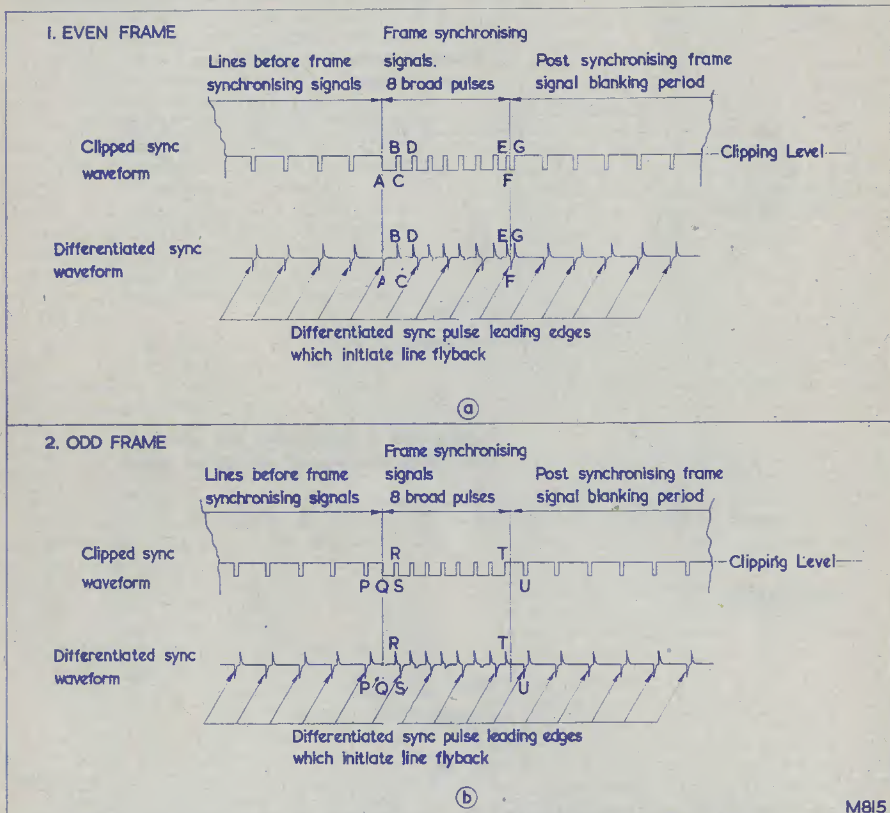


Fig. 191 (a) The result of differentiating the waveform around the even frame synchronising signals of Fig. 13

(b) Differentiating the waveform around the odd frame synchronising signals

repeated for each frame sync pulse until, at point E, the last frame pulse ceases, to be followed by a conventional line sync pulse, FG. The resulting differentiated pulses are shown below. After point G we have a blanking period in which line sync pulses appear at normal line intervals just as they did before point A.

A slightly different state of affairs occurs for the odd frame waveform of Fig. 191 (*b*).

followed, at S, by the next downward going differentiated pulse. The process continues until we reach point T, where the end of the last frame pulse causes the formation of an upward going differentiated pulse. At point U we have the leading edge of a normal line sync pulse, this pulse being followed by further line sync pulses with normal spacing.

We can now see the differentiated pulses occurring around the frame sync pulses for

both even and odd frames. Commencing with an examinatjon of the even frame pulses first (Fig. 191 (*a*)) we have an example where, before the commencement of the frame sync pulses, the line sawtooth generator is synchronised by downward going differentiated sync pulses space at intervals of one line. After point A, however, the downward going pulses are spaced at half-line intervals. What happens then is that the line sawtooth generator has its flyback initiated by the first downward going differentiated pulse, is unaffected by the second, has its flyback initiated by the third, is unaffected by the fourth, has its flyback initiated by the fifth, is unaffected by the sixth, and so on; until, after point F, the downward going differentiated pulses revert to normal line spacing. The pulses which initiate flyback are indicated in Fig. 191 (*a*).

In Fig. 191 (*b*) the last downward going differentiated pulse at regular line spacing occurs at point P. The first downward going differentiated pulse given by the frame pulses appears at Q. The line sawtooth generator is unaffected by this first pulse, has its flyback initiated by the second, is unaffected by the third, has its flyback unitiated by the fourth, and so on, until it reaches point T, after which downward going pulses spaced at normal line intervals commence once more. Again, the pulses which cause the initiation of flyback are indicated in the diagram.

Considering the two waveforms generally, it may now be seen that, although the frame sync pulses have exactly the same shape and number for both odd and even frames, they still allow the line sawtooth generator to remain in a synchronised condition. In Fig. 191 (*a*) the line sawtooth generator has its flyback initiated, during the frame sync pulses, by the first, third, fifth, seventh and ninth differentiated pulses; and, in Fig. 191 (*b*), the line sawtooth generator has its flyback initiated by the second, fourth, sixth and eighth differentiated pulses.

The fact that the line sawtooth generator may be synchronised by alternate half line pulses becomes readily evident if Fig. 192 is examined. In this diagram the grid waveform of Fig. 190 (*b*) is repeated, with intermediate half line pulses added. Since the grid voltage, when the intermediate pulse appears, is markedly more negative than when the second flyback-initiating pulse appears, the intermediate pulse does not raise grid voltage above cut-off level and does not, in consequence, affect the running of the sawtooth generator.

It should be pointed out that, under certain circumstances, and particularly if the differentiated sync pulses have large ampli-

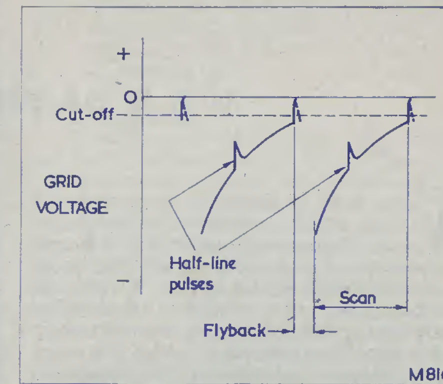


Fig. 192. During the frame synchronising period, differentiated half line pulses are fed to the line sawtooth generator. Since the oscillator grid voltage is considerably more negative, when these pulses appear, than when it is near the end of the scan period, they do not raise grid voltage above cut-off level and do not, therefore, initiate the flyback period. This diagram should be compared with Fig. 190 (b)

tude, it may be possible to find a setting of the line hold control whereby the line sawtooth generator has its flyback period initiated by the half line pulses. Such a line hold control setting will cause an obvious loss of line synchronisation at the top of the picture (i.e. immediately after the end of the frame blanking period) and would automatically be avoided.

Next Month

In next month's article we shall carry on to frame synchronising circuits. This article will refer to Fig. 13, and this month's issue should in consequence be retained.

Reference

The information given in Fig. 13 is taken from Report No. 83, Television Systems; Extract from the documents of the C.C.I.R. VIIIth Plenary Assembly, Warsaw, 1956. The term "field", where it appears in extracts from the report, has been changed to "frame".

QUIZ RIGGING LEGISLATION

The U.S. House of Representatives recently (28th June) approved a Bill against those engaging in deceptive programmes of the type exposed by a Congressional investigation of television quiz programmes and "payola".

The Bill, which now goes to the Senate, is designed to provide a maximum penalty of one year's imprisonment and a fine of $10,000 (approximately £3,600) for those failing to disclose that payment has been made for broadcast material or if they engage in rigged programmes. The penalty applies to both broadcasting stations and members of their staff.

Choosing a Valve

By J. B. DANCE, M.Sc.

The number of different types of valve from which a constructor can choose has now become so great that it is only possible to discuss some of the more important points in this article. A valve has to be chosen not only for its electrical performance but also for the ease with which it fits into the apparatus in which it is to be used. Obsolete and replacement types should be avoided in new equipment as difficulty may be experienced in obtaining replacements at some future date.

General Remarks

One of the most important characteristics of a valve is its heater voltage, or, in the case of a.c./d.c. equipment, its heater current. In equipment using a mains transformer, all of the valves are connected with their heaters in parallel and therefore the heater voltage of each valve must be the same; the most common value is 6.3 volts. When this type of heater connection is used the current taken by each valve may be different. Power valves, for example, require more heater power because they have a larger cathode which must be kept hot; this extra power is obtained by taking more current than the other valves. Directly heated valves with 1.4 volt heaters are made for operation from dry batteries; the heater power required is usually very small. In equipment for a.c./d.c. operation a mains transformer is not used, the valve heaters being connected in series. In this case the heater current for each valve must be the same (often 0.3 or 0.15 amp). Valves which require more power than the others have a heater with a higher working resistance and therefore a higher voltage is developed across the heaters of these valves. Thus the PL82 has a 16.5 volt, 0.3 amp heater. The heater voltage supply to any valve should be correct to within 5%.

Care must be taken that the maximum heater-cathode voltage rating of a valve, as indicated in the appropriate data, is not exceeded. Many rectifiers have high heater-cathode voltage ratings. Twin triodes which have a high heater-cathode voltage rating are useful in certain phase splitters.

Miniature valves may have advantages over the larger types at high frequencies because of the shorter lead lengths to the electrodes. Physical size, availability and cost are other considerations when deciding between miniature and other valves. Miniature valves are now used by almost all commercial manufacturers except possibly for power valves and rectifiers. The fairly new sub-miniature valves (having lengths of 28 mm and diameters of 5.4 mm) may become very popular in the future, but at present they are mainly used in large commercial equipment.

The choice of valves for the various stages of radio receiver will now be considered.

R.F. Amplifiers

If it is likely that an r.f. amplifier will be required to handle a large signal at any time, a variable-mu valve with appropriate automatic (a.g.c.) or manual biasing should be used in order to avoid overloading. On the other hand, if it is desired that an r.f. pentode amplifier should generate the minimum possible amount of noise, a sharp cut-off pentode should be used. Sharp cut-off pentodes can normally be made with a higher mutual conductance than variable-mu valves and therefore tend to generate less noise and to give a higher gain. Even less noise is obtained from grounded grid triodes, but the amplification is much smaller. Other special low noise circuits such as cascode amplifiers are also available. Pentodes such as the 6AK5 (EF95) and the 6AG5 have been designed for use in low noise r.f. stages operating at high frequencies. They have a fairly high mutual conductance and a very high input impedance—the two most important qualities for a very high frequency amplifier. In the two types mentioned, two separate cathode pins are used so that the input and output circuits can be kept entirely separate.

Converters

The main considerations concerning the design of a converter stage are (*a*) the amount of noise generated by the valve, (*b*) the means to be employed in avoiding pulling of the oscillator frequency and, possibly, (*c*) what gain will be obtained. The gain is determined by the conversion conductance of the valve. The multigrid mixers such as the 6K8 triode-hexode, the 6BE6 and 6SA7 heptodes are usually used as self-oscillating converters in broadcast receivers and generate a relatively large amount of noise. Very little pulling of the oscillator frequency occurs with a well designed multi-grid valve; this type of mixer is also the most economical with respect to components used in the circuit.

Multi-grid valve converters have a conversion conductance of about 0.3 to 0.4mA per volt. A conversion conductance of about 2.5mA per volt can be obtained by feeding the oscillator voltage to the cathode of a pentode mixer, or alternatively, to the same grid of the mixer that the signal is fed. This method gives much higher gain and much lower noise than when multi-grid converters are used, but an extra buffer amplifier should be used between the oscillator and mixer or pulling will almost certainly occur. Three separate valves (oscillator, buffer amplifier and mixer) are therefore needed in this type of converter; this may be well worthwhile in a good communication receiver. (In television and f.m. tuners a buffer amplifier is not, however, employed.—*Ed.*)

I.F. Amplifiers

Variable-mu pentodes are almost always used in the i.f. stages of a radio receiver because the receiver gain as a whole is controlled almost entirely by the i.f. gain. If the i.f. valves have a high value of anode resistance, the tuned circuits will be only slightly damped and the selectivity may be made as great as possible. The higher the mutual conductance of an i.f. valve, the higher the gain of the stage. If a valve is chosen so that its screen grid is designed to operate at the same voltage as its anode, fewer decoupling components will be required. Sharp cut off pentodes (i.e. not variable-mu), are often used in broad band i.f. amplifiers for use in radar, television and f.m. receivers.

Detectors

Most small diodes give very similar results as detectors. Any small triodes, or triode connected pentodes, are suitable for use as cathode follower detectors. Diode detectors load the previous tuned circuit and thus reduce its selectivity, but the load imposed by cathode follower detectors is very small (hence the name "infinite impedance detector"). Cathode follower detectors should be operated at a fairly high signal level. The choice of valves for these two types of detector may be made solely on physical size, preferred base, etc. The leaky grid detector virtually consists of a diode combined with an a.f. amplifier although no separate diode is employed. Leaky grid detectors are very sensitive to small signals, but the quality of reproduction obtained is poor and considerable loading is applied to the previous tuned circuit. A triode or pentode may be used.

Radio Amplifiers

Valves for use as very low level audio amplifiers should generate the smallest possible amount of noise, as any noise in the low level stages is amplified enormously. It is also desirable that low level audio amplifiers should have a bifilar heater construction to minimise hum. The valve holder should be made of a good electrical insulator such as P.T.F.E. or hum will be introduced by capacitative coupling through it. It is most important that microphonic valves are avoided in low level stages and good screening is essential. The 6BR7 and the EF86 have been specially designed for use in low level audio amplifiers. For the very best results it is advisable to pick out one valve from several of the same type. A valve with a very small reverse grid current should be chosen.

Audio amplifiers for use in stages at higher signal levels should have very linear characteristics or distortion will occur. Triodes tend to give much less distortion than pentodes at the higher voltage levels; negative feedback is essential for reasonably good reproduction when pentodes are used. If a high gain is required, an audio amplifier should have a large amplification factor. Pentodes give much higher gain than triodes.

Power Amplifiers

Valves required to give an appreciable power output have a lower anode resistance, a much greater maximum value of anode dissipation, and a greater anode current, than valves intended for use as voltage amplifiers. The valve chosen for the power amplifier must be capable of giving the amount of power required at a certain permissible distortion level. Small amounts of power may be obtained by using valves which are normally only used as voltage amplifiers. The impedance of the device (speaker transformer, etc.), into which the power is fed must match the optimum load impedance of the valve fairly closely. When deciding on the power output required from a high quality audio amplifier, it should not be forgotten that the peak power is much greater than the average power. The amplifier must be able to handle the peak transient power or distortion will occur. A valve with a high slope (mutual conductance), will give a large voltage amplification; that is, the voltage input to the amplifier for a certain power output will be smaller than if a low slope valve were used.

Beam tetrodes and pentodes can usually be made more efficient in operation than triodes, but triodes give less distortion for the same amount of negative feedback. At high power levels triodes need a higher h.t. voltage than tetrodes. Tetrodes may, of course, be triode connected if desired. The method of operation known as "ultra-linear" is popular. In this method, the valves are effectively operated somewhere between triode and tetrodes by connecting the screen of the valve to a tapping on the primary of the output transformer. Ultra-linear amplifiers are almost always of high fidelity standards and are therefore push-pull.

A power amplifier often takes as much current from the h.t. line as all of the other valves put together. When the amount of h.t. is limited (as when battery supplies are used), it is important to choose a power valve which is economical on h.t. current and which does not give much more power than is likely to be required.

H.T. Rectifiers

A heater supply of the correct voltage must be available for the rectifier (except in a.c./d.c. equipment); the heater power required by rectifiers is usually comparatively large. The 6X5 (octal), and 6X4 (miniature B7G) valves are sometimes useful because the 6.3 volt supply for their heaters can normally be taken from the commonly used 6.3 volt heater line feeding the other equipment. These two types of valve are limited to a maximum d.c. output of 70mA, however, In most other types of rectifiers the cathode is connected to the heater and a separate winding on the mains transformer is necessary for the rectifier heater.

It is usually advisable to choose an indirectly heated rectifier where possible so that, after switching on, the h.t. voltage is not applied to other valves until they have warmed up. This also prevents many of the capacitors in the equipment from having to withstand a higher voltage than normal just after the apparatus has been switched on.

The rectifier must have a peak inverse voltage rating which is larger than any inverse voltage which will appear across the valve. In the usual type of full wave rectifier circuit, the peak inverse voltage is 1.41 times the r.m.s. voltage appearing across the whole of the secondary h.t. winding of the transformer providing that condenser input is used. This is equal to double the h.t. output voltage at no load.

In condenser input filters there is a limit to the maximum size of reservoir condenser which can be used. In choke input filters there is a limit to the minimum size of choke which can be used. These values are normally given in the valve data for the rectifier concerned. If they are not observed the peak cathode current rating of the rectifier may be momentarily exceeded during each cycle.

Combined Valves

It is often possible to reduce the size of equipment by employing two or more valves in the same envelope. Triode-hexodes are often used as oscillator-mixers and double diode triodes as combined audio detectors, a.g.c. detectors and audio amplifiers in broadcast receivers. Choice of these valves depends on the electrical characteristics of each separate part of the valve. Care should be taken to avoid undesired feedback from one section of the valve to another. Double triodes are particularly useful for a wide variety of applications, but the uses of some double triodes (e.g. 6J6 and 6SC7), are limited because there is only one common cathode for the two triodes.

Voltage Stabilisers

A simple gas filled voltage stabiliser tube must be chosen for adequate stability, the current ratings being suitable for the circuit concerned. Stabilisers should not be connected in parallel in order to increase the maximum permissible current for the reason that one of the tubes would probably then take all of the current. Stabilisers may be connected in series, however, in order to increase the voltage of the stabilised supply. The VS110 and VR105/30 are quite suitable for stabilising the h.t. supply to an oscillator.

SOUTHERN TELEVISION GRANTS TO THE ARTS AND SCIENCES

Southern Television, the company serving central-southern and south-east England, recently announced that they are to make several grants to the arts and sciences. Repertory theatres, universities, music festivals and orchestras will receive sums totalling some £8,000. Of the repertory theatres, the following will each receive a sum of £500—Margate, Chichester, Canterbury, Guildford and Salisbury.

A grant of £1,250 will be used at Southampton University to found a research studentship in a branch of electronics and a similar sum will be used for the endowment funds of the new university college at Brighton.

The Central School of Speech and Drama has been offered £700 for a lectureship on aspects of television, this to encourage a better knowledge of the action and production techniques of this medium.

New Valves for Small-Boat Radar

The installation of radar in a growing number of fishing boats, yachts, and the like, has led to radar equipments designed specifically for use in small craft. Apart from the general demands of high performance and reliability, the essential requirements of such equipments are low cost, small size and weight, and low power consumption.

To meet these requirements the radar manufacturer needs valves that are also designed for the purpose. Mullard have already made available a "line-up" of valves for 3kW small-boat sets, and they have now introduced a new series of three types—a magnetron, klystron and pulse modulator—intended for 6kW installations. Details of these three types, which were shown for the first time at the Instruments Electronics and Automation exhibition, are given below.

6kW X-band Magnetron: type JP9-5

The JP9-5 is an inexpensive, low-voltage packaged magnetron giving a nominal peak output power of 6kW (minimum 5kW) at a fixed frequency in the band 9.345 Gc/s to 9.475 Gc/s. It requires an anode voltage of only 4.5kV and has a peak current rating of 5A. Its overall physical dimensions are small—11.4cm x 10.1cm x 5.1cm—and it weighs only 2½lb including the magnet system.

Pulse Modulator Valve: type QV12-P10

The QV12-P10 is a hard valve pulse modulator capable of a peak pulse output power exceeding 100kW with a d.c. hold-off voltage of 12kV. These ratings ensure that the valve is only lightly loaded when used in service with the JP9-5 magnetron.

The QV12-P10 is octal-based, and measures 13.3cm x 5.5cm.

X-band Local Oscillator Klystron: type KS9-40

Despite its low cost the KS9-40 provides a very high standard of performance and has several features hitherto confined to valves costing much more.

An important feature is its high frequency stability, due largely to the construction of the tuning cavity. Although an integral part of the valve, the cavity is external and thus is isolated from the effects of variations in beam current. The warm-up frequency drift is less than 3 Mc/s, 5 minutes after switching on. Rugged construction enables the valve to withstand accelerations of 10g with no more than 2 Mc/s shift in frequency.

The noise performance is very good, the typical a.m. signal-noise ratio being greater than 160db per cycle of i.f. bandwidth for receiver intermediate frequencies above 25 Mc/s.

The valve is fitted with a WG16 waveguide output to take a plain flange coupling. A matching screw is incorporated to ensure close tolerance of output power, eliminating the need for a waveguide attenuator to control crystal current.

Mechanical tuning is provided over the range 9.3 Gc/s to 9.5 Gc/s, with an electronic tuning range between half-power points of ±20 Mc/s. The output power is 40mW at resonator voltage and current ratings of 300V and 35mA.

Overall dimensions of the KS9/40 are 8.6cm x 4.1cm x 5.1cm.

ADHESIVE VENEER TAPES AND STRIPS

For the home constructor who carries out his own cabinet making a new product which edges chipboard, plywood or blockboard, etc., to obtain a "solid wood" appearance is currently available from Flexible Veneers Ltd., Cobbs Court Buildings, Carter Lane, London, E.C.4. The product consists of wood veneer fixed to a paper backing, this being stuck to the surface being covered by Agastik latex base adhesive (also available from Flexible Veneers). The paper backed veneer may be obtained in the form of Agastrips, these consisting of 4 or 10yd rolls having a width of ¾in, with the grain of the wood running across the width. Agastrips are also available with long grained veneer in individual lengths of 36in maximum. An alternative finish is offered by Agatapes, these being self adhesive and consisting of long grain veneer lengths of 19½in maximum. Width is again ¾in. Being real wood, the strips and tapes can, if desired, be stained, varnished or French polished. Colour grainings available are light oak, mahogany and walnut.

BULGIN INTRODUCE ROCKER - CONTACT SWITCHES

Following considerable research, Bulgin have now added eight rocker-contact switches to their well-known and already extensive range. These switches have the dolly, bush and milled circular panel mounting nut familiar with normal panel mounting switches, and they are capable of switching (depending on circuit conditions) 6 to 10A at 250V a.c. and (in non-reactive circuits) 10A at 125V a.c. ahd 10A at 28V d.c. Screw terminals are provided. Three of the eight switches have central "off" positions, wherein all circuits are broken. Throwing the switch to either side of central then completes one set of change-over contacts. All switches are two-pole, five (including the three with central positions) being change-over, and three single-throw. Both biased and non-biased types are available. Biased switches spring back to a previous setting when released, and this setting may be at central or to one side. The finish is brilliant chrome. List numbers for the switches are S780 to S787, full details being available from A. F. Bulgin and Co., Barking, Essex.

Comparing A.C. and D.C. Voltages for Meter Calibration

by **P. G. WRIGHT**

IN THE PAST THERE HAVE BEEN MANY circuits published for the construction of multimeters. The lower a.c. ranges on these meters are, however, dogged with non-linearity, and, since standard a.c. voltages are not generally available to the home constructor, calibration becomes extremely difficult. A method of comparing a.c. and d.c. voltages would be useful to have, since the latter can usually be measured accurately with the d.c. ranges of the multimeter in question if no other instrument is available.

A simple method of comparison is possible with the aid of a slide-back valve voltmeter. The basic circuit of such a voltmeter is shown in Fig. 1 (*a*). Fig. 1 (*b*) shows the variation of anode current with grid voltage for a normal sharp cut-off valve.

Consider the valve biased back by a d.c. voltage until it is just at the cut-off point; if now an alternating waveform is superimposed on the d.c. voltage, the positive peaks will cause anode current to flow. The valve may now be biased back still further, until the peaks cease to have any effect and the valve is at cut-off point again. The extra grid bias needed for the second operation will then be equal to the peak value of the superimposed a.c.

The Circuit

The valve used in the writer's circuit (shown in Fig. 2) was an EF50 strapped as a triode; this combination was found to give quite a sharp cut-off with an anode voltage of 100. The meter in the anode circuit should be as sensitive as possible in order that reliable indications are given as the valve approaches the cut-off point.

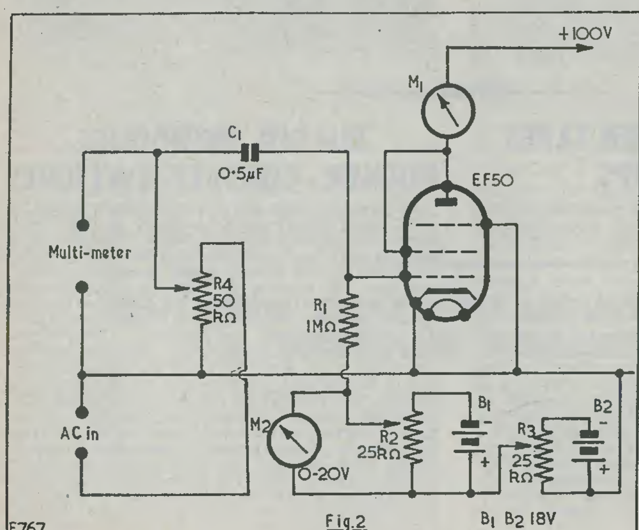


Fig.2

The meter which measures the negative voltage at the lower end of R_1 must be accurate, but need not be sensitive. If desired it may be calibrated by comparison with the multimeter itself. The calibration may be in volts, or in 0.707 times the actual applied volts, thus giving direct r.m.s. readings of the applied a.c. without recourse to the "guessing stick".

C_1 should have a low reactance compared to the resistance of R_1 at the frequency used. Layout is unimportant at low frequencies.

Calibration is carried out in the following manner. The instrument is switched on and allowed to warm up. The meter M_2 is set to zero reading by adjustment of R_2 and M_1 set to zero by manipulating R_3. An a.c. supply is connected across R_4, and a convenient fraction tapped off and applied at the same time to the multimeter and the input terminals of the comparator. R_2 is then rotated to cause a zero reading on M_1, thereupon the reading in M_2 is equal to the peak (or r.m.s., according to the calibration) value of the a.c. voltage applied.

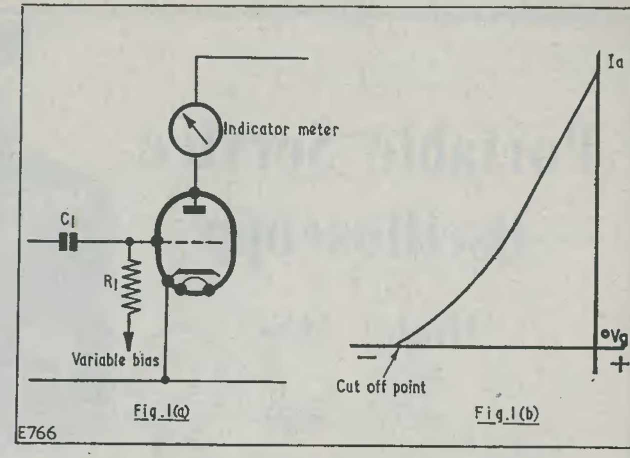


Fig.1(a) Fig.1(b)

The circuit shown in Fig. 2 gives accurate results, the component values specified for C_1 and R_1 being suitable for inputs at 50 c/s.

Brazil TV Station Opens Shortly

Marconi's Wireless Telegraph Co. Ltd. have supplied the complete studio and transmission equipment for a new television station at Recife, Brazil, which is expected to begin programme transmissions shortly.

Scheduled test transmissions are now in progress at the station, which is owned by Empresa Jornal do Comercio S.A., Recife.

The luxurious, contemporary-style building contains a suite of three studios, completely equipped by Marconi's with the most up-to-date units, including seven Marconi 4½in Image Orthicon cameras, master control equipment, two vidicon telecine units and lighting, sound, test and ancillary equipment. A three-camera outside broadcast vehicle and micro-wave link equipment are provided.

The transmission equipment consists of Band I 18kW vision and 9kW sound transmitters feeding into a 6-stack quadrant aerial, providing an effective radiated power of 110kW. The equipment operates on 625-line standards; it is capable of handling a compatible colour service should this be required.

A.R.M.S at U.S.A.F. Transmitter Site

On 19th June the Amateur Mobile Radio Society (Sec. G. E. Storey, G3HTC) held a memorable and extremely successful mobile meeting at U.S.A.F. Transmitter Site, Barford St. John, Oxon. It is estimated that more than 500 people were present, including over 30 American amateurs, some of whom travelled 200 miles just for the day. The majority of the 150 cars present were fitted with mobile radio. Whilst their families enjoyed baseball, a display of precision marching, go-cart and model flying demonstrations, OMs made frequent shuttle-service visits to the transmitter hall. The U.S.A.F. side of the organising was largely handled by Major Peter Kravchonok, K7LKS, who was, at a special emergency committee meeting, unanimously elected as the first honorary member of the A.R.M.S.

Seven New Silicon R.C.A. Rectifiers

R.C.A. is pleased to announce 7 new silicon rectifiers of the diffused-junction type 1N2858, 1N2859, 1N2860, 1N2861, 1N2862, 1N2863 and 1N2864.

These types, which are designed for use in both industrial equipment and consumer-type products, have a maximum d.c. forward-current rating of 750 milliamperes (for resistive or inductive loads), and 500 milliamperes for capacitive loads up to 75°C ambient temperature. They offer the equipment designer a wide choice of peak inverse-voltage ratings—from 50 volts to 600 volts, respectively.

Special features of these silicon rectifiers are:

(1) Rugged internal mount structure.

(2) Diffused silicon junctions of extremely high uniformity produced by a special precisely controlled diffusion process.

(3) Hermetically sealed, industry-preferred cases.

(4) Axial leads for flexibility of installation in either hand-wired or printed-circuit equipment designs.

Long life and stability of electrical characteristics are assured by conservative ratings and the following stringent quality-control procedures and tests:

(1) Thorough baking at high temperatures to assure stable performance.

(2) Pressure tests to assure a hermetic seal against moisture and contamination.

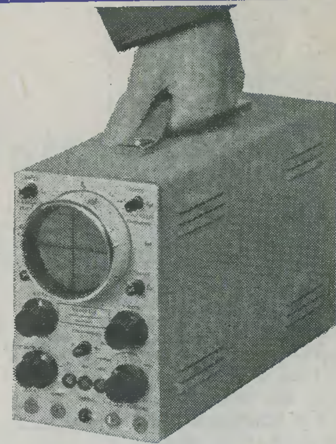
(3) Forward-and-reverse current characteristics tests at 25°C.

(4) High-temperature dynamic tests under full-load conditions.

A Portable Service Oscilloscope

Model OS-1

By G. J. Stone



WITH MANY RADIO AND T.V. FAULTS THE 'scope is as essential as the test meter and, with the additional servicing required by f.m. receivers, the demand on the use of the 'scope is continually increasing. To provide an efficient service, the engineer must employ efficient methods, this only being achieved if he has available the correct instruments for the particular job in hand.

It is probable that the average workshop has only one oscilloscope, this being shared by a number of engineers, and its weight may be anything up to 1 cwt.—hardly portable! There is, therefore, a need for a small portable inexpensive oscilloscope to overcome this problem and also fulfil the requirements of servicing in the field. The oscilloscope must not be complicated but must be simple and easy to use. Apart from its use by the service engineer for radio and t.v. work it should also prove ideal for the radio and audio enthusiast and the radio amateur. Portable oscilloscopes are produced by Jason Motor & Electronic Co. and Cossor Instruments Ltd., as well as by Daystrom Ltd., but for the purposes of this article we shall be considering the Daystrom Heathkit model OS-1.

CIRCUIT DETAILS

Y Amplifier

See Fig. 1. Two input sockets are available at the front panel, one being a direct input (X1) while the other introduces an attenuation of 10:1 (X10). The X10 input is frequency compensated by C_1 in order that the attenuator will be independent of frequency and therefore produce a frequency response which is substantially flat. Also, the attenuator circuit is such that distortion of the input signal is negligible. The first valve is connected as a cathode follower and has a continuously variable gain control VR_1 (Y Gain) in the cathode circuit. The slider of this control is connected to the grid of the pentode section of V_1 and this valve is compensated by L_1 and partly by C_4. Without the use of the compensating coil L_1, the frequency response would be reduced considerably at high frequencies due to the stray-capacitance (formed by the wiring capacitance and input capacitance of the following valve) shunting the anode load R_6. The use of L_1 in series with R_6 compensates for this effect since its inductive reactance is increased with frequency. The total anode impedance consequently increases with frequency and the normal loss at high frequencies is therefore compensated. Also, at low frequencies, the effect of C_4 across the bias resistor R_7 is negligible and a measure of negative feedback exists. At the higher frequencies, C_4 effectively decouples R_7, reducing the feedback and hence the gain increases. The net effect, therefore, of L_1 and C_4 is to extend and maintain a reasonably flat response characteristic. Output from the pentode section of V_1 is coupled to V_2 where V_2 and V_3 are connected as a cathode coupled or "long-tailed" pair.

The operation is as follows: consider a positive going signal at the grid of V_2. This will cause the anode potential to decrease and its cathode potential to increase. As V_2 and V_3 are cathode coupled, the increase in cathode potential will in effect make the grid of V_3A more negative with respect to the cathode, therefore the anode potential of V_3A will increase. We now have a state of affairs where the single ended input signal produces a balanced push-pull output, i.e. the anode potential of V_2 is driven a certain amount in one direction, while the anode potential of V_3A is driven an equal amount in the other direction. Frequency compensation is achieved by L_2 and L_3 in the respective anode circuits. Vertical positioning of the c.r.t. trace is adjusted by VR_2 (Y Shift) and has a range of approximately $\pm 2\frac{1}{2}$ cm. Its

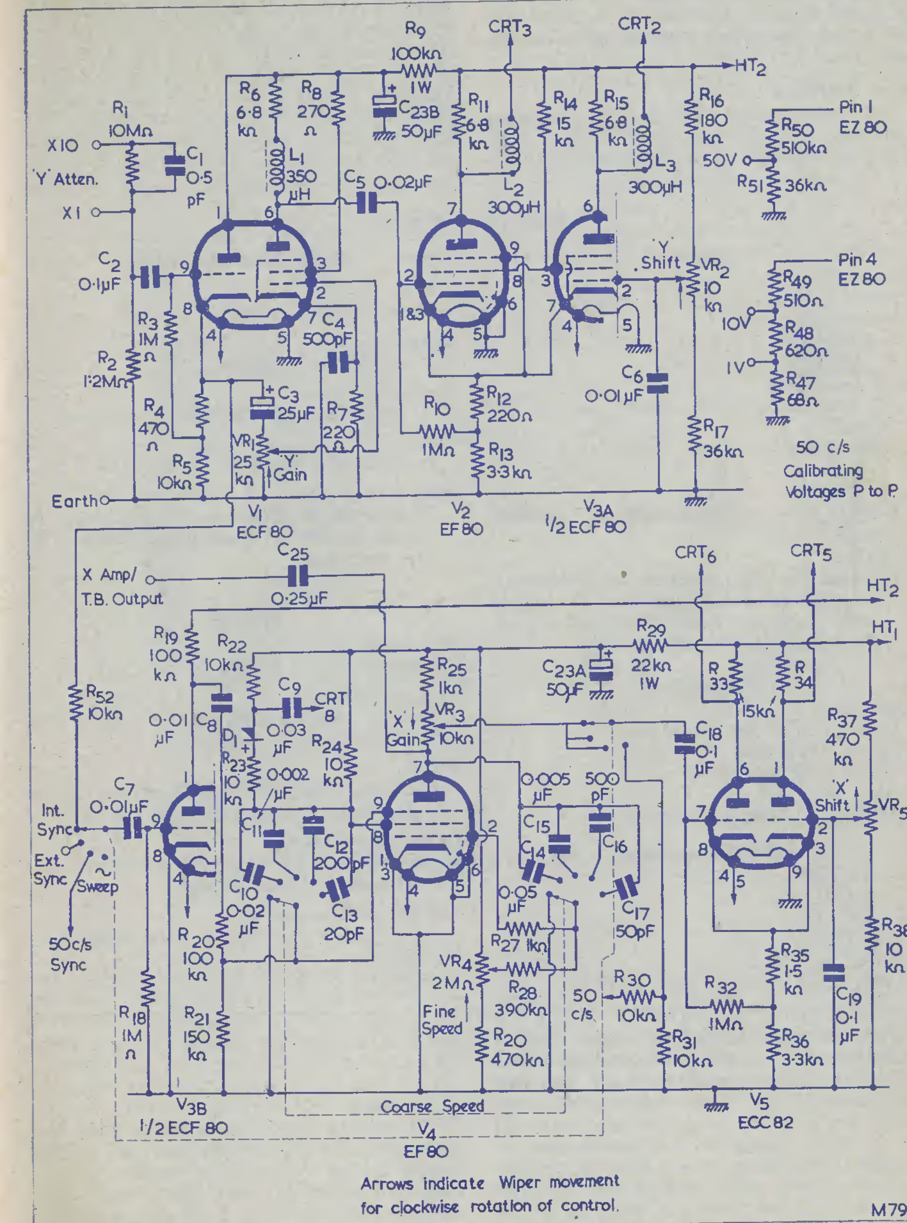


Fig. 1. Circuit diagram of the Portable Oscilloscope Model OS-1

operation depends upon the d.c. voltage produced by the potential divider R_{16}, VR_2, R_{17} and this voltage is applied to the grid of V_3A. The effect is similar to that already described except that this is a d.c. condition, i.e. the Y shift will adjust the static or quiescent anode potentials of V_2 and V_3A and hence the position of the trace on the face of the c.r.t.

Sync. Amplifier

The triode section of V_3 is used as a sync. amplifier. The valve is operated with zero bias and produces at its anode an amplified

Time Base Generator

The time base generator uses V_4 in the well-known Miller transitron circuit. Coarse frequency control is obtained by the switch SB, and fine speed control by VR_4. An output is taken from the anode of V_4 through an isolating condenser to a socket on the front panel, X AMP. While the time base is operating, a sawtooth waveform will be available at this socket. A switch position on SB allows the time base to be switched off and an external signal or time base can be fed into this socket. The amplitude of this

SPECIFICATIONS

Y Amplifier

Sensitivity
10mV (r.m.s.) per cm (XI input)

Frequency Response
±1dB, 10 c/s–1.5 Mc/s
±3dB, 10 c/s–2.5 Mc/s

Input Impedance
X1 attenuator input—1MΩ shunted by 20pF
X10 attenuator input—10MΩ shunted by 10pF

Input Circuit
Built-in blocking condenser rated at 600V d.c.

Y Shift
DC type permits placement of undeflected trace at any horizontal level on usable area ±2½ cm from centre of screen. Positioning is instantaneous

X Amplifier

Sensitivity
1 volt (r.m.s.) per cm at 1kc

Frequency Response
±3dB, 150 c/s–500 kc/s

X Shift
Approx. ±3 cm from centre

Valve Complement

2—ECF80
2—EF80
1—ECC82
1—EZ80

Cathode Ray Tube
High sensitivity 2¾in type 3AFP1

Time Base Generator

Circuit
Miller transitron type

Range
15 c/s–150 kc/s approx.

Sinusoidal Sweep
50 c/s fixed amplitude 4 cm.

Sync.
Int, Ext, and 50 c/s

Time Base Output
20 volt pk-to-pk nominal available at X amp socket on front panel when T/B is operating

General

Retrace Blanking
Operates on all ranges

Voltage Calibrator
Built-in source 1 volt, 10 volt and 50 volt 50 c/s pk-to-pk nominal

Finish
Polychromatic silver front panel with black printing. Ash grey wrinkle cabinet

Power Requirements
200–250 volt (3 tappings) 40–60 c/s a.c. 35 watts. Fused 500mA

Cabinet Dimensions
4$\frac{11}{16}$in wide x 7⅜in high x 12½in long

Net Weight
10½lbs.

and limited signal of the sync. input. Output from this valve is a positive going signal and is fed to the suppressor grid of the time base generator V_4. Three methods of synchronisation may be used—internal, external or 50 c/s. Internal synchronisation is obtained by taking the signal from the cathode of V_1 and through an isolating resistor R_{52}. As this is in front of the Y GAIN control VR_1, this control will not effect synchronisation of the c.r.t. trace.

signal is adjusted by means of the control VR_3 (X GAIN).

X Amplifier

The output from V_4 is taken from the slider of VR_3 (X GAIN) and fed to the double triode V_5 which is connected as a cathode coupled or "long tailed" pair. The operation of this valve is similar to that of V_2, V_3A. Horizontal positioning of the c.r.t. trace is adjusted by VR_5 (X SHIFT)

and has a range of approximately ±3cm. A switch position on SA allows the time base to be switched out and connects V_5 to a source of 50 c/s. This provides a 50 c/s sinusoidal time base and has a fixed amplitude of approximately 4cm. This feature is useful where Lissajou's figures are required for frequency comparison, phase shift, etc. It will be noted in the specifications that the frequency response is falling below 150 c/s, this being due to C_{25}. At the low frequencies the capacitive reactance of C_{25} becomes comparable to VR_3, R_{25} and hence the falling response. This can be improved by using a larger condenser but, due to the increase in physical size, it will be necessary to choose one having a lower voltage rating —C_{25} is a 0.25μF 400-volt working condenser.

V_4. This pulse is limited by D_1 and the resulting flat topped waveform is fed to the grid of the c.r.t. to blank the retrace or flyback of the time base sweep. C_{26} is included to reduce intensity modulation but its inclusion is a compromise between retrace blanking and intensity modulation. In general, the latter is the lesser of the two evils, the author personally preferring the improved retrace blanking by omitting C_{26}.

Power Supplies

A single copper banded transformer provides all supplies (see Fig. 2). For h.t. supplies a full wave rectifier V_6 is used and two h.t. supplies are obtained using resistance, capacitance smoothing. An e.h.t. winding on the transformer and a half wave

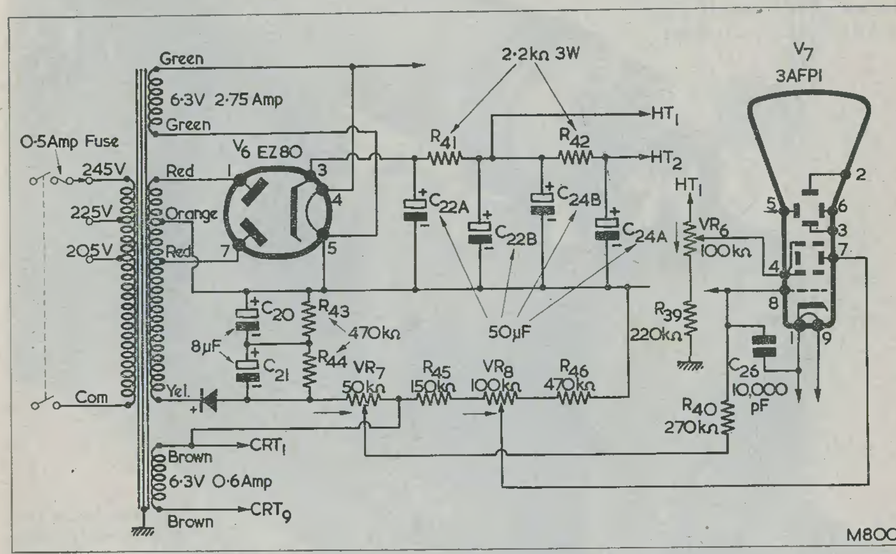


Fig. 2. Power supply and c.r.t. circuit

Calibration

50 c/s calibration voltages of 1, 10 and 50 volts peak-to-peak (nominal) are available at the front panel sockets. These enable the Y amplifier to be set to a specific gain.

Cathode Ray Tube (*see Fig.* 2)

Supplies for the c.r.t. are derived from the resistor chain across the e.h.t. supply. VR_6 is a spot shape or astigmatism control and is a pre-set potentiometer mounted on the chassis. This control is adjusted initially, in conjunction with the BRILLIANCE and FOCUS controls, to produce a well-defined trace. Flyback suppression is achieved by taking a negative pulse from the screen of

tubular rectifier provide a negative e.h.t. supply for the c.r.t. The e.h.t. supply is smoothed by two condensers connected in series across the supply, the two resistors R_{43} and R_{44} being used to ensure that equal voltages appear across each condenser.

The oscilloscope is protected by a 0.5 amp cartridge fuse which is integral with the mains voltage selector plug.

Anti-magnetic Shield for C.R.T.

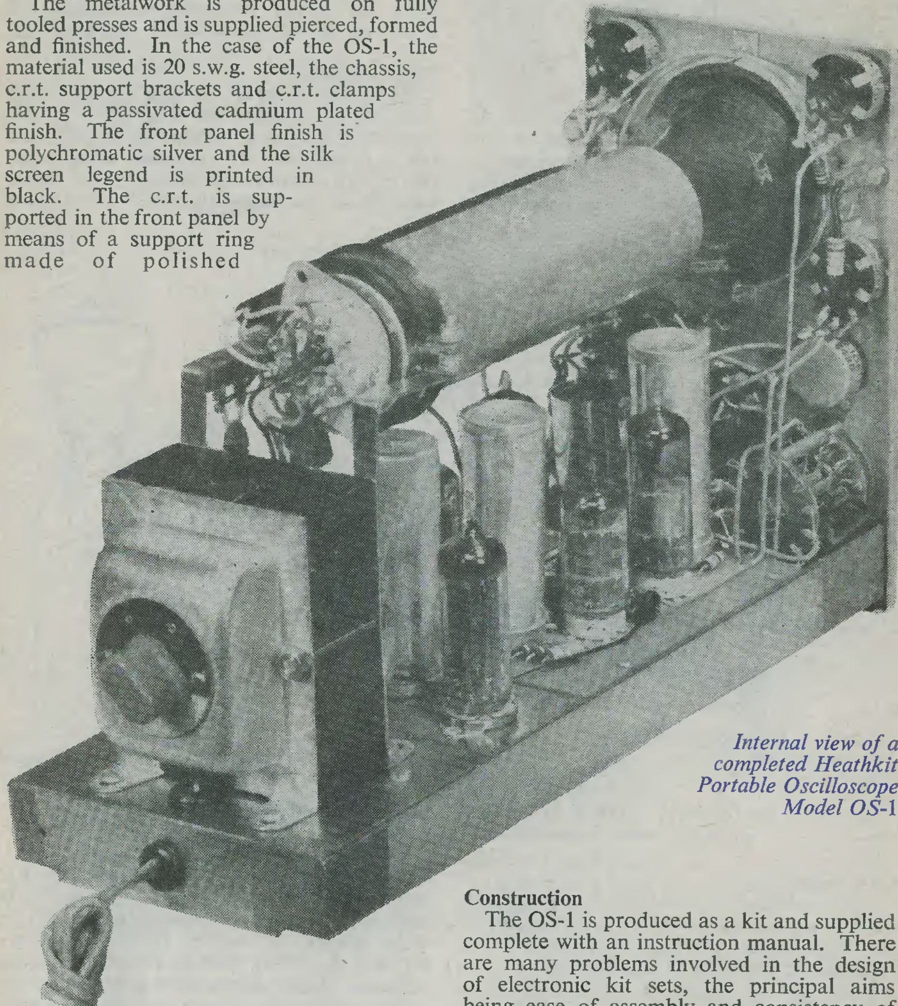
The cathode ray tube is fitted with a treated mild steel shield in order to reduce the 50 c/s hum, produced by the stray field from the mains transformer, on the trace. The magnitude of the hum is of the order of

0.2 cm peak-to-peak and the only way this can be reduced still further is by the use of a mumetal shield fitted over the c.r.t. Mumetal shields are, of course, extremely expensive, but are available as an optional extra.

Metalwork

The metalwork is produced on fully tooled presses and is supplied pierced, formed and finished. In the case of the OS-1, the material used is 20 s.w.g. steel, the chassis, c.r.t. support brackets and c.r.t. clamps having a passivated cadmium plated finish. The front panel finish is polychromatic silver and the silk screen legend is printed in black. The c.r.t. is supported in the front panel by means of a support ring made of polished aluminium. The ring, which is lined with a 1½in wide strip of black self-adhesive foam plastic material, also serves another useful purpose—that of a vizor. This reduces the amount of direct light falling on the face of the c.r.t. and therefore allows the tube to be operated at lower brilliancy and improved focus, etc. Also supplied with the OS-1 is a calibrated green plastic graticule which fits snugly within the plastic lined vizor.

The cabinet is finished in ash grey wrinkle paint which contrasts with the front panel. To ensure adequate ventilation the cabinet has four sets of louvres in each side panel and one set at the rear.



Internal view of a completed Heathkit Portable Oscilloscope Model OS-1

Construction

The OS-1 is produced as a kit and supplied complete with an instruction manual. There are many problems involved in the design of electronic kit sets, the principal aims being ease of assembly and consistency of performance. The assembly can be broken down into three sub-assemblies, (1) front panel (Fig. 3 showing component assembly and wiring), (2) chassis, and (3) the printed circuit board. Construction and assembly is greatly simplified by the use of a printed circuit board, the Y amplifier and time base circuits being contained thereon. The majority of the components associated with

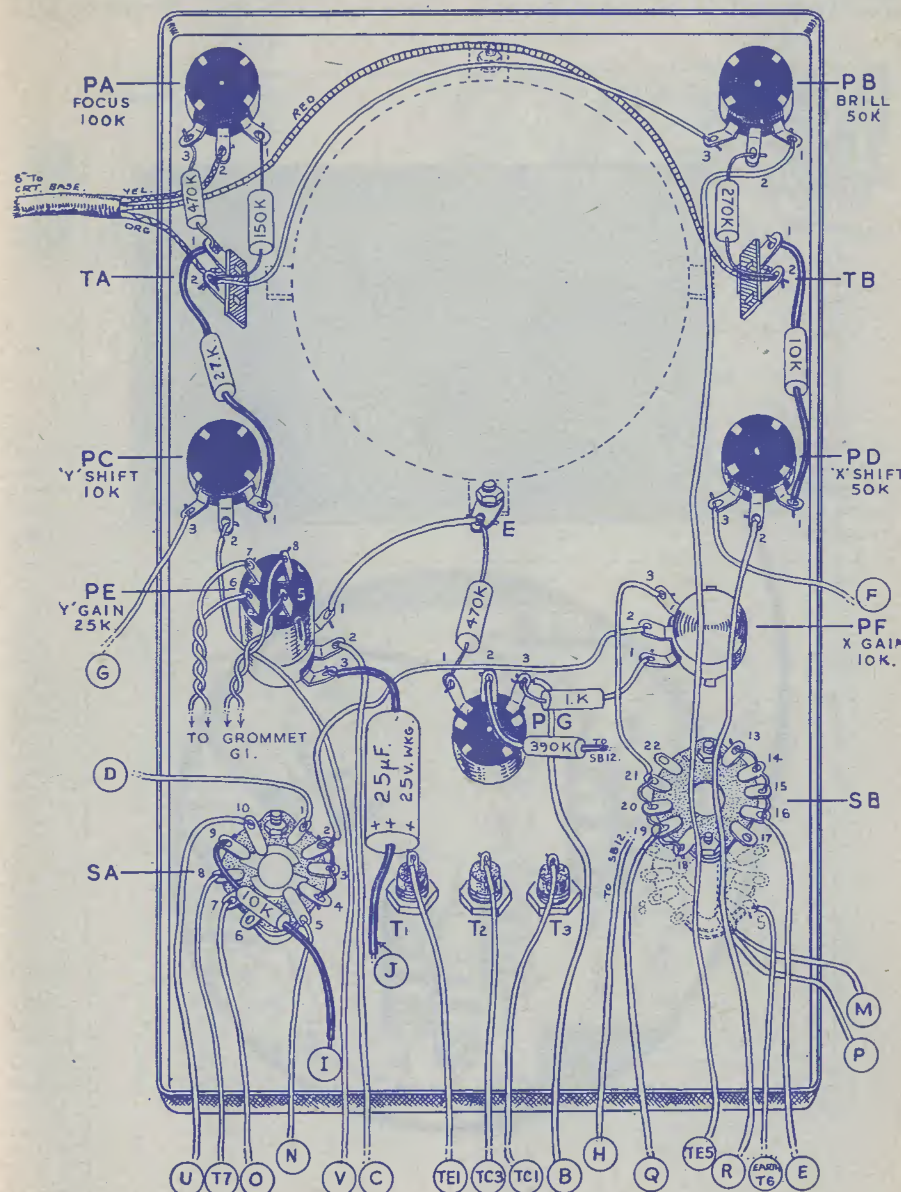
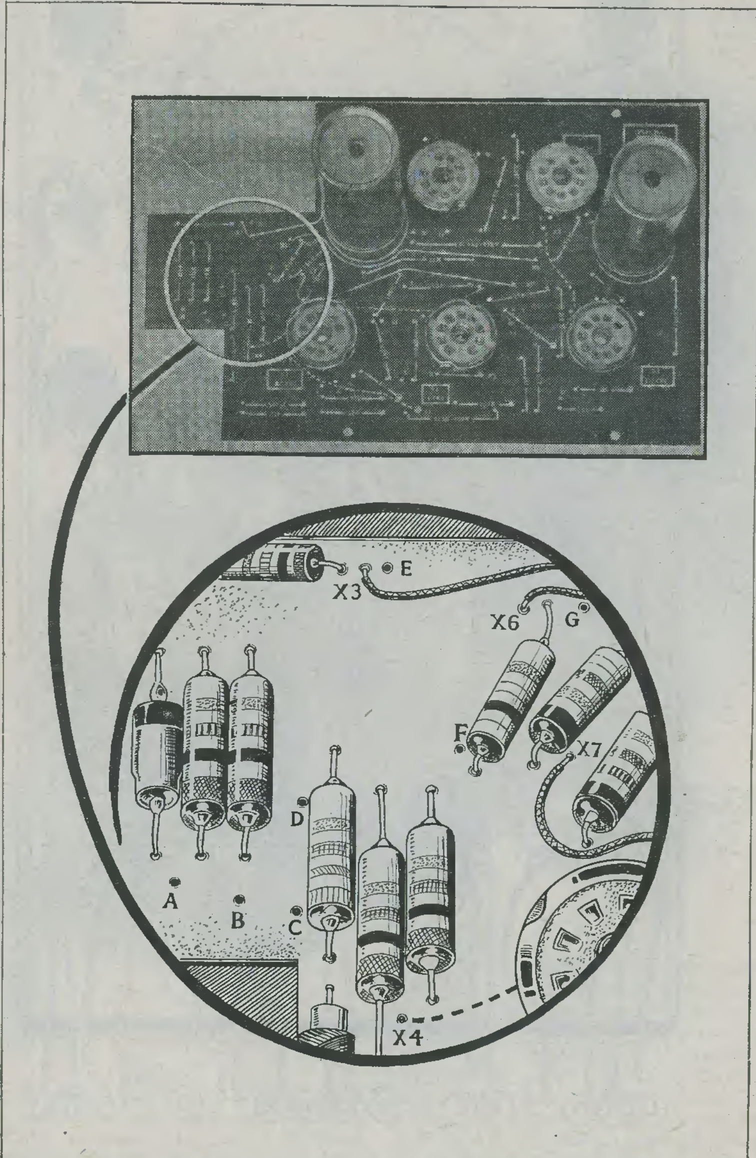


Fig. 3. Front panel sub-assembly showing component layout and wiring. This diagram is reproduced from the comprehensive Instruction Manual supplied with the kit. Note the component and wire references as an aid to assembly

these circuits are mounted on the printed circuit board and permit a consistent and high degree of circuit stability. The phenolic side of the printed circuit board is silk screen printed showing the exact location and value of each component to be mounted and this, in no small way, reduces the risk of wiring errors compared to the old point-to-point



View of the component side of a partly assembled OS-1 printed circuit board. Note the printed component locations and hole references for ease of assembly

wiring methods. The technique of component assembly and soldering to printed circuit boards is quite simple and full instructions are included in the manual. Methods of component mounting and soldering procedure are shown in Fig. 4. The photographs show a partly assembled OS-1 printed circuit board with the valveholders together with the two electrolytic condensers mounted to the board and the above chassis view of the completed oscilloscope.

Instruction Manual

As was mentioned previously, the OS-1 is supplied complete with an instruction manual, featuring a circuit diagram, circuit description, pictorial diagrams, step-by-step assembly and wiring instructions, voltage chart, operation, and other useful information.

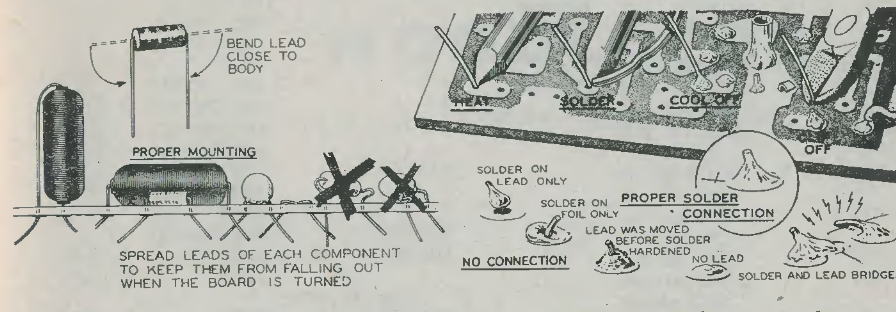


Fig. 4. Showing the component mounting and circuit board soldering procedure —right and wrong methods

Components List

Part No.	*Per Kit*	*Description*	*Supplier*
Resistors ±5% ½ watt			
H-680C5	1	68Ω	Erie
H-621C5	1	620Ω	,,
H-511C5	1	510Ω	,,
H-363C5	1	36kΩ	,,
H-514C5	1	510kΩ	,,
H-134C5	1	130kΩ	,,
H-273C5	1	27kΩ	,,
Resistors ±10% ½ watt			
H-221C10	2	220Ω	,,
H-271C10	1	270Ω	,,
H-471C10	1	470Ω	,,
H-102C10	2	1kΩ	,,
H-152C10	1	1.5kΩ	,,
H-332C10	2	3.3kΩ	,,
H-682C10	3	6.8kΩ	,,
H-103C10	7	10kΩ	,,
H-153C10	3	15kΩ	,,
H-104C10	2	100kΩ	,,
H-154C10	2	150kΩ	,,
H-224C10	1	220kΩ	,,
H-274C10	1	270kΩ	,,
H-394C10	2	390kΩ	,,
H-474C10	4	470kΩ	,,
H-105C10	4	1MΩ	,,
H-125C10	1	1.2MΩ	,,
H-106C10	1	10MΩ	,,
Resistors ±10% 1 watt			
1-103C10	1	10kΩ	,,
1-223C10	1	22kΩ	,,

Part No.	*Per Kit*	*Description*	*Supplier*
Resistors ±5% 3 watt			
3-222W5	2	2.2kΩ	Plessey
Condensers (ceramic and silver mica)			
21-527	1	½pF ±¼pF ceramic tube	L.E.M.
20-527	1	20pF ±5% silver mica	,,
20-528	1	50pF ±5% silver mica	,,
20-501	1	200pF ±5% silver mica	,,
20-529	1	500pF ±5% silver mica	,,
21-508	1	500pF ceramic disc	Hunts
21-511	4	10,000pF ceramic disc	,,
21-525	1	0.03µF 1,500V ceramic disc	
Condensers (paper)			
23-513	1	0.002µF 600V	Hunts
23-517	1	0.005µF 600V	,,
23-511	2	0.02µF 400V	,,
23-504	1	0.05µF 250V	,,
23-505	2	0.1µF 250V	,,
23-11	1	0.1µF 600V	,,
23-63	1	0.25µF 400V	,,
Condensers (electrolytic)			
25-512	2	8µF 500V	Dubilier
25-501	1	25µF 25V	Plessey

Part No.	Per Kit	Description	Supplier
25-502	2	50+50μF 300V	T.C.C.
25-523	1	50+50μF 350V	Hunts
Coils			
45-512	1	350μH	Kayblex
45-513	2	300μH	,,
Potentiometers-Switches			
10-524	1	10kΩ lin. pot. pre-set	Dubilier
10-525	2	50kΩ lin. pot. pre-set	,,
10-526	2	100kΩ lin. pot. pre-set	,,
10-527	1	2MΩ lin. pot. pre-set	,,
10-528	1	10kΩ lin. pot.	,,
19-505	1	25kΩ lin. pot. with switch	,,
63-520	1	4 position switch	Plessey
63-521	1	5 position switch 2-wafer	,,
Valveholders-Sockets			
434-528	5	9 pin valve-holder (printed circuit type)	Plessey
434-502	1	9 pin valve-holder	,,
434-526	1	9 pin valve-holder for C.R.T.	Cinch
436-503	3	Black socket	Belling-Lee
436-2	1	Black socket (non-insulated type)	Francois
436-504	4	Red socket	Belling-Lee
206-514	1	Valve screening sleeve	Plessey
258-506	3	Spring, valve retainers (large)	,,
258-507	3	Spring, ditto (small)	,,

Part No.	No. Kit	Description	Supplier
Tagstrips-Knobs			
431-14	1	1 way+earth tagstrip (R.H.)	Ariel Pressings
431-511	1	1 way+earth tagstrip (L.H.)	,,
431-2	2	2 way tagstrip	,,
431-10	1	3 way tagstrip (centre-tag earth)	,,
431-509	2	5 way tagstrip (centre-tag earth)	,,
431-502	1	4 way tagstrip	,,
462-506	4	Knob, with skirt	B. & G. Plastics
Valves-Rectifier			
411-502	2	ECF80	Mullard
411-521	2	EF80	,,
411-25	1	ECC82 (12AU7)	,,
411-522	1	EZ80	,,
411-524	1	Cathode ray tube, type 3AFP1	E.T.E.L.
57-505	1	Selenium rectifier K8/40	S.T.C.
56-502	1	Diode	G.E.C.
Miscellaneous			
54-516	1	Power trans-former	H.G. Brown
85-508	1	Printed circuit board	Mills & Rockleys
211-501	1	Handle with 2 end plates	Taylor
260-1	2	Crocodile clip	Bulgin
414-503	1	Graticule	Priestleys Studios
481-504	1	Mounting plate, for electrolytic capacitor	Plessey
206-512	1	C.R.T. shield	,,
595-523	1	Instruction manual	,,

IMAGE ORTHICONS AT HOME AND ABROAD

The flexibility of operation provided by the wide range of English Electric Valve Co. 4.5in Image Orthicons is reflected in the recent announcements concerning installations using the new Marconi Mark IV television cameras. The Ampex Corporation, U.S.A., has taken delivery of ten of these cameras, three have been supplied to Poland and two to Tyne Tees Television in Great Britain—all fitted with E.E.V. Co. tubes.

Eleven Marconi cameras using 4.5in E.E.V. Co. camera tubes have been supplied to Brazil for use in the new television station at Recife which is owned by Empresa Jornal do Comercio S.A. A suite of three studios and an o.b. van have been equipped with the most up-to-date units and scheduled test transmissions are now in progress.

3in and 4.5in Image Orthicon camera tubes manufactured by E.E.V. Co. are now marketed for many applications including studio and outside broadcast use under differing lighting conditions, colour television and general industrial, medical and scientific use.

Low-Power TRANSMITTER MODULATOR

by David Noble, G3MAW, and David Pratt, G3KEP

A low power modulator designed especially for the 160 metre transmitter described in our August 1959 issue.—Editor.

Since the publication of the writers' "Transmitter Circuit for 160 Metres" in the August 1959 issue of *The Radio Constructor*, there have been several requests from readers for a suitable modulator design. As the transmitter in question was designed for the 160 metre band, it is, therefore, only used on low power, and a single-ended modulator using a 6V6 or similar valve may be used. The writers' present modulator design used with the TT11 p.a. stage is a push-pull circuit with high power ratings. This was made principally for the reason that it could be used, if desired, for a rather more higher powered transmitter for the other bands, and this larger modulator will be described at a later date.

The small modulator described herein has been used with much success on the 160 metre transmitter, and also on a low power experimental transmitter for 10 metres.*

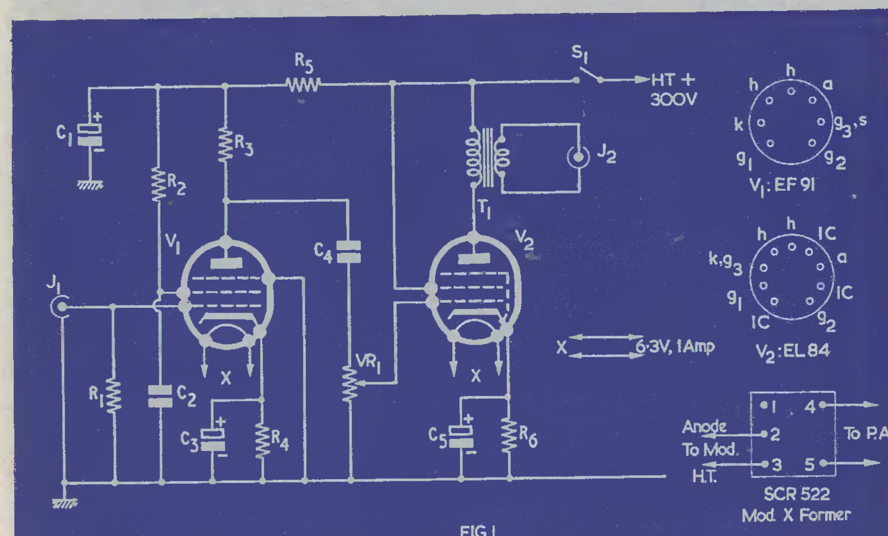


FIG.1. Circuit Diagram of the Low Power Transmitter Modulator

Circuit

The circuit consists of a very simple straightforward and orthodox two stage amplifier using the EF91–EL84 valve types. Although the EF91 is designed as an r.f. pentode, it functions very well in this a.f.

*"QRP Transmitter for 'Ten" — Noble & Pratt, January 1959. *Short Wave Magazine.*

application. The input is intended for a crystal microphone, a coaxial socket being provided for this on the left-hand side of the chassis. The modulator gain control is a standard broadcast receiving type potentiometer with the switch S_1 being inserted into transformer was that type used in the SCR522 transmitter. This transformer (A103018), connections for which are given in Fig. 1, is available quite cheaply on the surplus market. Other modulation transformers of a similar type may, however, be

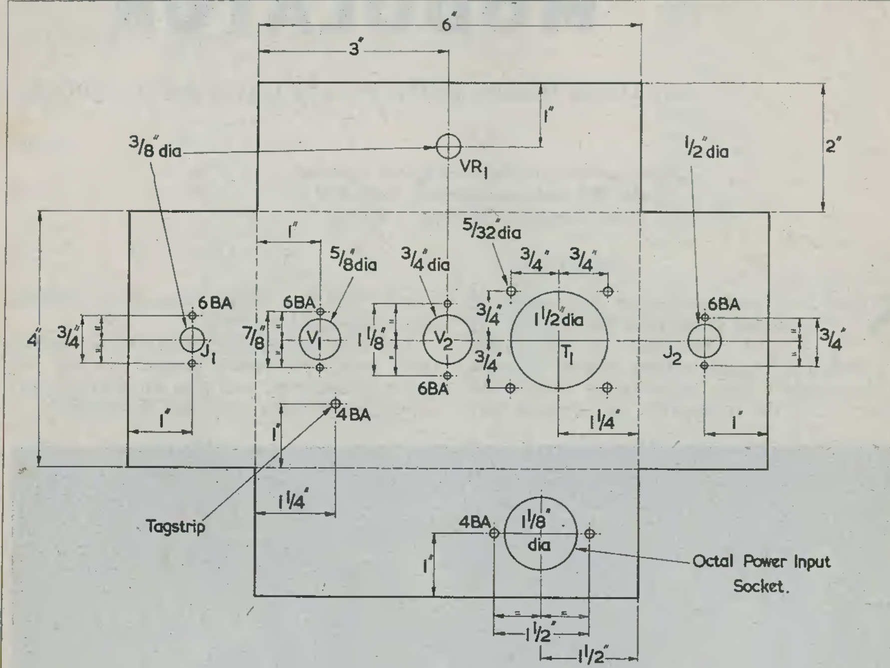


FIG.2.
Chassis details for the Low Power Transmitter Modulator.
M798

the h.t. line as shown in Fig. 1. The output is taken via an insulated coaxial socket, the secondary of the modulation transformer being connected to h.t. potential at the transmitter. The modulation is fed to the transmitter via a coaxial lead fitted with insulated plugs; this merely for neatness and insulation. Jack plugs and sockets have been tried in this position but have been found to break down due to the high peak voltages involved.

In the prototype modulator, the modulation used, but slight changes in the chassis dimensions will, of course, be necessary.

Power Requirements

An h.t. supply of 300 volts at approximately 40 milliamps is required for the modulator, and the 6.3 volt heater consumption is just over one amp. Unless the mains transformer in the transmitter has a h.t. current rating of, at least, 120 milliamps, it is recommended that the modulator be run from a separate power pack.

Components List

Resistors
- R_1, R_2 2.2MΩ 10% ¼ watt
- R_3 1MΩ 2% ¼ watt
- R_4 4.7kΩ 20% ¼ watt
- R_5 22kΩ 10% ½ watt
- R_6 150Ω 20% ½ watt

Condensers
- C_1 8μF 350V wkg. electrolytic
- C_2 0.1μF 400V wkg. paper
- C_3, C_5 25μF 25V wkg. electrolytic
- C_4 0.01μF 400V wkg. paper

Miscellaneous
- VR_1 500kΩ carbon potentiometer, log, with switch
- V_1 Valve type EF91, 6AM6, Z77, etc.
- V_2 Valve type EL84, 6BQ5, etc.
- T_1 SCR522 modulation transformer or similar
- 1 Co-axial socket
- 1 Insulated co-axial socket
- 2 Valveholders
- Chassis and front panel

A CONSOLE RECORDER FOR *Musique Concrète* * AND ELECTRONIC MUSIC

By F. C. JUDD, A.Inst.E., G2BCX

Our contributor, well known to readers of The Radio Constructor, *gives details of a very comprehensive tape recording installation and its special uses, introducing his subject with several examples of* musique concrète *composition*

The most striking difference between electronic and traditional music composition is that the former cannot be performed in public by a musician. The process of transforming sounds by cutting, splicing, retarding, accelerating or reversing magnetic tape excludes this possibility and leads to a different procedure in both composition and reproduction.

As there are no musicians to play *concrète* or electronic music and equally few able to compose, there is ample opportunity for original and interpretative re-creation. The composer of the "new music" has little need to offer a justification of his work, he can regard this as an experiment in an unexplored field and can supply musical motive by pointing to the fascination of creating new sounds.†

The following two examples of this new vogue in music were carried out with the aid of equipment designed and constructed with little more than the facilities available to many amateur recording enthusiasts. These and similar compositions are well within the scope of those willing to construct equipment on similar lines, or modify an existing recorder and build a few additional circuits for the creation of special effects and sounds.

The first example is one of an amusing composition based on the well-known melody *The Three Blind Mice*. The recording was made with the aid of the console recorder shown in the photographs and a multivibrator which, together with tone shaping circuits and an electric plectrum guitar, were used to produce the musical tones for both the introduction and the main theme. The guitar was used mainly for a background of chords and the production of special musical sounds and effects. Since the title of the finished composition was *Three Mice on a Blind* little imagination was needed to create a theme applicable to three inebriated mice. Echos and the stereophonic effect were introduced so that some of the sound, like the three boisterous rodents, was made to move somewhat unsteadily along a path between two loudspeakers positioned for conventional stereo reproduction.

Another example of original composition, this time monophonic and also descriptive, was called *The Butterfly*. It was based on a rhythmic background from a series of endless tape loops with a flight sequence realistically simulated by arpeggios on relative diminished and minor chords from the electric guitar. Extensive use was made of artificial reverberation (echo) and speed control, conventional tape cutting and splicing being used for the final assembly of the sequences and for removing the "attack" and/or "decay" of certain sounds. Concrete sound sources were a deep set drum and a 24in cymbal, which were of course recorded via a microphone. The final composition lasted two minutes but took three days to record, and won the writer a first award for originality in composition and technique.

The Console Recorder

The popular domestic tape recorder does

* When first employed, *musique concrète* referred to music which was entirely synthesised by such devices as the drawing of sound waveforms for subsequent reproduction by electronic means. Currently the term also embraces the production of sounds given by electronic oscillations, shaping circuits and the like. —*Editor.*

† Electronic Music and Musique Concrète. *By F. C. Judd,* A.INST.E. *(published by Neville Spearman Limited).*

not readily permit special recording techniques, although simple *musique concrète* composition can be created with it. Two tape recorders, however, may be used most effectively and the procedure is to make a recording on one machine and transfer it, with added material, to a tape on a second machine. A more flexible method is to use both tracks of a standard tape, recording from one track to the other as required. By this method three or four recordings can be finally dubbed on to a single track. One or more extra playback heads may be used for controlled artificial reverberation, this being an extremely potent effect and widely used in the production of electronic music and *musique concrète*.

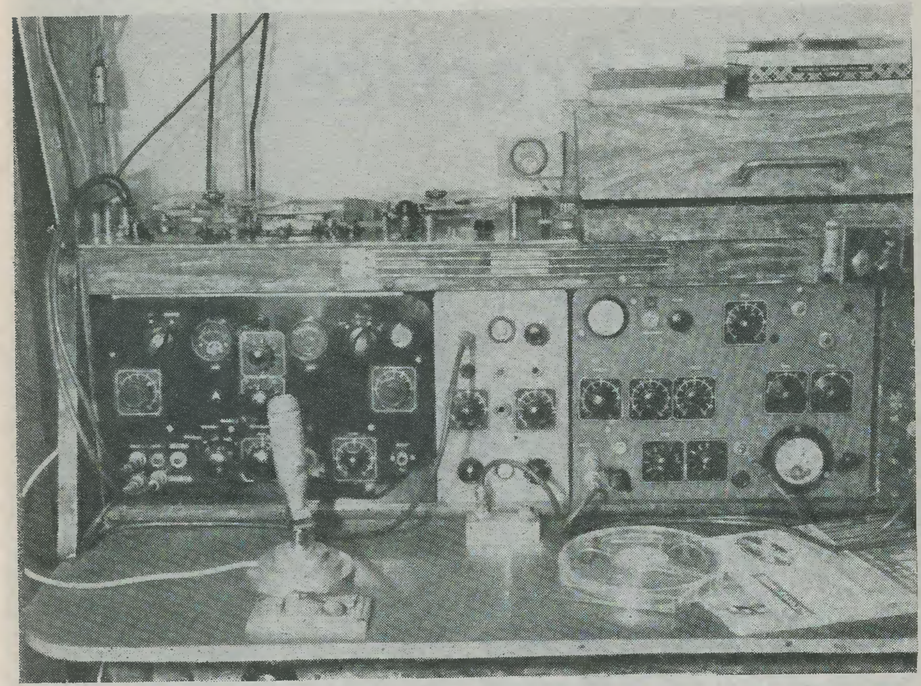
The very versatile equipment used by the writer incorporates all these features. It was entirely home constructed, including the deck, and may therefore be of interest to the more ambitious recording enthusiast. Stereophonic or monophonic recording approaching professional standards with a level frequency response (record to playback) of 20 to 15,000 c.p.s. and a very low percentage of harmonic and intermodulation distortion was the primary design requirement for first class reproduction. No less than nine "pitch related" speeds as well as gradual speed variation are available. Two pairs of record and erase heads, one pair for each tape track, and a Truvox "in line" stereo head make provision for a flexible track-to-track recording system including the facility of direct monitoring during recording and the production of artificial echoes.

Two playback amplifiers, each with an output of 10 watts, two recording amplifiers, three bias oscillators, one for erase and two for recording, cater for most requirements since the amplifier units may be interconnected by a standardised system of screened patch cords and jacks. The recorder includes a built-in oscilloscope to which the output of any amplifier may be directly switched for the analysis of new sounds and a single frequency audio generator which provides a line up tone for stereo balancing and recording level.

All this equipment is housed in the console shown in the photographs. A built-in f.m. receiver as well as a turntable and hi-fi pick-up are also included. Auxiliary equipment comprises two three-channel microphone and signal mixers, a tape head pre-amplifier for re-recording and echo work, a vibrato unit, several tone shaping networks and special gating devices for automatic removal of the attack or decay of sounds.

The work involved in designing and constructing this seemingly complex equipment has been more than justified, not only by its flexibility and the excellent quality of reproduction but by the very satisfying recordings of "new music" that have been made with it. This departure from recording and conventional music may be frowned upon by some, but justification lies in the fascination of achieving something new and in exploring new territory.

"Creating new sound" with the recording equipment described in the article. The writer frequently uses a special Ormston Burns Electric Guitar as well as an Audio Signal Generator and Concrète Sounds (sounds picked up by a microphone) for producing short film and TV backing tracks of abstract music and sound effects



General view of the console recorder

Most of the amplifiers were designed around circuits recently published by Mullard Limited.

The control scales and lettering used on the equipment are "Panel Signs" by Data Publications Limited.

Northwood Evening Institute

Potter Street Northwood Middlesex

Classes for the R.A.E., G.P.O. Morse Test, Elementary Radio Theory and a more advanced course, will be held at Northwood again, beginning on 19th September; enrolments on Monday to Wednesday, 12th to 14th September, 6.30 to 8.30 p.m.

The RADIO CONSTRUCTOR INDEX

The index for Volume 13, August 1959 to July 1960 inclusive, is now available. Direct subscribers to the magazine will already have received their copy enclosed with this issue. For non-subscribers, copies of the index are available from us at 6d. each plus s.a.e., preferably 9in x 6in.

RTTY In Theory and Practice

by **J. B. Tuke, G3BST**

PART 4

After discussing the relative advantages and disadvantages of the various methods of achieving r.t.t.y. signalling, we now come to the point of how to get these signals actually "on the air".

It was explained earlier how the only practical system—as far as the normal h.f. bands are concerned—is that employing frequency shift keying (f.s.k.), and we will at this point consider the various methods of generating these signals. The object of this article is not so much to give circuit diagrams with values which can be slavishly copied, but rather to discuss the relative merits of the various methods which exist for producing f.s.k. signals, leaving the enthusiast to make his own choice.

The methods of producing f.s.k. can be subdivided immediately under two main headings (*a*) Direct shift of the oscillator frequency, and (*b*) the s.s.b. system.

Method (*a*) is, of course, the simpler of the two, and consists of circuitry which will change the oscillator frequency by the required amount upon the application of a changing d.c. voltage from the teleprinter.

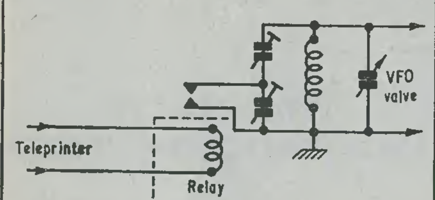


Fig.1
Relay switching

The simplest possible way of doing this would be to have a relay, operated by the teleprinter signals, which would switch in (or out) a small condenser connected directly across the v.f.o. tuned circuit. Although this system is not recommended for amateur use, it should not be considered as unworkable—it is in fact used on certain commercial transmitters mostly in the low frequency range. Its main snag, as far as amateurs are concerned, is obtaining the right type of relay, since this must be of the high speed type having, at the same time, very low self capacity (particularly to the body and coils). These are two conflicting requirements, high speed relays tending to be small, and low capacity types tending to be on the large side. If it is decided to use this circuit, better isolation and control can be achieved by having two condensers in series across the tuned circuit and arranging for the relay to short circuit one of them (see Fig. 1). Either or both of these condensers may be made variable thereby providing fine control of the frequency shift.

An improvement on this system is to use a diode (or diodes) in place of a mechanical relay. The diodes may be semiconductor or conventional valve types, though the former are more common. The *modus operandi* is really the same as that of the relay circuit, except that the relay is electronic and therefore the speed of operation is, for all practical purposes, instantaneous. The diode may be considered as conducting or non-conducting according to the polarity of the applied voltage, the capacitor therefore being effectively switched in and out of circuit. Isolation between the d.c. supply and the r.f. circuits is achieved by the use of r.f. chokes (see Fig. 2).

A further improvement on this method is to use one of the special variable capacity diodes. These devices have a self capacity which changes with the applied d.c. voltage, and they provide a simple method of achieving f.s.k. with the minimum number of components. It must be noted that in this case the frequency shift is dependent directly on the applied voltage from the printer which must therefore be stabilised within close limits. This is unlike the two previous circuits where, providing more than a certain minimum voltage is applied, the full shift takes place.

An alternative way of changing the frequency of an oscillator is to use a reactance modulator. In this circuit arrangement, a second valve is connected in a phase shift network so that it behaves either as a condenser or an inductor, and it is then joined across the oscillator tank circuit (see Fig. 3). The value of the "capacity" or "inductance" is dependent upon the current drawn by the reactance valve, so that if its grid voltage is changed the "C" or "L" changes accordingly. The d.c. signals from the teleprinter are therefore applied to the grid, and are reproduced as reactance changes across the oscillator tank circuit, thereby producing f.s.k. It must be remembered that, although the deliberate voltage changes are applied to the grid, a change of any of the electrode voltages will produce a change in anode current and a consequent change of reactance. A stabilised h.t. supply may therefore be considered essential with this circuit. Despite this additional complication, it is an easy circuit to get going and is confidently recommended. It has the further advantage that it can be constructed out of parts which will be found in any amateur's junk box, and that it invariably works first time!

The amount of frequency shift produced may be altered in two ways. Either the value of the d.c. from the printer may be altered, or, what is often easier, the value of the fixed bias applied to the reactance valve may be altered instead. Since the changing voltage from the teleprinter is applied on top of the steady bias, it follows that the amount of frequency shift produced will be greater or smaller according to whether the changing voltage is a large or small percentage of the total bias. The shift control, therefore, can be a variable resistor in the cathode of the reactance valve.

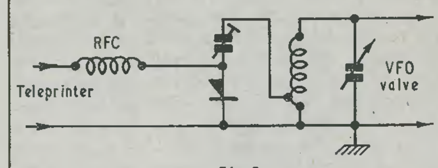


Fig.2
Diode switching

All the above systems suffer from one big disadvantage—if the operating frequency of the oscillator is changed, so also is the amount of frequency shift. Since, no matter which circuit is used, the frequency shift is produced by varying capacity (or inductance) relative to the oscillator tank constants, it follows that if these constants are altered, so is the amount of shift. This is not noticeable when "moving about" in one band, but if the oscillator tank components are changed, then the amount of frequency shift will require resetting. The large majority of amateurs do not, of course, change their oscillator tank constants when changing from one band to another—they simply use doublers and treblers. Unfortunately this does nothing to ease the problem, but only puts it in a different light. If an f.s.k. signal with a shift of 800 c/s is generated on, say, 3.5 Mc/s, and this is doubled to 7 Mc/s, the shift will also be doubled to 1,600 kc/s, and

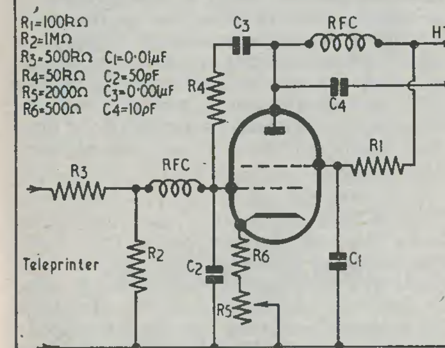


Fig. 3
Reactance modulator

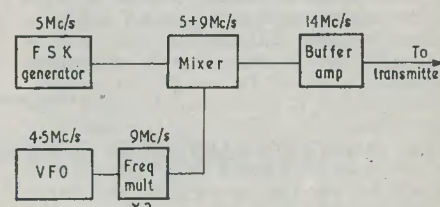


Fig.4
Mixer type FSK/VFO unit

if the frequency is again doubled to 14Mc/s, the shift will become 3,200 c/s! Consequently, resetting of the shift will be required whenever the band is changed—whether the oscillator frequence itself is altered, or whether frequency multipliers are used.

One way of overcoming this difficulty is to use the mixing technique, where the f.s.k. device is not associated directly with the v.f.o., but with another oscillator operating on a completely different (and usually fixed) frequency which has its output mixed with that of the v.f.o. to provide the final frequency (see Fig. 4). For example, the f.s.k. generator might operate on, say, 5 Mc/s. This could be mixed with a v.f.o. running on 1.2 to 1.5 Mc/s to give an output in the 80m. band, and with a v.f.o. on 2 to 2.15 Mc/s for output in the 40m. band, and so on. The amount of shift is obviously unchanged and independent on the final frequency. Although a perfectly sound system, this design involves a great deal of work simply to add r.t.t.y. to a transmitter, while there are the other much simpler methods; it may, however, appeal to those who already use a "mixing" system to provide their v.f.o. frequencies.

It is pertinent at this point to mention f.s.k. as applied to crystal oscillators. Any of the aforementioned shift circuits can be used, but their success is likely to depend upon the characteristics of the individual crystal, and would be difficult to forecast. It is unlikely that the required amount of frequency shift can be produced straight away, so that a crystal f.s.k. oscillator normally operates on a fairly low frequency and is followed by a number of frequency multipliers. Attempts to produce large shifts on a crystal often lead to instability.

The alternative to producing f.s.k. in the oscillator itself is to use an s.s.b. transmitter (or at any rate, the exciter portion). It is obvious that if a constant tone is fed into the modulator of an s.s.b. exciter, a definite carrier frequency is produced, and that if the audio tone is changed, then the carrier frequency is shifted by exactly this amount. Consequently, if two alternate tones, one corresponding to Mark, and the other to Space, separated from each other by 800 c/s (or whatever the desired value of shift may be) are fed into the s.s.b. exciter, the output is f.s.k. by 800 c/s, no matter what the actual radio frequency may be. It does not matter what the frequency of the audio tones are (providing they are within the band-pass of the audio section of the s.s.b. exciter) so long as they differ by the required amount of frequency shift.

The requirements for this system (apart from an s.s.b. transmitter!) are no more than an audio oscillator which will vary its frequency by the required amount on being fed with teleprinter voltages. This is not difficult to arrange and, since it is at audio frequency, direct connection may often be made between the oscillator and teleprinter contacts—as for example when extra capacity is added across a phase shift oscillator working in the a.f. range.

It is not seriously suggested that any would-be r.t.t.y. enthusiast should sit down and build an s.s.b. transmitter in order to use this mode of transmission, but it may encourage some "s.s.b. merchants" who are becoming interested in r.t.t.y. to know that they already possess the most sophisticated type of r.t.t.y. transmitter and that the only additional item required is a small audio oscillator.

It is interesting to note that when using an s.s.b. transmitter for r.t.t.y., the amplifier stages may be run in class C, since amplitude linearity between input and output no longer matters. This is important, since some amateur s.s.b. transmitters are not designed to operate continuously in the linear mode without overloading—so that when using r.t.t.y., the operating conditions of the final should be changed to class C in order to take full advantage of the increased efficiency and reduced anode dissipation.

From the foregoing it will be agreed that the modifications to any transmitter to produce f.s.k. are extremely simple and can be applied with little difficulty. Certainly the transmission side of r.t.t.y. should dismay no one. Whatever system is used, it is emphasised that some sort of filter should be interposed between the teleprinter contacts and the shift device (unless the latter is a mechanical relay). This filter need only be a simple R-C device as outlined earlier. The values are not critical and the filter should progressively attenuate frequencies above 125 c/s—although a sharp cut-off is better if this can be arranged. Omission of the filter may possibly produce the most objectionable "key clicks".

Regarding the use of an f.s.k. transmitter, there is little to mention, the adjustments being those which are employed for normal c.w. working. There is no doubt that any faults in the transmitter will certainly come to light very quickly due to the continuous "key down" operation. This is not so likely with transmitters which have been designed primarily for telephone work, but the "c.w. only" enthusiasts may be surprised how the scent of cooking insulation permeates the shack after a long r.t.t.y. contact. This is not a problem peculiar to amateurs—commercial c.w. transmitters are "de-rated" when used for r.t.t.y. In fact the commercial problem is more acute as transmission may

continue unbroken throughout several days or weeks!

The simplest possible solution does not lie in replacing all over-run resistors, etc., but in the installation of a small air blower. It is surprising how the overheating problem disappears (or should one say is wafted away) when a comparatively small air draught is fed into the lower regions of the transmitter. We are not discussing forced-air-cooled p.a's or anything like that—simply the introduction of cool air, which is left to find its own way out, into the transmitter. Small motor blowers can be obtained on the surplus market and a little bit of elementary pneumatics with small bore plastic pipe will save the transmitter from disappearing in a cloud of smoke. The blower should only operate when the h.t. is applied.

Using r.t.t.y. should not cause t.v.i. problems—in fact in some cases this mode may free the amateur from trouble, where the transmission produces either shock excitation, or an overall brightening (or darkening) of the received picture. This is objectionable when c.w. keying is employed, but when "switch on" and "switch off" are separated by several minutes, as with r.t.t.y., it may well pass unnoticed. If f.s.k. produces t.v.i. particularly where it was not troublesome before, then there is something radically wrong with the transmitter, or excessive sidebands are being radiated due to omission of the filter. The aerial current should not change due to alteration from Mark to Space, since the r.f. circuits are usually sufficiently wide-band to consider the two signals as one.

The aerial for an r.t.t.y. transmitter is like any other aerial, directivity always being an advantage. Commercial systems favour rhombics, but this is impracticable for most amateurs, and it is also open to question whether the average amateur requires the high directivity produced by a correctly operated rhombic.

Some form of a.f. standard is required for adjusting the amount of shift of any type of transmitter, and a calibrated audio oscillator is extremely useful. If an accurately calibrated one is not available, all is not lost, providing a stable variable a.f. oscillator can be produced. In the absence of a calibrated oscillator, the following method may be adopted. Listen on the station receiver to a commercial station using r.t.t.y. which is known to be using the correct value of shift. Zero-beat the audio oscillator with the alternate Mark and Space tones, and note these settings. Now switch on the f.s.k. generator, and arrange that it produces the same pair of tones in the receiver for Mark and Space as were produced by the commercial station—this being indicated by the oscillator zero beating on the same two settings. Providing the a.f. oscillator does not drift during this setting up procedure, the shift will be remarkably accurate.

One final point must be made before leaving f.s.k. devices—stability is of the utmost importance. If it is decided to use a system where the amount of shift is dependent upon the voltage produced from the printer, it is advisable to use batteries for this purpose, since if power supplies are used (and only a few volts are required to cause stabilisation problems) mains fluctuations will play havoc with the shift. H.T. supplies to the reactance modulator, its associated oscillator, and the v.f.o. (if separate) must be stabilised. The frequency of the v.f.o. must not shift even minutely when subsequent stages are switched on. Amateurs must operate highly selective r.t.t.y., and although this is primarily a job for the receiving end, a stable transmission is a first essential.

The final instalment of this article will deal similarly with receiving circuitry—discussing their relative merits, and leaving the amateur to take his choice. In transmitting as with receiving, the difference between simple and sophisticated circuitry is not so much in the actual results, but in ease of operation.

A NEW HIGH POWER MAGNETRON

Designed for high power long range radar applications, the M566 is the latest addition to the range of magnetrons marketed by the English Electric Valve Co. Ltd. This water and forced-air cooled, multi-resonator, pulse operated valve has a peak input power rating of 6mW and operates at a fixed frequency within the limits of 2,750 and 2,860 Mc/s.

The M566 is designed for use with a separate water cooled electro-magnet and a launching section for coupling the valve to wave-guide No. 10 (2.84 x 1.34in internal dimensions). The wave-guide may be pressurised to 65lb/sq in absolute; the minimum wave-guide pressure being 35lb/sq. in absolute.

Water cooling of the anode is incorporated with the electro-magnet and the window is cooled by air at high pressure in the wave-guide. Low pressure air cooling may be used on the cathode terminal.

A High Sensitivity Shorted Turns Tester

Designed by **M. D. ROBERTS**

An item of test equipment which is always of considerable use, whether in the hands of the amateur home-constructor or the professional service engineer, is a shorted turns tester. Such a tester may be readily brought into service to discover faults which are quite impossible to diagnose by normal visual or resistance tests, these faults including such frequently occurring examples as adjacent turns short-circuiting in wave-wound coils, and in line output and mains transformer windings, provided that the latter are removed from their cores.

The shorted turns tester described in this article has been developed to provide a considerably high degree of sensitivity. Due to the low frequency at which it operates (2.5 kc/s) it is, also, capable of detecting, without misleading readings due to excessive oscillator loading, shorted turns in windings having a large number of turns. A further attractive feature, again the result of the low operating frequency, is that it will not normally be affected by absorption due to resonance in the coil being tested. It is extremely unlikely that the self-resonant frequency of any coil presented to the tester will be as low as 2.5 kc/s.

Circuit Diagram

The circuit of the tester appears in Fig. 1. The oscillator coil assembly shown in this diagram consists of a coil fitted to one end of a relatively long core made up of a number of lengths of insulated soft iron wire. Part of the core projects from the oscillator coil, and suspect windings are tested by being passed over this projection.

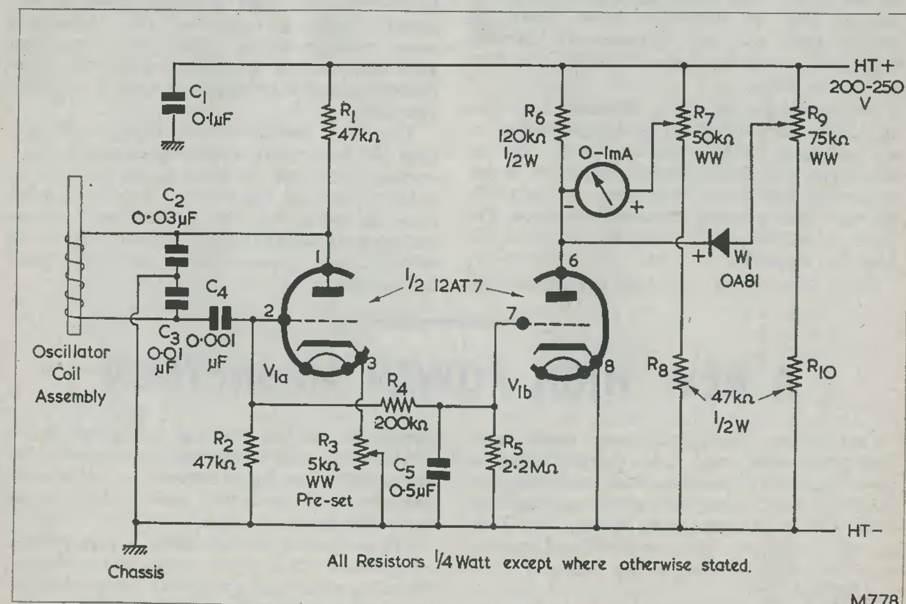


Fig. 1. The circuit of the high-sensitivity shorted turns tester

short-circuited turns is placed over the core, energy is drawn from the oscillator circuit and oscillator efficiency drops accordingly. This results in a drop in the negative voltage on the oscillator grid.

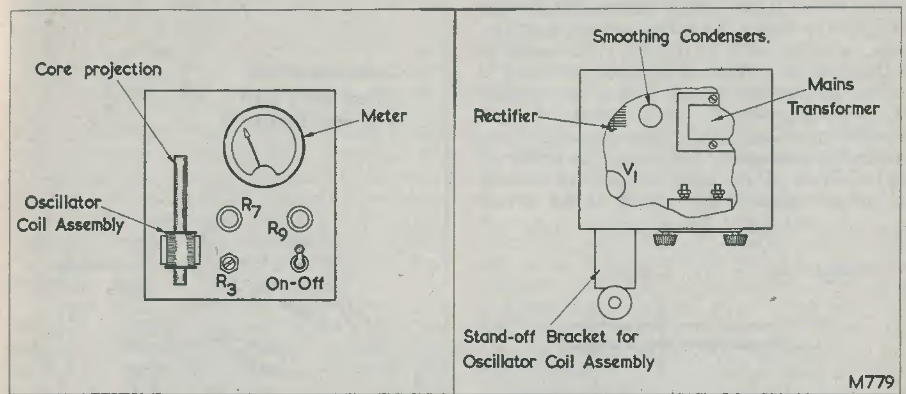


Fig. 2. A suitable front panel and parts layout for the tester. In the lower view, part of the cabinet top is cut away to show the main chassis components. The stand-off bracket for the oscillator coil assembly should be made of insulating material

The oscillator coil forms the inductive section of a Colpitts oscillator tuned circuit. The capacity tuning the coil is provided by C_2 and C_3 in series, the "earthy tap" into the tuned circuit appearing at the junction of these two condensers. R_2 and C_4 are oscillator grid leak and condenser respectively. A pre-set variable resistor, R_3, is inserted in series with the cathode of the oscillator triode, $V_{1(a)}$, in order to provide a sensitivity control.

A negative voltage, with respect to chassis, appears on the grid of $V_{1(a)}$ due to leaky-grid action, and this voltage is passed, via the filter R_4, C_5, to the grid of the amplifier triode $V_{1(b)}$. In the anode circuit of $V_{1(b)}$ is connected an indicating meter, together with a zero-adjust potentiometer and an overload protection circuit.

Tester Operation

The purpose of the circuit is to show visually, with the aid of the meter, the effects on oscillator efficiency caused by passing suspect coils over the projecting soft iron wire core. When no coil is fitted over the core, the oscillator functions at maximum efficiency, with the consequence that maximum negative voltage appears on the grid of $V_{1(a)}$. If a winding which has no short-circuited turns is placed over the core, oscillator efficiency remains unaltered and the negative voltage on $V_{1(a)}$ grid maintains its maximum value. If, however, a coil having

The amplifier triode $V_{1(b)}$ is connected in such a manner, that changes in negative voltage on the grid of $V_{1(a)}$ are shown visually as changes of current flow through the meter in its anode circuit. R_7 is set up such that, when the voltage on $V_{1(a)}$ grid—and, hence, that on $V_{1(b)}$ grid—is at its most negative, the meter indicates zero current. When, due to a coil with a short-circuited turn having been fitted over the oscillator coil core, the negative voltage on $V_{1(a)}$ grid drops, $V_{1(b)}$ draws increased anode current and the meter reading increases.

It is possible to set up the circuit to offer a high level of sensitivity, with the result that unless suitable precautions are taken, currents in excess of 1mA may be passed through the meter when a faulty coil is presented to the tester. This eventually is avoided by the overload protection circuit given by the diode W_1, in combination with resistors R_9 and R_{10}. R_9 is adjusted such that, for anode voltages in $V_{1(b)}$ which allow less than 1mA current to flow through the meter, the diode does not conduct. As soon as the anode voltage drops sufficiently far to cause a current of 1mA to flow through the meter, the diode conducts. In consequence, anode voltage is prevented from falling to any markedly lower value, and currents significantly in excess of 1mA cannot flow through the meter.

The Power Supply

A mains power supply is required for the tester. Provided that it incorporates a transformer giving isolation from the mains, the power unit may be of any conventional type, employing a valve, metal, or contact-cooled h.t. rectifier, as desired. The heater requirement for the tester circuit proper is 6.3 volts at 0.3A (or, using the series heater combination possible with a 12AT7, 12.6 volts at 0.15A). H.T. voltage should be 200 to 250 volts, and the power unit should be capable of providing 40mA h.t. current. Under normal working conditions, however, h.t. current consumption will be of the order of 10 to 20mA. There is no necessity to provide a voltage-regulated h.t. supply as the circuit

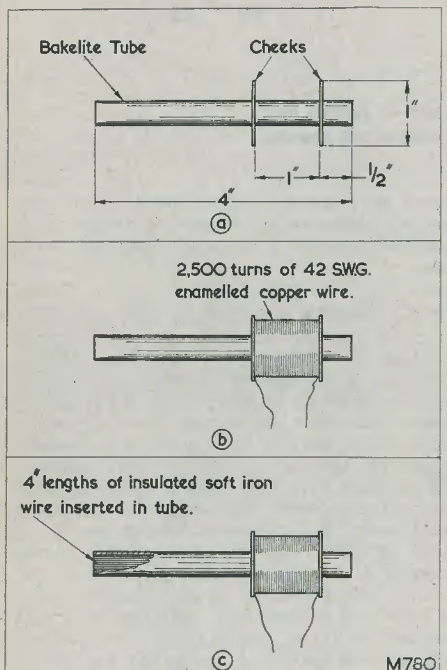


Fig. 3. The prototype oscillator coil assembly was constructed as shown here. (a) Two cheeks having a diameter of 1in were fitted to a Bakelite tube. (b) The coil, consisting of 2,500 turns of 42 s.w.g. enamelled wire, was then random-wound between the cheeks. (c) Finally, 4in lengths of 22 s.w.g. insulated soft iron wire were inserted in the tube and glued into position

is, to a certain extent, self-compensatory for changes in h.t. potential (an increase in h.t. potential causes a compensatory increase in negative grid voltage in $V_{1(a)}$). Another reason for not requiring a regulated h.t. supply is that the tester is a qualitative rather than a quantitative instrument. It is intended

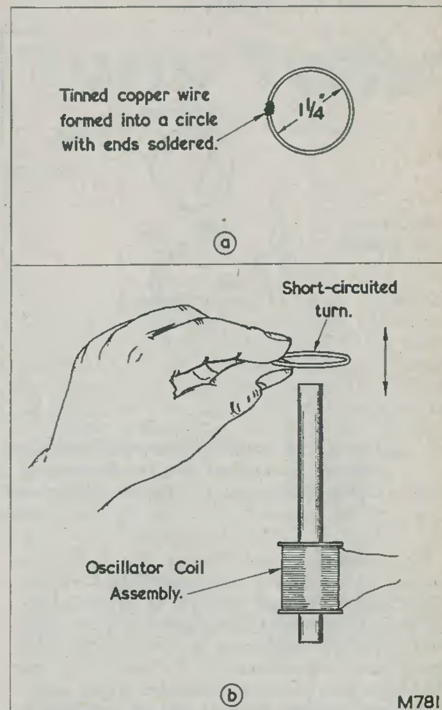


Fig. 4 (a) A Simple short-circuited turn, made up as shown here, is necessary for checking and setting up the tester. (b) When the short-circuited turn is passed completely over the projecting oscillator coil core the tester meter current will rise. A measure of sensitivity may be obtained by loosening the coupling between the short-circuited turn and the core, as shown here. Maximum sensitivity corresponds to a given meter deflection with minimum coupling

to indicate that changes in oscillator grid voltage have taken place without defining such changes in terms of magnitude.

Construction

Few difficulties should be experienced with the construction of the tester for the reason that, due to the low operating frequency employed, component layout is not excessively critical. It would, nevertheless, be preferable to position the double-triode, and the components immediately connected to $V_{1(a)}$, reasonably close to the oscillator coil connections. The circuitry around $V_{1(b)}$ is of a "d.c." character, and any convenient positioning of components may be adopted here.

A suitable layout, including that for the front panel, is illustrated in Fig. 2. It will be noted in this diagram that all components, with the exception of the oscillator coil assembly, are intended to be fitted in a case. The oscillator coil assembly is mounted outside the case so that it becomes available for the testing of coils. In order to reduce losses in the oscillator coil it would be advisable to make the case, or at least that side of the case to which the coil assembly is fitted, of insulating material. The coil assembly should not approach any large metal area, including metal areas *behind* an insulated panel, by less than 3ins.

There will, obviously, be some heat dissipation inside the cabinet in which the tester, together with its power unit, is fitted. A simple means of ventilation should be provided to prevent excessive temperature rise.

The Oscillator Coil Assembly

The oscillator coil assembly is completely home constructed. Fig. 3 illustrates graphically the manner in which the prototype assembly was made up. A 4in length of Bakelite tube having an internal diameter of $\frac{5}{16}$in and an outside diameter slightly in excess of $\frac{3}{8}$in was obtained and fitted with 1in diameter cheeks, as shown in Fig. 3 (*a*). Approximately 2,500 turns of 42 s.w.g. normal enamel (or synthetic enamel type F) copper wire were then random-wound in the space between the cheeks, care being taken to keep the winding depth uniform as the winding operation proceeded. The total number of turns employed only requires to be held within an accuracy of 10%, and so approximate turn counting techniques will suffice.

The lengths of wire which constitute the core were then prepared. These consist of 4in lengths of 22 s.w.g. (0.028in diameter) soft iron wire, and they were primarily insulated by being dipped in an insulating varnish, such as shellac. When dry they are packed into the 4in Bakelite tube side by side and glued into position. Some 60 to 80 pieces of wire are required. It should be pointed out that it is essential to insulate the lengths of iron wire before inserting them into the tube otherwise excessive oscillator losses will occur with a consequent degradation in tester sensitivity.

Setting Up

After the tester has been completed it must be set up before it is ready for use. For this purpose it is necessary to have available a specially prepared single short-circuited turn which can be used to check circuit operation. Such a turn is illustrated in Fig. 4 (*a*). Before switching on, R_3 should be set to its minimum resistance position. Also, the slider of R_9 should be temporarily left at the bottom end of its track, in which condition no overload protection is provided for the meter. The tester may now be switched on. As the double-triode warms up, R_7 should be adjusted to maintain the meter reading at any point near mid-scale. When the double-triode reaches full operating temperature, R_7 is set to give zero reading on the meter.

It is next necessary to adjust R_3 such that the negative voltage on the grid of $V_{1(a)}$ is just within the grid base of $V_{1(b)}$. The amount of resistance inserted by R_3 is experimentally increased until a reading of approximately 1mA is indicated on the meter, after which R_7 is adjusted to bring the meter reading back to zero again. The short-circuited turn is then brought up to the oscillator coil core (as in Fig. 4 (*b*)) whereupon the meter reading should increase. The short-circuited turn should be advanced until the meter indication is slightly in excess of full scale deflection, whereupon R_9 should be adjusted until the meter reading falls just below full-scale deflection.

The tester is now in a condition in which it may be used. However, it is advisable to make several further experimental adjustments to R_3, following up with adjustments to R_7 and R_9, until a condition of maximum sensitivity is obtained, as indicated by the short-circuited turn. An increase of sensitivity will be evident when it is possible to obtain a given meter deflection with the short-circuited turn further away from the core.

Next Month . . .

SIMPLE REFLEX SUPERHET
THE PHONE-GUARD
BEGINNER'S S.W. RECEIVER

RADIO topics

BY RECORDER

If the matter were not of such a serious nature, the recent pother over "bugs" could be described as providing a wryly amusing combination of science-fantasy and Ruritanian comic opera. "Bugs" are transistorised listening devices which, secreted in Embassies and the like, transmit whatever speech they pick up to nearby receivers. So far as can be judged from newspaper reports, "bugs" are powered by an external transmitter. Presumably, this transmitter is sited at the receiving post and a sufficient amount of its energy is picked up by the "bug" to provide, after rectification, a source of h.t. for its own transmitting circuits, which then radiate on another frequency.

As some readers may have noticed, a "bug" (and rather an old one at that) was visible during a television newsreel recently when the American representative at U.N.O. demonstrated how it had been hidden inside a plaque. So far as could be seen from the television picture, the body of the "bug" consisted of a cylindrical housing about an inch to an inch and a half in diameter and an inch in length, with an aerial some eight inches long protruding radially from the diameter. Such an aerial (assuming it were a quarter-wave) would set the operating frequency of the "bug" around 300 Mc/s.

The Russian delegate pooh-poohed the American evidence and asked, in effect, when "the play would be produced". In a later reply the American representative stated that the "bug" would be operated with the aid of a "technical" device elsewhere.

Falling back on the term "technical" instead of describing a little more fully what seems to be a relatively simple electronic process, highlights, to my mind, the fact that it may well be necessary for future diplomatic staff to be instructed in elementary electronics in addition to the complex subjects of their own calling. They would then be able to understand more readily the manner in which "bugs" operate and would not have to relegate them to a black magic pigeonhole labelled "technical devices". A general understanding of the functioning of "bugs" would, surely, assist in their earlier detection.

Present day "bugs" (again relying on newspaper reports) appear to be very tiny things indeed; so tiny that they may remain hidden in clothing without the wearer being even aware of their presence. One can sympathise with the security officers whose job it is to detect them. Some technically minded people might suggest that the best protection against such devices would be provided by holding secret conversations in rooms which were electrically screened. This screening would then act both to prevent the ingress of energising signals and to prevent the radiation from the room of transmissions from "bugs". In practice, however, the screening required would need to be extremely efficient. As most people who have worked at such frequencies will agree, it is impossible to get 100% screening at v.h.f. and higher frequencies by simply shrouding the screened object with wire netting or something of that order; it is necessary to shroud the object with unbroken copper sheet (or sheet made of a similarly good conductor) having all joins soldered or soundly connected together every few inches. And, even then, conductors carrying services such as telephone and lighting into the screened area would need to be fitted with filters!

Protection against "bugs" is not simple, and it is a sad comment on the rather lunatic world in which we live that such things should exist.

Film Dates

Turning to a lighter subject, some friends of mine complained recently that old films are presented on television without the viewer being advised of the year of their issue. I sympathised with this point of view: it is quite often desirable to know the year of issue, this enabling its dialogue to be followed with greater discernment. My friends were surprised when I next told them that the year of issue *is* shown on nearly all films televised, and that it is possible to see it on any receiver having reasonably good definition.

All films carry a copyright claim (which usually appears in the credits, before the start of the film, around the same time as the references to the sound recording system, etc.) this claim consisting of the word "copyright" followed by the year of issue. Simple, isn't it? The reason why most people fail to discern the copyright notice is that it is usually presented in small characters amongst credits which are not of interest to the average filmgoer or viewer. Also, the year is given in Roman instead of Arabic numerals. In recent films the word "copyright" may be replaced by the international copyright symbol, ©.

The following will help any readers who are a little rusty on their Roman numerals. The first three characters in the date of issue of any film are always MCM, these standing for 1900. MCM may be followed by XXX, signifying 30; by XL, signifying 40; by L, signifying 50; or by LX, signifying 60. These latter symbols will then be followed by the characters which stand for the last digit of the expression: V for 5; IX for 9; and so on. If the last digit is zero, no symbol follows that which defines the "tens". To take some complete examples, the Roman numerals MCMXXXIX stand for 1939, the numerals MCMXLIV stand for 1944, and the numerals MCML stand for 1950.

The next time you see a film on television look out for the copyright notice. Then you will know exactly the year in which it was issued.

Music While You Drive

I have often thought that, during long periods at the wheel, a car radio can sometimes be nearly as much of a nuisance as a blessing. My reason for thinking this is that one normally wants relaxing entertainment whilst driving, and it just isn't possible for suitable programme material to be always available at all times of the day. There is, also, the particularly annoying feature of car radio listening which is occasioned by programmes having orchestral music interspersed with dialogue. The music in such programmes tends to be annoyingly loud, with the result that one has to reduce volume; and the dialogue tends to be infuriatingly quiet, whereupon one has to turn the volume up again! This last effect is especially troublesome in a car because it is normally desirable to keep the output level of the radio sufficiently high to overcome ambient noise, but not so high as to distract attention from the road. Yet another shortcoming becomes evident when one is confronted with a long drive in the very early hours of the morning. One cannot normally use the car radio because hardly any stations are on the air!

All these snags are overcome by a car record player which has been introduced by Philips Electrical Ltd. This record player, the Philips' Auto-Mignon, accepts seven-inch 45 r.p.m. discs and is especially designed for permanent installation in a car. Amplification is provided by the radio already fitted, whereupon the whole installation becomes a car radiogram. The Auto-Mignon is capable of functioning from either a 6 volt or a 12 volt supply with the choice of positive or negative polarity.

Operation of the Auto-Mignon is simplicity itself. It has two controls, one being a gram/radio switch and the other being the record reject button. Records are played by inserting them into a slot; when they have finished playing they are automatically ejected. The record reject button is used only if it is desired to stop and eject a record before it has come to an end. The pick-up in the Auto-Mignon employs a crystal element with diamond stylus, and needle pressure is 10–12 grams. Output is quoted as 300mV. All the problems of possible disturbance by bumpy roads have been overcome by coupling the turntable assembly to a balancing system, and by fitting steadying weights to the underside of the turntable. Extensive tests, on the roughest roads and on the most difficult hills, and at any speed and with the sharpest turns, have demonstrated the stability of the player. At all times the stylus remains in the groove and reproduction quality is fully maintained.

If you want music while you drive—without the snags attendant upon broadcast entertainment—the Auto-Mignon provides the answer.

Soldering Techniques and Problems

Smithy the Serviceman has several pet aversions, but I think that the hobby-horse he mounts most frequently and vituperatively is concerned with "solder tags which won't solder". And who can blame him? There can be few things so infuriating as finding, when one has to make a connection in a crowded corner of a chassis, that the appropriate solder tag absolutely refuses to take any solder whatsoever. One scratches away at the tag with the iron (whose barrel, meanwhile, is melting great gouges out of adjacent wax-covered condensers) and all that results is the solder running off the tag like mercury.*

It may give readers who have suffered from this trouble, when carrying out constructional or servicing work, a certain grim satisfaction to learn that electronics manufacturers have also torn their hair out on this very same point. I think it is fairly safe to say that manufacturers' troubles rose to a peak with the introduction of printed circuit assemblies and the subsequent dip-soldering and wave-soldering operations which were evolved for their mass production techniques.

An ordinary soldering operation consists of wrapping a wire around a tag and of applying a soldering iron and resin-cored solder. Without thinking about it, the person using the iron automatically rubs the bit against the wire and the tag, thereby, by abrasive action, removing oxide film and getting good thermal contact to the members of the joint. A quickly made joint results. If the members of the joint have a relatively tough oxide film on the outside it is still possible for the solder to "wet" the surface which has been rubbed clean, thereby providing a better thermal contact than is given via the bit alone. The resulting speedy temperature rise of the joint members then provides the resin in the solder with a chance to break down the remaining oxides, and a good joint results once more.

With dip-soldering and wave-soldering techniques there is no abrasive action to initially "start" the soldering of the joint. In the dip-soldering process all components are inserted into the board with their wires, or tags, protruding underneath; whereupon the board is lowered so that its underside is in contact with molten solder contained in a bath. The solder should then bridge over the protruding wires and tags to the sections of copper pattern through which they pass. In the wave-soldering process the components are mounted as for dip-soldering and the whole assembly is passed slowly over a stationary wave of continually replenished molten solder. Again, the solder should connect the protruding wires and tags to the sections of copper pattern through which they pass. It should be noted that in neither of these two processes is there any abrasive action: the component leads and tags, and the copper of the pattern, must solder instantly.

At the introduction of the new soldering techniques it was found that instant soldering did *not* occur in many instances, and much research was put into this problem. Many of the faults discovered were obvious enough, but the fact that they are being corrected to satisfy printed circuit requirements means that standards throughout the industry will inevitably become higher. Thus, a frequent snag in the past with condenser and resistor wire ends has been that they have been soiled with grease or with the moulding resin used in the manufacture of the component. Special attention during manufacture and post-moulding cleaning operations have done a great deal to clear this trouble. Again and, perhaps, a little surprisingly, it has been found that tinned copper wire isn't always an ideal choice for making solder joints without abrasion. Because of this, some manufacturers have changed component wires from tinned copper to solder coated copper in order to meet printed circuit requirements. The solder coating has approximately the same thickness as the tin plating and it solders almost instantaneously.

Solder tags have been the subject of research in recent years, this being due to the general requirements of mass production and to the peculiar needs of printed circuits. Overall experience is worth quoting here, even though the facts may not surprise the older hands. Speaking generally, and keeping to the more economic tag finishes, it can be stated that electro-tinned solder tags are frequently a source of trouble, that hot tin dipped tags are almost perfect, and that silver plated tags are de-luxe! (Smithy will have to install a silver plating plant in his Workshop!)

Turning to a slightly different aspect of soldering, with which to conclude, some constructors and service engineers find themselves a little nonplussed when they encounter manufactured chassis having a yellow, brassy, appearance. Such chassis consist of mild steel, cadmium plated and "passivated". Passivation is a protective process which affects the outside molecules of the cadmium only; and it is quite simple to solder to a chassis having such a finish as the solder "wets" to the cadmium. A passivated chassis should *not* be heavily scraped before soldering as this may reveal the mild steel surface, to which it is much more difficult to solder.

* I am indebted to Mr. A. D. Besford, G3NHU, for referring to soldering problems in a recent letter, and for raising some of the points mentioned here.

Winding

COILS AND SMALL CHOKES

By "*Quench Coil*"

Many constructors of radio equipment, and other similar apparatus which require small chokes and random-wound coils, fight shy of trying to make these up themselves—often going to great trouble trying to locate something suitable from a dealer or from war surplus disposal stocks. If care is taken and the job is tackled in the right manner, excellent components of this type can, however, be made quite easily in the home workshop.

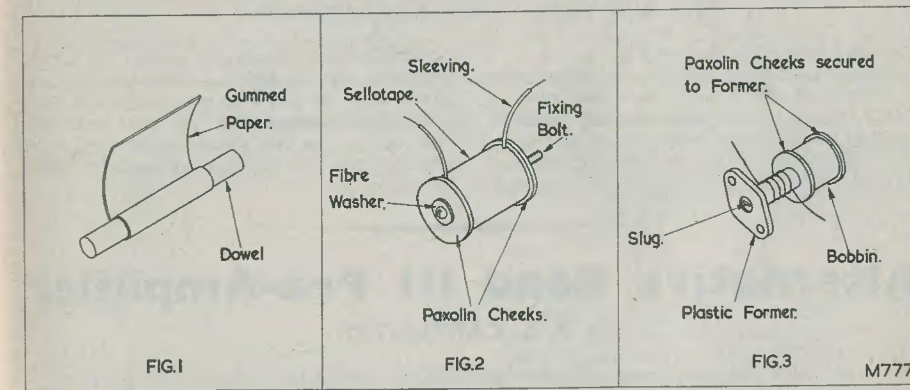
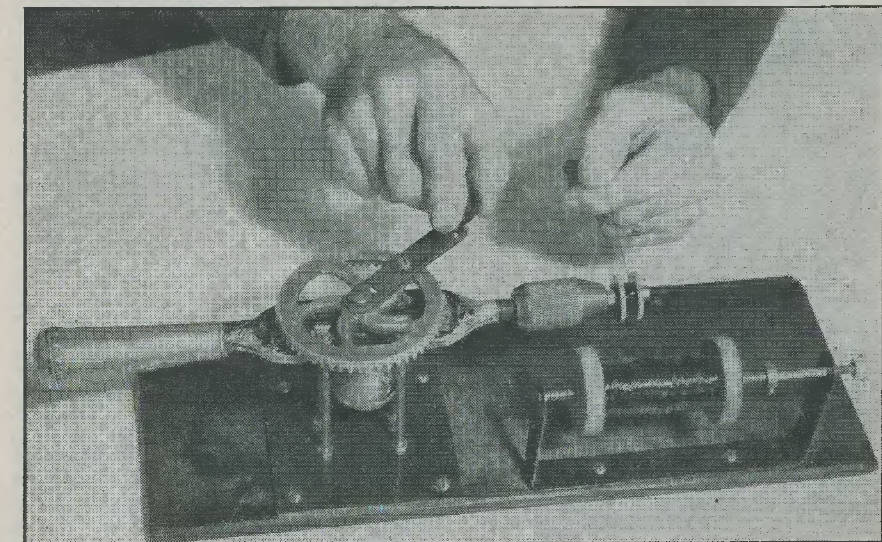


FIG.1 FIG.2 FIG.3

A small hand drill should be mounted as illustrated in the photograph, together with a shaft to carry the spool of winding wire. Two light springs, are fitted to the spool shaft, as shown, together with a brass bush whose position on the shaft can be easily adjusted. Varying degrees of spring tension may, in consequence, be applied to the spool. In this way the wire tension can be adjusted to suit differing winding conditions, and the spool can be prevented from unwinding too freely.

For chokes which do not require self-supporting iron wires, coil formers may be made very simply by winding gummed paper around a dowel of suitable diameter, as shown in Fig. 1. Care should be taken to ensure that the first few layers of paper do not stick to the dowel or it will be impossible to remove the former afterwards. By means of a nut and a bolt passing through the former, it now becomes possible to secure two Paxolin cheeks at either end, fibre washers being fitted under the bolt head and the nut. This assembly should next be painted with polystyrene dope, after which the threaded end of the bolt, with suitable packing to prevent damage to the threads, is held in the drill chuck. Winding then proceeds in the manner shown in the photograph. When complete, the choke has the appearance illustrated in Fig. 2, whereupon the protruding end of the bolt is at once available for mounting to the chassis.

Alternatively, cheeks may be fitted to an internally threaded polystyrene or Bakelite former, together with a nut and bolt to enable the assembly to be secured in the drill chuck. When the winding of this type of assembly is complete the bolt is removed and the requisite slug inserted, giving a complete working it from side to side in order to keep the turns even. Do not turn the drill too fast or the wire will tend to build up at one place.



The author winding a coil as described in the text

assembly similar to that of Fig. 3.

The ratio of hand drills varies from make to make. In the writer's case, the ratio is 4 to 1, which means that every 100 turns of the drill handle winds 400 turns of wire on to the coil former. The wire should be run through the thumb and finger during winding, After a little practice it is easy to tell if the turns are too light or loose by the feel of the wire. It is a wise plan to have a trial run before commencing the final winding. The ends of the coil should be covered with sleeving and the bobbin finished off with Sellotape.

Alternative Band III Pre-Ampilfier

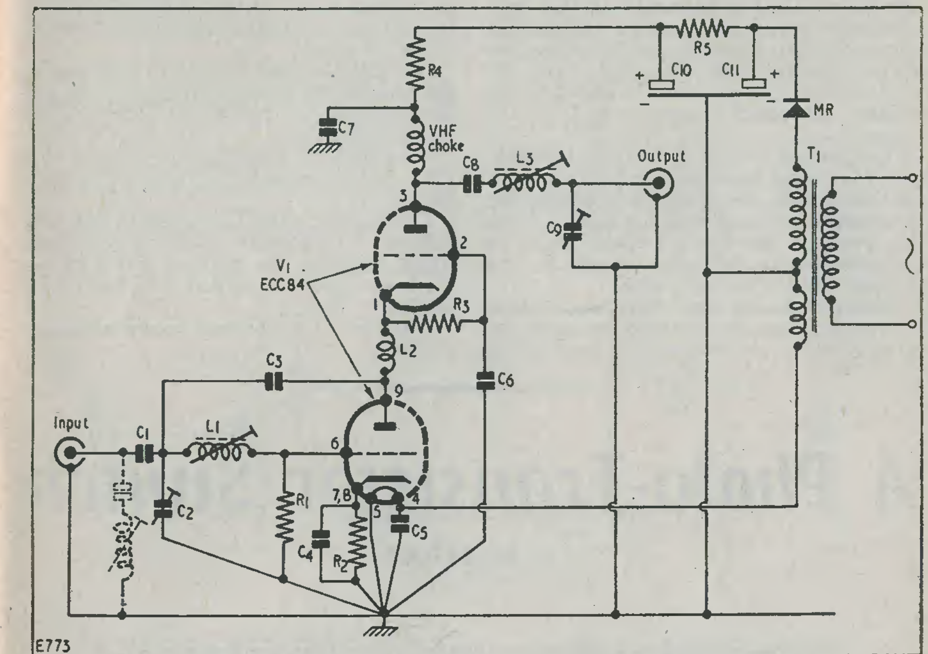
by A. S. CARPENTER

In which our contributor describes modifications successfully carried out to a popular pre-amplifier design

THE PRE-AMPLIFIER CIRCUIT PRESENTED here is suggested as an alternative to one described in an earlier issue of this journal.* Its general appearance is identical with that of the previous pre-amplifier and, as similar components are used, the above and below chassis layouts may be similarly adopted. Both versions have been tested under stringent conditions and, of the two, the arrangement depicted here is preferred by the writer. Where the original pre-amplifier is in use and already providing a good picture, no re-arrangement is required except where results are not sufficiently good.

No criticism of the previous pre-amplifier is made; the unit is a highly efficient one if properly constructed and used, and it has produced a tolerably satisfactory picture. Results, however, were only claimed on Channels 8, 9 and 10, and the importance of connecting impedances of the correct value to its input and output sockets was adequately stressed. To receive Channel 11 transmissions, therefore, over a distance of 60 miles on a 6-element Yagi array was expecting maximum efficiency of all equipment preceding the televisor was vital. The aerial was very carefully positioned and oriented,

* "The HI-GAIN Band III Pre-Amplifier" by Derek Winters, *The Radio Constructor*, March 1958. Subsequently issued as Radio Reprint No. 8.



Components List For the Modified Pre-amplifier

Resistors
- R_1 220kΩ ¼ watt
- R_2 100Ω ¼W
- R_3 47kΩ ¼W
- R_4 1.2kΩ ¼W
- R_5 1kΩ ½W

Condensers
- C_1 47pF, ceramic
- C_2, C_9 30pF, trimmers, ceramic
- C_3 2pF, ceramic
- C_4, C_5, C_6, C_7 1,000pF, ceramic
- C_8 500pF, ceramic
- C_{10} 8μF, electrolytic
- C_{11} 16μF, electrolytic

- V_1 ECC84. MR Miniature contact-cooled rectifier, 250V, 30mA
- T_1 Mains transformer, input 230V, output 200V at 30mA, 6.3V at 0.6 amp

Inductors
- L_1 Teletron type 20T (modified)
- L_2 Teletron type 21T (or see text)
- L_3 Teletron type 22T (modified)
- V.H.F. choke—Teletron RFC2

Chassis
- Teletron Converter Chassis, modified

Miscellaneous
- 2 Coaxial sockets
- 1 B9A ceramic valveholder
- 1 3-way tagstrip, end tag earthed, wire, etc.

rather a lot of the pre-amplifier, and was certainly a most stringent test. Nevertheless, an attempt was made and reception proved possible. The receiver used was a five year old commercial model and, in view of this, it was realised right from the start that care being taken with respect to matching. The resultant picture was passable but a fair amount of "snow" was present and, when steps were taken to lessen this, it was soon discovered that the pre-amplifier itself was not at fault but that impedances of unsuitable value were connected to its input and output sockets.

It was then decided to use pi-tuned circuits throughout instead of input and output transformers. The inductors in the pre-amplifier were simply modified by removing the single turn coupling windings, only the main windings being required. The re-arrangement proved most successful and "snow" disappeared completely from the screen.

The revised circuit is shown herewith. Band I or other breakthrough does not occur at this address due to opposing transmitter locations but should spurious signals cause patterning, a series tuned circuit could be incorporated at the point shown by the broken lines on the input side.

Inductor L_2 is an extremely critical component upon it depending most of the gain; spacing, or closing, the turns, even slightly, can cause large gain variations. Optimum results were obtained by winding four turns of 30 s.w.g. enamelled copper wire obtaining a diameter of $\frac{3}{16}$in, slight spacing of the turns being carried out whilst watching the picture, and using a long plastic knitting needle as a prod.

A slightly different method to that used in the original pre-amplifier circuit is employed for obtaining the potential for the grid of the second triode.

Note that the output circuit consists of a v.h.f. choke feeding the output inductor via C_8.

Capacitors C_2 and C_9 should be carefully adjusted for optimum operating conditions whilst watching the picture. For Channel 11, brass cores are needed in inductors L_1 and L_3.

A full list of components accompanies this article.

A Photo-Transistor Switch

By **K. BERRY**

An article describing three different versions of a basic light operated relay circuit in which especial care has been paid to switching transistor stabilisation

THE CIRCUIT DESCRIBED HEREWITH WAS developed to produce a general purpose light operated switch. The main requirements were reliability of operation, small size, and low power consumption. Several circuits were tried, but the one presented here gave by far the best results.

Circuit Description

The preferred circuit, shown in Fig. 1, uses one photo-transistor, one transistor, one variable resistor, one fixed resistor, one relay and a silicon diode. It is powered from a six-volt supply.

The photo-transistor (OCP71) forms one arm of a potential divider supplying base bias to a transistor (OC72), the other arm being a 5kΩ variable resistor. When the photo-transistor is exposed to light, its effective collector-emitter resistance falls, i.e. it conducts. This has the effect of making the base of the OC72 more negative than when the OCP71 is in darkness.

The emitter of the OC72 is connected to the positive supply via a silicon diode (OAZ208 or similar) which is supplied with a current of about 5mA by a 1kΩ resistor connected from the negative supply to the emitter of the OC72. A typical silicon diode characteristic is shown in Fig. 2 and it will be seen that when the diode is conducting, the voltage drop across it is substantially constant at 0.8 volts. Thus the emitter of the OC72 is stabilised at −0.8 volts (approx.) and, in order to switch the transistor on and off, the base voltage must therefore be varied about this given voltage. When the OCP71 is illuminated, the base of the OC72 becomes more negative than the emitter and the OC72 conducts, which causes the relay in its collector circuit to operate. When the OCP71 is in darkness, the base of the OC72 becomes positive with regard to the emitter and the OC72 is switched off (only I_{co} flows) causing the relay to fall out.

Measurements made on this circuit show that when the OCP71 is illuminated, the OC72 base is 0.25 volts negative with respect to the emitter, and, when the OCP71 is in darkness, the OC72 base is 0.28 volts positive

with respect to the emitter. Thus the transistor is well and truly off or on.

Modified Circuits

The use of a silicon diode to stabilise the emitter voltage of the OC72 may be avoided as shown in the two alternative circuits.

The first alternative circuit (Fig. 3) completely omits emitter bias and relies on the fact that the base of a transistor must be about 0.15 volts negative with respect to the emitter before the transistor conducts. The circuit is quite reliable at room temperatures but may prove somewhat troublesome at higher temperatures due to increasing I_{co} in the OCP71.

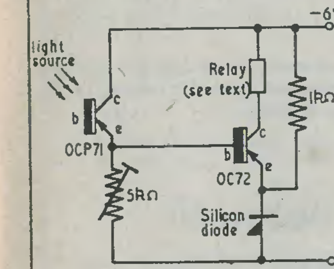


Fig.1

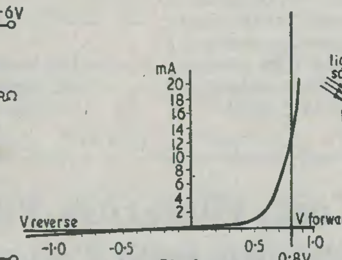


Fig.2
Silicon diode characteristics

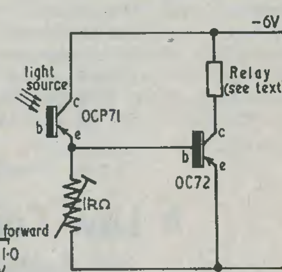


Fig.3

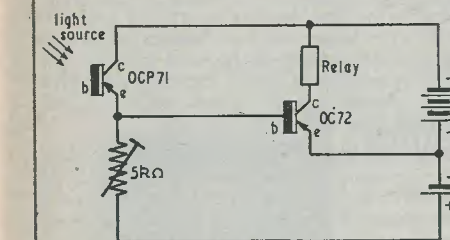


Fig.4

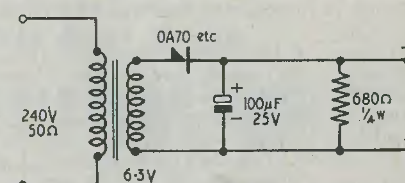


Fig.5

E772

The second alternative circuit (Fig. 4) uses a tap on the battery to stabilise the OC72 emitter voltage. This circuit gives a better overall performance than that of the preferred circuit, the disadvantage being that two batteries, or one tapped battery, must be used. It should be noted that a 6 volt accumulator tapped at −2.0 volts could be used in place of dry cells.

Choice of Components

The most critical component in any of these circuits is the relay. This should operate from a voltage of between 1 and 4.5 at a current of less than 25mA. The relay used by the author had a resistance of 140Ω and operated from a 1.5 volt cell. Such relays are *not* capable of switching large powers, and if it is desired to break more than about 15 watts then this relay should be used to switch a second relay which has heavy duty contacts. A less sensitive relay can be used with a higher supply voltage but great care must be taken to ensure that the collector dissipation of the OC72 is not exceeded.

Although a Mullard OCP71 photo-transistor was used for the prototype circuits, there is no need for the lack of same to prevent construction, an ordinary OC71 with the protective black paint covering removed working just as well. These circuits were in fact tested with an OC71 (paint removed!) and perfect operation resulted.

Power Supply Unit

If it is desired to operate this unit from the a.c. mains, a suitable power supply may be obtained by using a 6 volt filament transformer, a germanium diode (Mullard OA70, OA10, or similar), a fixed resistor, and an electrolytic condenser in the circuit of Fig. 5.

Typical Uses

This light-operated switch can be put to a great many uses. Since photo-transistors are very sensitive to red light, the circuit could be used as a fire detector. Operating in conjunction with a beam of infra-red or white light it could act as a burglar alarm or count passing objects such as vehicles, or articles on a conveyor belt. More mundane uses include switching of lights at home, outdoors, or in shop windows when daylight falls below a certain brightness. No doubt other uses will suggest themselves.

Setting Up Procedure

Having wired any of the given circuits, the setting up procedure is as follows:

First set the variable resistor to its minimum value, then connect the supply (preferably via a milliammeter), whilst shielding the photo-transistor from full light. Adjust the variable resistor until the relay operates, then reduce the setting of the rheostat until the relay "drops out". Exposing the photo-transistor to full light should now result in the relay operating, with subsequent removal of the light causing it to "drop out". The optimum setting of the variable resistor will be found in use.

Circuit Performance

Measurements of OC72 base-emitter potential for each circuit are tabled here, and the "factor of reliable operation" as denoted by the difference in "light" and "dark" potentials may be compared.

Circuit	V_{b-e} Light	V_{b-e} Dark	Comments
Fig. 1	+0.25	−0.28	Good
Fig. 3	+0.35	+0.1	Fair
Fig. 4	+0.3	−0.78	Excellent

Note: The base-emitter voltages listed above are dependent upon the setting of the variable resistor.

A Low Cost, Miniature Photo-cell for Industrial Control

A new photo-conductive cell, thought to cost less than any other photo-electric cell available in this country, has been introduced by Mullard.

The cell, of the cadmium sulphide type, is physically very small, and yet has a high sensitivity. It is housed in a standard transistor-type glass envelope measuring only 15mm long by 6mm diameter, which enables large numbers of the cell to be stacked in a small space. Its sensitivity is such that an illumination of 5ft candles, with a lamp colour temperature of 2700°K, will produce an average cell current of 500 microamps.

Applications of the cell include industrial counting and control systems where space is at a premium, and flame failure detection in oil-fired burners. Its tiny sensitive area of only 0.25 square mm makes it especially suitable for fine positional control systems. Unlike the larger types of Mullard cadmium sulphide devices it is intended not for the direct operation of relays, but rather to drive cold-cathode trigger tubes such as the Mullard type Z803U.

The cell has a dark current of less than 1.5 microamps at the maximum cell voltage of 350V (d.c. or peak), and a maximum dissipation of 70mW at 25°C. The ambient temperature range is −40°C to +70°C.

Two versions are available—type ORP60 for end-on incidence of illumination, and type ORP61 for side illumination. Both types have flying leads for wiring-in to the circuit and are suitable for dip soldering.

MARCONI'S POLDHU SITE GIVEN TO NATIONAL TRUST

On 6th July, at a private ceremony at Marconi House, London, Lord Nelson of Stafford, Chairman of the English Electric Group, presented to the National Trust the title deeds of 40 acres of land at Poldhu, Cornwall, the site of Marconi's historic transmitting station. The gift was accepted by Earl De La Warr, Chairman of the Trust's Estates Committee. Among those present was Mr. C. S. Franklin, who joined the Marconi Company in 1899 and was closely associated with Marconi in the Poldhu station project.

It was on 12th December, 1901, Marconi announced that signals from Poldhu had bridged the Atlantic and were being received by him at St. John's, Newfoundland. This dramatic news at once took wireless telegraphy out of the laboratory, not only demonstrating its capabilities as a practical communication medium, but also confounding the learned critics of the day who stated that wireless waves would never reach beyond the horizon. The achievement underlined Marconi's great faith in his apparatus and theories, and his courage in proceeding against "informed" opinion.

Poldhu continued in use as a commercial wireless station until its dismantling in 1937. All that now remains at the site is a granite column overlooking Mounts Bay, this serving as a reminder of the momentous events which took place nearly sixty years ago.

Better get the best — it costs less

VIDIO Offers you the finest rebuilding service available today! Each tube is completely rescreened, aluminised and fitted with a new Gun Unit! Available now—for IMMEDIATE DELIVERY!

ALL TUBES ARE GUARANTEED FOR ONE YEAR

Get full details now *from*

VIDIO REPLACEMENTS LIMITED

Hales St. Deptford High St.
London SE8
Telephone TID 4506

SMITH'S of Edgware Road

1910 GOLDEN JUBILEE YEAR 1960

BLANK CHASSIS

Precision made in our own works from commercial quality half-hard aluminium of 16 s.w.g. (1/16") thickness. these chassis go all over the world (and off it—in rockets!). Same day service for ANY SIZE, to nearest 1/16" and up to 17" of straightforward two, three or four-sided chassis. Orders for specials dealt with promptly if sent with clear instructions.

SOLDERED CORNERS. While these chassis, owing to their thickness, hardness and efficient folding, will carry components of considerable weight and normally require no corner strengthening, we can do this, if required, by a special soldering technique at **6d.** extra for each corner.

FLANGES. ¼", ⅜" or ½" flanges (inside or outside) **6d.** extra for each bend.

PRICE GUIDE (normal chassis only)
Work out total area of material required, including waste, and refer to table below:

48 sq. in.	4/–	176 sq. in.	8/–	304 sq. in.	12/–
80 sq. in.	5/–	208 sq. in.	9/–	336 sq. in.	13/–
112 sq. in.	6/–	240 sq. in.	10/–	368 sq. in.	14/–
144 sq. in.	7/–	272 sq. in.	11/–	and pro rata	
Post 1/3		Post 1/6		Post 1/9	

Discount for quantities. Trade enquiries invited. Spray finish arranged for quantities of 25 or over.

PANELS. The same material can be supplied for panels, screens, etc. Any size up to 3ft at **4/6** sq ft. (sq. in. x ⅜d.). Post, up to 72 sq. in. **9d.**, 108 sq. in. **1/3**, 144 sq. in. **1/6**, 432 sq. in. **1/9**, 576 sq. in. **2/–**.

287/289 EDGWARE ROAD LONDON W2
Telephone PAD 5891/7595

Powerful! Personal! Portable!

- ★ Sturdy metal case
- ★ No holes to drill
- ★ Detachable rod aerial
- ★ All batteries self-contained
- ★ Can be built in 1 hour
- ★ Covers medium waves
- ★ Loud clear tone
- ★ Selective tuning
- ★ All parts are sold separately

ONLY FOR **35/–**

This delightful set is designed to give you a completely personal portable radio.

Bronze-finished case. Ideal for the beach, the bedroom, the office—in fact, anywhere.

Send 2/– for wiring diagram and component price list

R.C.S. PRODUCTS (RADIO) LTD
11 Oliver Road London E17 *Mail Order Only*

HI-FI NEWS

The Magazine for . . .
. . . The Sound Enthusiast

● HI-FI NEWS carries regular Constructors' features, reviews of all high fidelity and good quality audio equipment, and articles for both beginners and experienced readers. It is well produced and illustrated. We think you will like it—but sample it at our expense. Send 6d. for a specimen copy. Annual subscriptions are 27/6, or 30/– with annual index.

Price **2/–** *Monthly*

HI-FI NEWS

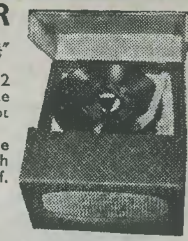
99 MORTIMER ST LONDON W1

PORTABLE TRANSISTOR RECORD PLAYER

—BARGAIN OFFER

- ★ **6V operation (2 E/R Type 800 Batts. 1/4d each.)**
- ★ **1 watt Push-Pull Output.**
- ★ **4 Latest G.E.C. Transistors.**
- ★ **Garrard Fidelity Gram. Unit.**

Size 11" x 8¾" x 5". **COLOUR:** 2 Tone Red/White with Polka Dot relief. Alternative Blue/Fawn with Polka Dot relief.



1 WATT—4 TRANSISTOR AMP. High Quality Unit with Neg. feedback giving 1 watt Audio output into standard 3 ohms Speaker. **AMPLIFIER KIT—only £3.19.6.** Ready Built and Tested, 17/6 extra. Carr. 1/6. Circuit diagram, full technical spec. and constructional details (free with Kit), 2/6 post free.

CABINET incl. Motor Board and 7" x 4" Speaker **£1.19.6** carr. 2/6.

COMPLETE RECORD PLAYER KIT
Bargain Price **£7.19.6** *carr. 4/6.*

GARRARD BA1 Gram Unit. **£2.19.6.** Carr. 2/6

SEND FOR FULL DETAILS NOW
LIMITED BARGAIN OFFER

RECORD PLAYER BARGAINS

All brand new latest 4-speed Models—fully guar.
Single Players—B.S.R. (TU9) with "FUL-FI" P.U. **90/–**. Garrard 4 S.P. with GC8 Crystal **£6.17.6.** Garrard TA Mk. 2 with Plug-in GC8 Head **£7.19.6.** Garrard 4HF Transcription Unit **£18.** Carr. 3/6.
Auto Changers—B.S.R. (UA8) **£6.19.6** UA8 Stereo **£7 19.6.** UA14 **£7.19.6.** Collaro Conquest **£7.19.6.** Garrard RC121/4D Mk. 2 **9½ gns.** Carr. 4/6.

SPECIAL—NEW RELEASE

Garrard RC210, New 4-speed Autochanger Model with all the latest features and GC8 Plug-in Head, wired for Stereo, Bargain **10 gns.** Carr. 4/6.
EMI 4-speed Single Player with Auto Stop/Start Dual Turnover Cartridge for Stereo and Monaural L.P. and 78—Bargain Buy at **£6.19.6.** Carr. 3/6.

THE TOURIST PORTABLE

4 valve. Med & L.W., lightweight battery Radio. Size only 8" x 5½" x 4". Weight 3½lb with battery B114.

Complete receiver component kit ...	**57/6**	P. & P. 1/6
Set 4 miniature valves (96 series) ...	**35/–**	P. & P. 9d.
5" Speaker and O/put Trans. ...	**21/–**	P. & P. 1/6
Cabinet, Dial and Knobs, etc. ...	**22/6**	P. & P. 2/–

Latest superhet circuitry, dual ferrite aerial, delayed AVC and A.F. Neg. feedback. A remarkable little receiver with lots of punch and quality results.
Complete Kit—BARGAIN **£6.10.0** *post free*

MAINS UNIT. Size as B114. Battery Complete Kit **45/–**. P. & P. 1/6.
Send for booklet now, **1/6** *post free*

RECORD PLAYER CABINETS

Contemporary styled, rexine covered cabinet in two-tone wine and cream, or mottled red with white polka dot. Size 18½" x 13½" x ht. 8¼", fitted with all accessories, including baffle board and anodised metal fret. Space available for all modern amplifiers and autochangers, as above, etc. Uncut record player mounting board 14" x 13" supplied.
Cabinet Price £3.3.0. Carr. and Ins. 3/6.

2-VALVE 2-WATT AMPLIFIER With vol. and tone controls. Neg. feedback. A.C. 200/250V. Complete, ready wired to fit above cabinet. **£2.17.6.** P. & P. 1/–
6" Speaker and matching trans., **22/–**. P. & P. 1/6

VALVES—New Reduced Prices—All Guaranteed

1T4	6/–	DK96	9/–	ECL82	10/6	EY86	10/–
IR5, 1S5	7/6	DL96	9/–	EF80	8/–	EZ80	7/6
3S4, 3V4	7/6	EABC80	8/6	EF86	12/6	EZ81	7/6
5Z4	9/–	ECF80	9/6	EF91	5/–	MU14	9/–
DAF96	9/–	ECH42	10/6	EL41	9/6	PCC84	9/6
DF96	9/–	ECL80	10/6	EL84	8/6	PCF80	9/6
				EY51	9/6	PCL83	12/6

CRT HTR ISOLATION TRANSFORMERS

New improved types, low capacity, small size and tag terminated, AC 200/250V. Secondaries Nil, +25%, +50% **BOOST** for 2V, 4V, 6.3V, 10.5V, 12V or 13V Tubes. Each type **12/6** each. P. & P. 1/6.

JASON FM TUNER UNIT KITS (87–105 Mc/s)
Standard Model (FMT1)—as previously extensively **Tuner Coil Set, IFs, and Ratio Detector, etc., 26/–.** advertised. **Complete Kit—5 gns.** Post free. Set of 4 spec. valves now only **20/–.**
Model (FMT2)—attractively presented shelf mounting unit in enclosed Metal Cabinet with Built-in Power Supply. **Complete Kit, £7.** P. & P. 3/6. Set of 5 spec. valves, **37/6.**
Latest Model—JTV2—Switched Band 1–2–3 AM/FM Unit with A.F.C. **Kit £12.19.6.** P. & P. **2/6**
New Jason Comprehensive FM Handbook, 2/6, post free. 48-hr. Alignment Service, **7/6.** P. & P. **2/6.**

CONDENSERS—Silver Mica. All pref. values, 2pF to 1,000pF, **6d.** each. Ditto ceramics, **9d.** each. Tubulars 450V T.C.C., etc., 0.001 mfd.–0.01 and 0.1/350V, **9d.** each, 0.02–1/500V, **1/–** each. 0.25 Hunts **1/6,** 0.5 T.C.C. **1/9.** 0.001 6kV **5/6.** 0.001kV, **9/6.**

RESISTORS—Full range 10 ohms–10 megohms 20%, ¼W and ½W, **3d.,** ¾W, **5d.** (Midget type modern rating), 1W, **6d.** 2W, **9d.** 10% Hi-Stab. ¼W., **5d.** ½W, **7d.** 5% ½W **9d.** 1% **HI-STAB,** ½W **1/6** (10–100 ohms **2/–**.)

LOUDSPEAKERS—P.M. 3 ohm, 2½" Plessey, **17/6;** 3½" Goodmans, **18/6;** 5" R. & A., **17/6;** 6" Celes., **18/6;** 7" x 4" Goodmans, **18/6;** 8" Rola, **20/–;** 10" R. & A., **25/–;** 12" Plessey, **30/–;** etc.

SPEAKER FRET—Expanded Bronze anodised make 8 x 8 in., **2/3;** 12 x 8 in., **3/–;** 12 x 12 in., **4/6;** 12 x 15 in., **6/–;** 24 x 12 in., **9/–** etc.

TYGAN FRET (Murphy pattern) 12 x 12 in., **2/–;** 12 x 18 in., **3/–;** 12 x 24 in., **4/–** etc.

COAX 80-OHM CABLE. Now only **6d.** per yd. High grade Low loss. Aeraxial Air spaced Polythene Coax—famous Manufacturer—Standard ¼" diameter approx. 20 yds., **9/–**, P. & P. 1/6; 40 yds. **17/6**, P. & P. 2/–; 60 yds. **25/–**, P. & P. 3/–. Bargain prices. Special lengths. Coax Plugs **1/–**. Coax Sockets **1/–**. Couplers **1/3**. Cable end sockets **1/6**. Outlet Box **4/6**.

VOLUME CONTROLS—5k–2 Megohm. ALL LONG SPINDLES, MIDGET TYPE, 1⅛" diam. Guar. 1 yr. LOG OR LIN Ratios less Sw, **3/–**. D.P. Sw., **4/6**. Twin gang stereo controls log. or linear less SW **6/6**. With D.P. SW **8/–**.

TRANSISTORS—BVA 1st Grade—ex Mfrs. Mazda XA102, **16/6;** XA101, **14/6;** XC101, **10/6;** OC70, **9/6;** XB102, **10/–;** XA103, **15/–;** XA104, **18/–;** OA70, **2/9.** *Hours 9 a.m.–6 p.m., 1 p.m. Wed.*

TRS Est. 1946

RADIO COMPONENT SPECIALISTS

70 Brigstock Road Thornton Heath Surrey *Telephone* THO 2188.
Terms: C.W.O. or C.O.D. Post and packing up to ½lb, 7d., 1lb 1/1, 3lb. 1/6, 5lb. 2/–, 10lb. 2/9.

★★ NO EXTERNAL AERIAL OR EARTH—NO REACTION CONTROLS ★★
—EASY AS A B C TO BUILD AND A THRILL TO USE—

MAJOR—2 *(Two-Transistor Pocket Radio)*

IDEAL FOR BEGINNERS

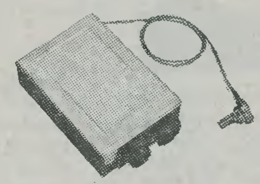
All components sold separately

- ★ 4-stage reflex
- ★ Medium wave; tunable
- ★ Very sensitive
- ★ No aerial or earth
- ★ Complete lay-out
- ★ Over 6 months on one battery
- ★ $4\frac{1}{2} \times 3 \times 1\frac{1}{4}''$
- ★ Weight only 4 oz.
- ★ Personal phone included.

TOTAL COST **69/6** P.P. 1/6 NEW BOOKLET FREE

RECEPTION GUARANTEED ANYWHERE!

MAJOR—3 *(Three-Transistor Pocket Radio*



(As describedi n R.C., Sept. '59)

- ★ 5-stage Reflex Circuit
- ★ No Aerial or Earth
- ★ Miniature Volume Control
- ★ 3 Ediswan Transistors.
- ★ Medium Wave Tuning
- ★ Size $4\frac{1}{2} \times 3 \times 1\frac{1}{4}''$
- ★ Personal phone included.

TOTAL COST **87/6** P.P. 1/6 NEW BOOKLET FREE

FANTASTIC OUTPUT, TERRIFIC RECEPTION. GUARANTEED ANYWHERE

★ ★ NOT TOYS BUT REAL WORKING RADIOS! ★ ★

TRANSISTORS
BRAND NEW AND GUARANTEED

XB102, 10/–; XA104, 18/–; XA103, 15/–; XC101 matched pairs, 32/– pr.; XA131, 35/–; OC44, 19/6; OC45, 18/6; OC71, 10/–; OC72 pairs, 30/– pr.; OC170, 35/–; V15/10P, 15/–; V15/20IP, 25/–; XC141, 30/–; OC76, 15/–; SBO78, 10/–; SB305, 15/–; Red Spot, 3/6; White Spot, 5/–;
SEND FOR LIST OF 50 TYPES WITH DATA AND PRICES

"STEREO 3-D"

New high-gain circuit with full tone, balance and volume controls. Can be used with all types of records as well as stereo.

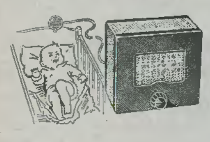
- ★ 2 WATTS PEAK PER CHANNEL.
- ★ ECC83: 2-ECL82 VALVES.
- ★ MAINS 110/250V A.C.

BUILT AND TESTED £5.7.6. P.P. 2/–.

Complete with speaker sockets, calibrated dials, etc.

- ★ Collaro 4-speed stereo auto-changer, ideal for use with above amplifier, **£7.10.0.** P.P. 3/6.
- ★ 9″ x 6″ large magnet Elac speaker ,for use with STEREO 3-D. **37/–** pair. P.P. 1/6.

ALL TRANSISTOR BABY ALARM
THE "BABY-SITTER"



- ★ **100% Safe—Guaranteed**
- ★ **Fully Portable**
- ★ **No Mains—Battery Operated**
- ★ **Can be used over ANY Distance**

USE IT AT HOME, TAKE IT ON HOLIDAY

Every Sound can be heard on large 5 inch Speaker

COMPLETELY ASSEMBLED WITH BATTERY **£5.10.0** P.P 2/6

— BE WITH YOUR CHILDREN ALL THE TIME —

(Illustrated leaflet free on request)

TRANSMITTER/RECEIVER
Army Type 17, Mark II

Complete with Valves, High Resistance Headphones, Handmike and Instruction Book and circuit. Frequency Range 44.0 to 61 Mc/s. Range approximately 3 to 8 miles. Power requirements: Standard 120V H.T. and 2V L.T. Ideal for Civil Defence and communications.

BRAND NEW **45/–** P.P. 5/–.

VALVE REDUCTIONS
(WHEN PURCHASED IN SETS)

TP25, VP23, HL23/DD, PEN25 (or QP25)	25/–
1A7GT, 1N5GT, 1HFGT, 1C5GT (or 3Q5GT)	35/–
X66, KTW61, DH63, KT63, U50	30/–
6K8G, 6K7G, 6Q7G, 5Z4G, 6V6G	32/6
1R5, 1S5, 1T4, 1S4 (or 3S4 or 3V4)	25/–
DK96, DF96, DAF96. DL96	35/–
6K8G, 6K7G, 6Q7G, 25L6GT, 25Z5 (or 25Z6G)	35/–
12K8GT, 12K7GT, 12Q7GT, 35Z4GT, 35L6GT (or 50LGT)	40/–
12SA7GT, 12SK7GT, 12SQ7GT, 35Z4GT, 35L6GT (or 50L6GT)	32/6

P.P. 1/– per set of valves

Type 38 Transmitter/Receiver

Complete with 5 valves. In new condition. These sets are sold without guarantee, but are serviceable.

7 to 9 Mc/s **22/6** P.P. 2/6

Headphones **7/6** pair. Junction Box **2/6**. Throat Mike **4/6**. Aerial Rod **2/6**.

"Practical Transistors Circuits"

14 Circuits for the Home Constructor, including date, prices and information. 1st Edition, 2/–, post free.

Our Specialities
Transistors, Quartz Crystals Valves, Miniature Components

Trade enquiries invited. Catalogues free. Compare our prices.

WE ARE ABLE TO SUPPLY MOST OF THE COMPONENTS USED ON CIRCUITS PUBLISHED IN THIS AND OTHER MAGAZINES AND BOOKLETS. WHERE THE EXACT ITEM IS NOT AVAILABLE WE CAN RECOMMEND A SUITABLE SUBSTITUTE WHERE POSSIBLE.

HENRY'S RADIO LTD · 5 HARROW ROAD · LONDON W2

Opposite Edgware Road Tube Station. *PADdington* 1008/9 OPEN MONDAY to SAT. 9–6, THURS. 1 o'clock

COMBINED PORTABLE/CAR RADIO

SEE PAGE 919 LAST ISSUE

JUST RIGHT FOR A DAY'S OUTING

"CONTINENTAL—6"

For Style, Quality Performance and Value for Money

Medium and Long Wave Full Tuning

- ★ New Printed Circuit
- ★ 6 "Top Grade" Ediswan Transistors
- ★ 5″ High Fidelity Speaker
- ★ 400mW Push-Pull Output
- ★ Internal Ferrite Aerial
- ★ Slow Motion Tuning
- ★ Full Illustrated Building Instructions
- ★ Printed Circuit marked out.
- ★ Car Radio aerial socket and A.V.C.
- ★ ALL COMPONENTS GUARANTEED
- ★ Double Tuned IFs for selectivity
- ★ Size $9\frac{1}{2} \times 7 \times 3\frac{1}{2}''$ Weight 4 lb.

Total Cost of all Components
£11.10.0 P.P. 3/6
including Cabinet, Battery, Transistors, Car Radio, AVC and all necessary items.

A highly sensitive and selective portable fully tunable on medium and long waves. Performs equally well as a car radio. Low running costs, good looks and ease of construction combine to produce a radio equal to any commercial receiver in the 20 gns. class.

ALL COMPONENTS AVAILABLE SEPARATELY

SEND FOR DESCRIPTIVE LEAFLET AND PRICES

CALL FOR DEMONSTRATION

Continental Transistors

Direct Equivalent OC44	15/–
Direct Equivalent OC45	12/6

BRAND NEW GUARANTEED
LIMITED QUANTITY ONLY

Crystal Microphones

ACOS 39–1 Stick Microphone with screened cable and Stand (List 5 gns.). **39/6.** P.P. 1/6.
ACOS 40 Desk Microphone with screened cable and built-in stand (List 50/–). **25/–.** P.P. 1/6.

Special Offer of MERCURY BATTERIES

1.3 volts, 500mA/H

Size $\frac{5}{8}''$ diam. x $\frac{3}{8}''$ length.
ONLY **1/3** ea. P.P. 3d. ea. or **12/–** dozen. P.P. 9d.
FOR ALL TRANSISTOR WORK

Telescopic Chrome Aerial

7-Sections, 3′ 6″ open; 6″ closed. Ideal for Portable Receivers. Walkie-talkies, Radio Control, etc.
With Clips **12/6.** P.P. 1/–.

Crystal Microphone Inserts

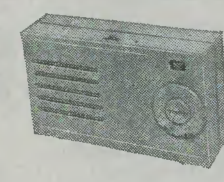
Latest ACOS 43–1, $2\frac{1}{4}$ inch Round Hi-Fi Insert. **14/–.** P.P. 6d.
$\frac{3}{4}''$ square (ex-units) **3/6** ea. P.P. 6d.

RED-SPOT TRANSISTORS
3/6 each

WHITE-SPOT
5/- each

NEW FREE LIST ON REQUEST
Fully Guaranteed

SPECIAL OFFER—LIMITED PERIOD
The Teletron "TRANSIDYNE"
6–Transistor Superhet



$6\frac{1}{4}'' \times 3\frac{3}{4}'' \times 1\frac{3}{4}''$

- ★ Medium and Long Waves
- ★ $2\frac{1}{2}''$ Rola Speaker
- ★ All Ediswan transistors
- ★ Marked printed circuit
- ★ Illustrated instructions

Includes cabinet, battery, transistors, etc.
FREE LEAFLET,
BOOKLET 1/– POST FREE
NOW ONLY P.P. 2/– **£9.10.0**

★ RF AND IF GENERATOR

Ideal for aligning TRF or Superhets. 470 Kc/s up to 3 Mc/s output. All components **25/-** P.P. 1/-.

★ SQUARE WAVE GENERATOR

2-Transistor. Chassis size 2″ x $1\frac{1}{2}''$. 15V supply. All components, **20/–.** P.P. 1/–.

★ 3-TRANSISTOR HEARING AID

High-gain circuit with built-in crystal microphone and battery. Includes miniature earphone. 3-Transformers. Size 3″ x 2″ x $\frac{3}{4}''$. All components, **89/6.** P.P. 1/–.

★ RF, IF AND AUDIO SIGNAL TRACER

Ideal signal peaker or quick fault-finder for receivers, amplifiers, etc. Size $4\frac{1}{2}''$ x 3″ x $1\frac{1}{2}''$. All components, with 'phones, **37/6.** P.P. 1/6. Less 'phones, **32/6.** P.P. 1/6

★ 2 WATT OUTPUT TRANSISTOR AMPLIFIER

For connection to any battery portable to give up to 2W output. Works from 12V battery. Ideal for car radio use. Size $4\frac{1}{2}''$ x 3″ x $2\frac{1}{4}''$, uses power transistor.
All components (less speaker) **52/6.** P.P. 2/–
Ideal for use with Continental 6, etc.

★ 250mW PUSH-PULL OUTPUT AMPLIFIER

For use with any 2, 3 or 4 transistor, earpiece or headphone radio to give room-filling volume on 3″ speaker. All components including 2 Ediswan transistors, speaker, battery, special input socket to take earpiece plug, cabinet, etc., **59/6.** P.P. 1/6.
Ideal for use with Major-2 or Major-3.

★ TRANSISTOR TRANSMITTER

1.8 to Mc/s coverage. 3 transistors unit size $4\frac{1}{2}''$ x 3″ x $1\frac{1}{2}''$. Range of 3-section rod aerial up to 300 yards. Includes built-in microphone, battery and 3-section rod aerial. All components, **57/6.** P.P. 1/6.

★ 27 Mc/s RADIO CONTROL RECEIVER

3-Transistor regen. circuit. Size 2″ x $1\frac{1}{2}''$ x $1\frac{1}{4}''$. Weight with batteries, $1\frac{1}{2}$ oz. Uses SB305 transistor. Multi-channel reed operated. All components (less reed), **50/–.** P.P. 1/–.

Get these

CIRCUITS & WIRING DIAGRAMS

T.R.F. Circuits
Battery Circuits
Portable Circuits
S'het Circuits

Single Valve FM Tuner, 2 Valve FM Complete Set. Same on Printed Circuit, etc., etc.
Postage 1/- (Stamps)

OSMOR COILS are regularly used and recommended by designers writing in *Practical Wireless, Wireless World* and *The Radio Constructor*. Why not follow the experts?

"Q COILS" All ranges • POTTED COILS • FM COILS

SPEAKER CROSS-OVER COILS

TAPE COILS • ROD AERIALS

SUB MINIATURE COILS

COILS and I.F.s for Transistor Circuits • MIDGET I.F. TRANS With ferrite cores

OSMOR 418 Brighton Road
South Croydon
Telephone CRO 5148/9

12" Speaker and 5" Tweeter with coupling condenser by leading maker, **75/–**. (£8.15.0 list price.)
Mains Transformers. Input 200/250V. Output tapped 3 to 30V 2A or 5, 11, 17V 5A. Each **24/6.**
F.W. Metal Rectifiers. 12/6 volt 1A, **7/6**; 3A, **13/–**; 4A, **17/6**; 6A, **27/6**; 24V 2A, **23/6.**
Mains Transformer and Rectifier, giving 12V 1A d.c. output, **19/6**; 30V 2A, **33/6.**
Relays. We hold large stocks. Any contact combination and operating coil voltage supplied from **3/–.**
Special Offer. 12V relays with 2 or 4-make contacts, **6/–**; 2 for **11/6**; 3 for **16/6**; 4 for **21/–.**
Key Switches from **3/–.**
Toggle Switches d.p.d.t., **3/6. Micro Switches,** M. & B., **5/6.**
Nickel Nife Batteries. 1.2V 2.5A. Size 3" x 2¾" x 1". Practically everlasting, **6/–**; or 3 for **16/–**; 4, **21/–.**
Army Morse Keys, 3/6, 6/– and **8/6.**
Lightweight Soldering Irons 17/9
H.S. Twist Drills. Set 7, 1/16"–1/4", **4/–**; also Full Size in Plastic Wallet, **6/–**. Set of 13, **9/6** and **17–15/6**, 1/16" to 5/16". Tubular Hack Saws (Eclipse Type) **11/6.**
5" Side Cutters, 5/6. 5" Plated Round Nose Tapered Pliers, **5/–**. Pocket Neon Testers with retractable Screwdriver, **5/6**. 7" Flat Nosed Tapered Pliers, **8/6.**
Celestion Speakers 8" x 5" **21/–.**
Very Powerful Geared Small 12V d.c. Motor. Instant stop. 3" x 1¾", **16/6.**
New 12" Speakers. 3 ohm, **32/6.**
Paxolin Panels, 12" x 6" x ⅛", **3/6.**
Paxolin Tubing, 1½" x 3/16" x 72", **17/6.** Ideal for masts.
Studio "O" Cartridges, 21/–.

All items post paid, new and guaranteed

LISTS SENT ON REQUEST

Post orders only to

THE RADIO & ELECTRICAL MART
29 STATION APPROACH SUDBURY TOWN WEMBLEY MIDDX

TRANSISTORISED "DO-IT-YOURSELF" CAR RADIO

MAYKIT REDUCED PRICE **£12.15.0**

Insist on this genuine quality radio *you* can build yourself, buy direct and save £'s. 5 valve superhet, standard size, 12 volt. Assembled and tested **£16.** P. & p. 5/–

MAYKLITE £4.0.0
AUTOMATIC LIGHT SWITCH

Single unit fixed to windscreen switches car lights on when dark. Easy to fit. Complete. P. & p. 2/–

MAYDEX £3.5.0
CARAVAN EXTENSION SPEAKER

Quality loudspeaker controls volume and on/off. Complete, plus cable at 2/6d. per yard. P. & p. 3/–

Write for details. Available ONLY from
MAYRA ELECTRONICS LIMITED
DEPT. D 551 HOLLOWAY ROAD LONDON N19

REPANCO
Easy-to-build Receivers

	Envelopes
R.E.P. One Valve Radio	**9d.**
The Hiwayman. A 4 valve portable Radio	**1/6**
F.M. Tuner Unit. 5 valves plus tuning indicator	**1/6**
Twinette. A 2 transistor portable Radio ...	**1/3**
Three Dee. 3 transistor radio	**9d.**
Mini-7. 7 transistor pocket radio	**1/6**
Mini-3. 3 transistor pocket radio	**1/3**
Transeven. 7 transistor portable. (Preset stations)	**1/6**
Major-7. 7 transistor portable (Tunable) ...	**1/6**
Transistor Car Radio Receiver	**2/–**
Transistor Amplifier and Feeder Unit circuits	**1/6**

Please add towards postage

aor details of uor components send 6d. in stamps for 1960 catalogue

Radio Experimental Products Ltd
33 Much Park Street Coventry
Telephone 27114

SMALL ADVERTISEMENTS

Readers' small advertisements will be accepted at 3d. per word, including address, minimum charge 2/–. Trade advertisements will be accepted at 9d. per word, minimum charge 6/–. If a Box Number is required, an additional charge of 2/– will be made. Terms: Cash with order. All copy must be in hand by the 12th of the month for insertion in the following month's issue. The Publishers cannot be held liable in any way for printing errors or omissions, nor can they accept responsibility for the bona fides *of advertisers.*

PRIVATE

FOR SALE.. Premier 4-valve portable and mains p.u. less valves and batteries £2. 5s.—Blaincilfan, Beulah, Newcastle Emlyn, Carms.

WANTED. Mains transformers for G.E.C. Miniscope. —Lunson, 17 Tongdean Rise, Brighton, Sussex.

FOR SALE. 9 volumes *Radio and Television Servicing* Vols. 1–5, 1955/56, 1956/57, 1957/58, 1958/59. New condition. £13 o.n.o.—Abraham, 1 Bassaleg Road, Newport, Mon.

FOR SALE. 30 copies *Wireless World* 15s. 18 copies *Aero Modeller* 9s. Varley dry accumulators Type VPT 9/17, 7s. 6d. Morse Code recorder. a.c. Motor variable speed. Marconi type UG9, £7. Top band portable Tx/Rx, 12 volt input, mic., etc. £7. Erskine Laboratory oscilloscope 1½ in. tube £8. Rotary, 12V in, 285V 60mA out, 12s. 6d. Rotary, 12V in, 480V 40mA out, 12s. 6d. Ext. speaker, wood cabinet 14 x 14 x 7 in., 10s. Gyro demonstration model with 12V rotary 15s. Fractional HP a.c. Motors £1. Speed control resistors for same 10s. E.D. Radio control transmitter £3. Postage and packing extra.—"East Keal", Romany Road, Oulton Broad, Suffolk.

FOR SALE. Mullard 5–10 and pre-amp. Perfect. TSL FM Tuner needs adjusting. Studio "O" Acos 67/1 cartridges, new. 15 ohms speaker and tweeter. Lot £15. Box No. F111.

FOR SALE. Teletron "Companion", as new, £4.— R. Holland, 16 Beacon Avenue, Loughborough.

FOR SALE. Supreme 581 Generator, 135 kc/s to 60 Mc/s, modulated r.f., a.f., and f.m. for scope alignment. Audio Generator 50–10,000 c/s, calibration charts, in excellent condition, £18. AVO model 7, £12. AVO Bridge, £8. AVO Valve Tester, 3 panels, £10. Weston 772, £10. Band III pre-amp, 50s. Offers to—C. Kemp, 6 West Park, Minehead, Som.

FOR SALE. Bush 12 in., ITV/B.B.C., £6 post paid, Ultra, Bush, Sobel, etc., complete with converter, £5 Few only, sent at buyers risk, complete with converter, £4 plus postage. MW 31/74, CRM123, etc. 25s. post paid. Converters, Stirling, Aerialite, etc., 55s. post paid.—O.D.B., 25 Ramshead Approach, Leeds, 14.

TRADE

BOUND VOLUMES *The Radio Constructor.* Attractively bound in blue cloth, with gold-blocked spine. The following only are available: Vol. 12, Aug. '58 to July '59 inc.; £1 5s., postage 1s. 9d. each. Where all issues of a volume are returned for exchange, 12s. 6d., postage 1s. 9d. "Easibinders" for temporary or permanent binding, 12s. 6d., postage 9d. each. Indexes are available for Volume 12, price 6d., postage 2d.—Data Publications Ltd., 57 Maida Vale, London, W.9. *Telephone* CUN 6141/2.

LEARN RADIO AND ELECTRONICS the NEW Practical way. Very latest system of experimenting with and building radio apparatus—"as you learn". FREE Brochure from: Dept. RC10 Radiostructor, 40 Russell Street, Reading, Berks.

MORSE CODE TRAINING. Special courses for Beginners. Full details from (Dept. R.C.) Candler System Company, 52 Abingdon Road, London, W.8.

continued on page 79

EDDY'S (NOTTM) LTD

172 Alfreton Road Nottingham *Dept. RC*

NIFE ACCUMULATORS 1.25 volt 7 amp hours. Weight 13 ozs.. Size 3" x 2¾" x ⅞", **1/11** each. Post **1/6** one only, add 9d. each cell.

HANDMIKES Carbon **3/11.** Post 1/9.

THROAT MIKES 1/–. Post 6d. Could be used for electrifying musical instruments.

HEADPHONE CORDS High Quality. 6 ft. lengths **1/11** per pair. Post 6d.

TRANSISTORS Red Spot **3/11.** White Spot **4/11.** Post and packing 6d.

VARIABLE CONDENSERS 0·0005μF Small twin gang built in slow motion drive **8/11.** Post 1/6.

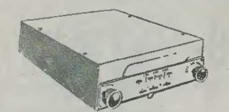
DIMMER SWITCHES Ideal for train Regulators **1/11.** Post 9d.

TUMBLER SWITCHES 250 volts 5 amp **1/–** each. Post 6d.

GERMANIUM DIODES 8d. each, **7/–** doz. Post 6d.

All above are new and guaranteed

BUILD YOUR OWN CAR RADIO



7 Transistors Long and Medium Waves. Two watts output. RF stage and automatic gain control. (6 or 12 volts, please state.) Supplied with full instructions at **10½ gns.** Size: 7¾" x 7¼" x 2½"
Speaker **17/11** extra (7 x 4 ellipt.) if required.
Postage and packing 5/– extra per kit

NEW OR SURPLUS VALVES
Guaranteed and Tested by Return Post

DAF96	6/11	GT1C	6/11	UY41	6/3	6V6GT	6/–
DF96	6/11	P61	2/–	1A7GT	11/9	6BJ6	5/11
DK96	6/11	PCC84	7/3	1C5GT	10/6	6H6	1/11
DL96	6/11	PCF80	7/–	1D5	7/6	6X4	5/11
EB41	6/11	PCL82	7/6	1H5GT	9/6	6X5G	4/11
EB91	3/6	PCL83	11/3	1L4	3/6	12K7	5/6
ECC81	5/3	PL36	11/6	1N5GT	9/6	12Q7	12/6
ECC82	5/11	PL81	9/–	1R5	6/–	12K8	11/–
ECC83	6/6	PL82	7/3	1S5	4/9	25A6G	6/11
ECL80	7/6	PL83	7/3	1T4	3/11	25L6GT	8/11
EF36	3/–	PY80	6/11	3Q5GT	8/6	25Z4G	7/11
EF40	13/3	PY81	6/–	3S4	6/3	35L6GT	8/11
EF42	7/3	PY82	7/–	3V4	7/–	35Z4G	5/3
EF86	10/–	PY83	7/3	6AG5	4/–	90AV	3/6
EF91	3/6	PY31	8/3	6B8G	2/11	6J7G	5/–
EL41	7/3	PY32	10/11	6BA6	5/11	6SG7M	4/9
EL42	9/3	PEN36C	8/–	6BE6	5/11	12AT6	7/6
EL84	6/6	MU14	8/–	6C4	4/3	954	1/6
EY51	8/6	UBC41	7/6	6C9	9/3	955	3/6
EY86	7/11	UCH42	7/6	6K7G	1/11	9001	3/11
EZ40	6/6	UF41	8/–	6K8G	5/6	9004	3/11
EZ80	6/–	UF42	7/–	6SN7GT	4/3	9006	3/11
EZ81	7/–	UY1N	10/11	6V6G	4/11	956	2/6

Any parcel, insured against damage in transit for only **6d.** extra per order. All uninsured parcels at customers risk. Postage and Packing 6d. per valve extra. C.O.D. or C.W.O. only C.O.D. charge **3/–**. S.A.E. with enquiries

SMALL ADVERTISEMENTS

Readers' small advertisements will be accepted at 3d. per word, including address, minimum charge 2/–. Trade advertisements will be accepted at 9d. per word, minimum charge 6/–. If a Box Number is required, an additional charge of 2/– will be made. Terms: Cash with order. All copy must be in hand by the 12th of the month for insertion in the following month's issue. The Publishers cannot be held liable in any way for printing errors or omissions, nor can they accept responsibility for the bona fides of advertisers.

TRANSFORMERS

Suppliers to B.B.C., I.T.A. and leading radio manufacturers, single or long runs, prompt delivery, home and export.

rewinds to all makes

H. W. FORREST (TRANSFORMERS) LTD.,
Shirley, Solihull, Warwickshire
Telephone SHIrley 2483

BRASS, COPPER, DURAL, ALUMINIUM, BRONZE
ROD, BAR, SHEET, TUBE, STRIP, WIRE
3,000 STANDARD STOCK SIZES
No Quantity too small. *List on Application.*
H. ROLLET & CO LTD
6 Chesham Place SW1 *BELgravia* 4300
Also at Liverpool, Birmingham, Manchester, Leeds

Teleprinters, Perforators, Reperforators Tape Readers, Pen Recorders, Terminals and V.F. Telegraph multi-channel units, Test Frames and Testing Equipment, Telephone Carriers and Repeaters, Signalling Rectifiers and Relays, Transformers, Transmit and Receive Filters, Repeating and Retardation Coils, Uniselectors, Racks, Relay Bases, Remote Control Transmitters: British, American and German Equipment.
BATEY & CO., Gaiety Works, Akeman Street, Tring, Herts. *Telephone* Tring 2183 and 2310

SERVICE SHEETS. 14 Days Free Hire
Line Output Transformer Specialists. All Makes/Models from 65/–. Volume Controls 3/–. Switched 4/9. Resistors ¼ watt, ½ watt 6d each. Hystab 10% ½ watt 10d. Wirewound 10% 5 watt 1/3. 10 watt 1/6. Sub-Miniature Electrolytics 1μF, 2μF, 4μF, 5μF, 25μF, 50μF, 100μF, 15V. 3/– each. Coax.Cable 6d. per yd. Crystal Diodes 2/–. GEX34 4/–. Hax. Coils 3/– each. R.E.P. DRR2 4/–. All Repanco and Teletron components in stock. All transistors stocked.
Service sheet free hire on all orders over 25/– Deposit 5/– extra returnable. P. & P. 1/–, over £2 free. S.A.E. all enquiries.
WYNDSOR TELEVISION SERVICE
ST. ALBANS ROAD BARNET HERTS.
Telephone BAR 1769

QUALITY COMPONENTS **FOR CONSTRUCTORS**

capacitors, resistors, coils, valves, diodes, controls, chassis, transformers, speakers, pick-ups, cartridges, stylii and all types of components in stock.

CONSTRUCTIONAL PUBLICATIONS

Mullard Circuits for Audio Amplifiers ...	8/6
Mullard Tape Pre-amp "C"	2/6
Quality Amplifiers, 7 designs	4/6
Jason F.M. Variable Tuners	2/6
Jason F.M. and T.V. Mercury 2	3/6
Jason F.M. and T.V. JTV2	3/6

Price lists available on request

J. T. FILMER 82 **DARTFORD ROAD DARTFORD KENT**
Telephone Dartford 24057

H.A.C. THE ORIGINAL SUPPLIERS OF SHORT-WAVE KITS

One valve Super Sensitive All-dry Short-wave Receiver Model "K". Complete kit including valve and chassis 77/–. (Other S.W. kits from 25/–.) Before ordering call and inspect a demonstration receiver, or send stamped envelope for full specification, catalogue and order form.

H.A.C. SHORT-WAVE PRODUCTS (DEPT. R)
11 OLD BOND STREET LONDON W1

SPECIAL AMATEUR LICENCE MORSE COURSE

COMPLETELY NEW METHOD takes all the drudgery out of learning Morse. Passes secured in all cases, even after previous failures.
By using **specially** prepared recordings (3 speed L.P. player required) students learn automatically and without effort, perfect Morse in half the time required by any other method. S.A.E. full details.
G3HSC 45 GREEN LANE PURLEY SURREY

"GLOBE-KING"
WORLD-FAMOUS KITS AND RECEIVERS
for the Radio Amateur and S.W. Listener. Catalogue Free, enclose stamp for postage. Kits from 79/6 obtainable at your dealers or direct from sole manufacturers
JOHNSONS (Radio)
ST. MARTINS GATE — WORCESTER

RADIO AMATEURS . . .
get your Licence in
Half The Usual Time!

You *must* be a good Morse operator!
A "slap-dash" 12 w.p.m. neither satisfies the authorities, yourself, nor your operator friends. Morse operating is an exacting art unless your training is made simple and is based on sound fundamentals. For this reason the Candler System was invented to take the "grind" out of Code tuition, turning a tricky subject into a pleasurable pursuit.
★ *Send 3d. stamp for the "Book of Facts"*
CANDLER SYSTEM CO
(Dept. 55 RC) 25b Abingdon Rd., London, W8
Candler System Company, Denver, Colorado, U.S.A.

3000 and 600 type relays brand new boxed and surplus, 4, 50, 100, 492, 500, 1000, 2000, 6500, Ohms. contacts etc. Resistors Capacitors, Valves, Meters, etc. SV–4X/450A eqvt £10 each. 832 £1 each, 807 7/6 each, CV36 (klystron). Large quantity of enamelled and silk-covered wire to be sold as a lot. Discount for quantity. Prompt reply to postal inquiries.

★ ★ ★

ABEL RADIO LTD
283 EDGWARE ROAD LONDON W2
Telephone **AMB 8614**

SCOTTISH INSURANCE CORPORATION LTD **62-63 Cheapside London EC2**

TELEVISION SETS, RECEIVERS AND TRANSMITTERS

Television Sets, Receivers and Short Wave Transmitters are expensive to acquire and you no doubt highly prize your installation. Apart from the value of your Set, you might be held responsible should injury be caused by a fault in the Set, or injury or damage by your Aerial collapsing.

A "Scottish" special policy for Television Sets, Receivers and Short Wave Transmitters provides the following cover:

(*a*) Loss or damage to installation (including in the case of Television Sets the Cathode Ray Tube) by Fire, Explosion, Lightning, Theft or Accidental External Means at any private dwelling-house.

(*b*) (i) Legal Liability for bodily injury to Third Parties or damage to their property arising out of the breakage or collapse of the Aerial Fittings or Mast, or through any defect in the Set. Indemnity £10,000 any one accident.

(ii) Damage to your property or that of your landlord arising out of the breakage or collapse of the Aerial Fittings or Mast, but not exceeding £500.

The cost of Cover (*a*) is 5/– a year for Sets worth £50 or less, and for Sets valued at more than £50 the cost is in proportion. Cover (*b*) and (ii) costs only 2/6 a year if taken with Cover (*a*) or 5/– if taken alone.

Why not BE PRUDENT AND INSURE your installation—it is well worth while AT THE VERY LOW COST INVOLVED. If you will complete and return this form to the Corporation's Office at the above address, a proposal will be submitted for completion.

NAME (Block Letters)..........
If Lady, state Mrs. or Miss
ADDRESS (Block Letters)..........
.... /JB

THE MODERN BOOK CO

The Radio Amateur's Handbook. 1960 Ed. **32s. 6d.** *Postage* 2s.

Radio Servicing. Specimen Answers to City and Guilds Questions. 1955/1959 (Intermediate). By A. R. Bailey and E. C. Bell. **8s. 6d.** *Postage* 6d.

Short Wave Receivers for the Beginner. A Data Publication. **6s.** *Postage* 6d.

Marine Radio for Pleasure Craft. By H. McKay. **23s.** *Postage* 9d.

A Beginner's Guide to Radio. By F. J. Camm. **7s. 6d.** *Postage* 6d.

Radio Valve Data. 6th Ed. Compiled by "WW". **5s.** *Postage* 9d.

TV Fault Finding, B.B.C. and I.T.A. A Data Publication. **5s.** *Postage* 6d.

Rapid Radio Repair. By G. Warren Heath. **23s.** *Postage* 1s.

Rapid TV Repairs. By G. Warren Heath. **23s.** *Postage* 1s.

Basic Mathematics for Radio and Electronics. By F. M. Colebrook and J. W. Head. **17s 6d.** *Postage* 1s.

Radio Servicing. By G. N. Patchett and B. Fozard. **21s.** 1 Volume Ed. *Postage* **1s.**

World Radio Handbook for Listeners. Broadcasting & Television. 1960. **15s. 6d.** *Postage* 1s.

G.E.C. Nine-One-Two Plus. 4s. *Postage* 9d.

FM Simplified. 3rd. Ed. By M. River. **45s.** *Postage* 1s. 6d.

We have the Finest Selection of British and American Radio Books in the Country
Complete catalogue 1/–

19–23 PRAED STREET (Dept RC) LONDON W2
Telephone PADdington 4185