AUGUST 1963

Practical WIRELESS

2/-

NEW Power Transistor DESIGN

THE *Kenilworth* PORTABLE P.A. AMPLIFIER

R.S.T. VALVE MAIL ORDER CO.

Tel: MITcham 6202
Open Daily to Callers

211a STREATHAM ROAD, MITCHAM, SURREY.

All Valves Brand New and Fully Guaranteed — Obsolete valves a speciality. Quotations given on any type not listed. Send S.A.E.

Special 24 Hour Express Mail Order Service

AC2/PEN	12/6
AC2/PEN DD	21/-
AC/TP	29/-
AC/VP1-5-7	15/-
AZ1	15/-
AZ31	9/6
B35	9/-
C1C	10/-
CCH35	20/-
CL33	12/6
CY1	15/-
CY31	10/-
D77	4/-
DAC32	9/6
DAF91	5/6
DAF96	7/6
DCC90	12/6
DF33	9/6
DF91	4/-
DF92	7/-
DF96	7/6
DH63	6/-
DH77	7/-
DK32	11/-
DK91	6/-
DK92	7/6
DK96	7/6
DL33	8/6
DL35	10/-
DL91	8/-
DL92	6/-
DL93	7/-
DL94	7/-
DL96	7/6
EA50	2/-
EABC80	5/-
EAC91	4/-
EAF42	9/6
EB34	2/6
EB41	5/-
EB91	4/-
EBC3	21/-
EBC33	4/6
EBC41	8/6
EBC81	10/-
EBF80	8/-
EBF83	8/-
EBF89	8/-
EBL1	21/-
EBL21	21/-
ECC35	8/-
ECC40	15/-
ECC81	5/-
ECC82	5/-
ECC83	7/-
ECC84	8/6
ECC85	7/6
ECC83	12/6
ECC91	3/-
ECF80	7/6
ECF82	8/6
ECH3	21/6
ECH21	21/-
ECH35	10/-
ECH42	9/6
ECH81	7/6
ECH83	8/6
ECL80	7/6
ECL81	10/-
ECL82	9/6
ECL83	10/6
ECL86	9/6
EF6	21/-
EF9	21/-
EF22	14/-
EF36	4/-
EF37	8/-
EF37A	8/-
EF39	4/-
EF40	15/-
EF41	8/-
EF42	10/-
EF50A	3/6
EF50E	3/-
EF80	5/-
EF85	5/-
EF86	8/-
EF89	9/-
EF91	4/-
EF92	4/-
EF95	5/-
EF98	10/-
EF183	10/6
EF184	10/6
EK32	8/6
EL3	21/6
EL32	4/6
EL33	10/-
EL34	14/-
EL35	10/-
EL37	17/6
EL38	17/6
EL41	9/6
EL42	9/6
EL81	12/6
EL84	6/9
EL85	10/-
EL90	8/6
EL91	4/-
EL95	10/6
EM80	8/6
EM81	8/6
EM84	9/6
EM85	10/-
EY51	7/6
EY81	8/6
EY83	12/6
EY86	7/-
EY91	3/-
EZ35	6/-
EZ40	7/-
EZ41	7/-
EZ80	6/-
EZ81	6/-
EZ90	5/-
E1148	2/-
FC2	15/-
FC2A	17/6
FC4	15/-
FW4/500	9/-
FW4/800	9/-
GZ30	10/6
GZ32	10/6
GZ33	19/3
GZ34	13/6
GZ37	19/3
HABC80	10/-
HL41	6/-
HL41DD	8/6
HL92	8/6
HL133DD	9/6
HN309	25/-
IW4/350	10/-
IW4/500	10/-
KT33C	8/-
KT36	17/6
KT61	9/6
KT66	15/-
KT76	10/-
KT81	15/-
KTW61	8/-
L63	5/-
LN152	8/-
LN309	11/6
LZ319	12/6
MKT4	17/6
MS4B	17/6
MVS/PEN	17/6
MVS/PENB	17/6
MU14	9/-
MX40	15/-
N18	8/-
N37	14/-
N78	22/6
N108	15/-
N308	18/-
N339	30/-
N369	10/6
OD3	5/-
OZ4	5/6
P2	10/-
PABC80	13/-
PCC84	8/-
PCC85	9/6
PCC88	12/6
PCC89	8/6
PCF80	9/-
PCF82	7/-
PCF84	12/6
PCF86	12/6
PCL82	9/-
PCL83	10/-
PCL84	7/-
PCL85	5/-
PCL86	12/6
PENA4	17/6
PENB4	17/6
PEN4DD	22/6
PEN4VA	17/6
PEN36C	20/-
PEN45	10/-
PEN45DD	25/-
PEN46	5/-
PEN453DD	20/-
PENDD4020	20/-
PL33	15/-
PL36	12/6
PL38	21/-
PL81	9/-
PL82	8/-
PL83	7/6
PL84	8/-
PL820	18/-
PM24M	13/6
PX4	15/-
PX25	25/-
PY31	15/-
PY32	12/6
PY33	10/6
PY80	7/6
PY81	7/6
PY82	6/9
PY83	8/-
PY88	10/-
PY800	10/-
PZ30	15/-
QS95/10	10/-
QS150/15	10/-
R2	10/-
R16	17/6
R19	16/-
R20	16/-
SP41	3/6
SP61	3/6
T41	15/-
TDD4	12/6
TDD13C	17/6
TH41	20/-
TY86F	12/6
U10	9/-
U12	9/-
U14	9/-
U22	8/-
U24	21/-
U25	11/-
U26	10/-
U31	9/-
U35	17/6
U37	17/6
U47	11/-
U50	7/-
U52	4/-
U76	7/6
U78	4/6
U145	10/6
U191	13/6
U251	15/-
U281	15/-
U282	19/6
U301	17/-
U329	15/-
U339	13/6
U403	10/-
U404	10/-
U801	19/6
UABC80	7/-
UAF42	8/6
UB41	7/6
UBC41	8/6
UBC81	10/-
UBF80	8/-
UBF89	7/6
UBL21	20/-
UCC84	11/6
UCC85	7/6
UCF80	12/6
UCH21	20/-
UCH42	8/6
UCH81	8/-
UCL82	9/6
UCL83	12/6
UF41	7/6
UF42	7/6
UF80	7/-
UF85	7/6
UF86	12/6
UF89	6/6
UL41	8/-
UL44	20/-
UL46	14/6
UL84	6/6
UL85	7/6
UM80	10/6
UR1C	15/-
UU6	17/6
UU8	15/-
UU9	7/6
UY1N	12/6
UY21	15/6
UY41	7/6
UY85	6/6
VMS4B	12/6
VP4	15/-
VP4A	15/-
VP4B	15/-
VR105/30	7/-
VR150/30	7/-
W61	11/-
W76	5/-
W77	4/-
W81	6/-
W81M	6/-
X41	22/6
X61M	10/-
X65	12/6
X76	12/6
X76M	12/6
X78	26/-
X79	40/9
X81	10/-
Y61	10/-
Y63	10/-
Z63	7/6
Z66	10/-
Z77	4/-
Z152	5/-
OZ4	5/-
1A7	11/-
1C5	10/-
1D5	8/6
1D6	10/-
1H5	9/6
1L4	5/-
1N5	9/6
1R5	6/-
1S4	8/-
1S5	5/6
1T4	4/-
1U5	5/9
2P	22/6
3A4	5/-
3A5	10/6
3Q4	8/-
3Q5	9/-
3S4	6/-
3V4	7/-
5U4	4/-
5V4G	7/9
5Y3G	5/6
5Y3GT	6/6
5Z4G	9/6
5Z4GT	12/6
6A7	9/-
6A8G	8/6
6A8GT	13/6
6AC7	6/-
6AK5	5/-
6AL5	4/-
6AM5	5/-
6AM6	4/-
6AQ5	6/6
6AT6	6/-
6AU6	9/-
6B8G	3/-
6BA6	6/-
6BE6	6/-
6BG6G	15/-
6BJ6	6/-
6BQ7A	12/6
6BR7	10/6
6BS7	12/6
6BW6	8/-
6BW7	8/-
6C4	3/6
6C5GT	8/-
6C6	6/6
6C9	12/6
6CD6G	27/6
6CH6	10/-
6CW4	16/-
6D2	4/-
6D6	5/6
6E5	10/-
6F1	10/6
6F6	6/9
6F12	4/-
6F13	10/-
6F14	10/-
6F15	12/6
6F19	12/6
6F23	10/6
6F25	16/6
6F26	13/6
6F33	5/6
6H6	2/-
6J5	5/6
6J5G	4/6
6J5GT	5/-
6J7	7/6
6J7G	5/-
6J7GT	7/6
6K7	7/6
6K7G	2/-
6K7GT	7/6
6K8	9/6
6K8G	5/-
6K8GT	9/6
6K25	17/6
6L1	10/-
6L6	7/6
6L7	10/-
6L18	10/-
6L19	15/-
6N7GT	9/6
6P25	10/6
6P28	12/6
6Q7	9/6
6Q7G	6/6
6Q7GT	8/6
6SA7	7/-
6SC7	8/6
6SF5	10/-
6SG7	7/-
6SH7	6/-
6SJ7	6/6
6SK7	5/6
6SL7GT	6/-
6SN7GT	5/6
6SQ7	8/6
6U4GT	10/-
6U5G	7/6
6V6G	4/6
6V6GT	8/-
6X4	4/6
6X5G	6/-
6X5GT	8/6
6/30L2	10/-
7B5	12/6
7B6	10/-
7B7	8/6
7C5	8/-
7C6	8/6
7D5	15/-
7D6	15/-
7D8	15/-
7H7	6/-
7R7	10/-
7S7	10/-
7Y4	6/6
8D3	4/-
9BW6	12/6
10C1	12/6
10C2	17/6
10F1	10/-
10F9	12/6
10LD11	15/-
10P13	15/-
10P14	19/-
11D5	23/6
12A6	6/6
12AH8	9/-
12AT6	7/6
12AT7	5/-
12AU6	17/6
12AU7	5/-
12AX7	5/-
12BA6	7/6
12BE6	7/6
12BH7	10/-
12C8	8/6
12J6GT	4/-
12J7GT	8/6
12K7GT	5/-
12K8GT	10/-
12Q7GT	6/6
12SA7	8/6
12SJ7	8/-
12SK7	6/-
12SL7	8/-
12SN7	10/-
12SQ7	12/-
14H7	10/-
14R7	10/-
14S7	16/-
19AQ5	8/-
19BG6G	15/-
20D1	10/-
20D2	21/-
20F2	17/6
20L1	22/6
20P1	15/-
20P3	24/-
20P4	20/-
20P5	20/-
25A6	8/-
25L6	8/-
25Y5	8/-
25Y5G	8/-
25Z4	7/6
25Z5	8/-
25Z6	8/6
27SU	19/6
30C1	9/-
30C15	12/6
30F5	10/-
30FL1	10/6
30L1	8/6
30L15	11/-
30P4	18/-
30P12	10/-
30P16	9/-
30P19	17/6
30PL1	11/6
30PL13	11/6
30PL14	16/6
35A5	15/-
35L6GT	8/6
35W4	7/6
35Z3	15/-
35Z4	7/6
35Z5	8/6
41STH	22/6
42	12/6
50C5	10/-
50CD6G	30/-
50L6	8/6
75	8/-
78	7/6
80	9/-
85A2	12/6
185BT	30/-
807A	6/-
807B	5/-

COMPLETE VALVE LIST FREE WITH ORDER

METAL RECTIFIERS

RM1	7/6	14A86	23/-	16RD 2-2-8-1	12/- (FC142)
RM2	8/-	14A97	26/-	16RE 2-1-8-1	10/-
RM3	10/-	14A100	28/-	18RA 1-1-8-1	5/-
RM4	17/6	14RA 1-2-8-2	21/- (FC301)	18RA 1-1-16-1	7/- (FC116)
RM5	19/6	14RA 1-2-8-3	25/- (FC31)	18RA 2N-1-8-1	12/-
		16RC 1-1-16-1	10/-	18RD 2-2-8-1	16/- (FC124)

BRAND NEW TRANSISTORS

OC44	6/-	OC74	8/-	OC81D	8/-
OC45	7/-	OC75	6/-	OC82	8/-
OC71	5/-	OC77	6/-	OC82D	6/-
OC72	8/-	OC81	6/-		

SILICON RECTIFIERS

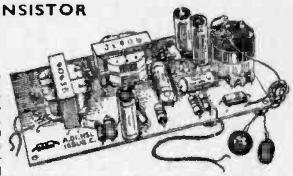
400 volts 350 mA ... ... 8/- each

TERMS OF BUSINESS C.W.O. or C.O.D. 4/2 PACKING CHARGE ON ALL C.O.D. ORDERS. POSTAGE 6d. per VALVE

SETS OF VALVES

1R5, 1S5, 1T4, 3S4, 3V4 ... ... Set of 4, 19/-
DAF91, DF91, DK91, DL92, DL94 ... Set of 4, 19/-
DAF96, DF96, DK96, DL96 ... ... Set of 4, 26/6

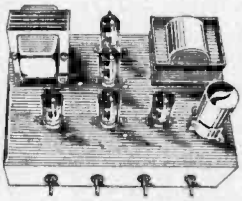
HIGH GAIN 4-TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT
Type TA1



● Peak output in excess of 1½ watts. ● All standard British components. ● Built on printed circuit panel, size 6 x 3in. ● Generous size Driver and Output Transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET114 or 81 Mullard OC81D and matched pair of OC81 o/p). ● 9 volt operation. ● Everything supplied, wire, battery clips, solder, etc. ● Comprehensive easy to follow instructions and circuit diagram 1/6 (Free with Kit). All parts sold separately.

SPECIAL PRICE 45/- P. & P. 2/6.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15 Ω speaker and 2 independent volume controls and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 1/6. (Free with parts).

All parts sold separately. ONLY **£6.19.6** P. & P. 6/6.

AMPLIFIER ON PRINTED CIRCUIT BOARD

Two valve. UY85, UL84 O.P. trans., use with 80 volt tap off motor. 39/6. P.P. 2/6 on above. Dropper res. for filaments if required. 2/6.

B.S.R. AUTO UNITS

160 v. Suitable for use with above. (Slightly soiled.) £4.4.0.

UNREPEATABLE OFFER!
BRAND NEW 8 x 5 3 OHM SPEAKERS
By well known maker
10/6 each.
P. & P. 1/6 per speaker
A pair of these are ideal for Stereo

LARGE CABINET Suitable for above two items. Complete with 3 ohm speaker. £3.9.6. Carr. 5/-.

Superior CABINET Similar to above to take 8 x 5in. speaker, with motor board, will accommodate BSR UA14 or UA16. £3.9.6. Carr. 5/6. Speaker 15/- extra. P. & P. 1/6 extra.

BRAND NEW 3 OHM LOUDSPEAKERS

2½in. 12/6; 5in. 12/6; 6½in. 15/-; 8in. 21/-; 10in. 25/-; 12in. 27/6.

Goodmans 5in. tweeter ..	10/6
E.M.I. 2½in. tweeter ..	10/6
E.M.I. 10in. x 6in. ceramic magnet	25/-
E.M.I. 13½in. x 8½in. high flux	32/6
Rola Celestion approx. 9in. x 6in. middle register speaker	10/6

Also 15 ohm 12 inch., 30/-

P. & P. up to 6in. 1/6; over 6in. 2/6 per speaker.

RECORDING TAPE

P.V.C. base, full frequency L.P. tape. 7in., 1800ft. (normally 50/-) 27/6; 5¾in., 1,200 ft. (normally 35/-), 18/9. 5in., 900ft. (normally 28/-), 15/-. P. & P. 1/- per spool. Ideal for 2 or 4 track recorder.

TAPE DECKS

COLLARO STUDIO DECK
£10.10.0, plus 5/6 carr. and ins.

B.S.R. MONARDECK
(Single speed) 3¾in. per sec., simple control, uses 5¾in. spools, £6.15.0 plus 5/6 carr. and ins. (Tapes extra on both).

SPECIAL BARGAIN OFFERS!

MAINS TRANSFORMERS. Tapped Primary. ½ wave or Bridge Rectifier. Secondary 250 v. at 75 mA 6.3 volts at 2 amps. 10/6 each. P. & P. 3/-.

TWO GANG .0005 TUNING CONDENSER. Geared precision reduction drive. Size $2^{7}/_{16}$ x 2 x 1¾in. Brand new and unused. 3/6 each. P. & P. 1/-.

MAINS TRANSFORMER. Impregnated and fully shrouded. Size 4½ x 3½ x 2¾in. Weight 6 lbs. Tapped primary 205, 225, 245v. Electrostatic screen. Output 360-0-360 v. at 120 m/a D.C. plus 1050 v. half wave at 3 m/a D.C. 6.3 v. at 3.5 amps, centre tapped 5 v. at 2½ amps and 6.3 v. at .6 amps PRICE ONLY 21/- each. P. & P. 5/-.

CARBON MIKE INSERTS. Brand new, 2¾in. dia., 3/6. P. & P. 9d.

ELECTROSTATIC H.F. TWEETERS. Type L.S.H. 75. Size 3 x 3in., 2/6 each, plus 9d. P. & P.

MIDGET 2/GANG CONDENSERS. Capacity 195 and 100 pF. Polystyrene case with built-in trimmers. Size ¾ x ¾ x ½in. Not used but removed from P/C Boards. Two for 9/-, plus 1/- P. & P.

ACOS CRYSTAL MIKES. High imp. For desk or hand use. High sensitivity, 18/6. P. & P. 1/6.

TSL CRYSTAL STICK MIKE. Listed at 45/-. Our price 18/6. P. & P. 1/6.

TRANSISTOR DRIVER and O/P TRANSFORMERS. (Tapped 3 ohms and 15 ohms output), plus 4 suitable Transistors giving approx. 1 watt output. 30/-. P. & P. 2/-.

3 PUSH-BUTTON TRANSISTOR SWITCH. D.P.—D.T. Each Switch 5/6 and 1/- P. & P.

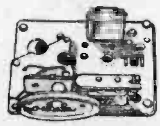
FURTHER HUGE PURCHASE

TELEFUNKEN HI-FI STEREO AMPLIFIER. Model 882 with BALANCE CONTROL 110/250 v. A.C. input. 5 watt undistorted output (10 watts nominal). Size 12 x 9 x 2in. Weight 9 lb. Complete with spec. and instructions. Now only £5.19.6 Carr. 7/-.

SPECIAL PURCHASE! TURRET TUNERS

by famous maker. Brand new and unused. Complete with PCC84 and PCF80 valves, 34-38 Mc/s I.F. Biscuits for Channels 1 to 5 and 8 and 9. Circuit diagram supplied. ONLY 25/- each. P.P. 2/6.

F.M. TUNER HEAD



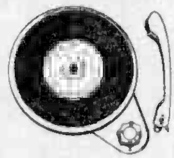
A permeability tuned tuner head by a famous maker, supplied without valve (ECC85) and drum and spindle. 18/6, plus 1/9 P. & P. Valve 8/6 extra. Drum and spindle 3/6 extra.

GÖRLER F.M. TUNER HEADS

10.7 Mc/s I.F., 15/-, plus 1/9 P. & P. (ECC85 valve. 8/6 extra.)

E.M.I. 4-speed Player and P.U.

FURTHER HUGE PURCHASE enables us to offer these at **67/6** P. & P. 4/6.



Heavy 8½in. metal turntable. Low flutter performance 200/250V shaded motor with tap at 45 V for amplifier valve filament if required. Turnover LP/78 head.

RECORD PLAYER AMPLIFIER

2 valve (EZ80, ECL82), A.C. mains, 3 watts output, ready built, tested and complete with valves and output transformer. Size 7in. w. x 2½in. d. x 5½in. h. 55/-, P. & P. 3/-. Suitable speakers: 6in. 15/- P. & P. 1/6. 10 x 6in. 25/-, P. & P. 1/6.

4-SPEED PLAYER UNIT BARGAINS

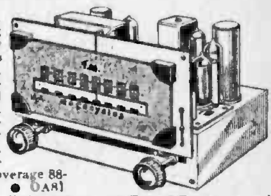
SINGLE PLAYERS
TU/12, £3.10.0. Carr. 3/6.

AUTO CHANGERS
B.S.R. UA14, £6.2.6.
Latest B.S.R. UA16, £7.2.6.
Latest Garrard "Auto-Slim" £6.17.0. Carr. 5/- on each.

SPEAKER & CABINET FABRICS

Oatmeal fabric for speaker or cabinet or Red rexine for cabinet 54in. wide 13/6 per yard length. (Minimum order). P. & P. 1/6.

HARVERSON'S F.M. TUNER Mk.I



● F.M. tuning head by famous maker. ● Guaranteed non-drift. ● Permeability tuning. ● Frequency coverage 88-100 Mc/s. ● OA81 balanced diode output. ● Two I.F. stages and discriminator. ● Attractive maroon and gold dial (7 x 3in. glass). ● Self powered using a good quality mains transformer and valve rectifier. ● Valves used ECC85, two EF80s, and EZ80 (rectifier). ● Fully drilled chassis. ● Size of completed tuner 8 x 6 x 5½in. ● All parts sold separately. Set of parts if purchased at one time £5.19.6, plus 8/6 P.P. and ins. Circuit diagram and instructions 1/6 post free. **Mark II Version** as above but complete with magic eye, front panel and brackets, £6.12.6. P. & P. 8/6.

Mark III Version as Mark 1 but with output stage (ECL82) and tone control. £7.7.0. P. & P. 8/6.

Handsome Metal Cabinets. Choice of Grey, Black or Green. To fit Mark I, 25/-, P. & P. 2/6. To fit Mark II, 17/6, P. & P. 2/6.

6 TRANSISTOR AND DIODE SUPERHET

A first-class 2 waveband transistor superhet. ● Printed circuit panel (size 8½ x 2¾in.) ● 3 pre-aligned I.F. transformers. ● High-gain Ferrite rod aerial. ● All First-grade transistors. ● Car aerial winding. ● Push-pull output. ● All parts supplied with simple instructions.

All parts sold separately. Set of parts if purchased at one time.

ONLY £4.5.0 P. & P. 2/6

35 OHM SPEAKERS

Suitable for use with above. 2in. Goodmans. Ideal replacement for most pocket portables 8/6; 2½in. 10/6; 3½in. 12/6; 5in. 17/6; 7 x 4in. 21/-.

P. & P. 1/6 per speaker.

Portable CABINET

Size approx. 9½ x 6¾ x 3½in. Suitable for above using 3½in. speaker. 25/-. P. & P. 2/-.

COIL AND TRANSFORMER SET FOR TRANSISTOR SUPERHET

3 I.F. transformers, one oscillator coil, one driver transformer and wound Ferrite aerial (med., long and aerial coupling), 28/6 complete, post 1/-. 6 transistor printed circuit, board to match, 8/6, post 9d. Circuit diagram 1/6 extra.

QUALITY RECORD PLAYER AMPLIFIER

A top-quality record player amplifier. This amplifier (which is used in a 29 gn. record player) employs ECC83, EL84, EZ80 valves. Bass, treble and volume controls. On/off controls.

PRICE 69/6, P. & P. 3/6

DITTO. Mounted on board with output transformer and 6½in. speaker.

Complete at 89/6, P. & P. 4/6.

TRANSISTORS

GAT 15 (Matched Pair) 15/-

OC71	5/-	PXA101 ..	6/6
OC72	6/-	XA103 ..	6/6
OC76	6/-	V15/10p ..	12/6

Set of Mullard 6 transistors, OC44, 2—OC45, OC81D, matched pair OC81. 25/-. All Post Free.

HARVERSON SURPLUS CO. LTD.

170 HIGH ST., MERTON, S.W.19. CHErrywood 3985/6

Open all day Saturday. *Early closing Wed., 1 p.m.*

A few minutes from South Wimbledon Tube Station. *(Please write clearly)*

Please Note: P. & P. charges quoted apply to U.K. only. P. & P. on overseas orders charged extra. (S.A.E. all enquiries).

UNIVERSAL AVOMETERS

Guaranteed perfect working order. Supplied complete with leads, batteries and instructions.

Model "D" 34 range **£8.19.6**

Model "7" 50 range **£11.0.0**

Registered Post 5/- extra.

MICROAMMETERS

0-500 microamps. 2¼in. circular flush panel mounting. Dials engraved 0-15, 0-600 volts. BRAND NEW. BOXED. **15/-.** P.P. 1/6.

7.5 K.V.A. AUTO TRANSFORMERS

0-115-230 volts. Brand new boxed. **£15.** Carriage 10/-.

230/250 VOLT A.C. MOTORS

4¼ x 3in. dia., 90 watts. 5,000 r.p.m. ¼in. spindle. **22/6.** P.P. 1/6.

1 K.V.A. ISOLATION TRANSFORMERS

230 v. Pri.: 230 v. Sec. Boxed, **£5** each. Carriage 10/-.

VARIAC TRANSFORMERS

24 amp., 230 volt primary, 185 to 250 volt output, **£12.10.0.** Carriage 10/-.

TELEPHONES TYPE "H"

Sound powered, generator bell ringing, 2 line connection. Fully tested, **£4.19.6** pair. Carr. 5/-.

MINIFLUX HI-FI TAPE HEADS

Set of three, record, playback, erase. Only **29/6** set. P.P. 9d.

3000 WATT AUTO TRANSFORMERS

0-115-230 volts, step-up or step-down. Brand new, boxed ex-U.S.A. **£7.10.0** each. Carr. 10/-.

PANEL METERS

100μA	2½"	F.M.	D.C.	**42/6**
100μA	3½"	F.M.	D.C.	**62/6**
1 mA	2½"	F.M.	D.C.	**25/-**
30/0/30 mA	2½"	F.M.	D.C.	**9/6**
350 mA	2½"	F.M.	D.C.	**10/6**
300 v.	2½"	Proj.	A.C.	**19/6**
300 v.	2½"	F.M.	A.C.	**25/-**
500 v.	2½"	F.M.	A.C.	**25/-**
120 v.	3½"	F.M.	D.C.	**32/6**

Postage Extra.

FIELD TELEPHONES TYPE "F"

Suitable for many applications. Generator bell ringing. 2 line connection. With batteries and wooden carrying case, fully tested, **£4.19.6** per pair. Carr. 5/-.

SUB-STANDARD D.C. AMMETERS

9 ranges. 150mA, 1.5A, 3A, 7.5A, 15A, 30A, 60A, 300A, and 450A. Housed in teak portable case, 8in. mirror scale. Supplied brand new with all shunts and leather carrying case. **£15** each. P.P. 10/-.

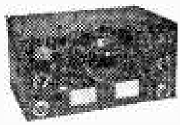
P.C.R.2 RECEIVERS

800-2,000 metres. 190-550 metres 6-22 Mc/s. output for phones or 3 Ω speaker. As new **£5.19.6.** Carr. 10/6. **PCR3** as PCR2 but covers 190/550 metres, 2-7 Mc/s, 7-22 Mc/s, including top band. As new **£8.8.0.** Carr. 10/6. All above models can be supplied with internal power unit to operate on 200/250 v. A.C. at **39/6** extra or alternatively plug-in external power units are **35/-.**

AVO WIDE RANGE SIGNAL GENERATORS

Frequency coverage 50 Kc/s to 80 Mc/s in six turret operated ranges. For use on standard A.C. mains. Packed in original transit cases with accessories. Supplied in as new condition, fully checked before despatch, **£15.** Carriage 10/-.

NATIONAL H.R.O. RECEIVERS



SENIOR MODEL. Supplied complete with full set of 9 coils covering 50 kc's. to 30 Mc/s. Each receiver thoroughly checked and available as follows:
TABLE MODEL. As new condition **£25.**
TABLE MODEL. Extremely good used condition **£19.19.0.**
RACK MODEL. Extremely good used condition **£18.18.0.**
Carriage £1 extra.

200/250 volt A.C. power packs for above receiver, also sold separately, **59/6.** Carr. 5/-.

PRECISION COMBINATION VOLTMETER/AMMETER FOR A.C. AND D.C.

Two separate instruments housed in polished wood case. 6in. scales with knife edge pointers.
Ranges:
Volts A.C. and D.C. 160-300-600 v.
Amps. A.C. and D.C. 25-50-150-200 A.
Supplied complete with all current shunts, leads and leather carrying case. Manufactured by Elliott Bros. Supplied brand new. **£9.19.6** each. Carriage 7/6.

HALLICRAFTER S-36 V.H.F. RECEIVERS

F.M./A.M. 27-143 Mc/s. 110 volt A.C. (transformer supplied for 230 v. A.C.) Improved version of S-27. Tested before despatch. Brand new boxed with instruction manual. **£40** each. Carr. £2

MINE DETECTOR No. 4A

Will detect all types of metal. Fully portable. Complete equipment supplied tested with instructions, **39/6.** Carriage, 10/6. Battery **8/6** extra.

COLLARO STUDIO TAPE TRANSCRIPTOR

Brand new 1962 model, 3 speeds, 3 motors, digital counter, etc. With latest Bradmatic heads and interlock button. Supplied with spare spool, instructions, fixings, **10 gns.** each. Carr. paid.

FABULOUS TAPE OFFER

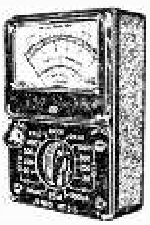
Famous American Brand Tapes. Brand new, fully guaranteed. 5in.—600ft., **10/6**, 5in.—900ft., **13/6**, 5in.—1200ft., **17/-**, 7in.—1200ft., **13/6**, 7in.—1800ft., **18/6**, 7in.—2400ft., **27/6.** P. & P. extra. S.A.E. for full tape list.

MULTIMETERS BRAND NEW—FULLY GUARANTEED LOWEST EVER PRICES

Supplied with Leads, Batteries and Instructions.

1,000 Ω/VOLT
0/15/150/1,000 v. A.C. and D.C.
0/150 mA. D.C.
0/100 K Ω etc.
39/6. P. & P. 1/6.

20,000 Ω/VOLT
0/10/50/250/500/1,000 v. A.C. and D.C.
0/50μA/0/25/500 mA. D.C.
0/50K/500K/5 meg., etc. **97/6.** P. & P. 2/6.



30,000 Ω/VOLT
0/¼/1/10/50/250/500/1,000 v. D.C.
0/10/50/250/500 v. A.C.
0/50μA/0/10/250 mA. D.C.
0/10K/1 meg./10 meg., etc. **£5.10.0.** P.P. 2/6.

30,000 Ω/VOLT
0/¼/1/2½/10/25/100/250/500/1,000 v. D.C. and A.C.
0/50μA/5/50/500 mA/0/12 amp. D.C.
0/60 K/6 meg./60 meg., etc. **£8.17.6.** Post paid.

50,000 Ω/VOLT
0/10/50/250/500/1,000 v. D.C. and A.C.
0/25μA/2.5/25/250 mA. D.C.
0/10K/100K/1 meg./10 meg., etc. **£7.10.0.** P.P. 2/6.

100,000 Ω/VOLT
.5/2.5/10/50/250/500/1,000 v. D.C.
2.5/10/50/250/1,000 v. A.C.
10/250μA/2.5/25/250 mA/10 amp. D.C.
20K/200K/2 meg/20 meg. ohm. etc.,
£6.19.6 post paid.

MARCONI CR100/8 RECEIVERS BRAND NEW

Packed in original transit cases and complete with handbook/manual. 60 Kc/s to 30 Mc/s. 200/250 volt A.C. operation. Tested before despatch.

£35 Carriage £2.

DOUBLE BEAM OSCILLOSCOPES

Erskine Type 13A. **£27.10.0.** Carr. £1. **Cossor Type 103S.** **£45.** Carr. 30/-. All fully checked perfect equipment. Other types in stock.

L.T. METAL RECTIFIERS

All full wave, bridge connected. Brand new.

12/18v. 1.5A.	**3/9**	24/36v. 4A.	**22/6**
12/18v. 2.5A.	**6/3**	24/36v. 6A.	**27/6**
12/18v. 4A.	**8/3**	24/36v. 15A.	**45/-**
12/18v. 6A.	**12/3**	36/48v. 2A.	**19/6**
12/18v. 10A.	**22/6**	36/48v. 4A.	**29/6**
12/18v. 15A.	**37/6**	36/48v. 6A.	**32/6**
24/36v. 1A.	**7/3**	48/60v. 2A.	**21/-**
24/36v. 2A.	**13/6**	48/60v. 10A.	**82/6**

Please add postage.

L.T. TRANSFORMERS

All primaries tapped 200/250 volts **1 Battery Charging.** 3.5, 9 or 17 volt, 1 amp., **9/9.** Ditto 2 amp., **14/3.** Ditto 4 amp., **16/6.** 9 or 17 volt, 6 amp., **26/-.**
2 Model Type 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volt, 2 amp., **18/6.** Ditto 4 amp., **30/-.** Ditto 5 amp., **37/6.** Add Postage.

MINIATURE MODEL ACCUMULATORS

Lead Acid. BRAND NEW. **2v. 1.5 A.H.,** 4 x 1¼ x 1in., ¼lb., **5/6.** P.P. 1/3. **12v. 0.75 A.H., 4 x 3 x 1¼in.** 2lb., **15/6.** P.P. 1/6.

R.C.A. PLATE TRANSFORMERS

Pri. 200/250 v. sec., 2,000-0-2,000 v. 500 mA, tapped 1,500 v. New. Boxed, **£6.10.0.** Carriage 15/-.

DUMONT K1051P1 DOUBLE BEAM C.R.T.

Twin Gun. **Brand new, boxed.** **59/6.** P.P. 3/6.

1.2 Ohm 12 Amp RHEOSTAT

Geared slider type, **new boxed.** **15/6** each. P.P. 3/6.

MARCONI TF-885 VIDEO OSCILLATORS

25c/s-5Mc/s. Supplied in guaranteed as new condition. **£90 each.**

H.R.O. DIALS

Brand new, **27/6.** P.P. **2/6.**

MINIATURE PANEL METERS

For 1¼in. dia. panel hole.

0-50 μA	**39/6**	0-300 v. D.C.	**27/6**
0-500μA	**32/6**	"S" meter	**35/-**
0-1 mA	**27/6**	"VU" meter	**42/6**
0-5 mA	**27/6**		

CONSTANT VOLTAGE TRANSFORMERS

95-130v. Input. 115v. Output. 500 Watts. Can be used in **series for** 230v. **£4** each. Carr. 10/-.

WESTON MICROAMMETER MOVING COIL RELAYS. Brand new boxed, fully **guaranteed.** **42/6** each, P.P. 2/-.

Hours of Business: **3 LISLE STREET, 9 a.m.—6 p.m. Half Day Saturday**
34 LISLE STREET, 9 a.m.—6 p.m. Half Day Thursday

Send S.A.E. For Bargain Lists

C.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

Stern's MULLARD DESIGNS

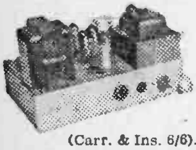
COMPLETE KITS OF PARTS

MULLARD 3-VALVE PRE-AMPLIFIER TONE CONTROL UNIT

Designed mainly for Mullard Range of Amplifiers, also suitable for any Amplifiers requiring input up to 250mV. Incorporates 5 input Channels, including for Tape and Magnetic Pickups. Separate Bass and Treble controls. High pass filter 20 to 160 c/s. low pass filter 5-9 Kc/s. Totally enclosed in case size 11½"x4½"x4".

KIT OF PARTS **£10.0.0** ASSEMBLED & TESTED **£13.13.0**
(Carr. & Ins. 5/-).

MULLARD "5-10" MAIN AMPLIFIER

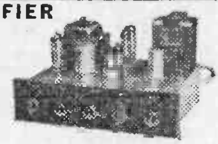


For use with MULLARD 2 or 3 valve pre-amplifiers with which an undistorted power output of up to 10 watts is obtained. SPECIFIED COMPONENTS AND MULLARD VALVES including PARMEKO MAINS TRANSFORMER and choice of PARMEKO or PARTRIDGE Output Transformer.

COMPLETE KIT (Parmeko Output Trans.) **£10.0.0**
ASSEMBLED AND TESTED **£13.10.0**
(Carr. & Ins. 6/6).

ABOVE incorporating PARTRIDGE OUTPUT TRANS. £1.6.0 extra.

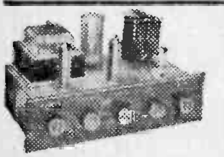
THE MULLARD 510/RC AMPLIFIER



The popular complete "5-10" incorporating Passive Control Unit providing up to 10 watts high quality reproduction with input of 600 mV. Specified components and new MULLARD VALVES. Includes PARMEKO MAINS TRANSFORMERS and choice of PARMEKO or PARTRIDGE Output Transformers. Surplus Power available for Tuner.

COMPLETE KIT **£12.0.0**
ASSEMBLED AND TESTED **£16.0.0** With PARTRIDGE OUTPUT TRANS. £1.6.0 ex.
(Carr. & Ins. 7/6).

THE MULLARD 33/RC

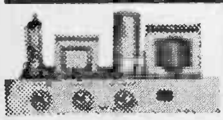


A HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-WATT MULLARD "3-3" DESIGN.

KIT OF PARTS **£8.8.0**
ASSEMBLED AND TESTED **£11.10.0**

Complete to the MULLARD specification including PARMEKO OUTPUT TRANSFORMER. Switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available. (Carr. & Ins. 6/6). Please state L.S. impedance.

THE "MONO-GRAM"



A small Amplifier of genuine high quality performance. Incorporates MULLARD ECL86 Valve, separate BASS and TREBLE controls and produces up to 3 watts undistorted output. (Carr. & Ins. 3/6).
Kit of Parts **£4.10.0** Assembled and Tested **£6.0.0**

Perfectly suited for Portable Installations for which purpose we offer PORTABLE CASE (£3.10.0), the AMPLIFIER (Kit) and 8" x 5" SPEAKER (£1.0.0). All for **£9.0.0**
Alternatively with ASSEMBLED AMPLIFIER **£10.0.0**
(Carr. & Ins. 5/-).

The Case quoted above will accommodate some 4-speed Single Record Units. A larger model is available for extra 10/-. With this Equipment a COMPLETE PORTABLE RECORD PLAYER can be built for **£14.0.0**

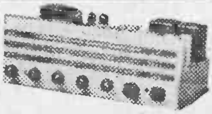
MULLARD FOUR CHANNEL MIXING UNIT

Self powered Cathode follower output. Incorporates two inputs for CRYSTAL MICROPHONES, one for CRYSTAL PICK-UPS and a fourth for Radio or Tape.

KIT OF PARTS **£8.8.0** ASSEMBLED AND TESTED **£11.10.0** (Carr. & Ins. 5/-).

Alternative Model I/L provides for one input matched for moving coil or ribbon mike £1.17.0 extra.

ARMSTRONG RADIOGRAM CHASSIS



We have the full range in stock. Prices range from £20.10.0. Full details are readily available.

Send S.A.E. for fully descriptive technical leaflets, or call at our showrooms and hear the equipment on demonstration.

MULLARD 2-VALVE PRE-AMPLIFIER TONE CONTROL UNIT

Employing two EF86 valves and designed to operate with the Mullard AMPLIFIERS but also perfectly suitable for other makes with input up to 250 m/V.

- ★ Equalisation for the latest R.I.A.A. characteristics.
- ★ Input for Crystal Pick-ups and variable reluctance magnetic types.
- ★ Input (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.
- ★ Sensitive Microphone Channel. ★ Wide range BASS and TREBLE Controls.

KIT OF PARTS **£6.6.0** ASSEMBLED AND TESTED **£9.10.0** (Carr. & Ins. 5/-).

PRICE REDUCTIONS

(a) THE KIT OF PARTS to build both the "5-10" Amplifier and the 2-Valve Pre-Amplifier .... (Carr. & Ins. 8/6).	**£15.15.0**
(a) Assembled and Tested	**£21.10.0**
(b) THE KIT OF PARTS to build both the "5-10" Amplifier and the 3-Valve Pre-Amplifier .... (Carr. & Ins. 10/-).	**£19.10.0**
(b) Assembled and Tested	**£25.10.0**

With PARTRIDGE OUTPUT TRANSFORMER **£1.6.0** extra.

HIGH FIDELITY LOUDSPEAKERS

WE STOCK THE COMPLETE RANGE BY GOODMANS, WHARFEDALE and W.B. STENTORIAN
A few recommended examples

8 INCH TYPES	
GOODMANS "AXIETTE"	£5.5.7
W.B. HF 816	£5.19.6
WHARFEDALE "SUPER 8/RS/DD"	£6.14.2
10 INCH TYPES	
GOODMANS "AXIOM 10"	£6.5.11
W.B. MODEL HF 1016	£7.0.0
WHARFEDALE "GOLDEN 10/RS/DD"	£7.17.5
12 INCH TYPES	
GOODMANS "AXIOM 201" 15 watts	£10.7.0
GOODMANS "AXIOM 301" 20 watts	£14.10.0
W.B. MODEL HF 1214 15 watts	£10.5.6
WHARFEDALE "W12/RS"	£10.15.0
WHARFEDALE "Super 12/RS/DD"	£17.10.0

Carr. & Ins. on above 5/6 each.

We are pleased to announce that all Stern's products are now available from

CLYNE RADIO LTD.
12 SUFFOLK HOUSE
GEORGE STREET, CROYDON
Telephone: MUN 3250

RECORD PLAYERS

THE COLLARO "JUNIOR" 4-speed single player with separate crystal pick-up..........	**£3.10.0**
THE NEW GARRARD "AUTOSLIM" 4-speed autochanger with crystal pick-up........	**£6.10.0**
GARRARD "AUTOSLIM DE LUXE" 4-speed autochanger, incorporates transcription pick-up arm	**£11.8.0**
THE COLLARO "C60" 4-speed autochanger unit with Studio "O" pick-up..........	**£6.19.6**
B.S.R. Model UA14. 4-speed mixer autochanger with crystal pick-up	**£5.19.6**
The new GARRARD Model 4HF High Quality Single Record Player fitted with the latest T.P.A. 12 pick-up arm and G.C.8. crystal Cartridge	**£16.17.6**
GARRARD Model S.R.P. 10 single record player fitted with high output crystal pick-up	**£5.9.1**
PHILIPS Model AG1016. A 4-speed player can be operated both manually and automatically. Suitable for Mono or Stereo operation ..	**£12.12.0**

Carr. and Ins. on each above 5/6 extra.

Mk. 11 "Fidelity" FM TUNING UNIT

An attractively presented Unit incorporating MULLARD PERMEABILITY TUNING HEART and corresponding Mullard valve line-up. Very suitable to operate with our Mullard Amplifiers.

KIT OF PARTS **£10.10.0**
ASSEMBLED AND TESTED **£14.5.0**
Carr. & Ins. 5/-.

IF YOU ARE PLANNING TO INSTALL "Hi-Fi" and UNCERTAIN OF THE TYPE OF EQUIPMENT TO USE—OUR WIDELY EXPERIENCED TECHNICAL STAFF WILL WITH PLEASURE PUT FORWARD RECOMMENDATIONS—STATE TYPE OF INSTALLATION CONTEMPLATED AND APPROX. PRICE LEVEL.
CREDIT SALE TERMS are available on all Equipment over £10.0.0.
FULLY DESCRIPTIVE LEAFLETS are readily available—please advise items of interest and enclose S.A.E.

Stern's

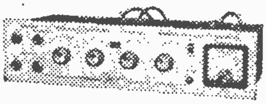
SPECIALISTS IN SOUND EQUIPMENT FOR OVER 25 YEARS

MODEL CR3/S TAPE RECORDER

MODEL CR3/S incorporates the HF/TR3 Mk. II Tape Amplifier (described below) and the Collaro "Studio" Twin Track 3-speed Deck operating at 1⅞in., 3¾in., and 7½in. speeds. Complete with microphone and 1,200ft. tape.

KIT OF PARTS £33.8.0
ASSEMBLED AND TESTED £43.0.0
(Carr. & Ins. 15/- extra).

STEREO TAPE PRE-AMPLIFIER



MODEL STP-1. For use with current TRUVOX, BRENELL, or COLLARO "STUDIO" ¼ and ½ track Stereo Decks. Incorporates Ferroxcube Oscillator, 4 speed Equalisation Signal Level Meter and separate Gain Controls. Includes separate Power Unit.

KIT OF PARTS £22.0.0 (Carr. & Ins. 8/6). ASSEMBLED £28.0.0

TAPE PRE-AMPLIFIER MULLARD Type "C"

Suitable for most ½ track, Mono Tape Decks. Incorporates Ferroxcube Push Pull Oscillator. Treble Inductor and 3-speed Equalisation. Includes Separate Power Unit.

KIT OF PARTS £14.0.0 ASSEMBLED £19.10.0
(Carr. & Ins. 7/6)

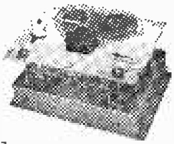
MULLARD TAPE AMPLIFIER

MODEL HF/TR3 MK. II

Based on Mullard's Type "A" design and suitable for most ½ track Mono Tape Decks. Incorporates Ferroxcube Treble Inductor. Gilson Output Transformer, and 3-speed Equalisation. Includes separate Power Unit.

KIT OF PARTS £13.13.0 (Carr. & Ins. 7/6). ASSEMBLED £19.0.0

STERN'S "ADD-A-DECK"



A self contained Unit consisting of Garrard Deck and matched Preamplifier on one chassis. Provides full tape recording facilities and replays through Pick Up Sockets of standard Radio receiver or Amplifier.

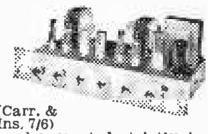
PRICE includes complete Tape Magazine. £18.18.0
(Carr. & Ins. 10/-).

COMBINED PRICE OFFERS ! ! !

Includes small charge for special testing and PRECISE MATCHING of the ASSEMBLED PRE-AMPLIFIER (or Amplifier) to TAPE DECK

STP-1 (Kit) and "STUDIO" Deck	£39.0.0	Assembled £46.0.0
STP-1 (Kit) and Brenell Deck ..	£66.0.0	Assembled £75.0.0
STP-1 (Kit) and Truvox Deck ..	£51.0.0	Assembled £59.0.0
TYPE "C" (Kit) and "STUDIO" Deck	£26.10.0	Assembled £33.0.0
TYPE "C" (Kit) and BRENELL Deck	£43.0.0	Assembled £50.0.0
TYPE "C" Assembled and Wearite Deck	£70.0.0	Inc. Head Lift Trans.
HF/TR3 (Kit) and "STUDIO" Deck	£26.0.0	Assembled £33.0.0
HF/TR3 (Kit) and BRENELL Deck	£43.0.0	Assembled £50.0.0
HF/TR3 Assembled and Wearite Deck	£70.0.0	Inc. Head Lift Trans.

MULLARD "10+10" STEREO AMPLIFIER



A high fidelity design providing up to 10 watts (per channel). Superb reproduction frequency response flat to within 3db from 3 c/s to 60 Kc/s at 50 mW Total Harmonic Distortion at 10 watts 0.1%.

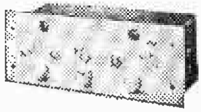
Price (a) ASSEMBLED AMPLIFIER (as illustrated) £24.0.0
(b) KIT OF PARTS.......... £20.0.0 (Carr. & Ins. 7/6)

Built to the highest technical standards and presented strictly to MULLARD'S specification. Two specially designed GILSON ULTRA-LINEAR OUTPUT TRANSFORMERS with 20% taps are used.

We can also supply the assembled MAIN AMPLIFIER only for operation with our DUAL CHANNEL PRE-AMPLIFIER: this provides a more versatile installation and is essential if a low output pick-up is to be used. When ordering specify loudspeaker impedance.

(a) THE ASSEMBLED MAIN AMPLIFIER and ASSEMBLED DUAL CHANNEL PRE-AMP...................... £34.0.0
(b) KIT OF PARTS for both Units........................ £27.0.0
(Carr. & Ins. 10/6).

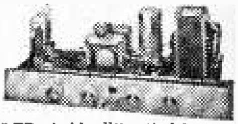
MULLARD DUAL-CHANNEL PRE-AMPLIFIER



A four Valve design for both STEREOPHONIC and MONOPHONIC operation. Operates equally well with any make of Amplifier requiring an input of up to 250 m/v.

KIT OF PARTS £12.10.0 ASSEMBLED AND TESTED £15.0.0
(Carr. & Ins. 5/-)

THE "TWIN THREE" STEREO AMPLIFIER



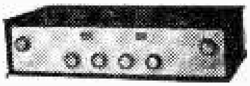
ASSEMBLED AND TESTED

£9.0.0 (Carriage and Insurance 5/- extra)

Based on a recent design by MULLARD LTD., is ideally suited for use in Portable RECORD PLAYERS for which purpose we offer a specially designed Case: incorporates MULLARD ECL 86 Valves, separate BASS and TREBLE CONTROLS and produces up to 3 watts per channel. Frequency response is 40 c/s to 35 Kc/s, size is only 11½in. x 3in. x 5in.

To construct a STEREO PORTABLE RECORD PLAYER we offer: Assembled AMPLIFIER with two ROLA 8in. x 5in LOUDSPEAKERS and PORTABLE CASE for.... £16.10.0 Carr. & Ins. 10/-

THE "TUDOR" STEREO AMPLIFIER

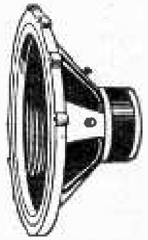


PRICE £15.0.0 (Packing & Carr. 7/6)

A self-contained Shelf-mounting Amplifier designed to provide high quality stereophonic and monophonic reproduction. Each channel provides a rated output of 6 watts and for monophonic operation approx. 12 watts is produced. Separate BASS and TREBLE CONTROLS. The Cabinet is finished in Black Crackle. Size 14 x 8 x 4in. Send for full specification.

PLESSEY 15in. P.M. LOUDSPEAKER

Ex B.B.C.



A high quality 15in. loudspeaker, handling 20 watts of audio. Suitable for use in public address systems where considerable power is handled, or as a bass reproducer in dual or triple loudspeaker systems where full use can be made of the low fundamental resonance and smooth response.

Impedance	15 ohms at 400 c/s.
Dia. of pole piece	2 inches
Power rating	20 watts
Flux density	12,000 lines
Total flux	185,000 Maxwells
Bass resonance	25 C.P.S.
Frequency range	20 C.P.C. to 5 Kc/s.
Nett weight	251¾ oz.

PRICE 12 gns. Carr. & Ins. 10/6 extra

Our Technical dept. will be happy to advise on the choice of matching PICK-UPS, Microphones, Loudspeakers.

Send for current price list of all leading recording tapes and accessories

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HALF TRACK

B.S.R. TD2 Monardeck, latest model 5¾in. spool £9.9.0
Deposit £1.0.0 and 9 monthly £1.1.0

Tape Amplifier for B.S.R. deck, printed circuit ready wired, with ECC83, ECL82, EM85 and EZ81. Complete with all plugs, sockets, panels, knobs, etc. The whole amplifier mounts on to the deck, making a self-contained unit .. £8.8.0
Deposit £1.0.0 and 8 monthly £1.1.0

Case with 7in. x 4in. speaker in two tone grey £4.4.0

Complete Kit as above £22.0.0
Deposit £2.4.0 and 12 monthly £1.16.6

The above recorder can be supplied assembled, tested and complete with tape and microphone for £25.0.0
Deposit £2.10.0 and 12 monthly £2.1.6

Collaro Studio Deck. Very latest model 3 speeds 7in. spools £12.10.0
Deposit £1.5.0 and 12 monthly £1.0.8

Tape Amplifier for studio deck, with ready wired printed circuit control and input panels, mains and output transformers. Complete with valves, knobs, plans, screws, etc. EF86, ECC83, EM84, EZ81, OA81 and 2 EL84, 3 watts output. Magic eye, radio and mic. inputs, EX L/S socket, tone and monitor controls. Can be used as an amplifier £11.11.0
Deposit £1.4.0 and 12 monthly 19/-

Case for above including 9in. x 5in. speaker £5.5.0

Total Kit as above £29.0.0
Deposit £2.18.0 and 12 monthly £2.8.2

We can offer the above recorder, complete with tape and microphone, in a De Luxe two tone grey cabinet, assembled for £35.0.0
Deposit £3.10.0 and 12 monthly £2.18.2

This Machine is listed at 39 gns. by makers and is a very good buy.
Building Instructions available at 2/6 each kit (refunded if kit bought)

QUARTER TRACK

B.S.R. TD2 .... £11.11.0
Deposit £1.4.0 and 12 monthly 19/-

Tape Amplifier as above, but quarter track £9.9.0
Deposit £1.0.0 and 9 monthly £1.1.0

Case, two tone grey, with speaker £4.4.0

Complete Kit as above £25.0.0
Deposit £2.10.0 and 12 monthly £2.1.6

Collaro Studio Deck, 4 track £17.17.0
Deposit £1.17.6 and 12 monthly £1.9.5

Tape Amplifier, as above, but 4 track £12.12.0
Deposit £1.7.0 and 12 monthly £1.0.8

Case with 9in. x 5in. speaker £5.5.0

Complete Kit 4 track Collaro £35.0.0
Deposit £3.10.0 and 12 monthly £2.18.2

Tape Pre-amplifier for Collaro deck, with power supplies, ECC83, ECL82, EZ80 and EM85 Radio and Mic. sockets, gives an equalised output of 400 m/Volts.

Half Track £8.8.0
Deposit £1.0.0 and 8 monthly £1.1.0

Quarter Track £9.9.0
Deposit £1.0.0 and 9 monthly £1.1.0

Bradmatic R/PB and Erase on Collaro bracket ½ track £1.19.6

Bradmatic R/PB Ideal 3rd head Collaro deck ¼ track £1.12.6
Pressure pad (Studio deck only) 4/0

Brenell Mk.5 deck, ½ track, 4 speeds £29.8.0
Deposit £3.1.6 and 12 monthly £2.8.7

Brenell Mk. 5 Amplifier, with power £24.0.0
Deposit £2.8.0 and 12 monthly £1.19.10

JASON F.M. TUNERS

FMT1, complete with valves £6.17.6
Deposit £1.1.0 and 6 monthly £1.2.9

FMT2, complete with valves, Less Power £7.17.6
Deposit £1.0.0 and 7 monthly £1.2.6

FMT2, complete with valves, Self powered £9.15.0
Deposit £1.0.0 and 9 monthly £1.1.8

FMT3, complete with valves, Less power £9.12.6
Deposit £1.0.6 and 9 monthly £1.1.4

FMT3, complete with valves, Self powered £12.0.0
Deposit £1.4.0 and 12 monthly 19/10

Power pack kit ready drilled chassis for FMT1, etc. £2.12.6
The instruction books are included in all kits but are otherwise 2/6.

JTV/2, switched F.M. and TV. Sound self powered. All valves £14.15.0
Deposit £1.9.6 and 12 monthly £1.4.5

Mercury 2 as JTV/2 but less power, with all valves £10.15.0
Deposit £1.1.6 and 12 monthly 17/10
The instruction book is again included but is otherwise 3/6.

All the above units are available ready built and aligned. Price on request.

RADIO TUNERS

Armstrong T4 C, V.H.F. Tuner self powered £17.19.0
Deposit £1.19.6 and 12 monthly £1.9.5

Armstrong ST3 Mk2, AM/FM self powered £25.12.0
Deposit £2.13.0 and 12 monthly £2.2.4

Armstrong AF208 AM/FM Radio chassis, Bass and Treble controls. P.U. inputs etc. £21.4.0
Deposit £2.6.0 and 12 monthly £1.14.10

Armstrong Jubilee Mk2. AM/FM Push Pull Output stage. Bass and Treble £28.5.0
Deposit £2.16.6 and 12 monthly £2.6.11

Armstrong Stereo 55, AM/FM Radio chassis, with stereo gram. Bass and Treble etc. £29.18.0
Deposit £3.2.6 and 12 monthly £2.9.5

Armstrong Stereo 12 Mk2, AM/FM Radio chassis, Stereo gram. Push pull output £40.5.0
Deposit £4.0.6 and 12 monthly £3.6.11

Brass escutcheon available for AF208 and Jub. Mk2 .... 7/6

Pye HFT109. FM tuner self powered £23.12.6
Deposit £2.9.6 and 12 monthly £1.19.0

Pye HFT113. AM/FM Tuner self powered £28.7.0
Deposit £2.18.6 and 12 monthly £2.6.11

Quad F.M. Tuner un-powered £24.18.9
Deposit £2.13.3 and 12 monthly £2.1.1

AMPLIFIERS (MONO)

Linear L45 Three valve amplifier £5.19.6

Linear Diatonic Five valve, push pull £12.12.0
Deposit £1.7.0 and 12 monthly £1.0.8

Linear Concord 30 watt with case £18.0.0
Deposit £1.16.0 and 12 monthly £1.9.10

Tripletone Hi Fi Major, with Pre-amp £15.18.9
Deposit £1.15.3 and 12 monthly £1.6.1

Pye Mozart, including Pre-amp, 10 watt £25.4.0
Deposit £2.10.6 and 12 monthly £2.1.11

Leak TL 12. Main amp. only 10 watt £18.18.0
Deposit £2.0.6 and 12 monthly £1.11.1

Leak Varislope 111 Pre-amplifier £15.15.0
Deposit £1.11.6 and 12 monthly £1.6.1

Quad Main amp. only 15 watt £22.10.0
Deposit £2.5.0 and 12 monthly £1.17.4

AMPLIFIERS (STEREO)

Dulci AC202. Integrated £12.12.0
Deposit £1.7.0 and 12 monthly £1.0.8

Dulci GA505. Integrated £18.18.0
Deposit £2.0.6 and 12 monthly £1.11.1

Rogers Cadet Mk2. with Pre-amplifier £26.15.0
Deposit £2.13.6 and 12 monthly £2.4.5

Leak Stereo 20 Main amplifier £30.9.0
Deposit £3.4.6 and 12 monthly £2.10.3

Leak Varislope 111 Stereo Pre-amplifier £25.0.0
Deposit £2.10.0 and 12 monthly £2.1.6

Quad 22 Stereo Control unit, Pre-amplifier £25.0.0
Deposit £2.10.0 and 12 monthly £2.1.6

GRAMOPHONE UNITS

Garrard SRP10, with G.C8 Mono Cartridge £5.9.11

B.S.R. UA14 TC8 cartridge £6.19.6
Deposit £1.0.0 and 6 monthly £1.8.2

Garrard Autoslim Mono cartridge £7.17.0
Deposit £1.0.0 and 7 monthly £1.2.6

Garrard Autoslim De Luxe Mono cartridge £11.9.0
Deposit £1.6.6 and 9 monthly £1.4.9

Philips AG1016 with Stereo cartridge £12.12.0
Deposit £1.7.0 and 12 monthly £1.0.8

Decca Deram Arm only £5.5.0
Decca Deram Transcription cartridge £4.14.6
Decca Deram Auto cartridge £3.13.6

Goldring GL53, with arm, less cartridge £15.19.8
Deposit £1.12.0 and 12 monthly £1.6.6

Goldring '88' Transcription, no pick up £17.14.0
Deposit £1.19.0 and 12 monthly £1.9.0

Goldring GL55X as GL58 but less P.U. arm £13.1.7
Deposit £1.7.7 and 12 monthly £1.1.6

Garrard 4HF with Mono cartridge £17.0.0
Deposit £1.14.0 and 12 monthly £1.8.2

Garrard Lab. Type 'A' Auto-changer. Mono £19.14.9
Deposit £1.19.6 and 12 monthly £1.12.9

Garrard 301 .... £20.12.2
Deposit £2.3.2 and 12 monthly £1.14.0

Garrard 301 Strobe £22.0.0
Deposit £2.4.0 and 12 monthly £1.16.6

LOUDSPEAKERS

Goodmans Axiette 8 .... £5.5.7
Goodmans Axiom 10 .... £6.5.11
Goodmans Axiom 201 .... £10.7.0
Deposit £1.1.0 and 8 monthly £1.5.9

Goodmans 5H/20/XL Tweeter with cross over £7.0.0

Wharfedale RS12/DD 12in. full range £11.10.0
Deposit £1.7.6 and 9 monthly £1.4.9

Whiteley Electrical W.B. H.F. 1012 10in. £4.7.6

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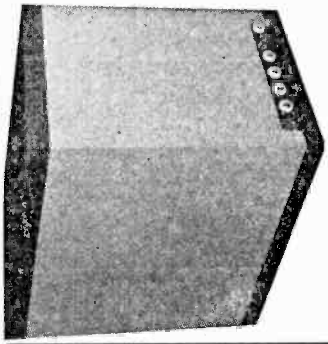
THE R.S.C. BASS-MAJOR 30 WATT GUITAR AMPLIFIER



A MULTI-PURPOSE HIGH FIDELITY, HIGH OUTPUT UNIT FOR VOCAL AND INSTRUMENTALIST GROUPS

Eminently suitable for bass guitar and all other musical instruments

- ★ Incorporating two 12in. heavy duty 25-watt high flux (17,000 lines) loudspeakers with 2in. diameter speech coils. Designed for efficiently handling full output of amplifier at frequencies down to 25 c.p.s.
- ★ Dual Cone in second speaker reproduces frequencies up to 17,000 c.p.s.
- ★ Heavily made cabinet of convenient size 24 x 21 x 14in. has an exceptionally attractive covering in two contrasting tones of Vynair.
- ★ For 200-250 v. to 50 c.p.s. A.C. mains operation.
- ★ Four jack socket inputs and two independent vol. controls for simultaneous connection of up to four instrument pick-ups or microphones.
- ★ Separate bass and treble controls providing more than adequate "Boost" or "Cut".
- ★ LEVEL frequency response throughout the audible range.
- ★ SUPERIOR TO UNITS AT TWICE THE COST.

39½ Gns. Send S.A.E. for leaflet. OR DEPOSIT of £4.3.0 and 12 monthly payments of £3.9.11. Carr. 17/6.

R.S.C. JUNIOR GUITAR AMPLIFIER 5-watt high quality output. Separate bass and treble "cut" and "boost" controls. Sensitivity 15 m.v. Two high impedance inputs. 10in. loudspeaker. Handsome, strongly made cabinet (size 14 x 14 x 7in. approx.) finished in attractive and durable polychrome. 200-250 A.C. mains operation. **£8.19.6** Or DEPOSIT £1 and 9 monthly payments of £1. Carr. 7/6.

LINEAR TREMOLO/PREAMP. UNIT Designed for introducing the Tremolo effect to any amplifier which is fitted with a reserve power supply point for smoothed H.T. and 6.3 v. A.C. L.T. This applies to practically all amplifiers of our manufacture, and to those of several other manufacturers. The unit plugs into power supply point and any input socket of amplifier. Controls are Speed (frequency of interruptions). Depth (for heavy or light effect), Volume and Switch. Three sockets are for two inputs and Foot Switch. ONLY **4 Gns.**

LEICESTER BRANCH NOW OPEN

TRANSISTOR SALE. Mullard OC71 3/9. OC45 4/11, OC44 4/11, OC72 4/9, OC81 4/11. OC171 8/9, Ediswan XA101 3/9, XB102 3/9, XA112 3/9, XB113 3/9, XB104 3/9, XC101A 3/9. Postage 6d. for up to 3 Transistors.

D.C. SUPPLY KIT. 12 v. 1 a. consisting of a partially drilled metal case, mains trans., F.W. Bridge Rectifier, 2 fuseholders and fuses. Change Direction switch, variable Speed regulator and circuit. For 200-250 v. A.C. mains. Suitable for Electric Trains. Limited number available at 29/11.

SELENIUM RECTIFIERS

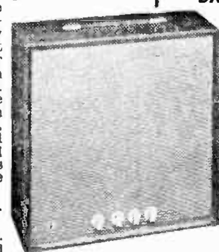
F.W. BRIDGE		24 v. 2 amp.	14/9
6/12 v. 1 a.	3/11	24 v. 20 amp.	89/9
6/12 v. 2 a.	6/11	H.T. TYPES H.W.	
6/12 v. 3 a.	9/9	150 v. 40 mA	3/9
6/12 v. 4 a.	12/3	250 v. 50 mA	3/11
6/12 v. 6 a.	15/3	250 v. 60 mA	4/11
6/12 v. 10 a.	26/9	250 v. 80 mA	5/11
6/12 v. 15 a.	35/9	250 v. 250 mA	11/9

CONTACT COOLED. 250 v. 75 mA. F.W. (Bridge). 10/11. 250 v. 50 mA. F.W. (Bridge). 8/11. H.W. 250 v. 60 mA. 5/11.

LINEAR TAPE PRE-AMPLIFIER Type LP/1, Switched Negative feedback equalisation Positions for Record 1⅞in. 3¾in., 7½in. and Playback. EM84 Recording Level Indicator. Designed primarily as the link between a Collaro Tape Transcriptor and a high fidelity amplifier, but suitable for almost any Tape Deck. Only 9 gns. S.A.E. for leaflet.

HUGE PURCHASE OF BRAND NEW 24 v. 20 Amp. F.W. (Bridge) SELENIUM RECTIFIERS. each **49/9**

R.S.C. SENIOR Guitar Amplifier 14 watt high-fidelity push-pull output. Separate bass and treble "cut" and "boost" controls. Twin separately controlled inputs so that two instruments or "mike" and pick-up can be used at the same time. Two loudspeakers are incorporated, a 12in. high flux 14 watt bass unit, and a 6 x 4in. elliptical for treble. Cabinet is well made and finished as Junior Model. Size approx. 18 x 18 x 8in. Only **16 Gns.** Carr. 10/- Send S.A.E. for leaflet. Or DEPOSIT 37/- and nine monthly payments of 37/-.



HEAVY DUTY LOUDSPEAKERS IN SUBSTANTIAL REXINE COVERED CABINETS. Type BG1. Suitable for Bass Guitar. Speak Unit 15in., High Flux, 15 ohms, 25 watts. Cabinet size approx. 24 x 21 x 13in. Only 19½ gns. Or Deposit 42/- and 12 monthly payments of 34/9. Type BG2. Suitable for Bass Guitar. Super Sensitive, 15in. 15 ohms high flux speaker. Cabinet size approx. 30 x 21 x 14in. Attractive covering of two contrasting tones of Rexine and Vynair. Rating 50 watts. Only 29 gns. Or Deposit £3.7.6 and 12 monthly payments of 50/-. Type BG3/2. Suitable Bass and Lead Guitar. Two 12in. high flux 15 ohm 25 watt speakers, one with aluminium speech coil and dual cone to provide smooth frequency response from 25 to 17,000 c.p.s. Cabinet size approx. 30 x 21 x 14in. Covered in two contrasting tones of grey Vynair and Rexine. Rating 50 watts. Only 29 gns. Or Deposit £3.7.6 and 12 monthly payments of 50/-.

LARGE REXINE COVERED SPEAKER CABINETS. Heavy blockboard construction. Very attractive two tone covering of Rexine and Vynair. Size 30 x 21 x 16in. cut for 15in. or 18in. speaker or for two 12in. 11 gns. or Deposit 25/9 and nine monthly payments 25/9. Size 30 x 30 x 16in. cut for 15in. or 18in. speaker 13 gns. or Deposit 30/4 and nine monthly payments 30/4. Suitable speakers available.

FANE ACOUSTICS 15in. HEAVY DUTY LOUDSPEAKER. High flux, 15 ohm 25 watt. Total flux 186,000 lines. Cast chassis. Suitable for Bass Guitar. Only 13 gns. or Deposit 31/6 and nine monthly payments 31/6.

EXTRA HEAVY DUTY 15in. Type 153. 40 watts. Total flux 375,000 lines. Extremely high sensitivity. 15 ohm voice coil. Only 18 gns. or Deposit 35/- and 12 monthly payments 35/-.

ANNOUNCING THE R.S.C. B20 BASS GUITAR AMPLIFIER

A highly efficient unit incorporating a massive 15in. high flux loudspeaker specially constructed to withstand heaviest load conditions. Rating 25 watts. Individual bass and treble controls give ample "boost" and "cut". Two high impedance jack socket inputs are separately controlled. All controls are conveniently positioned in a recess on top of the cabinet. Cabinet is of substantial construction and attractively finished in two contrasting tones of Rexine and Vynair. Size approx. 24 x 21 x 13in. Operation from 200-250 v. 50 c.p.s. A.C. mains. Send S.A.E. for leaflet.

29½ Gns Or Deposit £3.2.0 and 12 monthly payments of 56/10. Carr. 17/6.

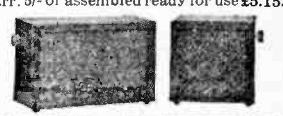
EX. GOVERNMENT ACCUMULATORS. Size 7¾ x 4 x 2in., 2 v. 16 A.H. brand new, 6/9 each, 3 for 15/6.

EX. GOVT. SMOOTHING CHOKES. 200 mA, 3-5 H, 50 ohms. Parmeko 8/9; 150 mA, 10 H, 50 ohms 9/9; 80 mA. 20 H, 900 ohms 5/9; 120 mA, 12 H, 100 ohms 8/9; 50 mA. 50 H, 1,000 ohms 6/9; 100 mA. 10 H, 100 ohms 6/9: 60 mA, 5-10 H, 250 ohms 2/11.

COMPLETE POWER PACK KIT. 19/11 Consisting of Mains Trans., Metal Rectifier. Double electrolytic, smoothing choke chassis and circuit. For 200-250 v. A.C. mains. Outputs 250 v., 60 mA. 6.3 v. 2 a.

R.S.C. POWER PACK, 39/9. Louvred metal case only 8 x 5½ x 2¾ins. Stove enamelled. For 200-250 v. A.C. mains Output at 4 pin plug and socket 250 v. 60 mA, fully smoothed and 6.3 v. 2 a. Suitable for power requirements of almost any Pre-amp or Radio Tuner.

R.S.C. BABY ALARM or INTER-COMM. KIT. Complete set of parts with diagrams, etc. Housed in two polished walnut finished cabinets of pleasing design. High sensitivity. For 200-250 v. A.C. mains. Fully isolated. Controllable at both units. An Intercomm. of this class would normally cost £20-£30. Only 79/6, carr. 5/- or assembled ready for use £5.15.0.



EX. GOVT. SELENIUM RECTIFIERS 12v 15 AMP (BRIDGE) F.W. ONLY 19/9

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AUDIOTRON HI-FI TAPE RECORDER KIT 25½ GNS. Carr. 17/6.

REALISM AT INCREDIBLY LOW COST, CAN BE ASSEMBLED IN AN HOUR

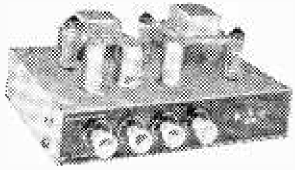
Incorporating the latest Collaro Studio Tape Transcriptor. The audiotrine High Quality Tape Amplifier with negative feedback equalisation for each of 3 speeds. High Flux P.M. Speaker, empty Tape Spool, a Reel of Best Quality Tape and a Handsome Portable carrying Cabinet with latest attractive two-tone polychrome finish, size 14½ x 15 x 8½in. high and circuit. Total cost if purchased individually approximately £40. Performance equal to units in the £60-£80 class. S.A.E. for leaflets. **TERMS.** Deposit £2.13.9 and 12 monthly payments of 44/-. Cash price if settled in 3 months.

ONLY 3 PAIRS OF SOLDERED JOINTS PLUS MAINS

SPECIAL NOTE. The Tape Decks we supply are latest models. Where customers already have a Deck or wish to use one of those being offered cheaply we can supply Kit less Deck at 13 gns. carr. 10/-. Or deposit 2 gns. and 12 monthly payments 23/9. Also if required we can supply in lieu of portable cabinet and 7 x 4in. speaker, the Equipment Cabinet illustrated at foot of opp. page and a high flux 8½ x 5½in. speaker for 8½ gns. extra.

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES

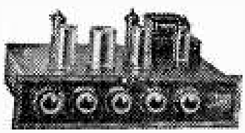


Two input sockets with associated controls allow mixing of "mike" and gram., as in A.10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, EZ81. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut". Frequency response ± 3 D.B. 30-30,000 c/s. Six negative feedback loops. Hum level 60 D.B. down. ONLY 23 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING, BASS, LEAD OR RHYTHM GUITARS,** etc. **OUTPUT SOCKET** with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12-9-7in. For A.C. mains 200-250 v. 50 c.p.s. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Only **8 Gns.** Carr. 10/- (Or factory built 51/- extra.)
If required louvred metal cover with 2 carrying handles can be supplied for 18/9. **TERMS ON ASSEMBLED UNITS. DEPOSIT** 24/9 and 9 monthly payments of 24/9. Send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets. Speaker. Microphones, etc., with cash and credit terms.

B.S.R. MONARDECK TAPEDECKS. Speed 3¾in. per sec. With high quality recording heads. £6.19.6. Carr. 5/-. Cabinets to take Deck and amplifier 39/6.

R.S.C. TRANSISTORISED GRAM. AMPLIFIER. Output 1 watt, for 3ohm speaker. Transistors Mullard OC71, OC81D, OC81, OC81. Fitted Vol. Control with switch. Assembled and tested. Suitable for any normal crystal pick-up. Only 59/9.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER



A complete set of parts for the construction of a stereophonic amplifier giving 5 watts high quality output on each channel (total 10 watts). Sensitivity is 50 millivolts, suitable for all crystal stereo heads. Ganged Bass and Treble Control give equal variation of "lift" and "cut". Provision is made for use as straight (monaural) 10-watt amplifier. Valve line-up ECC83, ECC83, EL84, EL84, EZ81. Outputs for 2-3 ohm speakers. Point-to-Point wiring diagrams and instructions supplied. Send S.A.E. for leaflet. **8 Gns.** Full constructional details and price list 2/6. Carr. 10/-.
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HI-FI CRYSTAL PICK-UP HEADS. (Cartridges.) Acos Standard replacement for Garrard, B.S.R. and Collaro, 16/9. Acos Stereo-Monaural 29/9. Ronette Stereo-Monaural 59/6. B.S.R. Stereo 39/9. **BRADMATIC RECORDING HEADS.** High Impedance Record/Playback 22/-. Low Impedance Erase, 12/6. **PICK-UP ARMS.** Complete and with latest Acos/hi-fi Turnover Cartridge 29/11. **CRYSTAL MICROPHONES.** Hand type NP110 14/9, R.T.C. 19/9, Acos Mic 40 25/9, Acos Mic 45 29/9, Stick type Acos 39-1 39/9, BM3 with neck band and heavy table stand 59/9. Lapel type 35/9. **COLLARO JUNIOR** 4-speed, Single Player Unit and Crystal Pick-up with hi-fi Turnover head. Only £3.19.6. **B.S.R. UA14 4-sp'd AUTO-CHANGERS** with hi-fi turnover head, £6.19.6. Carr. 4/6. **GARRARD AUTO-SLIM 4-SPEED AUTO-CHANGER** with high fidelity pick-up. Latest model For 200-250 v. A.C. mains. £7.19.6. Carr. 4/6. **GARRARD AT6 AUTO-SLIM DE-LUXE 4-SPEED AUTO-CHANGERS.** Turnover GC8 head, for 200-250 v. A.C. mains. 11 gns. **GL3A MINIATURE 2-3 WATT GRAM AMPLIFIER.** For use with any single or auto-change unit. Output for 2-3 ohm speaker. For 200-250 v. A.C. mains. Size 11½ x 2½ x 2¾in. Controls: Vol. and Tone with switch. Only 59/6.

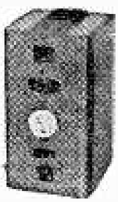
R.S.C. BATTERY CHARGING EQUIPMENT

All for A.C. Mains 200-250v., 50 c/s. Guaranteed 12 months.

HEAVY DUTY CHARGER KIT 6/12 v. 6 amps. variable output. Consisting of Mains Transformer 0-200-230-250 v.; F.W. (Bridge) Selenium Rectifier; Ammeter, Variable Charge Rate Selector Panels, Plugs, Fuses, Fuseholder and circuit, 59/9. Carr. 4/6.

CHARGER KIT, 12v. 14 AMP or 24v. 7 amp. Consisting of mains trans. 200-230-250 v. F.W. (Bridge) selenium Rectifier, F Ammeter, Fuses, Variable Resistor and Circuit. Only 6 gns. Carr. 15/-. Please state if 12v. or 24v. kit required.

SOLDERING IRONS. 230-250 v. 30 watts. First quality. For Radio work, 18/9. Spare elements and bits available.



Assembled 4-5 amps 6/12 v.
Fitted Ammeter and variable charge rate selector. Also selector plug for 6 v. or 12 v. charging. Louvred steel case with stoved blue hammer finished. Fused and ready for use with mains and output leads. **69/9** Carr. 5/-. Terms: Deposit 13/3 and 5 monthly payments 13/3. 6/12 v. 3a., all facilities as above. Only 59/9, carr. 3/9.

ASSEMBLED 6/12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case finished attractive hammer blue. Fused, ready for use with mains and output leads **49/9** Carr. 3/9
6/12 v. 1 amp. 27/9 Less meter.

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BATTERY CHARGER KITS Consisting of Mains Transformer. F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses. Fuse-holders. Grommets, panels, Heavy Duty Clips, circuit. Carr. 3/6 extra
6v. or 12v. 1 amp 22/9
As above, with Ammeter 28/9
6 v. 2 amps 19/9
6v. or 12v. 2 amps 25/9
6 v. or 12 v. 2 amps, inclusive of Ammeter 35/9
6 v. or 12 v. 4 amps 45/9
6 v. or 12 v. 4 amps. with Ammeter and variable charge rate selector 52/9

CHARGER AMMETERS 0-1.5 a., 0-3 a., 0-4 a., 0-7 a., 0-60 a., 8/9.

R.S.C. MAINS TRANSFORMERS (FULLY GUARANTEED)

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250-0-250v. 70mA. 6.3v. 2a. 0-5-6.3v. 2a 17/9
350-0-350v. 80mA. 6.3v 2a, 5v. 2a .. 18/9
250-0-250v. 100mA. 6.3v. 2a, 6.3v. 1a .. 21/9
250-0-250v. 100mA. 6.3v. 3.5a, C.T. .. 19/9
250-0-250v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a 25/9
300-0-300v. 130mA. 6.3v. 4a, 6.3v. 1a, for Mullard 510 Amplifier 29/9
300-0-300v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a 26/9
350-0-350v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a 26/9
350-0-350v. 150mA. 6.3v. 4a, 0-5-6.3v. 3a 29/9
425-0-425v. 200mA. 6.3v. 4a, 5v. 3a .. 49/9
FULLY SHROUDED UPRIGHT
250-0-250v. 60mA. 6.3v. 2a, 0-5-6.3v. 2a, Midget type 2½-3-3in. 17/11
250-0-250v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a 27/9
300-0-300v. 100mA. 6.3v. 4 a. 5v. 3a 27/11
300-0-300v. 130mA. 6.3v. 4a, C.T. 6.3v. 1a, for Mullard Amplifier .. 33/9
350-0-350v. 100mA. 6.3v. 4a, 5v. 3a 27/11
350-0-350v. 150mA. 6.3v. 4a, 5v. 3a .. 35/9

FULLY SHROUDED (continued)—
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425-0-425v. 200mA. 6.3v. 4a, C.T., 6.3v. 4a, C.T., 5v. 3a 59/9
450-0-450v. 250mA. 6.3v. 4a, C.T. 5v. 3a 69/9
OUTPUT TRANSFORMERS
Midget Battery Pentode 66 : 1 for 3S4, etc. 4/6
Small Pentode, 5000Ω to 3Ω 4/6
Small Pentode 7/8,000Ω to 3Ω .. 4/6
Standard Pentode 5,000Ω to 3Ω .. 5/9
Standard Pentode 7,000Ω to 3Ω .. 5/9
10,000Ω to 3Ω 5/9
Push-Pull 8 watts, EL84, or 6V6 to 3Ω or matched to 15Ω 9/9
Push-Pull 10-12 watts to match 6V6 or EL84 to 3-5-8 or 15Ω 19/9
Following types for 3 and 15Ω speakers:
Push-Pull 10-12 watts 6V6 or EL84 .. 18/9
Push-Pull 15-18 watts, 6L6, KT66 .. 22/9
Push-Pull Mullard 510 Ultra Linear . 29/9
Push-Pull 20 watts, sectionally wound, 6L6, KT66, EL34, etc. .. 49/9

MIDGET MAINS Primaries 200-250 v. 50 c/s. 250 v. 60 mA, 6.3 v. 2a. 11/9
250-0-250 v. 60 mA. 6.3 v. 2a .. 12/11
Both above size 2½ x 2½ x 2½ins.
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150 mA. 7-10 H H 250 ohms .. 11/9
100 mA. 10 H 200 ohms 8/9
80 mA. 10 H 350 ohms 5/9
60 mA. 10 H 400 ohms 4/11
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All with 200-230-250 v. 50 c/s Primaries; 0-9-15 v. 1½ a. 12/9; 0-9-15 v. 2a, 14/9; 0-9-15v. 3 a., 16/9; 0-9-15 v. 5a., 19/9; 0-9-15 v. 6 a. 23/9; 0-9-15 v. 8a. 28/9.
AUTO (Step up/Step down) TRANS. 0-110/120-230/250 v. 50-80 watts, 13/9; 250 watts, 39/9; 150 watts, 27/9.
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CR 66 COMMUNICATIONS RECEIVER ★ A CODAR KIT TRIUMPH

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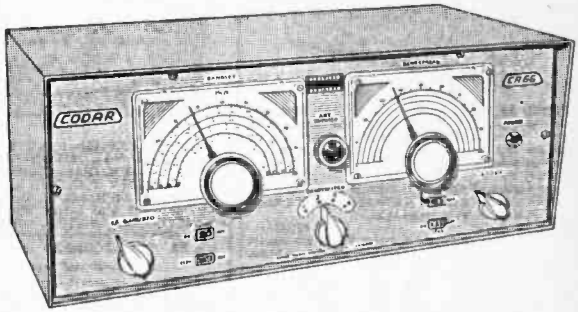

This completely new Communications Receiver with its many design features and handsome styling offers more in performance and quality than many higher priced units.

Frequency Range 540 Kc/s to 30 Mc/s in four Bandswitched ranges. Separate Main Tuning and Electrical Bandspread. Entirely new disign High "Q" ferrite cored Coils. Oscillator Coils fitted temperature compensated trimmers for stability. Coil Unit is wired and assembled, and with the I.F. Transformers is supplied factory aligned and tested. Low loss Trolex glass alkyd switch wafers. Controlled regenerative I.F. amp. for maximum gain and B.F.O. Panel Ant. Trimmer. Delayed A.V.C. Cathode follower output for tape recorder, etc. 3 watts output for external 2/3 ohm speaker. For panel slider switches. On-Off/Standby-Receiver/A.V.C. On-Off/Speaker On-Off Front Panel Silver and Black, control knobs Grey with Silver trim. Provision for EM 84 Signal strength indicator. Panel phone jack. Heavy gauge steel chassis, cadmium plated. Valve line-up: ECH81/EBF89/ECC81/EL84/EZ80. Instruction Manual, 17 pages. Cabinet size 16 x 6½ x 8¾ins. Silver Grey. For AC 200-250 volts. (Export and Marine Model 115 volts).

Total cost of complete Kit, less Cabinet and Indicator **£16.10.0** carr. 6/-. CR 66 Cabinet **£1.15.0** Signal strength indicator with EM84 **17/6**

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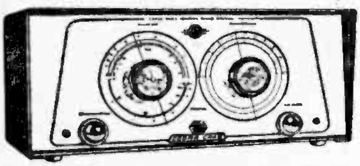
THE NEW CR 45 ★ *NEW STYLING TOP PERFORMANCE*



- ★ Tunes 10-2000 metres (5 Coils).
- ★ Separate electrical bandspread.
- ★ Three slow motion vernier drives.
- ★ Low loss polystyrene plug-in coils, factory aligned.
- ★ Dials calibrated in frequencies and degrees.
- ★ Power output 3 watts for 2/3 ohm speaker.
- ★ Valve line-up: ECC81/EL84/EZ80.
- ★ Front Panel Silver and Black, control knobs Grey.
- ★ Provision for panel phone jack.

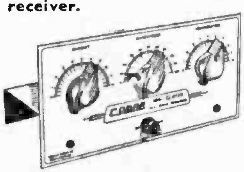
Superb styling. World-wide reception. Total building cost, with 2 Coils, 25-75 and 60-175 metres. Instruction Manual 11 pages, less Cabinet **£6.19.6** carr. 3/6.

CR 45 Cabinet Silver Grey, 12 x 5¼ x 7in. sliding door for easy coil changing **27/6**. Extra coils, all ranges **4/9** each.

ALL PARTS AVAILABLE SEPARATELY

★ THE MINI-CLIPPER ★ 36/6

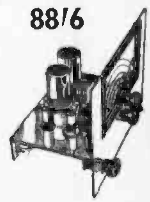
- ★ Tunes 10-2000 metres (5 coils).
- ★ Miniature I valve, all band receiver.
- ★ Low loss polystyrene plug-in coils, factory aligned.
- ★ Air spaced ball bearing condensers.
- ★ Provision to add two-transistor amplifier.
- ★ Battery lasts months.



Can be built in an evening, will receive Amateur and Broadcast stations from all parts of the world. Total building cost with one coil 25-75 metres, Instruction Manual 4 pages, 36/6, carr. 2/6. Extra coils, all ranges, 4/9 each. Electrical bandspread available. All parts available separately.

★ THE SUPER CLIPPER ★ 88/6

- ★ Tunes 10-2000 metres (5 coils).
- ★ Large precision dial, dual slow motion drives.
- ★ Bandspread on all Bands.
- ★ High gain valve/transistor hybrid circuit.
- ★ 2 Mullard transistor amplifiers, pre-assembled and tested.
- ★ Low loss polystyrene plug-in coils, factory aligned.
- ★ Batteries last months.



Easy to assemble, this top performing All Band Receiver brings a new world of listening pleasure to your finger-tips at low cost. Total building cost with 2 Coils, 20-60 and 55-190 metres, Instruction Manual 7 pages, 88/6, carr. 2/6. Extra Coils, all ranges, 4/9 each. Front Panel, Silver Grey, 10 x 7½in.. 6/9.

Please note NEW address. We have now acquired new modern premises, combining all depts., offices and laboratories. New equipment under development will be announced in due course. Now available P.R.30 R.F. Preselector 1.5/30 Mc/s., greatly improves performance of any superhet receiver. CODAR Equipment is famous for Top Quality, Peak Performance and Easy-to-Follow Instructions—no guesswork. 6d. in stamps brings illustrated leaflets. Coming shortly, 70 watt 5 Band Transmitter Model No. CT80.

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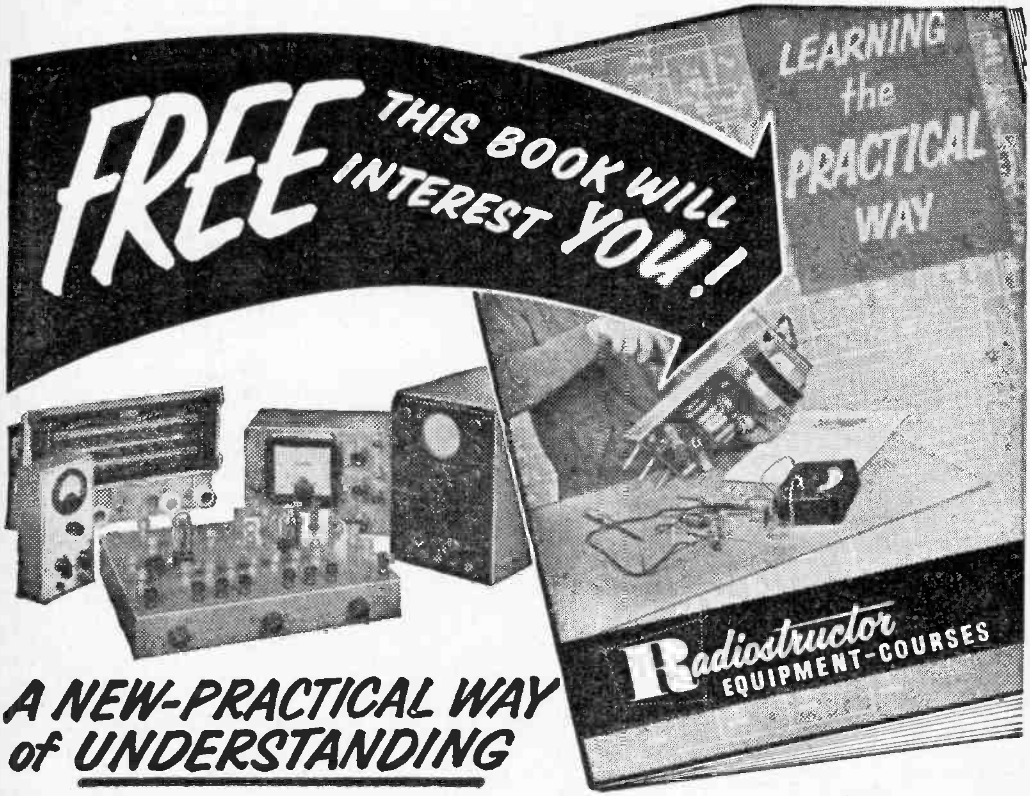
G3IRE Canadian Distributors: JAYCO ELECTRONICS, TWEED, ONT. G3IPA



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Practical Wireless

Vol. XXXIX No. 678 AUGUST, 1963

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Contents

The Bright Side

IN the July Editorial we briefly discussed some of the keys to successful construction. As a corollary it might be useful to consider some aspects of failure.

The average piece of equipment built by the average constructor (assuming that either of these really exist!) generally functions satisfactorily; if not at first, at least after eliminating initial troubles. But there are also the failures.

Among these are some that can never hope to be converted into workable apparatus. These are often experimental hook-ups in which the chances of complete success was a calculated risk. But there are also efforts so poorly constructed that the only real hope lies in complete reconstruction.

Readers with little experience or knowledge can take heart that even the most advanced enthusiast cannot deny his quota of monumental flops! It is understandably frustrating when the result of hours of work culminates in an infuriating collection of components that steadfastly refuse to co-operate and do the job they were assigned. But there is, strangely, a bright side to all this.

Just as troubles are said to be sent to try us, so it might be claimed that unsuccessful home-built equipment is sent to teach us. For no piece of apparatus fails to work for any sinister motive. There must be a logical reason. And the enthusiast who adopts a philosophical attitude, refuses to be flustered and is willing to probe, has the key to future success in his hands.

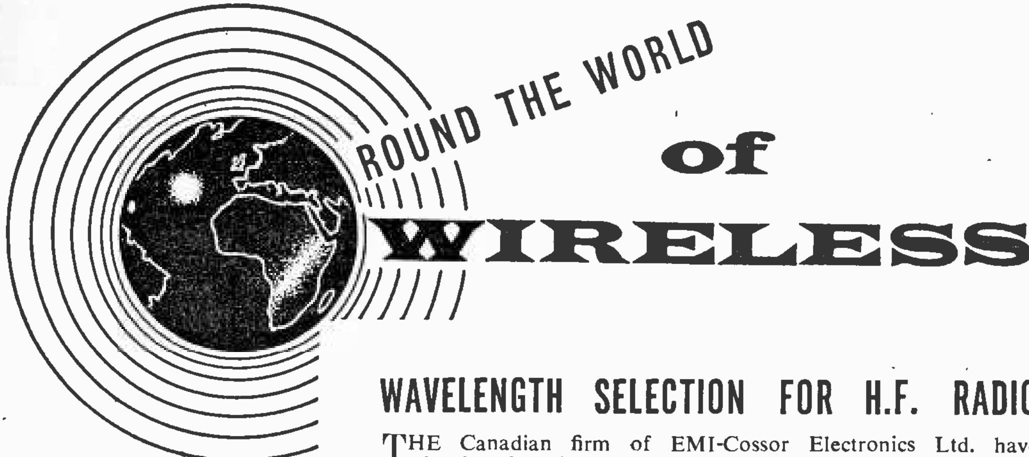
Most failures are a potential source of valuable information. In the case of the experimenter, he will have learned a good deal about the type of circuitry he has been trying out, and can either redesign and reconstruct on the lines suggested by the behaviour of his hook-up, or he can abandon the idea as impracticable. In either case he adds to his store of knowledge.

If a beginner has failed to build a piece of equipment from an already proven design he should think hard before considering stripping it down. Possible reasons are legion—dry joints, incorrect wiring, poor layout, faulty or inefficient components, etc.

In exploring the possibilities, a basic theoretical knowledge is obviously helpful, and for those likely to build more than an occasional item, a basic test meter and at least a rudimentary knowledge of its applications is essential.

It may be little consolation at the time, but when faced with a piece of equipment that refuses to work properly it is worth bearing in mind that although *everyone* makes mistakes, the range and extent of successful construction and design will be enhanced by learning the nature of these mistakes and not making the same ones twice!

Our next issue dated September will be published on August 7th



NEWS AT HOME AND ABROAD

Transatlantic Telephone Cable

THE first 600 nautical miles of the first direct submarine telephone cable between the U.S.A. and Britain is being layed by the G.P.O. cable ship HMTS Alert. Previous transatlantic cables have been made via Newfoundland, but this project (named TAT-3) joins Tuckerton, New Jersey and Widemouth, Cornwall, by a single cable link of 3,600 nautical miles—making it the longest in the world.

The cable for the TAT-3 project is being made by Standard Telephones and Cables Limited at Southampton. The cable will be laid by HMTS Alert and the American cable ship "Long Lines".

The TAT-3 cable system was designed. in the Bell Telephone Laboratories and will provide 128 transatlantic voice circuits.

WAVELENGTH SELECTION FOR H.F. RADIO

THE Canadian firm of EMI-Cossor Electronics Ltd. have developed equipment to determine rapidly the optimum wavelength for long range h.f. radio communication. Previously, lengthy trial and error methods only were available to forecast the results to be expected on any particular short wave band, which are so much influenced by the structure of the ionosphere. The new device (Ionosonde model 8000) is designed for use with existing transmitter/receivers.

In use, one Ionosonde at one point commences pulse transmissions, the frequency of which is rapidly changed in a series of 128 logarithmic steps to cover the band from 1·8 to 28·8Mc/s. At another point a second Ionosonde has a receiver which similarly steps and tunes through the same frequency steps in synchronisation with the first equipment. In this fashion the entire band is covered in just two seconds.

Pulses received at the second equipment are shown on the face of a long persistence screen c.r.t. by one or more dots appearing on vertical lines. Reception will be best at frequencies where just a single dot occurs—indicating no multipath.

Radio and Radar for New Airport

CONSTRUCTION on Kuwait's new International Airport has already begun eight miles from the city of Kuwait. As the airport will be capable of handling the latest jet aircraft, extensive radio and radar installations have been ordered. The contract for this equipment has been placed with a consortium formed by Marconi's Wireless Telegraph Company Limited and N. V. Philips Telecommunicatie Industrie.

This contract covers overall responsibility for the supply, installation and full commissioning of all radar, radio navigational aids and telecommunications equipment, together with the maintenance of the equipment during the first year of operation.

Equipment to be supplied by the Marconi Company includes airways surveillance and long range height-finder radars, together with display facilities for each. A Marconi v.h.f. direction finder will also be installed at the airfield. N. V. Philips Telecommunicatie Industrie are to supply h.t. transmitters and receivers, m.f. locator beacons, short range radio telephone system, mast, feeders and aerials, etc.

The total value of the contract exceeds £2½ million.

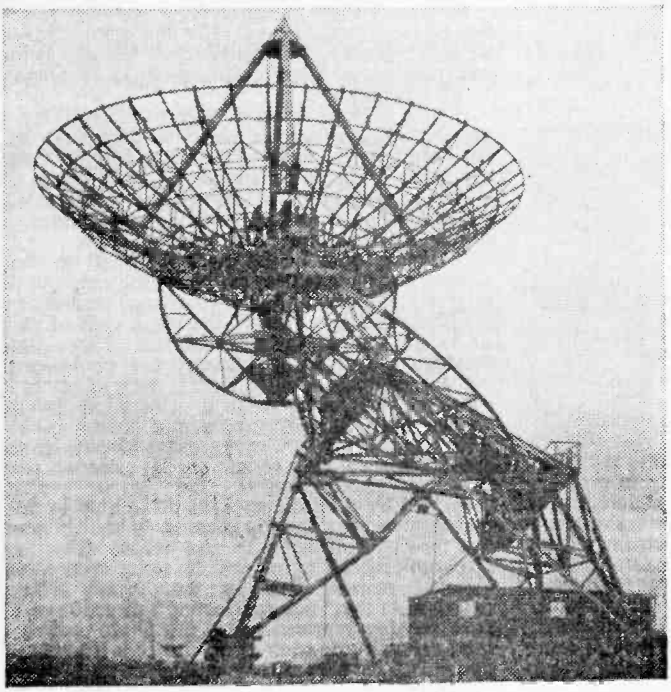
BRITISH EQUIPMENT AT POLISH TRADE FAIR

FIFTY-SEVEN British firms exhibited at the 32nd International Trade Fair held recently at Poznan, Poland, and among the exhibits, EMI Electronics Ltd. had on show their instrumention tape deck type TD4 which processes and stores information in analogue and digital forms. Another exhibit was the EMIac II analogue computer and a range of specialised valves and tubes was shown along with much tape and audio equipment.

CAMBRIDGE'S NEW RADIO TELESCOPE

A NEW radio telescope will shortly be in operation at the Mullard Radio Astronomy Observatory at Cambridge, adding greatly to the research being done by Professor Ryle and his colleagues of Cambridge University.

One movable and two fixed installations form the aerial system of the new telescope which has been financed by a grant of £542,000 by the Department of Scientific and Industrial Research. The three paraboloid aerials are mounted in line, on an E-W axis, the two outermost aerials being separated by a maximum distance of one mile. The dish of each aerial is 60ft in diameter and can be steered individually, although normally all three will be controlled in unison from a central control.



When in use, the signals received by the three aerials will be recorded and then combined in an electronic computer at the University. The results obtained will provide information about the Universe which would require an aerial with a dish of about one mile in diameter, if a single installation were employed. Professor Ryle's three aerial system, however, obtains these results more economically and without the very exacting engineering problems that would arise with a single paraboloid. Nevertheless, the accuracies called for in the construction of the new telescope were of a very high order, and the half-mile railway track of the movable aerial, for example, has been levelled to an accuracy of $\frac{1}{16}$in.!

The receivers and data recording equipment will be constructed by Cambridge University.

This illustration shows the central, fixed aerial of the new radio telescope at Cambridge. Underneath this aerial is its control building and just visible above the skyline is the movable aerial.

NEW COPPER MICROWIRE IS GLASS INSULATED!

INSULATED copper "microwire", 50 times thinner than a human hair, is now being produced in this country and is finding many uses wherever micro-miniaturisation is necessary. The insulation used is a glass sheath around the wire, and this has been made possible by research into new techniques made by Glass Developments Ltd.

Some of the gauges of wire produced are so fine that they cannot be seen by the naked eye and a 100-mile length would weigh only 1lb. So flexible is the wire that it is possible to coil it round a pin without damaging the glass cover.

Quantities of the wire are being exported to the U.S.A. where earlier attempts to produce a similar wire proved unsatisfactory.

Radar for Swedish Ships

RADAR equipments for four new vessels being built for a Swedish shipping firm, will be supplied by Associated Electrical Industries Ltd. Each ship will be fitted with two types of radar equipments, both designed and manufactured by the Electronic Apparatus Division of AEI.

Stereophonic Transmissions

ALTHOUGH the BBC recently concluded the second series of field trials of the Zenith-G.E. pilot-tone stereophonic system, using the Wrotham Third Programme transmitter, test transmissions continue on Wednesdays, with programme transmissions from 11 a.m. to 11.30 a.m. and tone test transmissions from 12 p.m. to 12.30 p.m.

The fortnightly experimental stereophonic transmissions on alternate Saturday mornings using the television sound channel and the v.h.f. and medium wave band Network Three frequencies are also continuing.

The Photophone

By M. L. Michaelis

Experiments with light waves - a new interest for the amateur electronics enthusiast.

LIGHT is a form of electromagnetic radiation, in no way whatsoever different from ordinary wireless waves except for a difference of wavelength and frequency. Thus, whereas ordinary wireless waves occupy a spectrum from a fraction of a metre to some thousands of metres, representing frequencies from a few kc/s to some thousands of Mc/s, visible light occupies altogether higher frequency bands and much shorter wavelengths. Thus yellow light has a frequency of some 600 million Mc/s (6×10^{14}c/s) and a wavelength of about half a millionth of a metre.

It is easy to understand why the wavelengths of visible light must be so short, once it is appreciated that the "transmitting aerials" are the tiny atoms themselves. The "receiving aerials" are, again atoms, normally special arrangements of these at the back of the human eye, which convert the energy of the incident light to corresponding *electric* signals going down the optic nerves to the brain.

This conversion of the energy of light, an electromagnetic radiation, into energy of electric currents in a receiving circuit is not only analogous to, but in fact *fully identical* to the function of a conventional wireless receiver.

Apart from the biological example of eyes, there exist purely electronic devices which "receive" light in this way, and these are called "photoelectric devices" or "photocells".

For various reasons beyond the scope of this article it is generally not practicable to frequency-modulate a beam of light for the purposes of transmitting intelligence along it in the usual manner, yet ordinary amplitude modulation is very easy indeed, even with the simplest mechanical or electromechanical devices.

All photocells give primarily a *d.c. output* which is a direct or logarithmic measure of the incident light intensity, this output therefore corresponding in every way to rectified carrier voltage at the detector-stage of an ordinary wireless set. In addition to this, all photocells give a greater or lesser a.c. output voltage corresponding to any amplitude modulation (intensity modulation) which the received light possessed.

Types of Photoelectric Devices

Photocells may be divided, very roughly, into two major groups of types. The first group includes virtually all semiconductor devices (*all* diodes and transistors, in addition to those specifically intended as photo-elements).

If the barrier layer of any semiconductor is illuminated, a voltage is generated across the barrier, and the resistance of the barrier in the "non-conducting" direction is reduced. Both effects are always present *together* in *any* semiconductor, and either may be used for providing signals into the subsequent registering circuitry.

However, both effects may be small in those devices not intended for photoelectric use, and are fully removed in ordinary transistors and diodes, rectifiers, etc. by virtue of the black coat of paint or other opaque exterior coating. Those semiconductors specifically intended for photoelectric use are manufactured in such a way as either to enhance the barrier-voltage generation (photo-elements) or the barrier-resistance change (photo-resistors). Thus ordinary conventional photographic exposure meters use special selenium rectifiers as photo-elements, the barrier voltage generated by the incident light being able to drive sufficient current directly through a built-in sensitive moving coil meter to give usable deflections. A photo-resistor is operated in series with a high external resistor from a d.c. supply voltage polarised in the "non-conducting" direction of the pure rectifier represented by the photo-resistor in total darkness. As soon as the device is illuminated, the resistance falls correspondingly, and a current flows to give a voltage drop across the external resistance, giving a measure of the incident light intensity. Both photo-elements and photo-resistors may be built directly as transistors, giving amplified effects in the collector current.

A feature which all these semiconductor devices have in common, apart from excellent sensitivity at (relatively) low impedance—i.e. good *power* output—is their relative sluggishness. Thus, if the incident light is amplitude-modulated, an a.c. output at usable effective sensitivity is generally limited to the lower audio frequencies. This is connected with the time needed for the barrier-effects to take place, and is also due to the high capacity represented by the barriers in many devices. However, more recent research has produced some semiconductor photo-devices capable of operating at much higher frequencies.

The second major group of photoelectric devices is given by the true "photo-*cells*", which are vacuum or gas-filled cold-cathode diode valves.

The gas-filled types again have a limited frequency response, on account of times needed for ionisation and de-ionisation effects in the gas filling, yet they usually cover at least the full hi-fi audio-spectrum. However, due to secondary effects in the gas-filling, these types bring dangers of non-linear response when demodulating light, if proper attention is not paid to circuit design.

This danger is very much less in the vacuum types, a good reward for the small price of slightly lower sensitivity. Furthermore, the frequency response of the vacuum types is limited only by the (very small) self-capacity, and the transit time of the electrons. Thus response up to many Mc/s is easily possible, which means, among other things, that very brief flashes of light are faithfully recorded. Thus, for example, the light/time characteristic of discharge lamps, photographic flash-tubes, etc., may be studied on an oscilloscope, using a vacuum-photocell circuit as detector.

Up to a certain maximum intensity of illumination, which is usually quite high, a vacuum-photocell is an extremely linear device, i.e. the output voltage is accurately proportional to the incident light intensity.

Characteristics of Photocells

All photocells, vacuum or gas-filled, are operated with a high anode or cathode load (one or several megohms) from a d.c. supply of normal polarity for diode conduction (anode positive to cathode, or cathode negative to anode), and having a voltage around 90. Higher voltages are not usable because of dangers of continuous or sawtooth-oscillation self-discharges. Lower voltages are inadvisable because the voltage drop across the anode or cathode load, representing the output signal, is then restricted before the effective remaining voltages across the tube has fallen to about 20, at which point non-linearity starts.

In other words, as long as the voltage actually across an ordinary vacuum-photocell tube exceeds about 20, the anode current is completely independent of the applied voltage, being purely proportional to the incident light-intensity. When such a tube is completely dark, the rest anode-current is very small indeed, being produced by cosmic atomic radiation and other residual effects. It is for all intents and purposes zero. Any incident light reaching the cathode hurls electrons out of this, which can be collected by the anode. Provided the anode is, as just stated, as least 20V positive to the cathode, it can capture all the electrons released by the light, i.e. the tube operates in saturation current, and increases can be effected only by increasing the light intensity so as to produce more electrons.

The voltage sensitivity of a vacuum photocell tube can be excellent. Thus shining a pocket torch on to the cathode of the 90AV tube can cause an anode current of some 10μA, giving a voltage output of some 27V across a 2·7MΩ load. However, it is seen that the impedance is very high indeed, so that the *power* output is negligibly small, this being characteristic of photocells, in contrast to the semi-conductor types.

Thus valve diode photocells require a subsequent *power-amplifier* for the operation of metres, relays, etc. In most cases a single-stage cathode follower is

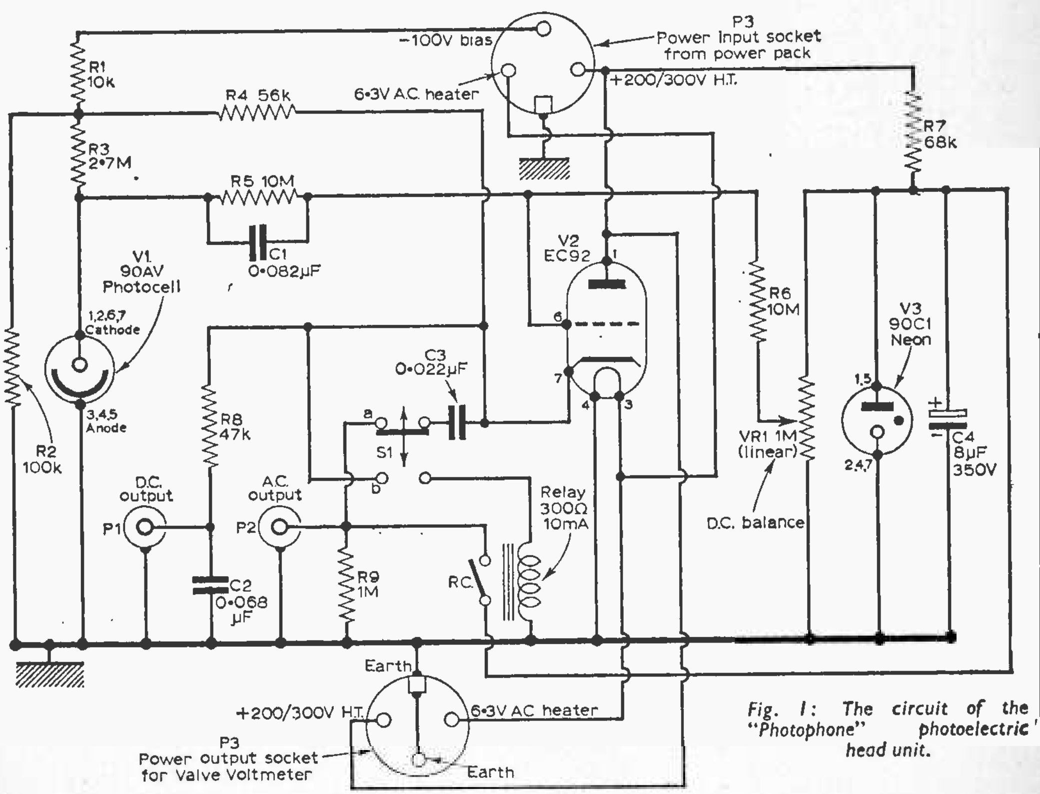


Fig. 1: The circuit of the "Photophone" photoelectric head unit.

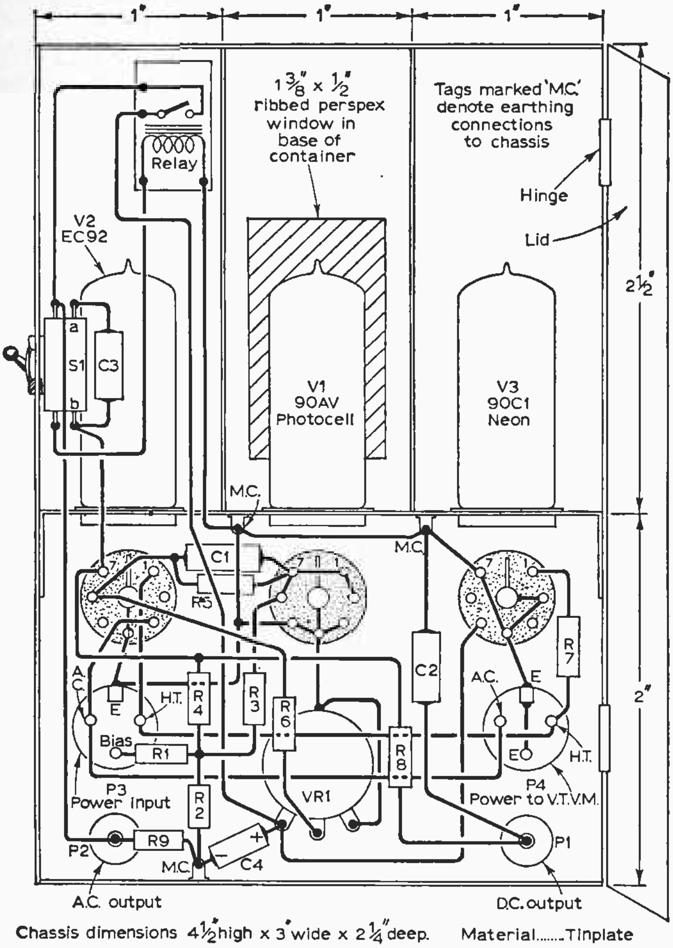


Fig. 2: The complete wiring diagram (valve bases shown 'detached' for clarity).

outputs for a digital counter, for counting light flashes, or for counting the number of times a steady beam of light is interrupted by passing objects (e.g. counting articles on a conveyor-belt).

A suitable circuit employing a vacuum photocell tube and a cathode follower power amplifier is both simple and cheap, and satisfies all of these requirements. Fig. 1 shows the theoretical circuit and Fig. 2 the wiring details and dimensions. It is seen that the whole unit, although being, together with its neon stabiliser, a three-valve circuit, can be built to a size little greater than a clenched fist. This unit has been, very aptly, called the " photophone ".

Description of Circuit Function

The power supplies required for the photophone are fed in at P3, a four-pole (three-pole and casing as earth) socket such as found on the connection boards of Grundig (and some other makes) of tape recorders. These supplies are of the standard form: 6·3V a.c. heaters; 200-300V h.t.; and minus 100V bias.

The anode of the photocell, V1, is earthed direct to chassis, and the cathode fed negative from the bias supply. This gives a positive-going output voltage from R3, with a negative bias. The stabiliser neon V3, together with VR1, give a corresponding adjustable positive voltage. V1, V3; R5, R6 thus form a d.c. bridge circuit; those out-of-balance voltage is the signal applied to the grid of V2, the cathode follower power amplifier.

sufficient for this purpose, as shown in the practical circuit now to be described. This circuit is concerned with the vacuum tube photocell type 90AV, which is a small device of the usual shape and size of a miniature valve, on a B7G base, with the light-sensitive cathode vertical and so orientated that pin 4 of the base must face the incoming light.

Requirements for a Universal Circuit

From the above discussion of general practical principles, those design-features which would lead to a reasonably universal unit are already clear.

A unit for as many of the applications possible in general with photoelectric devices should be able to give d.c. and a.c. outputs over as high a range as possible, have excellent sensitivity, and it should have a linear light intensity/output voltage characteristic. It should be able to give d.c. outputs to a meter, for monitoring light intensity in the usual foot-candle units, also it should give an audio output for any ordinary audio amplifier-speaker unit, for uses in experiments with modulated-light transmissions. Finally, it should provide pulse

This bridge may be balanced under any conditions of illumination or darkness of V1, for various purposes as will become clear in the course in the course of further discussion below, by means of suitable adjustment of VR1. The range of control of VR1 is definitely sufficient for enabling balance to be established for any intensity illumination of V1. The condition of balance (considering, for the present, S1 switched such as to make contact " a " and break " b ", the condition labelled " Audio ") is represented by grid pin 6 of V2 resting at chassis potential, zero, because the voltage selected at the slider of VR1 is of equal magnitude but opposite polarity to the voltage existing across V1. Under these conditions, the voltage drops across R5 and R6 always being equal, the centre point, to which the grid of V2 is connected, must be resting at zero potential. Apart from the slight difference caused by the grid base of V2, a sensitive moving coil meter or valve voltmeter connected to the d.c. output socket, P1 should read zero at the balanced condition. If a moving coil meter is used, then this should be a

COMPONENTS LIST

Resistors:

R1	10kΩ	R6	10MΩ
R2	100kΩ	R7	68kΩ
R3	2·7MΩ	R8	47kΩ
R4	56kΩ	R9	1MΩ
R5	10MΩ		

All ± 20%, 1W carbon.
VR1 1MΩ carbon potentiometer linear.

Capacitors:

C1	0·082μF paper 500V
C2	0·068μF paper 500V
C3	0·022μF paper 500V
C4	8μF electrolytic 350V

Miscellaneous:

V1	90AV photocell
V2	EC92 (6AB4)
V3	90C1 neon
P1, 2	Miniature coaxial sockets
P3, 4	4-pole sockets
S1	Toggle switch, 1 pole on/off

Midget relay 3,000Ω 10mA. Pointer knob. Tin box 3 x 4½ x 2¼in. approx. Three ceramic B7G holders.

microammeter of about 250 or 500μA f.s.d. A centre-zero type should be used, or a reversing switch used. R8 automatically converts this meter into a suitable voltmeter. C2 smooths the d.c. output.

Greater sensitivity is obtained if a valve voltmeter is connected to P1. The output voltage is some 15V at P1 (positive) if the bridge was balanced with V1 dark, and an average pocket torch shone into V1 then at close range.

A valve voltmeter should have two ranges giving, when connected to the photophone at P1, a f.s.d. at 2·5V and at 25V. A suitable design for such an instrument will be included in the second part of this article.

Sensitivities

Using the dimensions shown in Fig. 2, with the specified components and voltages, and using all bright metal construction internally and the Perspex window, of the stipulated dimensions, ribbed but clear (i.e. not milky), half a volt of output voltage at P1 respresents one foot-candle, to a good approximation.

If greater accuracy is required, calibration by comparison with a standard foot-candle meter is required. On a moving coil meter connected to P1, each 10μA deflection represents (approximately) one foot-candle illumination intensity reaching the window area of V1. The response is primarily to the blue component of the incident light, which is deliberate in the choice of valve type for V1, to match the response of photographic enlarging papers—as one of the primary uses for this function of the unit will doubtless be as a darkroom exposure meter for making photographic enlargements.

As will be familiar to photo enthusiasts, the sensitivity of a conventional exposure meter is seldom sufficient for such purposes, and the accuracy also often insufficient. Whilst photographically minded readers are reminded of the ultimate need to perfect final calibrations by means of trial exposures when first putting the unit into operation, some indication of the approximate conversion factors is here nevertheless useful. Thus an illumination of about one foot-candle on to many ordinary types of enlarging paper calls for an exposure time of about quarter of a second. Regarding films, if a scene is illuminated at intensity one foot-candle, the correct exposure on a film of 40 ASA speed will come out at about 2 to 3 seconds at stop *f*8. For other intensities, film speeds, stops, etc., the usual photographic conversion rules apply, so that no more need be said here.

Light Beam Interruption Counting

The second most important group of uses to which the average reader may wish to put a photoelectric head unit concern counting the number of times a beam of light is switched on or off, or causing any desired functions of switching or mechanical nature to be performed when a beam of light is interrupted.

A typical application is the counting of articles on a conveyor belt as they interrupt a beam of light by passing between the lamp and photocell. Here we require a voltage pulse output from the photoelectric head, of suitable character for operating a digital counter of the type, for instance, as published in PRACTICAL WIRELESS, February, 1962, and following issues.

On the other hand, the switching functions require a relay to operate in response to the changes of photoelectric current. For example, the relay can operate a motor to open a door when a person approaches and interrupts the beam of light across a passageway. However, we shall shortly see that the requirements for counting functions and operative mechanical functions turn out to be identical, both cases needing, primarily, a relay, it then being a matter of mere detail whether a digital counter or any other electromechanical device is operated by the relay.

TO BE CONTINUED

SIGNAL STRENGTH COMPARATOR

An S-Meter and Tuning Indicator

BY J. LONGRISE

EXPENSIVE communication type receivers often feature an S-meter on the front panel, to provide an indication of the strength of the carrier of the transmission to which the receiver is tuned. This can be extremely useful for comparing the signal strength of one transmission with that of another and for observing how the strength of a particular signal varies throughout the day and night.

S-meters are used extensively by transmitting amateurs so that details of the received signal strength, of a station being worked, may be recorded and transmitted back to the operator in "standard" terms. Listeners on the short wave and amateur bands also find such meters useful for, apart from giving relative signal strengths, they can be employed for facilitating the adjustment and orientation of an aerial for optimum pick-up at one particular frequency or band of frequencies.

Tuning Indicators

Ordinary receivers in the domestic class rarely provide a definite means of indicating signal strength. Early models sometimes have embodied a so-called tuning indicator. This may be a simple milliammeter which operates across an uncalibrated scale, the idea being to tune the set for maximum deflection.

More recent models have a magic-eye tuning indicator in which a fluorescent glow within the eye alters in width or shape depending upon the tuning of the station. In the past there have also been other forms of tuning indicators, some of which use ordinary low-voltage lamps or neon tubes for providing the indication in terms of light intensity.

All these methods, including the S-meter, have much in common, and that is they invariably work from the receiver's automatic gain-control (a.g.c.) line.

All modern receivers incorporate a.g.c., and there are two main ways of achieving this. The circuit in Fig. 1 shows the usual arrangement, where one of the two diodes in a double-diode-triode valve is employed exclusively for the production of a.g.c. bias.

Diode A is the ordinary detector diode, while diode B is the a.g.c. diode. To the latter is applied some of the i.f. signal from the anode circuit of the final i.f. amplifier valve V1, via a small coupling capacitor C1. This diode rectifies the signal and produces across its load resistor, R1, a d.c. voltage whose value is proportional to the amplitude of the i.f. carrier—the stronger the signal, the greater the voltage across R1.

Now, since the load is connected direct to the diode itself, the voltage developed is *negative* with respect to the chassis side of R1. A negative bias is thus produced which goes more negative with increase in signal strength. The voltage is fed through the filter comprising R2 and C2—which eliminates residual i.f. signal no longer required—to the controlled valves in the receiver.

In Fig. 2 is shown the other method sometimes used to produce an a.g.c. bias. Here only one diode is used. and in the case of a double-diode-triode valve, the redundant diode is connected to chassis out of the way. However, there may be only a single diode in the valve (such as a diode-pentode) or a germanium crystal diode may be used.

The i.f. signal at the secondary of the i.f. transformer is fed direct to the diode (diode A) and voltage due to the rectified signal appears across R1 and R2 in series. These are really the detector load resistors, and the audio signal is filtered through the coupling capacitor C1 to the volume control—this capacitor isolating the d.c. component, of course.

The d.c. voltage across R2 is fed to the controlled valves through the filter made up of R3 and C2, as in the former example. There are various arrangements of these circuits, but the basic ideas given in the foregoing rarely differ in practice to any large extent.

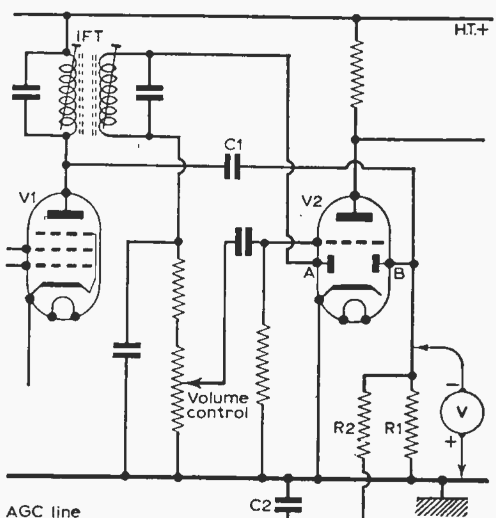


Fig. 1: In this circuit a separate diode (diode B) is employed for the production of an a.g.c. bias. Diode A is the ordinary detector diode.

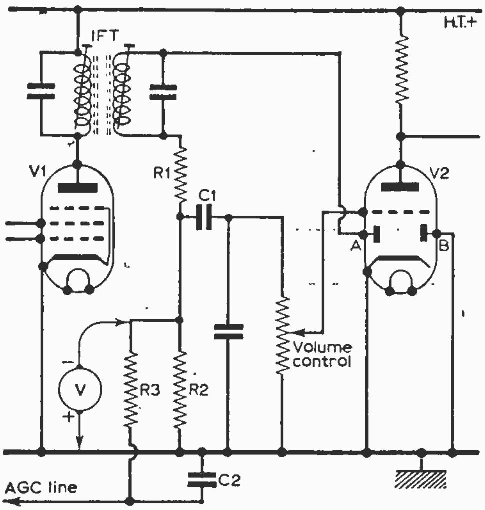


Fig. 2: Sometimes just a single diode is used for the dual functions of detection and a.g.c., as this circuit shows.

Signal Indication

A way is thus at hand for indicating comparative signal strengths simply by connecting a sensitive voltmeter between the a.g.c. line and chassis, as shown on the circuits. Although on strong signals the a.g.c. voltage may rise in excess of 1V negative, this is not a very practical method of connecting a signal indicating meter.

The chief disadvantage is the very high resistance of an average a.g.c. line, this necessitating the use either of a valve-type voltmeter or a very sensitive moving-coil instrument. The indication given on an average voltmeter of round a 1,000Ω/V sensitivity is negligible due to the loading of the meter on the high resistance feed and load circuits.

When a magic-eye tuning indicator is employed, direct connection can be made to the a.g.c. line, as shown in Fig. 3, owing to the very high input impedance of the device, which is comparable to a valve-type voltmeter.

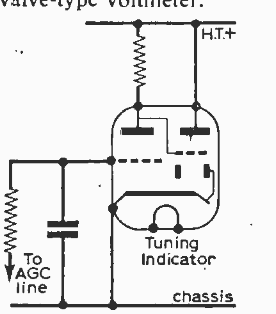


Fig. 3: Showing the circuit of a magic-eye tuning indicator and how this is connected direct to the a.g.c. line.

There is yet another method of obtaining a meter indication related to the change in a.g.c. line voltage, and this is shown in Fig. 4. The valve here is the controlled i.f. amplifier, to the control grid of which is applied the a.g.c. voltage through R1 and the secondary of the first i.f. transformer. This is the normal method of applying a.g.c., and capacitor C1 simply holds the bottom end of the secondary of the i.f. transformer at chassis potential so far as the signal is concerned.

The valve usually has variable-mu characteristics, and the gain of the stage is decreased progressively as the negative bias at the control grid is increased, such as would happen due to a rise in signal strength. Now, as the bias is increased, so the anode current of the valve decreases, and if this is monitored on a milliammeter as shown, the current indicated will have a relationship to the applied signal. For example, the stronger the aerial signal, the smaller the anode current, and vice versa. Such a meter, therefore, could be calibrated in terms of signal strength units or decibels to provide, at least a comparative indication of signal strength.

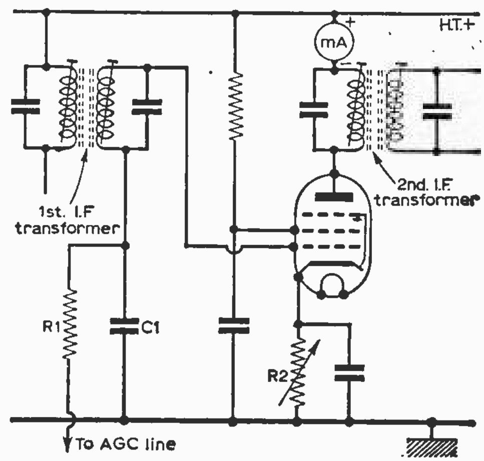


Fig. 4: The anode current of a controlled stage decreases with increase in signal strength, and by connecting a milliammeter in the anode circuit as shown, relative signal strength is indicated.

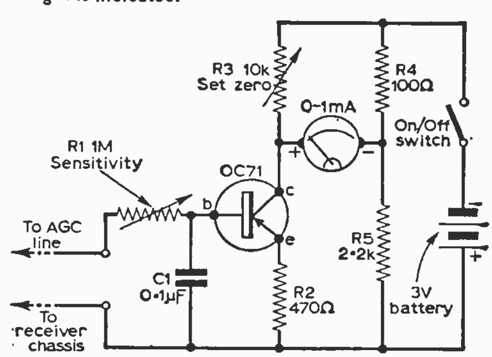


Fig. 5: A simple transistorised signal strength comparator.

The idea would be to select a meter which would give full-scale deflection (approximately) under conditions of zero signal, and final adjustment could be made on a variable resistor in the cathode circuit (e.g., R2). Signal levels would then be given as something *less* than full-scale deflection.

Transistorised Unit

A useful transistorised signal comparator is given in Fig. 5. This can easily be built into a small

—continued on page 321

The KENILWORTH Public Address Amplifier

☆ **10 Watt Output**

☆ **12 Volt Operation**

☆ **5 Transistor Circuit**

BY S. GIBSON

THIS 10W amplifier has been designed to obtain the highest performance from a transistorised circuit. The unit lends itself particularly to outdoor power amplifier use where a car battery is available. It should have particular appeal for organisers of fetes, garden parties, outdoor sports, political meetings and so on.

The electrical performance of the amplifier is good and there is no apparent distortion at full power—and, of course, there would be no mains hum when driven from a d.c. source. The unit can be made at a very reasonable cost and, as will be seen from the layout, it is of the simplest design from the constructional point of view. Indeed it would be possible for anybody with little or no previous experience of electronics to put this together. It is reasonably light to carry yet of a robust construction. Having transistors instead of valves, it should prove less prone to damage.

Before going on to a detailed construction procedure the following is a stage-by-stage description of the circuit.

The amplifier requires a 12-14V d.c. supply. This input is controlled by the on/off switch S1, connected in the negative lead.

First Amplifier Stage

The input signal is applied to the amplifier via a jack plug JK1 to one end of the gain control VR1. A simple potentiometer was chosen here because it was envisaged that a pre-amplifier would be designed later which could incorporate tone correcting network and matching circuits for various types of microphone or gramophone pick-up.

The signal from the gain control VR1 is passed via R1 and C1 to the base of Tr1, which is OC71. This transistor is used in a conventional amplifier circuit. Adequate decoupling from the next stage is obtained by R3 and C2.

Negative feedback from the secondary of the

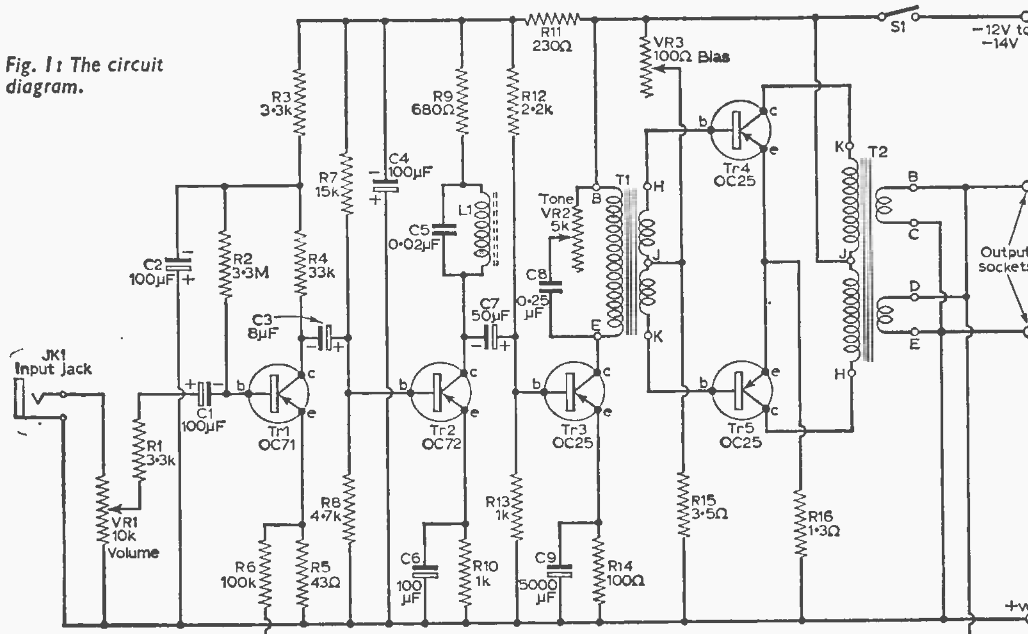


Fig. 1: The circuit diagram.

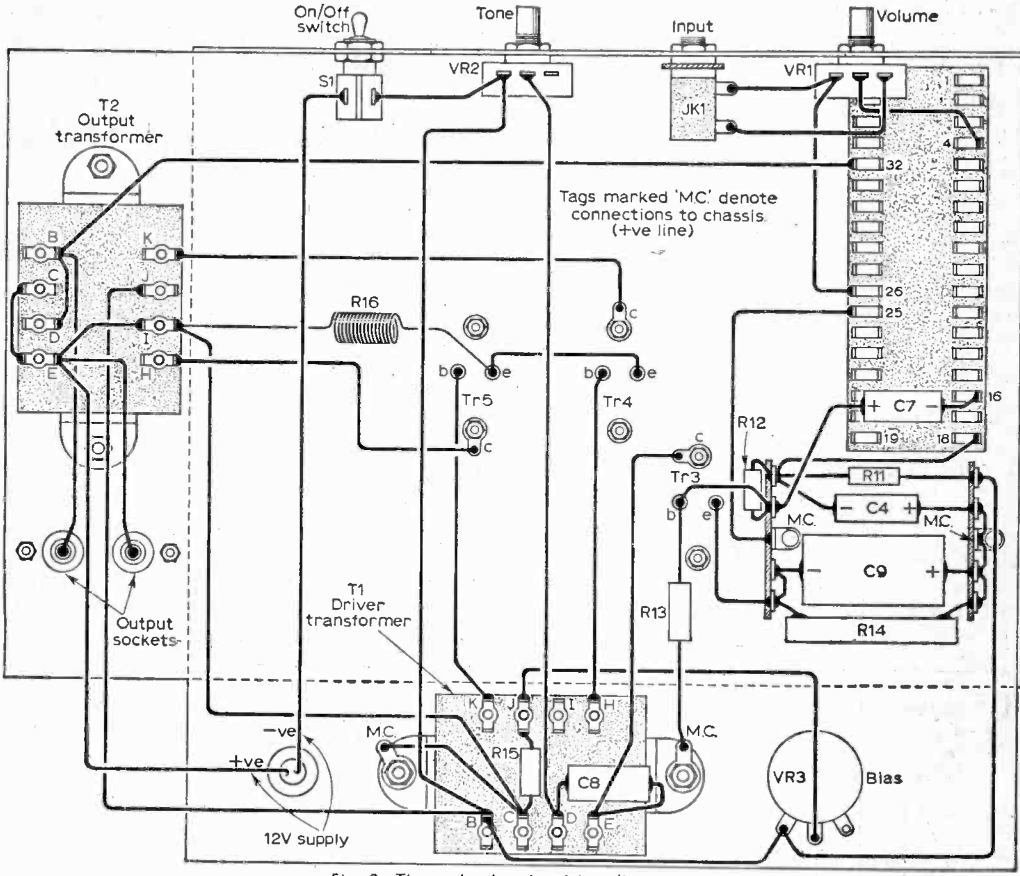


Fig. 2: The underchassis wiring diagram.

output transformer T2 is fed back to this stage via R6 and developed across R5. The values of these two resistors were determined by balancing the gain required and overall response of the amplifier. More negative feedback would in theory have given a better frequency response curve, but at the expense of gain.

Second Amplifier Stage

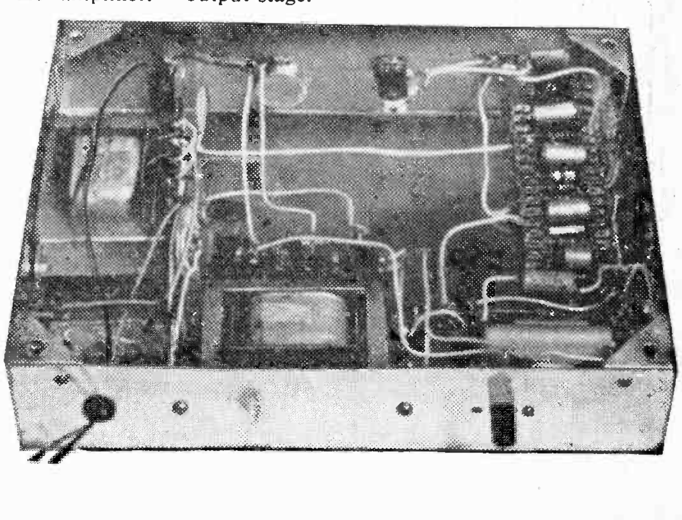
The second transistor Tr2 is an OC72 which acts as a pre-driver stage to boost the signal to the power transistors. R7 and R8 are the biasing resistors for Tr2. The emitter bias resistor R10 is bypassed by C6.

High frequency tone correction is provided in the collector load by the circuit consisting of a 10mH ferrite-cored L1 and the 0·02μF capacitor C5.

Right—This illustration gives an idea of the layout of the amplifier.

First Power Stage

The first power stage employs an OC25, Tr3. The output from this stage drives the final push-pull output stage.



The bias to Tr3 is provided by R12 and R13. The emitter bias resistor is R14 (which is a 100Ω wire-wound type) and is bypassed by C9. Tone correction is provided in the collector load, which is the primary of the driver transformer T1.

Tone control is provided by VR2 which is in series with a 0·25μF variable top cut capacitor C8 across the primary of T1.

Final Stage

The final stage comprises two OC25 transistors (Tr4 and Tr5) in push-pull operation. These transistors do not need to be exactly matched, but, on the other hand, they should not be grossly mismatched. A variable bias network is provided by VR3 and R15. The setting-up of VR3 is discussed later. The emitter bias resistor is R16 wire-wound.

Output Transformer

The output transformer T2 is a Repanco TT24. The circuit diagram shows the secondary connections for matching to a 3Ω loudspeaker. Connections for 15Ω output are shown in Fig. 5(b).

Method of Construction

The layout is comparatively simple although much care went into it to avoid any possibility of instability or unwanted feedback.

Construction falls roughly into four steps:

(1) Drilling the 10in. x 7½in. x 2¼in. chassis to the template drawing provided (Fig. 3).

(2) Wiring up the tag panel which contains components for the first two amplifier stages.

(3) Assembly of tag strips, power transistors, transformers, potentiometers supply switch, input jack plug and output socket.

(4) Wiring up the complete circuit.

Step 1—The chassis

The components are all mounted on a normal 10in. x 7½in. x 2¼in. aluminium chassis. The drilling diagram Fig. 3 shows the position and size of the holes. The variable resistors VR1, VR2 and the jack socket require ⅜in. holes; VR3 has a ⅜in.

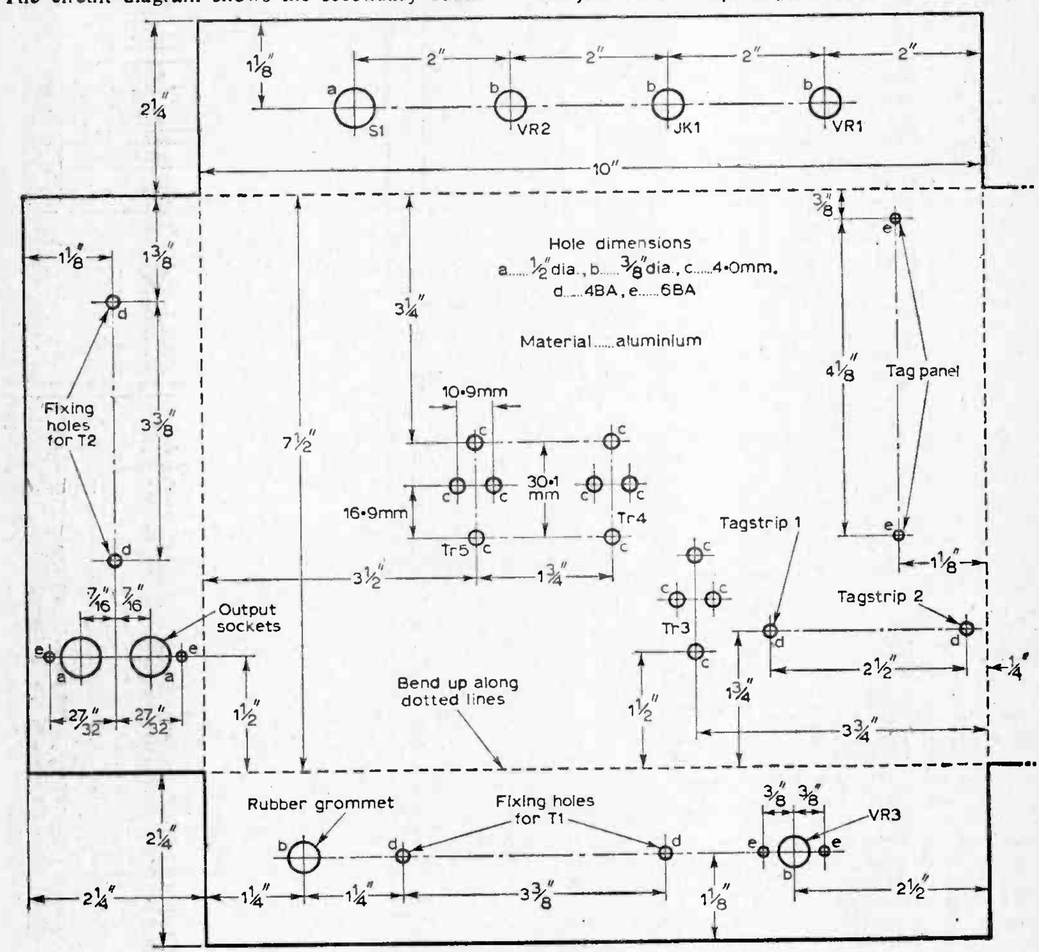


Fig. 3: The drilling dimensions of the chassis.

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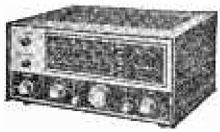

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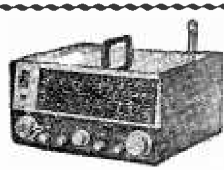

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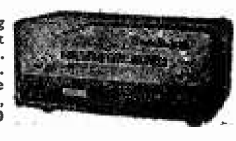

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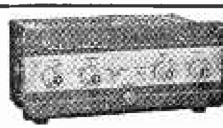

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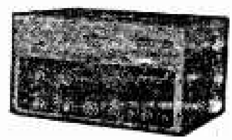

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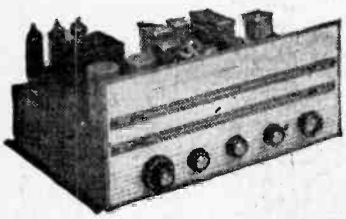

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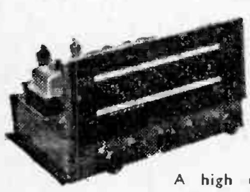

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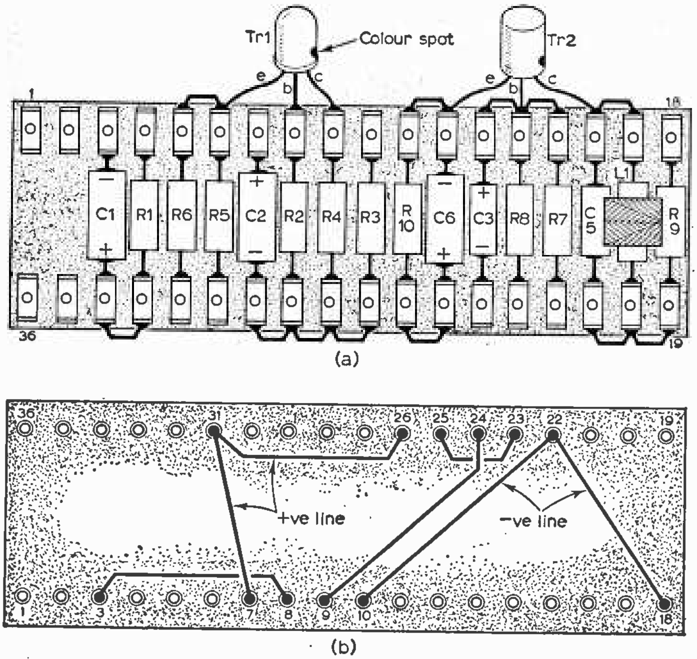


Fig. 4: Above and below views of the tag panel.

and two 6B.A. holes. The on/off switch requires a ½in. hole. Otherwise all holes are 6B.A. or 4B.A. clearance.

The dimensioning of the three power transistors calls for some comment.

On the drawing (Fig. 3) the makers exact measurements have been used, but these are in millimetres. Similarly the size of all the holes marked C is given as 4mm. Conversion of course is easily done as 25·4mm equals 1in. A $\frac{6}{32}$in. or a 4B.A. clearance drill may be used for the holes marked C.

Step II—Wiring up Tag Panel

The main 18-way tag panel carries most of the components for the first two transistor stages. Fig. 4(a) shows the layout on the top of the tag panel, and Fig. 4(b) the underside wiring connections. This should present no difficulties if this layout is followed carefully. There is an exception here, in as much as R9 should only be soldered to one tag until the tag strip has been mounted on the chassis. This is necessary in order to get at the nut securing the tag strip in position on the chassis.

Care should be taken in soldering the transistor leads. P.V.C. sleeving about ¾in. long should be pushed on each transistor lead. The leads should not be shortened but soldered in as they are. A pair of pliers should be used to grip the leads between the soldering iron and the transistors. Soldering should be done as quickly as possible. The pliers will carry the heat away and the procedure will tend to protect the transistors OC71 and OC72.

Fig. 4(b) shows the underside wiring. This is in fact best done first using 22s.w.g. tinned copper wire and 1mm sleeving.

Step III—Assembly of Parts to Chassis

Method of assembly of the parts on the chassis allows for individual preference, but the following is a pretty logical sequence.

First, the power transistors Tr3, Tr4 and Tr5. Fig. 6(a) gives the connections to the OC25, power output transistors. Two stiff leads project through the mounting base. These can be identified as the base and emitter connections by reference to Fig. 6. The collector is electrically connected to the mounting base. Collector connection later is made to a tag which is held in contact with the top of the mounting base by one of the mounting nuts. Each OC25 transistor is insulated electrically from the chassis by a mica washer and two bushes. The chassis acts as a heat sink and the mica washer is so thin that it gives minimum thermal insulation. Two 6B.A. ⅜in. or ½in. screws and nuts are used to clamp the transistors using the insulating bushes.

The 18-way tag panel which was assembled under Step II can next be assembled to the chassis. It is held by two 6B.A. screws with

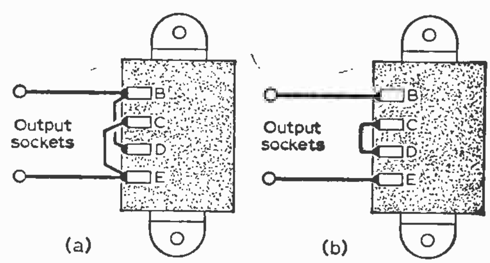


Fig. 5: Output transformer connections for (a) a 3Ω loudspeaker, (b) a 15Ω loudspeaker.

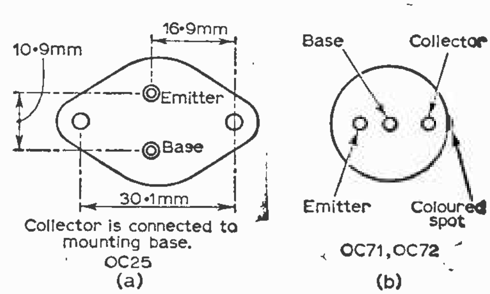


Fig. 6: Transistor connection details.

two ½in. spacers or two 6B.A. nuts to keep it away from the chassis.

The three potentiometers, VR1, VR2 and VR3, on/off switches, input jack JK1 and the output sockets can now be assembled to the chassis. The rubber grommet carrying the supply lead into the chassis is fixed in the appropriate ⅜in. hole.

Next the two 5-way panels carrying in due course R11, C4, C9, R14 and R12 can be screwed to chassis by one 4B.A. screw and nut each.

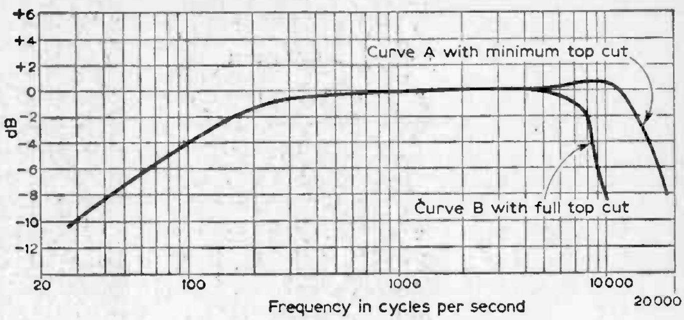


Fig. 7: Response curves.

Finally, the two transformers can be bolted to the chassis by the four 4B.A. screws and nuts with a 4B.A. solder tag under each nut in the case of T1.

Step IV—Wiring the Circuit

The 18-way tag panel was wired up in Step II except that R9 was only soldered to one tag until after assembly to the chassis: the other lead of R9 can now be soldered to the tag.

The input jack is wired to the volume control potentiometer VR1 and connections made to the appropriate points on the tag panel as shown on the wiring diagram.

Wiring of the power stages according to the wiring diagram and layout diagram should present no difficulties. Care should be taken to solder the leads to the base and emitter tags of Tr3, Tr4 and Tr5 as quickly as possible. This will avoid damaging the transistors.

Connection of the output transformer T2 (Repanco TT24) will vary according to whether a 3Ω or 15Ω loudspeaker is being used. Fig. 5 shows the connections for both these impedances. For a 3Ω loudspeaker the split windings of the secondary are connected in parallel, that is E and C are connected and the loudspeaker is connected across B and E.

For 15Ω output C is connected to D and the loudspeaker is across B and E.

R16 is given as 1·3Ω wire-wound. This resistor acts as a stopper or protection device for the OC25's to prevent thermal runaway. The value was set at 1·3Ω as that which would cause the circuit to operate in Class A condition. Probably the easiest way to obtain the 1·3Ω is to wind it if there is a meter for measuring resistance available. The value is not too critical say within 0·3Ω. Two 3Ω resistors in parallel would also be satisfactory.

COMPONENTS LIST

Resistors:

R1	3·3kΩ	R9	680Ω
R2	3·3MΩ	R10	1kΩ
R3	3·3kΩ	R11	230Ω
R4	33kΩ	R12	2·2kΩ
R5	43Ω	R13	1kΩ
R6	100kΩ	R14	100Ω 3W w-w
R7	15kΩ	R15	3·5Ω 3W w-w
R8	4·7kΩ	R16	1·3Ω 3W w-w

All 10% 5W carbon, unless otherwise stated.
VR1 10kΩ carbon potentiometer
VR2 5kΩ carbon potentiometer
VR3 100kΩ wire-wound potentiometer

Capacitors:
C1 100μF electrolytic 12V
C2 100μF electrolytic 12V
C3 8μF electrolytic 12V
C4 100μF electrolytic 12V
C5 0·02μF paper
C6 100μF electrolytic 12V
C7 50μF electrolytic 12V
C8 0·25μF paper
C9 5,000μF electrolytic 6V

Transformers:
T1 Driver transformer (Repanco TT23)
T2 Output transformer (Repanco TT24)

Transistors:
Tr1 OC71 Tr4 OC25
Tr2 OC72 Tr5 OC25
Tr3 OC25

Other Circuit Components:
L1 10mH choke (Repanco CH2)
JK1 Jack socket (Radiospares)
S1 On/off toggle switch s.p.d.t.

Miscellaneous:
Two-way output socket panel. Two control knobs. Three mica washers (Mullard 56201B) and six insulated bushes (Mullard 56201A). One eighteen-way miniature tag panel. Two 5-way tag strips. Chassis 10in. x 7½in. x 2¼in. Quantity of 4 or 6 B.A. screws, nuts and solder tags.

Operating Conditions

As has been explained this amplifier has been set to operate in Class A, since this gives the best possibility of reducing any distortion. However this does mean that there is a high quiescent current. The quiescent current of the amplifier under Class A conditions is 600mA, and VR3 was adjusted to obtain this figure. This control can also be adjusted to give a condition approaching Class B with the current in the quiescent conditions between 250 to 375mA. This, of course, means that there is less drain on the d.c. supply.

Under the Class A condition the quiescent current is 600mA as stated and the current for full power output is 1·2A. Current to the final stage is 100-150mA for each OC25 of the output stage.

The supply required is 12V d.c. and mains operated supply units to give this voltage at 1·2A are available, although it is envisaged that a unit of this kind to go with this amplifier will be designed in due course. As stated previously, an ordinary car battery gives this order of current without difficulty for a long time and the amplifier was designed with this fact in mind. Where complete portability is required away from a mains unit (if available) or from a car battery, it would be possible to operate the amplifier for a short time from lantern batteries. In this case when not in use the amplifier should be switched off to allow the batteries to recover. According to the state of charge of a car battery, the voltage may vary up to 14V and the amplifier will accept this input.

Performance

As has been explained the negative feedback has been adjusted to give a balance between gain and performance, and Class A conditions for the amplifier should bring operation under best conditions from the point of view of distortion.

The variable resistor VR2 provides a tone control adjustment by giving a varying degree of top cut. The effect of this is shown on the approximate response curves in Fig. 7 which give an indication of the response with the top cut at a minimum (curve A) and with full top cut in operation (curve B).

The −3dB points with no top cut are approximately 150c/s and 14,000c/s; with all the top cut in circuit the −3dB points are approximately 150c/s and 8,000c/s. These figures are approximate but give an indication of the performance. For public address systems the frequency response of 150c/s to about 8,000c/s is in fact a desirable range of frequency reproduction.

Response figures apart, the proof of the amplifier is in the listening, and all those who have listened to this amplifier have found it very acceptable.

Conclusion

Having completed the amplifier and adjusted it to obtain the required conditions, the remaining operation in the design as it stands is to make the bottom cover. This cover consists of a piece of 18 gauge aluminium sheet cut to approximately 7$\frac{1}{4}$in. x 10in. A piece of insulating paper is glued on the aluminium sheet on the side facing into the chassis to prevent any possibility of touching the tags on the driver and output transformers; this insulating paper should be approximately 5$\frac{1}{2}$in. x 8in. in size.

This bottom plate is fixed in position by four plastic-headed fixing buttons. These fixing buttons are not easy to obtain but are often held in stock by motor dealers because they are widely used for attaching panels and the like in motor cars. A quarter-inch hole is drilled through the corner supports on the chassis and a similar hole in each corner of the bottom plate. These fixing buttons can be levered out with a screwdriver and being very springy will click into position again very easily.

With the completion of this bottom plate the amplifier is finished and ready for use. ■

Signal Strength Comparator

—continued from page 313

plastic case, such as one of these sold by popular stores as sandwich containers. A metal case should not be employed on account of the danger that may arise when used with a "live" chassis type of receiver.

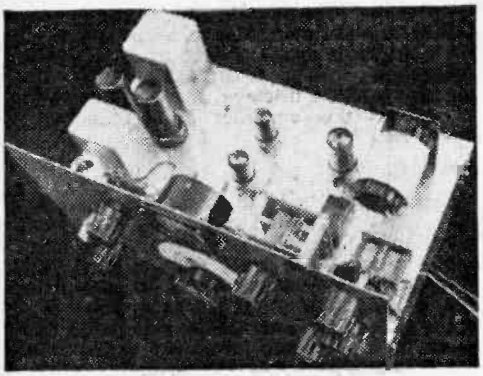
The circuit is perfectly straightforward, and a Mullard OC71 transistor is connected in the "earthed-emitter" mode. The collector load is formed by R3, R4 and R5 in conjunction with a milliammeter of 1mA f.s.d. The emitter is connected to battery positive through a 470Ω resistor which provides stabilisation, and the instrument is operated from a 3V battery, such as two 1·5V cells in series.

The a.g.c. line voltage is applied to the base through the sensitivity control R1, and C1 clears all traces of residual i.f. signal from the base circuit.

With the instrument connected to the a.g.c. line of a receiver and with the instrument and receiver switched on (the latter with the aerial disconnected) the milliameter should be set to zero current by adjusting the "set zero" control R3.

The aerial should then be connected to the receiver and the strongest possible signal tuned in. This will cause the milliammeter to deflect, and the extent of deflection can be controlled by the "sensitivity" control R1. This should be adjusted to give almost full-scale deflection.

Thus, relative to zero and f.s.d., the milliammeter can be calibrated as required in terms of signal strength units or decibels. ■



A Top Band R.T. Transmitter

By G3OGR

THIS transmitter is intended for use in the 1·8-2Mc/s band, and can be operated by a licensed amateur at the full permitted input of 10 watts. A push-pull modulator is incorporated, designed for use with a crystal microphone, and this gives very satisfactory modulation and speech quality. The transmitter is controlled by a variable frequency oscillator (v.f.o.) so that it can be operated anywhere in the band, and no frequency crystals, as required for a crystal-controlled transmitter, are necessary. A separate power pack is used.

The R.F. Section

Fig. 1 shows the complete r.f. section of the transmitter. V1 is the v.f.o. tunable from 1·8—2Mc/s. This stage employs series tuning, with a high slope pentode, and if construction is rigid, sufficient frequency stability is obtained. VC1 is the v.f.o. tuning capacitor.

V2 is a pentode buffer, and VR1 allows the output of this stage to be adjusted, to secure correct grid drive to the power amplifier. No tuned circuits are used between V1 and V2, and the anode circuit of V2 is broadly resonant at about 1·9Mc/s. This arrangement avoids any need for tuning the buffer stage, and 4mA p.a. grid current, which is more than adequate can be obtained throughout 1·8—2Mc/s.

For the power amplifier, a 6BW6 is used. In

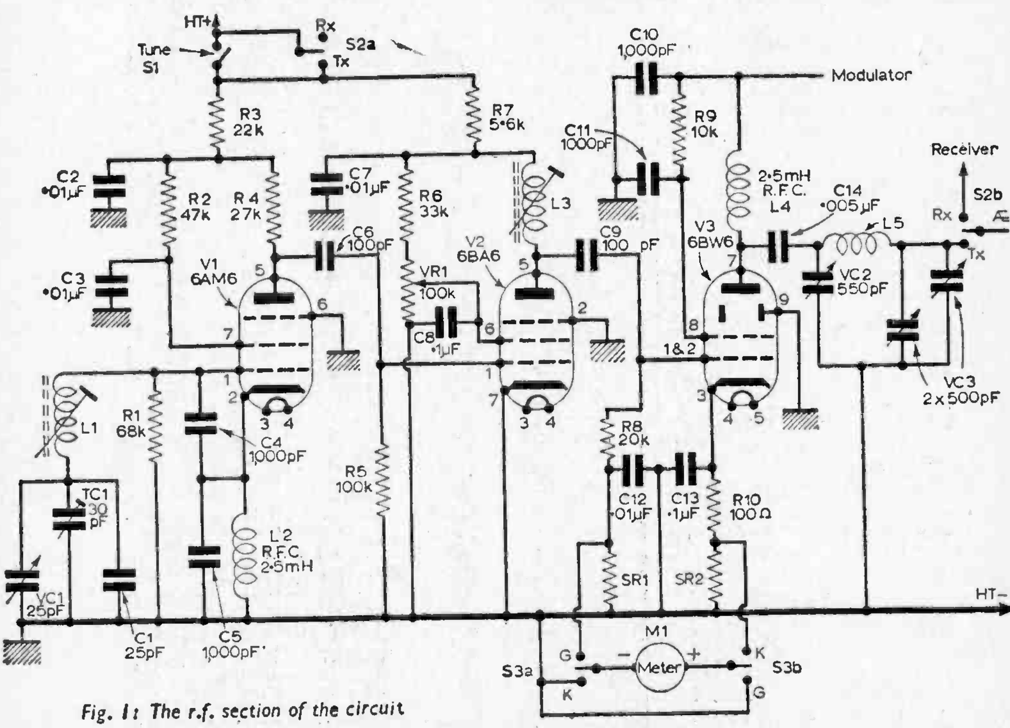


Fig. 1: The r.f. section of the circuit

such equipment, a 5763 is often fitted, but the 6BW6 was found satisfactory, and can easily be loaded up to full input. Should a 5763 be to hand, it may be used by wiring the holder to suit. Operating bias is obtained in the usual way by voltage drop across the grid resistor. The 100 ohm cathode resistor furnishes protective bias, limiting anode current in the absence of grid drive, or when the stage is off tune.

The popular type of π output circuit allows the transmitter to operate into many kinds of end-fed aerials. For other aerials, a small aerial tuner can be used as a separate unit.

When the "Tune" switch is closed only the v.f.o. and buffer stages are operating. This allows the v.f.o. to be adjusted to the required frequency by corresponds to about 40V bias across the 20kΩ grid resistor.

With the meter switched to show cathode current, aerial loading is adjusted, as explained later, to obtain a reading of about 40mA, with a 250V h.t. supply. This indicates 250 x 0·04, or 10 watts. As the meter reads the combined cathode current, there is a slight safety margin against exceeding the 10W limit.

Modulator

Fig. 2 shows the modulator circuit. V4 is a double triode, with an r.f. filter in the microphone circuit (R11 and C15). With the crystal microphone used, adequate modulation was obtained, so the cathode by-pass capacitor was omitted from

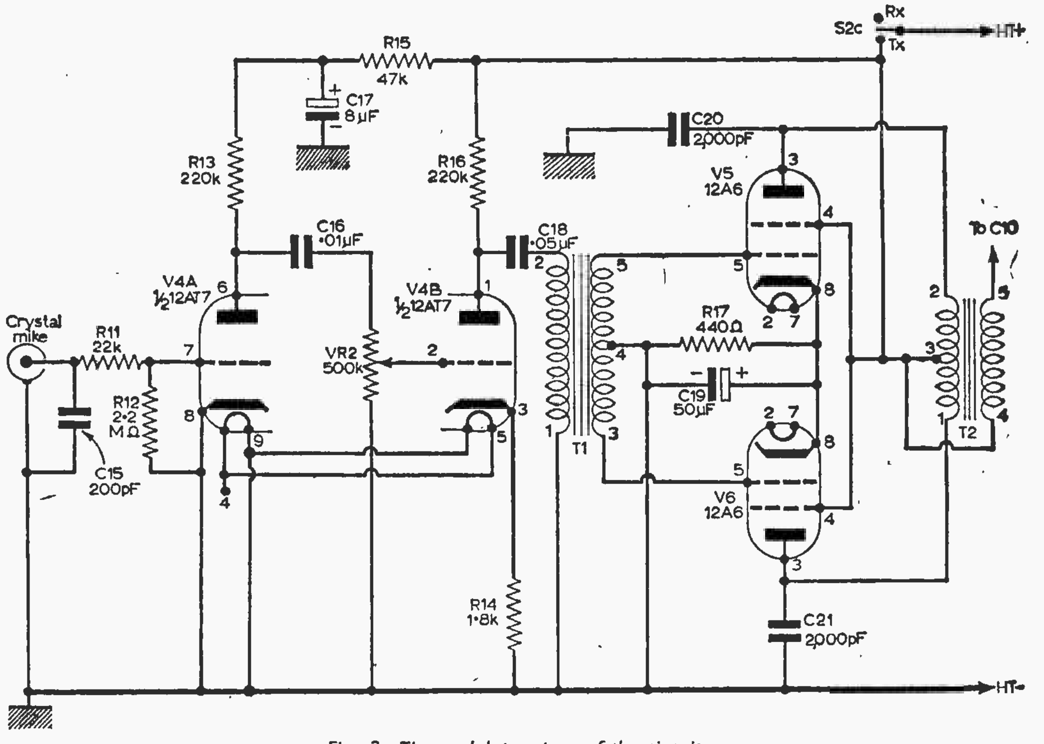


Fig. 2: The modulator stage of the circuit.

listening for the carrier on the station receiver. The p.a. grid drive may also be adjusted by VR1, if necessary.

The "Transmit-Receive" switch S2 controls the transmitter, switches the aerial from receiver to transmitter, and also silences the receiver loudspeaker, if necessary. When working, this gives single knob control of the station, for easy changing from transmit to receive.

A single meter M1, with switch S3, reads grid and cathode current. R.F. output is not much influenced by quite large changes in grid current, but begins to fall off with less than 1mA. VR1 is thus adjusted to obtain between 1·5mA and 2·5mA grid current, as shown by the meter. Here, 2mA the second triode. If more gain is required, for a microphone with a lower output, a 25µF capacitor may be wired in parallel with R14.

Two 12A6's are used in the modulator, as these are easy to obtain and inexpensive, and originally employed in equipment using the surplus modulation transformer. These valves have 12·6V heaters, so they are run from a small 12·6V heater transformer.

Other small output pentodes or tetrodes, able to deliver some 5 watts or so in push-pull, would be satisfactory. The modulating impedance of the p.a. (V3) is approximately 6,200 ohms. The optimum load for various output valves other than the 12A6's may be found from valve data,

COMPONENTS LIST

Resistors:

R1	68kΩ	R10	100Ω
R2	47kΩ	R11	22kΩ
R3	22kΩ	R12	2·2MΩ
R4	27kΩ	R13	220kΩ
R5	100kΩ	R14	1·8kΩ
R6	33kΩ	R15	47kΩ
R7	5·6kΩ	R16	220kΩ
R8	20kΩ	R17	440Ω
R9	10kΩ		
SR1 and SR2	shunts		
VR1	100k pot.	VR2	500k pot.

Capacitors:

C1	25pF	C12	0·01μF
C2	0·01μF	C13	0·1μF
C3	0·01μF	C14	0·005μF 1000V mica
C4	1,000pF	C15	200pF
C5	1,000pF	C16	0·01μF
C6	100pF	C17	8μF 350V
C7	0·01μF	C18	0·05μF
C8	0·1μF	C19	50μF 25V
C9	100pF	C20	2,000pF
C10	1,000pF	C21	2,000pF
C11	1,000pF		
TC1	30pF trimmer		
VC1	25pF miniature variable		
VC2	250-500pF	VC3	2x500pF

Valves:

V1	6AM6	V4	12AT7
V2	6BA6	V5	12A6
V3	6BW6	V6	12A6

Transformers:

T1 Push-pull input transformer, surplus SCR522, 1:2 ratio or similar

T2 Modulation transformer, surplus SCR522, ratio 2:1, or similar

Inductors:

L1 See text
L2 R.F. choke 2·5mH 100mA
L3 See text
L4 R.F. choke 2·5mH 100mA
L5 See text

Switches:

S1 On/off toggle switch
S2 4-pole, 2-way rotary switch
S3 2-pole, 2-way rotary switch

Meter:

M1 0–1mA meter

Miscellaneous

Two B9A holders. Two B7G holders. B9A screen. Two octal holders. Four-sided chassis 12 x 7 x 3 and 12 x 7 panel (Home Radio, Mitcham). Knobs, etc.

and the ratio of the modulation transformer T2 can thus be calculated in the usual way, if necessary. New multi-ratio modulation transformers are obtainable, allowing correct matching of any output stage.

Both the r.f. and the modulator sections are built on a common chassis, with meter and all controls except the power pack on/off switch.

Chassis

This is 12in. x 7in. x 3in. deep, so that the v.f.o. may be constructed underneath. A four-sided chassis is required, for rigidity, and a 12in. x 7in. panel is held in place by the component nuts. The positions of the valveholders and other items will be seen from Fig. 3.

TO BE CONTINUED

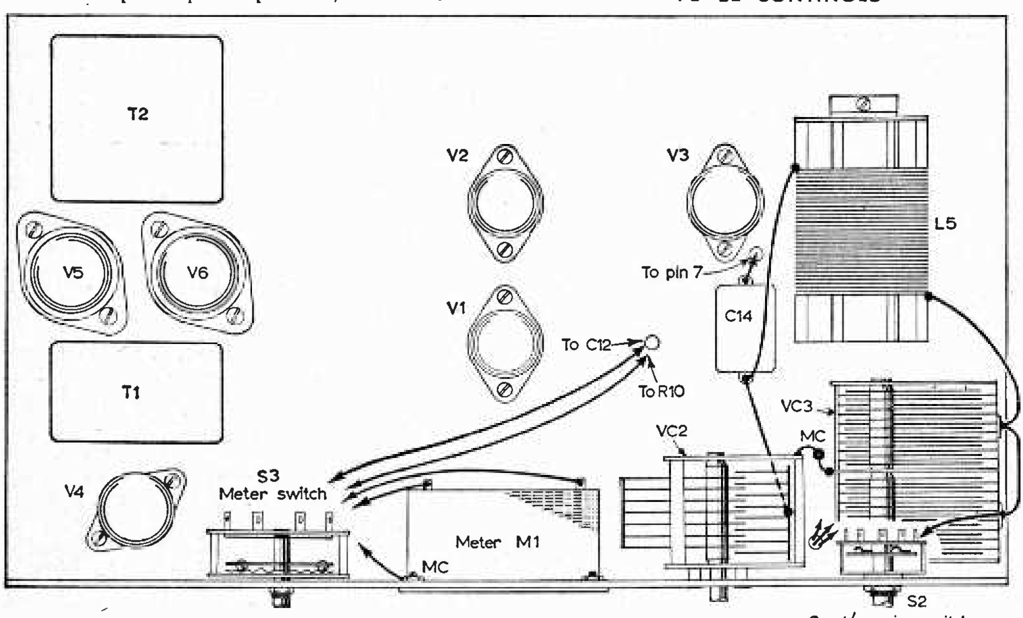
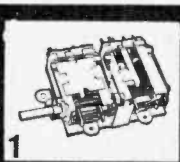
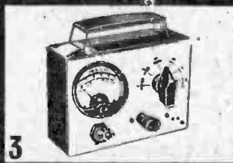
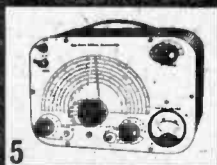


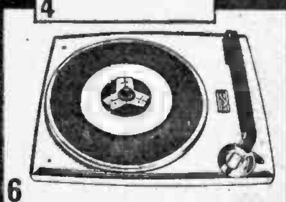
Fig. 3: The above-chassis layout of components.

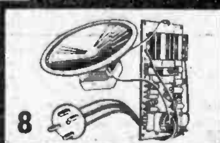
Just a few of our BARGAINS

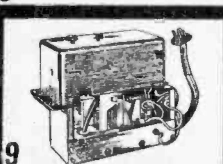


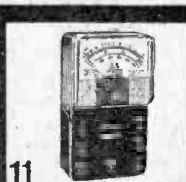


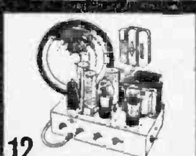


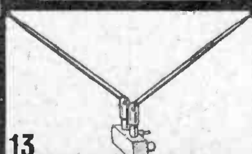


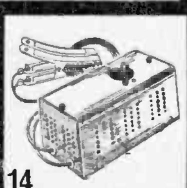












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11. **POCKET MULTI-METER.** Size 3½ x 2½ x 1¾in. Meter size 2½ x 1¾in. Sensitivity 1,000 O.P.V. on both A.C. and D.C. A.C. and D.C. volts 0-15, 0-150, 0-1,000. D.C. current 0-150 mA. Resistance 0-100KΩ. Complete with test prods, battery and full instructions, 35/-. Plus 1/6 P. & P.

12. 8-watt **PUSH-PULL 4 VALVE AMPLIFIER plus METAL RECTIFIER.** A.C. mains 200-250 v. Size 10½ x 6½ x 2¾in. 5 valves. For use with all makes and types of pick-up and mike. Negative feed back. Two input, mike and gram, and controls for same. Separate controls for Bass and Treble lift. Response flat from 40 cycles to 15 kc/s. 2 dB down to 20 kc/s. Output 8 watts at 5 per cent total distortion. Noise level 40 dB down all hum. Output transformer tapped for 3 and 15 ohms speech coils. For use with Std. or L.P. records, musical instruments such as guitars, etc. Suitable for small halls, £3.19.6. P. & P. 6/-. Crystal mike to suit 15/-. P. & P. 2/-. 8in. P.M. Speaker to suit, 12/6. P. & P. 2/-.

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GOODS NOT DESPATCHED OUTSIDE U.K.

7 VALVE STEREOGRAM

CONTINUED FROM PAGE 243 OF THE JULY ISSUE

By J. B. Willmott

TO commence wiring-up, first prepare the four-way power supply cable; this may conveniently comprise a suitable length (according to the dimensions of cabinet in which the receiver is to be housed) of twisted twin red/black flex (for the h.t. supply), and twisted twin plain flex (for the heater supply). One end of the cable should be terminated with an octal plug. Wire the red lead to pin 6, the black lead to pin 1, and the plain leads to pins 2 and 7, the pin numbers being numbered from below the plug, in the same manner as an octal valveholder (into which, of course, it is to be plugged on the power supply chassis when the latter is constructed). Thread the other ends of the four-way cable through the ⅜in. grommeted hole in the top left hand corner of the main chassis (Fig. 2), and anchor the ends beneath the chassis as follows: the red wire (which is h.t. positive), leave free for the moment (later this will be soldered to the h.t. connection on the 5-way tagboard); the black lead to the solder tag mounted on V4 valveholder; the twisted plain leads to pins 7 and 8 of this same valveholder (these being the heater tags for a 6SL7 valve), and at the same time, earth pin 8 to the nearby solder tag. Note that this is the only point at which the heater supply is earthed. Now carry out the wiring to all other valve heaters, using twisted plastic flex, starting from pins 7 and 8 of V4 just mentioned to include pins 2 and 7 of every other valveholder. Keep this wiring pressed down close to the chassis. Also wire in the clip-on pilot bulbholders (which must be of the two-pole "isolated" type) mounted on the tuning dial assembly.

Wiring of this receiver is greatly simplified by the use of two tagboards for supporting many of the resistors and capacitors, and the preparation of these should next be undertaken. Figs. 3(a) and 3(b) clearly show what is required, and if care is taken when mounting and interconnecting the various components, no trouble should arise. Observe carefully the polarity of the electrolytic capacitors. Short lengths of wire, about 4in. long, can be attached to the lower tags where shown, in readiness for connecting into the circuit when the tagboards are mounted in position, when these leads can be trimmed down to the requisite lengths.

Screened Leads

It is not proposed to give detailed point-to-point wiring instructions—any constructor of average experience should be able to carry out wiring satisfactorily by reference to the theoretical diagram (Fig. 1), in conjunction with Figs. 3, 4 and 5. The only "tricky" parts are possibly the connections to the wavechange switch, and to the dual-gang potentiometers, but a

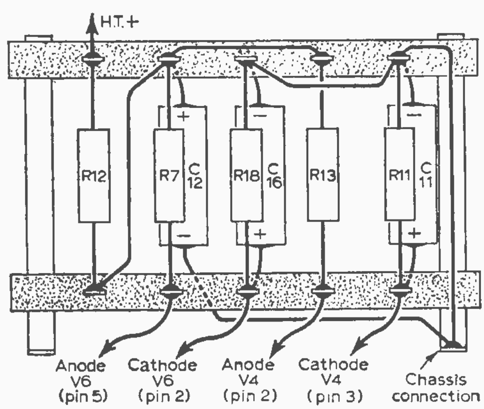


Fig. 3(a): Showing the connections of the anode and cathode components of V4 and V6.

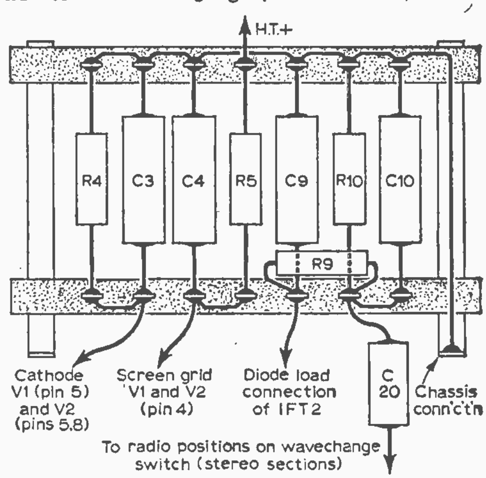


Fig. 3(b): The connections of the screen grid and cathode components of V1 and V2 and the diode load filter.

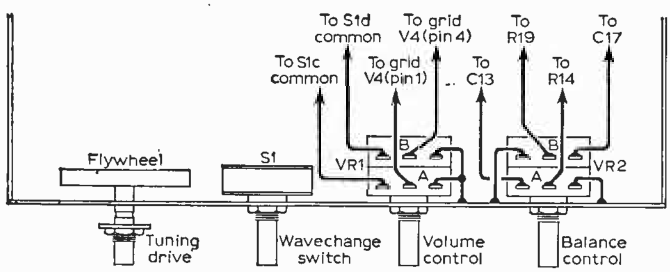
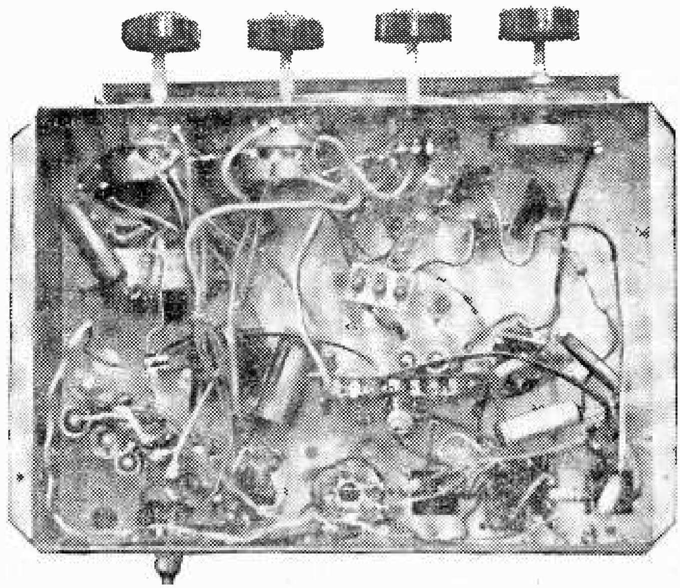


Fig. 4: The wiring of the dual volume and balance potentiometers.

methodical approach, taking each tag in turn, should obviate errors. The following connections should be carried out in screened wire, the outer screening being earthed to any convenient earth tag at *one* end of each lead; from C20 to the wavechange switch; from the "live" pick-up sockets to the wavechange switch; from the wavechange switch to the "top" of each section of the dual-gang volume control: from the "slider" of each volume control to the control grids of V4 and V6; from C13 and C17 to the "end" tags of the balance control, and finally from the "centre" tags of the balance control to the top cap connections of V5 and V7. Note that a grid stopper resistor (R14 and R19) is mounted as close as possible to the top-cap grid connection of V5 and V7.

When wiring up the r.f. and i.f. circuits, short, neat wiring is particularly important, otherwise uncontrollable oscillation, or at the very least, a disappointing standard of sensitivity on radio signals, will result. Check over all wiring carefully.



A view of the underside of the receiver chassis.

The Power Supply Unit

Construction of this unit is very straightforward, and practically all the necessary information can be gleaned from Figs. 6 and 7. The chassis used in the prototype measured 11½in. x 6in. x 2½in., but as the layout is in no way critical, practically any type of chassis will serve, so long as the components can be accommodated. Drilling dimensions applicable to the prototype are given; if a different make of mains transformer and smoothing choke are used, the actual components should be used as marking templates.

Note that rubber grommets should be provided in all holes through which leads pass between components above the chassis and those below.

Do not test the power supply unit without any "load" connected, as the high voltages produced may cause breakdown of the electrolytic capacitor C21.

Initial Tests

Make sure that a suitable loudspeaker (3Ω impedance) is connected to each of the output sockets, and insert the octal power plug into the socket provided on the power supply chassis. Set the volume control to minimum, the balance control to mid-way, and the wavechange switch to the "gram" position (fully clockwise). Slowly turn up the volume control, and at maximum setting a faint hum should be audible from each speaker. Place the blade of a screwdriver on each of the "live" pick-up sockets in turn, when a loud hum should be heard from first one loudspeaker, then the other. Keep the screwdriver blade on one of the pick-up sockets, and try the effect of rotat-

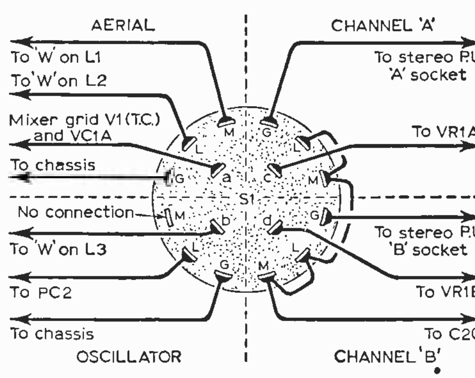
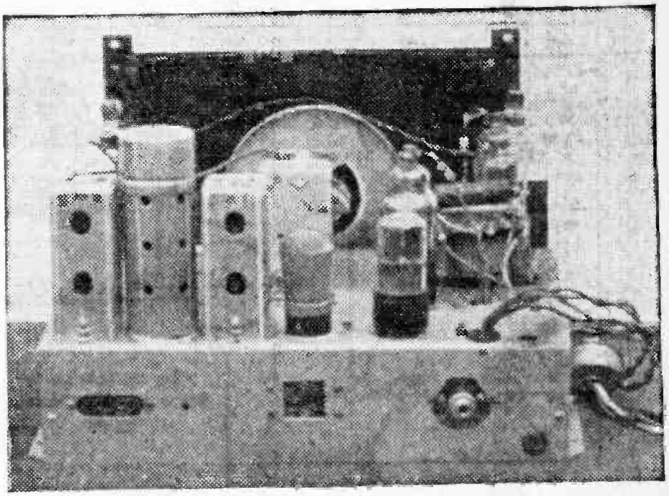


Fig. 5: The wiring of the wave-change/gram switch.

ing the balance control; this should be found to vary the output of the two channels, one increasing as the other decreases and vice-versa when the blade is transferred to the other pick-up socket.

Receiver Alignment

Set the signal generator to provide a modulated output of 465kc/s, switch it on and allow some five minutes for it to warm up. Meanwhile, remove the top cap connection to V1, and temporarily wire in (using crocodile clips) a 100kΩ resistor between the top cap and chassis. Using the "direct" output leads from the signal generator, connect them to the top cap of V1 and to chassis. Make sure that the wavechange switch is set either to the long or medium wave position (i.e. not to "gram" as the r.f. and oscillator circuits would be rendered totally inoperative). With the volume control at maximum, turn up the generator output until the note is heard in the loudspeakers. Now, using the sharpened end of a plastic knitting needle (or a proper trimming tool if you possess one), adjust the cores of the i.f. transformers in turn, beginning with the secondary of IFT2, following with the primary of IFT2, the secondary of IFT1, and finally the primary of IFT1. Repeat the process, and as the circuits come into tune, reduce the output from the signal generator to the lowest possible level consistent with an audible output from the loudspeakers.



A rear view of the main chassis.

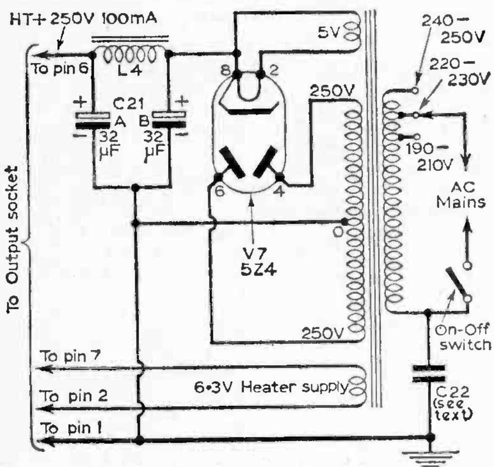


Fig. 6: The circuit of the power supply.

Next replace the "direct" output leads of the signal generator with the "dummy aerial," and connect them between the aerial and earth sockets of the receiver. Remove the temporary 100kΩ resistor from the top cap of V1, and replace the cap and lead going to the fixed plates of the mixer tuning section of the 2-gang capacitor. Set the wavechange switch to medium waves (fully anti-clockwise), and the dial pointer to the 200m mark. Set the generator to 1,500 kc/s, and adjust the output until a signal is audible, if necessary slightly rocking the tuning control of the receiver. Now adjust TC3 and TC1 for maximum response with the dial pointer correctly indicating 200m: again, keep the output from the generator to lowest level possible. Now turn the receiver dial to 500m and the generator to 600kc/s, and adjust the cores of L3 and L1 for maximum response. Repeat these adjustments at 200m (1,500 kc/s) and 500m (600kc/s) several times until no improvement can be heard.

The only station likely to be required on the long waveband is the BBC Light Programme, and this adjustment is best carried out on the actual signal. Turn the wavechange switch to the long wave position, and search for the programme in the vicinity of 1500m on the dial. As soon as it is located, try to bring it into tune by adjustment of TC2 and the core of L2, but on no account touch TC3 or L3 in the oscillator section, as this would, of course, completely upset the medium wave alignment previously carried out. If it is found that the BBC Light Programme "peaks" at a point removed from the 1500m mark on the dial, some slight adjustment of the long wave oscillator padder PC2 is called for. Try the effect of connecting a small capacitor, say 50pF, in parallel, and if this brings the point of resonance nearer to the correct point on the dial, try varying values of parallel capacity (it is unlikely that more than 50pF will be required) until the desired setting is obtained. If addition of capacity only drives the point of resonance further from the desired setting, a reduction in value of PC2 is called for, and a component of slightly lower value (by some 20pF or so) should be tried.

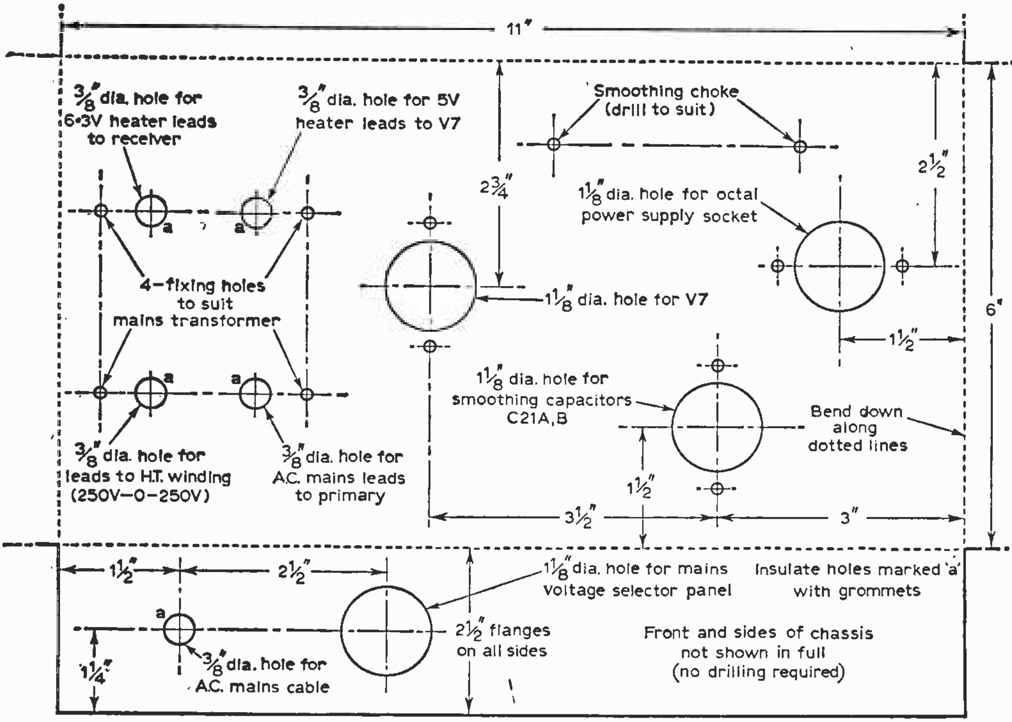


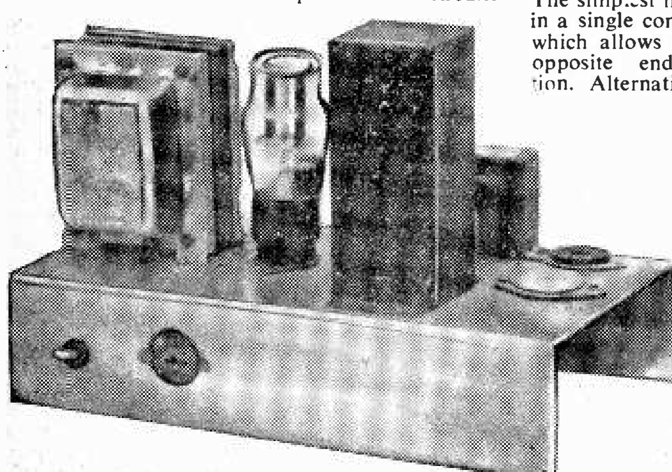
Fig. 7: The dimensions of the power supply chassis.

In the prototype, the value of 390pF was found to give correct alignment.

Setting Up and Installation

Having completed the alignment of the radio section, attention may now be turned to the setting up of the audio section for correct stereo operation. It is essential that the two loudspeakers employed be of identical characteristics. It will be found that with the simple audio circuits employed, perfectly adequate results will be obtained from loudspeakers in the lower price range, although it is recommended that these should preferably be of not less than 8in. diameter.

Some thought should be given to the ultimate method of housing the various units, and there are various possibilities, using the range of cabinets offered by advertisers in this magazine. The simplest method is to mount all the equipment in a single console cabinet of the "wide" pattern, which allows the loudspeakers to be mounted at opposite ends and give reasonable separation. Alternatively, the receiver and power supply unit, together with one loudspeaker, may be mounted in the main console, and the second loudspeaker in a separate free-standing cabinet. Yet a third possibility is to mount the receiver and power supply in a compact "control console", with the two loudspeakers as separate free standing units, possibly of the vertical column type. This latter method offers considerable flexibility, and is often the most suited to living rooms of modest dimensions. For the initial tests, however, it will suffice if the loudspeakers are placed in some form of temporary mounting,



The power supply.

COMPONENTS LIST

Resistors:

R1	10kΩ	R11	3·3kΩ
R2	100kΩ	R12	22kΩ
R3	1M	R13	270kΩ
R4	220Ω	R14	100kΩ
R5	27kΩ 2W	R15	470Ω
R6	47kΩ	R16	22kΩ
R7	47kΩ 1W	R17	270kΩ
R8	1M	R18	3·3kΩ
R9	47kΩ	R19	100kΩ
R10	220kΩ	R20	470Ω
		R21	22kΩ

All 10%, ½W carbon, unless otherwise stated.
VR1a, b 1MΩ + 1MΩ dual-ganged potentiometer, log/log.
VR2a, b 500kΩ + 500kΩ dual-ganged potentiometer, log/antalog.

Capacitors:

C1 0·01μF paper 450V
C2 2,500pF 5% silver mica
C3 0·1μF paper 350V
C4 0·1μF paper 350V
C5 100pF mica or ceramic
C6 100pF mica or ceramic
C7 50pF mica or ceramic
C8 0·1μF paper 350V
C9 100pF mica or ceramic
C10 100pF mica or ceramic
C11 25μF electrolytic 25V
C12 8μF electrolytic 350V
C13 0·01μF paper 450V
C14 25μF electrolytic 25V
C15 0·05μF paper 450V
C16 25μF electrolytic 25V
C17 0·01μF paper 450V
C18 0·05μF paper 450V
C19 25μF electrolytic 25V
C20 0·01μF paper 450V
C21 32μF } dual electrolytic 450V
C22 32μF }
PC1 470pF 5% (or better) silver mica.
PC2 390pF 5% (or better) silver mica.

Variable Capacitors:

VC1a, b 500pF + 500pF twin-gang tuner.
TC1 50pF compression type trimmer.
TC2 50pF compression type trimmer.
TC3 50pF compression type trimmer.

Inductors:

L1 Medium wave aerial coil (Weymouth HA3).
L2 Long wave aerial coil (Weymouth HA1).
L3 Oscillator coil (Weymouth HO3).
L4 Smoothing choke 100mA.

Transformers:

IFT1, 2 Standard size 465 kc/s i.f. transformer.
T1, 2 Pentode output transformer, 8,000Ω primary, 3Ω secondary.
T3 Mains transformer. Tapped primary. Secondaries: 250-0-250V. 100mA; 6·3V 4A; 5V 2A.

Switches:

S1 4-pole, 3-way single wafer.
S2 Toggle type s.p. s.t.

Valves:

V1	ECH35 (6K8)	V4	ECC35 (6SL7)
V2	EF39 (6K7)	V5	EL32
V3	EB34 (6H6)	V6	E632
		V7	GZ30 (5Z4)

Miscellaneous:

Two 8in. diameter 3Ω loudspeakers. Two 6·5V 0·3A lamps and holders (twin tag type). Eight I.O. valve holders. One I.O. plug (discarded valve base). Aerial and earth socket strip. Loudspeaker socket strip, 4-way. 3-pin plug and socket (for pick-up). Two 2-way tag strips. One 5-way group board. One 7-way group board. Four I.O. valve top cap clips. Four control knobs. One spin wheel drive assembly (Jackson SL8). Receiver chassis 12 x 9 x 2½in. Power supply chassis 11 x 6 x 2½in. Connecting wire, insulated sleeving, screened wire, 4 B.A. and 6 B.A. nuts, bolts, washers and solder tags. Rubber grommets.

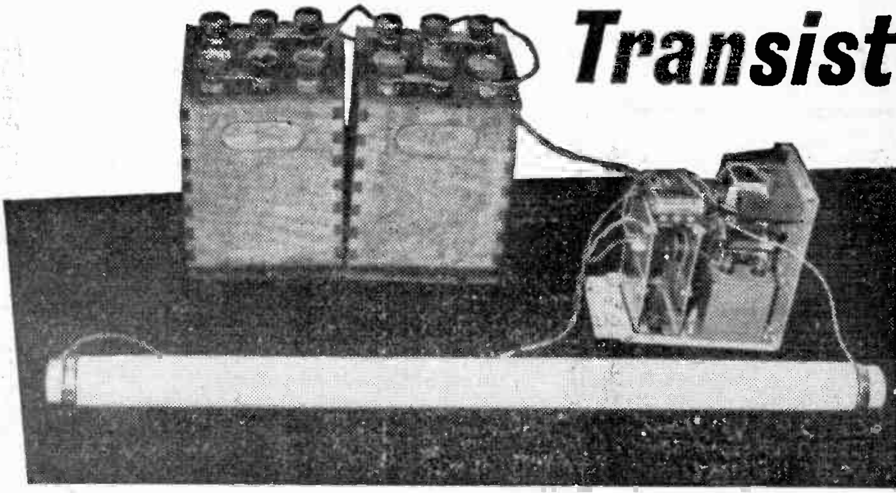
such as a plywood baffle board. For best results they should be placed about eight to twelve feet apart, facing towards the normal listening position.

Gram Testing

It is assumed that a suitable record playing unit, together with the necessary stereo head, has already been obtained, with the necessary length of two-way screened lead. A three-pin plug, to match the socket provided on the rear chassis panel, is fitted to the pick-up lead, the two inner leads to the outside pins, and the screening to the centre (earth) pin. Insert the plug into the pick-up socket, and for the first trial, place an ordinary (mono) L.P. record on the turntable, and with volume at a suitable level, play the record. By careful adjustment of the balance control, a setting should be reached where the sound appears to come from a point midway between the two speakers. If this cannot be realised, the reason is probably that the speakers are not correctly phased, i.e., the cones of the two speakers, instead of moving inwards and outwards in unison, are moving in opposite directions at any given time. To correct this, reverse the plugs of one of the speakers, and try again. Once the correct phasing has been found, it is a good plan to mark the speaker plugs in some manner, together with their sockets, so that if at anytime they have to be disconnected, they can be reinserted correctly without further trials.

Having achieved a satisfactory balance, the "mono" record can be exchanged for a "stero" one, preferably one of the special "Test and Demonstration" records which are ideal for setting up purposes. Listen carefully, and first of all make sure that the "right hand" and "left hand" channels are being reproduced by the correct speaker, either from the spoken commentary of the test record, or as a rough guide, it is general practice in orchestral and dance band records for the bass instruments, saxophones, etc., to predominate in the right-hand channel, and the strings and other higher pitched instruments in the left hand channel, whilst a vocal solo will appear to come from the mid-point. If the reproduction appears to be reversed, change over the connections of the loudspeakers, i.e. exchange the right- and left-hand channel connections. ■

Transisto



IT is always difficult to provide adequate means of lighting once one is away from the usual mains electricity supply. One way of overcoming this obstacle is to make fuller use of battery-operated fluorescent strip lighting.

This lighting is ideal for seaside chalets, caravans, vans and boats, and for emergency lighting in homes, hospitals or at the site of road accidents or breakdowns. Unfortunately, at these times, there is generally only low voltage d.c. current available from accumulators. In order to overcome this difficulty a transistor converter can be connected between the available batteries and the striplight: this produces the high voltage a.c. power with which to operate the light.

It is even possible to use dry-cell batteries for small striplights. For example, four bicycle lamp batteries will run a miniature 6in. fluorescent striplight for several hours. For use with larger striplights, however, it is necessary to use correspondingly larger batteries. It is advantageous to use accumulators rather than dry-cell batteries in this case.

Striplights are economical to use in that although they may cost considerably more than an ordinary lamp they have about five times the working life. They also have the advantage of being " shadowless " and there is a choice of several colours available.

A transistor inverter, suitable for supplying a small fluorescent striplight with power, can alternatively be used to supply the necessary power for a photographic electronic flash.

Striplights

A fluorescent striplight contains a low-pressure gas through which an electric current is induced to pass. The passage of the current produces ultra-violet light which is in turn used to activate a fluorescent coating on the inside of the tube. The composition of the coating determines the colour of the light produced.

Alternatively the striplight may be constructed from uncoated Wood's glass, which permits the free passage of the ultra-violet light, allowing it to be used in various ways; e.g., suitable materials or paints can be made to fluoresce, it is used as a sterilising agent, killing bacteria or it can even be used for acquiring a suntan.

In order to obtain the passage of a current through the tube at a reasonable voltage, heated cathodes are fitted at each end to provide electron emission for tube starting. Once the tube has struck (i.e. a current has started to flow) the heating current to the cathodes may be reduced or removed and the cathode temperature is then maintained by ionic bombardment from the gas particles in the tube.

The electrical characteristic of the working tube is such that the discharge exhibits the property of negative resistance, i.e. an increase in current through the tube is associated with a decrease in the voltage across it.

This characteristic necessitates the employment of control equipment, termed "ballast ", with these tubes, in order to limit the discharge current to the desired level. The ballast may be inductive, capacitative or resistive.

ised STRIPLIGHTS

AN INVERTER FOR SUPPLYING FLUORESCENT TUBES FROM LOW VOLTAGE D.C. SUPPLIES

The inductive ballast is generally preferred as the resistive ballast is wasteful in power and the capacitative ballast produces an undesirable current waveform in some circumstances.

The inductive and capacitative ballasts are, however, only suitable for use on an alternating current supply. The shape of the waveform of the a.c. supply is not restricted, although much may be said in favour of the sinewave.

The Inverter

Modern striplights are designed to operate from a 210-250V 50c/s a.c. supply via their own associated control equipment. It can be shown, however, that an increase in the efficiency of the lamp can be obtained by using a supply of higher frequency. The use of a higher frequency also implies a reduction in the size of inductive components.

It was decided that the output of the inverter in this example should be 250V, for easy lamp starting, and at 6,500c/s to facilitate easy construction of the inductive components required. The choice of a lower frequency would have meant more larger windings on the transformer and choke, while the choice of a higher frequency would have precluded the use of certain moderately priced power transistors of low cut-off frequency.

The comparatively high working frequency does, however, necessitate the use of ferrite transformer and choke cores rather than the usual laminated iron or steel. The choice of mica capacitors, for low losses in the secondary circuit, would also be necessary.

The Circuit

The circuit of the inverter is a single-stage, push-pull sinewave transistor oscillator. The frequency of oscillation is set by a resonant tuned secondary of the feedback transformer. This winding also supplies the h.t. output to the striplight. Further windings on the transformer provide the currents for cathode heating.

Feedback signals are provided by the cross-coupled windings on the transformer between the collectors and bases of the transistors. Small reverse bias to drive the transistors into class "C" operation is provided by the transistor base currents and the capacitor connected in parallel with the drive control resistor.

In class "C" operation each transistor conducts for less than half of each cycle, which aids economical operation. Forward bias for starting is provided from the h.t. rail via R1. The bias components R2/C2 form a compromise between efficiency, easy starting and good waveform. A capacitor C1 connected between the two collectors suppresses switching transients.

The discharge circuit is fed from the resonant transformer secondary via a series inductance to limit the discharge current as previously described. For example, a 6in., 4W lamp requires approximately 150mA at 30V during discharge and the series inductance is used to set this value. To obtain 150mA with the 6,500c/s 230V source an inductance of 40mH is required.

A suitable core on which such a choke might be wound can be made up of Mullard Ferroxcube pieces FX1036, "U" Core, and FX1067, "I" Core.

With the specified cores, the number of turns required is 158. The two halves of the core should be firmly butted together and clamped. The wire used should be enamelled copper, not less than 30s.w.g., to handle the current.

If this unit, however, is to be used with a selection of different wattage striplights, it is suggested that the choke be wound with 300 turns of wire and the inductance adjusted later to the requisite value by the introduction of a suitable air gap in the core.

The Transformer

To produce a sinewave in a simple circuit a tuned resonant element is required. This may be most conveniently incorporated in the transformer. If the resonant circuit has reasonable "Q" the reflected e.m.f.s of the circulating currents can be used to reduce the number of turns per volt necessary in the transformer from what would have been required in a conventional transformer, providing the same voltage and current output.

The one remaining consideration is the provision of adequate coupling between the windings. In order to prevent undue voltage excursions of the primary windings during the cut-off intervals of transistor operation, the two halves of the primary must be closely magnetically coupled. This may be most conveniently achieved by bifilar winding.

In order to present parasitic oscillation of the circuit during use, the leakage inductance of the transformer should be kept as low as possible. This is achieved by keeping the primary to secondary coupling high by sandwiching the secondaries between two electrically identical primary windings connected in parallel.

Transformer Construction

First construct a cardboard bobbin on to which the windings will be wound. Ensure that the centre spool is a loose fit on the ferrite cores (see Fig. 3).

The bobbin should be dried in an oven and shellaced against damp. The centre of the bobbin should be well bound with Sellotape.

Take 2yd of 21s.w.g. enamelled wire and fold it into a double 1yd length, ensuring that the two wires are not twisted together. Puncture two holes through the side of the bobbin near the centre, marking this side of the bobbin "Start". Thread the two strands of wire through the holes from the outside, leaving a 6in. loop on the outside for connecting purposes.

Holding the two strands together and avoiding twists, wind nine turns of the double wire and pass the ends through two holes punctured on the other side of the former. Mark this side of the former "Finish". Well tape the winding into position with Sellotape to provide insulation and prevent vibration.

The resonant high-tension secondary winding is wound next. The 250 turns are wound in even layers, one thickness of Sellotape between each layer. When the winding is complete it, too, should be tightly bound with several layers of Sellotape.

Two separate windings of 11 turns each are now wound to provide current to pre-heat the tube cathodes. They are well insulated from one another and from the remaining transformer windings by layers of Sellotape.

The bifilar secondary winding of four turns of double 21s.w.g. enamelled wire is now constructed similarly to the first winding and well taped. Finally the remainder of the primary winding is bifilar wound, similarly to the first winding, except that, due to the increase in diameter, a rather longer length of wire will be required. All windings should be wound in the same direction.

Taking in turn the inner primary, feedback, and outer primary windings, cut the loop where the wire has been doubled, bare the ends, and with a continuity tester identify the ends of each part of the winding. Connect the halves of the bifilar winding in series (the "Start" end of one half to the "Finish" end of the other). Connect the inner and outer primary windings in parallel (see Fig. 1).

The wires may be trimmed and connected to a small tag-strip, marked to identify connection.

Other Components

The transistors should be mounted on suitable cooling fins, 3in. x 3in. 18s.w.g. aluminium being suitable where the unit is to be run at low wattages,

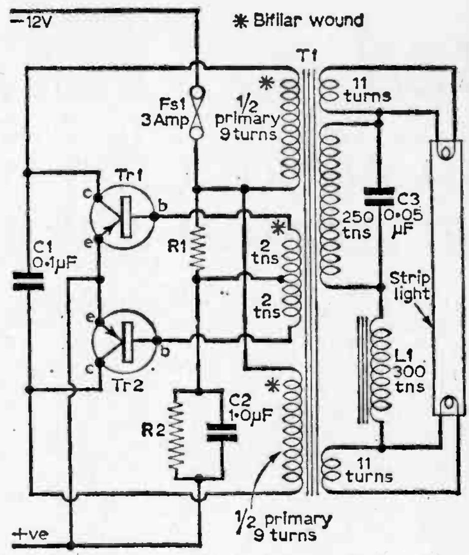


Fig. 1: The inverter circuit

and 9in. x 9in. 16s.w.g. for maximum ratings. The cooling fins may be folded into more compact shapes as long as free air circulation is not impeded, and the effective areas thereby reduced. The plates are drilled to take the transistor connections and mounting bolts, and the areas of contact of transistor and plate smeared with silicone grease before assembly.

During operation the cooling fins are "live" to collector potentials and should therefore be electrically insulated from the supports and chassis. During connection of the transistors, the customary "heat shunt" must be used for soldering.

As previously mentioned, the tuned secondary winding requires a mica capacitor for tuning (C3). Values of mica capacitor in excess of 0·01μF are not plentiful and it will be found that a bank of mica capacitors of this value, connected in parallel, give a ready solution to this difficulty.

Low value, high wattage, resistors may be simply constructed from measured lengths of electric fire replacement elements of the coil type. A complete 1kW, 240V electric fire element has a resistance of

COMPONENTS LIST

Ref.	(4 watt tube)	(20 watt tube)
Tr1, Tr2	Transistors V30/10P	Transistors V30/10P
C1	Capacitor 0·1μF paper	Capacitor 0·1μF paper
C2	Capacitor 1μF paper	Capacitor 1μF paper
C3	Capacitor 0·05μF mica (see text)	Capacitor 0·05μF mica (see text)
R1	Resistor 1·5kΩ ½W	Resistor 100Ω 1W
R2	Resistor 30Ω ½W	Resistor 2Ω w.w. (see text)
FS1	Fuse <3·0 A	Fuse 3·0 A
T1	Transformer (see text)	Transformer (see text)
L1	Choke (see text)	Choke (see text)

approximately 60Ω and may be sub-divided with the aid of a ruler.

Setting up

A length of thin wire should be taped along the length of the striplight bulb and one end connected to a pin of the lamp. This assists in the initial striking of the lamp.

When the unit has been assembled and checked for correct wiring, power should be cautiously applied. Audible oscillation should be at once apparent although the striplight may not appear to be fully lit. If oscillation does not commence at once and all else is in order, the fault is probably a reversal of either the feedback winding of the transformer or one half of the primary winding. The effect of reversing each of these windings in turn should be tried at once.

If this should fail the cause will be probably due to transistors of low β gain, requiring more bias. The value of R1 should be reduced by 10%—20%. Once oscillation has been established the frequency and current are adjusted. The frequency is controlled by inserting pieces of paper between the halves of the transformer core to produce a suitable length gap. The sound required is one octave above the sound of the highest black key on a piano.

The current is adjusted by inserting thicknesses of paper between the two halves of the choke core, until the requisite current flows through the striplight. This may be assessed either by means of a suitable meter (a surplus r.f. milliammeter is adequate) or by comparing the brightness of the striplight on a photographic exposure meter with one operating from an orthodox source of power.

As the flow of secondary current effects the operating frequency it is likely that a second adjustment of the transformer core gap may be required when the tube current has been set. Once satisfactory gaps have been established the choke and transformer should be firmly clamped in position. The drain from the battery will be about 0·7A for a 4W lamp to about 2·5A when using a 20W lamp.

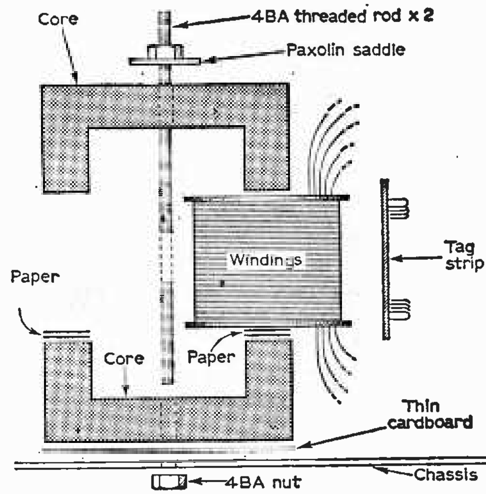


Fig. 3: Assembling the transformer.

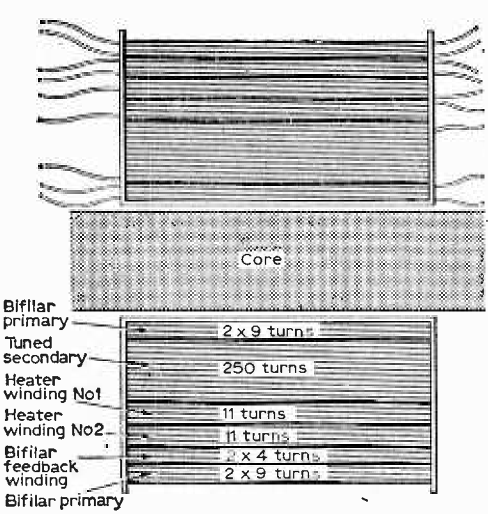


Fig. 2: A section through the transformer windings.

During the initial run the transistors should be checked to ensure that neither is overheating. If they both become too warm for comfortable contact with the back of the hand, the bias and/or drive are too high and the resistors R1 and R2 should be proportionately increased. One transistor, only, overheating indicates that either the transistors are not a matched pair, or that there are short circuited turns in one side of the transformer.

If it is required to operate the unit from a high impedance source, or if two or more such units are to be operated from the same power supply, a capacitor of 100μF should be connected across the input to the unit.

Alternative Striplights

Any standard type striplamp between four and 20W may be used with this converter as long as the drive and core gaps are set up to suit the particular tube. The drive is increased by decreasing the values of R1 and R2, but only up to the point where it is just possible to obtain the necessary tube current by adjustment of the choke and transformer core gaps. If, however, any difficulty in starting is experienced, a little extra drive should then be applied.

Alternative Transistors

Any power transistors of more than 3A, 25V capacity may be used in the converter if the drive resistors are adjusted to suit. The resistors R1 and R2 should be increased in proportion to the transistor gain. If it is found that the β gain falls off excessively at 6,500c/s the working frequency may be dropped slightly by reducing the transformer core gap which will, in turn, necessitate a reduction of the choke core gap. ■

TEST GEAR techniques

PART 6 - THE OSCILLOSCOPE

H. W. Hellyer

PERHAPS the most useful yet, paradoxically, least-used instrument in the average radio and television service department is the oscilloscope. There are many applications in which this device is the only possible means of making a satisfactory test. But there are also a great number of alternative techniques where the oscilloscope can reduce fault-finding time, confirm a tentative diagnosis, increase the test range and provide an instant, observable answer to an obscure problem. It finds its value not only in the observation of waveforms but in the measurement of a.c. and d.c. voltage, with negligible load upon the circuit, as a signal tracer, a hum detector, a response measurement instrument and a frequency comparator.

Provided the oscilloscope has a Y amplifier with a sensitivity of at least 100mV/cm and a frequency response which is flat within 3dB from about 20c/s (or, preferably, zero frequency) up to 4 or 5Mc/s, plus a timebase which covers the frequency range 10c/s to 100kc/s (or up to half a megacycle if there is no trace expansion), most workshop tests can be carried out effectively.

These are not unreasonable standards as we shall see. In fact some instruments that have been constructed and described in these pages possess much more rigorous specifications and have a wide range of facilities. Take, for example, the M. L. Michaelis design, the Auditron, which has been fully described in previous issues of PRACTICAL WIRELESS with a wealth of incidental detail on oscilloscope design. Readers who wish to brush up on their basic information on the oscilloscope would be advised to turn up these back issues from September, 1962, to April, 1963, even if they have no intention of setting about the construction of this comprehensive instrument.

It is not proposed to cover the same ground in these articles; this must be stressed, for already there have been instances of readers requesting specific constructional data on some of the instruments described in these articles. The author's purpose is merely to present a review of the types of instrument in modern use with a few comments on their employment.

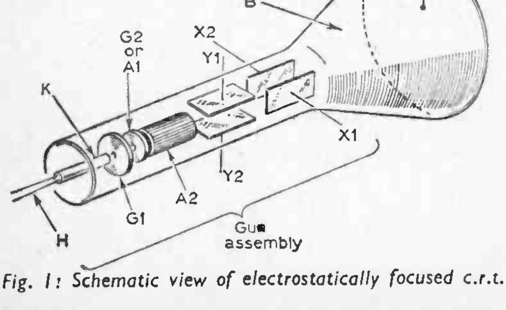


Fig. 1: Schematic view of electrostatically focused c.r.t.

Fundamental Sections

Any oscilloscope must have certain fundamental sections and the wide differences in price that will be noted from a quick flick through the catalogues usually refers to the fine limits to which these sections are built, plus some extra facilities for special purposes.

Basically we have a cathode ray tube and a power supply, a vertical deflection amplifier, a horizontal timebase and, in many instruments, a horizontal deflection amplifier. The trace is displayed on the face of the c.r.t. by feeding a signal to the vertical deflection plates of the electrostatic tube while the internal timebase of the instrument drives the spot across the face of the tube by the sawtooth voltage applied to the X plates (horizontal deflection). See Fig. 1.

It is important that the sawtooth waveform be true in order to obtain a linear movement of the spot across the screen, and the speed of this movement must be such that the waveform applied to the Y plates will trace a small enough number of cycles to make an observable pattern. Thus, if a sample of mains frequency is to be checked, a 50-cycle supply is fed to the Y plates and the X timebase is adjusted to scan the width of the screen 50 times a second, and the result is the display of a complete single cycle. See Fig. 2.

This display will only be a steady trace if the speed of the timebase is synchronised with the frequency of the input—that is if the timebase is "triggered" by the signal. But this term "triggering" is used to apply to a special function and can be misleading here.

Normal procedure for simple scope construction is an X timebase that is controlled to run at just less than the input frequency, which then forces the display into synchronisation by feedback of a part of the Y signal to the X timebase. Triggering, however, refers to the principle of forcing the timebase into single responses so that the horizontal trace only occurs in step with each impulse from the Y signal.

The normal procedure is for the synchronising terminal on the oscilloscope control panel to be connected to the timebase via a potentiometer which reduces the Y input to prevent distortion. But it may be unnecessary where a "sync switch" is incorporated, for these instruments have an internal connection and an alternative external route to the X timebase, and the refinement of a "sync selector" completes the facilities and allows triggering. In addition to this, an X amplifier can

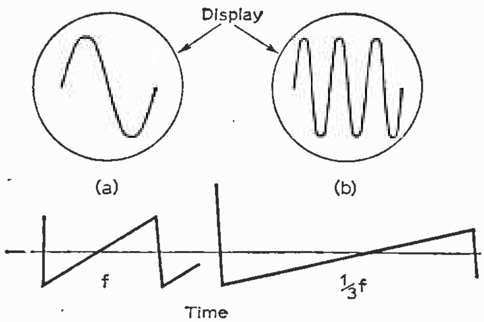


Fig. 2: Sawtooth timebase and sine wave input signal. (a) time of sweep duration approximates time of complete cycle of signal, (b) timebase running at one-third signal frequency.

be used to provide trace expansion, which allows a portion of the scanned waveform to be inspected.

Trace Expansion

As an example of the above facility of "trace expansion" an amplifier connected between the timebase and the X plates of the tube may have a gain which provides a linear expansion of ten times. The effective sweep length can be expanded from six to 60 centimetres and a portion of a waveform which would otherwise be too cramped for comfortable observation is displayed on the whole face of the small tube.

So we now have at least three controls for the X timebase: a coarse frequency control, giving typical ranges from 10c/s to 5 kc/s; a fine frequency control which covers the intermediate frequencies of oscillation between the switched steps and a gain control which provides sweep expansion. Collectively these may be referred to as "sweep controls" and the typical specification denotes the time per sweep length as in milliseconds per centimetre. The range may be from 500msec to 1μsec per centimetre. This should not be confused with the frequency range of the oscilloscope, which refers to the coverage of the Y amplifier.

The generation of an accurate sawtooth voltage is an important part of oscilloscope design. A number of ingenious circuits have evolved both for the basic oscillator and for associated amplifiers. Some representative circuits are shown in Fig. 3 and the choice of an ultimate design depends largely upon the current requirements, the timebase frequency coverage, the c.r.t. characteristics and the general design of the rest of the instrument.

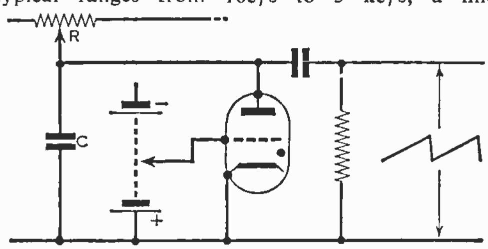


Fig. 3(a): Thyratron timebase.

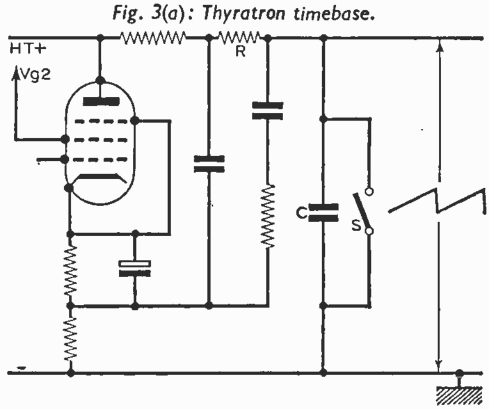


Fig. 3(c): Cathode follower, basic circuit.
Fig. 3(d) (right): Pentode as charge resistor.

Timebases

Basically this part of the circuit consists of a means of charging and discharging a capacitor through a resistor. For this reason these components are marked C and R in the diagrams. Choice of components is made to ensure that the sweep speed allows the rise-time of the Y signal to be displayed over about one-tenth of the screen; that the flyback time should be as short as possible; and a blanking pulse is then applied to the c.r.t. to avoid the confusion of misleading traces and that synchronisation of the timebase with the Y signal is made possible.

There are various advantages and defects of

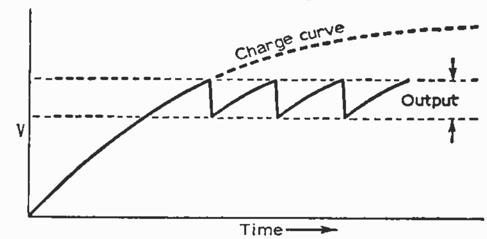
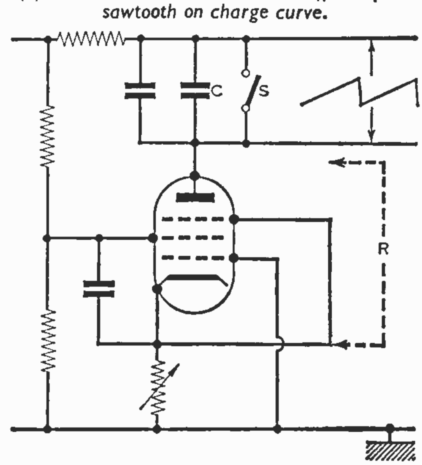


Fig. 3(b): Choice of CR combination affects position sawtooth on charge curve.



alternative circuits, but this is not the place to enter into a discussion—even a controversy—about oscillator design. Perhaps the most popular method of obtaining a "linear" sawtooth of sufficient output, with short flyback, is the Miller Transitron and this will be discussed at greater length.

Many of the older instruments employed a thyratron timebase such as illustrated in Fig. 3(a). Here the capacitor is charged to a determined voltage, but only partially discharged, and the output is a direct voltage on which the sawtooth is superimposed as in Fig. 3(b). The d.c. component is filtered out before application to the deflecting plates of the tube. But the introduction of a coupling circuit and, indeed, the necessary inclusion of some form of amplifier, affects the charge rate. Some velocity distortion may also be apparent by alteration of timebase frequency.

The amplifier can be designed within very accurate limits, but in this work it must be considered as part of the whole timebase and there are several considerations that apply. The time constants of the coupling components must be sufficiently high to avoid distortion of the transferred voltage and the output should be in phase with the input. A two-stage amplifier is therefore needed for a 180° phase shift.

Of course this phase shift can be obtained by other means, as demonstrated in the circuit of Fig. 3(c), where a cathode follower is shown. The switch S is the discharge device and, as we shall see, is part of the electronic circuitry, not a mechanical switch.

Constant Current Device

In another theoretical configuration, Fig. 3(d), the charge resistor R is replaced by a pentode valve, taking advantage of the fact that the anode current of a pentode is largely constant over a great part of the Ia/Va characteristic as depicted in Fig. 3(e). The curvature of the characteristic can

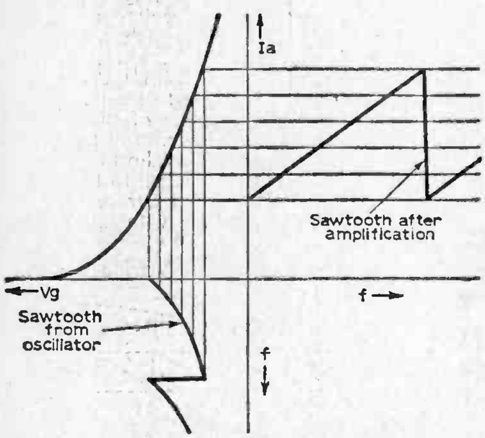


Fig. 3(e): Curvature of amplifier Ia/Vg characteristic can be used to correct distortion in exponential applied signal.

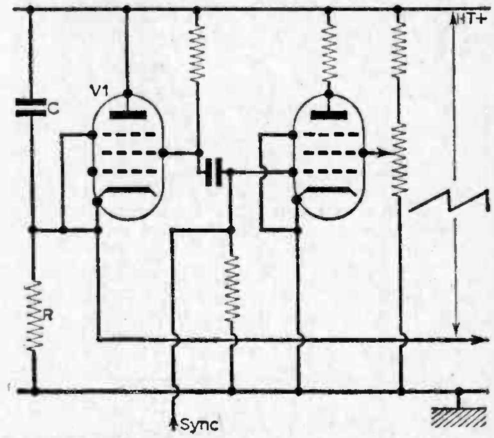


Fig. 3(f): Two-valve timebase with one pentode as feedback element and the other as switch.

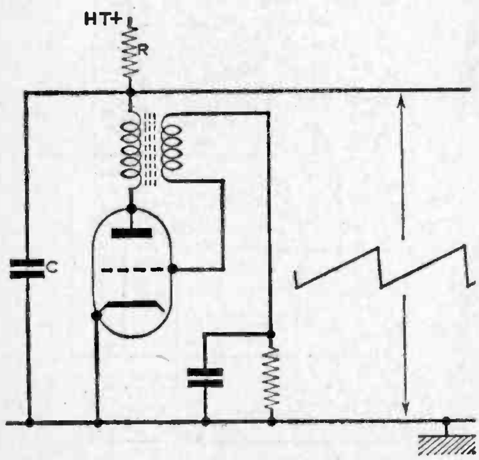


Fig. 3(g): Blocking oscillator timebase.

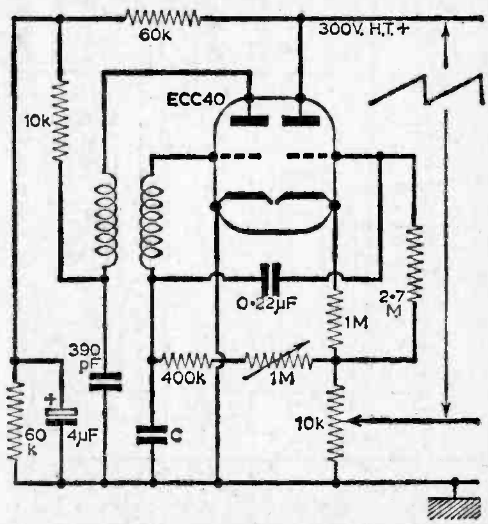


Fig. 3(h): Squegging oscillator timebase.

be used to provide compensation for an exponential waveform, as this diagram shows, and this design is the fundamental stepping point for the practical techniques that follow.

Our next circuit, Fig. 3(f), shows the connection of two pentodes with one acting as the switch part of the circuit and the other as the feedback element. A double triode can be used — and has been in many simple instruments for home constructors—but the higher input capacitance of the triode has its effect on the flyback ratio. In the arrangement of Fig. 3(f) no coupling capacitor is needed between the second anode and first grid, and the amplitude of the sawtooth is less dependent on frequency. A potentiometer control in the screen grid of the second pentode allows amplitude variation, controlling the anode current, and thus the V1 grid voltage and the anode voltage, consequently, at which V1 commences conducting.

This multivibrator circuit has its disadvantages: the cathode of V1, for example, is at a fairly high potential, and it is necessary to avoid high heater-cathode stresses by feeding the heaters from a separate power pack winding.

Blocking and Squegging Oscillators

A simple alternative, using a single valve, is the familiar blocking oscillator shown in Fig. 3(g).

This type of circuit will not often be used except for special applications, for its fundamental advantage, stability and high output at its resonant frequency, is also its basic drawback; less flexibility for frequency control over the wide range necessary for a "general purpose" instrument.

A more practical circuit, which can be built around the windings of a 470kc/s i.f. coil for experimental work, is the squegging oscillator of Fig. 3(h). By making C a series of switched capacitors between 150 and 50,000pF, and other components as shown, a timebase frequency of 20c/s to 20kc/s can be achieved with an amplitude of 54 to 42V peak to peak, a flyback ratio of 1:40 to 1:12, depending on the charge resistor setting, and a velocity error of −8·8 to −5·4%. This interesting circuit derives from the Philips Technical Library publication, "An Introduction to the Cathode Ray Oscilloscope", by Harley Carter, A.M.I.E.E.

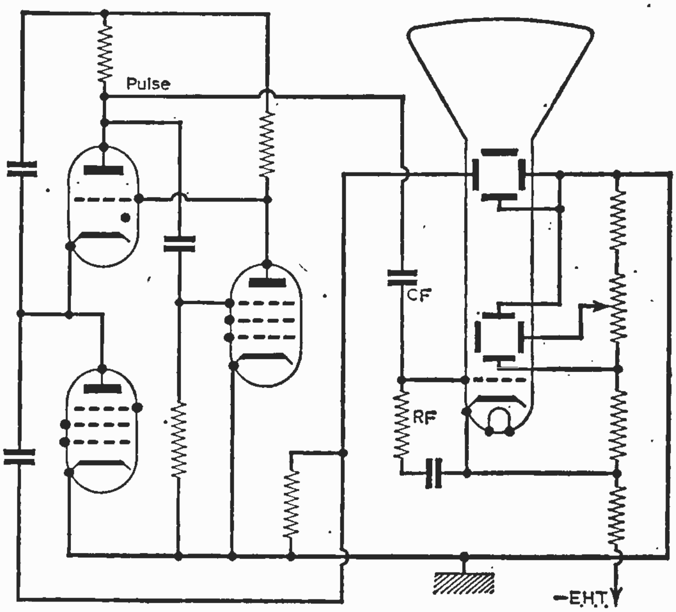


Fig. 4(a): Puckle timebase with blanking pulse applied to c.r.t. grid.

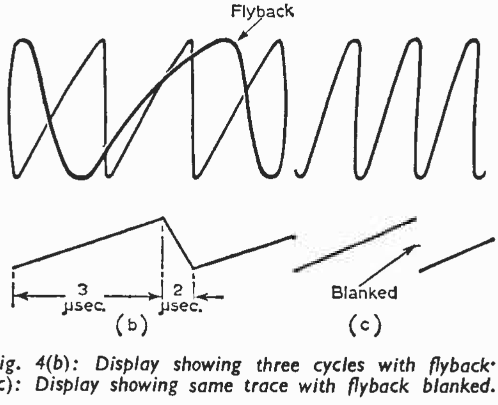


Fig. 4(b): Display showing three cycles with flyback. (c): Display showing same trace with flyback blanked.

Eliminating Flyback

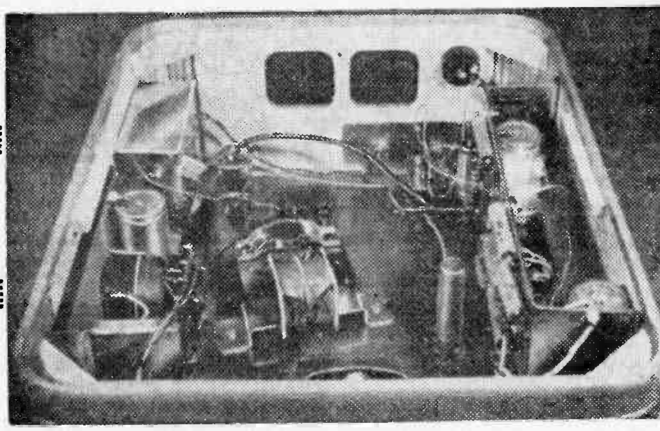
Blanking circuits are deceptively simple. On many television receivers, for example, the "frame flyback" components consist of no more than a capacitor and resistor taken from a convenient point in the frame oscillator/output. A similar principle is used for some oscilloscope timebases as in the case of the Puckle timebase shown in Fig. 4(a). The need for a flyback eliminator becomes apparent as the frequency of the signal under inspection is raised. Fig. 4(b) shows the sort of trace one would expect from a 1Mc/s timebase and a signal of a frequency that provides about three complete cycles of trace. The outward trace has a 3μs duration and the flyback pulse 2μs. The result is that for three cycles of our required signal we obtain also two cycles of a flyback signal. Suppression of the flyback provides us with a clear trace as in Fig. 4(c). This is done by applying a negative pulse to the grid of the tube with a high-rated capacitor and a suppression resistor connected from a convenient circuit point.

This is not always so simple as it appears: there is a risk of cross-modulation and parasitic oscillation at the higher timebase frequencies, which is just when the flyback elimination is most needed. Moreover the connection of the blanking circuit to the oscillator may affect its stability and there may not be a convenient point to extract a negative pulse. It is for this reason that we sometimes come across an additional stage; a positive pulse is taken and a phase inverter added.

PART 7 APPEARS NEXT MONTH.

THE MALVERN TAPE RECORDER

By T. Snowball



CONTINUED FROM PAGE 219 OF THE JULY ISSUE

THE output transistors are fed from Tr4 the OC71 driver, the collector load of which is somewhat more complicated than usual; the load resistor being the 1·8kΩ resistor R21 and the diode OA10.

A small d.c. voltage is developed across this diode due to the collector current, but of course no signals are developed across the diode, because of its low a.c. resistance. The small d.c. voltage developed this way is used to stabilise the quiescent current in the output transistors. The diode voltage changes with temperature and so controls the base voltages on the output transistors and keeps their current steady with variation in temperature.

The 100μF capacitor C16 feeds the audio signals on to the top of the 1·8kΩ resistor R21, so allowing larger drive signals to the output transistors during large volume peaks. Negative feedback comes via the 33kΩ resistor (R18) to the base of the driver transistor Tr4. If the centre point of the output stage tends to move, current is fed back through the 33kΩ resistor, which tends to cancel the original change; this works for both d.c. to counteract temperature changes, and for a.c. to reduce distortion and to lower the output impedance.

The output driver stage is fed from Tr3 with the treble boost circuit as the coupling network.

Treble Boost Amplifier

Tr3 (OC71) is a rather more normal stage with some negative feedback due to the 22Ω resistor R13 in its emitter lead. The 1kΩ collector load R12 feeds the treble boost circuit, which consists of a series resonant circuit L1, C11 shunted by a resistor (R16) and capacitor (C12). Without the shunt resistor, signals could only go through at the resonant frequency, thus the boost of high frequencies would be considered to be very large. But with the shunt resistor, the gain at other frequencies can be set by this resistor. With the value used the resistor cuts the gain by 6dB and when the coil resonates the signals go straight through. The sharpness of the peak depends on the "Q" of the tuned circuit and the value of the shunt capacitor, because this starts to feed the high frequencies through before the inductor resonates. This was shown in Fig. 2, last month.

The volume control VR1 precedes this stage and controls the amount of output applied from the feedback pair in the pre-amplifier stage.

Pre-amplifier

On record, the pre-amplifier consists of two transistors Tr1 and Tr2, GET106 (OC45) and OC71. These transistors are d.c. coupled in a temperature stabilised circuit, whose response is uniform from 50c/s to 5kc/s.

The first transistor is a GET106, which is used at a very low collector current of 400μA, to provide a low noise performance. The 200μF capacitor C6 decouples the feedback path to a.c., while the 4·7kΩ resistor R4 sets the current in the first transistor, by feeding in the voltage existing at the junction of the two 220Ω resistors R6, R7.

Of course, as this is a feedback circuit the

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7×4	8500	3	10/6
7×4	9500	3	11/-
7×4	9500	4	11/-
7×4	9500	5	11/-
7×4	9500	30	11/6

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8×2½	7000	5	9/-
8×2½	6000	6	8/6
8×2½	6000	30	9/6
8×2½	8500	5	9/6
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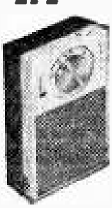

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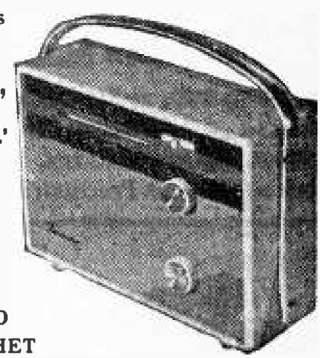

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characteristics of the transistors are largely taken out by the negative feedback; but unusual transistors may cause variations which cannot be taken care of by the feedback.

If any trouble is experienced, the best way of checking the circuit is to measure the supply at the circuit, while on record—which is the condition which gives the lowest voltage. Assume this measures 10V, then as the emitter of Tr2 should be at 0·3V, it is obvious that the collector of Tr2 should be between 3·5V and 6V in order to allow large voltage swings before cut-off or bottoming.

So with the h.t supply of 10V and collector load of 8·2kΩ the current should be between 0·5mA and 0·8mA, which of course is the easiest to measure, unless a high resistance testmeter is available.

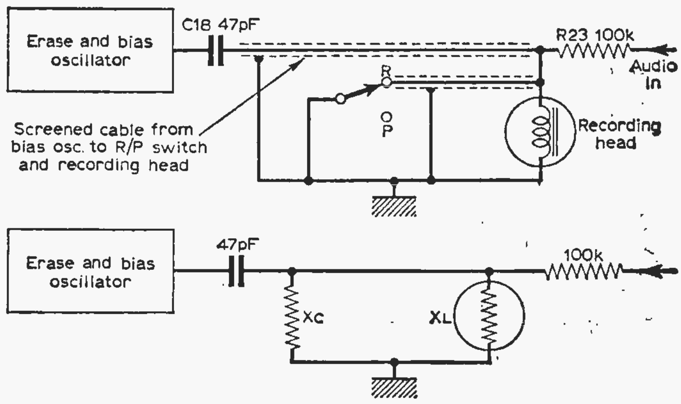

Fig. 5: Illustrating the effect of a long cable on bias power. Ordinary screened cable has a capacity of about 50pF/ft. If one foot of such cable is used at 60kc/s then Xc=50kΩ and XL=60kΩ, thus half the bias power will flow through the cable.

Input Conditions

The input to the pre-amplifier is fed in through series resistors of 1·5MΩ (R1) and 100kΩ (R2) in order to accommodate various amplitudes of input signals. As a guide, crystal microphones and magnetic pick-ups will be best connected via the 100kΩ resistor and high impedance outputs from radio tuners and crystal pick-ups through the 1·5MΩ resistor.

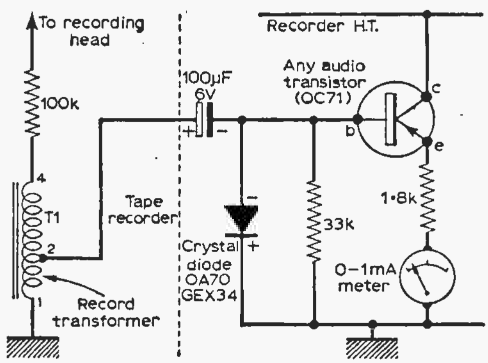

Fig. 4: A suggested recording level monitor.

THE PLAYBACK CIRCUIT

When used on playback the erase oscillator is switched off by the record/playback switch and the output stage remains as for "record", with the exception that the loudspeaker is joined directly across the output.

The treble boost circuit is removed from the collector or Tr3, and an RC circuit is inserted in its place. This gives a gradual rise of up to 3 or 4dB at 4kc/s in order to compensate for tape and head losses as already mentioned.

The characteristics of the feedback pre-amplifier are considerably changed by the removal of the 200μF capacitor C6.

The pre-amplifier now becomes an LR integrator, with the head inductance and the 4·7kΩ resistor R4 as the active elements. This provides a characteristic falling at 6dB octave that would be correct for an ideal head and tape. But as was shown earlier the output has to stop falling and remain roughly constant up to 4 or 5·kc/s. This is achieved by the 0·5μF capacitor C5 which removes the feedback at 1kc/s and above.

The overall frequency response was shown in Fig. 3 in which it can be seen that it is not linear at the low frequency end; this is due to the resistance of the head, but with the characteristic as shown it is matched to the system.

ADDITIONAL FACILITIES AND IMPROVEMENTS

So now, as in Fig. 1 is a tape recorder with facilities for monitoring the output as recording is in progress, switching to external loudspeakers, and also the possibility of some extra facilities by the addition of simple switches.

Straight-forward Amplifier

For instance, the motor switch S3 stops the motor when the recorder is required as an amplifier for records or radio. All that is required to perform this function is to put the record/play switch at record.

This switch is, of course, spring-loaded and should not be held in position by the tape deck control while the motor is not running; otherwise indentations may be made on the pinch roller. The solution here is to prepare a small block of wood which can be dropped in and so hold the record/play switch at record. Also when the motor is stopped, the switch cuts out the series resistor in the loudspeaker circuit, and also stops the erase oscillator by breaking the earth lead from chassis. This is a precaution to avoid overheating of the erase head if left on for long periods; or to prevent erasure of a small portion of tape near the head.

Extending the Frequency Response

If the constructor includes in his specification a larger loudspeaker housed in a separate cabinet, he no doubt would like to improve the recorder in order to take advantage of the better quality available.

The frequency response can be extended to at least 6kc/s by means of tuning the treble boost inductor to 6kc/s and increasing the amount of boost to 12dB. This is done by changing C11 to 2,000pF, R16 to 5·6kΩ and C12 to 0·003μF at the expense of 6dB in signal to noise ratio.

Minimising Distortion

In order to minimise distortion, a check in bias level is useful.

There is an optimum value of bias which gives less distortion but needs more h.f. boost to be applied during recording. The lower ranges of bias give more output from the tape on playback, but more distortion.

If the constructor wishes to check the bias current, a 50Ω resistor should be inserted in the earthy end of the recording head, and of course with 1mA r.m.s. bias current, there should be 50mV r.m.s. across the resistor. This can be adjusted by varying the value of the capacitor C18.

The measurement demands an oscilloscope or valve voltmeter because of the low levels.

The correct bias current for any particular tape is arrived at by recording a sine wave at 400c/s and increasing the bias in known steps from 0·4mA to 1·2mA. Then, when playing back, the output will be found to increase at first and then decrease; when it has dropped by about 2dB, this is the bias level for minimum distortion.

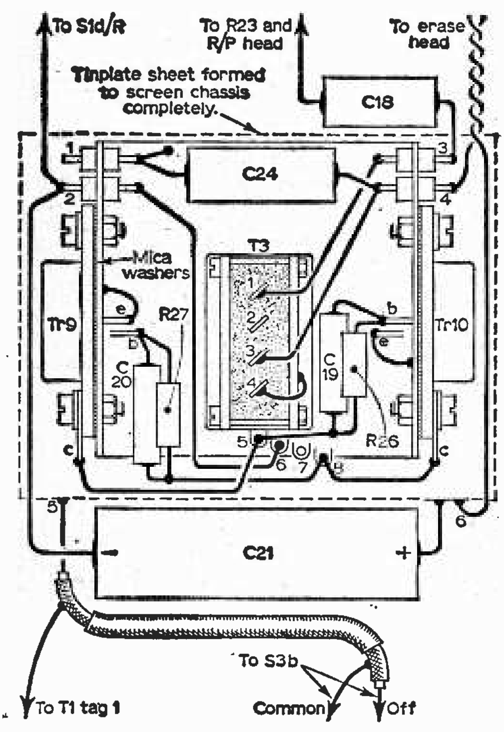

Fig. 6: Layout of the erase oscillator.

Recording Level Meter

The use of a recording level meter will mean that when recording large ranges of signal levels, such as orchestral items, it will be easier to make sure that the loud passages do not overload, and the quiet passages do not get lost in noise and hum. As the output stage is of very low output impedance it is easy to drive a cheap 1mA meter using a circuit as given in Fig. 4.

A simple transistor amplifier is used to drive the meter, since this was considered cheaper than using a more sensitive meter, such as 100 or 200μA movement. The circuit consists of a shunt diode rectifier and an emitter follower to provide a low drain on the rectifier, and also to supply the current for the meter. The 1·8kΩ resistor sets the meter reading and will give half-scale reading for the normal recording peaks, that is 150mA. The 33kΩ sets the amount by which the meter is slugged. These values may be adjusted as found necessary.

CONSTRUCTION

Plugs and sockets can be used to connect the deck to the circuits, but inevitably they add quite a lot of capacity to the head wiring, thus endangering the h.t. response and of course shunting the h.f. bias. This can be seen in Fig. 5 in which the cable from the bias feed point on the oscillator can be seen as a shunt capacitor to the h.f. bias, so indicating the need for as short a lead as possible.

Three Sub-Units

Bearing these points in mind, this tape recorder is built in three sections.

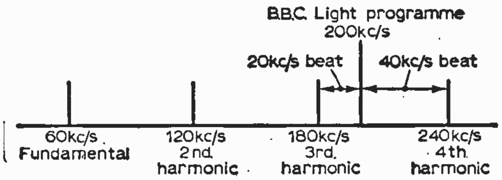

Fig. 7: Relationship between the frequencies of the bias oscillator and the broadcast station.

The three sections are easily seen in the illustrations and consist of (1) record/playback amplifier, (2) erase oscillator, and (3) power unit. Actually the head transformer is mounted separately on the tape-deck chassis, in order to get short leads to the erase chassis and to record/playback switch.

The erase oscillator should be reasonably well screened, as previously mentioned, in order to avoid pick-up in the amplifier; and also in this respect the lead from the bias output to the record/play switch and head transformer should be screened, short coaxial cable is best but ordinary screened cable will do if kept short.

Erase Oscillator

A sketch is shown in Fig. 6 giving details of how the erase oscillator was built. A screening can was made from thin tin, bent to shape and soldered to the chassis in two or three places after checking the operation of the circuit.

The chassis acts as a heat sink for the transistors but of course they must be electrically insulated from the chassis by thin mica washers. Suitable washers are usually supplied with the transistors. Remove all the sharp edges from the mounting

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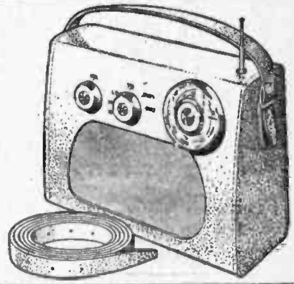

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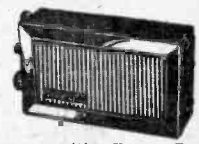

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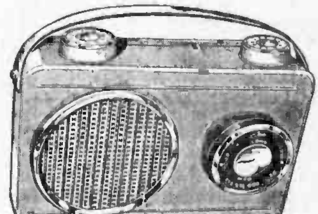

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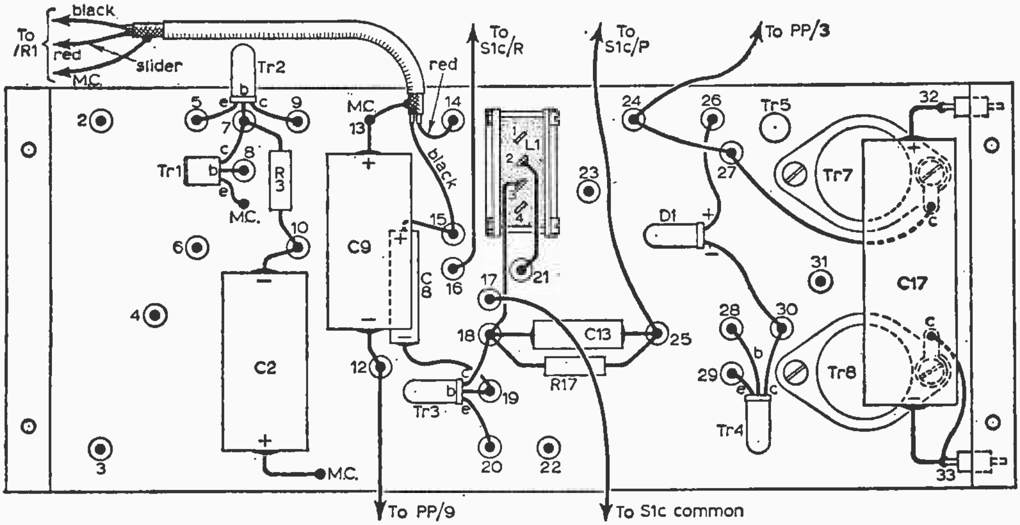
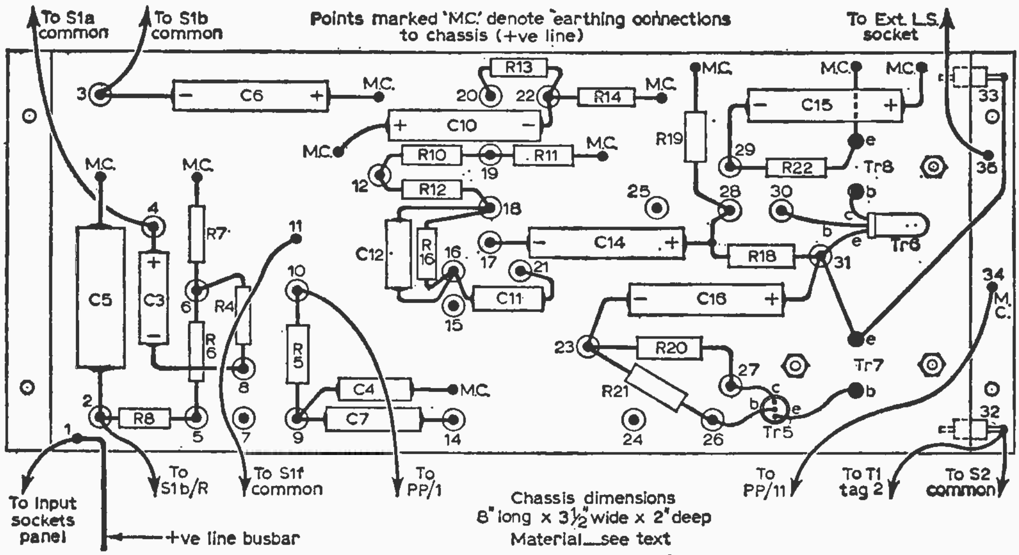


Fig. 8a (above): The top of the record/playback chassis and b (below)—the below-chassis view.



holes in order to avoid puncturing the mica washers when bolting down the transistors.

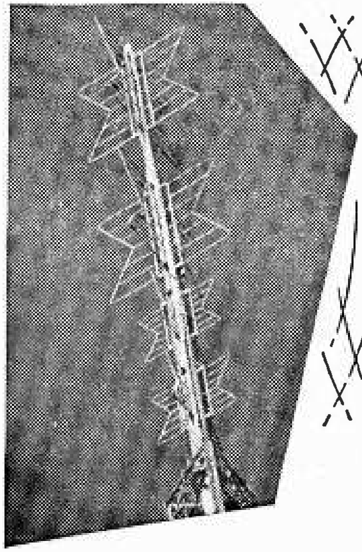
One point about the oscillator is that when a radio is used near, or inside, the recorder a beat between the station and an oscillator harmonic may cause a bad whistle. This can be cured by moving the oscillator frequency in order to make the beat inaudible. In Fig. 7 is shown the oscillator 3rd and 4th harmonics at 180 and 240kc/s if the fundamental is 60kc/s. This of course will cause no interference with the Light Programme on 200kc/s because the beat frequencies are 20kc/s and 40kc/s. But had the oscillator fundamental been 66kc/s, the 3rd harmonic would have been 198kc/s and the result would be objectional interference at 2kc/s on top of the station.

Changing the oscillator frequency is best performed by adding a small capacitor across C24. Use a small value as is necessary, in order to avoid changing the oscillator frequency too drastically

The Record/Playback Amplifier

The layout of the record/playback amplifier is sketched in Fig. 8 and the chassis can be made from tinplate for ease of making earth connections Push-through tags were used in the prototype, but these are rather expensive and stand-off insulators or small tagstrips are equally suitable for anchoring the components.

TO BE CONTINUED



On Your Wavelength

By THERMION

COMPARED with the glamour that has been bestowed upon the transistor the modern dry battery has received scant attention. Yet the unique features of the transistor could not have been fully exploited in the production of small portable apparatus without the availability of compact, highly reliable and efficient sources of h.t. current.

The advent of the layer type of battery represented the first major change in the methods of dry battery construction. This type battery is built up from a number of flat, rectangular units stacked together; the electrodes are flat plates and these provide a more efficient arrangement than the conventional Leclanche-type dry cell employing a cylindrical case and carbon rod.

Looking Back

It is interesting to reflect how the humble dry battery has regained or possibly surpassed its former pre-eminence of the early days of radio. Some of my older readers will surely recall the rows of 3V pocket torch batteries arranged alongside that masterpiece in a mahogany case and black ebonite panel. Then eventually, in response to the growing demand, the manufacturers produced the multicell package to supply our h.t. needs, and so the jungle of inter-connecting clips and leads disappeared. Next followed what may, I suppose, be described as the heyday of the old-style dry batteries (yes, accumulators as well!). Soon the widespread availability of a.c. mains supplies encouraged us to try the mains-operated battery "eliminator" for a while, until finally the all-mains valves came on the scene. From then until round about 1945 the radio battery had but a modest role to perform, mainly in battery portables, and these sets were comparatively rare—unlike the ubiquitous transistor radio of today!

The layer-type battery was originally developed and put into production to meet the requirements of the Services. In the post-war era this battery (like many other new developments) became available for general commercial use.

In its modern form, the dry battery has rebounded back into general use and indeed in so many of our activities and pastimes we have become dependent upon this miniature store of energy to power electronic equipment of some kind or other.

Is Recharging Practical?

I have often been asked whether it is possible to recharge a dry cell or battery. In theory primary cells (such as these) are not rechargeable.

However, it is no secret that in practice a certain amount of rejuvenation is possible in the case of the conventional round-cell battery, provided the cell has not been more than about half exhausted. Care is necessary since charging at an excessive rate will cause damage. It must be emphasised that this recharging treatment should not be attempted with layer-type batteries. Due to the compact nature of the cell units, gassing can easily occur if current is passed through them and the battery will be permanently ruined.

Bearing in mind the reasonable prices of present-day batteries and the low current taken by transistors, I cannot believe that it is really worth while to build mains-operated rejuvenators.

Twiddlers

Variable controls are irresistible! If you don't believe me just place a radio receiver, test instrument or any odd chassis (with knobs on) in front of someone who happens to be around. In no time he will be twiddling—and, more likely than not, doing this quite unconsciously. This habit is often harmless enough where operating controls are concerned, but there is the danger that a certain important preset control will next receive attention.

Some individuals are indeed a positive menace if let loose among exposed equipment. Be especially on your guard for the character armed with a newly acquired screwdriver or trimming tool which needs must be tested.

Apart from trouble and inconvenience caused by disturbed settings, the iron-dust cores of r.f. and i.f. coils are particularly susceptible to actual material damage should an oversize trimming tool be pushed into the slot, since this action may cause the core to fracture and become jammed in the former. It is usual for makers of miniature permeability tuned components to supply a suitable tool with each order. Keep this tool in some safe place, otherwise the occasion may arise when *you* will be tempted to carry out alignment with the wrong tool.

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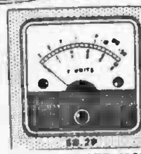

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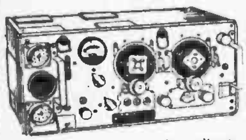

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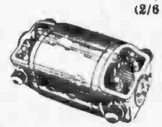

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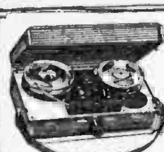

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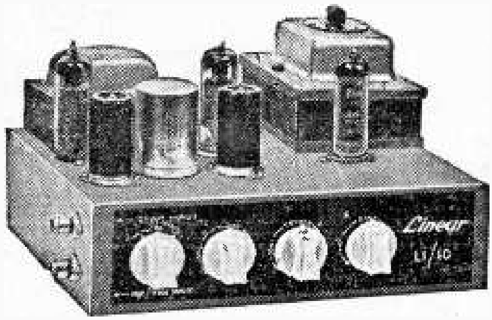

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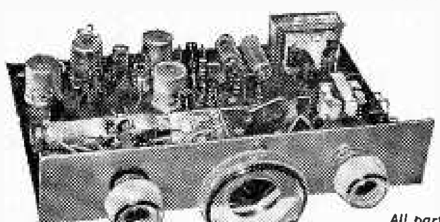

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TALKING POINTS ON CIRCUIT PRACTICE

No. 7—Transistor Characteristic Curves

Continued from page 232 of the July issue

IT has been suggested that as the characteristic curves published for transistors differ considerably from those published for valves, now that we have dealt with some of the fundamental aspects of transistors themselves, a few words on these curves and how to use them might be helpful.

There is quite a considerable number of curves published for transistors. The amateur is likely to be interested in only one or two of them. Basically the "Output-Characteristic" is likely to concern him most because by means of this curve he can judge what he can put into his transistor in the way of input, what he can take out of it without overloading it, what values of base bias he should use and what values of collector load.

The difficulty is that some readers may already understand the use of these characteristic curves and others may not. In keeping with the policy followed throughout these articles, therefore, we had better start with first things and explain just what these curves mean and how they are compiled.

"OUTPUT CHARACTERISTIC"

The "Output Characteristic" curve as published for transistors is obtained by fixing the base at a definite value of bias and then plotting a curve for output *current* with varying values of output *volts*, i.e. collector volts. This on the face of it may seem to be a queer method when what we really want to know is output values for various values of *input*. But let us examine it.

Let us fix the base bias at, say, to choose an arbitrary figure merely for the purpose of explanation, 40μA, sticking to bias in terms of current rather than volts as before. Let us then increase the voltage on the collector by gradual stages from, say, no volts to a maximum of 12V negative, and let us read the changing values of output *current* (by putting a meter in the collector or emitter lead) for each change of collector volts. We shall obtain a curve like the one marked "40μA" on Fig. 1.

Now let us repeat the process at a different value of base-bias, say, 20μA, and draw the curve corresponding to that value of bias. Repeating the procedure until we have a whole "family" of

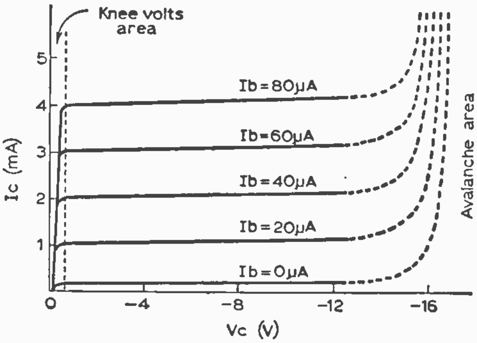

Fig. 1: Family of output-characteristic curves.

curves drawn on the same graph—each individual curve relating to one definite value of bias on the base (assuming common-emitter configuration as before).

Now let us look at these imaginary curves of Fig. 1. Each one of these curves, taken at different values of bias on the base, exhibits similar characteristics. The first thing we notice is that with Vc=0 volts collector *current* is substantially zero. As we increase Vc there is a sharp rise in current over the first tenth or so of a volt until, at a defined value of Vc—something less than 1V—the current reaches its maximum value, after which no matter how much we increase the voltage on the collector it rises no more, right up to the maximum value shown, 12V negative.

This restates in graphical form what we have said more than once in this series of articles, namely that collector *current*, with transistors, is independent of collector voltage; unlike valve technique where the anode current is determined largely by the anode voltage and varies as the anode voltage varies quite apart from variations due to variation of grid bias. This is one of the large differences between transistors and valves. Output current in transistors does *not* depend upon output voltage. They are controlled, as regards current, solely by the bias on the base.

Having made that statement we must now say that it is not entirely true. Obviously over the first few tenths of a volt Vc the current depends very much on collector voltage; it is only after that that the curve levels out and it ceases to be influenced by changing collector volts. It would also cease to be true were we to go on increasing the collector voltage beyond the value of 12V shown . . . we would reach a value at which the current would start to rise again very sharply and we would get the curves shown dotted in Fig. 1 and the transistor would be destroyed.

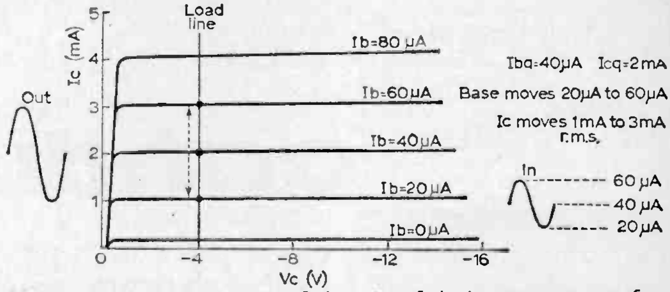

Fig. 3: This shows how a magnified version of the input current waveform appears in the collector circuit.

But what is true is that *over the range of normal operation*, that is from a few tenths of a volt Vc (known as the knee voltage) up to the critical voltage at which the "avalanche effect" commences, collector current is not influenced by collector voltage. It is no part of our purpose to consider avalanche effects here since these lie beyond the voltages at which the normal user is likely to operate a transistor.

The knee-voltage, however, we must consider, for this represents the minimum voltage which we must use on the collector to achieve linear transfer (input/output). This differs from transistor to transistor and, as a glance at the figure shows, it increases slightly as the value of base bias is increased, but is still only a few tenths of a volt.

Another point which is shown in these curves is the fact that with even no base bias at all, i.e., with base open circuit, a definite collector current . . . very small but nevertheless there . . . still flows. This is the leakage current and may average round about 100μA.

These curves, therefore, give a complete picture of what happens to collector current at various values of base-bias, at any collector potential from no volts to -12V.

PRACTICAL APPLICATION

Having understood this, then, now for the practical use of these curves. Let us use a battery voltage of 4V for our collector supply. Vc will then be -4V. Let us place a standing base-bias on the transistor of 40μA. Looking at the 40μA curve in Fig. 1 we see that at this collector voltage the collector current will be 2mA.

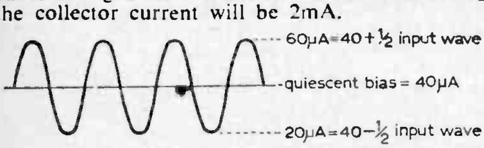

Fig. 2: A sine wave input signal.

Suppose now a sinewave of sufficient amplitude be fed on to the base to move the base-bias up to 60μA and down to 20μA as the signal changes (Fig. 2). We will not worry at the moment about what the r.m.s. voltage of the sinewave would have to be, we will simply assume that it is sufficient to increase the current passed through the base/emitter path of the transistor from 40μA to 60μA on the negative half of the wave, and sufficient to decrease it to 20μA on the positive half of the wave.

It will be obvious then that the characteristic of the transistor output will travel upwards from the 40μA curve to the 60μA curve, and correspondingly down to the 20μA curve. It will move above and below the standing (40μA) bias—from one curve to the other.

The collector voltage remains that of the supply, 4V, therefore if we draw a vertical "loadline" at the 4V point on the horizontal axis, passing through the three curves (Fig. 3), the output will swing, as shown by the arrow; the variation in output current according to input signal will be between 1mA and 3mA, about a standing value (with no signal) of 2mA.

If we increased the value of the incoming wave then the output would swing further up and down the loadline . . . say from 0mA up to 4mA.

Reducing the amplitude of the signal would have the reverse effect. Ic might swing only between 1·5mA and 2·5mA, but it would still swing up and down the loadline we have drawn; collector volts would not change, only collector current.

It is seen, then, that the transistor is a current amplifying device—changes in current passing via the base are reflected in (amplified) changes in current via the collector. The amplification factor or "gain" of the transistor is a pure ratio: of input current/output current.

If 100μA input produces 1,000μA output, then the gain of the transistor is 10—remembering the point brought out in earlier articles that the gain of a transistor is not constant . . . suppose it be 10 at a certain value of base current (small signal conditions), it may have a different value at large values of base current (large signal conditions). We have already dealt with this point in past articles and cannot go into it again here.

So far, so good. If we have understood how these curves are drawn, and how to use them, we

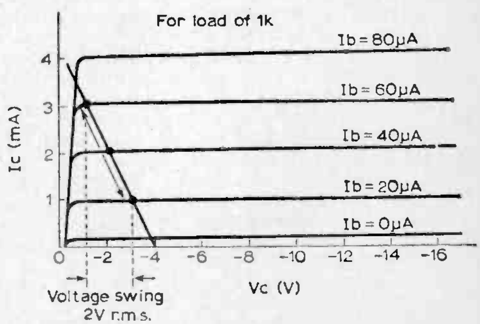

Fig. 4: Loadline for collector load of 1kΩ.

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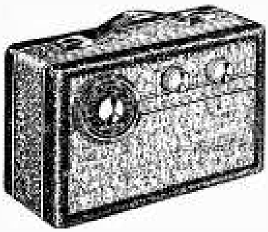

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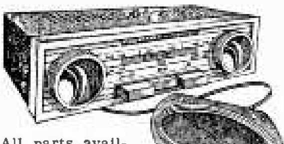

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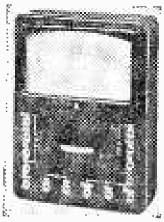

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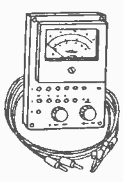

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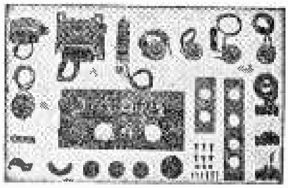

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PLASTIC SPOOL CONTAINERS for spool sizes 5in. **1/6**; 5¾in. **2/-**; 7in. **2/3**.

PLASTIC TAPE SPOOLS. Best quality. 3in., **1/3**, 4in., **2/-**, 5in., **2/-**, 5¾in., **2/3**, 7in., **2/6**. P. & P. 6d. per item. Orders over £1 post free.

must now realise that the output curves as published refer to the performance of the transistor *with no load in the collector circuit*—a condition impossible to obtain in practice.

Let us assume now, then, that we have a resistive load of 1k ohms in the collector (emitter) circuit. Any load in the emitter is also in the collector, of course, as well as in the base circuit. Keeping the same quiescent bias on the base, namely 40μA, the current as before will be 2mA (from the 40μA curve). But now the 2mA passes through the 1kΩ load, which drops 2V, so that the actual voltage on the collector under quiescent conditions is now 2V.

We must now plot a fresh loadline (Fig. 4). The transistor is now seated at Ic=2mA Vc=2V in quiescent conditions. The incoming signal on the base, moving the base as before, swings the output current between 1mA and 3mA, over the standing value of 2mA, as before. But at the maximum Ic of 3mA the 1k ohm load drops 3V (Fig. 4). At the minimum value of Ic the load drops 1V. Joining on the graph the point 3mA—1V (4V—3V) and 1mA—3V (4V—1V) we get a new loadline as shown. The characteristic now travels as shown by the arrow in Fig. 4.

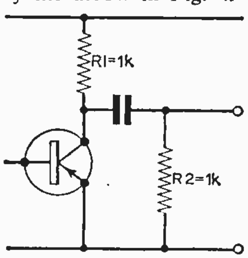

Fig. 5: R.C. interstage coupling.

It will be seen that the current changes in the output are the same as before, for the same changes in input (namely the gain of the transistor), but there are now voltage changes in the output also, developed across the load. And the *slope* of the loadline is different.

The current swing in the output, therefore, is independent of the load, but by introducing a load we have achieved voltage swing as well as current swing, the voltage swing depending upon the value of the load.

Now take another and very practical set-up. Let us suppose that we are going to connect our transistor to a following stage through a normal RC coupling such as Fig. 5. Let the value of the capacitor be sufficiently large to have negligible reactance so that we can ignore it as far as signal a.c. is concerned. Let the value of R2 be another 1k ohm (for simplicity).

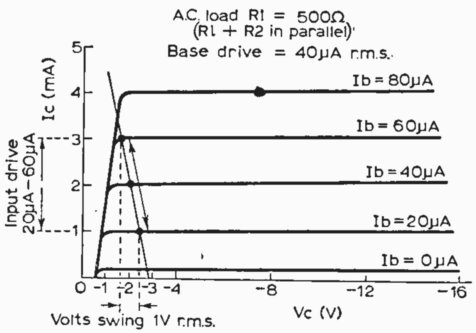

Fig. 6: The graph modified for an effective load of 500Ω.

Now let us draw a loadline for the new set of conditions (Fig. 6).

So far as the standing d.c. is concerned the capacitor isolates the collector of the first transistor. Taking the same standing base-bias, 40μA, therefore, Ic will be 2mA (d.c.) at any value of collector volts . . . but we have 1k ohms in the collector circuit, which drops 2V at 2mA; the transistor therefore is seated d.c.-wise at the same point as before, namely 2mA—2V (4V—2V). Now let the d.c. signal come on to the base, moving it as before so that the output current Ic moves between 1mA and 3mA. At a.c. the capacitor no longer isolates the collector from the following stage but can be considered as virtually a short-circuit. Therefore, as explained in previous articles, we have R2, the resistive factor in the RC coupler, as far as a.c. is concerned, in parallel with R1, reducing the total value of the load in the collector circuit from 1kΩ to 500Ω (to a.c.).

As Ic rises to 3mA on signal, 3mA drops 1·5V through 500 ohms, but the transistor is already seated (d.c.-wise) at 2V with 2mA flowing. Ic increases by 1mA (to 3mA) on signal and decreases by 1mA (to 1mA) on signal. These changes are at a.c. frequency, half being developed over the collector load R1 and half over the coupling resistor R2. The characteristic, therefore, now travels as shown by the arrow (Fig. 6), the 1mA swing on either side of the standing value producing only 0·5V on each side of the standing value.

As before, current swing is unchanged but voltage swing, dependent upon the load, is now reduced, because by introducing the RC coupling we have effectively reduced the value of the load (to a.c.) by half.

It is obvious, therefore, that if we are going to use RC coupling to the next stage the loadline we drew previously, which did not take into account this RC coupling, is useless. We would in practice be getting far less gain (volt-wise) from our stage than we had calculated on getting.

How we overcome this difficulty by shifting the loadline will be dealt with in the next article.

SERIES CONTINUED NEXT MONTH

CLUB NEWS

AMATEUR RADIO MOBILE SOCIETY
Hon. Sec.: G3FPK, 79 Murchison Road, London, E.10.

The fourth International Mobile Rally organised by this Society was held successfully on June 16th at the United States Air Force base, Barford St. John, Oxfordshire. As in previous years, mobile amateurs gathered from all parts of the country and from abroad to join in this stupendous occasion.

The main attraction for visitors, many of whom made a weekend of it by camping out on the previous night, was the appearance of the United States Third Air Force band. Many other attractions and events made the rally really enjoyable for all who attended and especially so for those who took home the many prizes which were won.

BRADFORD RADIO SOCIETY
Hon. Sec.: E. G. Barker, G3OTO, 63 Woodcot Avenue, Baildon, Shipley, Yorkshire.

"Adjustment of Linear Amplifiers" was the topic for A. W. Walmsley's lecture which he gave on June 11th. On 25th June members paid a visit to the C.E.G.B. power station at Canal Road, Bradford.

DERBY AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: F. C. Ward, G2CVV, 5 Uplands Avenue, Littleover, Derby.

This Society operated two stations from Glebe Farm, Littleover, in participating in N.F.D. this year.

The "open evening" meeting of June 19th was followed a week later by the third d.f. practice run. The R.S.G.B. d.f. qualifying event held at Derby on June 30th was organised by members A. Hitchcock and F. Allsopp.

EAST WORCESTERSHIRE GROUP
Hon. Sec.: L. Hickingbotham, G3HZG, 95 Oakenshaw Road, Redditch, Worcestershire.

This group meets on the second Thursday of each month at the Old Peoples Centre, Park Road, Redditch, and at the June meeting a number of members described their stations and operating activity.

FLINTSHIRE RADIO SOCIETY
Hon. Sec.: Alan Antley, Fairholme, Fairfield Avenue, Rhyl, Flintshire.

As usual, unlicensed members were able to get in some morse practice before the main meeting for June began. This was followed by another lecture from L. W. Barnes on "Simple Hints and Kinks", and arrangements for v.h.f. field day took up the remainder of the evening.

LOTHIANS RADIO SOCIETY
Hon. Sec.: W. T. Sutherland, GM3JWS, 47 Great King Street, Edinburgh 3.

Although the most important meeting in June was the Annual General Meeting, a good deal of interest was raised by a Constructional Competition for members which was held earlier in the month on June 13th.

MID-WARWICKSHIRE AMATEUR RADIO SOCIETY
Hon. Sec.: T. Inkester, 13 Dormer Place, Leamington Spa, Warwickshire.

As the Whitsun holiday coincided with the first meeting date of June, no meeting was held on the 3rd. However, on June 17th, members assembled at the Leamington Boys Club to hear a lecture on "Microphones."

At the July meeting held on the 1st, "Transistors" was the subject under discussion.

NORTHERN HEIGHTS AMATEUR RADIO SOCIETY
Hon. Sec.: A. Robinson, G3MDW, Candy Cabin, Ogden, Halifax, Yorkshire.

The meeting for June 19th was the usual ragchew, with anything and everything being discussed informally. Earlier in the month, however, members manned a demonstration station at the Halifax Fete, under the call sign G3MDW/A. This is the first of four such demonstration stations which this Society has undertaken to provide this year.

On July 3rd, the Society visited the local C.E.G.B. power station at Elland which is near Halifax itself.

READING AMATEUR RADIO CLUB
Hon. Sec.: R. G. Nash, G3EJA, "Peacehaven", 9 Holybrook Road, Reading, Berkshire.

On June 29th the Club met to hear a discussion by Mr. Shears on a range of gear which is available to amateurs today.

If there are enough interested members, the Club is hoping that the Reading Technical College will arrange a course of lectures covering the R.A.E.

SHEFFIELD AMATEUR RADIO CLUB
Hon. Sec.: D. A. Justice, G3PYL, 9 Leslie Road, Sheffield 6.

The Meeting for June, which fell on the 14th, was mainly devoted to a demonstration by G3LLV of "Radio Teletype."

SLADE RADIO SOCIETY
Hon. Sec.: D. D. S. Williams, 117 The Boulevard, Wylde Green, Sutton Coldfield, Warwickshire.

Some of the Society's newly licensed members gave accounts of their experiences prior to and during the R.A.E., at the meeting for June 14th.

On June 28th, Mr. J. E. Smith continued his series of lectures on "Radio Fundamentals."

The one d.f. event for June was the Harcourt Trophy test, which was run on the 16th.

SOUTH SHIELDS AND DISTRICT AMATEUR RADIO CLUB
Hon. Sec.: Derek Forster, G3KZZ, 41 Marlborough Street, South Shields, Co. Durham.

This Club is to hold its 5th Mobile Rally on Sunday, July 7th at Bents Park Recreation Ground, Coast Road, South Shields. The control station—G3DDI—will be operating on 160m.

SOUTH YORKSHIRE AMATEUR RADIO SOCIETY
Hon. Sec.: V. J. Ludlow, 50 Wellington Road, Lindholme, Hatfield, Doncaster, Yorkshire.

Formal meetings, which are now held fortnightly, alternate with constructional evenings when the club transmitter is in operation.

Members are building a 14Mc/s phone transmitter to supplement the 160m rig already operating under the Club call sign.

SPEN VALLEY AMATEUR RADIO SOCIETY
Hon. Sec.: L. A. Metcalfe, 1a Moorlands Road, Birkenshaw, Bradford, Yorkshire.

On June 15th F. L. Allen gave a lecture entitled "Oscilloscope Patterns."

The meeting on June 27th was the last of the Society's meetings for the year 1962/63, before the Annual General Meeting to be held on July 11th.

STOURBRIDGE AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: R. A. G. MacIntosh, 50 Field Lane, Oldswinford, near Stourbridge, Worcestershire.

The Society was represented at an exhibition staged at the Town Hall, Stourbridge, during June, and in conjunction with this exhibition, a working station was set up by members in a local park.

On July 2nd, Mr. T. R. Smith (G3BMN) delivered a lecture with the title "Mobile."

WESSEX AMATEUR RADIO GROUP
Hon. Sec.: G. K. Fowle, 138 Surrey Road, Branksome, Poole, Dorset.

This Group reports a steadily increasing membership and a number of these members faced the Southampton R.S.G.B. Group in an amateur radio quiz held on 10th June. This quiz, which was a return match, was followed by a talk on "Radio Controlled Boats" by G. Wood.

Mr. Simmonds (G8VB) was the judge of the constructional contest open to all members and held on 1st July.

WEST KENT AMATEUR RADIO SOCIETY
R. Trevitt, 28 Delves Avenue, Tunbridge Wells, Kent.

W. H. Allen's lecture given on June 14th was on the subject of "2m Convertors." On June 28th, G4IB gave a talk on "Modulators."

WIRRAL AMATEUR RADIO SOCIETY
Hon. Sec.: A. Seed, G3FOO, 31 Withert Avenue, Bebington, Wirral, Cheshire.

On 19th June the Society conducted an inquest into their participation of N.F.D.

On the agenda for July 3rd was a talk by L. Flint entitled "Metals."

WOLVERHAMPTON AMATEUR RADIO SOCIETY
Hon. Sec.: J. Rickwood, 738 Stafford Road, Wolverhampton, Staffordshire.

On June 15th, this Society organised a mobile rally to run in conjunction with a local sports day and gala. Many prizes were awarded to mobile visitors and the numerous other attractions made the occasion enjoyable for all those who attended.

R.S.G.B. Contests for July. Second 144 Mc/s Portable Contest (July 6th to 9th) and D/F Qualifying Event (July 21st).

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VIBRATOR POWER SUPPLY UNIT

6 volts D.C. input, 230 volts 100 mA A.C. output and 6 V. L.T. out. Fully smoothed, with OZ4 rectifier valve. Brand new in steel case with pilot light, on/off switch and Slydlok fuse on front panel. Measures 8¼ x 6 x 5¼in. 39/6 plus 6/6 post and packing.

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Westinghouse 1,000 P.I.V. 500 mA, 9/- each. 800 P.I.V. 500 mA, 7/6 each. 400 P.I.V. 200 mA, 3/6 each.

SELENIUM F.W. HIGH CURRENT BRIDGE RECTIFIERS

18 v.	8 amps.	4¼in. sq.	Price	19/6
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18 v.	36 amps.	7¼in. sq.	Price	79/6
18 v.	54 amps.	7¼in. sq.	Price	117/6
36 v.	8 amps.	4¼in. sq.	Price	39/6
36 v.	18 amps.	7¼in. sq.	Price	79/6
36 v.	36 amps.	7¼in. sq.	Price	119/6
36 v.	54 amps.	7¼in. sq.	Price	235/-
54 v.	8 amps.	4¼in. sq.	Price	59/6
54 v.	18 amps.	7¼in. sq.	Price	117/6
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Voltages indicated are maximum input volts and amps. are max. current out. Supplied brand new and guaranteed. Not government surplus.

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100-150 Mc/s. Contains 0-1 mA meter. 1S5 valve, chrome telescopic aerial, etc. New condition in black crackle case. Operates on 1.5 V. and 90 V. batteries. Dimensions: 7 x 7 x 7in, 45/-. P. & P. 2/9.

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AR 88 LF RECEIVERS

75-550 Kc/s and 1.5 to 30 Mc/s. 110/240 v. A.C. input. In as new condition and fully tested £30. Carriage and packing 25/-.

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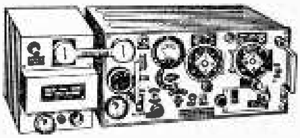

Complete with original power supply unit for 12 volts input. Transmitter/Receiver covering 2-8 Mc/s and V.H.F. 240 Mc/s. 6 valve superhet receiver and 6 valves in Transmitter. Using I.F. of 465 Kc/s. For voice and C.W. In good condition not tested. £4.17.6. Plus £1 packing and carriage. **Microphone and headset for this set 17/6** plus 2/6 post and packing. **19 Set Variometers, 17/6** plus 2/6 post and packing. **Control box for 19 set, 10/-** plus 2/- post and packing.

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0/20/50 mA, 0/100 mA, 0/15 mA, 0/500 mA, 0/50 mA, 0/300 volts D.C., 0/30 volts D.C., 0/50 volts, 0/100 volts, 0/5 Kv, 0/500 volts, and many others. All in perfect condition (surface mounting).

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Pri.: 240 volts. Output 6.3 volts 5 amps, 8/6, post 2/6. Pri.: 240 volts. Output 17 volts 1 amp., 9/6, post 2/-.

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Type (350/120) Tapped 200/250 V. input 350/0/350 v. 120 mA. 6.3 V. 3½ amp., 5 V. at 2 amps., 16/6. P. & P. 3/6. Type 5K Pri. 200/250 V. Output 350/0/350 V. 350 mA. 5 V. 3 amps. Tapped 4 V. 2 V. 2 amps. 10 kV. ins. 20 V. 1 amp. 7.5 V. 1 amp. 5 kV. 5 mA. Price 25/-. Post & Packing 6/-.

SPECIAL H.D.

50 volts 10 amps. transformers. 250 volts input. Brand new and boxed. Conservatively rated. 55/- each. Carriage 7/6.

ASSORTED PACKETS OF 100 BRAND NEW RESISTORS

including miniature and high stab., 12/6 post paid all useful values.

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including mica, ceramic, metal tubular etc. 15/- post free.

VARIABLE AIR-SPACED CONDENSERS

150 pFd with ¼in. spindle, 4/6 each.
75+75 pFd with ¼in. spindle, 4/6 each.
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100 pFd pre-set, 2/- each.
50 pFd pre-set, 1/6 each.

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Ex R.A.F. strap-on type. Perfect condition. 2/6 each, post paid.

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WOBBULATOR FREQUENCY MULTIPLYER

Band 1. Channels 1-13, with 50 micro/ammeter and 0-80 dB attenuater. £9. P.&P. 10/-.

DECCA X.M.5 L.P. PICK-UP HEADS

Brand New. 8/6. P.&P. 1/-.

TF.144G STANDARD SIGNAL GENERATOR

85 Kc/s to 25 Mc/s. Fully serviced and in perfect condition. £36 post paid.

DOUGLAS AUTO TRANSFORMERS

Auto 115-200-230-250v. 300w. 45/-, P.P. 5/-.
Auto 110-120-200-240v. 75w. 16/-, P.P. 3/6.
Auto 115-200-230-250v. 500w. 76/6, P.P. 5/-.
Auto 115-200-220-240v. 1kW. 119/-, P.P. 6/6.

MOTORS 200v-230v 50c

Shaded pole. Made by Hoover for washing machines. Brand New, 30/- each, P. & P. 7/6 Also 115v. A.C. 22/6 each, P. & P. 7/6.

E.H.T. TRANSFORMERS

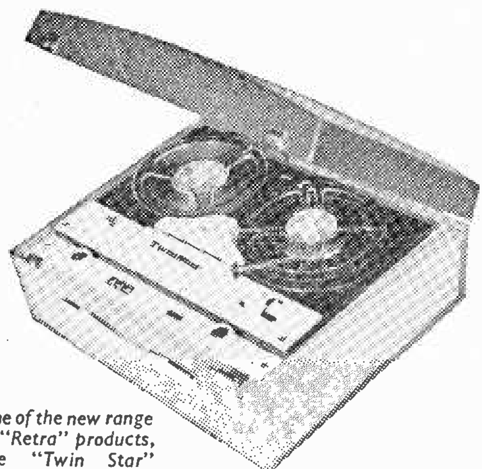
E.H.T.1. Input 200/250 volts 50 C/s. Output 2kV. 10 M/a 4 v. 1A. 0-2-4V. 1.5A., 22/6, P. & P. 5/-.
E.H.T.2. Input 200/250 volts 50 C/s. Output 2.5 kV. 10 M/a. 6.3 v. 3A. 2 v. 1.5A. 3.5 kV. D.C. Wkg., 22/6, P. & P. 5/-.
E.H.T.4. Input 200/250 volts 50 C/s. Output 2,000 v. 15 M/a. 4 v. 1.5A. 0-2-4 v. 2A., 29/6, P. & P. 5/-.

Trade News

Morse Trainer

A COMPREHENSIVE morse training instrument has just been announced by Aero Electronics Limited. Mains or battery operated versions of this unit (the SCOBA T/20) are available, and each trainer can provide for 20 headsets and keys.

The SCOBA T/20, which features a fully transistorised circuit, is manufactured by *Aero Electronics Limited, Gatwick House, Horley, Surrey.*



One of the new range of "Retra" products, the "Twin Star" tape recorder.

New Brand of Electrical Merchandise

A COMPLETELY new brand of electrical merchandise has been introduced recently under the trade name of "Retra". These goods will be exclusive to Radio and Television Retailers Association (R.T.R.A.) member shops, and will be quality controlled by a committee of the R.T.R.A.

The twin-track tape recorder illustrated above, is one of the new "Retra" products. Called the "Twin Star" it costs only 22 guineas.

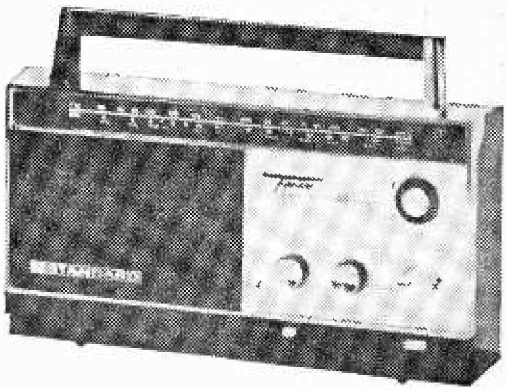
R.T.R.A., 19-21 Conway Street, Fitzroy Square, London W1.

Four Waveband Portable

A NEW four waveband, portable receiver has been added to the range of radios made by the Standard Corporation of Japan and stocked, in the U.K., by their agents Denham and Morley Limited.

This new model—the SR-J802FL—covers long, medium and short waves, and also a v.h.f. band. It is powered by four torch batteries and employs a ten transistor circuit.

The price of the SR-J802FL is 32 guineas and is available from *Denham and Morley Limited, Denmore House, 172-175 Cleveland Street, London W1.*

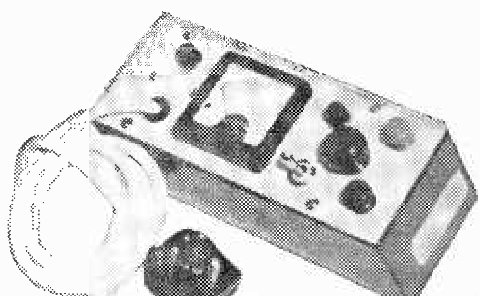


This Standard portable receiver is stocked in the U.K. by Denham and Morley Ltd.

Low Voltage Power Supply

A LOW voltage power supply is an essential for anyone proposing to service transistor equipment and for this purpose, Anagraph Precision have brought out the type V.P.10 unit which provides a d.c. output continuously variable from 0·1 to 10V. The output is controlled by a single knob and currents between 0 and 250mA can be obtained.

The unit is housed in a steel box, 3in. x 3in. x 8in. and costs £14 10s. The manufacturers are *Anagraph Precision, 31 Charlton Road, Two Mile Hill, Kingswood, Bristol.*



This low voltage power supply unit is made by Anagraph Precision.

LETTERS TO THE EDITOR

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying commercial or surplus equipment. We cannot supply alternative details for receivers described in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. If a postal reply is required a stamped and addressed envelope must be enclosed with the coupon from page iii of the cover.

The Editor does not necessarily agree with the opinions expressed by his correspondents

Novice Licences

SIR,—I think that the enclosed article I submitted to our School Magazine and which was duly published, will be of interest to all your readers.

"*Past and present members of the School Radio Society mourn with me the passing of an era. You who enjoyed the thrill of speaking into the microphone of the Society's transmitter . . . with the blessing of the representatives of the powers that be—mourn with me the death of an institution.*

"*For eight years . . . we have enjoyed contacts with old and new friends over the air. Now, however, the blow has fallen. Red-tape, bureaucracy, pomposity, or call it what you will, has decreed that if a boy speaks into the microphone, by the same token he is operating the transmitter, and this he cannot do unless he has taken the necessary Amateur Examination and shown a proficiency in sending and receiving Morse. By the same token, if a boy coughs, laughs, slams a door or hammers a nail into a piece of wood, he modulates the transmitter and is committing the crime of "operating" the set. Hence, at all times in the future when the only authorised operator is transmitting, a deathly hush will be over all in the shack, Big Brother Monitor will be listening somewhere in England for the slightest wheeze, cough snuffle or crackle*".

This will indicate to all those who hopefully seek a novice licence the amount of sympathy they can expect from official circles!—E. T. WARD (G3JWC, Burton-on-Trent, Staffordshire).

No Justification Necessary

SIR,—With reference to "Amateur Ambassador" on the Club News page of the July issue, I would like to comment that the Ham fraternity are *always* defending and justifying themselves; to prove that they are entitled to wavelength allocations because of their usefulness to society. That they do serve a useful purpose I do not dispute, but why this attitude?

Are we only allowed to operate because we are useful to the community? Is the G.P.O. waiting to grab our bands unless we can prove this?

We all know that there are many demands on the radio space—that powerful interests may dominate and gradually steal our allotted bands, but will cringing to authority get us anywhere? After all this is a democracy and we a free people, thus the ether is common property and every individual has a right to use it. The duty of authority is to safeguard these rights by allowing everyone a fair and equal share, not by allowing strong influences to dominate over the weak. I can see the heads shaking as these words are read and the reader saying to himself "this chap is living in a dream world".

Well, maybe so. As individuals we submit to examinations and inspection because we understand that this is necessary, but I see no reason to have to justify amateur operation further.

This letter is not an attack on the G.P.O. for I have always found them most helpful and I think they would respect us more if we stopped making excuses.—H. COLE (Workington).

TRADE NEWS

—continued from previous page

Oil Applicator

A NEW Swiss-made device for lubricating switch contacts occurring in radio equipment is available in Britain under the trade name of "Lubristyl". It is constructed in the form of a pen so that oil may be applied accurately by placing the nozzle on the point to be lubricated and pressing down slightly, which opens a valve and allows a small amount of oil to flow.

The Lubristyl oil applicator is available from the U.K. distrubutors (Haymor Ltd.) on their receipt of a remittance of 12s. 6d. (the retail price). The sole distributors in this country are *Haynor Ltd., 167 Greyhound Road, London W6.*

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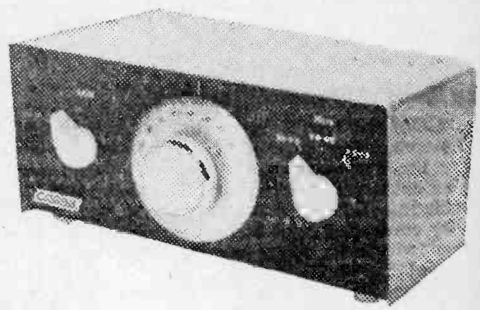
THE new model PR.30 preselector from the Codar Radio Company, covers a frequency range of 1.5 to 30Mc/s. Used with any superhet receiver it will provide up to 20dB gain together with substantial image rejection and improved signal/noise ratio.

The price of the PR.30 is £4 17s. 6d. and it is obtainable from *Codar Radio Company, Bank House, Southwick Square, Southwick, Sussex.*



Codar's new model PR.30 preselector.

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THE PERFECT SET FOR YOUR HOLIDAY!

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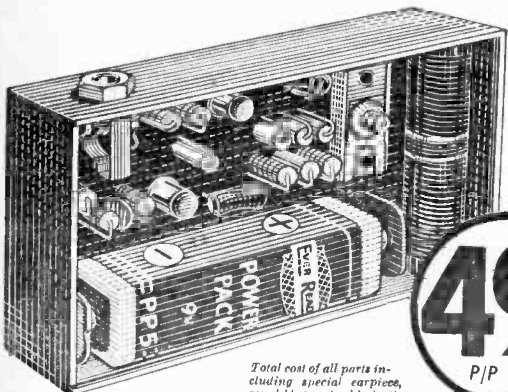

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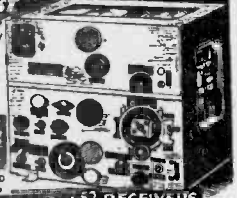

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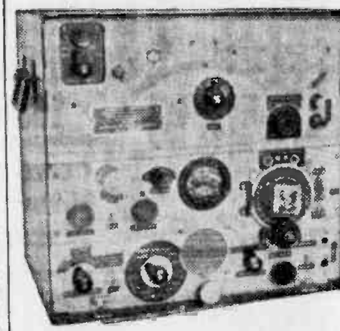

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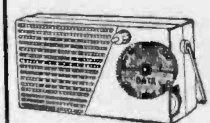

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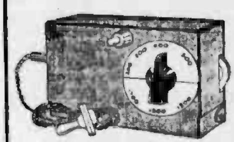

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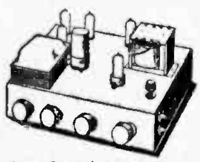

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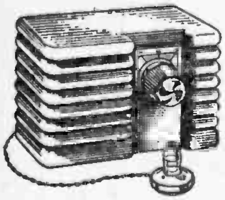

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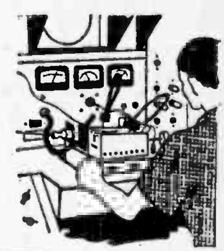

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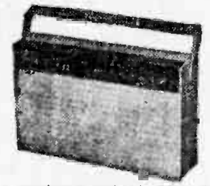

This superhet receiver uses the very latest circuitry, 6 transistors and two diodes and is fully tunable over both medium and long wavebands. First stages uses three Mullard AF.117 alloy diffused transistors with OA79 and OA91 diodes. output—OC81D and two OC81's in push-pull. I.F. frequency 470 Kc/s. Large internal ferrite rod aerial gives excellent reception over all ranges. 3 inch high flux speaker has a maximum output of 350mW. Operates on four 1.5 v. pen torch batteries. All components are mounted on a single printed circuit board. Attractive plastic case with carrying handle—fitted sockets for personal earpieces, tape recorder and car aerial. Size 6¼ x 4 x 1½in.

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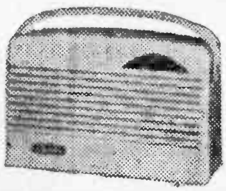

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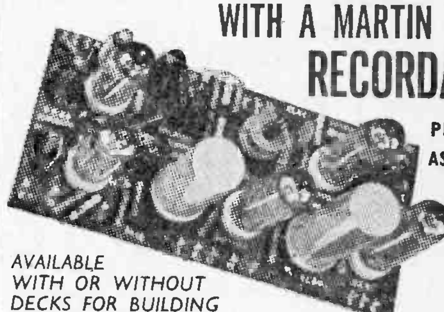

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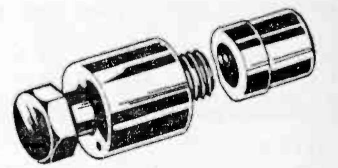

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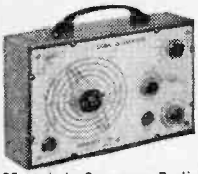

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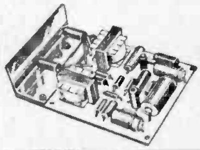

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