PRACTICAL WIRELESS

OCTOBER 1963

2/-

AN A.F./R.F. SIGNAL GENERATOR

Two-Transistor Circuit

Tuning Range 170kc/s–1·6Mc/s

FREE inside!

OHM'S LAW CALCULATOR

FOR CURRENT, VOLTAGE, RESISTANCE AND WATTAGE

MILLIAMPS

1 2 3 4 5 6 7 8 9 10 20 30 40 50 60 70 80 90 100 200 300 400 500 600 700 800 900 1000

MILLIAMPS

TO FIND VOLTAGE

Set left-hand or right-hand pointer to appropriate Resistance (kilohms or ohms) on scale B. Read off Voltage on scale B above appropriate Milliamps on scale A.

TO FIND CURRENT

Set left-hand or right-hand pointer to appropriate Resistance (kilohms or ohms) on scale B. Read off Milliamps on scale A below appropriate Voltage on scale B.

TO FIND RESISTANCE

Rotate scale A to bring Milliamps in line with Voltage on scale B. Read off Resistance in kilohms or ohms at appropriate pointer on scale B.

TO FIND POWER (WATTS)

Set pointer to Voltage on scale B. Read off Watts on scale B above Milliamps on scale A. Use the right-hand pointer for Watts ; the left-hand pointer for Milliwatts.

Typical examples are given on the back of this calculator

A KILOHMS

OHMS A

TO FIND VOLTAGE $V = I \times R$

Set kilohms at left-hand pointer, or ohms at right-hand pointer. Read volts above the milliamps scale.

Example : 10 mA is passing through a 2 kilohm resistor. Set left-hand pointer to 2 (kilohms) ; reading off 10 (milliamps) on Scale (A) gives the voltage drop as 20V (Scale B).

TO FIND CURRENT $I = \frac{V}{R}$

Set kilohms at left-hand pointer, or ohms at right-hand pointer. Read current below volts.

Example : 30 volts is dropped across a 300 ohm resistor. Set right-hand pointer to 300 (ohms). Reading down from 30 (volts) on Scale B, the current is shown as 100 mA.

TO FIND RESISTANCE $R = \frac{V}{I}$

Set volts above milliamps and read either kilohms at left-hand pointer or ohms at right-hand pointer.

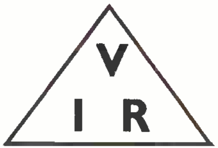
Example : Current is 20 mA and voltage 60 V. Set Scale A so that the 20 (mA) is lined up with 60 (V) on Scale B. Reading left-hand pointer gives resistance as 3 kilohm.

TO FIND POWER (Watts) $W = I \times V$ or $I^2 R$

Set right-hand pointer to volts (Scale B), when the wattage is read off above the milliamps on Scale A.

Example : Voltage applied is 250 V; current drawn is 20 mA. Set right-hand pointer to 250. Reading above 20 (milliamps) on Scale A, gives 5 (watts) on Scale B. To find milliwatts proceed as above but use the left-hand pointer.

OHM'S LAW MEMORY AID



The relationship between voltage (V), current (I) and resistance (R) is given at a glance in the left-hand triangle. Wattage (W), current and voltage are similarly indicated in the other triangle.

Place finger over the *unknown* factor and the formula is given by the relationship of the two uncovered characters.

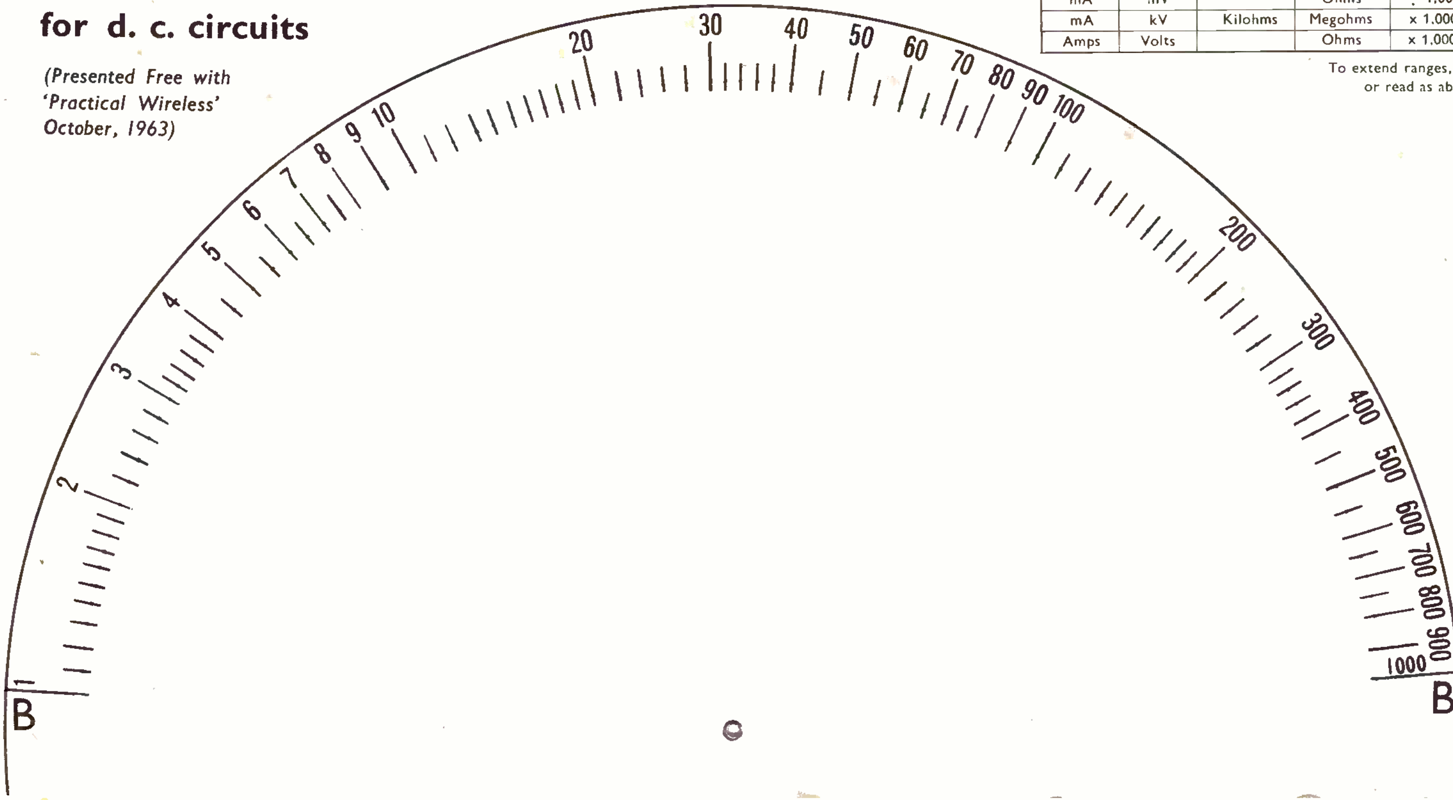
PRACTICAL WIRELESS

Ohm's Law Calculator for d. c. circuits

(Presented Free with 'Practical Wireless' October, 1963)

SCALE 'A'	SCALE 'B'	OHMS POINTER	KILOHMS POINTER	WATTS
μ A	μ V		Ohms	
μ A	mV	Ohms	Kilohms	
μ A	Volts	Kilohms	Megohms	÷ 1,000
μ A	kV	Megohms		x 1
mA	mV		Ohms	÷ 1,000
mA	kV	Kilohms	Megohms	x 1,000
Amps	Volts		Ohms	x 1,000

To extend ranges, set or read as above



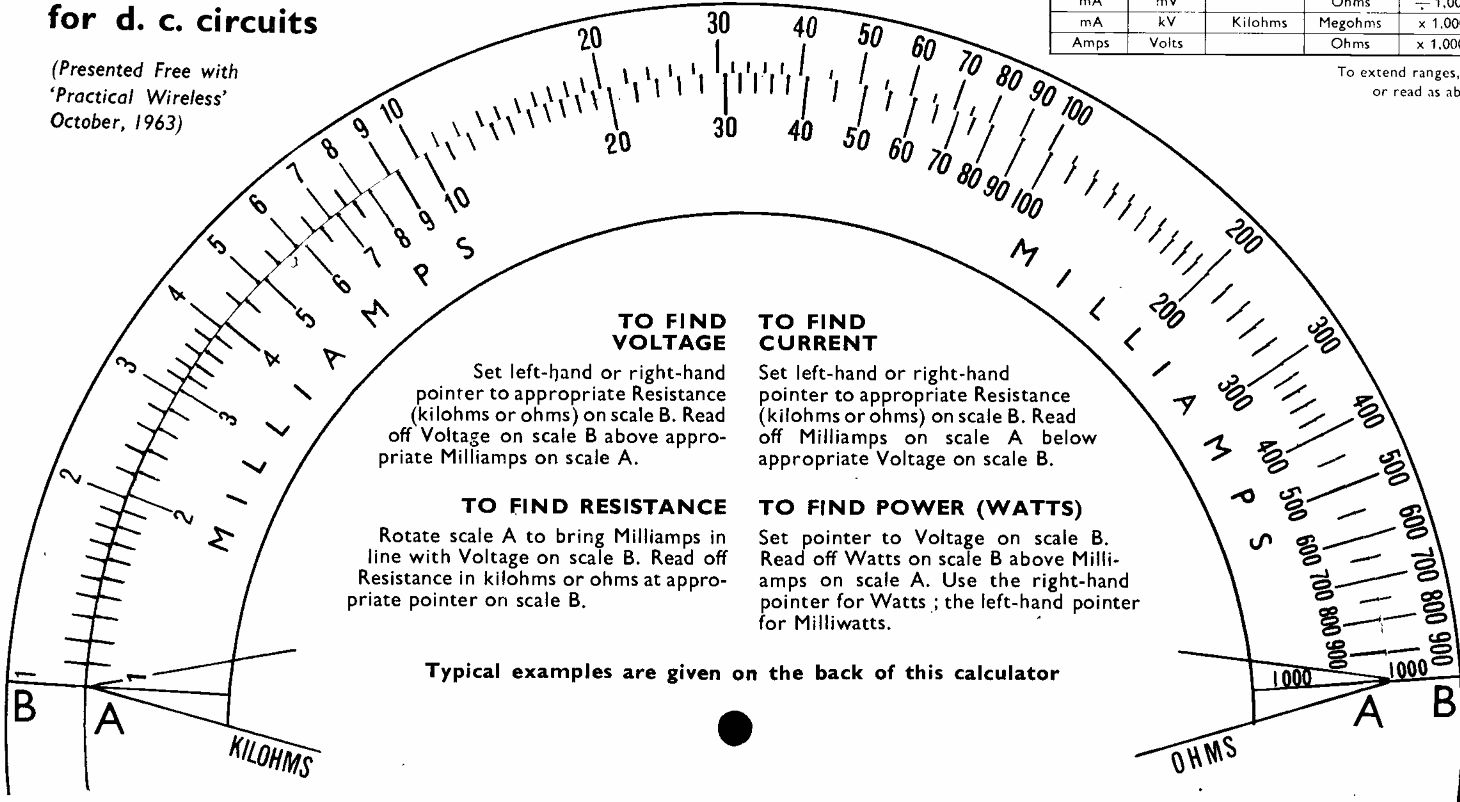
PRACTICAL WIRELESS

Ohm's Law Calculator for d. c. circuits

(Presented Free with 'Practical Wireless' October, 1963)

SCALE 'A'	SCALE 'B'	OHMS POINTER	KILOHMS POINTER	WATTS
μ A	μ V		Ohms	
μ A	mV	Ohms	Kilohms	
μ A	Volts	Kilohms	Megohms	÷ 1,000
μ A	kV	Megohms		x 1
mA	mV		Ohms	÷ 1,000
mA	kV	Kilohms	Megohms	x 1,000
Amps	Volts		Ohms	x 1,000

To extend ranges, set or read as above



TO FIND VOLTAGE

Set left-hand or right-hand pointer to appropriate Resistance (kilohms or ohms) on scale B. Read off Voltage on scale B above appropriate Milliamps on scale A.

TO FIND CURRENT

Set left-hand or right-hand pointer to appropriate Resistance (kilohms or ohms) on scale B. Read off Milliamps on scale A below appropriate Voltage on scale B.

TO FIND RESISTANCE

Rotate scale A to bring Milliamps in line with Voltage on scale B. Read off Resistance in kilohms or ohms at appropriate pointer on scale B.

TO FIND POWER (WATTS)

Set pointer to Voltage on scale B. Read off Watts on scale B above Milliamps on scale A. Use the right-hand pointer for Watts; the left-hand pointer for Milliwatts.

Typical examples are given on the back of this calculator

R.S.T. VALVE MAIL ORDER CO.

Tel: MITcham 6202
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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
ECC88	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	8/-
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
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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	9/-
PCL86	12/6
PENA4	19/6
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	13/-
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	13/6
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

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6Q7G	6/6
6Q7GT	8/6
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6SF5	10/-
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6SH7	6/-
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6SK7	5/6
6SL7GT	6/-
6SN2GT	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
12K2GT	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/-
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35W4	7/6
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35Z4	7/6
35Z5	8/6
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DAF91, DF91, DK91, DL92, DL94 ... Set of 4, 19/-
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Complete Kit as above, with Tape and Microphone £22.0.0
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Tape Amplifier for Studio Deck, with ready wired printed circuit, control and input panels, mains and output transformers, knobs, plans, screws etc., EF86, ECC83, EM84, EZ81 and 2-EL84. 3 watts output. Magic eye, Radio and Mic., inputs Ex L/S socket, Tone and Monitor controls. Can be used as amplifier £11.11.0
Deposit £1.4.0 and 12 monthly 19/-

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Complete Kit, with Tape and Microphone £29.0.0
Deposit £2.18.0 and 12 monthly £2.8.2

Building instructions available at 2/6 each kit (refunded if kit bought).

QUARTER TRACK

B.S.R. TD2. Marriott heads, L series £11.11.0
Deposit £1.4.0 and 12 monthly 19/-

Tape Amplifier, as over, 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, with tape and microphone £25.0.0
Deposit £2.10.0 and 12 monthly £2.1.6

Collaro Studio Deck, Marriott X series heads £17.17.0
Deposit £1.17.6 and 12 monthly £1.9.5

Tape Amplifier, as over but quarter track £12.12.0
Deposit £1.7.0 and 12 monthly £1.0.8

Case, with speaker, two-tone grey £5.5.0

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Tape Pre-amplyer for Collaro Studio Deck, with power supplies, ECC83, ECL82, EZ80 and EM85. Radio and Mic sockets, gives an equalised output of 400mV

Half Track £8.8.0
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M.S.S. Quarter track Record/Playback and Erase Set £3.3.0

Bradmatic Half track Record/Playback head only £1.12.6

Bradmatic Half track Record/Playback and Erase as Studio Set £1.19.6

Collaro pressure pad for third head position 4/-

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Brenell Mk. 5 Tape Amplifier with power pack £26.0.0
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FMT1, complete with 4 EF91 valves £6.12.6
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FMT2, less power, complete with 4 EF80 valves £7.17.6
Deposit £1.0.0 and 7 monthly £1.2.6

FMT2, with power, complete with 4 EF80 and 1 EZ80 .... £9.15.0
Deposit £1.0.0 and 9 monthly £1.1.8

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

FMT3, with power, complete with all valves £11.10.0
Deposit £1.7.6 and 9 monthly £1.4.9

JTV/2, switched F.M. and TV sound, self powered, all valves £15.7.6
Deposit £1.13.0 and 12 monthly £1.5.3

Mercury II, as JTV/2 but less power, all valves £11.2.6
Deposit £1.4.6 and 8 monthly £1.7.3

Instruction book is included in all kits, but otherwise 2/6 and 3/6.

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Armstrong T4C V.H.F. Tuner, self powered £17.19.0
Deposit £1.19.6 and 12 monthly £1.9.5

Armstrong ST3 Mk. 2 A.M./F.M. Tuner, self powered £25.12.0
Deposit £2.13.0 and 12 monthly £2.2.4

Armstrong AF208 A.M./F.M. 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 Mk. 2 A.M./F.M. push-pull output stage £28.5.0
Deposit £2.16.6 and 12 monthly £2.6.11

Armstrong Stereo 55 A.M./F.M. Radio chassis, with stereo gram. £29.18.0
Deposit £3.2.6 and 12 monthly £2.9.5

Armstrong Stereo 12 Mk. 2 A.M./F.M. Radio chassis, stereo gram and push-pull output stages £40.5.0
Deposit £4.0.6 and 12 monthly £3.6.11

Brass escutcheon available for AF208 and Jubilee Mk. 2 .... 7/6

AMPLIFIERS (MONO)

Linear L45 3 watt, 3 valve £5.19.6

Linear Diatonic, 12 watt, suitable Mic. or Guitar £12.12.0
Deposit £1.7.0 and 12 monthly £1.0.8

Linear Concord, 30 watt, ideal Guitar amp., with case £18.0.0
Deposit £1.16.0 and 12 monthly £1.9.10

Dulci GA5, integrated amp. and P.A., 5 watt, ECL86 valve £13.2.6
Deposit £1.8.6 and 12 monthly £1.1.6

Dulci DPA15, 15 watt with 2 valve pre-amp £25.4.0
Deposit £2.10.6 and 12 monthly £2.1.11

Tripletone Hi-Fi Major with pre-amp. Guitar or Mic £15.18.9
Deposit £1.15.3 and 12 monthly £1.6.1

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

Leak Varislope III pre-amplifier £15.15.0
Deposit £1.11.6 and 12 monthly £1.6.1

Quad, 15 watt Main amplifier only £22.10.0
Deposit £2.5.0 and 12 monthly £1.17.4

Quad pre-amplifier, Mono £19.10.0
Deposit £1.19.0 and 12 monthly £1.12.4

GRAMOPHONE UNITS

Garrard SRP10 with GC8 cartridge, Mono, single player £5.9.11

B.S.R. UA14 with TC8 cartridge, Mono 4 speed changer £6.19.6
Deposit £1.0.0 and 6 monthly £1.3.3

Garrard Autoslim, Mono GC8 cartridge, 4 speed changer £6.19.6
Deposit £1.0.0 and 6 monthly £1.3.3

Garrard AT6 Autoslim de Luxe, GC8 Mono cartridge £11.9.0
Deposit £1.6.6 and 9 monthly £1.4.9

Philips AG1016 stereo cartridge, will change 7in. records £12.12.0
Deposit £1.7.0 and 12 monthly £1.0.8

Decca Deram Arm and Plug-in Shell £5.5.0

Decca DeramTranscription Cartridge £4.14.6

Decca Deram Auto Cartridge £3.13.6

Goldring GL58 with arm, less cartridge £15.19.8
Deposit £1.19.0 and 12 monthly £1.6.6

Goldring "88" Transcription, no arm £17.14.0
Deposit £1.19.0 and 12 monthly £1.9.0

Goldring GL55X, as GL58 but less pick-up arm £18.1.7
Deposit £1.7.7 and 12 monthly £1.1.6

Garrard 4H/F with Mono GC8 cartridge £17.0.0
Deposit £1.14.0 and 12 monthly £1.8.2

Garrard Lab Type "A" Transcription auto-changer, Mono GC8 .... £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

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 Mk. 2 with pre-amplifier, 4 ECL86 valves £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 III, stereo pre-amplifier £25.0.0
Deposit £2.10.0 and 12 monthly £2.1.6

Quad 22 Stereo Control Unit £25.0.0
Deposit £2.10.0 and 12 monthly £2.1.6

For Quad Main Amplifiers see Mono section above.

LOUDSPEAKERS

Goodmans Axiette 8 .... £5.5.7

Goodmans Axiom 10 .... £6.5.11

Goodmans 5K/20/XL £7.0.0

Wharfedale Super 8/RS/DD £6.14.2

W.B. HF1012 10in £4.7.8

R.T.C. 12in. Unit, 15 watt £5.5.0

R.T.C. Hi-Fi Master £8.8.0

Goodmans XO 5000 cross-over £1.19.0

Goodmans Axiom 201 12in. Unit £10.7.0
Deposit £1.1.0 and 8 monthly £1.5.9

Goodmans Axiom 301 12in. Unit £14.10.0
Deposit £1.9.0 and 12 monthly £1.4.0

Wharfedale W12/EG 12in. 15 watt Guitar speaker £10.10.0
Deposit £1.1.0 and 12 monthly 17/5

Wharfedale Super 10/RS/DD 10in. high quality unit £10.18.0
Deposit £1.3.8 and 12 monthly 17/11

Wharfedale RS/12/DD 12in. 15 watt Hi-Fi speaker £11.10.0
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PORTABLE TRANSISTOR RADIOS

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ROAMER SEVEN Mk. III

● 9 stages—7 transistors and 2 diodes.

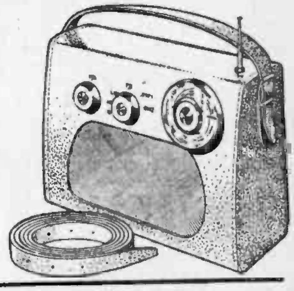
Covers Medium and Long Waves, Trawler Band and two Short Waves to approx. 17 metres. Push-pull output for room filling volume from rich toned heavy duty 5in. speaker. Ferrite rod aerial for M & L waves and telescopic aerial for S Waves. Air spaced ganged tuning condenser ensures wonderful station selection. Simulated hide case with gilt trim and shoulder and hand straps. Size 9 x 7 x 4in. approx. The perfect portable and the ideal car radio. (Uses PP9 battery available anywhere.)

5 WAVEBAND PORTABLE OR CAR RADIO

Amazing performance and specification

Total cost of parts now only **£5.19.6** P. & P 5/6

Parts Price List and easy build plans 3/-.



MELODY SIX

". . . amazed at volume and performance . . . has really come up to my expectations." S. G., Stockton on Tees.

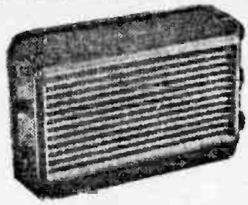
● 8 stages—6 transistors and 2 diodes.

Our latest completely portable transistor radio covering medium and long waves. Incorporates pre-tagged circuit board, 3in. heavy duty speaker, top grade transistors, volume control, tuning condenser, wave change slide switch, sensitive 6in. ferrite rod aerial. Push-pull output. Wonderful reception of B.B.C. Home and Light, 208, and many Continental stations. Handsome leather look pocket size case, only 6¼ x 3¼ x 1½in. approx., with gilt speaker grille and supplied with hand and shoulder straps.

Total cost of all parts only **£4.9.6** P. & P. 3/-. *Parts Price List and easy build plans 2/-*

TRANSONA FIVE

"Home Light AFN, Luz, all at good volume." G.P., Durham



● 7 stages—5 transistors and 2 diodes.

Fully tunable over medium and Long Waves and Trawler Band. Incorporates Ferrite rod aerial, tuning condenser, volume control, new type fine tone super dynamic speaker, etc. Attractive case. Size 6¼ x 4¼ x 1¼in. with red speaker grille. (Uses 1289 battery available anywhere).

Parts Price List and easy build plans 2/-

Total cost of all parts now only **42/6** P. & P. 3/6.

TRANSONA SIX NEW!

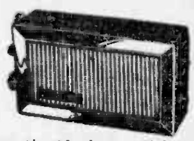
● 8 stages—6 transistors and 2 diodes.

This is a top performance receiver covering full Medium and Long Waves and Trawler Band. High-grade powerful magnet 3in. speaker makes listening a pleasure. Push pull transformers for ample power. Ferrite rod aerial. Many stations listed in one evening including Luxembourg loud and clear. Attractive case in grey with red grille. Size 6¼ x 4¼ x 1½in. (Uses PP4 battery available anywhere). (Carrying strap, 2/- extra).

Total cost of all parts now only **59/6** P. & P. 3/6 *Parts Price List and easy build plans 1/6*

POCKET FIVE

● 7 stages—5 transistors and 2 diodes.



Covers Medium and Long Waves and Trawler Band, a feature usually found in only the most expensive radios. On test Home, Light, Luxembourg and many Continental stations were received loud and clear. Designed round supersensitive Ferrite Rod Aerial and fine tone 2½in. moving coil speaker, built into attractive black case with red speaker grille. Size 5¼ x 1¼ x 3¼in. (Uses PP4 battery available anywhere).

Total cost of all parts now only **42/6** P. & P. 3/-. *Parts Price List and easy build plans 1/6*

SUPER SEVEN

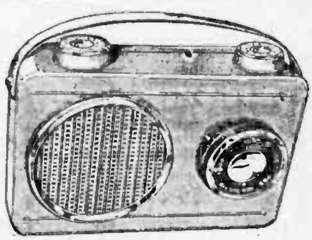
● 9 stages—7 transistors and 2 diodes

Covers Medium and Long Waves and Trawler band. The ideal radio for home, car or can be fitted with carrying strap for outdoor use. Completely portable—has built in aerial for wonderful reception. Special circuit incorporating 2 R.F. stages, push pull output. 3in. speaker (will drive larger speaker). Size 7¼ x 5¼ x 1½in. (Uses PP6 battery available anywhere.)

Total cost of all parts now only **£3.19.6** P. & P. 3/6

Parts Price List and easy build plans 2/-.

ROAMER SIX



● 8 stages 6 transistors and 2 diodes.

Listen to stations half a world away with this 5 waveband portable. Tunable on Medium and Long waves, Trawler Band and two Short waves. Sensitive ferrite rod aerial and telescopic aerial for short waves. Top grade transistors, 3-inch speaker, handsome case with gilt fittings Size 6¼ x 4¼ x 1½in.

Total cost of all parts now only **£4.19.6** P. & P. 3/6. *Parts Price List and easy build plans 3/-.*

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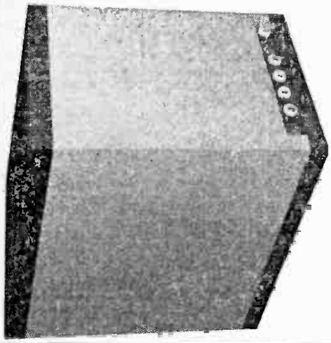
All components used in our receivers may be purchased separately if desired. Parts price lists and easy build plans supplied free with sets of parts or available separately at prices stated.

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.**

DERBY NOW OPEN AT 26 Osmaston Road THE SPOT

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

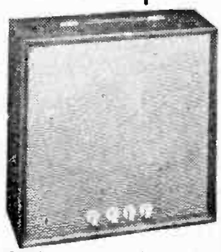
F.W. BRIDGE		24 v. 2 amp.	14/9
6/12 v. 1 a.	3/11	24 v. 20 amp.	89/9
6/12 v. 2 a.	6/11	H.T. TYPES H.W.	
6/12 v. 3 a.	9/9	150 v. 40 mA	3/9
6/12 v. 4 a.	12/3	250 v. 50 mA	3/11
6/12 v. 6 a.	15/3	250 v. 60 mA	4/11
6/12 v. 10 a.	26/9	250 v. 80 mA	5/11
6/12 v. 15 a.	35/9	250 v. 250 mA	11/9

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.

HI-FI 10-WATT AMPLIFIERS. Brand New Complete Units. **£7.19.9** Carr. 5/6. Manufacturers' discontinued Model. Push-Pull output. Latest high efficiency valves. Dual separately controlled Inputs for "Mike". Separate Bass and Treble Controls. High sensitivity. Output for 3 or 15 ohm speaker. Guaranteed tested and in perfect working order.

HUGE PURCHASE OF BRAND NEW 24v. 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 ohms 25 watt speakers, one with aluminium speech coil and dual code 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 EXTRA HEAVY DUTY LOUDSPEAKER 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/-.

FANE EXTRA HEAVY L/SPEAKER 183. 18in., 15 ohms. 60 watts. 3in. diam. Speech Coil. Total Flux 375,000 lines. High sensitivity. ONLY 25 gns. or Deposit 52/9 and 12 monthly payments of 43/-. Send S.A.E. for leaflet on 153 and 183.

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.

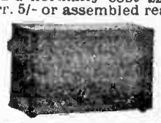
Ex. GOVERNMENT ACCUMULATORS. Size 7¾ x 4 x 2in., 2 v. 16 A.H. brand new, 6/9 each, 3 for 15/6.

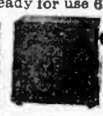
Ex. GOVT. SMOOTHING CHOKES. 200 mA. 3-5 H. 50 ohms. Parmeko 8/9; 150 mA. 10 H. 50 ohms 9/9; 80 mA. 20 H. 900 ohms 5/9; 120 mA. 12 H. 100 ohms 8/9; 50 mA. 50 H. 1,000 ohms 6/9; 100 mA. 10 H. 100 ohms 6/9; 60 mA. 5-10 H. 250 ohms 2/11.

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. Output 250 v., 60 mA, 6.3 v. 2 a.

R.S.C. POWER PACK, 39/9. Louvred metal case only 8 x 5½ x 2¼ins. 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 89/6 carr. 5/- or assembled ready for use 6 gns.





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

R.S.C. (Manchester) Ltd. *MAIL ORDERS to 5 County Arcade, Leeds 1. Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 2/9 extra under £2. 4/6 extra under £5. Trade Supplied. S.A.E. with all enquiries please.*

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32 High St. Half-day Thursday	6 Gt. Western Arcade (Opp Snow Hill Sta) No half-day	13 Exchange St. Castle Market Bldgs. Sheffield	51 Savile St., Hull	73 Dale St. Liverpool 2	56 Morley St. (above Alhambra Theatre) Bradford	8-10 Brown St. (Market St.) Manchester 2 No half-day	5-7 County (Mecca) Arcade Briggate, Leeds No half-day
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R.S.C. (Manchester) Ltd.

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32 High St.	6 Gt. Western Arcade (Opp Snow Hill Sta)	13 Exchange St. Castle Market Bldgs. Sheffield	51 Savile St., Hull	73 Dale St. Liverpool 2	56 Morley St. (above Alhambra Theatre) Bradford	8-10 Brown St. (Market St.) Manchester 2	5-7 County (Mecca) Arcade Briggate, Leeds
Half-day Thursday	No half-day	Half-day Thursday	Half-day Thursday	Half-day Wednesday	Half-day Wednesday	No half-day	No half-day

FANE HEAVY DUTY HI-FI SPEAKERS

12in. 15 ohms. Cast chassis. Exceptionally robust 2in. diam. Voice coil Assemblies.
122/10 20w.. 5 gns. 122/10A 20w.. 6 gns.
122/12 20w.. 6 gns. 122/12A 20w.. £7.19.6.
122/14 22w.. 9 gns. 122/14A 22w.. 10 gns.
122/17 25w.. 11 gns. 122/17A 25w.. 12 gns.
15in., 15 ohms. Cast chassis. Exceptionally robust 2in. diam. Voice Coil Assemblies.
152/12 20w.. 12 gns. 152/12A 20w.. 13 gns.
152/14 27w.. 14 gns. 152/14A 27w.. 15 gns.
152/17 35w.. 16 gns. 152/17A 35w.. 17 gns.
"A" indicates dual cone type, 30-17,000 c.p.s. Send S.A.E. for leaflets. Terms available.

R.S.C. 30-WATT ULTRA LINEAR HIGH FIDELITY AMPLIFIER A10

A highly sensitive Push-Pull high output unit with self-contained Pre-amp. Tone Control Stages. Certified performance figures compare equally with most expensive amplifiers available. Hum level 70 db down. Frequency response ±3 db. 30-30,000 c/s. A specially designed sectionally wound ultra linear output transformer is used with 807 output valves. All components are chosen for reliability. Six valves are used EF86, EF86, ECC83, 807, 807, GZ34. Separate Bass and Treble Controls are provided. Minimum input required for full output is only 12 millivolts so that **ANY KIND OF MICROPHONE OR PICK-UP IS SUITABLE.** The unit is designed for **CLUBS, SCHOOLS, THEATRES, DANCE HALLS or OUTDOOR FUNCTIONS**, etc. For use with Electronic **ORGAN, GUITAR, STRING BASS**, etc. For standard or long-playing records. **OUTPUT SOCKET PROVIDES** L.T. and H.T. for a **RADIO FEEDER UNIT.** An extra input with associated vol. control is provided so that two separate inputs such as Gram and "Mike" can be mixed. Amplifier operates on 200-250 v. 50 c/s. A.C. Mains and has output for 3 and 15 ohm speakers. Complete Kit of parts with fully punched chassis and point-to-point wiring diagrams and instructions. If required perforated cover with carrying handles can be supplied for 19/9. The amplifier can be supplied, factory built with EL34 output valves and 12 months guarantee, for 14 gns. Send S.A.E. for leaflet.

11 Gns. Carr. 10/-

TERMS: DEPOSIT 33/9 and 9 monthly payments of 33/9.
Suitable microphones and speakers available at competitive prices.

WE STOCK ARMSTRONG, DULCI, LINEAR, ROGERS, LEAK and JASON EQUIPMENT GOODMANS, W.B. AND FANE SPEAKERS

GARRARD AND GOLDRING T/TABLES

SUPERHET FEEDER UNIT. Design of a high quality Radio Tuner (specially suitable for use with our Amplifiers). Delayed A.V.C. Controls are Tuning, W/Ch. and Vol. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size approx. 9 x 6 x 7in. high. Simple alignment procedure. Point-to-point wiring diagrams, instructions and priced parts list with illustrations, 2/6. Total building cost £4.15.0. S.A.E. for leaflet.

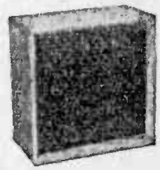
P.M. SPEAKERS. 10in. W.B. "Stentorian" 3 or 15 ohms type HF 1012 10 watts, hi-fidelity type. Recommended for use with our A11 Amplifier. £4.7.6. 12in. R.A. 3 ohms 10 watts (12,000 lines). 59/6.

TWEETERS. R.A. 3 ohm 19/9. 15 ohm 25/9.

R.A. 12in. DUAL CONE 3 ohm 8 watt **Speakers.** Ideal for Stereo. Only 39/9 ea.

Jason FMTI V.H.F./F.M. Radio Tuner design. Total costs of parts including valves. Tuning dial, Escutcheon, etc., £7.19.6

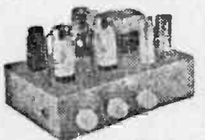
LINEAR L45 MINIATURE 4/5 WATT QUALITY AMPLIFIER. Suitable for any record playing unit, and most microphones. Negative feed-back 12 db. Separate Bass and Treble Controls. For mains 200-250 v. 50 c/s. Output for 2-3 ohm speaker. Mullard valves EZ80, ECC83, EL84. Size only 7 x 5 x 5½in. high. Guaranteed 12 months. Only £5.19.6. Send S.A.E. for leaflet. Terms: Deposit 22/6 and 5 monthly payments of 22/6.



12in. 10 WATT HIGH QUALITY LOUDSPEAKER in walnut veneered cabinet. Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only £4.19.6 Carr. 5/-. Terms: Deposit 11/3 and 9 monthly payments of 11/3.
12in. 20 WATT HI-FI LOUDSPEAKERS IN CABINETS. Size 18 x 18 x 10in. Finish as above. Terms: Deposit 17/9 and 9 monthly payments of 17/9. Only £7.19.6. Carr. 8/6.
For larger types see page 477.

LINEAR LG34 GRAM AMPLIFIER High quality. Separate Bass and Treble controls. Handsome appearance. Completely enclosed. Black/Gold Frontplate 5 gns.

R.S.C. 4-5 WATT A5 HIGH-GAIN AMPLIFIER



A highly-sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads, in addition to all other types of pick-ups and practically all "mikes". Separate Bass and Treble Controls are provided. These give full long-playing record equalisation. Hum level is negligible being 71 db. down 15 db. of Negative feedback is used. H.T. of 300 v. 25 mA and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit, or Tape-Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes full punched chassis (with baseplate) with Blue Hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only £4.15.0, or assembled ready for use 25/- extra. Plus 3/6 carr., or deposit 22/6 and 5 monthly payments of 22/6 for assembled unit.

NOW OPEN AT 26 Osmaston Road THE SPOT DERBY

R.S.C. GRAM. AMPLIFIER KIT. 3 watts output. Negative feedback. Controls Vol. Tone and Switch. Mains operation 200-250 v. A.C. Fully isolated chassis. Circuit, etc., supplied. Only 39/9. Carr. 3/9.

THE SKYFOUR T.R.F. RECEIVER A design of a 3 valve long and medium wave 200-250 v. A.C. Mains receiver with selenium rectifier. High gain H.F. stage and low distortion detector. Valve line-up 6K7, SP61, 6V6G. Selectivity and quality excellent. Simple to construct. Point-to-Point wiring diagrams, instructions and parts list 1/9. maximum building costs £4.19.6. inc. attractive walnut veneered wood cabinet 12 x 6½ x 5½in.

MULTI-METERS. CABY M1. Sensitivity 2,000 ohms per volt. A.C. and D.C. 54/-. **A.10.** Basic Meter sensitivity 155 micro-amps A.C. and D.C. ranges £4.17.6. **B.20.** Sensitivity up to 10,000 ohms per volt A.C. and D.C. £6.10.0. 30,000 ohms per volt, with overload buzzer, £8.19.6.

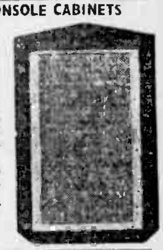
R.S.C. JUNIOR HI-FI REPRODUCER. The very latest Goodman Axiette 8 High Fidelity loudspeaker (retailing at approx. 5 gns.) fitted in a specially designed Bass Reflex cabinet size 12 x 18 x 10in. Acoustically lined and ported and finished in polished walnut veneer. Matching impedance 15 ohms. Frequency range 40-15,000 c.p.s. Power handling 6 watts nominal. Ideal for Stereo. Limited number.

8 Gns. Carr. 4/6

R.S.C. BASS REFLEX CABINETS. JUNIOR MODEL. Specially designed for W.B. HF1012 Speaker, but suitable for any good quality 10in. speaker. Acoustically lined and ported. Polished walnut-veneer finish. Size 18 x 12 x 10in. Handsome appearance. Ensure superb reproduction for only £3.19.6.

STANDARD MODEL. As above but for 12in. speakers. Size 20 x 15 x 13in. For vertical or horizontal use. £5.19.6. Suitable legs with brass ferrules, 19/6 per set of 4.

R.S.C. CORNER CONSOLE CABINETS



Polished walnut veneer finish. Pleasing design. **JUNIOR MODEL.** Size 20 x 11 x 8in. for 8 x 5in. or 10 x 6in. speakers. £2.9.9. **STANDARD MODEL.** Size 27 x 18 x 12in. for 8 or 10in. speakers. £4.11.9. **SENIOR MODEL.** Size 30 x 20 x 15in. for 12in. Speaker. Suitable Speaker systems below. Only 7 gns.

AUDIOTRINE HI-FI SPEAKER SYSTEMS. Consisting of matched 12in. 12,000 line, 15 ohm high quality speaker: cross-over unit (consisting of choke, condenser, etc.) and Tweeter. The smooth response and extended frequency range ensure surprisingly realistic reproduction. Standard 10 watt rating £4.19.9. Carr. 5/-. Or Senior 15 watt, 7 gns. Carr. 7/6.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces battery supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s is available. **Suitable for all battery portable receivers requiring 1.4 and 90 v.** This includes low consumption types. Complete kit with diagrams. 39/9, or ready to use, 46/6.

Type BM2. Size 8 x 5½ x 2½in. Supplies 120 v. 90 v. and 60 v. 40 mA and 2 v. 0.4 a. to 1 amp. fully smoothed. **Thereby completely replacing both H.T. batteries and L.T. 2 v. accumulators when connected to A.C. mains supply** 200-250 v. 50 c/s. **SUITABLE FOR ALL BATTERY RECEIVERS** normally using 2 v. accumulators. Complete kit of parts with diagrams and instructions. 49/9, or ready for use, 59/6.

AUDIOTRINE EQUIPMENT CABINETS Size 36 x 15 x 18in. Beautiful walnut veneered finish. Elegant contemporary design. Robust construction. Uncut, removable baseboard. Depth above baseboard 5½". Only 12½ gns. Carr. 15/-.

Terms: Dep. 29/9, and 9 mthly. pymts. 29/9.

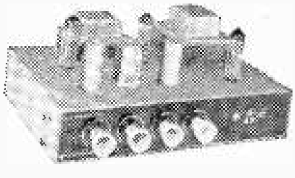
AUDIOTRON HI-FI TAPE RECORDER KIT 25½ GNS. Carr. 17/6.

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 14¼ x 15 x 8¼in. 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

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

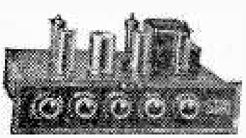
PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES



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 200-250v. 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 Cabinets. Speakers, Microphones, etc., with cash and credit terms.

LINEAR TAPE PRE-AMPLIFIER. Type LP/I, 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.

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/-.
Kit can be supplied assembled ready to use for **59/6** extra.

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.**
MARRIOTT RECORDING HEADS. High Impedance, Record/Playback **15/-.** Low Impedance, Erase, **10/-.**
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 AUTOCHANGERS. 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 11¼ x 2¼ x 2¼in. Controls: Vol. and Tone with Switch. Only **59/6.**
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.**

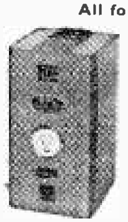
SENSATIONAL STEREO OFFER

A complete set of parts to construct a good **(4 Gns.)** quality Stereo amplifier with an undistorted output total 6 watts. For A.C. mains input of 200-250 v. Sensitivity 130 m.v. Ganged Vol. and Tone Controls. Preset balance control. Full instructions and wiring diagrams supplied. Stereo Pick-up Head **19/9** extra with above only.

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

R.S.C. BATTERY CHARGING EQUIPMENT

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



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
6/12v. 1 amp. **27/9** Less meter.

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.
6 v. or 12 v. 1 amp. 22/9
As above, with Ammeter 28/9
6 v. 2 amps 19/9
6 v. or 12 v. 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

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 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. 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
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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
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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
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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
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Push-Pull 8 watts. EL84, or 6V6 to 3Ω or matched to 15Ω 9/9
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Push-Pull 10-12 watts 6V6 or EL84 .. 18/9
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Both above size 2½ x 2½ x 2¼ins.
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All with 200-250 v. 50 c/s. primaries 6.3 v. 1.5a. 5/9; 6.3 v. 2 a. 7/6; 0-4-6.3 v. 2a. 7/9; 12 v. 1 a. 7/11; 6.3 v. 3 a. 8/11; 6.3 v. 6 a. 17/6; 12 v. 1.5 a. twice, 17/6.
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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. 8 a. 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.
MICROPHONE TRANSFORMERS 120 : 1 high grade, clamped, 7/9.

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6L1	9/6
6L6G	6/6
6L6M	9/-
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6L19	9/9
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6SG7	4/9
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6SL7	5/9
6SN7	4/6
6SQ7	5/9
6SR7	12/6
6SS7	2/-
6U4GT	9/6
6U5G	5/-
6U7G	9/6
6V6G	3/9
6V6GT	6/-
6X4	4/-
6X5	4/6
6Y6	6/-
7B6	9/-
7B7	7/6
7C5	10/-
7C6	7/6
7D3	21/-
7D5	15/-
7D6	15/-
7D8	15/-
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7R7	12/6
7S7	14/-
7Y4	5/-
8D2	2/6
8D3	3/-
9BW6	13/5
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11D3	17/6
11D5	17/6
11E1	15/-
11E3	17/-
12A6	2/8
12A8	16/6
12AC6	13/5
12AD6	15/2
12AE6	12/3
12AH7	5/-
12AH8	9/-
12AT6	4/9
12AT7	4/-
12AU6	6/6
12AU7	4/6
12AV6	6/9
12AX7	4/9
12BA6	6/6
12BE6	5/-
12BH7	7/6
12E1	17/-
12H6GT	1/6
12J5GT	2/6
12J7GT	7/6
12K5	17/6
12K7GT	3/9
12K8GT	9/-
12Q7GT	3/9
12SA7	7/-
12SC7	4/-
12SG7	3/-
12SH7	3/-
12SJ7	5/-
12SK7	8/6
12SQ7	8/-
12SR7	5/-
12U5G	7/-
12Y4	2/-
14B6	20/9
14H7	22/8
14S7	17/6
15D2	6/-
18	12/6
19	10/6
19AQ5	7/9
19BG6G	20/5
19H1	6/-
20D1	18/5
20D2	21/-
20F2	12/3
20L1	12/6
20P1	12/6
20P3	12/6
20P4	13/9
20P5	14/6
25A6G	7/6
25L6GT	6/9
25U4GT	16/2
25Y5	8/-
25Y5G	8/-
25Z4G	7/-
25Z5	8/-
25Z6GT	8/-
27SU	23/3
28D7	7/-
30C1	6/-
30C15	10/-
30F5	6/-
30FL1	9/6
30FL12	12/6
30L1	5/9
30L15	10/3
30P4	12/3
30P12	7/6
30P16	6/-
30P19	12/3
30PL1	10/-
30PL13	9/6
30PL14	19/3
35A5	20/9
35L6GT	6/-
35W4	6/-
35Z3	16/4
35Z4GT	4/9
35Z5GT	6/6
408UA	18/2
418TH	25/11
42	5/-
43	10/-
50A5	21/10
50B5	7/-
50C5	7/-
50CD6G	40/9
50L6GT	7/-
52KU	14/6
53KU	14/6
72	6/6
75	5/6
76	12/6
77	6/-
78	5/-
80	5/6
83	15/-
83V	19/5
85A1	55/6
85A2	9/9
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90AV	67/6
90CG	37/6
90CV	42/-
90C1	15/-
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150C2	5/-
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302	10/6
303	10/6
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C1	12/6
C1C	12/6
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CL4	23/10
CL33	11/6
CV6	2/6
CV63	10/6
CV271	12/6
CY1	18/2
CY1C	18/2
CY31	6/9
D1	1/3
D15	13/6
D41	3/3
D42	10/6
D63	5/-
D77	2/3
DAC32	8/3
DAF91	3/9
DAF96	6/3
DCC90	6/9
DD4	12/6
DD41	12/3
DDT4	8/6
DET25	7/6
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DF72	30/-
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DF96	6/3
DF97	7/6
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DH63	4/6
DH76	3/9
DH77	4/6
DH81	25/11
DH101	27/11
DH107	18/9
DK32	8/9
DK40	18/8
DK91	4/9
DK92	6/9
DK96	6/9
DL33	7/3
DL35	6/6
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DL68	15/-
DL72	15/-
DL75	30/-
DL92	4/9
DL94	5/6
DL95	6/-
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EA76	7/-
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EAF42	7/6
EB34	1/-
EB41	4/9
EB91	2/3
EBC3	20/6
EBC33	8/6
EBC41	7/-
EBC81	7/-
EBC91	5/6
EBF80	7/-
EBF83	8/-
EBF89	7/-
EBL21	9/-
EC52	4/6
EC53	12/6
EC54	6/-
EC70	12/6
EC81	27/6
EC90	2/6
EC91	3/-
EC92	8/3
ECC31	7/6
ECC32	4/-
ECC34	21/7
ECC35	5/9
ECC40	7/6
ECC81	4/-
ECC82	4/6
ECC83	4/9
ECC84	6/-
ECC85	7/-
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ECC807	22/6
ECF80	6/9
ECF82	7/6
ECF86	19/5
ECF804	20/-
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ECH21	11/-
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ECH35	6/6
ECH42	7/9
ECH81	6/8
ECH83	8/-
ECH84	14/7
ECL80	6/-
ECL82	7/9
ECL83	10/-
ECL86	9/-
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EF9	20/6
EF22	6/9
EF36	3/3
EF37A	6/-
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EF83	9/9
EF85	5/-
EF86	6/6
EF89	4/9
EF91	3/-
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EF95	5/-
EF97	11/8
EF98	11/8
EF183	9/-
EF184	8/9
EF804	20/5
EH90	15/2
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EK32	6/-
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EL3	21/-
EL32	3/6
EL33	7/6
EL34	10/-
EL35	13/6
EL37	17/6
EL38	12/-
EL41	7/6
EL42	7/9
EL81	8/9
EL83	7/6
EL84	5/6
EL85	9/-
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EL91	2/6
EL95	6/3
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EY81	8/-
EY83	11/6
EY84	14/-
EY86	6/-
EY88	9/3
EY91	3/-
EZ35	4/6
EZ40	5/9
EZ41	6/6
EZ80	4/6
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H63	7/-
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HL23DD	5/-
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HL42DD	8/6
HL133DD	9/6
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KL35	12/6
KLL32	23/11
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KT8	15/-
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KT33C	4/-
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KT41	7/6
KT44	5/9
KT61	7/6
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PCC85	7/6
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PCF84	14/7
PCF86	8/3
PCL82	7/-
PCL83	8/9
PCL84	5/3
PCL85	8/6
PCL86	10/-
PCL88	12/6
PEN4DD	25/11
PEN25	3/9
PEN40DD	34/-
PEN45	8/6
PEN45DD	16/-
PEN46	4/6
PEN383	11/6
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PENA4	7/6
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PL84	6/6
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PY31	7/6
PY32	9/-
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PY80	5/9
PY81	5/9
PY82	5/3
PY83	6/3
PY88	9/-
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SP41	2/-
SP42	12/6
SP61	2/-
SU25	27/2
SU61	6/3
T41	9/-
TDD2	12/6
TDD4	8/6
TH21C	14/6
TH30C	14/6
TH41	13/-
TH233	17/6
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TP25	6/-
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UAF42	8/-
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UBC81	7/6
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UCC84	9/-
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UCF80	10/8
UCH21	9/-
UCH42	7/3
UCH81	7/3
UCL82	8/6
UCL83	9/6
UF41	6/9
UF42	5/6
UF80	6/9
UF85	7/-
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UL44	23/3
UL46	9/-
UL84	6/3
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UM34	16/10
UM80	9/3
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UU5	7/-
UU6	11/9
UU7	13/3
UU8	12/6
UU9	5/6
UU12	4/8
UY1N	10/9
UY21	8/9
UY41	5/-
UY85	4/6
U10	9/-
U12/14	7/6
U16	10/-
U17	5/-
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U19	48/6
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U22	6/9
U24	15/-
U25	9/-
U26	8/-
U31	7/-
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U35	26/2
U37	23/3
U41	19/6
U43	6/3
U45	15/6
U47	9/-
U50	4/6
U52	4/9
U76	4/9
U78	4/-
U84	47/7
U101	19/6
U107	17/6
U191	11/-
U251	9/6
U281	9/6
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U404	6/-
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VP2B	9/6
VP4	14/6
VP4A	14/6
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VP13C	7/-
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OC66	25/-
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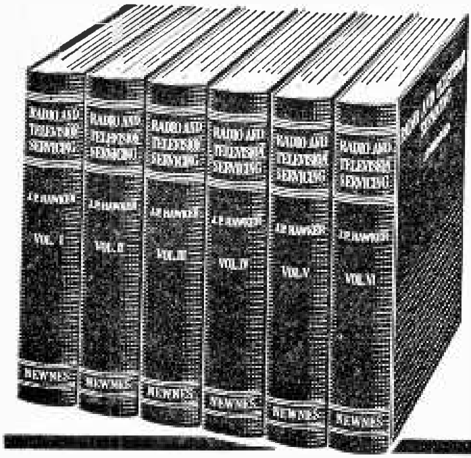

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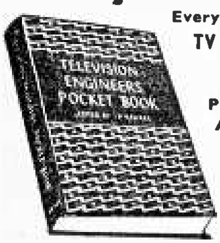

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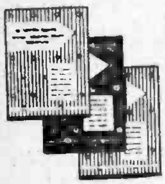

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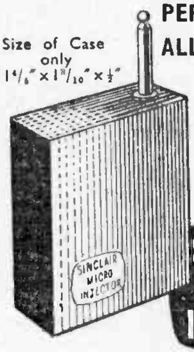
NOW—THE SINCLAIR MICRO INJECTOR — Fascinating to build

Smaller, more versatile, covers 1 Kc/s to 30 Mc/s

PERFECT FOR FAULT FINDING AND SERVICING ALL RECEIVERS AND AMPLIFIERS

Size of Case only $1^4/_5" \times 1^3/_{10}" \times \frac{1}{2}"$



Using two MICRO-ALLOY TRANSISTORS the Sinclair Micro-Injector is a precision sub-miniature instrument which generates and injects a test signal into any part of a receiver or amplifier at any frequency from 1 Kc/s to 30 Mc/s. By this means the location of any fault can be rapidly found.

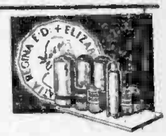
The Sinclair Micro-Injector is powered by a 6d. standard battery which will last for about 6 months. Its size is $1^4/_5" \times 1^3/_{10}" \times \frac{1}{2}"$, excluding the probe which is $^3/_5"$ long, by far the smallest instrument of its kind available. Assembly is extremely simple and will take even a beginner only half an hour. Clearly illustrated building instructions are provided together with operating instructions.

SINCLAIR MICRO INJECTOR

Total cost including all parts, MAT Transistors, printed circuit board, plated probe, and case in royal blue with gold trim. **27/6**

SINCLAIR MICRO AMPLIFIER

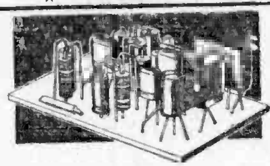
OUTPERFORMS AMPLIFIERS 20 TIMES LARGER



This fantastically small, powerful amplifier is smaller than a 3d. piece. With a frequency response from 30 to 50,000 c/s ± 1 dB, and power gain of 60dB (1,000,000 times) it becomes a valuable tool in the hands of the keen experimenter as well as providing an excellent sub-miniature hi-fi amplifier with an output suitable for any earpiece or even loudspeaker. With MAT Transistors, brand new micro-miniature quality components and micro-printed circuit.

28/6

★ WITH DETAILED INSTRUCTIONS, APPLICATIONS, DATA AND CIRCUITRY.



SINCLAIR TR.5

COMBINED PRE-AMPLIFIER AND HALF-WATT POWER AMPLIFIER

Embodies the latest circuitry techniques to produce a perfectly clean half watt of audio power even from very low output sources such as low-impedance tape recorder heads, pick-ups and microphones. Each amplifier is supplied ready built and unconditionally guaranteed.

- CIRCUIT—5 matched transistors and temperature compensating diode in a transformerless complementary-symmetry configuration.
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- SENSITIVITY—0.5 mV.
- POWER GAIN—80 dB (100 million times).
- FREQUENCY RESPONSE—50 c/s to 20 kc/s ±3dB.
- SIZE—2¼ x 1¼ x ⅝in.
- POWER REQUIREMENTS—10 mA quiescent and 150 mA peak from 9V. battery or power supply.

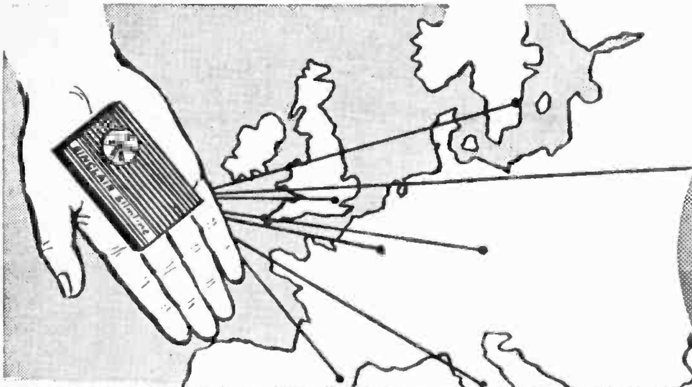
FREE with every amplifier, circuits showing how to use it with low and high impedance pick-ups, microphones, tape-heads in various radio circuits, transmitter circuits, in guitar amplifier, as a mono or stereo hi-fi system, intercom., etc.

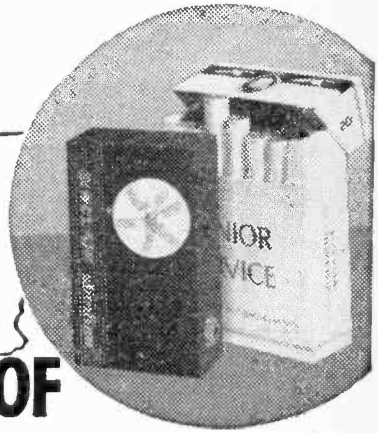
BUILT AND TESTED **59/6**

ALL EQUIPMENT UNCONDITIONALLY GUARANTEED

SINCLAIR radionics LTD

69 HISTON ROAD, CAMBRIDGE





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MICRO-RADIO RECEIVER

- ★ NEW improved solid dielectric tuning capacitor
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- ★ USES Micro-Alloy Transistors throughout (MATs)
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- ★ ELEGANT royal blue case with gold trim and calibrated dial

TOTAL COST

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WITH FEATHERWEIGHT QUALITY EARPIECE

Size $2\frac{13}{16} \times 1\frac{11}{16} \times \frac{3}{8}$in.

Comprises brand new sub-miniature components, printed circuit board, genuine MAT transistors, case, earpiece and well illustrated easily followed instructions.

FULL SERVICE FACILITIES ALWAYS AVAILABLE

THOUSANDS ALREADY IN USE

. . . and thanks to all the hundreds of enthusiasts who have written to us about the Slimline.

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"The case is superbly designed . . . I have built several other kits and none have been truly successful, but yours is a winner." A.E.C., Leicester.

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★

The originals of these and countless other unsolicited testimonials may be seen at our offices at any time during business hours.

BUILD IT IN A COUPLE OF HOURS !

Success is assured before you begin to build, even if you are new to receiver construction, and the finished result is a delight to experienced builder and beginner alike.

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12in. x 8in. x 2½in.	8/6 each
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All are four-sided—ideal for radio receivers, amplifiers, power packs, etc.

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2 amp.	7/-
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Specification: Controls—Volume, Treble, Bass with on/off. Valves—EZ80 rectifier, ECL86 amplifier and output. Output power—3 watts at 3.5 ohms impedance. Input sensitivity—200 millivolts. Frequency response—75-20,000 c/s. Hum and noise——70 dB. Feedback—10 dB. For 200-250 volts A.C. 50 c/s. Well finished in blue with a smart panel with gold markings. Soundly made of good components and performs exceptionally well for the price, £4.19.6.

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AF126	10/-
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OC19	25/-
OC26	25/-
OC42	8/-
OC44	9/3
OC44M	9/3
OC45	9/-
OC45M	9/-
OC70	6/6
OC71	6/6
OC72	8/-
2-OC72	16/-
OC74	8/-
OC75	8/-
OC78	8/-
OC81	8/-
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Set 1. Comprising OC44, 2 x OC45, matched pair OC81 ... 32/6 set
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For double ended push-pull output stage. Ratio 4.5 to 1 + 1. Secondaries bifular wound, 5/-.

TT46. PUSH-PULL OUTPUT TRANSFORMER

For double ended output matching to a 3 ohm speaker. Ratio 4 + 4 to 1, 5/-.

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For single ended output stage matching to a 35 ohm speaker. Secondaries bifular wound. Ratio 4.5 to 1 + 1, 5/-.

TT49. L.F. TRANSISTOR COUPLING TRANSFORMER

Suitable for interstage coupling in simple L.F. amplifiers. Ratio 4.5 to 1, 5/-.

MINIATURE DOUBLE TUNED I.F. TRANSFORMERS

455 to 475 kc/s. Can size ½in. sq. x 11/16in. Ferrite pot and core construction. Suitable for 1st and 2nd I.F.T. giving better selectivity than single tuned I.F.T's. Can be used with normal R.F. transistors. Extra sensitivity when used with diffused alloy 4 element transistors. (Boxed with circuit.) Coil ratios: Total primary to collector tap—2.5 to 1. Collector tap to secondary tap—7.3 to 1, 6/9.

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Paxolin sheet 1/16in. thick, 6 x 6in., 1/- each
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Empty tape spools 3in.	1/6 each
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A really sensitive dynamic earphone o exceptionally fine quality. Provides clear reproduction of music as well as speech. Fully guaranteed and complete with ear insert, 3 feet cord, sub-miniature plug. **Model C.R.5.** Crystal Earpiece, high imp. **Model MR-4.** Magnetic Earpiece, low imp. 6/- each.

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PL82	7/6	3S4	5/6
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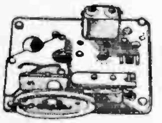
SPECIAL PURCHASE! TURRET TUNERS

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



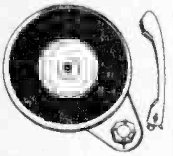
A permeability tuned tuner head by a famous maker, supplied without valve (ECC85) and drum and spindle, 18/6, plus 1/9 P. & P. Valve 8/6 extra. Drum and spindle 3/6 extra.

GORLER 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.

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SINGLE PLAYERS
TU/12. £3.10.0. Carr. 3/6.
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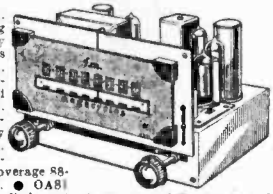
B.S.R. UA14 £6.2.6.
Latest B.S.R. UA16. £7.2.6.
Latest Garrard "Auto-Slim" £6.17.0. Carr. 5/- on each.

LOOK OPPOSITE FOR MORE BARGAINS

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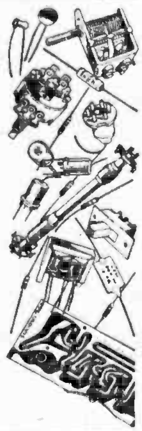
Handsome Metal Cabinets. Choice of Grey, Black or Green. To fit Mark I, 25/-, P. & P. 2/6. To fit Mark II, 17/6. P. & P. 2/6.

6 TRANSISTOR AND DIODE SUPERHET



A first-class 2 waveband transistor superhet. ● Printed circuit panel (size 8¼ 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.

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Size approx. 9½ x 6½ 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.

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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. Complete with output transformer matched for 3 ohm speaker.
PRICE 69/6 P. & P. 3/6
DITTO. Mounted on board with output transformer and 6in. speaker.
Complete at 89/6, P. & P. 4/6.

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GET 15 (Matched Pair) 15/-

OC71	5/-	PXA101	6/6
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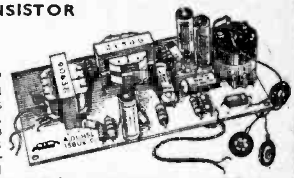
Set of Mullard 6 transistors. OC44, 2—OC45, OC81D matched pair OC81, 25/-. All Post Free

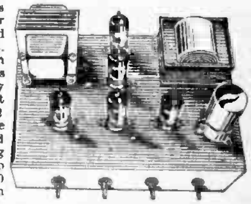
HIGH GAIN 4-TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TAI



● 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. 8/6

BRAND NEW 3 OHM LOUDSPEAKERS

2½in. 12/6; 5in. 12/6; 6½in. 15/-; 8in. 21/-. 10in. 25/-; 12in. 27/6.
E.M.I. 2½in. tweeter .. 10/6
8in. x 5in. By famous maker 10/6
E.M.I. 13½in.x8½in. 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.

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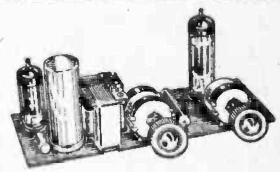
BRAND NEW.
Strongly made wooden construction, tough vynide covered, complete with carrying handle. Overall size 13½in. wide x 9in. deep x 8in. high with sloping front panel. Weight only 4½ lbs. Ideal for our 10/14 watt amplifier and many others.
BARGAIN PRICE **28/6** P. & P. 4/-.

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.

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.

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 2⁷/₈ x 2 x 1½in. Brand new and unused. 3/6 each. P. & P. 1/-.
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CARBON MIKE INSERTS. Brand new, 2½in. 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 ⅞ x ⅞ x ⅜in. 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.
ACOS GP65/1 T/O MONO CRYSTAL CARTRIDGE. Complete with sapphire styli and mounting bracket. Limited number only at 12/6. P. & P. 1/-.

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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. £8.15.0 plus 5/6 carr. and ins. (Tapes extra on both).

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

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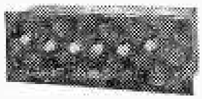
COMPLETE KITS OF PARTS

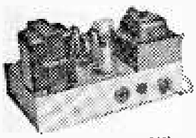
MULLARD 3-VALVE PRE-AMPLIFIER TONE CONTROL UNIT



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 11¼" x 4½" x 4".

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

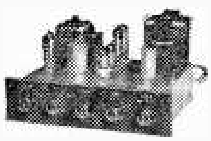
MULLARD "5-10" MAIN AMPLIFIER



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.

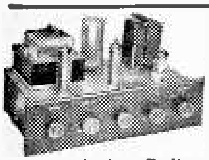
THE MULLARD 510/RC AMPLIFIER



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



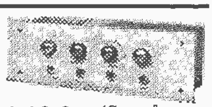
A HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-WATT MULLARD "3-3" DESIGN.
KIT OF PARTS **£8.8.0**
ASSEMBLED AND TESTED **£11.10.0**
Complete to the MULLARD specification including PARMEKO OUTPUT TRANSFORMER. Switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive 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**

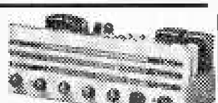
Perfectly suited for Portable Installations for which purpose we offer PORTABLE CASE (£3.10.0), the AMPLIFIER (Kit) and 8" x 5" SPEAKER (£1.0.0). All for **£9.0.0**
Alternatively with ASSEMBLED AMPLIFIER.................. **£10.0.0**
(Carr. & Ins. 5/-).
The Case quoted above will accommodate some 4-speed 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.

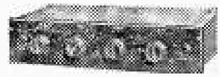
ARMSTRONG RADIOGRAM CHASSIS



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.... **£15.15.0**
(Carr. & Ins. 8/6).
(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.... **£19.10.0**
(Carr. & Ins. 10/-).
(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

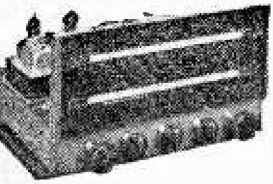
Carr. and Ins. on each above 5/6 extra.

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 ready available—please advise items of interest and enclose S.A.E.

ARMSTRONG AF208AM/FM RADIOGRAM CHASSIS



STEREO 12 Mk. 2 £40/5/-
8 watts push-pull output from each channel, 16 watts total; VHF, with automatic frequency control medium and long bands; A hi-fi system on one compact chassis.
STEREO 55 £29/18/-
Junior version of Stereo 12: 5 watts per channel, 10 watts total; VHF and medium bands; Inputs for tape, pick-ups and future stereo radio.
JUBILEE Mk. 2 £28/5/-
Mono: 8 watts push-pull output; VHF, automatic frequency control, medium and long bands; Separate tone controls: Pick-up and tape inputs.
AF208 (ILLUSTRATED) £21/4/-
An AM/FM mono chassis of 5 watts output covering VHF and medium bands. An inexpensive version of the Jubilee Mk. 2.
All carriage free. Write for free literature.

New Boxed VALVES 90-day Guarantee

OZ4	5/-	6K7G	5/-	EB91	4/-	PCL82	10/-
1R5	6/-	6K8G	5/-	EBC41	8/-	PCL84	10/-
1S5	6/-	6L6G	8/-	EBC81	8/-	PL81	10/-
1T4	3/-	6N7M	5/-	EBF80	9/-	PL83	8/-
2X2	2/-	6Q7G	6/-	ECH42	9/-	PY33	15/-
3S4	7/-	6SN7	5/-	ECH81	9/-	PY80	7/-
3V4	7/-	6V6G	5/-	ECL80	9/-	PY81	8/-
3Q4	7/-	6X4	5/-	ECL82	10/-	PY82	7/-
5U4	6/-	6X5	6/-	EF85	6/-	PQ25	7/-
5Y3	6/-	12AT7	6/-	EF89	8/-	SP41	3/-
5Z4	9/-	12AU7	6/-	EL32	5/-	SP61	3/-
6AC7	4/-	12AX7	7/-	EL84	7/-	U22	7/-
6AM6	4/-	12BH7	7/-	EY51	9/-	UBC41	8/-
6AT6	6/-	12K7	5/-	EY86	9/-	UBC81	9/-
6BA6	7/-	12K8	14/-	EZ40	7/-	UBF89	9/-
6BE6	5/-	12Q7	5/-	EZ80	7/-	UCH81	9/-
6BW6	7/-	25Y5G	9/-	EZ81	7/-	UCL82	10/-
6C4	5/-	35L6	9/-	HABC80	10/-	UCL83	12/-
6D6	5/-	35Z4	5/-	HVR2A	5/-	UF89	9/-
6G6	4/-	954	2/-	KT33C	8/-	UL41	9/-
6H6	3/-	DAF96	8/-	KT76	8/-	UY41	7/-
6J5	5/-	DF96	8/-	MU14	7/-	UY85	7/-
6J6	5/-	DK96	8/-	PCC84	8/-	UU9	7/-
6J7G	6/-	DL96	8/-	PCF80	8/-	VR150	7/-
6K6	5/-	EABC80	8/-	PCF82	8/-	W81	6/-

NEW ELECTROLYTICS FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350V	2/-	50/350V	5/6	8/600V	9/-
2/350V	2/3	100/25V	3/-	16/600V	12/-
4/450V	2/3	250/25V	3/-	16/450V	5/-
8/450V	2/3	500/12V	3/-	32/350V	4/-
16/450V	3/-	1,000/12V	3/-	50/450V	6/6
32/450V	3/9	5,000/6V	5/-	32+32/350V	5/-
				32+32/450V	6/-
25/25V	1/9	8+8/450V	3/6	32+32+32/350V	7/-
25/50V	2/-	8+16/450V	3/9	50+50/350V	7/-
50/25V	2/-	16+16/450V	4/3	64+120/350V	11/6
50/50V	2/-	32+32/350V	4/6	100+200/275V	12/6

TELESCOPIC CHROME AERIALS. 13in. extending to 43in., 8/6 ea. Coax Adaptor Plug. 1/6 extra.
TRIPLEXERS Bands I, II, III 12/6
COAX PLUG .. 1/- **LEAD SOCKET** .. 2/-
PANEL SOCKETS 1/- **OUTLET BOXES** .. 4/-
BALANCED TWIN FEEDER yd. 6d. 80 or 300 ohms.
DITTO SCREENED per yd. 1/6. 80 ohms only.
Wirewound Ext. Speaker Control, 10Ω 3/-, 25Ω 6/6.
WIRE-WOUND POTS. 3 WATT. Pre-set Min. TV Types. All values to 10 ohms to 25 K., 3/- ea. 30 K., 50 K., 4/-. (Carbon 30 K. to 2 meg., 3/-).
WIRE-WOUND 4 WATTS Pots. Long spindle. Value, 50 ohms to 50 K., 6/6; 100 K. 7/6.
PHILIPS TRIMMERS. 0-10 pF., 3-30 pF., 1/-.
TRIMMERS, Ceramic. 30, 50, 70 pF., 9d.; 100 pF, 150 pF, 1/3; 250 pF, 1/6; 500 pF, 750 pF, 1/9.
TV etc. TRIMMER, 1000 pF. with knobs, 2/-.
RESISTORS. Preferred values. 10 ohms to 10 meg., ¼ w., 4d.; ½ w., 4d.; 1 w., 6d.; 1½ w., 8d.; 2 w., 1/-.
High Stability. ½ w., 1%, 2/-. Preferred values 10Ω to 10 meg. Ditto 5% 10Ω to 22 meg., 9d.

WIRE-WOUND RESISTORS 10 ohms—10,000 ohms
5 watt 1/3
10 watt 2/-
15 watt 2/-
12.5K to 47K 10 w. 3/-

Volume Controls
Linear or Log Tracks Long spindles. Midget 5 K ohms to 2 Meg. L.S. 3/-; D.P., 4/6; Stereo L/S 10/6; D.P. 14/6

80 ohm CABLE COAX
Semi-air spaced ¼in. Stranded core **6d. yd.**
40 yds. 17/6
60 yds. 25/-
Fringe Quality Air spaced **1/- yd.**

MAINS TRANSFORMERS 200/250 v. A.C.
Postage 2/- each transformer.
STANDARD, 250-0-250, 80 mA, 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier, 6.3 v. 1 a. 5 v. 2 a. or 4 v. 2 a. **22/6,** ditto, 350-0-350 .. 29/6
MINIATURE 200 v. 20 mA, 6.3 v. 1 a. 10/6
MIDGET, 220 v. 45 mA, 6.3 v. 2 a. .. 15/6
SMALL, 220-0-220, 50 mA, 6.3 v. 2a. .. 17/6
STD. 250-0-250, 65 mA, 6.3 v. 3.5 a. .. 17/6
HEATER TRANS. 6.3 v. 1½ amp. .. 7/6
Ditto, tapped 1.4, 2, 3, 4, 5, 6.3 v. .. 8/6
Ditto, sec. 6.3 v. 4 amp 10/6
GENERAL PURPOSE LOW VOLTAGE, 2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24, 30 v. .. 22/6
AUTO TRANSFORMER, 150 w. .. 22/6
0, 115, 200, 230, 250 v., 500 w. 82/6
MULLARD "510" Mains Transformer .. 38/6
PARMEKO MAINS TRANSFORMER. Made for special contract, the ratings can safely be doubled. Guaranteed 2 years. Primary 0-110-210-230-250 v. H.T. 300-0-300 v. 50 mA. L.T. 6.3 v. 1.8 amp. Size 4 x 3½ x 3in. .. 17/6

INTERVALVE TRANSFORMERS. 3:1 or 5:1, 9/-.
O.P. TRANSFORMERS. Heavy Duty 50 mA 4/6. Multiratio, 7/6. Multiratio heavy duty push-pull 10 w., 15/6. Miniature, 3S4, etc., 5/9.
10 w. O.P. matching trans. 3, 7, 15Ω, 12/6.
L.F. CHOKES 15/10H., 60/65 mA, 5/-; 10H., 85 mA, 10/6; 10 H., 150 mA, 14/-.
TINNED COPPER WIRE 16 to 22 swg. ½lb. 3/-.
ENAMEL COPPER WIRE 16-22, 2/9; 24—30, 3/6; 32—40, 4/6; D.C.C. 28, 34, 36 swg, 2oz. 3/6.

I.F. TRANSFORMERS 7/6 pair
465 K/s Slug Tuning Miniature Can, 2 x ¾ x ¾in. High Q and good bandwidth. Data sheets. Standard size Weyrad, 10/6 pair.

FULL WAVE BRIDGE SELENIUM RECTIFIER: 2, 6 or 12 v. 1½ amp., 8/9; 2 a., 11/3; 4 a., 17/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v., 1½ amps., 15/6; 2 amps., 17/6; 4 amps., 22/6. Circuit included.
4 AMP CAR BATTERY CHARGER with amp. meter Leads, Fuse Case, etc., for 6 v. or 12 v., 69/9.
AMMETER 0 to 5 amp., 9/6.

BOOKS list S.A.E.
Boys' Book of Crystal Sets.. .. 2/6
"W.W." Radio Valve Data .. 6/-
High Fidelity Speaker Enclosure 5/-
Valve and TV Tube Equivalents .. 9/6
TV Fault Finding 5/-
Mullard Amplifier Manual .. 8/6
Radio Valve Guide, Books 1, 2, 3, 4 or 5 .. .. 5/- each
Transistor Superhet Receivers .. 7/6
Practical Radio Inside Out .. 3/6
Master Colour Code Chart.. .. 1/6
Transistor Controlled Models .. 7/6
Principles of Colour TV 16/-
International Radio Stations List

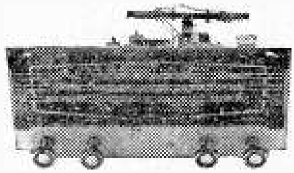
4 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER
Size 3 x 1½ x ½.
A ready built miniature push-pull amplifier with Driver and output transformers, 4 transistors. Ideal for use with record players, intercoms, BABY ALARMS, etc. Complete with full instructions and circuit.
Price, **47/6** 9v. Batt. 2/3 2½in. Speaker 15/-.

BAKER SELHURST LOUDSPEAKERS

12in. Baker 15w. Stalwart 3 or 15 ohms, 45-13,000 c.p.s. 90/-
12in. Stereo, Foam Suspension, 12w., 35-16,000 c.p.s. £6.17.6
12in. Standard H.D. 20w. 40-14,500 c.p.s. .. £8.0.0
12in. De Luxe 15w. 25-17,000 c.p.s. ..£9.10.0
12in. Bass 25w. 20-18,000 c.p.s. .. £12.12.0
15in. Auditorium, 35w., Bass, 20 c.p.s. to 12 kc/s. Ideal Bass Guitar. £18.
Details and Enclosures, plans, S.A.E.

LOUDSPEAKERS P.M. 3 OHM. 2½, 3, 4in., 5in. Rola, 7in. x 4in. Rola, 15/6; 6½in. Rola, 16/6; 8in. Plessey 17/6; 10 x 6in., 22/6; 10in. Rola, 30/-; 12in. R.A. 30/-; 13½ x 8in. Double Cone E.M.I., 35/-.
STENTORIAN HF1012. 10in. 3 to 15ohms, 10w. 87/6; 8in. HF812 72/-; Tweeter T359 30/-.

1963 RADIOGRAM CHASSIS



THREE WAVEBANDS — S.W. 16 m.—50 m. M.W. 200 m.—550 m. L.W. 800 m.—2,000 m.
FIVE VALVES — LATEST MULLARD ECH81, EF89, EBC81, EL84, EZ80
12-month guarantee.
A.C. 200/250 v. 4-way Switch; Short-Medium, Long/Gram. Ferrite Aerial A.V.C. and Negative feedback, 3 ohm output, 5 watts. Glass dial, horizontal wording, size 13in. x 4in. Aligned and calibrated. Isolated Chassis, size 13½in. x 9in. high x 5½in. deep.
£8.19.6 Carr. & Ins. 4/6.

C.R.T. BOOSTER TRANSFORMERS for heater cathode short circuit, or tubes with failing emission. Full instructions supplied, mains input. Type A optional 25% and 50% boost 2v. or 4v. or 6.3v. or 10.8v. or 12.6v. State voltage required. PRICE 10/6.

TWIN GANG TUNING CONDENSERS. 365 pF, miniature 1in. x 1½in. x 1¾in., 10/-; 500pF Standard with trimmers, 9/-; midget, 7/6; with trimmers, 9/-; 500pF slow motion tuning, standard or midget, 9/-.
SMALL 3 gang 500 pF, 17/-. **SINGLE** 365 pF, 7/6.
SINGLE 10 pF, 25 pF, 50 pF, 75 pF, 100 pF, 160 pF, 5/6. Solid dielectric 100, 300, 500 pF, 3/6.
CONDENSERS. New stock. 0.001 mfd. 7 kV, T.C.C., 5/6; Ditto, 20 kV, 9/6; 0.1 mfd., 7 kV, 9/6. Tubular 500 v. 0.001 to 0.05 mfd., 9d.; 0.1 1/-; 0.25, 1/6; 0.5/350 v., 1/9; 0.1/350 v. 9d.; 0.1/2,000 v., 0.1/1,000 v., 1/9; 0.1 mfd, 2,000 volts, 3/6.
CERAMIC CONDS. 500 v. 0.3 pF to 0.01 mfd., 9d.
SILVER MICA CONDENSERS, 10% 5 pF to 500 pF, 9d.; 600 pF to 3,000 pF, 1/-. Close tolerance (+1 pF) 2.2 pF to 47 pF, 1/-. Ditto 1% to 50 pF to 815 pF, 1/-; 1,000 pF to 5,000 pF, 1/9.

465 kc/s SIGNAL GENERATOR
Price 15/-. Uses B.F.O. Unit, ZA 30038 ready made with valve 1S5. POCKET SIZE 2½ x 4½ x 1in. One resistor to change, full instructions supplied. Battery 3/6 extra. 69V1½V. Details S.A.E.

WAVECHANGE SWITCHES
8 p. 4-way 2 wafer long spindle 6/6
2 p. 2-way, or 2 p. 6-way long spindle .. 3/6
4 p. 2-way or 4 p. 3-way long spindle .. 3/6
3 p. 4-way or 1 p. 12-way long spindle .. 3/6
Wavechange "MAKITS". Wafers available: 1 p. 12 way, 2 p. 6 way, 3 p. 4 way, 4 p. 3 way, 6 p. 2 way, 1 wafer switch, 8/6. 2 wafer switch, 12/6; 3 wafer switch, 16/-; additional wafers up to 12, 3/6 each extra; Toggle Switches, s.p., 2/-; d.p., 3/6. d.p.d.t., 4/-. Min. Slide d.p.d.t., 3/6.

CRYSTAL MIKE INSERTS, 6/6
High output. Size 1½in. dia. x ⅜in.
ACOS MIC. 14, Insert 1½in. dia. x ⅜in. 8/6
ACOS 39-1 DE LUXE STICK MIKE 35/-
TSL QUALITY STICK MIKE.... 25/-

Valveholders. EA50, 6d. B12A, CRT, 1/3. Engl. and Amer. 4, 5 and 7 pin, 1/-. MOULDED Mazda and Int. oct., 6d.; B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6. B9A with can, 1/9. Ceramic EF50, B7G, B9A, Int. oct., 1/-. B7G, B9A cans. 1/- each. Valve plugs B7G, B9A. 2/3.

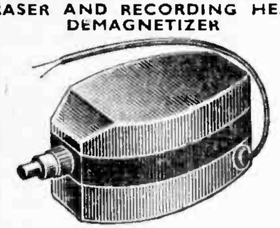
HIGH GAIN TV PRE-AMPLIFIERS
BAND I B.B.C.
Tunable channels 1 to 5. Gain 18dB. ECC84 valve. Kit price 29/6 or 49/6 with power pack. Details 6d. (PCC84 valves if preferred.) Coils only 9/6.
BAND III I.T.A.—Same prices.
Tunable channels 8 to 13. Gain 17dB. Circuit and coils only, 9/6.

THE ORIGINAL
RADIO COMPONENT

Our written guarantee with every purchase
NEW COMPONENT LIST 1/-.

Bus 133 or 68 pass door.
S.R. Station Selhurst.

THE "INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETIZER



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Constructor's Booklet	2/-
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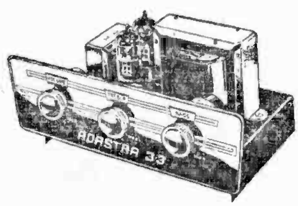

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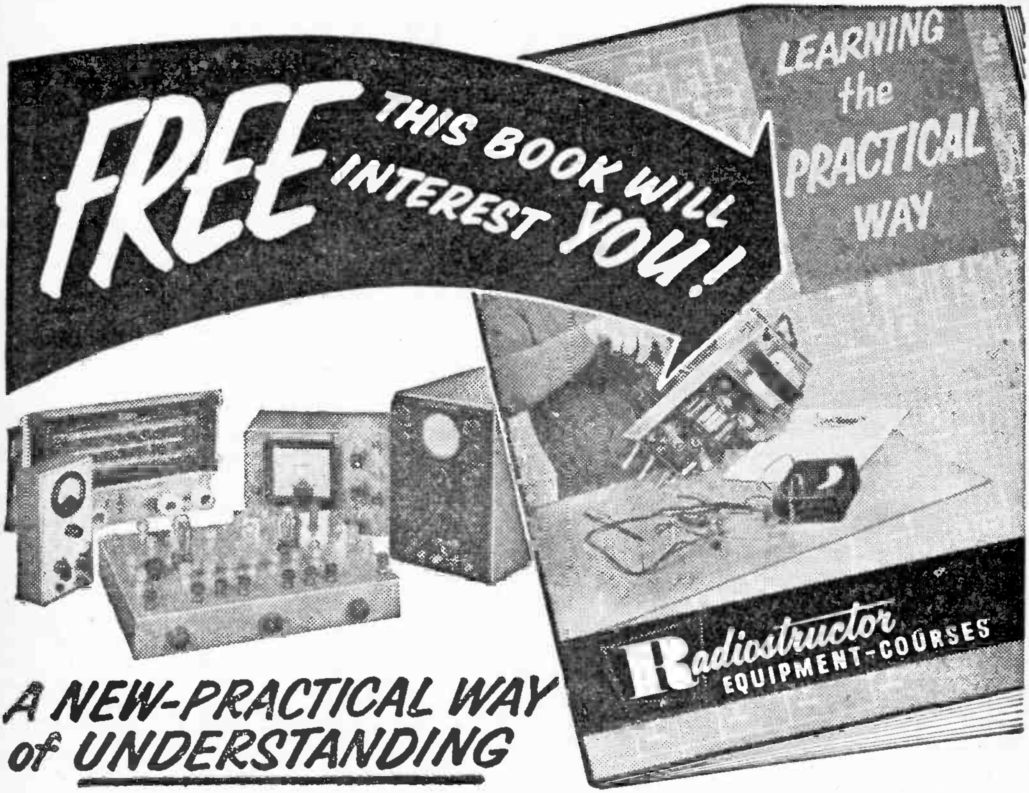

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Practical Wireless

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Contents

BE PREPARED!

AT this time of year, as autumn approaches and the evenings draw in, most readers will be spending less time in outdoor pursuits and more on indoor activities. And in particular, thoughts of the impending constructional "season" will occupy a good many minds.

For whereas the majority of enthusiasts (quite rightly) enjoy as much of the outdoor life as our capricious climate allows during the summer months, the winter sees a peak in constructional activity that restores the average.

After a reduction of building projects for a month or two, most amateurs look forward keenly to this resurgence of activity which begins to gain impetus as the autumn leaves fall. Many readers, of course, maintain a certain level of practical activity all through the year, but nevertheless there is something about the autumn and winter that presents an irresistible lure even to those who temporarily forsake practical work in the summer.

Perhaps it is the cosy atmosphere of the workshop, den or "shack", with the smell of flux on the soldering iron and the low hum of power packs. Perhaps it is because, shut off from the obtrusive world with the curtains drawn, one can get to work without external distractions and concentrate fully on the work in hand. Or maybe it is because the true enthusiast, though seemingly inert during the summer, has been quietly planning new ideas for equipment and now feels the time is ripe to put them to the test.

Whatever it is, one thing is certain: during the next few months much solder is going to flow, many holes are going to be drilled and many thousands of components are going to be wired into hundreds of different circuits. With, we hope, a large percentage of successes!

But despite the fact that this general pattern follows regularly, we wonder how many are *really* prepared for the approaching high level of activity. The facilities available to the radio amateur vary enormously from, literally, the kitchen table to the separate permanent workshop—with a wide assortment in between.

Yet whatever the enthusiast's personal circumstances, he would do well to ensure that he is fully prepared to embark on an extended period of constructional work. For instance, is the wiring in the workshop adequate and is it really safe? Have those important extra points been installed? Are all tools in good shape? Are there any gaps in the tool kit? Is the spares box in reasonable order? Are the boxes of nuts, bolts, small components, etc., sorted and conveniently housed? In other words—are you ready for working at maximum efficiency and ease?

If somewhere along the line you get a negative answer, now is the time to put things right. *Before* the season really gets under way—when you will *never* find the time!

Our next issue dated November will be published on October 4th

ROUND THE WORLD of WIRELESS

NEWS AT HOME AND ABROAD

RADIO EXHIBITION IN AMSTERDAM

NINETEEN manufacturers will have exhibits on the official British stand at the International Exhibition of Radio, Television and Electronic Equipment (FIRATO) to be held in Amsterdam, Netherlands, from September 13th to 22nd

The stand, which will cover 2.600sq.ft, has been organised by the Board of Trade and the Audio Manufacturers' Group. A special demonstration room on the stand will enable visitors to judge the performance of British made tape recorders, record players, amplifiers, loudspeakers and radios, under the best acoustic conditions.

STEREOPHONIC TRANSMISSIONS

THE number of experimental stereophonic transmissions per week from the BBC's Wrotham Third Programme transmitter, has been increased recently from one to three. Test transmissions can now be received on Tuesdays, Wednesdays and Thursdays on 91·3Mc/s.

A tone test transmission between 10.30a.m. and 11a.m. will be followed by a programme test transmission from 11.15a.m. to 11.45a.m. A tuning signal consisting of two tones of different pitch is transmitted for four minutes before the test transmissions.

U.S. Order for Blind Persons' Aids

AN order for a number of electronic aids for blind persons, which were described in these pages a few months ago and which rely on the difference of frequency between an ultrasonic beam of energy and its reflection from nearby objects to enable the blind user to "hear" obstacles ahead, has been received by the manufacturers from the Bureau of Rehabilitation Services of the Department of Education for the State of Kentucky, U.S.A.

Ultra Electronics Limited, who produced the first of the aids for the preliminary evaluation tests, have also received an order for 50 units from St. Dunstan's.

H.F. Equipment for Ministry of Aviation

THE Ministry of Aviation has recently ordered a number of Marconi type D11 and D13 high-frequency mobile radio stations. The contract is valued at approximately £1,500,000.

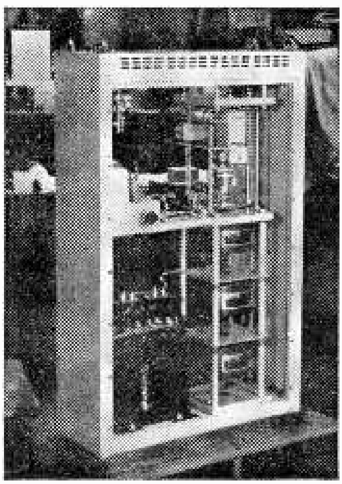
The type D11 transmitter/receiver equipment is a mobile field communication unit providing the latest h.f. facilities, including s.s.b./i.s.b. telephony and f.s.k. telegraphy, with incorporated teleprinter. The output power of the transmitter is rated at 300-350W over the frequency range 2 — 21·999Mc/s. The receiver is a high stability independent side-band and telegraph equipment, crystal controlled and operating on the double superheterodyne principle.

The type D13 equipment operates over the same frequency range but with a transmitter power output rating of 1kW. It also differs from the D11 in that it employs two receivers (for dual diversity operation) instead of one.

REGULATORS FOR BBC

THE BBC's v.h.f. transmitting and radio link stations as well as television stations, require very stable voltage supplies, and recently at the Wimbledon works of Foster Transformers (a member of the Metal Industries Group) six new voltage regulators for various BBC stations have been undergoing extensive tests prior to delivery.

Each of the regulators has an output of 17kVA which is necessarily maintained stable for the transmitter and associated equipment it will be serving when installed.



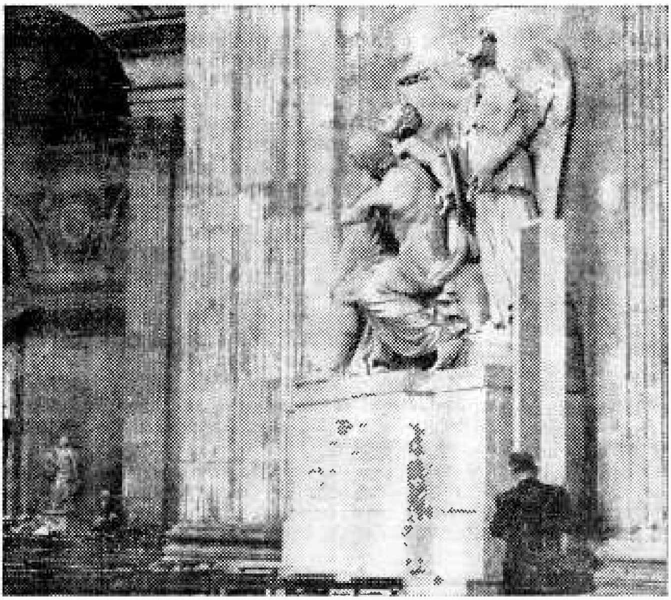
One of the voltage regulators made by Foster Transformers for the BBC.

IMPROVED SOUND FOR ST. PAUL'S

AFTER extensive tests made by engineers from Standard Telephones and Cables Limited, the sound system of St. Paul's Cathedral, London, has undergone considerable alteration, designed to improve audibility to every part of the congregation.

The Cathedral's architecture and size have posed special problems for the sound engineers involved on the operation, and in particular there is a problem of the time lapse of speech from the altar and pulpit areas, and along the length of the Nave. (It was found that sound took three-tenths of a second to travel from the altar to the far end of the Nave.)

As it was decided to incorporate the Cathedral's existing system of loudspeakers in the new improvements, it was obvious that a delay mechanism would be necessary to co-ordinate sound arriving direct from the source and the sound delivered over the loudspeakers; which, in the normal course of events, would arrive almost immediately. Failure to compensate for this phenomenon would result in garbled speech reaching the distant parts of the congregation.



An STC engineer positions an 8 ft. column loudspeaker in St. Paul's Cathedral during recent accoustic tests.

The method used by STC to give the necessary delay employs a magnetically loaded neoprene belt, stretched around a metal drum. In operation the drum is revolved at 80 revolutions per minute. Several magnetic heads are distributed at specific points around the drum and held in contact with it as it revolves. One of two of these heads. records speech on to the belt from either the altar or pulpit microphone. As the drum revolves, the recorded speech is carried to replay heads successively spaced further around the drum from the recording head; and from these the speech is carried to loudspeakers situated at various distances from the microphone. The time taken for the signal to travel round the drum from record to replay heads provides the necessary delay.

Finally as the recorded speech moves past the last replay head, an erase head removes the signal before once again the recording heads are reached at the end of one complete revolution of the drum.

SERVICING EXAMINATION

IT was announced recently that out of the 853 candidates who entered the final written examination for the Radio and Television Servicing Certificate of the City and Guilds of London Institute, 456 passed and thus qualified for the practical test to be held later this year.

Modernisation for East African Telephone Link

TEN years ago the Marconi Company installed a multichannel link between Nairobi, Mombasa, Tanga and Dar-es-Salaam in East Africa Now the East African Posts and Telecommunication and Administration has placed a contract with Marconi's to modernise the complete system which will result in improved performance and increased capacity for the telephone channels.

After modernisation there will be two radio paths over the whole link, carrying a total of 96 telephone channels, and automatic change-over facilities will ensure that priority traffic is not interrupted by failure of either radio path.

Despite the increased capacity of the links, the original terminal and repeater stations will be used, some of which link distances of up to 97 miles.

Chairmen for B.V.A. and VASCA

TWO associations of valve manufacturers have recently elected their chairman for the forthcoming year. The British Radio Valve Manufacturers' Association (B.V.A.) has elected Mr. F. V. Green of Brimar Limited, and the Electronic Valve and Semiconductors Manufacturers' Association (VASCA) has elected Mr. A. J. Young of the English Electric Valve Company Limited.

A SIGNAL GENERATOR

transistorised . . . a.f. and modulated r.f. outputs . . . battery operated . . .

BY F. G. RAYER

THIS signal generator uses two transistors, and will provide either an audio frequency output or a modulated radio frequency output. The a.f. output can be used to check audio amplifiers, or the a.f. stages of a receiver. The r.f. output is tunable from about 1·6Mc/s to 170kc/s (approximately 190 to 1,800m) and can be used to test or align intermediate frequency amplifiers, or medium and long wavebands of a receiver. Harmonics of 200kc/s are audible to 10mc/s, while harmonics of 1Mc/s are audible to 30Mc/s, with a sensitive receiver. This allows frequency spotting through the short wave ranges of a receiver.

The generator operates from a 4·5V dry battery supply, and may be used for checking transistor sets, or mains or battery operated valve receivers.

The circuit is shown in Fig. 1. Tr1 is a radio frequency transistor, such as is commonly employed as a self-oscillating mixer in superhet receivers. Tr2 is an audio type; a yellow-green spot audio transistor was used by the author, but any small transistor in working order should be satisfactory.

T1 is a transistor coupling or driver transformer, with a ratio of about 1:2 or 1:1. The transformer fitted was intended for push-pull, so one secondary lead is unused. If Tr 2 does not oscillate, connections to the primary of T1 should be reversed. With the switch S1 in position 1, the audio signal is taken to the output control potentiometer VR1, which allows volume to be kept down as required.

Tr1 is the r.f. oscillator. A two-gang 400pF or similar value tuning capacitor is used to obtain adequate coverage with only two bands.

With the switch S1 in position 2, the generator tunes from about 1·6Mc/s to 500kc/s (190 to 600m approximately). When the switch is in position 3, the coverage is approximately 500 to 170kc/s (600 to 1,800m approximately) and this includes most of the long wave band, in addition to 370kc/s and adjacent intermediate frequencies.

C5 provides coupling from the a.f. oscillator, which acts as modulator, so that the note can be heard on a receiver tuned to the same frequency as the generator.

Small transistor type components can be used throughout, except for C6, which must be a mica or other high voltage capacitor, in order to provide effective isolation from mains equipment.

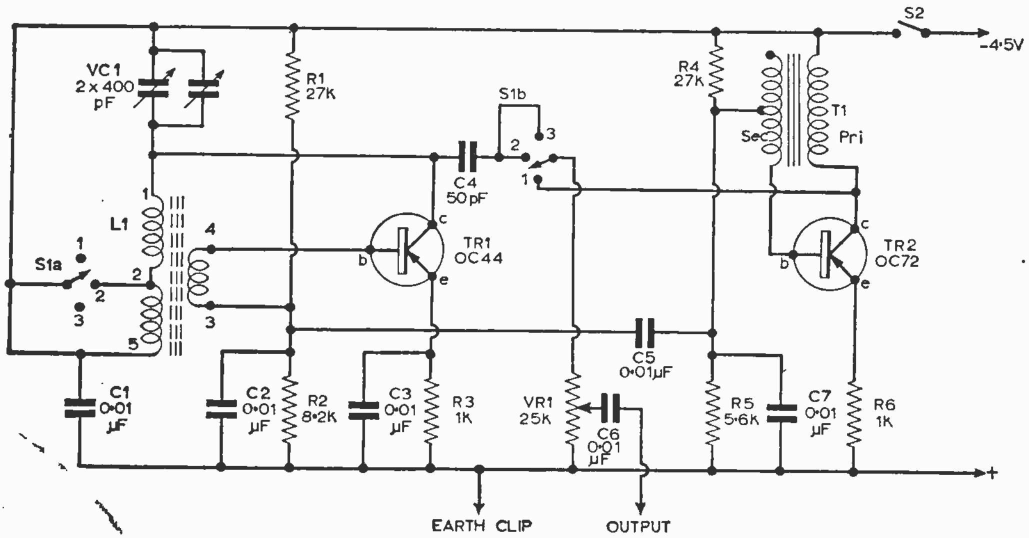


Fig. 1: The complete circuit of the generator.

Tuning Coil

This was wound as in Fig. 2, silk covered wire of 34s.w.g. being used throughout. The m.w. section consists of 50 turns wound side by side, between points 1 and 2, a layer of paper being placed over the rod. A space of about 1/5in. is left, and seven turns are wound side by side (leads 3 and 4). A narrow space (about 1/20in.) is left, and 100 turns are wound in a compact pile, for the l.w. section. The end of the m.w. winding is joined to the beginning of the l.w. winding (lead 2). The end of the l.w. winding is lead 5. Dabs of cement are used to hold windings and the ends secure, and all turns must be in the same direction.

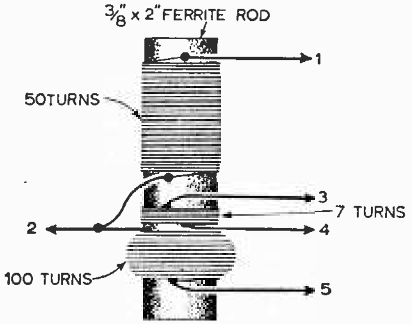


Fig. 2: Winding details of the tuning coil, L1.

In general, other coils should be satisfactory. However, some experiment may be needed. If coverage is too high in frequency (low in wavelength) additional turns are required; but if frequency coverage is too low, turns need removing. Air cored coils were found to work, but need many more turns. Some ready-made dual-wave coils could be expected to be satisfactory, though coverage might need modifying slightly, either by changing the core positions, or by altering the number of turns. With most coils, turns will need removing, to reach about 500kc/s on the l.w. band, with VC1 fully open.

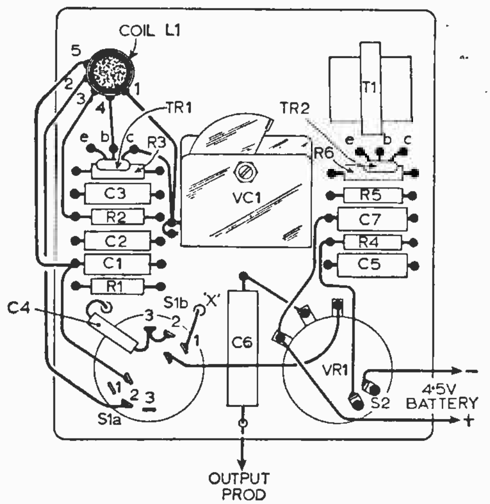


Fig. 3 (above) and Fig. 4 (right): Component layout and wiring diagrams.

Construction

A paxolin panel about 4in. x $4\frac{3}{4}$in. is used, drilled as in Fig. 4. The ferrite rod (L1) is a push fit in a $\frac{3}{8}$in. diameter hole, being held with cement. A $\frac{1}{16}$in. drill will do well for all the small holes, with $\frac{3}{8}$in. hole for the switch and potentiometer and a $\frac{1}{2}$in. hole to clear the gang capacitor.

The components are mounted as in Fig. 3. Emitter, base and collector leads of Tr1 and Tr2 are inserted as shown and there is no need to cut these wires short. The transformer T1 is held by its leads.

Three short 4B.A. bolts hold the gang capacitor. These must not penetrate sufficiently to short-circuit or damage the capacitor. The circuit requires a three-way, two-pole switch and, if a surplus switch with more contacts is fitted, unwanted tags are ignored.

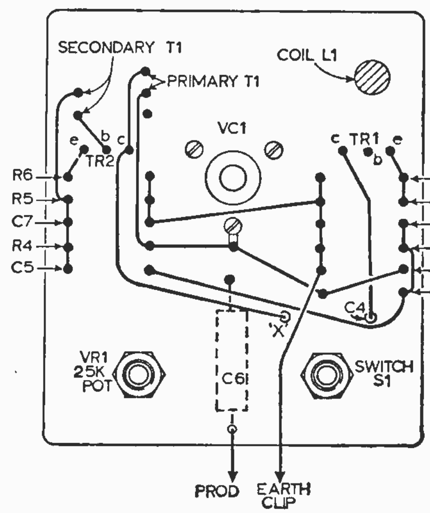
Fig. 4 shows wiring on the front of the panel between resistors and other parts. Any thin, insulated wire is satisfactory or thin tinned copper bare wire can be employed with 1mm sleeving.

The audio oscillator stage can be tested alone when wired. To do this connect phones from C6 to battery positive. If no tone is heard reverse the primary leads to T1 as mentioned.

Two short pieces of thin flex are provided for battery connections and there was found to be no advantage in using more than 4·5V. Consumption is between about 2mA and 6mA according to the actual transistors, so very small cells will do well. To avoid trouble from bad contact leads may be soldered to the cells. Three dry cells in series will provide 4·5V and the zinc case is negative.

Output Lead

A flexible lead from the positive line terminates in a clip which can be attached to the chassis or other earthed circuit of a receiver.



The output lead from C6 is fitted with an insulated prod so that the signal can be injected into various parts of a circuit.

There is no chance of shocks when testing a battery operated transistor receiver. With battery operated valve sets the h.t. may be sufficient to cause a shock. In the case of mains receivers the usual care must be taken. The danger is particularly great with a set of the a.c./d.c. type or one drawing h.t. directly from the mains.

The Case

The case is made of thin wood approximately 4¼in. x 4¾in. x 2¼in. deep internally. The panel is thin paxolin 4¾in. x 5¼in. if the case is of ¼in. thick wood. Nuts on the switch and potentiometer secure the generator and panel together and scales are marked on the paxolin or on thin card placed over the paxolin. For tuning a fairly large knob is required and is fitted with a celluloid cursor marked with a line to permit reading against the scales.

To check the generator the a.f. output may be applied to a pair of phones or to an amplifier or receiver. To test for modulated r.f. output place the prod or lead near the aerial of a receiver. The audio tone should be heard when the receiver and generator are tuned to the same frequency.

Harmonics

The generator note will also be heard when the receiver is tuned to a multiple of the generator frequency. For example, if the generator is tuned to 200kc/s its note will be heard at 200, 400, 600, 800, 1,000, 1,200kc/s and so on. This fact is very useful both to calibrate the generator tuning scales and to furnish a signal for a short-wave receiver.

The correct tuning point will most easily be found when coupling between generator and receiver is low, and output small, so that the received signal is not too strong.

Calibration

If a calibrated generator is available, set this to various frequencies, tune in the signal on a receiver, then tune the transistor generator to the same frequency and mark its scale.

If no calibrated generator is to hand, calibration can first be at 200kc/s points. Find this fundamental point from the BBC Light Programme transmitter. Tune the generator to the same frequency and mark its long-wave scale. Then tune the receiver to a harmonic as mentioned. Leave the receiver tuning untouched and tune the generator until its fundamental is heard on the receiver. This can then be marked on the generator scale. Repeat the whole procedure until the scales are calibrated to 1·6Mc/s (1,600kc/s). Other calibration marks can be obtained by selecting other harmonics. For example, the third harmonic of the Light Programme (long waves) is 600kc/s. The generator may then be tuned to 300kc/s (600kc/s is the second harmonic of 300kc/s) to obtain the 300kc/s point between 200 and 400kc/s. Proceeding in this way, sufficient calibration points can be secured.

Note that the tone is not heard if the generator is tuned to a multiple of the receiver frequency but only when the receiver frequency is a multiple of the generator frequency.

The signal generator may be used to test or align a receiver in the normal way. The following brief details will help indicate how this work is carried out.

Checking Audio Circuits

If a receiver or audio amplifier does not operate, a quick check of the audio stages can be made by utilising the a.f. output of the signal generator. An insulated test lead with prod is used to apply the a.f. output to various circuit points in turn, working backwards from the loudspeaker. When the point at which a fault arises is passed, reproduction will deteriorate or cease.

As an example the first test will show if the loudspeaker is working. The next test will indicate if the output transformer is in order and connected. The output valve or transistors are then brought into the portion of the circuit under test by injecting the signal at the control grid or base. The coupling capacitor or driver transformer can then be checked by removing the prod to the input side of this component. Earlier a.f. stages are then taken in one by one.

This is a very rapid means of localising a fault. If such tests are carried out on a receiver or amplifier in good order this will show what to expect. When the a.f. signal is applied directly to a loudspeaker or output transformer and loudspeaker, volume is low. An earth return lead from generator to receiver chassis will be necessary when little or no amplification is available. To test a loudspeaker, output and earth leads must be taken to the speech coil. As one or more stages of amplification are introduced, by moving the output lead to grid or base, volume from the loudspeaker should increase considerably. The earth lead from generator to receiver is then often unnecessary.

COMPONENTS LIST

Resistors:

R1	27kΩ	R4	27kΩ
R2	8·2kΩ	R5	5·6kΩ
R3	1kΩ	R6	1kΩ

VR1 25kΩ potentiometer with s.p. switch (S2)

Capacitors:

C1 0·01μF paper
C2 0·01μF paper
C3 0·01μF paper
C4 50pF ceramic
C5 0·01μF paper
C6 0·01μF mica, or paper 500V
C7 0·01μF paper
VC1 400+400pF 2-gang variable

Inductors:

L1 H.F. coil (see text)
T1 Transistor coupling or driver transformer

Switches:

S1 2-pole, 3-way miniature rotary
S2 s.p.s.t. (see VR1)

Transistors:

Tr1 OC44 or similar r.f. or mixer type
Tr2 OC72 or similar a.f. type

Miscellaneous:

Two small pointer knobs. One 1½in. diameter knob. Paxolin, wire, sleeving, clip and prod, etc. Ferrite rod for L2 (2in. x ⅜in.).

If a fault is present in audio stages these tests will show where it arises. If the whole audio section of a receiver works satisfactorily this shows the defect is in earlier stages.

I.F. Testing, Alignment

If the receiver is already aligned, stage-by-stage tests of the intermediate frequency amplifier can be made in the same way as described for audio stages. However, the generator is tuned to provide a modulated radio frequency output corresponding to the receiver intermediate frequency. This is done by tuning the generator for best output from the receiver.

The signal may be injected at the final IFT primary. If the audio section has tested satisfactorily and there is no output from the receiver, then the IFT or detector or wiring here must be suspected. If output is satisfactory the prod is moved back to take in the last i.f. valve or transistor, then the preceding IFT and so on. The whole i.f. amplifier may thus be quickly checked.

The strength of the signal injected into the receiver is adjusted as required in a similar manner to that already explained. When a stage or two of i.f. amplification has been introduced into the part of the circuit being tested, loose coupling between prod and receiver circuit will generally be sufficient. That is, the prod point only need be placed near the receiver lead or against the insulation of the lead.

Should the receiver be newly built, and not aligned, the generator should be tuned to the wanted frequency (often 470kc/s). This signal is injected at the last IFT and the IFT core is adjusted for best output from the receiver. The previous IFT is then taken in and adjusted, followed by any earlier IFTs present.

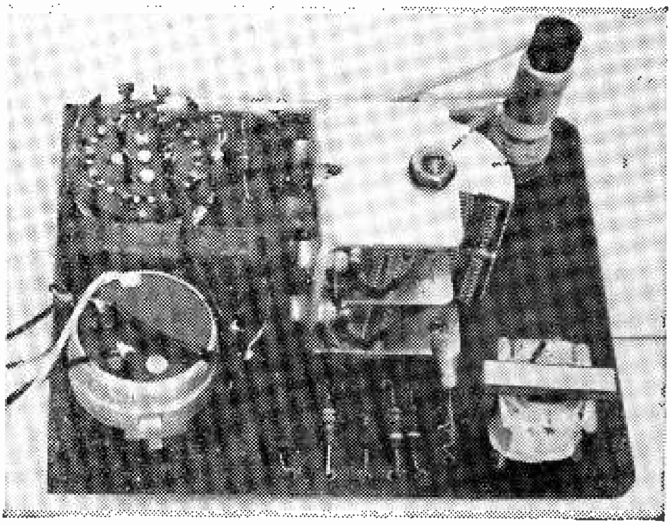
As capacity from the generator prod will slightly influence alignment, all the IFTs are given a final check to see if any slight readjustment is wanted. This is done with the generator coupled to the input (grid or base) of the mixer or frequency changer.

When i.f. or earlier stages are being tested the receiver volume control should be at maximum, but volume should be kept quite low by reducing the strength of the injected signal as described. This is to avoid the automatic volume control circuit of the receiver making accurate adjustment difficult.

If some form of output meter is preferred to adjustment by ear this is easily arranged. A 25mA, 50mA or other d.c. meter may be added in one battery lead of transistor sets having push-pull output. Alignment is then to secure maximum meter reading. An a.c. voltmeter with 0·5μF or other blocking capacitor in one lead can be used as an audio output meter. A d.c. meter can be used to measure the anode current of an i.f. stage to which a.v.c. is applied, adjustments being to obtain minimum current. The meter should be at the h.t. side of the IFT primary with a bypass capacitor to chassis. Alternatively a high-resistance voltmeter may be used to measure the a.v.c. line voltage. Adjustments are directed towards securing an increased negative voltage with valve sets. With transistor receivers the a.v.c. line is positive.

Mixer, R.F. Stages

Tests in r.f. stages are as described, the generator being tuned to the same frequency as the receiver. To trim such stages adjust the generator to a high frequency (low wavelength). To make adjustments to coil or aerial inductance tune the generator to a low frequency (high wavelength). It is usual to deal with the m.w. band first, followed by long waves.



The instrument completely wired up, ready for installing in its case.

Sufficient input should be obtained by placing the generator prod or lead near the receiver aerial socket or frame aerial or ferrite rod. If trimming is initially badly out a fairly strong signal (closer coupling) may be used, followed by more accurate trimming on a weaker input (looser coupling).

To secure agreement with a printed dial, trimming and inductance adjustments are made as described for various frequencies after checking that the dial or pointer is properly fitted to the tuning capacitor. If a dial is to read accurately throughout, the tuning capacitors, trimmers, coils or aerial and padders must all be of the specified values intended for use together.

With mains operated equipment, remember to take the usual care to avoid shocks. Receivers of the a.c./d.c. type or sets drawing h.t. directly from the mains may have dangerous mains voltages present on the chassis, etc., if fed from a reversible two-pin plug or adaptor or from a wrongly wired three-pin plug. ■

A Novel A.F. Amplifier

BY E. A. PARKER

FIG. 1 is the circuit diagram of an amplifier which has been used for some time past in conjunction with a simple regenerative transistor receiver to provide loudspeaker output for a fairly large living-room. In fact the output was sufficient at times to make the provision of a volume control essential. The amplifier was found to be capable of driving loudspeakers of diameters of from 3in. to 8in. with equal efficiency and has been incorporated into a small portable t.r.f. receiver using a 3in. speaker.

Directly-coupled Output Stage

The main design considerations were that the amplifier should be easy to construct, economical to run and should require as few components as possible—this saved space and money. It was decided, therefore, that two of the transistors should be d.c. coupled. Now audio amplifiers capable of driving a loudspeaker are as often as not of the push-pull variety, requiring expensive push-pull driver and output transformers and matched transistors. So an attempt was made to construct a directly-coupled output stage.

As stated above, the final product of experiment was the circuit of Fig. 1, which seems to provide a large current gain in addition to providing an output well in excess of 100mW.

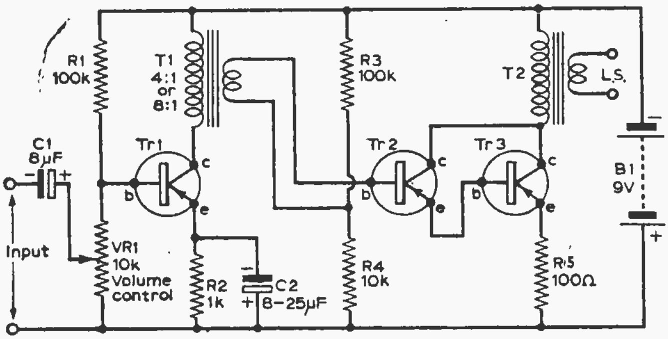


Fig. 1: The circuit of the amplifier.

Alternative Transistors

The transistors used were XB102s (or XB112s) for Tr1 and Tr2 and an XC101 (or XC111) for Tr3, the output transistor.

Although Ediswan transistors were used the Mullard OC71 and OC72 (Tr3) are equally suitable. The amplifier also works well with surplus transistors (red spots for Tr1 and Tr2 and green/yellow spots for Tr3) but if these are used the directly-coupled pair should be selected so as to have low leakage currents.

The layout of the amplifier was not found to be critical and in view of this no constructional details are given, but Fig. 2 indicates the orientations of the connecting leads of the transistors. One point to note is that the emitter bias of the output pair tends to be slightly more critical than does that of a conventional single-ended output stage, but the value of 100Ω for the resistor R5 in the emitter leads as shown in Fig. 1 will be found to be satisfactory in most cases. Depending on the individual transistors used, the optimum value of this resistor should be found to be within the range 50-500Ω.

The interstage transformer T1 may be replaced by an R—C coupling circuit if economy demands this; the collector load should then be of the order of 4·7kΩ and the coupling capacitor should have a value of 8μF with a minimum of 12V d.c. working voltage. A slight loss in stage gain will result with this arrangement.

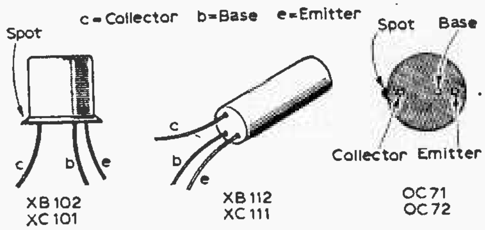


Fig. 2: Lead identification of types of transistors that can be used in this circuit.

Output Transformer

The output transformer T2 should be chosen so as to reflect a collector load of about 4·8kΩ to Tr2 and Tr3. If this load be designated by Rc and the

—continued on page 504

COMPONENTS LIST

Resistors:

R1	100kΩ	R4	10kΩ
R2	1kΩ	R5	100Ω (see text)
R3	100kΩ		

All 10%, ¼W carbon.
VR1 10kΩ potentiometer

Capacitors:
C1 8μF electrolytic 12V
C2 8—25μF electrolytic 12V

Transformers:
T1 Interstage transformer; 4 : 1 or 8 : 1
T2 Output transformer (see text)

Transistors:
Tr1, 2 XB102, XB112, OC71 or red spot
Tr3 XC101, XC111, OC72 or green/yellow spot

The PHOTOPHONE

By M. L. Michaelis

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

CONTINUED FROM PAGE 427 OF THE SEPTEMBER ISSUE

CONTINUING the discussion from last month on radiation, it may be said that the intensity of an electromagnetic radiation is given by the electric or magnetic field intensities on the wave picture and by the *average* number of photons arriving in a given time on the "photon" picture. It is necessary to stipulate "average" rate of arrival of photons in the second case because the actual sequence of arrival of photons, in common with all particle radiations, is quite random, subject to purely statistical fluctuations over short periods. This phenomenon has already been discussed in detail in connection with the digital Geiger counter apparatus published in this journal in the February, 1962, and following issues. The methods of interpreting quantitative results when forced to use the particle way of looking at things, rather than the wave method, at the very high frequencies represented by atomic radiations have also been described in the named articles.

Visible light represents just about the reasonable borderline case where it is about equally convenient to treat it statistically as a random sequence of particles, called photons, or to treat it as a continuous wave electromagnetic radiation. Indeed some optical devices are most conveniently treated on a basis of photons, whereas others are more conveniently explained on a wave basis, it always being necessary to remember that the two treatments amount to the same thing, and thus the practical engineer designing equipment operating at visible light frequencies will use the method of approach offering the greater simplicity in a given case.

A final point should bear this out. We are normally accustomed to thinking of light as a wave radiation, which is indeed more often than not the most useful line of approach. However, the photophone unit described in this article is an excellent example of the manifestation of the "photon" particle properties of light if we look more closely.

The detailed action is best represented by a "photon-for-electron" picture. Each photon particle of the incident light *actively* reaching the cathode of the photocell ejects one electron contributing to the resulting anode current. Were the rate of arrival of photons absolutely steady, then the stream of electrons produced in the photocell would be quite steady for an unmodulated steady beam of incident light. An audio amplifier connected to P2 would register no a.c. signal. Upon trying this in practice, however, we find that this condition is only approximately true. If the gain of the audio amplifier is very high, or at least reasonably high (e.g. both stages of an ECC83, followed by an EL84 output stage), a *powerful hiss* will be heard as soon as a steady beam of light is shone into the photophone. This shows that there are random statistical fluctuations taking place in the rate of arrival of the photons, leaving only a constant long-term average. Exactly the same hiss is heard if a Geiger counter is subjected to strong atomic radiation, giving a high average counting rate. The true average frequency of arrival of atomic particles, which may in that case be in the region of 10kc/s, is not heard primarily, but rather the band of frequencies represented by the random variation, leading to a raucous hiss.

The same effect is found, yet again, in the thermionic emission of electrons from a valve cathode. The average rate of emission of electrons, representing the total saturation cathode current of which the valve is capable, nevertheless contains the short-period random statistical fluctuations characteristic of all particle emissions and radiations in Nature. These statistical fluctuations of cathode emission give rise to the same characteristic hiss. responsible for the major portion of "valve noise" in sensitive input stages of amplifiers.

The same statistical laws apply for the absorption of particle radiation as for its emission, thus if several grids and anodes are receiving each a certain average portion of the total cathode current the exact momentary partition of current among the electrodes is subject to further random statistical fluctuation, giving further hiss. Thus, as will doubtless be familiar to many readers, multi-electrode valves are more "noisy" than triodes.

Use of Valve Voltmeter

With the valve voltmeter circuit of Fig. 4 it is seen that, when using the universal probe shown, connected to P5, d.c. ranges of 5, 50 and 500V f.s.d. are available.

The upper range is not useful for the Photophone, being intended for general usage of the valve voltmeter, but the lower two ranges are so intended. For this purpose P5 of the valve voltmeter is connected directly with P1 of the Photophone without any probe. The probe

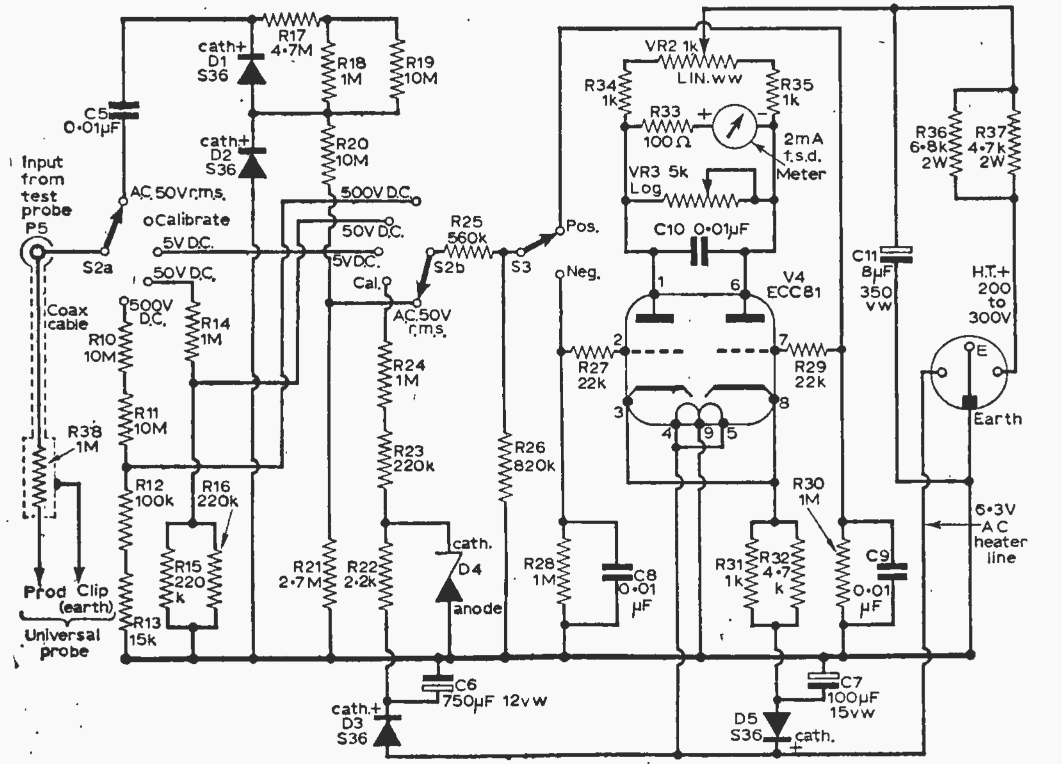


Fig. 4: A high quality valve-voltmeter circuit for use with the Photophone.

resistor R38 is missing under such circumstances so that the effective sensitivity is doubled, f.s.d. being obtained for 2·5 and 25V input respectively.

As the voltage calibrations on the meter for correspondence to readings with the universal probe are 5V or 50V f.s.d., and we have seen that an output of 0·5V per foot-candle is to be expected, the valve voltmeter readings on the existing voltage scales give foot-candles directly.

If, upon more accurate comparisons, corrections are found necessary to bring the voltage calibrations of the meter in Fig. 4 and the foot-candle values into true correspondence, various measures can be adopted. Within limits the values of R5 and/or R6 in the Photophone may be adjusted if only small corrections are required either way. If larger *reductions* are found to be needed, then suitable resistors may be included in series in the cable connecting P1 and P5.

Larger *increases* of sensitivity are best obtained by fitting a switch to select different values for R25 and R26 in the valve voltmeter when switching to "photometer" setting on this switch. Much greater overall sensitivity is easily obtainable by using a more sensitive meter. This can be fitted with a universal shunt for switching back to the 2mA f.s.d. sensitivity for normal use in the design of Fig. 4 or for multiplying the sensitivities of the incorporated voltage scales.

The Valve Voltmeter

It is not proposed to go too deeply into the principles of the circuit but merely to give sufficient information to enable the reasonably experienced reader to build the valve voltmeter.

The design is based on a simpler version which was published in the December, 1961, issue of Practical Wireless. This earlier design suffered to some degree in the matter of obtaining linearity up to full-scale deflection.

However, some further experiments have in the meantime been undertaken on this circuit, Fig. 4 showing the result. For the price of some appreciable increases in complexity, it was ultimately found possible to get good linearity to full-scale deflection for both positive and negative inputs, polarity-switching being undertaken by changing over between the two grids of V4 by means of S3.

The same 2mA meter was able to be retained and in fact virtually the same layout and design as published in December, 1961. Thus the same disposition of tagstrips was maintained and those readers who have already built the simpler instrument could very easily and quickly convert to the new comprehensive form.

Those building the unit new from scratch will find that the layout is not critical except for the need to mount the grid stoppers R27 and R29 *very* close to the grids concerned and to connect nothing else directly to the grids. These grid stoppers were not required in the simpler circuit because this operated at much lower standing anode current, where parasitic oscillations were far less likely than in the present circuit.

In all other respects meticulous insulation, to avoid errors due to leakage in the high-impedance circuits, is far more important than any particular layout which may be chosen to suit individual requirements and available materials.

Methods of Cathode Bias

To get the present circuit to operate on negative inputs as well as positive ones, the operating point of the valve had to be shifted to higher current, at the same time retaining the relatively high cathode load to give proper coupling between the two sections. The only way of achieving this was to bias the cathodes down to a negative voltage, which was conveniently obtained at sufficient current capabilities by means of D5 and C7 from the heater line.

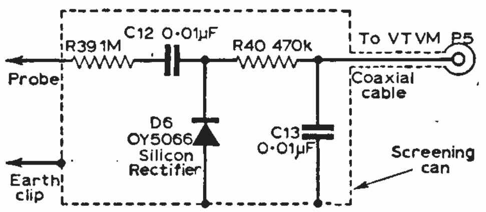


Fig. 5: An a.c. probe usable throughout audio, long wave, medium wave and short wave ranges, and able to tolerate all voltages present in normal receiver and amplifier circuitry. (See *also table below*).

Full scale deflection at 50c/s mains frequency input, using this probe in P5 of the prototype valve voltmeter (Fig. 4) represents:—

VTVM switched to:	*Sensitivities:*
50V r.m.s. a.c. range	Do not use here
5V d.c. range	15V r.m.s.
50V d.c. range	150V r.m.s.
500V d.c. range	500V r.m.s.

Notes: (1) The sensitivities given hold true up to about 100kc/s and down by factor six at 20Mc/s in the prototype. (2) On the 500V d.c. range do not exceed 250V r.m.s. input.

This, incidentally, is a most useful general method of biasing a cathode negative wherever this may be required in a circuit to enable the cathode-load resistor to be increased without choking back anode current. The converse of biasing a cathode more positive still than the voltage given anyway by virtue of anode current through the cathode load, is available by means of taking an additional high resistor from the cathode to h.t. positive, a measure capable of driving the valve even beyond cut-off in the resting state. This is, of course, never possible with a cathode load alone, for a cut-off valve takes no anode current and thus cannot produce bias across a cathode load, and thus could not be cut off, which contradiction proves the impossibility.

Trimming the Valve Voltmeter

The combination R31, R32, as in the earlier circuit, remain the crucial components for proper operation. Too low a value gives insufficient deflection sensitivity on the meter, too high a value severe non-linearity in the form of cramping near full scale. This might, however, be considered useful in the interests of opening up low readings and those readers taking this point of view could use an appropriately calibrated non-linear scale attached to the meter.

To reduce the actual current swing required in the *valve* for f.s.d. meter deflection, it is useful to ascertain that as little current as possible is normally shunted through VR3. For this purpose R25 and R26 are simultaneously adjusted in such

COMPONENTS LIST FOR VALVE VOLTMETER

Resistors:

R10	10MΩ	R26	820kΩ
R11	10MΩ	R27	22kΩ
R12	100kΩ	R28	1MΩ
R13	15kΩ	R29	22kΩ
R14	1MΩ	R30	1MΩ
R15	220kΩ	R31	1kΩ
R16	220kΩ	R32	4·7kΩ
R17	4·7MΩ	R33	100Ω
R18	1MΩ	R34	1kΩ
R19	10MΩ	R35	1kΩ
R20	10MΩ	R36	6·8kΩ 2W
R21	2·7MΩ	R37	4·7kΩ 2W
R22	2·2kΩ	R38	1MΩ
R23	220kΩ	R39	1MΩ
R24	1MΩ	R40	470kΩ
R25	560kΩ		

All carbon 1W ±20% unless otherwise stated

Capacitors:

C5	0·01µF paper 500V
C6	750µF electrolytic 12V
C7	100µF electrolytic 15V
C8	0·01µF paper 500V
C9	0·01µF paper 500V
C10	0·01µF paper 500V
C11	8µF electrolytic 350V
C12	0·01µF paper 500V
C13	0·01µF paper 500V

Miscellaneous:

V4	ECC81 (noval holder)
D1—3 & D5	Diode Type S36. Inverse resistance 10MΩ or better. Inverse voltage rating 350. Capacity approx. 10pF or less. Forward current 20mA or more.
D4	5V Zener-diode
D6	Silicon mains rectifier Type OY5066. Inverse voltage rating 700. Current rating unimportant. Selected specimen for performance up to 20Mc/s in Fig. 5.
S2	2-pole 5-way ceramic rotary switch; high insulation
S3	Single-pole double-throw toggle switch
VR2	1kΩ lin. carbon or wire-wound
VR3	5kΩ log. carbon
Meter	2mA f.s.d. moving-coil
P5	Coaxial socket
P6	4-pole socket (as on Grundig tape recorders)
	Chassis, casing, wire, solder, bolts, etc.

a manner that the dividing ratio is altered, but the sum of R25 and R26 in parallel with 1MΩ remains equal to 1MΩ—in order that the input voltage dividers to the left of S2b remain correct.

This adjustment of R25 and R26 is undertaken on the "calibrate" setting, with VR3 disconnected, until the meter only still reads *very slightly* high, final correction then being continuously available on VR3 when this is reconnected. This adjustment of R25 and R26 has already been carefully undertaken in arriving at the component values specified and these should be found satisfactory.

If trouble is experienced, readers should first check for low emission in V4 by substitution and also check that R25 and R26 are of the values specified.

Further New Features

While modifying the original simple valve voltmeter circuit to a form ideal for use with the Photophone, other changes were made to improve its general usefulness, again at some additional expense and complication.

The two grid circuits have been fully symmetrised and kept to normal impedance levels of around 1MΩ. This avoids trouble from zero point drifts due to electron impact grid current otherwise present in high-impedance grid circuits and also makes the zero point fall at virtually the same setting of VR2 on *all* ranges.

Furthermore the zero point now falls very close to the middle position of VR2 under all conditions and requires only very infrequent adjustment after an initial five to ten minutes' warming up. These advantages have been obtained at the price of one disadvantage over the original, namely a reduction of overall impedance presented as load across the voltage source being measured. However, a reasonable compromise has been struck.

The disposition of smoothing capacitors has been changed to give a quicker response and quicker return to zero and a high resistance has been removed to the probe head to prevent a.c. damping stopping, for example, oscillators functioning when d.c. potentials at electrodes are to be measured.

Furthermore the whole aggregate around D1 and D2 has been incorporated to give a 50V r.m.s. f.s.d. range for a.c., usable at mains frequency only, without changing probes. The combination R17 to R19 should be adjusted until this scale reads correctly; it may be possible to select a single 5·6MΩ resistor in place of these three. The new circuit uses a pair of diodes, D1 and D2, for achieving high inverse voltage rating, preventing damage even if the a.c. signal is superimposed on a d.c. voltage of some hundreds of volts, which is blocked at C5.

It is thus possible to measure the gain of amplifier stages with this instrument, using a 50c/s sine-wave signal and comparing levels at grid and anode, without any need to be concerned with d.c. potentials which may or may not be present. Finally the work on this valve voltmeter was completed with the design of a special a.c. probe, for use at other frequencies, operating into the d.c. ranges. This rectifies at the probe head in the usual way so that high-frequency signals do not have to pass down the coaxial cable and get lost in the capacity thereof.

Experiment revealed the interesting fact that, although D6 is a silicon rectifier intended for mains power rectification, usable performance was possible at frequencies up to 20Mc/s. The high inverse voltage rating of the silicon diode is a great advantage, so that this probe cannot be damaged by any normal h.t. voltages found in receivers and amplifiers. Otherwise it is of the conventional form already mentioned in the other publications.

Conclusion

It is hoped that this article has been successful in introducing the possibilities of optical frequencies for radio experiments as well as explaining some of the significances and aspects of various types of radiation in the light of modern science in a form which is surely of a more practical usefulness for the understanding of one's equipment than mere philosophical theory for which it might at first sight be mistaken. ■

Novel A.F. Amplifier

—continued from page 500

loudspeaker impedance by R_L, then use a transformer of turns ratio $n = \frac{\text{number of primary turns}}{\text{number of secondary turns}}$ where $n^2 = \frac{R_C}{R_L}$

The following table gives the value of n for three popular loudspeaker impedances. (Here, R_C 4·7kΩ.)

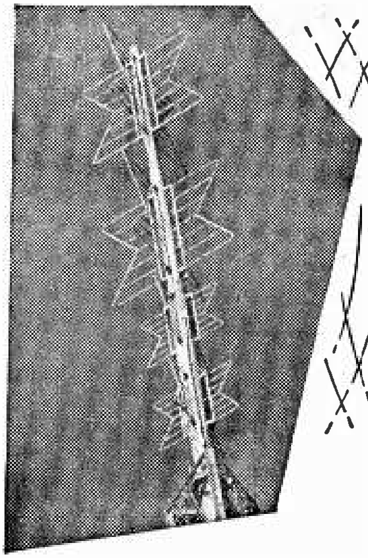
Loudspeaker impedance (R_LΩ)	Output transformer turns ratio (n:1)
3	40:1
8	25:1
35	10:1

The transformer used by the writer was abstracted from a defunct battery operated valve portable receiver—its physical size was small enough.

Additional Pre-amplifying Stages

Clearly the number of transistors preceding the output pair may be varied according to the number available and the final output required; three such transistors would overload the power output transistor Tr3 on loud passages of music if the amplifier is used with an average local station t.r.f. receiver. Only one was required in the writer's home town (Orpington, Kent) to provide ample listening volume on the Light Programme (247m) and the Home Service (330m) from a one-transistor regenerative receiver with a 5in. loudspeaker connected to the amplifier outputs.

The amplifier is powered by a PP7 (9V) battery which has a life of more than 70 hours when the amplifier is run at full volume. ■



On Your Wavelength

By THERMION

IT is unfortunately true that some amateur constructors (and not only "beginners" at that) fail to take sufficient pains with their soldering operations. Bad workmanship really does not pay, since much time and effort are often spent afterwards in tracking down obscure faults that have their origin in inadequately made connections. Even when satisfactory performance is obtained initially, there is always the danger of leads becoming disconnected later due to the shock or vibration sustained under normal working conditions. This applies particularly to miniature receivers and to other electronic equipment of a portable nature.

One of the cardinal rules of soldering is that a sound mechanical joint should be made before the solder is applied. (It is, of course, essential that the mating surfaces are perfectly clean and free from grease and such like.)

Joints, Various

Now, what constitutes a sound mechanical joint? Certainly it is not necessary to go to the lengths illustrated by some ex-government radio and electronic equipment. Most of my readers will have handled surplus equipment of one sort or another, and many of you will have had experience in stripping down various specimens for the sake of the components contained therein. I recall the tussles that occurred when trying to detach resistors and capacitors from groupboards—the difficulty arose because the manufacturers' wiremen, dutifully following the Ministry's directions, had tightly wrapped each component lead two or three times (if not more) round the tag prior to soldering. The problem was always whether to arm oneself with soldering iron and long-nosed pliers and attempt to acquire the desired component complete with its leads, or whether to take the simpler course and to seize the diagonal cutters and amputate!

While thorough-going wiring-up methods are justified with equipment required for military or similar purposes, they are not warranted (or indeed desirable) with more commonplace equipment. But, let me emphasise, guard against going to the other extreme of merely bringing the two surfaces into contact and relying on a generous blob of solder to do the rest. True, I admit, that this procedure can be quite effective with some miniature components where mechanical strain is negligible. Even so, I consider it advisable to make a self-supporting connection wherever this is at all possible. This is certainly no hard task, and the following suggested methods will usually suffice.

Push the lead through the hole in the tag and, if it is a loose fit, bend the protruding portion just sufficiently to provide a locking effect, then cut off the surplus wire fairly close to the tag. With larger components it is sometimes necessary to make a full right-angled bend and to squeeze the end of the wire against the flat surface of the tag. Where the lead is not passed through a hole in the anchoring device, it should be hooked around the edge of the tag or terminal.

A Tape Teaser

One of the interesting uses to which magnetic tape recording is now being applied is the training of foreign language students in correct pronunciation. Recording systems known as "Language Laboratories" allow a number of students to perform oral exercises simultaneously without causing interference.

The usual method of operation is like this: each student sits in a booth equipped with a special tape recorder and, via headphones, listens to speech pre-recorded by the tutor. This recording is divided into a number of fairly short passages, and each is followed by a pause of similar duration. At the end of each passage the student repeats this phrase or sentence into his microphone endeavouring to copy faithfully the pronunciation of the original.

Whenever he wishes, the student can rewind his recorder and set it to playback. He then hears once again the tutor's voice followed immediately by his own efforts at imitation. For further practice he resets to record and proceeds as before, his earlier efforts being erased in the process, as is normal.

The little problem I now leave you with is this: how is it contrived that the tutor's recording remains preserved throughout and cannot be erased by the student no matter how often he re-records his own voice in the gaps provided?

PERSONAL TRANSISTOR TWO

A Simple Medium Wave Set Suitable for the Beginner

BY A. SYDENHAM

ONLY a comparatively small cash outlay is involved in the construction of the receiver to be described and little or no test equipment is required to bring it into use.

Quite often a newly constructed superhet fails to provide any kind of signal when first switched on due to severe misalignment, but this is not likely to occur here as only a single tuned circuit is used. This set can, if necessary, be built quite easily on the kitchen table and no risk of lethal mains shocks is likely since transistors are used, two being employed since this is about the minimum number capable of providing a decent signal in a pair of headphones.

The prototype has also been tested with a loudspeaker by substituting the primary of a ratio 8:1 transistor output transformer in place of the headphones and connecting a 3Ω loudspeaker unit to the secondary winding. If the surroundings are quiet, as in a bedroom, for example, programmes can be heard quite well.

The receiver is powered by a single 4·5V dry battery and the current consumption is so low (less than 1mA) that replacement is likely but rarely.

The frequency coverage is 600-1460kc/s (500-205m), this covering practically the whole of the medium waveband. If long-wave reception is required this can be incorporated but has not been attempted in the prototype.

In common with all simple t.r.f. circuits arranged to work at their most sensitive point the receiver is likely to prove slightly temperamental at the first try-out and slight adjustments to certain of the components might be occasioned. This point has been taken care of in the layout, however, which if followed accurately will allow changes to be made very easily. The range of component tolerances and the production spreads in the transistors, etc., cause discrepancies that cannot be disposed of cheaply.

The Circuit

In Fig. 1 it may be seen that the first transistor Tr1 is operated as a regenerative demodulator feeding a stage of audio amplification built around Tr2, high impedance headphones being inserted in the collector circuit of this transistor to enable the user to hear the selected programme.

The circuitry around Tr1 might be more easily understood by referring to Fig. 2, where a typical

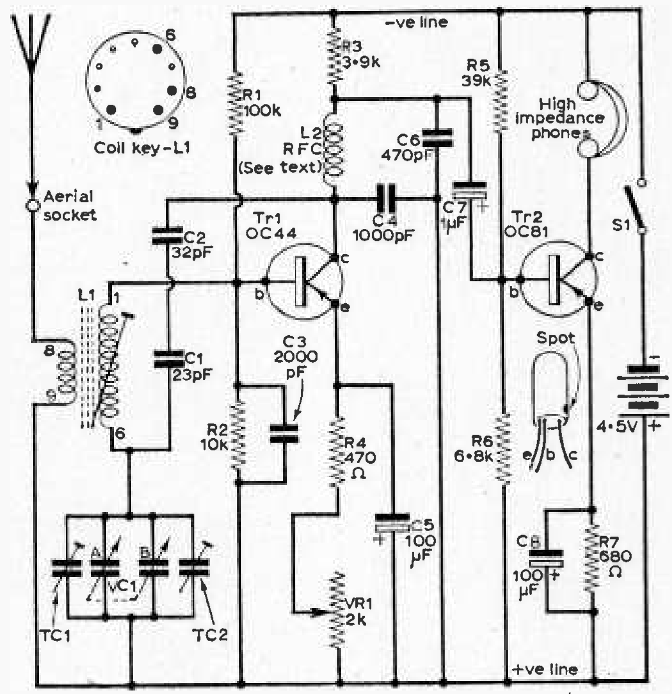


Fig. 1: The circuit.

valve oscillator circuit is shown. Here the external tuning of the coil L is effected by capacitors Cx and Cy. Sometimes no resistor is included in the cathode circuit, bias for the valve being derived entirely from grid current. This circuit is widely used, the triode usually being part of a frequency changer valve when Cx is often made one section of a twin-gang tuning capacitor with Cy operating as a "padding" capacitance.

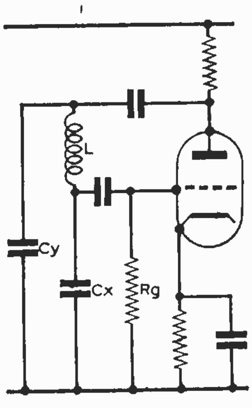


Fig. 2: A typical valve oscillator circuit.

Looking now at the circuitry around Tr1 (Fig. 1) the similarity will immediately be apparent and it will be appreciated that the transistor will oscillate if operating conditions are suitable.

By controlling the emitter current by means of a variable resistor bypassed by a capacitor, detection can occur if the transistor is not allowed to oscillate but instead is brought close to the point of the occurrence.

A suitable impedance match into the base of Tr1 can be effected by employing a capacitive potentiometer across the coil and using one section of it for tuning. Capacitors VC1 and C3 perform

COMPONENTS LIST

Resistors:

R1	100kΩ	R5	39kΩ
R2	10kΩ	R6	6·8kΩ
R3	3·9kΩ	R7	680Ω
R4	470Ω		

VR1 2kΩ wire-wound potentiometer

Capacitors:

- C1 23pF mica
- C2 32pF mica
- C3 2,000pF ceramic
- C4 1,000pF mica
- C5 100μF electrolytic 6V
- C6 470pF mica
- C7 1μF electrolytic 6V
- C8 100μF electrolytic 6V
- VC1 208pF / 176pF } twin-gang variable (Jackson 'OO')
- TC1 / TC2 } trimmers—with VC1

Switch:

- S1 Toggle switch, on/off

Inductors:

- L1 M.W. coil (Denco Yellow dual purpose, range 2)
- L2 R.F. choke (see text)

Transistors:

- Tr1 OC44 Tr2 OC81

Miscellaneous:

Miniature 18-way tag board 4½in. x 1½in. (Radiospares). Battery 4·5V (Ever Ready 1289). High impedance headphones. Panel material, hardboard, Aerial and phone sockets. Control knobs.

this function and are in effect identifiable with Cx and Cy respectively in Fig. 2.

Since these capacitors are connected across the coil in series the total value of capacitance available will always be less than that of the smaller of the two. This reduced capacitance effect will make itself most apparent at the low-frequency end of the band, i.e. where the vanes of C1 are most fully engaged, and if a suitable coil is not used for L1, only a section of the band will be receivable. Fortunately suitable coils are available from the Denco miniature range.

A miniature Jackson "00" twin gang with sections paralleled (208+176pF) form a total value of 384pF, ignoring the trimmers, but this is reduced to about 330pF by C3 and is then suitable for use with the coil specified. When another coil designed to work with a 500pF tuning capacitor was tried in the circuit maximum low frequency coverage was reduced to 750kc/s.

Note that two capacitors—C1 and C2—are fitted between Tr1 collector and L1; this is not a safety

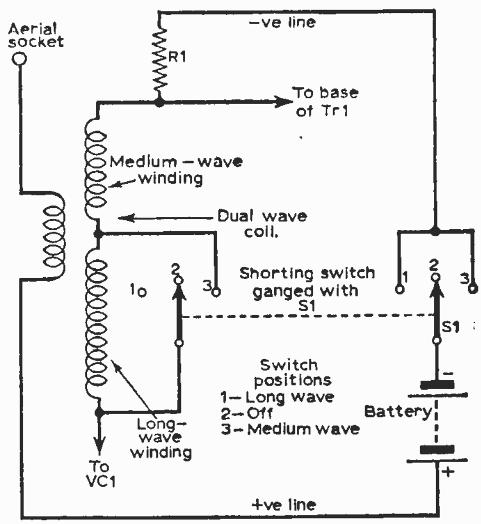


Fig. 3: The modified circuitry necessary to provide long wave coverage.

measure but an aid to obtaining good results on completion, since these items control the amount of positive feedback to a great extent.

The efficiency of the receiver largely depends upon the characteristics of Tr1 and this should be a good specimen; the use of a surplus type is not recommended.

The small r.f. choke of 3,000μH inductance (L2) fitted in the collector circuit of Tr1, consists of the main winding of a dust-cored long-wave coil, the primary winding being removed and the coil former sawn off to the length of the core.

As mentioned earlier, inclusion of long waveband facilities can be provided either by fitting a separate coil from the Denco range (Range No. 1) or by using a miniature dual-waveband coil as shown in Fig. 3. The additional switching required can be incorporated with S1 by using a rotary switch. A two-pole, three-way switch used as shown will allow the central position to be "off"

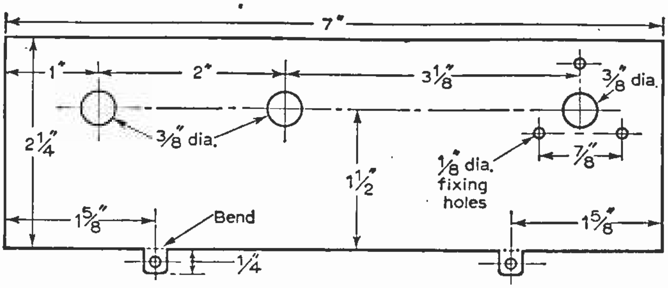


Fig. 4: Dimensions of the control support panel.

with "medium" and "long" situated on either side. This makes accidentally leaving the receiver switched on less likely than in other arrangements. No extra panel control will be needed if this idea is followed.

Constructional Notes

The receiver is built around a miniature 18-way tag board to which is affixed a simple metal panel that carries the three controls. This assembly is finally located on a main hardboard panel to which simple sections are finally fitted to form a cabinet. A short throw-out type aerial is required and this, together with the headphones, is plugged into sockets provided on one side. The completed receiver is 7¾in. wide and 5in. high and the front slopes backwards slightly, for the sides taper from 3in. at the base to 2½in. at the top.

Preliminary work consists of constructing the metal control support panel from 16s.w.g. aluminium or tinplate and details of this are given in Fig. 4. Prior to bolting this panel to the tag-board, one of the small holes running down the centre of the board must be enlarged with a circular file to ¼in. diameter—as indicated in Fig. 6—to accept the coil mounting stem. The coil is locked in position by means of a polystyrene nut provided and this should only be twisted thumb tight, if pliers are used the stem will fracture.

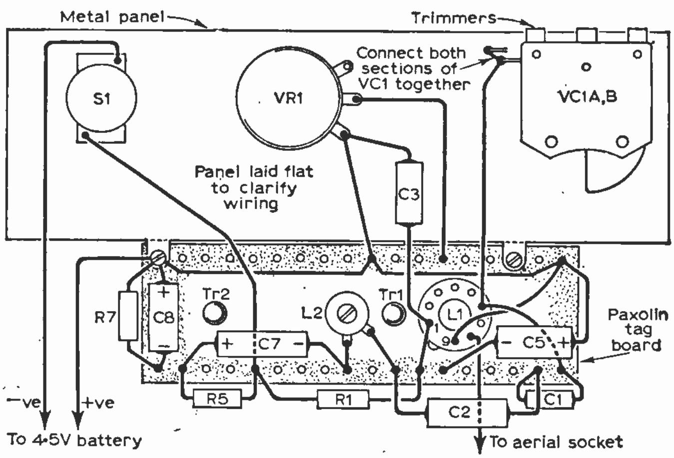


Fig. 5: Showing connections between the tag board and control panel. The tagboard has been drawn in the same plane as the panel for clarity.

Wiring Up

The remaining construction consists of mounting and wiring the various components to agree with the above and below plans shown in Figs. 5 and 6 respectively, leaving the transistors to one side until a good check has been made.

When satisfied that no mistakes have been made the lead-out wires of the transistors may be sleeved and then passed through existing holes from above the board. These may then be soldered to the tags shown, using a heat shunt. The actual transistor shells should remain on top of the paxolin board as shown in the photographs and diagrams.

Black and red insulation should be used for the battery negative and positive leads respectively and it is not difficult to fashion a pair of sliding clips from thin tinplate to act as connectors soldered to the ends of the leads.

Testing

High impedance headphones should be connected before switching on and these should not be removed whilst the set is working or Tr2 collector circuit will be broken. With VR1 set to approximately half travel and a short aerial connected the set may be switched on and C1 swung through its full range of rotation. If oscillations are heard all is well, but VR1 should be adjusted very quickly to just remove them, when little difficulty should be experienced in receiving transmissions. The quality should be crisp and will be surprisingly clear and alive. It will now be discovered that VR1 can be used as a volume control and should normally operate very smoothly indeed. Smoothness of operation will best be obtained from use of a wirewound component in

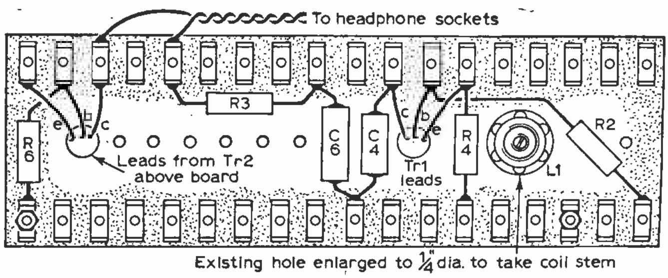


Fig. 6: The reverse side of the tag board.

the VR1 position, but care should be taken not to advance the control excessively or the programme material will be supplanted by undesirable oscillation.

Final Adjustments

The next step lies in adjusting the waveband coverage. If no signal generator is available transmissions must be used and the various regional transmitters can most easily be recognised at such times as separate news bulletins are being radiated. After dark Radio Luxembourg might be heard when the vanes of VC1 are almost fully disengaged. The coverage can be varied within limits by adjusting the core of L1 by means of the brass stem fitted and also by changing the trimmer positions.

Faults

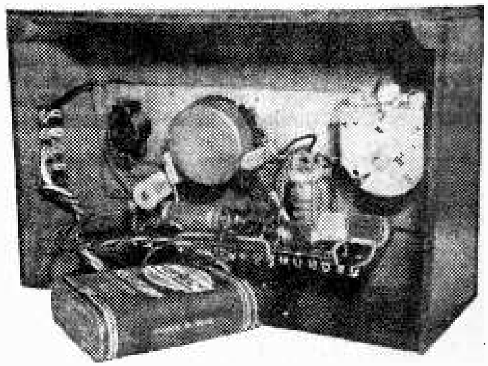
If the receiver fails to oscillate at any setting of VR1 or VC1, either C1 or C2—*but not both together*—may be temporarily short-circuited to increase feedback. Resistor R1 might need changing also if an indifferent transistor is in use and the value may be reduced to about 56kΩ. Noise may result in the form of a rushing sound if R1 is excessively reduced in value and 39kΩ is about the limit.

If on the other hand it is not possible to eliminate oscillations at any setting of VC1 or VR1, remove C2 and replace it with one of smaller value—say 10pF—and try again. Emitter resistor R4 can also be increased to, say, 680Ω or even 820Ω, this further limiting Tr1 current. The receiver should, of course, be switched off to make alterations.

Cabinet

Since negligible weight is involved it is possible to construct a simple cabinet from hardboard using a frame of $\frac{3}{8}$in. quadrant beading mitred at the corners to improve the frontal appearance. The dimensions of the case used for the prototype are shown in Fig. 7 the whole being held together with impact adhesive and small reinforcement strips.

With the aerial and phone sockets mounted on one side, ample space exists for the battery which can if necessary lie flat on the cabinet base plate beneath the tag-board or stand at the rear. On completion the case may be lacquered or otherwise finished to suit individual tastes.



A rear view of the receiver nearing completion.

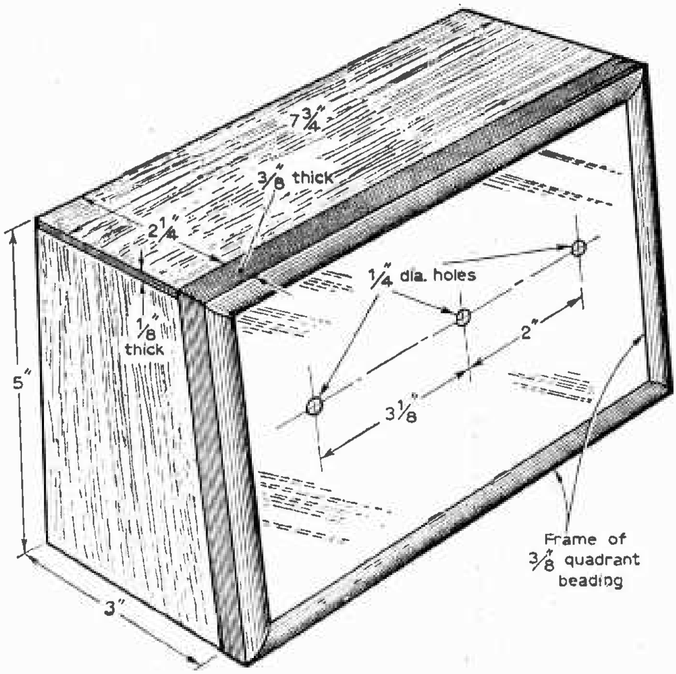


Fig. 7: The construction of a simple cabinet for the receiver.

Conclusion

Although this simple little set can provide a great deal of constructional and listening enjoyment, it obviously has its limitations and cannot be expected to compare with the high sensitivity and selectivity of the superhet form, for, of course, it is not in the same price class.

The receiver can be used as a simple tuner to feed an existing audio amplifier by connecting a 4·7kΩ resistor in place of the phones and taking the audio from between Tr2 collector (via a 0·1μF capacitor) and the positive line. *No such connection must be made under any circumstances to d.c. apparatus or to so called a.c. equipment that derives its h.t. direct from the mains supply or danger to life will result.* ■

The EUPHON

A frequency selective unit for feeding two loudspeakers

By I. Kampel

THE unit about to be described is a simple and inexpensive means of obtaining a spacial effect in audio reproduction. With the addition of the two loudspeakers required, the total cost of the author's model was about two guineas only, and this included the cost of making the walnut cabinet.

Two loudspeakers are set up as for stereo, but instead of two channels, one loudspeaker handles the lower frequencies, while the other handles the higher frequencies. With the aid of the balance control an effect similar to stereo is achieved as the higher pitched instruments come through on the tweeter and the bass instruments on the woofer.

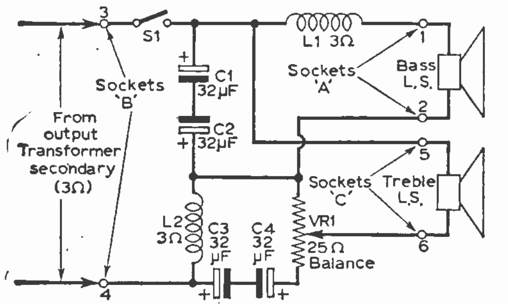


Fig. 1: The simple circuit of the Euphon.

The idea is based on the familiar divider network, used in modern audio equipment, but the original crossover circuit is not suitable when the speakers are separated as there will not be enough volume in the tweeter to give the required effect. The conventional divider network uses paper capacitors and extra components, whereas the Euphon uses ordinary electrolytics.

Fig. 1 shows the circuit. On the actual model there are single-type wander-plug sockets at the back of the cabinet, to plug in the bass and treble loudspeakers, and also sockets for the radio input. Numbers 1 to 6 indicate these sockets.

The circuit incorporates four identical electrolytic capacitors coupled in pairs, can to can, this arrangement having the same effect as a single paper capacitor, though not the same value as used in the conventional divider network. The two coils are the most expensive items (7s. 6d. each) and are of 3Ω to match the output transformer. The potentiometer of 25Ω simply acts as a balance control between the two loudspeakers to obtain bass or treble emphasis, or a perfect balance as required.

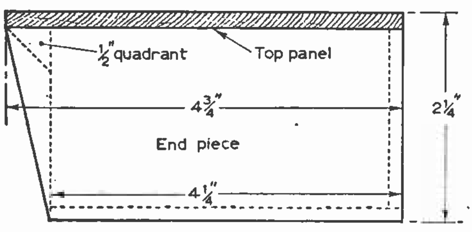


Fig. 2: An end view of the cabinet.

Cabinet construction

The whole unit may be built into a cabinet 7½in. x 4¼in. x 2¼in. A small square of ¼in. five-ply will be good enough for the first stages of construction. Fig. 2 shows an end elevation. The cross shaded triangle in Fig. 4 is a small length of ½in. quadrant. The two end pieces of Fig. 2 fit on to the sides of the 6¾in. x 4¼in. baseboard. However, the top, which is made to slide out, rests on the top of these two edges and hence is ½in. greater in length. Fig. 3 shows this, the shaded portions being the ends.

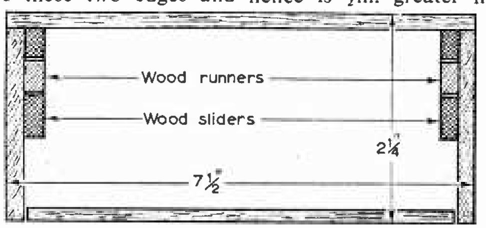


Fig. 3: This front elevation shows the wooden runners fitted to the sides.

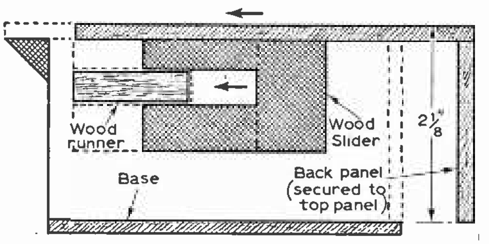


Fig. 4: How the top is slid into place along the runners and tops of the sides.

Fig. 4 shows the method of sliding the top into place, the back being permanently joined. Crossed shading indicates the extra shaped pieces of ply fitted to the top panel to run next to the walls (also indicated by crossed shading in Fig. 3). The piece of oblong ply cut from the wood slider is fixed on to the inner wall of the cabinet to form the runner (see Fig. 4). Panel pins and glue will hold this construction firmly; however, the front panel *should not* be affixed yet, but be made to slide out freely.

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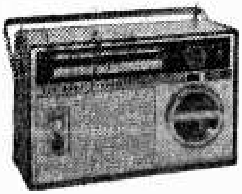

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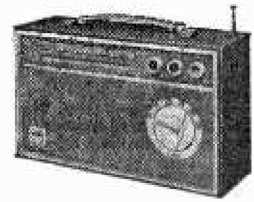

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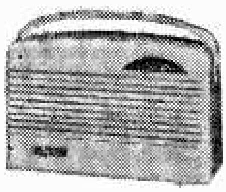

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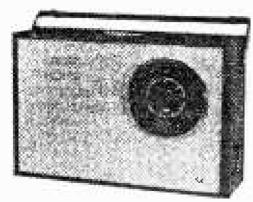

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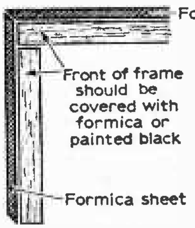


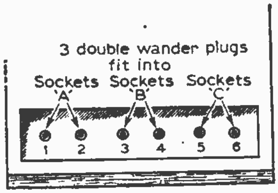


Fig. 5 (left): Showing the use of Formica to provide a suitable finish to the cabinet.

Fig. 6 (right): The three double wander-plug holders at the back of the cabinet.

To make a professional job of the cabinet Formica panels can be cut to cover the whole of the cabinet, excepting the base. Most "do-it-yourself" shops have a selection of cheap offcuts, and the author found in this way an offcut which had the appearance of expensively polished walnut. This costs only 1s.

Fit the Formica panels to the plywood case, seeing that the Formica sides are a little over ¼in. above the ply sides, so that these meet the Formica panel on the sliding lid. All edges of Formica should be bevelled (Fig. 5), so that they fit snugly together. Take care not to stick the lid in when fixing these. Also see that a length of Formica is fitted over the quadrant to be at top of front panel.

The frame round the front panel may be painted black or surrounded with Formica. The latter may be a little tricky however as allowance has to be made for the sliding lid. Fig. 6 shows the back of the cabinet and the three double wander-plug holders, which can be obtained on a small strip of Paxolin.

Components should be arranged in the cabinet after the potentiometer and toggle switch have been mounted on the front panel, and the front panel secured. As it is advisable to mount the coils at right angles, a small strip of ply will hold one coil in place leaving space for sliders to pass, whilst the other may be mounted straight on the reverse side of the front panel.

As the input and output sockets are mounted on the back which comes out with the lid, the wires going to these should be left a little (not too much) long to allow for this.

COMPONENT LIST

L1, L2	Divider network coils, 3Ω (Denco)
C1–C4	32μF, 450V
S1	Toggle switch
Sockets A–C	Double type mounted on small paxolin strip
VR1	25Ω potentiometer

The Euphon in use

A certain amount of care is necessary in the choice of loudspeakers. The h.f. loudspeaker should be small (2½in.—6in.) and the l.f. one larger (8in.—12in.), both being matched at 3Ω. The author uses a 3in. and a 7in. with excellent results.

However, the most important point to stress is that *it is absolutely essential to have a good bass cabinet*. If the l.f. loudspeaker does not have this, results will most certainly be disappointing. Only a small cabinet is necessary for the tweeter, which may, of course, be fixed in a cabinet to match the woofer.

Set up the loudspeakers as for stereo, and sit between them adjusting balance. This system is mainly for music and has no application on speech only. Loudspeakers should be 6ft to 12ft apart, and connections should be reversed on one loudspeaker until, by judgment, the best arrangement is found.

It should be noted that when used to simply improve the reponse of an old radio, it might have very little effect. It will only reproduce the frequency ranges supplied to it, and if the receiver cuts off below 10kc/s, or before it reaches the higher notes, nothing will be gained by the use of this unit. ■

A Versatile DOUBLE-TRACE OSCILLOSCOPE

By J. H. B. Gould

This series deals with the construction of instruments based on the 5in. and 6in. cathode-ray tubes currently available on the surplus market. The series of articles cover the basic instrument and progressively more advanced versions that incorporate a timebase, a.c. amplifiers, a square-wave generator and double-trace facilities. The individual constructor can decide for himself how far to go—according to his inclination and requirements. A further article will deal with the use of the instrument as an oscillograph. This month, the basic instrument described in the September issue, is taken two stages further.

CONTINUED FROM PAGE 461 OF THE SEPTEMBER ISSUE

PROBABLY the most useful piece of auxiliary equipment to be found in any normal oscilloscope is the timebase or sweep generator. This makes it possible to analyse a waveform on a linear time scale. The timebase details which follow enable the basic oscilloscope described last month to be extended to Instrument Type 2.

The Generator

The generator described here (see Fig. 10) consists of one valve (V5) connected as a "standard" Miller-integrator with transitron maintaining oscillator. As its output is not great enough to drive the spot the full width of the screen without assistance, an amplifier (V6) is used.

The amplifier is well above its job so that, at high gain, it provides sufficient output for "expanded timebase" working; this makes it possible to enlarge a small part of the trace, chosen by the shift control, for closer examination. The load resistor of V5 takes the form of a potentiometer VR6 that serves as a "Sweep Amplitude" control.

Synchronisation

In practice it is impossible to freeze a waveform on the screen using a free-running timebase; it will always tend to slip one way or the other. To prevent this, part of the waveform can be taken, amplified and applied to the transitron oscillator, causing the timebase scan to lock on to the observed waveform. This is the function of V4, the sync amplifier.

In some circumstances it is desirable to lock the timebase on some other frequency (in frequency-comparison tests, for example), so the "sync" input comes from a panel socket. To save using a switch here, the internal synchronising supply from the "Y" input is brought to this socket by a wander plug that can be transferred to a dummy socket when an external synchronising waveform is being used.

To avoid distorting the observed waveform, the minimum possible synchronising input must be used, so V4 is also equipped with a gain control, "Sweep sync" (VR5).

Timebase Frequency

With this circuit, the sweep frequency can be varied from about 10c/s to about 30kc/s in six bands. Switching between bands is carried out with the aid of the "Y Selector" S3. In addition to selecting the band-setting capacitors for the

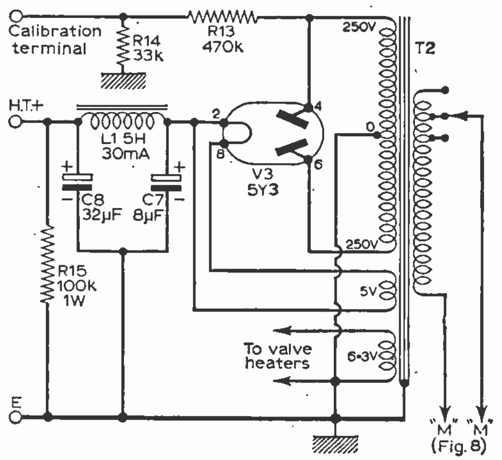
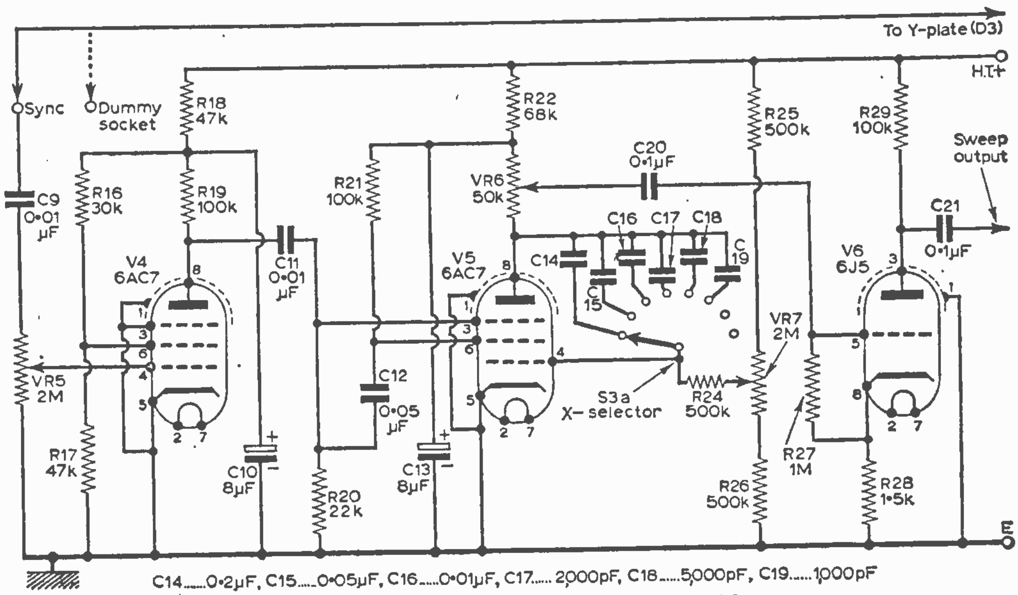


Fig. 9: The h.t. power supply for the timebase valves.

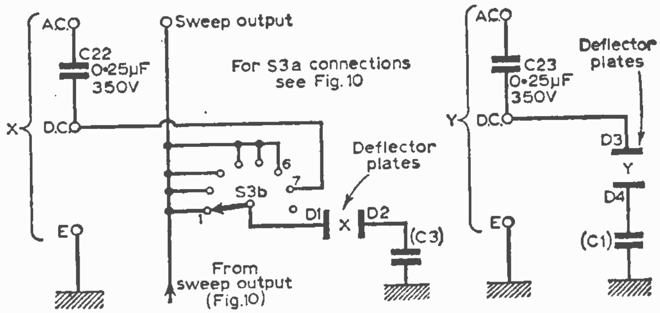


C14......0·2µF, C15......0·05µF, C16......0·01µF, C17...... 2000pF, C18......5000pF, C19......1000pF

Fig. 10: Timebase generator, timebase and sync amplifiers.

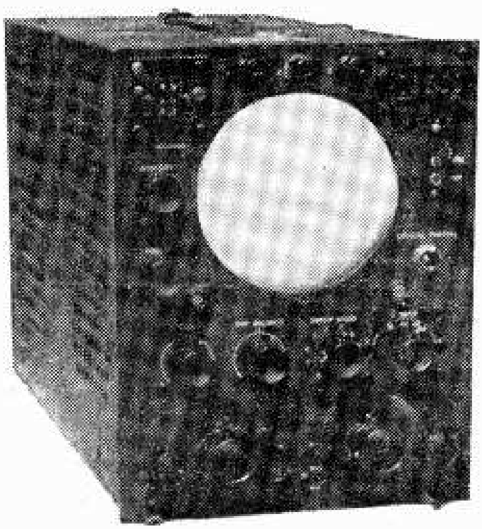
sweep generator, S3 also decides whether the X plates will be fed from the timebase or from some external source via the "X" terminals on the panel.

For this reason, the switch has two wafers, the wiring to the second of these being given in Fig. 11. (If it is intended to build amplifiers into the oscilloscope, S3 will need *three wafers;* the wiring to the third is shown in Fig. 13.



S3 positions......1 to 6 = timebase, 7=plates

Fig. 11: Selector switching (without amplifier).



Fine control of the sweep frequency is made possible by potentiometer VR7. Most people will find it easier to set up a waveform with this control if the slider moves *positive* as the control knob is turned *clockwise.*

Power Supplies

A power pack is necessary to supply the timebase valves and a suitable circuit is suggested in Fig. 9. This power unit includes a circuit for providing a 50V peak-to-peak output for the calibration terminal.

Deflector Polarity

In the timebase generator, the working part of the sawtooth waveform is negative-going with

Left—The author's finished model.

COMPONENTS LIST FOR INSTRUMENT TYPE 2 (timebase version Figs. 9, 10 and 11)

Resistors:

R13	470kΩ	R22	68kΩ
R14	33kΩ	R23	—
R15	100kΩ 1W	R24	500kΩ
R16	30kΩ	R25	500kΩ
R17	47kΩ	R26	500kΩ
R18	47kΩ	R27	1MΩ
R19	100kΩ	R28	1·5kΩ
R20	22kΩ	R29	100kΩ
R21	100kΩ		

All 10%, ½W carbon except where otherwise stated.

Variable Resistors:
VR5 2MΩ carbon potentiometer
VR6 50kΩ carbon potentiometer
VR7 2MΩ carbon potentiometer

Capacitors:
C7 8μF electrolytic 350V
C8 32μF electrolytic 350V
C9 0·01μF paper
C10 8μF electrolytic 350V
C11 0·01μF paper
C12 0·05μF paper
C13 8μF electrolytic 350V
C14 0·2μF paper
C15 0·05μF paper
C16 0·01μF paper
C17 2,000pF ceramic or mica
C18 5,000pF ceramic or mica
C19 1,000pF ceramic or mica
C20 0·1μF paper
C21 0·1μF paper
C22 0·25μF paper 350V
C23 0·25μF paper 350V

Transformer:
T2 Mains (h.t.) transformer. Tapped primary. Secondaries: 250-0-250V 30mA; 5V 2A; 6·3V 3A

Inductor:
L1 Smoothing choke 5H, 30mA

Switches:
S3 2-pole 7-way wafer type rotary or 3-pole 8-way if Instruments Type 3 or 4 are to be built

Valves:

V3	5Y3	V5	6AC7
V4	6AC7	V6	6J5

respect to time. The waveform is then inverted by the amplifier before being fed to the plates.

In order to provide a timebase crossing the screen from left to right, a *positive* signal at the "X" terminal should deflect the spot to the *right*, i.e. precisely as described for the simple oscilloscope.

Sweep Generator Output

As will be seen from Fig. 11, the output of the timebase amplifier goes to a panel terminal. If a wobbulator is to be used with the oscilloscope, the sweep-frequency drive will be obtained from *this* terminal and not from "X a.c." which leads nowhere when the timebase is working.

INSTRUMENT TYPE 3

By adding a.c. amplifiers and associated switching, the development of the progressive oscilloscope can be taken a stage further. The details which follow, discuss the progression from Instrument type 2 to Instrument type 3.

Amplifiers

"A1" and "A2" are wideband a.c. amplifiers, identical to each other, each consisting of a triode voltage amplifier and a cathode follower. The circuit is given in Fig. 12. As double triodes are used in the circuit, two valves only are necessary.

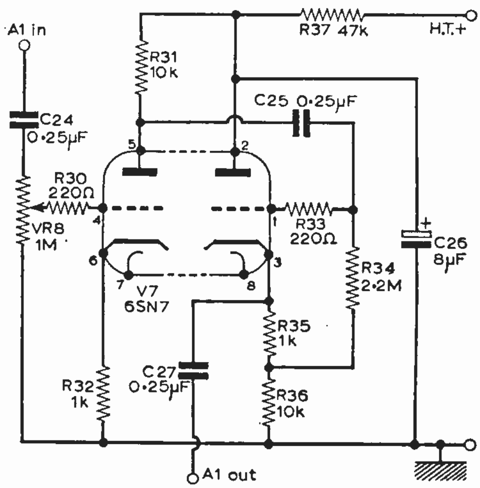


Fig. 12: The circuit of the A1 amplifier—the A2 amplifier is identical.

COMPONENTS LIST FOR INSTRUMENT TYPE 3 (a.c. amplifier version Figs. 12 and 13)

Resistors:

R30	220Ω	R35	1kΩ
R31	10kΩ 1W	R36	10kΩ 1W
R32	1kΩ	R37	47kΩ 1W
R33	220Ω	R38	470kΩ 1%
R34	2·2MΩ	R39	2MΩ 1%

VR8 1MΩ potentiometer
All ½W, 10% except where stated.

Capacitors:

C24	0·25μF	C27	0·25μF
C25	0·25μF	C28	20pF
C26	8μF electrolytic		

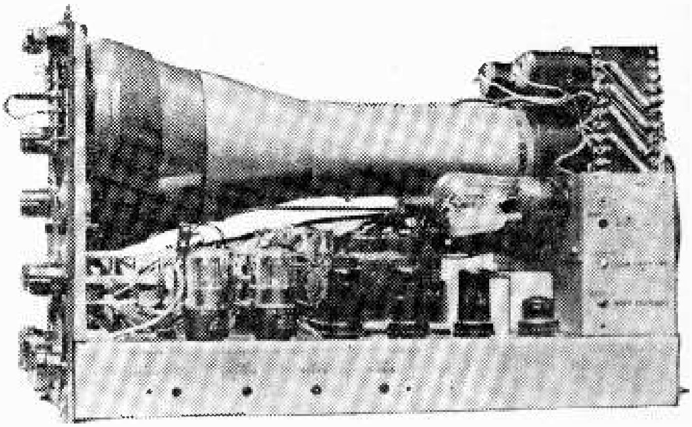
All 350V d.c.
TC1 3-30pF trimmer

Valve:
V7 6SN7

Switches:
S3 3-pole 8-way wafer type rotary
S4 3-pole 4-way if Instrument type 3 only is to be built. 4-pole 5-way if Instrument Type 4 is to be built

The only controls are the two gain potentiometers.

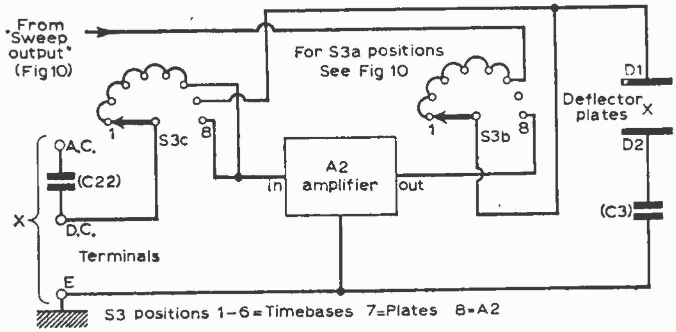
The amplifiers should not be used at low levels of gain if high-frequency components are present in the signal, as the valve input capacitance will act with the potentiometer as a frequency-selective filter, distorting the waveform before it appears on the screen.



The oscilloscope in an advanced stage of construction.

Switching Scheme

Fig. 13 shows the switching scheme for use with these amplifiers. Both the switches are of the rotary (wafer) type.



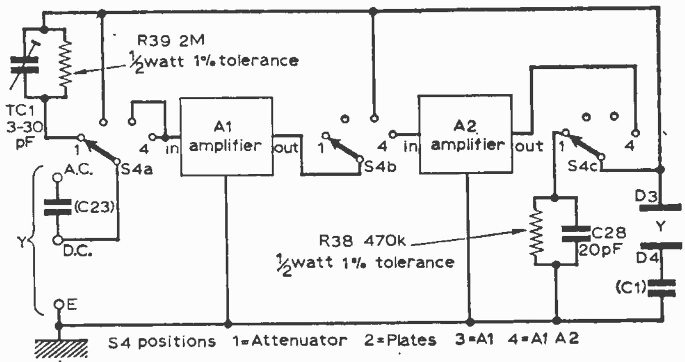


Fig. 13: Selector switching (with amplifiers): a (left); "X" (sweep) selector: b (below); "Y" selector.

The first pole of the X-selector switch "S3" is used in the timebase generator to select the band-setting capacitors. The first six positions are concerned with the timebase and the seventh connects the input terminal directly to the deflector plate; only in the eighth position does the "A2" amplifier come into play on the X plates.

The input signal should be fed to the "X a.c." or "X d.c." terminals regardless of whether the selector switch is at "Plates" or "A2"; this saves a lot of trouble in swopping-about wires.

The "Y Selector" switch "S4" offers a choice of four ways in which a signal can reach the plates from the Y terminals: attenuated, direct, amplified by one amplifier or amplified by both amplifiers in cascade.

The Attenuator

For good high-frequency performance, the trimmer capacitor shunting the upper arm of the attenuator should be set to balance out stray circuit capacitances. A square wave applied to the Y terminals will soon show up any faults in the frequency characteristic of this circuit.

If it is proposed later to build the trace-splitter circuit, *this* can be used for the purpose.

Rotary Switches

The information given in Table 3 (Sept. issue) requires amending as follows: Instruments 3 and 4: S3 should be 3-pole 8-way. Instrument **4**: S4 should be 4-pole 5-way.

SERIES TO BE CONTINUED NEXT MONTH

QUALITY MW TUNER

W. GROOME

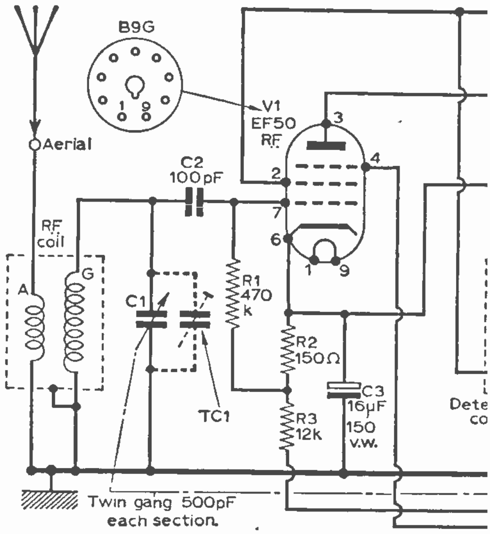


Fig. 1: Two-valve t.r.f.

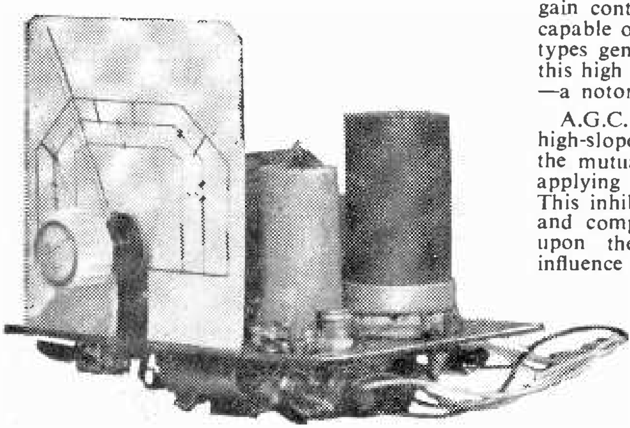
WHILE a v.h.f. tuner in most areas will provide the finest local radio input for high fidelity equipment, the quality of some medium-wave broadcasts justifies the addition of a small a.m. unit. Leaving local transmissions to the existing tuner, the new unit can be designed for a balance between sensitivity and fidelity to make the best of those Continental stations that reach the aerial relatively unblemished.

Superhet selectivity is undesirable because of bandwidth considerations; on the other hand the usual fidelity t.r.f. designs are too insensitive for any distant signals. The unit to be described, however, has a high sensitivity for a two-valve circuit and brings in the worthwhile transmissions with satisfactory quality.

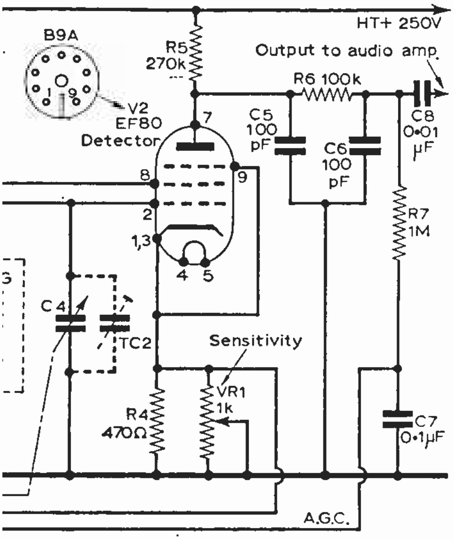
The Circuit

The circuit, Fig. 1, is based on principles developed by BBC engineers to enable automatic gain control to be applied to high-slope pentodes capable of much greater gain than the variable-mu types generally used for a.g.c. The advantage of this high gain is that the use of a second r.f. stage —a notoriously unstable arrangement—is avoided.

A.G.C. by grid injection is not practicable with high-slope pentodes but it is possible to control the mutual conductance—and hence the gain—by applying sufficient negative bias to the suppressor. This inhibits the arrival of electrons at the anode and compels many (*all* at full cut-off) to alight upon the screen, where they are unable to influence the external circuit. As a rather high control potential is required, some d.c. amplification is necessary and this, fortunately, can be provided by the detector.



At this stage, as audio quality is one of the



vith amplified a.g.c.

objects, the question of detector distortion must be put into correct perspective. So far as background silence and audio bandwidth are concerned v.h.f. is supreme, but the harmonic distortion of the usual discriminator, at about 3%, is rather higher than that of some a.m. detectors. (I know of only one somewhat rare, though simple, f.m. discriminator that can maintain a truly distortionless performance.)

The figure is horrifying but complaints are few even among high fidelity enthusiasts and we can bear this in mind when balancing the interests of sensitivity and quality.

The distortionless a.m. detectors have less than unity gain and require some r.f. amplification even for local station reception. Additional r.f. amplification to improve the sensitivity is almost certain to bring distortion and instability to cancel all the advantages of such a detector. Better results are likely with a detector that can itself contribute enough gain to work well with the stable single r.f. stage.

Although an anode-bend detector may distort on occasional heavy modulation, its performance on average signal is good. With a high-slope pentode a gain of over 100 is possible and the stage is particularly suitable as a source of amplified a.g.c. potential. To avoid loss of d.c. gain through negative feedback in the cathode resistor R4 it must be kept small (a bypass capacitor would not prevent this feedback from reducing the gain of the d.c. component of the signal).

Nevertheless the resistor must still yield the correct bias and this is achieved by making it carry additional current to increase the voltage drop, the current being that of V1, which has the earthy end of its cathode network common with that of V2.

For a similar reason the screen of V2 derives a stable potential from the cathode of V1, which is raised rather high above earth to suit the a.g.c. conditions. The d.c. control potential from the anode of V2 is filtered by the network C5, R6, C6 to eliminate the r.f. content and passed via the a.f. filter C7, R7 to the suppressor of the r.f. valve.

It is, of course, a positive potential varying with the signal strength but must be negative with respect to the cathode of V1. It is for this reason that the 12kΩ resistor R3 is included to raise the cathode. The normal potential difference for grid bias is picked off by returning the grid resistor R1 to the junction of R2, R3. The grid capacitor C2 is essential to block the d.c. path to earth through the tuning coil.

Choice of Valves

Choice of r.f. valve is governed by its suppressor grid base, for this must be short enough to lie within the range of available control voltage. My admittedly brief experiments seemed to indicate that the EF50 recommended by the originators of this a.g.c. system is more suitable than some newer types, but there is scope for the interested amateur to take the investigation further. As the veteran EF50 is readily obtainable as a surplus item at less than half a crown it is included in the present unit.

Although this valve seems large by today's standards, and other components used were by no means the smallest made, the tuner was built on a "bread board" measuring 6in. x 3¾in. without crowding. The detector is an EF80 but type EF50 can be used for this stage, too.

Ordinary aerial and r.f. coils are suitable for a circuit such as this, in which knife-edge selectivity is undesirable, and it is not necessary to limit the constructor to one specific make. They should be canned because of the high gain of the circuit. The base connections of coils may not be the same as indicated in the point-to-point wiring diagram (Fig. 2) but this will necessitate only slight variation of the wiring layout.

The potentiometer in the detector cathode circuit is included to enable the a.g.c. operating conditions to be adjusted. Once set it can be forgotten, but experimenters who wish to exploit the full gain of the unit could mount this component on the front for use as a sensitivity control.

It is usual to power a small unit such as this from an outlet in the main amplifier, and therefore no supply arrangements are included here. It is unlikely that the tuner will be granted the efficient aerial so often recommended for a good signal-to-noise ratio and it must be admitted that a really large one would bring selectivity troubles with the simple tuned circuits employed. In the Midlands the customary bit of wire—about 2yd dangling behind the tuner—brings in several Continental transmissions at good strength and quality.

Conventional chassis construction could be adopted but a "bread board" layout can be made compact, reliable and requires no metalwork.

CONTINUED OVER

Using available components rather than the smallest possible, the prototype was assembled on a piece of unmetallised laminated plastic 6in. x 3¼in. x $\frac{1}{16}$in. thick.

The wiring was arranged as shown in the point-to-point diagram, Fig. 2. The potentiometer VR1 is under the panel and occupies more depth than is generally needed for bread board wiring, but this depth permits C3, C7 and C8 to be housed below to avoid increasing panel area.

The two-gang capacitor, canned coils, standard valveholders, aerial socket and audio output socket are all mounted on top and solder tags are fitted under their fixing screws to enable earth continuity wires to link them. Small trimmers should be fitted if there are none already present in the tuning capacitor.

Wiring-up

Begin wiring by soldering bare wire from tag to tag on the top side to form the earth links, remembering to include the frame of the tuning gang and the coil cans, which are not earthed automatically as in the case of metal chassis construction. Drill small holes at convenient points to enable short earth connections to be passed through to the underside and soldered to the appropriate tags on the valveholders, coils and potentiometer as shown in the diagram.

Next connect the heater wiring, which has been omitted from the diagram for clarity. As this will be taken from the main amplifier it will probably be a centre-tapped supply requiring an insulated twisted pair. For an unbalanced supply (one side earthed) run a single insulated wire to one heater tag on each valveholder and earth the other tag. No socket is fitted for power supply connections; instead the heater, h.t. and earth wires are led out as flexible leads ending at a plug to suit the outlet on the main amplifier.

Most of the circuit wiring is in 20 s.w.g. bare tinned copper wire "stitched" to the panel by passing it through small holes. Anchorage, where needed, is provided by passing wire twice through close pairs of holes and bonding solid by soldering.

At first glance the diagram may seem to show breaks in the coil-to-grid connections, but use is made of the tags provided on both sides of the fixed vanes in most tuning gangs so that the path to the grids is continuous across the vanes. Insulated wire is shown at points where the diagram might suggest contact in unwanted places but in practice these could be air-spaced and bare wire used.

The prototype has an epicyclic tuning drive, this being simple and reliable and free from the troubles so likely to occur with cord and pulley arrangements. As the interest is in only those transmissions that are received well it was decided that a ready-made dial printed with all stations from here to Tokyo would be of little benefit. The home-made one used instead has a limited number of stations marked to indicate three standards of reception quality.

Although it was intended to add the station

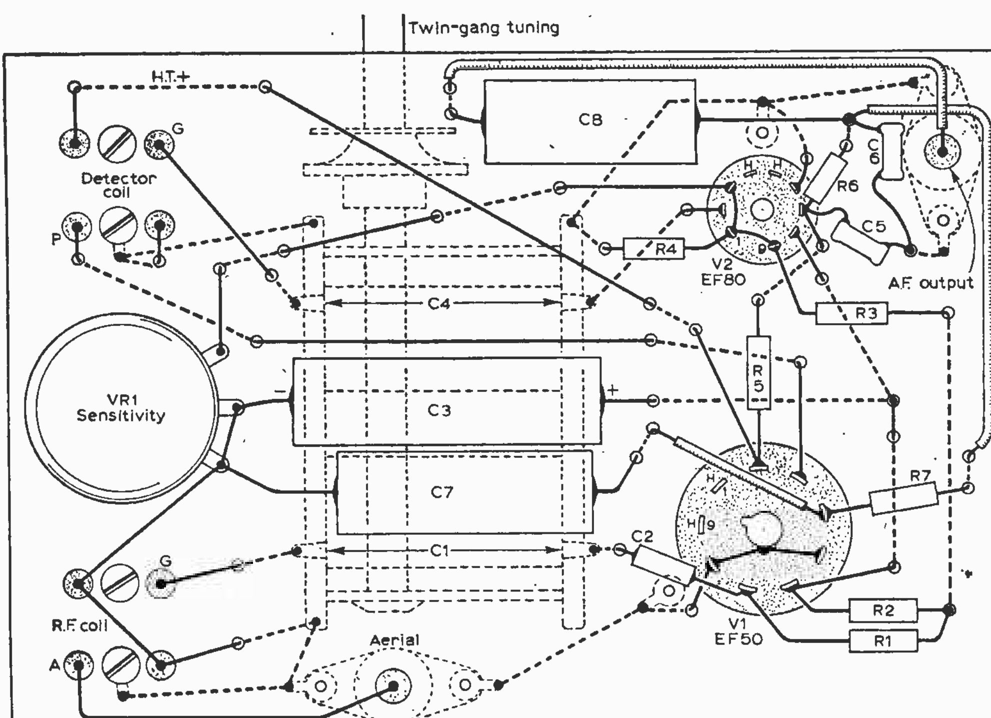


Fig. 2: Underside view of the "bread-board" wiring.

COMPONENT LIST

Resistors:

R1	470kΩ ¼W	R5	270kΩ ½W
R2	150Ω ¼W	R6	100kΩ ¼W
R3	12kΩ ½W	R7	1MΩ ¼W
R4	470Ω ½W	VR1	1kΩ pot.

Capacitors:

C1, C4	2-gang 500 pF
C2, C5, C6	100pF
C3	16μF electrolytic 150V
C7	0·1μF

Valves:

V1	EF50	V2	EF80

names the users so quickly memorised the transmissions associated with the simple dash marks that even that refinement has been omitted! The usual dial lighting arrangements can be included if required.

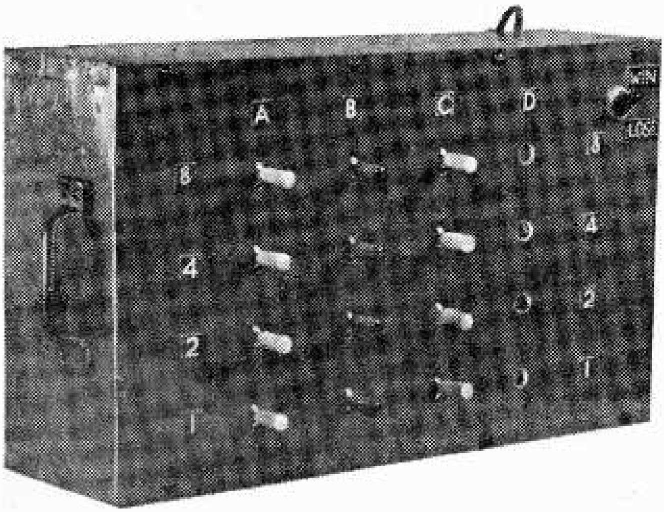
Alignment of the tuned circuits follows the usual procedure for a t.r.f. tuner and can be done "by ear". The split-vane type of gang permits a useful correction for tracking error that might be evident at the ends of the band, but if overdone there is a risk of contact between fixed and moving vanes. In the conditions that have to be accepted as normal for the medium-wave band nowadays, only a few of the receivable transmissions are acceptable as entertainment for the music lover.

When these have been logged the split vanes can be used to favour them. The potentiometer has "dead" and "live" positions at each end of the track. Set it at the live end and then adjust it until a weak signal just begins to fall in strength. A.G.C. will then be operative.

If you are more interested in quality than in logging the maximum number of stations it is worthwhile to reduce the sensitivity still further with this control to the point where the best signals are still comfortably received. This avoids overloading the detector and also keeps the unit free of the slight positive feedback that can degrade quality at the highest sensitivity levels even though still clear of oscillation.

The quality obtainable is about the best that is likely from distant medium-wave stations but the unit cannot restore audio frequencies missing from the transmission nor adjust for the over-modulation that is evident in some broadcasts. Whistles can sometimes be handled by the filters and tone-control circuits of the high-fidelity equipment. However, it is generally possible to log a number of stations that can provide an agreeable standard of entertainment. ■

An unbeatable machine based on the game of Nim



AN ELECTRIC NIM MACHINE

By J. R. Stewart

NIM is a game for two players. Starting with a number of matches, counters or other objects arranged in piles or rows, each player alternately draws as many matches as he chooses from one row only. Two variations of the game are possible; in one, the player who picks the last match wins the game, in the other, he loses. There is no limit to the number of counters in any one row, nor to the number of rows with which to begin the game, although recent TV programmes have made popular the game of "last match loser" with four piles containing 7, 5, 3 and 1 matches.

The Theory of Nim

The theory of this game has been completely worked out, and an elementary knowledge of it helps to understand the construction of the machine. To begin with, the operation of "last match wins" variation will be explained.

Briefly, any number can be written as the sum of some of the powers of 2, together with the number 1, i.e. using the numbers in the sequence 1, 2, 4, 8, 16, etc. For example, $9 = 8 + 1$; $30 = 16 + 8 + 4 + 2$. In representing any number by such a sum, none of the sequence numbers occurs more than once. This can be checked by noting that the sum of all the sequence numbers up to any point is always 1 less than the next number in the sequence; for example, $1 + 2 + 4 = 7$, and the next sequence number is 8.

Calling the individuals Player and Opponent, it can be shown that in playing Nim, if the Player produces what we call a safe combination, the Opponent's move always upsets this arrangement, allowing the player to reset a safe combination when he draws in his turn. By safe combination we mean a set of numbers (the numbers of counters in each row) which will lead to a win for the Player. The secret of the game lies in knowing the safe combinations, and how t produce them. For "last match wins" variation, th safe combinations are found as follows:

(1) Represent the number of counters in eacl row as the sum of the sequence number given above;

(2) Count the number of 1s, 2s, 4s, 8s, etc. whicl appear in the arrangement;

(3) A safe combination is one in which th numbers of each of the 1s, 2s, etc. is EVEN and the Player who sets up such a combina tion will win.

Take the familiar example of 7, 5, 3 and 1.

$$\begin{aligned} 7 &= 4 + 2 + 1 \\ 5 &= 4 \phantom{{}+2} + 1 \\ 3 &= \phantom{4+{}} 2 + 1 \\ 1 &= \phantom{4+2+{}} 1 \end{aligned}$$

Reading vertically we see that the numbers o 1s, 2s, etc. are all even, hence this is a saf combination for the Player who set it up. Whe the Opponent draws, because he draws from on pile only, he must make some of the numbers of 1s 2s, etc. odd, since he can remove only one 1, 2 or 4. This makes the combination unsafe, and th Player has then only to even things up again t keep a winning line. Suppose the Opponen removes all the 7 counters from the first row. Thi then leaves

$$\begin{aligned} 5 &= 4 \phantom{{}+2} + 1 \\ 3 &= \phantom{4+{}} 2 + 1 \\ 1 &= \phantom{4+2+{}} 1 \end{aligned}$$

All the 1s, 2s and 4s are now odd. To even th arrangement, the 4 must go, so that the Playe must draw from the 5 row. The other rows ar even in 1s and odd in 2s. Thus if he leaves onl 2 counters in the 5 row, the combination will b safe, i.e.

$$\begin{aligned} 2 &= 2 \\ 3 &= 2 + 1 \\ 1 &= \phantom{2+{}} 1 \end{aligned}$$

When the machine plays, the procedure is that it is "told" the numbers of counters in all but one of the rows. These numbers are given to it in the form of the sequence numbers 1, 2, 4, 8, etc. It then counts the numbers of 1s, 2s, etc. or rather it selects the cases in which these numbers are odd. This selection is then the number of counters which the machine decides to *leave* in the last row. Again, an example will make things simpler. Suppose three rows contain 9, 7 and 4 counters.

$9 = 8 + 1$
$7 = 4 + 2 + 1$
$4 = 4$

This is odd in 8s and 2s, so that the machine will elect to have $8 + 2 = 10$ in the fourth row, making its own safe combination. If the opponent draws 5 from the 10 row, this leaves—

$9 = 8 + 1$
$7 = 4 + 2 + 1$
$4 = 4$
$5 = 4 + 1$

If the machine is again told the first three numbers, it will again select 10 for the last row, which is now impossible, since 10 cannot be left

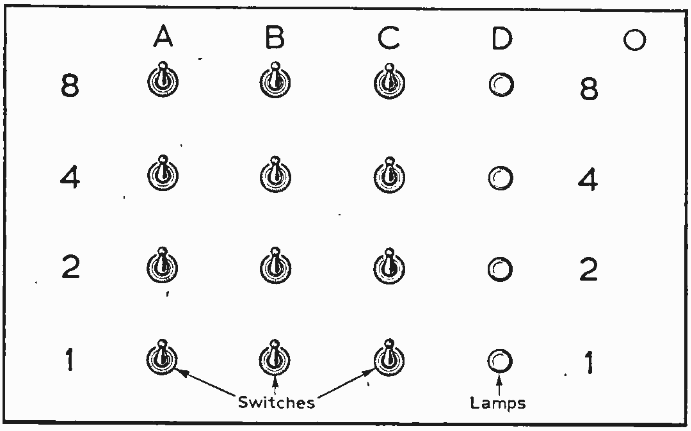


Fig. 1: The layout of the front panel.

if there are only 5 in the row. Looking at the last three, the combination is odd in 4s and 2s. Thus if the machine is told the numbers 7, 4 and 5, it will select $4 + 2 = 6$ for the other row, i.e. it draws 3 from the 9 row, again making its own safe combination. The machine does not always draw from the row having the largest number of counters; if the rows contain 9, 8, 7 and 4 it will reduce this to 9, 8, 5 and 4.

With a four-row machine, there are four possible ways of selecting any three rows, i.e. there are four possible sets of numbers which can be told to the machine. One of these will always give a workable answer—workable in the sense that the number selected by the machine will be less than the number already in the remaining row. This applies provided that the combination is unsafe. If the combination is already safe, no matter what selection of three from four is made, the machine will always reply with the number already in the remaining row; in this sense we can say that the machine refuses to play.

Thus when playing with 7, 5, 3 and 1, which we have seen is a safe combination, if we tell the machine 7, 5 and 3, it will reply 1; if we tell it 5, 3 and 1, it will reply 7 and so on. To sum up, the machine is unbeatable if it is allowed at the start of the game to select the number in one row, having been told the numbers in the others.

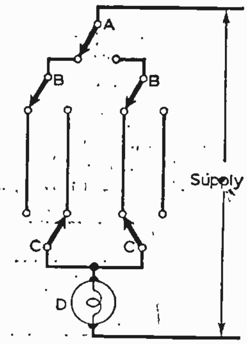


Fig. 2: The basic switching circuit.

If the opponent sets out the numbers in all the rows at the start, the machine will beat him if he sets an unsafe combination. If he sets a safe combination, the machine will refuse to draw from any pile; this could be called a drawn game.

Construction

Using four rows the machine requires to be told the numbers in three rows. This is done by throwing various switches. The reply which the machine makes is read off on small lamp bulbs. The 1s, 2s, etc. of the sequence numbers are completely independent, and depending on the number of switches one uses, the machine can be made to cope with any given number in a row.

Calling the rows A, B, C and D, and designing for up to 15 in a row, we need (Fig. 1) 12 switches, and four lamps. The number of counters in rows A, B and C, are told to the machine by throwing the appropriate switches in each column; the lamps which light up in row D tell us how many counters to leave in that row Remembering that a safe combination has an even number of 1s, 2s, etc. and that the 1s, 2s, etc. are independent of each other we get the following set of rules which the switching circuit must give:

Reading horizontally along any row,

(1) None of the switches A, B or C, thrown must keep the lamp off;
(2) Any one of the switches A, B or C, thrown must bring the lamp on;
(3) Any two of the switches A, B or C, thrown must keep the lamp off;
(4) All three switches A, B and C, thrown must bring the lamp on.

In this way we always have an even number of (lamp + switches) in the ON position.

A switching circuit which will perform these operations is shown in Fig. 2. As drawn, all the switches are in the OFF position, and the arrowed contact moves across to the "free" contact when the switch is thrown. Each switch and lamp has been marked to correspond with the row in which it is situated. If the connections are traced out, it will be seen that conditions 2 and 4 bring the lamp on, while conditions 1 and 3 provide no conducting path for the supply. From Fig. 2, the switches in row A require a single change-over contact; those in B and C a double change-over contact.

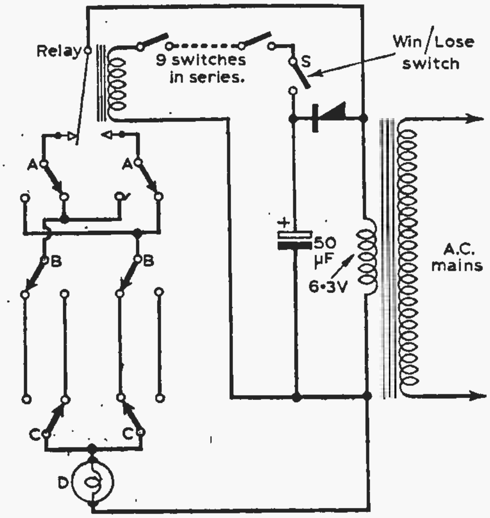


Fig. 3: The circuit of the bottom row of switches and power supply.

Toggle switches having a double change-over can be purchased; because the writer required a machine which would play both varations, and as "last match loses" needs an extra contact on nearly every switch, Post Office type key switches were used in the unit to be described. These have the added advantage that the handle, being longer than the toggle dolly, is more easily read to determine a given number.

Once again it should be emphasised that there are no connections between the horizontal rows of switches except that of a common supply line. A 3V dry battery can be used, together with 2·5V bulbs. One side of all the bulbs in D will be connected together to one side of the battery, while the other battery terminal, through an ON/OFF switch if desired, goes to the movable contact point of all the A switches.

Last Match Loses

The above is the simplest version of an unbeatable Nim player, playing last match wins. For those who want to play last match loses, or both variations, the circuit becomes more complicated. In playing last match loses the theory of the game is only slightly different. The same combinations as in last match wins are safe, until the game reaches the stage of only 1 or 0 in all the piles. Then an *odd* number of 1s is safe, while an even number is unsafe. A little reflection will show this to be true; if there are three singles matches left, the opponent who picks the first of these must also pick the last, thus losing the game.

We therefore require a circuit which is the same as in Fig. 2 for the top three rows, i.e. 8s,

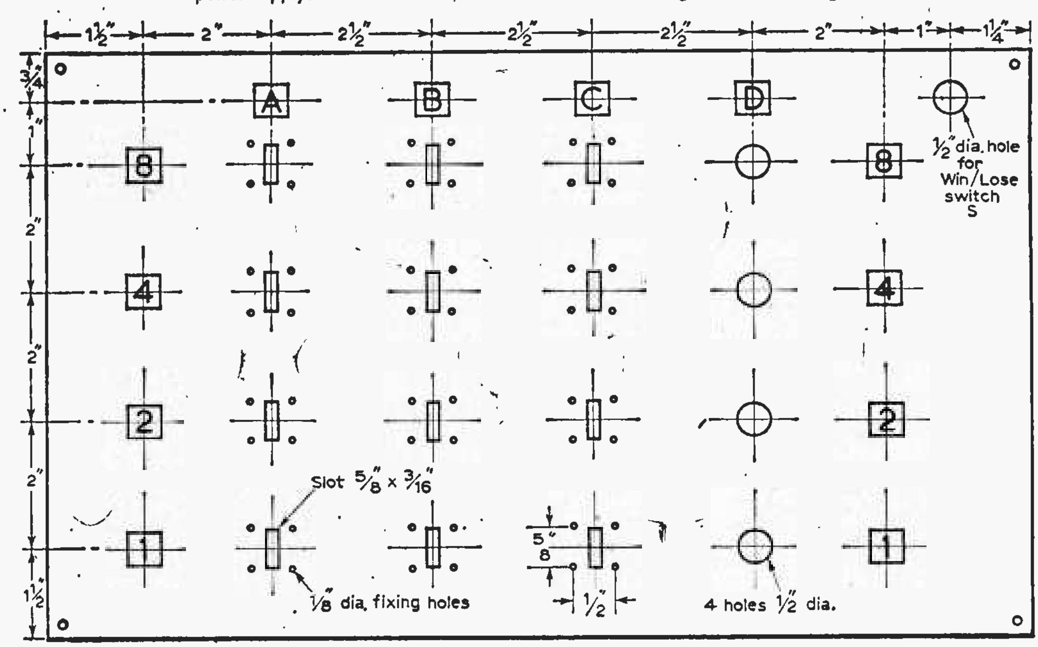


Fig. 4: Details of the front panel. The four holes for the keys are drilled in tin plate only, not in the cover.

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5	6000	5	8/-
5	7000	3	8/6
5	7000	5	8/6
5	7500	3	9/-
5	8500	3	9/6
5	8500	5	9/6
5	9500	3	10/6
5	9500	5	10/6
5	10000	3	11/6

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5	9500	25	11/6
5	9500	35	11/6
5	10000	25	12/-
6½	7000	3	11/-
6½	7000	5	11/-
6½	8500	3	11/6
8	7000	3	12/-

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5 × 3	7000	3	8/-
5 × 3	9000	3	8/6
5 × 3	9000	4	8/6
5 × 3	9000	5	8/6
5 × 3	6000	25	9/6
5 × 3	7000	25	10/-
5 × 3	9000	25	11/-
5 × 3	9000	35	11/-
6 × 4	6000	3	8/6
6 × 4	7000	3	9/-

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6 × 4	9500	5	10/-
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7 × 4	7000	3	10/-
7 × 4	7000	5	10/-
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

Elliptical Size	Gauss in lines	Imped. in ohms	Price
7 × 4	9500	50	11/6
7 × 4	10000	15	12/6
7 × 4	9500	3*	13/6
8 × 2½	6000	3	8/6
8 × 2½	7000	3	9/-
8 × 2½	7000	5	9/-
8 × 2½	6000	6	8/6
8 × 2½	6000	30	9/6
8 × 2½	8500	5	9/6
8 × 2½	9500	3	10/-
8 × 2½	9500	4	10/-

Elliptical Size	Gauss in lines	Imped. in ohms	Price
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8 × 2½	10000	5	10/6
8 × 5	6000	3	8/6
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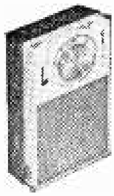

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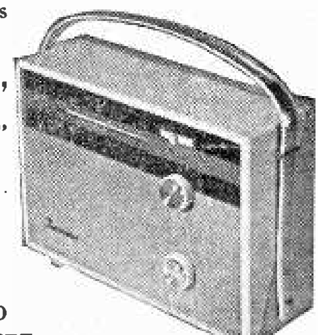

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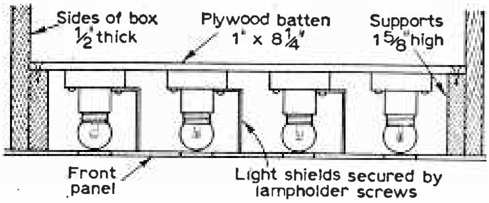


Fig. 5: Details for mounting the lamps.

4s and 2s, and which will reverse the lamp operation in the bottom row of 1s if, and only if, all the switches in the 8s, 4s and 2s, are in the OFF position. Fig. 3 shows the circuit for the bottom row of switches, and the power supply. A change-over contact on a relay is used to reverse the operation of the bottom row, the relay being controlled by the position of the keys in the 8s, ls and 2s. When the relay is off, is drawn. Fig. 3 gives the same conditions as Fig. 2. When the relay closes, the right-hand contact of switch A comes into operation, and we then get

(1) None of A, B or C, hrown, lamp lights;

(2) Any one of A. B or C, hrown, lamp off;

(3) Any two of A, B or C, hrown, lamp lights;

(4) All three of A, B and C, hrown, lamp off.

These are the safe combinations for last match loses when educed to only one match in a ow.

The relay is controlled by switch S and by nine contacts in series, one on each of the 8s, 4s and 2s switches. These contacts are closed when the switches are off; when any one of these switches is thrown, the relay is kept off. Switch S is brought out to the front panel; if it is open the relay remains off and the machine plays last match wins, if closed the machine will play last match loses.

Convenience and price dictated the design of the power supply; batteries were discarded because of the trouble of replacement, and also because a rather higher voltage is usually needed for a relay than for the lamp bulbs. A search through the catalogues brought up a 6V operating relay with a change-over contact, and it was then decided to use a valve filament transformer together with 6V dynamo bulbs, each taking 0·3A. If it is felt that these may be overrun on 6·3V, and there is a tendency sometimes to be over-generous with filament voltages, particularly as the transformer is not working at full load—a 6·3V, 2A rating transformer is used—a length of

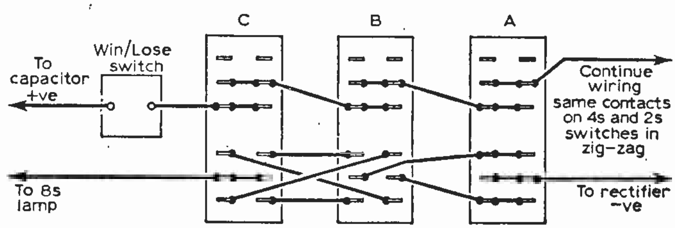


Fig. 7: The wiring of keys in 8s, 4s and 2s rows. The upper half of each key carries the relay control switch; the lower half controls the lamp in the D pile.

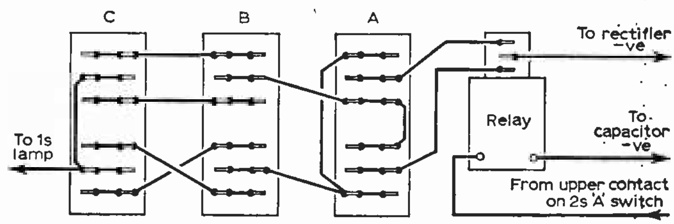
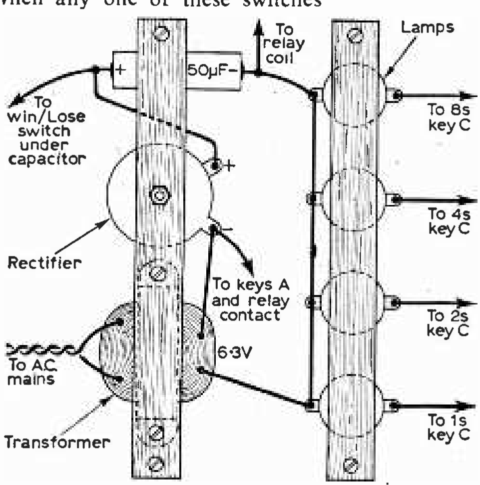


Fig. 8: Wiring the keys in 1s row.

resistance wire can be incorporated in each lamp lead. The direct supply to the relay is obtained from a battery charger type half-wave rectifier, rating 6V, 1A charging a 50μF, 12V electrolytic. This gives an off load voltage of 8V, dropping to just under 6V when the relay comes in. No mains switch has been used, the unit being on when it has been plugged in. This is permissible since it is unlikely that it will be left plugged in when not in use.



g. 6: Mounting and wiring of power supply and lamps.

Housing the Instrument

The writer already had a wooden box with hinged lid, measuring 15¼in. x 9¼in. x 4in. deep. and this was used to house the unit. Any other similar size will serve, the only critical dimension being the 4in. depth, as the keyswitches require this amount. Lid and base were removed, and a front panel 15¼in. x 9in. of tin plate was cut and drilled as shown.

Two small wooden supports, 1in. x 1⅝in. x ½in. were glued one on each side of the box opposite

—continued on page 537

THE HOME PRODUCTION OF Printed Circuit Boards

DESCRIBED BY H. W. RUTT

PRODUCING printed circuit boards in a home workshop is not as difficult as it may sound. This type of circuitry is very convenient for miniature units, and it practically eliminates wiring errors.

The first step, naturally enough, is to design the layout of the conductors on the circuit board. Until some practice is gained in designing these boards it will be found rather difficult. The only tips one can give are not to have the conductors spaced by less than $\frac{1}{16}$in., and not to have the conductors narrower than $\frac{1}{16}$in. It should also be remembered that the circuit will have to be painted out by hand, and so should not be impossibly complicated.

Drawing the Circuit

When the design has been finalized it should be drawn out on a piece of tough paper of the correct size. The copper-clad laminated plastic board is then cut to size, using a fine-bladed hacksaw, and cutting with the copper layer uppermost. When the board has been cut, its edges should be smoothed down with a fine-toothed file to remove the rough edge of the foil. The design is now transferred to the coppered side of the board by means of carbon paper.

The areas where the copper must remain are now painted with a black, cellulose paint, of the type sold by garages, and this is allowed plenty of time to dry. It is wise to check the painted areas for tiny holes in the paint caused by air bubbles, and to check the layout of the conductors against the design.

Etching Process

The next step in producing the board is to etch away the exposed copper. The etching bath consists of a solution of ferric chloride with 1% by volume of dilute hydrochloric acid added. A 10% solution of ferric chloride may sometimes be obtained from the chemist without waiting. How ever this 10% solution gives a rather slow etch and if one is prepared to wait a few days th chemist will usually be able to obtain, or make up the correct etching solution, which is a 30% solution of ferric chloride in water, with 1% o dilute hydrochloric acid (i.e. 30 gr of ferric chlorid made up to 100cc with distilled water and 1cc o dilute hydrochloric acid). This solution will no burn skin (though it should be quickly washed off however, it stains terribly, and old clothes shoul be worn when using it.

The board, with the design painted on it, i placed in a shallow tray of the type used by photo graphers, and just covered with the etching solu tion, which may be warmed to about 40°C; it mus *not*, however, be hot. The tray is now gentl rocked until all the exposed copper has dissolvec When this has happened the board should be we washed, and then allowed to dry.

When the board is dry the paint used to protec the conductors has to be removed. The best sub stance for this job is trichloroethylene, which ma be ordered from the chemist. It costs about 6s. fo a ½ litre jar. *If one does use this substance, car should be taken not to inhale much of its vapou as it has harmful effects.* It is possible that othe substances such as turps or petrol could be used t soften the paint, but if something like this is triec it should be checked (on an old piece of boarc that it does not damage the bakelite backing, c cause the copper to peel off.

Whatever substance is used, the board should b allowed to soak in it until the protective paint i soft, and then it should be gently brushed off.

Drilling the Board

The final operation in preparing the board is t drill it. Each point where a hole is needed : marked, but not centre punched; centre punchin can easily cause the backing to crack. A No. 5: slow spiral drill is used to make the holes for wire which have to be soldered to the copper. Th board *must* be drilled from the coppered side, t prevent the copper peeling off the board, and slow spiral drill is essential for this operation.

The board itself is now finished, but sever: points should be observed when wiring it. Firstl all connections to the board should be mac quickly, or the heat may cause the copper coi ductor to peel off the bakelite backing. Secondl one should be very careful to solder in mult contact parts (such as IFT's) the right way roun the first time—they can be very difficult indeed t remove if you do not get it correct. Thirdly a resistors, capacitors, etc., should be right u against the bakelite backing, for if they are n any pressure on the component will tend to pe the copper off the board. When the board is con pletely wired up and tested the soldered side of th board may be varnished to protect it from co rosion, but this tends to make servicing rather mo difficult.

Any constructors wishing to make their ow printed circuit boards should have little difficult obtaining the chemicals or the copper-cla laminate board, and it is hoped that this article wi help to bring printed circuits out of the "oh, that much too difficult" class of construction.

A Variable Mains Transformer

BY T. PALMER

WHEN it is required to apply a fraction of the mains voltage to a given load, it is possible to use a resistive potential divider, but often the resistors will be bulky, and there may be problems of heat dissipation. If the supply is a.c., a variable voltage mains transformer is frequently more convenient; also, in addition to providing a ratio less than unity, the transformer can step up the voltage, which is beyond the scope of the resistive potential divider.

Commercial Equipment

Variable mains transformers are commercially available, and are known by various trade names. They work on the principle of an auto-transformer: a manual control determines the position of a tapping on a toroidal winding. It enables adjustments to be made in such small increments that the transformers are described as being infinitely variable. They can also be described as rather expensive.

The device discussed in this article uses a comparatively cheap battery-charging transformer; and it is not infinitely variable. The increments of voltage are however small enough for most purposes. A suitable transformer is the Douglas MT3. It has a 30V secondary, tapped at 12, 15, 20 and 24V. A fraction of the secondary voltage is added to, or subtracted from, the mains voltage. This gives a range of 60V. However the primary has tappings for 240, 220 and 200V. These enable us to use auto-transformer action and to obtain a wider range. When the tappings on the primary and on the secondary are fully used, the output can be varied from 155 to 308V, with the mains voltage at 225V.

The wiring is such that, if necessary, the secondary can be quickly disconnected from the primary; it is then available for supplying voltages less than 30V. A voltmeter is incorporated in the instrument, with a switch which provides a reading of the incoming mains, the outgoing mains, or the low voltage secondary.

In Fig. 1, P1 and P2 represent voltage-adjusting panels of the type frequently associated with mains transformers. S1 and S2 are single-pole, 3-way switches. They are not ganged.

Principle of Operation

Let us first assume that the incoming mains voltage is 220V, and that the studs in the voltage-adjusting panels, P1 and P2, are both set to 220V. If switches S1 and S2 are both set to position A, the outgoing mains voltage is the same as the incoming. For simplicity, only one tapping is shown on the secondary. If S1 is set to A and S2 to B, the voltage AB may be added to the primary voltage. Then, if S1 is set to B, and S2 to A, the voltage AB is subtracted from the incoming mains voltage. Thus, adjusting the secondary switches S1 and S2 gives a range from 220+30V to 220−30V, i.e. from 250 to 190V.

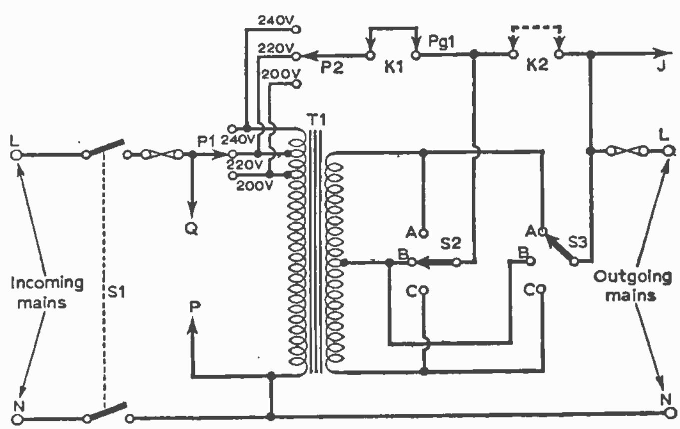


Fig. 1: The circuit of the transformer.

Suppose we want a voltage higher than 250V. We shall continue to assume that the incoming mains voltage remains at 220V.

We screw the stud in P1 in the 200V position and that in P2 in the 240V position. The full secondary voltage is now more than 30V, and it can be added, by suitable operation of S1 and S2, to a voltage which is now greater than 220V, because of the auto-transformer action in the primary. It is on this basis that the outgoing mains voltage can be stepped up to a value of the order of 300V.

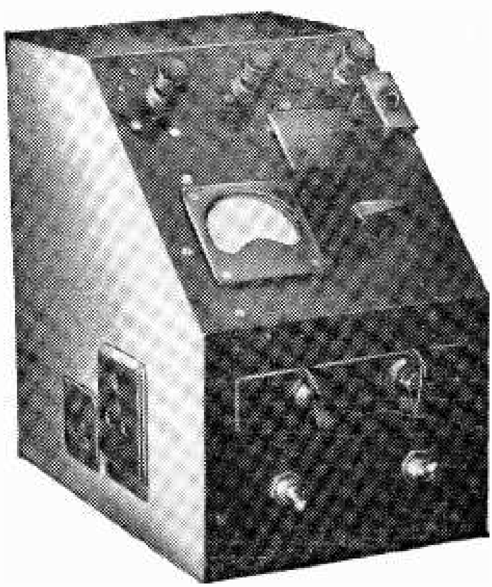
If we want a voltage which is less than 190V, we screw the studs in P1 in the 240V position, and that in P2 in the 200V position. S1 and S2 are adjusted so that the secondary voltage subtracts from the primary voltage.

In the model made by the writer, sufficient variation was obtained for his purpose by adjusting switches S1 and S2 on the front of the instrument. The voltage-adjusting panels P1 and P2 were mounted at the back. If greater variation is frequently required, it may be more convenient to have P1 and P2 in the form of two single-pole, 3-way switches on the front.

The secondary voltage, as selected by switches S1 and S2, is taken to a 2-pin, 2A socket, K2. A 2-pin, 5A plug Pg1, with the pins connected by a short length of wire, connects the primary to the secondary. It fits into the socket K1. The 5A plug has a small paxolin panel associated with it so that when the plug is inserted in K1, the 2-pin, 2A, socket K2 is masked by the panel. It is thus impossible to insert a plug into the socket for the secondary, when the secondary is connected to the mains.

The Voltmeter

The writer used a meter scaled from 0 to 300, which had a full scale deflection of 5mA. A 5mA rectifier was used with it. The voltmeter had two ranges: 0—30V, for measuring the secondary voltage; and 0—300V for the incoming and outgoing mains voltage. The series resistors to be used with the meter depend on the full-scale deflection of the meter, and on the range. The following will show the method of calculating their values. The example relates to a 5mA meter used on the 300V range.



A view of the author's unit.

When a current with a mean value of 5mA flows through the meter giving full scale deflection, the maximum current in each half cycle is $5 \times \pi/2$mA.

If the r.m.s. value of the voltage is 300V, the maximum voltage in each half cycle is $300 \times \sqrt{2}$. Thus the resistance in the circuit must be

$$\frac{300\sqrt{2}}{5/1{,}000 \times \pi/2} = \frac{300{,}000}{5} \times \frac{1}{1{\cdot}11}$$
$$= 54{,}000\Omega.$$

For the 30V range the resistance of the circuit must be 5,400Ω. The resistance of the meter itself (and the rectifier) is negligible in comparison with these values. The voltmeter circuit is shown in Fig. 2.

The terminals at the top of the instrument are provided so that the 30V range of the voltmeter can be used to measure external voltages. Alternatively, the external voltage can be applied by inserting a plug into a socket situated between two of the terminals. (This socket is not the socket K2, which is masked by the paxolin panel.) The voltmeter range switch, S4 in Fig. 2, is next to the meter. Switches S1 and S2 have pointer-type knobs. Of the remaining two

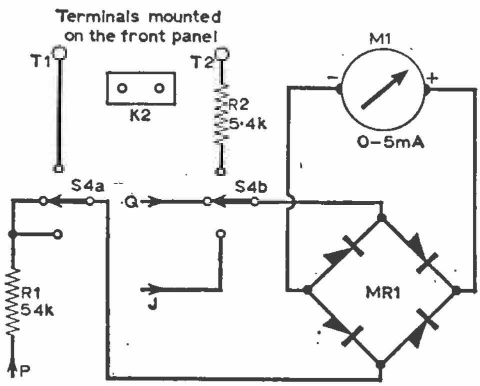


Fig. 2: The voltmeter circuit.

switches, one is the on/off switch S3; the other is not used in the final form of the instrument. The model is larger than is necessary for the facilities mentioned in this article; it includes a 12V, 2A rectifier, and a 3-pin, 2A socket, for the rectified voltage.

To measure the secondary voltage selected by switches S1 and S2, the socket K2 must be connected to two of the terminals at the top of the instrument.

Resistance and Capacitance Measurement

The provision of a link Pg1 to connect the primary to the secondary enables the instrument to be used for measuring resistance and capacitance. With the link Pg1 in position, the outgoing mains voltage is adjusted to the same value as the incoming mains voltage, V_1. The resistor or capacitor to be tested is then connected in place of Pg1. The voltage V_2, read when the voltmeter switch is thrown to the position for the outgoing mains, is then observed to be less than V_1. The ratio V_1/V_2

and the value of the voltmeter resistor R_1, enable the value of the resistor or capacitor under test to be calculated.

If Rx is the value of the resistor which replaces Pgl it can be shown that

$$Rx=R^1\left(\frac{V_1}{V_2}-1\right)=R^1\left(\frac{V_1-V_2}{V_2}\right)\ldots\ldots(1)$$

If Xc is the reactance of the capacitor which replaces Pgl, it can be shown that

$$Xc^2=R_1^2\left[\left(\frac{V_1}{V_2}\right)^2-1\right]\ldots\ldots(2)$$

If the frequency is 50c/s, we have

$$C=\frac{10^6}{314\ R1}\ \frac{V_2}{(V_1^2-V_2^2)^{\frac{1}{2}}}\ \mu F\ \ldots\ (3).$$

These expressions assume that when resistance is being measured, the component under test has no reactance, and when capacitance is being measured, the component has no resistance.

Alternatively, with the mains voltage at a value which is usual for a given site, various resistors of known value can be connected in place of the link Pgl. The corresponding values of V_2 are noted. A graph can be drawn relating Rx and V_2. When an unknown resistor is connected, V_2 is noted, and the corresponding value of Rx is read from the graph.

A similar graph can be constructed for capacitance.

Constant Output Voltage

The action of the variable transformer has been described in terms of deriving a variable voltage from a constant mains voltage. It may be worthwhile mentioning that it can also be used to give a constant output voltage when the input voltage varies. The equipment was orginally devised for this purpose. Soon after it was completed, the local supply company improved the stability of its mains voltage.

COMPONENTS LIST

Resistors:
R1 54kΩ R2 5·4kΩ

Transformer:
T1 Douglas MT3 with primary tapped at 240, 220 and 200V, and secondary tapped at 12, 15, 20, 24 and 30V.

Switches:
S1 Double-pole, on-off
S2, S3 Single-pole, 6-way rotary
S4 Double-pole, 3-way rotary

Meter:
M1 Moving coil with full scale deflection of 5mA, preferably scaled 0–300

Rectifier:
MR1 Bridge type, full wave, 5mA

Sundries:
3-pin, 5A socket for outgoing mains.
K1 2-pin, 5A socket
K2 2-pin, 2A socket
P1, P2 Voltage-adjusting panels
Pg1 2-pin, 5A plug with pins connected together

In fact, if any readers are troubled with a fluctuating mains voltage, it may be worth their while to make up a unit of this kind. When they have finished it, they are pretty sure to find that their supply has been improved. If however, the supply company reacts slowly, when the unit has been completed, and if some readers actually need to use the unit, they may like to know that operation is very simple: you switch on, turn the voltmeter switch to the position for the outgoing mains, and adjust S1 and S2 until you have the desired voltage. You then switch on the load.

Incidentally, with a secondary tapped at 12, 15, 20, 24 and 30V, the following increments are available: 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V.

These values can be obtained without using the voltage-adjusting panels. If these panels are used, fractions and multiples of these values are available. ■

AN ELECTRIC NIM MACHINE

—continued from page 529

the line of lamp holes, to support a wooden plywood battens 8½in. x 1in. on which were screwed the four M.E.S. lampholders. This brings the bulbs flush with the front panel holes. One of each of the lampholder fixing screws was used to anchor a 1in. wide strip of tin plate which also extends to the front panel; this serves to shield the hole from the light of the bulbs adjacent to it. A similar batten of ½in. thick wood, screwed to two supports 3½in. x 1in. x ½in. supports the transformer, rectifier and condenser. The relay is screwed direct to the side of the box, counter-sinking the fixing bolts from the outside.

All wiring is done from the rear with the front panel screwed into position, the relay being mounted with its contacts forward, so that the soldered ends of these contacts are readily accessible. The wiring diagrams assume that the keyswitches have a central OFF position and a down ON position, i.e. all the key contacts shown are above the centre line of the keys.

The keys drawn have four change-over contacts, arranged in two side-by-side banks. When off, the lower two of each trio of contacts are connected, and when switched on, the centre contact is lifted to connect with the top one. In the 1s keys, only two change-overs are needed on each switch, so that side-by-side contacts can be wired together, rather than leave one set unused. This serves as a precaution against a dirty contact on one set. On the 8s, 4s and 2s keys, another contact is needed to control the relay, and these connections have been drawn on the upper trio of contacts, again wiring the two side-by-side in parallel.

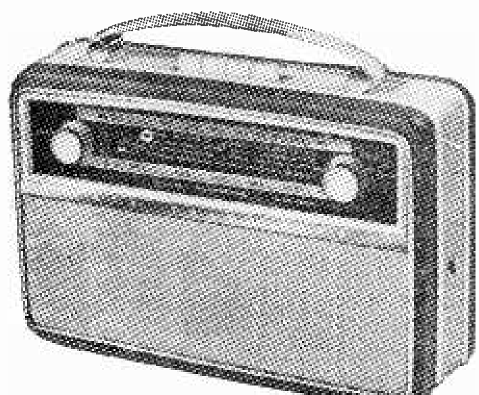
The unit was completed by cutting a cover of polished sheet (Formica was used by the writer, but paxolin will do equally well) to the same dimensions as the front panel, with lamp holes and slots only for the key handles. ■

Trade News

Mains/Battery Receiver

FROM Ekco Radio and Television Ltd. comes a new transistor receiver, designed to operate either from the mains or from its own internal battery. The receiver has been named "Varsity" (model number MBT425) and it sells for 19 guineas.

The eight-transistor circuit covers medium and long waves and incorporates a transformerless output stage. The makers of the "Varsity" are *Ekco Radio and Television Ltd., Southend-on-Sea, Essex.*



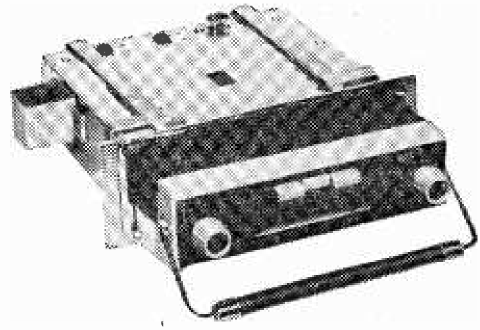
This 8-transistor portable is made by Ekco Radio and Television Ltd.

Dual-function Receiver

THE second transistor receiver made by the Ever Ready Co. (Great Britain) Ltd. to have the dual function of portable and car radio has just been announced. Called the "Sky Tourer", it has been designed to fit into a special container which is permanently installed in the vehicle and which, with the receiver inserted, automatically connects it to the car's power supply, external aerial and separate 6in. x 4in. loudspeaker.

When removed from the container the "Sky Tourer" operates as a normal transistor portable, using its own internal battery, aerial and speaker.

The set tunes over the long and medium wave bands and the six-transistor circuit provides 540mW output when used as a portable and 1W when used in the car. The price of this new receiver complete is £22 1s. and it is manufactured by the *Ever Ready Co. (Great Britain) Ltd., Hercules Place, Holloway, London, N.7.*



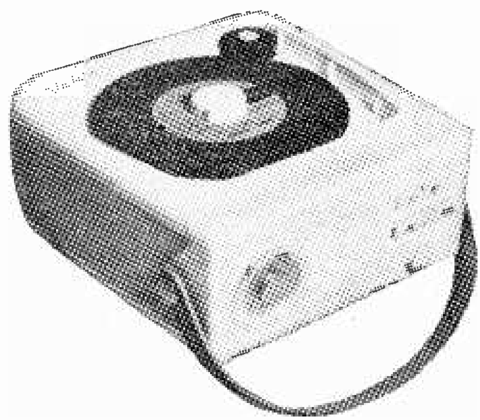
The "Sky Tourer" is a new dual-purpose receiver from Ever Ready.

Portable Radiogram

ONE of the most interesting pieces of radio merchandise to be handled recently by Denham and Morley Ltd. (U.K. distributors of imported electrical equipment) is a portable record player/transistor receiver called the "Swing-Along".

The receiver section covers both medium and long waves and the record player will take 45r.p.m. records. The circuit employs six transistors and provides a maximum output of 750mW.

The "Swing-Along" weighs only 6lb and is finished in cream and red. The agents for this German-made "radiogram" are *Denham and Morley Ltd., Denmore House, 173-175 Cleveland Street, London, W1.*



Denham and Morley Ltd. are the U.K. distributors for this German-made record player/receiver.

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LASKY'S FIRST AGAIN!

Now offer to the Home Constructor - full short wave coverage

The SKYROVER and the SKYROVER DE LUXE

The SKYROVER

Controls: Waveband Selector, Volume Control with on/off Switch, Tuning Control. In plastic cabinet, size 10 x 6¼ x 3½in. with metal trim and carrying handle.

Can be built for

£10.19.6

Post & Pkg. 5/- extra.

GENERAL SPECIFICATION:
7 transistor plus 2 diode superhet, 6 waveband portable receiver. Operating from four 1.5 torch batteries.
The SKYROVER and SKYROVER DE LUXE covers the full Medium Waveband and Short Waveband 31–94 M. and also 4 separate switched band-spread ranges, 13M, 16M, 19M and 25M, with Band Spread Tuning for accurate Station Selection. The coil pack and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our easy to follow, stage by stage instructions.

SPECIFICATION:

Superhet, 470 Kc/s.	All Mullard Transistors and Diode.
Uses 4-U2 batteries.	5in. Ceramic Magnet P.M. Speaker.
Easy to read Dial Scale.	Band Spread Tuning.
500 MW Output.	Telescopic Aerial & Ferrite Rod Aerial.

WAVEBAND COVERAGE: 180-576M; 31-94M and Band Spread on 13, 16, 19 and 25 metre Bands.

The SKYROVER de luxe

Tone Control Circuit is incorporated, with separate Tone Control in addition to Volume Control, Tuning Control and Waveband Selector. In a wood cabinet, size 11¼ x 6¼ x 3in. covered with a washable material, with plastic trim and carrying handle. Also car aerial socket fitted.

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Data for each receiver: 2/6 extra. Refunded if you purchase the parcel. Four U2 batteries, 2/8 extra. Four Leak-Proof batteries, 3/4 extra. *All Components Available Separately.*

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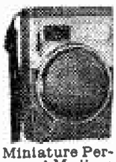


Can be built for

79/6

P. & P. 3/6 extra.

★ Six-Transistor Superhet Miniature Personal Pocket Radio. ★ Long and Medium wavebands. ★ Ferrite Rod aerial. ★ I.F. Frequency 470 Kc/s. ★ 3in. Speaker. ★ Printed circuit 2¼ x2in. ★ Slow Motion Drive. ★ In Plastic Case. Size 4 x 2¼ x 1in. In order to ensure perfect results, the SPRITE is supplied to you with R.F. and I.F. stages. Driver and Output stages ready built with all components mounted on the printed circuit. The SPRITE preassembled, plus cabinet, speaker and all components for final construction, at the inclusive price of **79/6** P. & P. 3/6 extra. Data and instructions separately 2/6. Refunded if parcel is purchased. *Real calf leather case! wrist strap, personal earphone and case for earphone and battery* **12/6** the lot extra. **Make no mistake this is a SUPERHET receiver of genuine commercial quality. It is not a regenerative circuit.**

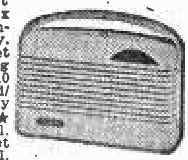
"COROVER" 'SIX'

★ A 6-transistor plus 2-diode superhet. ★ I.F. 470 Kc/s. ★ Covers the full, medium and long wavebands. ★ Sockets for personal earpiece or tape recorder and car radio aerial. Uses MULLARD Transistors. Diode and large internal ferrite rod aerial. ★ Uses four 1·5 v. pen torch batteries. ★ All components on a single printed circuit. Simple stage by stage instructions. ★ Cabinet size 6¼ x 4 x 1½in. With carrying handle. ★ All coils and I.F.'s ready wound.

ALL COMPONENTS AVAILABLE SEPARATELY. *Data and instructions separately 2/6. Refunded if you purchase the parcel.*

CAN BE BUILT FOR **£5.7.6** P. & P. 4/- ex. Batteries 1/4.

"REALISTIC" Seven



★ 7-transistor Superhet. ★ 350 milliwatt output into 4in. high flux speaker. ★ All components mounted on a single printed circuit board, size 5¼ x 5½in. in one complete assembly. ★ Plastic cabinet with carrying handle, size 7 x 10 x 3½in., in Red/Grey, Blue/Grey or all Grey. ★ Easy to read Dial. ★ External socket for car aerial. ★ I.F. frequency 470 Kc/s. ★ Ferrite rod internal aerial. Operates from PP9 or similar battery. ★ Full comprehensive data supplied with each receiver. ★ All coils and I.F.'s etc. fully wound ready for immediate assembly.

An Outstanding Receiver. **LASKY'S PRICE** for the complete parcel including Transistors, Cabinet, Speaker, etc., and Full Construction Data. **£5.19.6**

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Decca FFSS Stereo Pick-up £18.18.0	2 x Sharon Loudspkr systems £19.19.0	P'table Case £3.15.0	Portable Case with Speaker.... £5. 5.0
		7 x 4in. spkr. 15/6	
Total £50. 4.6	Total £47. 8.6	Total £24. 0.0	Total £31.16.6
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ROD AERIAL—RA2W
6 in. long, ⅜ in. diameter, connections to tags on Coils. For 208pF tuning capacity. Complete with Car Aerial Coil 12/6

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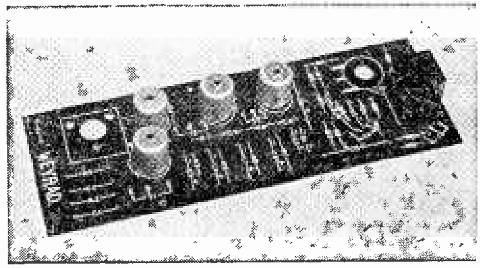

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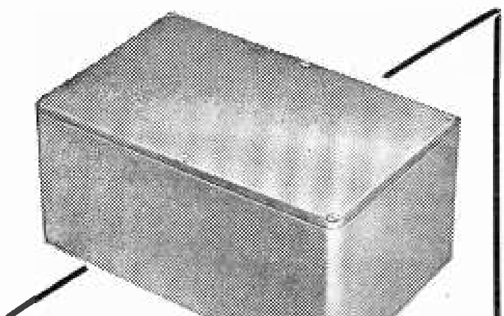

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1P1	6/6	6F12	4/-	16A5	9/-	DL96	6/6	EY81	10/-	U52	7/6
1P10	5/6	6H6GT	2/-	19AQ5	9/6	EB91	4/-	EZ40	5/6	U76	7/6
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1U5	5/6	6SL7GT	6/-	35L6GT	7/6	ECC83	6/9	N17	5/6	UF41	8/6
3Q4	5/6	6SN7GT	7/6	35W4	8/6	ECC84	6/6	N18	5/6	UL41	8/6
3S4	5/6	6V6G	7/6	35Z4GT	8/-	ECC85	7/6	N19	6/-	UY41	7/6
3V4	6/-	6X4	5/-	5763	7/6	ECF80	6/6	N709	7/-	W17	3/-
5Y3GT	5/-	6X5G	5/9	80	6/-	ECF82	7/6	PCC84	7/6	W76	4/6
5Z4G	7/6	7S7	9/6	DAF91	4/-	ECH42	9/-	PCF80	7/6	W142	8/6
6AK6	5/6	8D3	4/-	DAF96	6/6	ECH81	10/-	PCF82	6/6	X17	4/9
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High Stability Resistors ½W 5% 50Ω to 1M, 9d. Midget Ceramics 500 v., 9d. Coax. Super Quality ¼in., 6d. yd. Plugs 9d. Sockets 9d. Silicon H.T. Rects, 250 v. 300 mA ½in. x ¼in. 8/6. Contact Cooled 250 v. 50 mA 6/6. 85 mA 8/6. NEW TRANSISTORS BY MULLARD. OC19, OC26, OC66, 25/-; OC44, OC45, 5/-; OC70, 6/-; OC71, 5/-; OC72, 6/-; OC72 Matched pair. 12/-; OC74, OC75, OC78, 7/6; OC81, 6/-; OC81 Matched pair, 12/-; OC170, OC171, 7/6.

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Postage and packing 6d. Over £1 post free. C.O.D. 4/-.

TEST GEAR techniques

PART 8 THE OSCILLOSCOPE CONTINUED

H. W. Hellyer

THE facility of "Trace Expansion" was mentioned in the preceding article (Part 7) of this series. While we pay a lot of attention, quite properly, to the sensitivity and bandwidth of the Y amplifier, and consider the provision of the X amplifier as a simple means of trace expansion, it is as well to remember that for several useful applications the X amplifier comes into play.

Typical of this test technique is the display of Lissajous figures, and wobbulator waveforms.

When two sinusoidal a.c. waveforms are applied to the X and Y inputs of the oscilloscope simultaneously, the pattern displayed will depend on a number of factors. Principal among these are: relative amplitudes, frequencies and phase of the two waveforms. If the input to the X timebase is a known frequency, and that to the Y amplifier a variable frequency, then the display will form a number of loops, according to the ratio between them. For normal work, ratios of about 10:1 are the maximum practical, and there must be a definite, stable relationship for a still trace.

If the waveforms are not exact multiples of each other the patterns of loops will rotate on the screen. This may be very pretty but does not help us much, although it is possible to note the speed of rotation of the individual loops and calculate the frequency difference.

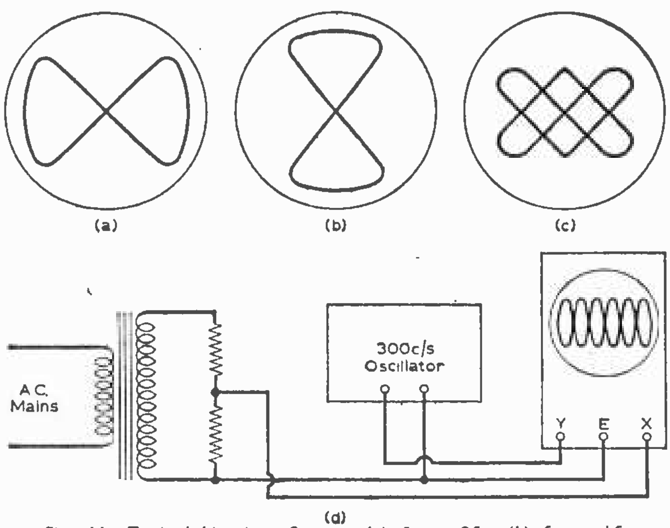

Fig. 11: Typical Lissajous figures: (a) fy = 2fx; (b) fy = ½fx; (c) fy = 3/2fx; (d) fy = 6fx; using 50c/s mains.

Typical Lissajous figures, with the Y frequency twice the X frequency (a), half the X frequency (b) and a ratio of 3:2 (c) are shown in Fig. 11.

If the mains frequency is used as a "yard-rule" to the X input, via a suitable attenuator for matching the two signals to be compared, and the frequency under test, say, the 300c/s output from an audio oscillator, a trace of six whole loops should be displayed when the two frequencies are in step, ratio 6:1, as shown in Fig. 11(d). As can be seen from the display, when the number of loops touching an imaginary horizontal line is divided by the number of loops touching an imaginary vertical line, we have the ratio of Y:X.

Involved Waveforms

Interpretation of these figures is simple when the waveforms are exactly sinusoidal and the ratio a whole number, as in the cases stated above. Considerable experience is required to determine how many loops are displayed, let alone touching the imaginary axes, when the waveforms are distorted, the phase angle varying, and the ratio an odd figure. Take for example the drawings of actual oscillograms in Fig. 12. Drawings are used here as the difficulty of photographing the more erratic of these figures makes the outline indistinct, and for the purpose of our argument clarity is essential.

As we shall see in a moment (Phase Measurement), when the waveform X is equal to Y in frequency and the phase angle is 90°, and voltages equal, a circle is displayed. If the phase angle changes, the circle becomes an ellipse, inclined according to the phase angle.

Fig. 12 (b) and (c) shows the ellipse with sinusoidal inputs and again with a distorted waveform, such as given by the clipping of the X waveform shown in (d). Note that the first ellipse can be considered as one loop touching the horizontal and one the vertical line and thus fy = fx. But the severely distorted display also resolves to fy = fx, if a close look is given to the actual loop formation.

Going a little further, consider Fig 12(e) where the Y waveform is three times that of the X waveform (frequency). The phase angle has distorted the trace, but there are still three contact points on the horizontal line and one on the vertical, as indicated.

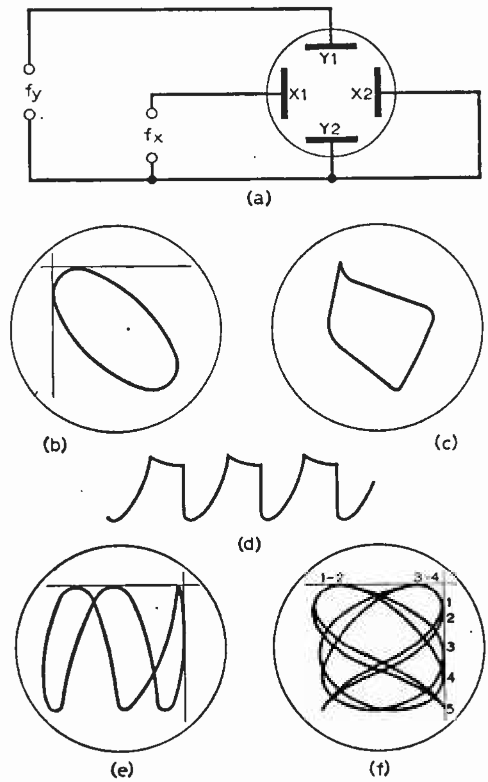

Fig. 12: Frequency comparison: (a) shows the basic connections; (b) ellipse formed when fy = fx — phase angle 90°; (c) distorted trace of (b) when input is non-sinusoidal; (d) X-waveform producing (c); (e) fy = 3fx, waveform distorted; and (f) fy: fx = 4: 5, note superimposed loops.

Even more complicated is Fig. 12(f), which indicates a ratio of fy:fx = 4:5, and where the superimposition of the loops can only be sorted out by careful tracing.

The point of the X amplifier can now be seen. If it is required to interpret a complicated display, and, moreover, one that may be moving all the while, it is desirable that the trace be expanded or contracted to readable limits.

The Circular Timebase

It is evident, from some of the traces of Fig. 12, that a large ratio of the two frequencies being compared would make interpretation extremely difficult. A method of comparing frequencies with a wide difference is to apply a circular timebase. This consists of a phase-splitting network, as in Fig. 13(a), producing a phase difference of 90° between points A and B.

To obtain this, R must equal the reactance of C, and so the frequency of the X signal must be known. If the mains frequency is used, and C, for example is 0·1μF, then $XC=\frac{10^6}{2\pi fC}\Omega$ which is $\frac{10^7}{314}=32{,}000\Omega$, which must be the exact value of R.

The test frequency is applied between the deflector plate system and the final anode, thereby effectively varying the deflection sensitivity, so the circular timebase is modified into a succession of ripples. Each inward and outward excursion of the spot represents one multiple of fx, so that the trace shown in Fig. 13(b), having six such ripples, denotes an fz of 6 × 50 = 300c/s. If a double trace is obtained the frequency ratio is n/2, where n is the number of loops. Thus, Fig. 13(c) has nine loops and a double trace and the ratio is therefore 9/2, or 225c/s, where a 50c/s fx is used. Where a triple trace is obtained, the ratio is n/3, and so on.

Other methods of applying networks to produce an elliptical trace for easier counting of the loops, and of modulating the tube differently to produce a dotted trace, are employed for frequency comparison.

Phase Measurement

Of more practical use to the amateur and serviceman is the hook-up used to measure phase shift. This can be applied to an audio or r.f. amplifier, an LC filter or similar network, and proves handy in checking phase shift of an amplifier, particularly of negative feedback loops. Obviously, some care is needed, both in the methods of connection and in the observance of frequency limits, as the oscilloscope amplifiers themselves can introduce some phase shift.

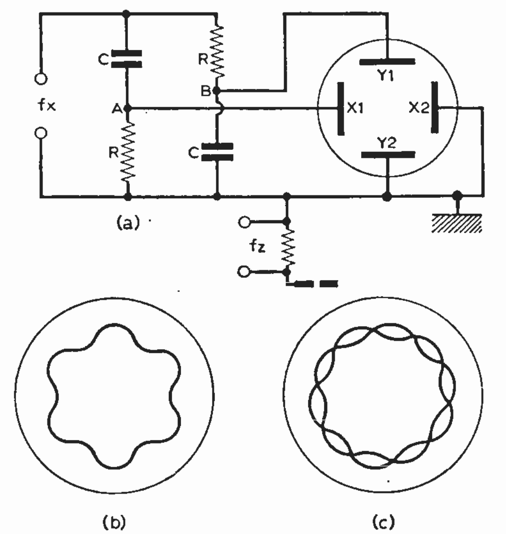

Fig. 13: Phase-splitting network for circular timebase; (b) fz = 6fx; (c) fz = 9/2fx — double trace.

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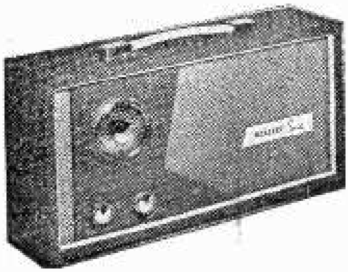

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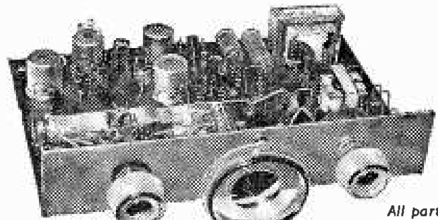

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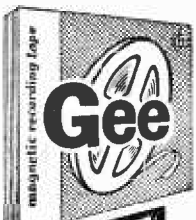

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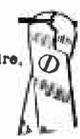

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In the set-up shown in Fig. 14(a), the signal applied to the amplifier input is also fed to the Y input of the scope, while the signal from the output of the amplifier goes to the X input, with a correct load resistor R to maintain matching, and a variable resistor X Def.

The procedure is to apply sufficient signal to drive the amplifier fully, but not to overload it, adjusting the Y amplifier gain of the scope to give about two-thirds deflection. If the Y input is now disconnected and the deflection potentiometer adjusted (timebase switched off), a similar horizontal deflection can be obtained. (If the oscilloscope has the internal X amplifier we discussed formerly, so much the better; the potentiometer can be dispensed with).

When the Y input is reconnected, an ellipse will be displayed, its size, shape and angle depending on the phase shift between input and output of the amplifier. A sample of the ellipses that are displayed for various principal angles are shown in Fig. 14(b). Note that in each case the shift controls are adjusted so that the ellipse sits centrally about the crossover line on the graticule.

Now, if a measurement is taken from the point where the upper limit of deflection is projected across to the vertical axis, to the horizontal axis, calling this B; then another measurement from the point where the ellipse cuts the vertical axis, calling it A, we can calculate the phase angle from the formula Sin $\theta = A/B$.

It will be noted that only when the phase angle is zero (or 360°, which is the same thing in this case), or 180°, is there a straight, diagonal line. And when the phase angle is 90° the trace displayed is a circle.

In practice, this also depends on matching the amplitudes of the signals, and will often require that the sensitivities of the oscilloscope amplifiers have to be known. Again, this is where the X amplifier becomes useful. Note also that a variation in the supply voltage can make a difference, and a flattening of the trace in opposite quadrants, as opposed to the formation of an ellipse, indicates the presence of harmonics in the base supply.

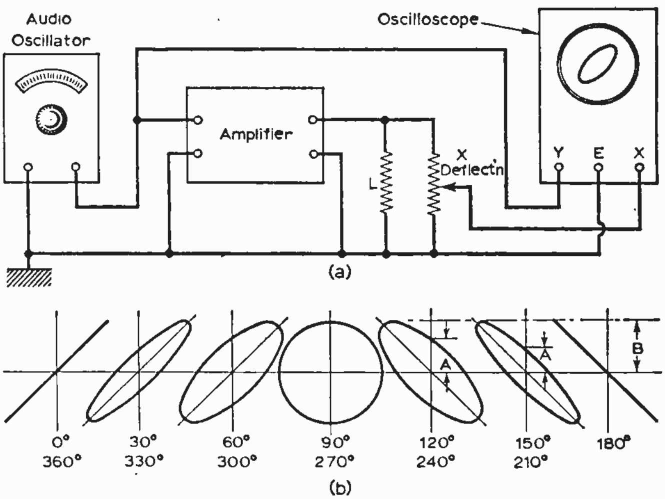

Fig. 14: Phase shift measurement: (a) typical hook-up; (b) phase-difference oscillograms.

Use of a Graticule

Where an oscilloscope does not have a transparent graticule, it is essential that some form of visual indication of trace length is available. A graticule is easily made from a piece of transparent plastic, and one simple method of noting measurements is to mark the plastic where required with a soft chinagraph pencil, whose mark can easily be erased.

The foregoing is sufficient also to demonstrate the way a response curve is traced out. For further notes on alignment, the reader is referred to the companion articles to this series, entitled "TV Alignment," which appeared in the May and June issues of *Practical Television*, and to Part 5 of this series.

The latter article, dealing with f.m. signal generators, with illustrations of some typical response curves, appeared in the July issue of PRACTICAL WIRELESS. Alignment of an a.m. receiver can be carried out in much the same way as described previously, with the difference that input settings and oscilloscope connections will be different. The Y input of the scope is connected to the detector load, via a screened lead. A convenient point for connection is often the top of the volume control.

Wobbulator Deviation Frequency

The deviation of the wobbulator must be slightly more than the passband characteristics of the tuned circuits of the receiver. Too small a deviation will restrict the response curve, too great a deviation will make the displayed curve too narrow for effective observation.

The deviation frequency is derived from the X sawtooth waveform, the wobbulator connected to the aerial and earth sockets of the set (or to the output from the frequency changer if only the i.f. amplifiers are to be checked). The wobbulator is set to the central frequency either the nominal i.f. or the selected radio frequency, and the deviation about 20c/s, adjusted at the wobbulator. The X timebase is set for an adequate display, and the marker signal, if available, applied from a fixed r.f. oscillator—which can be a signal generator with the modulation switched off.

As previously described, many wobbulators have an inbuilt marker generator, often crystal-controlled. But even if this is absent, and the

—continued on page 553

CLUB NEWS

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

The extensive programme of events which made up the Torbay A.R.S. mobile rally, held on August 11th, was arranged by A.R.M.S. member G3NBR.

The June/July issue of "Mobile News",—the A.R.M.S. journal—sets a new "high" in standards of amateur radio society publications by employing, for the first time, three colour printing for its front and rear covers.

COVENTRY AMATEUR RADIO SOCIETY
Hon. Sec.: A. J. Wilkes, G3PQQ. 141 Overslade Crescent, Coundon, Coventry, Warwickshire.

Of late, members of this Society have been anticipating a move to new headquarters, affording better accommodation and facilities, car parking space, etc.

August 12th was mobile night on the air, and on 26th August, G5PP gave a talk entitled "Mobile Operation".

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

The programme for August began with a surplus sale held on the 7th. This was followed on the 14th by a meeting devoted to preparations for the Society's mobile rally which was held four days later at Rykneld School.

The last event to be held in August was a direction finding practice run on the 28th.

Another sale was held on September 4th, the first meeting of the month.

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

At the meeting on August 26th, L. W. Barnes (GW3PCZT) gave a lecture on "Single Sideband", which followed the usual slow morse practice and talk on "Simple Hints and Kinks".

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

Members of this Society manned another two demonstration stations during August; one on the 10th at the Halifax Agricultural Show and the other on the 17th at the Forest Cottage Community Centre Gala. August 14th was ragchew night and on the 28th, a number of members brought along their photographic slides to provide the evening's entertainment.

RADIO CLUB OF SCOTLAND
Hon. Sec.: A. Barnes, GM3LTB, 7 Southpark Terrace, Glasgow, W.2.

The constitution and financial affairs of this relatively young society are still rather involved, owing to the decision to operate the Glasgow section as a separate group within the RCS, and not as the "mother" body as had been the situation previously.

The Club's journal—"GM Magazine"—has undergone a change in cover design with the latest issue.

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

This Club reports increasing attendance figures for meetings.

On August 25th another mobile picnic meeting was held at the Childe Beale Trust when members and their families enjoyed an informal afternoon outing.

At the last meeting for August, Dud Charman (G6CJ) gave a lecture and demonstration of aerials.

RODING BOYS SOCIETY: RADIO SECTION
Hon. Sec.: R. T. Marchant, 154 Essex Road, Leyton, London, E.10.

The Society's annual field day was held successfully during August with the single transmitter operating on 160m.

SCARBOROUGH AMATEUR RADIO SOCIETY
Hon. Sec.: P. B. Briscombe, G8KU, "Roesacre", Irton, Scarborough, Yorkshire.

Local short wave enthusiasts and visitors to Scarborough are invited to the meetings of this club which are held at 8 p.m. every Thursday at Chapman's Yard, Waterhouse Land, North Street, Scarborough. At the meeting for August 8th, "v.h.f. working" was under discussion.

An R.A.E. paper formed the topic for the meeting on August 15th and a week later "Servicing" was discussed.

STOCKPORT RADIO SOCIETY
Hon. Sec.: E. G. Houldsworth, G6NM, 52 Worsley Crescent, Stockport, Cheshire.

Any potential members are invited to go along to meetings of this Society, which are held on alternate Wednesdays at 8 p.m. All meetings are at the Blossoms Hotel, Buxton Road, Stockport; the next being on September 11th.

STOKE-ON-TRENT AMATEUR RADIO SOCIETY
K. H. Parkes, G3EHM, 28 Grove Road, Heron Cross, Stoke-on-Trent, Staffordshire.

Recent events have included a talk on aerials and a demonstration of a transistorised electric organ.

Decoration and renovation work is at present in progress at the club premises.

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

As it was not possible for the Society to meet at the usual rendezvous during August, members assembled at a local hotel where a meeting was held.

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

The only meeting for August was held on the 12th, when members heard a talk given by R. Weston.

G. J. Fowle's lecture of September 2nd was entitled "Building Mains and Battery Operated Communication Receivers".

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

On August 25th members and their families were able to enjoy a picnic, arranged by the Society and held in the beautiful grounds of Sheffield Park.

R.S.G.B. Contests for September. V.H.F. National Field Day (September 7th to 8th); D.F. National Final (September 15th) and Low Power Field Day (September 22nd).

COURSES OF INSTRUCTION

Below are listed a number of technical institutes which will be running radio and television courses this autumn. All courses begin in September (except where stated) and further details can be obtained from the institute itself or from the address given.

Allan Glens School, Montrose Street, Glasgow: radio theory, morse, G.P.O. regulations, aerials, etc., and a general radio course.

Bradford Technical College: inquiries—Mr. D. M. Pratt, 30 Lyndale Road, Eldwick, Bingley, Yorkshire: R.A.E. and morse courses.

Brentford Evening Institute: inquiries—Evening Institute Department, Education Offices, Town Hall, Chiswick, London, W.4: radio amateurs' course, morse, radio and TV servicing.

Carshalton College for Further Education: inquiries—The Registrar, Carshalton College for Further Education, Nightingale Road, Carshalton, Surrey: if enough interest is shown radio theory and morse classes will be held.

Central Evening Institute, Lea Mason Centre, Bell Barn Road, Birmingham: R.A.E. courses.

Hendon College of Technology, The Burroughs, Hendon, London, N.W.4: short courses on digital computors, transistor circuit design (beginning October), microwaves, global communications (beginning October) and high fidelity sound reproduction (beginning October), also a design course for electronic engineers (beginning October).

Holloway L.C.C. Evening Institutes: inquiries—A. W. H. Wennell, 145 Uxendon Hill, Wembley Park, Middlesex: R.A.E. and morse classes.

North End Evening Institute, Portsmouth: inquiries—The Secretary, Eastney Modern Boys' School, Reginald Road, Southsea, Hampshire: R.A.E. course.

Northwood Evening Institute, Potter Street, Northwood Hills, Middlesex: radio amateur examination, morse and practical courses.

Wembley Evening Institute, Copland School, High Road, Wembley, Middlesex: R.A.E. and morse classes.

Wesley Evening Institute: inquiries—"Jeanville", Brighton Road, Addlestone, Weybridge, Surrey: radio and television course.

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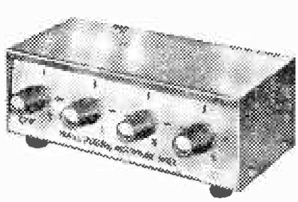

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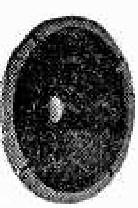

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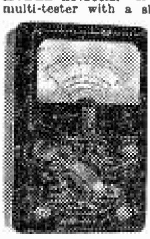

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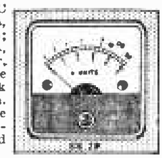

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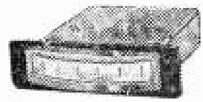

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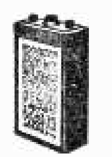

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The Practical Wireless

OHM'S LAW CALCULATOR

A time-saving aid for every enthusiast

By F. P. Rozee

THE relationship between voltage, current, resistance and power is of the utmost importance; a full understanding of the terms and the ability to manipulate them rapidly is the first essential of radio engineering. The relationship is known as Ohm's Law and the importance of this law to the engineer cannot be overstated.

As arithmetical operations are somewhat tedious and mental calculations are unreliable, a mechanical means of computing, with an accuracy better than the tolerance of practical components, becomes necessary.

The Ohm's Law Calculator presented with this month's issue of PRACTICAL WIRELESS has been designed by the author for readers of this publication. It will be found to be a valuable addition to the workshop and a useful companion to the Parallel Resistor Calculator presented with the April 1963 issue of PRACTICAL WIRELESS.

Ohm's Law, using the terms E, I and R, only holds good for d.c. circuits, but it can be used at low frequencies where the load is almost purely resistive.

A mains dropper resistor, although wire-wound and thus to some extent inductive, would, at 50c/s, behave more or less as if d.c. were being applied. Computations using the calculator may be made at mains frequency for any resistive loads such as fires, heaters, etc.

A word about filament lamps and valve heaters; these will have a very low resistance when cold, only at their working temperature will the resistance agree with the working voltage and current.

The range of voltage, resistance and current encountered in radio and television engineering is far greater than in most other branches of electrical work. Depending on the type of equipment, voltage may range from a few microvolts to several kilovolts, current from a few microamps to several amps and resistance from an ohm or so to several megohms. It is necessary to cater for all of these possibilities and for this reason a range extension chart has been printed on the calculator.

The Two Scales

An inspection of the calculator shows that it consists of two scales. Scale "A" being the inner or slide and scale "B" the outer. Scale "A" is used for current only and is marked on a logarithmic scale from 1mA to 1,000mA, this being the current range that is most likely to be encountered.

Scale "B" is used for resistance, voltage and power ratings. It is marked 1—1,000, and for voltages would be regarded as 1 to 1,000V. For resistance, using the left-hand pointer on scale "A", the fixed scale covers from 1 to 1,000kΩ, while with the right-hand pointer, the range is from 1 to 1,000Ω.

For power rating, using the left-hand pointer, scale "B" covers from 1 to 1,000mW, and with the right-hand pointer from 1 to 1,000W. The whole of this latter range is not likely to be required, the largest resistor that would be used is probably a 60W component, where 200V are dropped in a 300mA heater chain. Power dissipations below 100mW are rarely of interest as a $\frac{1}{10}$W is the smallest component normally available.

To Find Voltage or Current

Where the unknown value is that of either voltage or current, set the known resistance against the appropriate pointer. The unknown voltage is then revealed directly above the known current, or the unknown current directly below the known voltage.

Examples

Known values, 200Ω and 10mA. Set ohms pointer to 200, read 2V above 10mA.

Known values, 8kΩ and 5mA. Set kilohms pointer to 8, read 40V above 5mA.

If it is found that with the appropriate pointer on the value of resistance, either the known voltage is not above some part of scale "A" or that the known current is not below some part of scale "B", it will be necessary to use the other pointer and refer to the range extension chart.

Examples

Known values, 50kΩ and 100mA. Set the kilohms pointer to 50, it will be seen that 100mA is not below any part of scale "B". Set the ohms pointer to 50. We now know that the ohms pointer must indicate in kilohms, the chart (under the column headed "ohms pointer") shows that this could be in association with either microamps and volts, or milliamps and kilovolts. As we have 100mA, it must be then, that the figure 5 revealed above the 100 is kilovolts. Therefore 50kΩ, 100mA = 5kV.

Known values, 2·5MΩ and 200μA. The chart shows that in association with microamp, megamp could either be set against the ohms pointer and the answer be in kilovolts, or megohm could be set against the kilohms pointer and the answer be in volts. As the first does not allow 200 to appear against scale " B ", the second is used. Set kilohms pointer to 2·5 and 500 is revealed above 200. Therefore 2·5MΩ, 200μA=500V.

To Find Resistance

Where the unknown value is that of resistance, set the known current in scale " A " directly below the known voltage in scale " B " and read the resistance from whichever of the pointers is on scale " B ". If this is the right-hand pointer the answer is in ohms and if the left-hand pointer, in kilohms.

Examples:

Known values, 8mA and 4V. Set 8 on scale " A " against 4 on scale " B " and read 500Ω from the ohms pointer.

Known values, 3mA and 120V. Set 3 on scale " A " against 120 on scale " B " and read 40kΩ.

Should either or both of the known values not fall in the ranges 1—1,000mA or 1—1,000V, refer to the range extension chart, this is quite easy to follow.

According to the top line of the chart, if scale " A " is used for microamps and scale " B " for microvolts, the resistance reading is in ohms and will be indicated by the kilohms pointer, and so on down the chart to amps and volts where the resistance in ohms is indicated by the kilohms pointer.

Should the ohms pointer be on the scale when microamps and microvolts are associated, or milliamps and millivolts, or amps and volts, the indication would be in thousandths of an ohm. When microamps and kilovolts are associated, the kilohms pointer would indicate from 1,000MΩ up, about equal to an open circuit.

To Find Power Rating

It is necessary to know both the voltage and the current in order to find the power dissipated in either watts or milliwatts (to accommodate the formulæ $P=E^2/R$ and $P=I^2R$ would require an extra sliding scale and make the calculator unduly complicated).

Should either voltage or current be the unknown value, finding this using the method described earlier, will take but a moment. The known voltage is set against the left-hand pointer and the power in milliwatts read directly above the known current. If the current is not below some part of scale " B " the power is in excess of 1W and it is necessary to set the right-hand pointer to the voltage, when the power in watts is read directly above the known current.

The extension chart includes a multiplying or dividing factor on certain ranges. Where no factor is shown the power dissipation is negligible.

Resistor Voltage Ratings

The reader is reminded that resistors have a maximum voltage rating. This is not troublesome on the lower resistance values. With a 100kΩ component 1·6mA=160V which is approximately ¼W, so 160V is the maximum that would be applied if the power rating were observed. However with a 5MΩ component, the full ¼W rating is met by 1·1kV at 210μA, and 1·1kV is well above the voltage rating for a ¼w carbon resistor.

The following figures will serve as a rough guide to the maximum voltages for carbon composition resistors: ⅛W—250V, ¼W—400V, ½W—600V, 1W—800V, 2W—1·2kV.

Manufacturer's data should be consulted where possible as the construction, composition and certain techniques in production are among the factors that impose these limits. ■

TEST GEAR TECHNIQUES

—continued from page 545

provision of a connecting terminal for a marker is lacking, the marker signal can be loosely coupled to the wobbulator signal input lead.

Miscellaneous Points

There are one or two small points to be noted when using an oscilloscope for alignment. Inversion of the trace, vertically, while presenting no real problem, can be confusing. Simply reverse the Y input leads to invert the image. Horizontal reversal is rather more difficult to detect, and requires a frequency shift of the wobbulator input, to determine whether a rise or fall produces the correct lateral shift. Used in conjunction with the marker, this method soon becomes familiar to the operator.

As a final reminder—the response curve displayed is linear, with reference to amplitude—and due allowance must be made when comparing with a published curve, which may be drawn to a logarithmic (decibel) scale. ■

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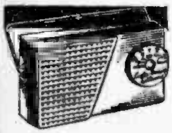

42/6

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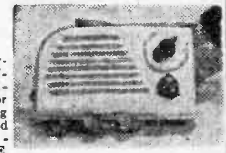

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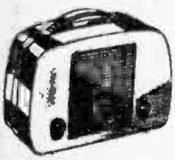

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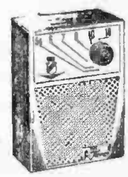

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LETTERS TO THE EDITOR

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

EGG CRATE LINING

SIR,—Recently I was loaned a copy of July 1951 P.W. by a friend. In this issue is an article describing how to make use of papier mâché egg crates as a lining for loudspeaker cabinets of the bass reflex or infinite baffle type.

Having a loudspeaker enclosure which suffered badly from cabinet resonance, I tried this idea and found that the quality of absorption and irregular surface of the egg crate lining allowed 10W of audio power to be fed into the loudspeaker, without the troublesome "booming" which had occurred previously. I should like to take this opportunity to thank Mr Simmons who wrote this most useful article.—R. W. MOTH (Tettenhall, Staffordshire).

LANGUAGE BARRIER

SIR,—I absolutely agree with Mr. Dhenau when he says in his letter (PRACTICAL WIRELESS, July) that Esperanto "would be an untold boon" to wireless communication.

I should like to add that I too know from personal experience that it is much easier to understand and be understood by a foreigner using Esperanto than broken English. Quite apart from the obvious fact that it is a neutral language, one cannot fall into errors and ambiguities of speech. It is impossible to detect the nationality of a reasonably fluent Esperantist, and this surely helps to break down the barriers of language.—MISS E. STOREY (Hexham, Northumberland).

NOVICE LICENCES

SIR,—For some months now I have followed carefully all the correspondence published in P.W. with regard to the licensing of individuals to operate transmitters, and I am convinced that the issue involved is far wider than the question of whether or not "novice licences" should be introduced.

As a member of a free and democratic society, I believe that every citizen of the U.K. should be able to look upon the use of the ether as his right as an individual and not as the privilege of the initiated few. To refuse anyone permission to use such a convenient method of communication in this day and age is not only narrow-minded but also dictatorial.

Of course there must always be limitations on power, frequency, etc., but such things are easily enforced and whereas only limited rights prove acceptable, the complete rejection of these rights is criminal.

No one would deny that, in view of the good name of amateur radio, established over the years, and in consideration of the pioneer work of early hams in "opening up" new bands, the privilege of working certain frequencies should remain exclusively theirs. However, that is no excuse for forbidding the man-in-the-street the use of part of the spectrum and, if we are to be logical about this, we cannot expect every individual to sit and pass a highly technical examination beforehand.—R. L. J. STEVENSON (Carlisle, Cumberland).

Sir,—I would be grateful if any reader could sell or loan me . . .

. . . a manual or any information on the G73 wavemeter.—F. MURDON, 13 Bridge Street, Risca, Newport, Monmouthshire.

. . . the manual of the Bendix RA-1B receiver.—M. J. LANG, 4 Lynton Road, Burnham-on-Sea, Somerset.

. . . the September 1961 issue of P.W.—R. D. SAXTON, 165 Gloucester Road, Patchway, Bristol.

. . . the handbook for the oscilloscope No. 11 (A.A. Predictor Mk. 1).—J. E. GRIFFIN, 113 Gladys Avenue, North End, Portsmouth, Hampshire.

. . . data or circuit diagram of the R.1392D receiver. — W. SMITH, 6 Salisbury Crescent, Blandford Forum, Dorset.

CORRESPONDENT WANTED

SIR,—As a regular reader of PRACTICAL WIRELESS and an enthusiast of amateur radio and television, I would like a correspondent in England of about my own age (16 years). I will answer all letters received.—RON SWALLOW, JNR., 1 Chauvel Street, North Ryde, Sydney, N.S.W., Australia.

BOOK REVIEW

RADIO AND LINE TRANSMISSION: VOLUME 2

By G. L. Danielson, M.Sc.(Tech.), B.Sc., A.M.I.E.E., and R. S. Walker, Grad.I.E.E., Grad.Brit.I.R.E.; published by Iliffe Books Limited.

295 pages, 224 diagrams, 5½in. x 8¾in. Price 22s. 6d.

THE whole of the syllabus of the City and Guilds of London Technicians' Certificate examination in Radio and Line Transmission B is covered by this volume.

Communications students preparing for this third year examination will find that the authors have catered for their requirements using the same well-defined style as in their first volume of this series. As readers of volume 1 will know, both authors are particularly qualified to write on this subject; Mr. Danielson is the Head and Mr. Walker a Lecturer of the Telecommunications Department of the Norwood Technical College.

The range of subjects dealt with is substantially the same as volume 1, but the treatment is deeper; where general introductory statements often sufficed in the earlier book, fuller explanations and mathematical proofs are now given. The text still continues to be mainly of a descriptive nature, and the standard of mathematics required is no higher than ordinary level G.C.E.

For those not familiar with the syllabus of Radio and Line Transmission B it should perhaps be explained that it embraces both general principles and practical aspects of components employed in communications equipment.

CORRIGENDA

An Electric Timer

Referring to Fig. 1 (page 131 June issue), the batteries should be transposed: B1 (3V) feeds the buzzer (Z1) and lamp (LP1); B2 (22·5V) supplies the main circuit.

This article was written by D. Gibson and we apologise for misprinting the author's name.

Making Tin Plate Chassis

In Fig. 1 (page 73 May issue) tinplate of 16 or 28s.w.g. was specified in error for 26 or 28s.w.g. Bearing in mind the simple tools employed, the technique described in this article is applicable only to the thinner gauges of tinplate.

Double Conversion Communications Receiver

(1) Referring to Fig. 2a (pages 50, 51 May 1963 issue), L6 should be redesignated "L6A" and the following item should be added to the components list (page 141 June 1963 issue):

L6A 2nd oscillator coil (Repanco RO3).

On page 142 (last line but one) the reference to "second oscillator coil L5" should be amended to read "L6A".

(2) The correct type for V13 is VR150/30 (Brimar) or QS150/40 (G.E.C.).

Kenilworth Public Address Amplifier

In the components list (page 320 August 1963 issue) the resistors are described as 5W types; this was a misprint for ½W.

JUST TO PUT YOU IN THE PICTURE

TO a steadily increasing band of practical enthusiasts TV no longer signifies passive viewing of BBC or ITV programmes, but a branch of communications offering opportunities for experimental and creative work, just as sound radio has provided for many years past.

Television DX hunting, or the reception of distant TV stations, can be a fascinating hobby where one's knowledge of v.h.f. and u.h.f. propagation conditions, operating skill, location and—of course—a certain amount of luck! all contribute to the bag of stations received. A standard TV receiver can be modified for DX hunting without much difficulty—and there is at the moment a plentiful supply of secondhand receivers on the market at rock bottom prices. A commentary on DX TV now appears regularly in our companion journal *Practical Television*. This interesting feature lets you know what the other fellow has received and gives guidance on seasonal conditions, and transmitting frequencies and times of operation of the quarry.

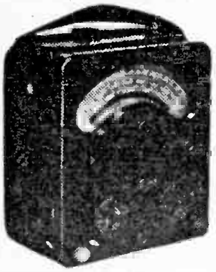
Why not build your own TV camera? Starting in this month's *Practical Television* is a series of articles describing the construction of a closed-circuit TV camera suitable for use with any domestic TV receiver. This camera opens up all kinds of possibilities for home entertainment, as well as more serious applications in picture production. No prior knowledge of camera circuit technique is needed—everything essential is fully explained in these articles.

Of course if you are a little more ambitious there is no reason why you should not build and operate your own TV station. Amateur TV transmissions are permitted on 70cm and on shorter wavelengths by licensed operators—and there is still an element of pioneering in the establishment of contact and the exchange of pictures with fellow hams on these ultra high frequencies. The background to TV ham activities will be discussed in the November issue of *Practical Television* and subsequent articles in this new series devoted to Amateur Television Transmission will provide full constructional details for a 70cm convertor, a complete receiver, a transmitter and a camera unit; aerials and ancilliary equipment for the TV ham's station will also be described.

So if you are looking for some further interest in the realm of electronics and communications to help occupy the long Winter evenings that loom ahead, may we suggest that you get into focus and start scanning the pages of *Practical Television* right away!

Despite our opening paragraph *Practical Television* is not oblivious of the millions of broadcast viewers. In fact many of its pages are devoted regularly to the servicing and maintenance of domestic TV receivers. Commencing shortly will be a series describing an all-transistor dual-standard TV receiver for the home constructor. ■

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.

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Low impedance, comfortable headband. Suitable for AR88, CR100, etc. Brand New, **15/6.** P. & P. 1/6.

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100µA	3½"	F.M.	D.C.	62/6
1 mA	2½"	F.M.	D.C.	25/-
30 mA	2½"	F.M.	D.C.	12/6
30/0/30 mA	2½"	F.M.	D.C.	9/6
350 mA	2½"	F.M.	D.C.	10/6
15 amp.	3½"	F.M.	D.C.	39/6
5/0/5 amp.	3½"	F.M.	D.C.	25/-
300 v.	2½"	Proj.	A.C.	19/6
300 v.	2½"	F.M.	A.C.	25/-
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OA 202 miniature silicon rectifiers 1/- each.
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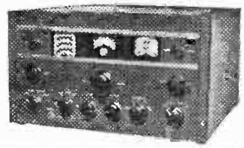
R.C.A. AR.88 D. RECEIVERS



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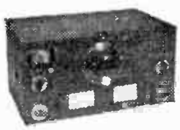

SENIOR MODEL. Supplied complete with full set of 9 coils covering 50 Kc/s. to 30 Mc/s. Each receiver thoroughly checked and available as follows:—
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NB—Rack model is identical to table model with extended front panel to fit a 19in. rack. Carriage £1 extra.
200/250 volt A.C. power supplies for all above receivers, also sold separately, 59/6, carr. 5/-.

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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

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5in.	600ft.	std. ..	8/6
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Supplied with Leads, Batteries and Instructions.

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0/150 mA. D.C.
0/100 K Ω etc.
39/6. P. & P. 1/6.

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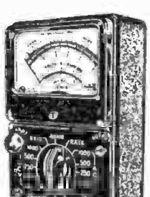
0/50K/500K/5 meg., etc. 97/6. P. & P. 2/6.



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0/10K/100K/1 meg./10 meg., etc. £7.10.0. P.P. 2/6.

100,000 Ω/VOLT
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12/18v. 15A.	37/6	48/60v. 2A.	21/-
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"S" meter 35/-

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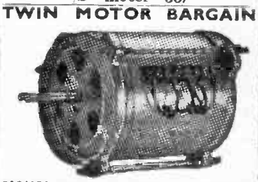

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EF80	4/3	PCF82	6/9	UCH81	7/6
EF85	5/-	PCL83	9/-	UY85	5/9
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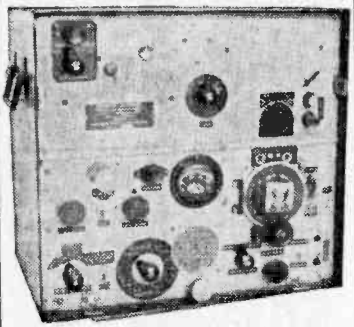

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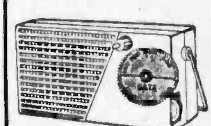

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5 SEMI-CONDUCTORS
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50/- P.P. 2/9 extra.
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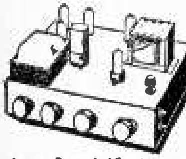

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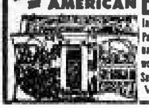

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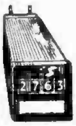

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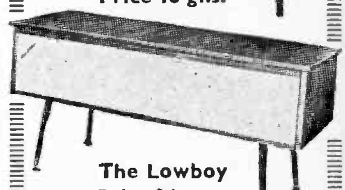

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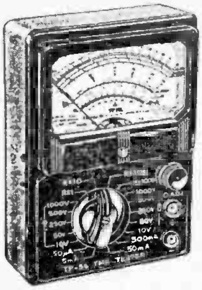

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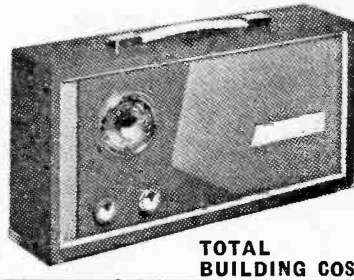

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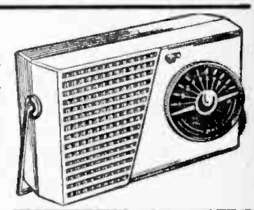

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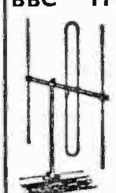

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GZ32	5/-	U301	9/-	10C2	10/-
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Checks all types of resistors, condensers
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Built in 1 hour. Direct reading.
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1 Valve 6d., 2-11, 1/-. FREE for 12 or more valves.	In writing with every valve.	Satisfaction or Money back Guarantee on Goods if returned within 14 days.

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6F19	6/-	12Q7GT	4/6	DF96	7/3	EL85	9/9	PY88	9/-	X81M	9/-
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6F33	4/-	12SG7	4/6	DH63	5/6	EL95	6/6	PZ30	9/6	Z63	4/9
6H6	1/6	12SH7	3/6	DH76	4/6	EM34	8/9	R19	9/6	Z66	8/6
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6J6	3/6	12SQ7	8/6	DK96	7/3	EM85	9/6	SU25	16/-		
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SPECIAL TEMPORARY OFFER Due to huge Bulk Special Purchase we are offering MW 31-74 Tubes at the unrepeatable price of 29/-. MW 36/24 ditto. 39/-. P.P. 12/6. The above are guaranteed for 6 months.

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4 watt AMPLIFIERS

excellent amplifier with high gain preamp stage, 10F3 driving 10P14 output stage, complete with 8in. speaker. In attractive 2-tone case. Tone control, negative feed-back, ready for immediate use, individually tested. Amazing volume and clarity, ideal for guitars, record players, p.a. in small halls, baby alarms etc. Easily worth £5. Our price whilst stocks last. Carr. Packing, etc. 7/6. **45/-**

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Kit of new parts, consisting chassis, mains and output transformers, valves (P61, 6G6G, 6X5G) and all components. With full instructions for making high gain amplifier with separate base and treble controls, negative feed-back, etc. Truly unusual value at **29/-**

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With Widest Stocks, Keenest Prices: TV's, Radios, Valves, Transistors, Hi-Fi Equipment, Loudspeakers, Autochangers, Cables, Components, etc.

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Fantastic offer. 7 valves plus 2 diodes. Contemporary Cabinet. Top quality and finish. A.F.C. P.V.C. Absolutely complete Guaranteed 3 months **£11**

PORTABLE RECORD PLAYERS. Take all sizes Records, all speeds, amplifier, auto-changer Garrard new "Slimline" Gram. In two-tone Case. All absolutely new. **13 gns.**

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TELEPHONE C.O.D. ORDERS DISPATCHED THE SAME DAY.

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Huge reductions. Red Spot standard L.F. type now only 1/6; White Spot R.F. 2/-. Mullard Matched Output Kits (OC81D and 2-OC81's). 12/6. Receiver Kits. (OC44, OC45(2), OC81D, OC81(2), six transistors. **24/-**

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Post: 2 lbs. 2/-, 4 lbs. 2/6, 7 lbs. 3/6, 15 lbs. 4/-, etc. (C.O.D. 2/- extra). ALL ITEMS LESS 5% AND POST FREE IN DOZENS. Send 6d. for list of 1,000 snips.

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Send (preferably) a postal order to cover the cost of the Blueprint (stamps over 6d. unacceptable) to PRACTICAL WIRELESS, Blueprint Dept., George Newnes, Ltd., Tower House, Southampton Street, London W.C.2.

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Each blueprint in this series contains details of two separate instruments or items of equipment.

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THE following blueprints include some pre-war designs and are kept in circulation for those constructors who wish to make use of old components which they may have in their spares box. *The majority of the components for these receivers are no longer stocked by retailers.*

Experimenter's Short Wave	PW30a	2/6
Midget Short Wave Two	PW38a	2/6
Simple S.W. One-valver	PW88	2/6
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BBC Special One-valver	AW387	2/6
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QUERY COUPON

This coupon is available until 4th October, 1963, and must accompany all queries in accordance with the notice on our "Letters to the Editor" page.

PRACTICAL WIRELESS, OCTOBER, 1963.

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★ The easiest Superhet Radio to build on the market. Features clearly-marked printed circuit and packaged components with full illustrated building instructions. Full tuning of medium and long wave bands with unbeatable sensitivity and selectivity. Excellent tone and volume with over 600mW push-pull output.

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★ 6 Mullard Transistors and 2 Diodes.

TOTAL COST OF ALL PARTS **£9.19.6** P.P. 3/6.

All parts sold separately.

Guaranteed the Best Obtainable.

● **Attractive Appearance—Reliable Design—Quality Performance** ●

UNBEATABLE FOR QUALITY AND VALUE

Fully Detailed and Illustrated Leaflet on request.

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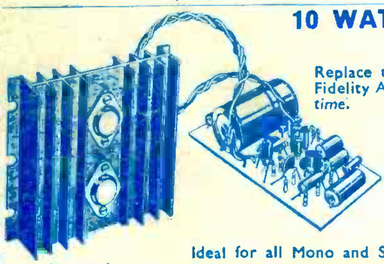

Replace that Valve Amplifier with this High Fidelity Amplifier. *Call for demonstration—any time.*

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- 100mV INPUT FOR 10 WATTS OUTPUT
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Ideal for all Mono and Stereo Hi-Fi systems.

Supplied complete with booklet showing preamplifiers, mixers, stereo, public address, etc. Can be used with any commercially available valve or transistor preamps, tuners, etc. Can be used with batteries—any voltage 4½ to 24 volts.

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PERFORMANCE EQUIVALENT TO VALVE AMPLIFIERS OF FOUR TIMES THE PRICE AND MANY TIMES THE SIZE

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- 6 position input selector—Treble—Volume—Bass—Filter controls.
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- 4 watt peak.
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- Size only 6" x 2½" x 2".

Ideal for mains or battery, portable or domestic record players, grams, etc. (Mains Unit 80/- extra). *Call for demonstration.*

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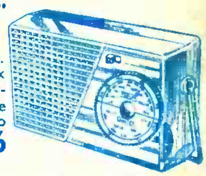
"QUINTET" POCKET RADIO



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