PRACTICAL WIRELESS

1/6

MARCH 1961

THE P.W. SIGNAL GENERATOR

— *unit-constructed*
— *mains-powered*
— *wide-range; low cost*

PORTABLE RADIOPHONES MODEL MK II

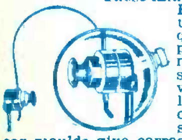
Brand New British Army Portable Transmitter Receivers.

Designed for reliable voice intercommunication operating up to 10 miles depending upon obstructions and elevation. The combined Transmitter Receiver covers the whole frequency range between 7.4-9 Mc/s. and is fully tunable on both Transmitter and Receiver. Simple and a delight to operate as all controls are mounted on the front panel of the set and clearly marked. Operates from standard dry batteries 3 v. L.T. and 120 v. H.T. Incorporates 5 valves: R.F. Amplifier, I.F. Amplifier, Second Detector, Output and Power Amplifier.

All sets are supplied complete with all accessories comprising dynamic sound powered headphones, electro magnet supersensitive microphone, 4ft. aerial, junction box, battery connection details and full circuit diagram.

PRICES:
60/- EACH (P. & P. 4/-).
TWO FOR £6.0.0 (Post Free).
Batteries 20/- per set.

HI-FI HEADPHONES



These miniature Hi-Fi phones use high quality permanent magnetic speakers with regulated voice coil. The soft rubber ear moulds give correct spacing for optimum acoustic load. Each unit has a built-in miniature Hi-Fi transformer to ensure the finest music and voice reproduction. Supplied free is a small transformer unit which steps impedance up to 4000 ohms. Only 15/- P. & P. 2/6.

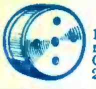
COMMAND TRANSMITTERS

Complete with all valves, crystal etc. 3-4 Mc/s. 45/-. 4-5.3 Mc/s. 45/-. 5.3-7 Mc/s. 45/-. P. & P. 3/6 each.

COMMAND RECEIVERS

6-9.1 Mc/s. 60/-. P. & P. 3/6 ea.

CRYSTAL MIKE INSERTS



1in. dia. 70-6000 c/s response. Brand new. ONLY 6/6. P. & P. 6d. 2 for 12/-.

PORTABLE TRANS/RECEIVER No. 18. A self-contained Trans/Receiver for Telephone and C.W. Range approx. 10 miles. Freq.: 6-9 Mc/s. (50-33.3 metres). Valve line-up: 3 ARP-12. 2 AR-8. 1 ATP4. Complete with aerial. H.T. and L.T. meter and all accessories. Weight 20 lbs. Size 8 x 10 x 17in. Only 80/-. Carr. 10/-.

AERIAL VARIOMETERS

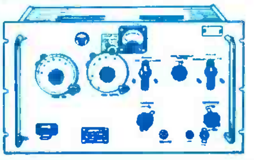
These magnificent instruments will enable you to receive maximum signal strength on all S.W. receivers. Precision calibrated control. 12/6. P. & P. 2/6.

MICROPHONES. BRAND NEW. Throat magnetic. 4/6; Throat carbon 3/6; No. 8 carbon with switch 6/6; No. 7 moving coil 7/6. Tannoy power mikes only 5/-. Crystal mike 22/6.

NEW! TRANSISTOR RADIO With Miniature Speaker.

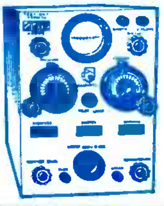
Simple instructions enable anyone to build this miniature radio. Gives reception over the entire broadcast band. Each kit is supplied with all latest miniature parts including: ★ two transistors ★ ferrite rod ★ speaker ★ coloured plastic case ★ step by step illustrated instructions. Size 4 x 3 x ¾in. ONLY **27/6** P. & P. 1/6. Battery 1/- ex.

VHF RECEIVER 1392



15 valve superhet covering 95-150 Mc/s which includes police, aircraft and amateur bands. Complete with slow motion tuning, tuning meter, circuit diagram, etc. Here is your opportunity to explore the VHF bands on a really sensitive receiver offered at a fraction of original cost. ONLY £6.5.0 Carr. 15/-.

OSCILLOSCOPE MODEL 74



This basic scope represents one of the finest buys we have ever made! Contains Brilliance, Focus, Gain and 2 speed time base controls. Separate X plate terminals. Signal Generator modulated at 2 frequencies over 150-255 Mc/s. Complete with 12 valves, VCR 139A tube, internal A.C. power pack, and complete circuit and technical details.

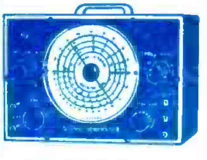
ONLY **97/6** Carr. 12/6

MINIATURE EARPHONE

A really sensitive dynamic earphone of exceptionally fine quality. Provides clear reproduction of music as well as speech. Fully Guaranteed and complete with transparent ear insert, 3 feet cord, sub-miniature plug and socket.

CR-5 High imp. .. **8/-** Each
MR-4 Low imp. .. Post 1/-

SIGNAL GENERATOR



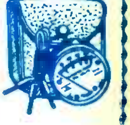
Model SWO-300 150 kc/s—300 Mc/s. Frequency Range: 150 kc/s-150 Mc/s on fundamentals (6 bands). 150 Mc/s- 300 Mc/s or harmonics. Calibration Accuracy within ± 1 per cent. Modulation: Internal and external. Attenuation: To —40db. Output: Facilities for high and low. Power Supply: Internal 230 v. A.C. Size: 7 x 10 x 5in. Complete with test leads and instruction manual. ONLY £14.19.6. Carriage 5/6. Fully Guaranteed.

MINIATURE MODEL MOTOR

A really high-speed precision motor with 101 uses: Model control, fan, saw, buffer, etc. Operates from standard battery (3-6 volts). Complete with full instructions at only 5/- each. Post 1/-. 2 for 10/-, post free.

R.F. UNITS. R.F. 25. 40-50 Mc/s. switched tuning, 8/6. **R.F. 27.** 65-85 Mc/s. variable tuning, 29/6. Circuits supplied. P. & P. 3/6 on each.

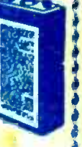
POCKET VOLT TEST METER



Two D.C. ranges: 0-250 v. and 0-25 v. Complete with test prods. and leather case. Very limited quantity. Only 12/6. P. & P. 1/6.

R.C.A. COMMUNICATION RECEIVER AR-88 LF. Range: 73-550 kc/s and 1.48-30.5 Mc/s. Undoubtedly the finest communication receiver ever produced for service and laboratory use. Now Relda's exclusive purchase enables you to obtain this Rolls-Royce of communication receivers at the lowest price ever offered. Fully guaranteed. ONLY £37.10.0. carr. 50/-.

ACCUMULATORS. 2 volts 16 A.H. (unspillable). Ideal for 6 and 12 volts supply, etc. Brand new. Original cartons. Size 4in. x 7in. x 2in. 5/6 each. P. & P. 1/6, 3 for 15/-. P. & P. 3/6, 6 for 27/6. P. & P. 5/-.



WIRELESS SET No. 19 MK. II Incorporates TX/RX covering 2-8 Mc/s (37.5-150 metres), and inter-com. amplifier. Complete with 15 valves, 500 microamp check and tuning meter, circuit and instruction book. ONLY 65/-. Carr. 10/-.

T.C.S. RECEIVER. 1.5 to 12 Mc/s. 7-valve superhet, built like a dream. Panel controls: R.F. Gain, A.F. Gain, C.W. Pitch, band-switch, mod.-C.W. switch, power switch, ground and aerial posts, M.O. or crystal frequency switch, speaker jack, card holder to log 30 stations, hand vernier tuning knob turning a large etched calibrated plate behind hair lined window, anti-backlash gears used. 90% complete, store soiled, offered at ONLY £5.10.0. Carr. 10/-.

Exciting New Product Exclusive to RELDA

TELEPHONE PICK-UP COILS

MODEL FC-8 Induction Pick-up coil enabling conversations to be picked up without tapping of wires or special telephone circuits. No electrical connections! Simply place telephone on the pick-up platform and connect lead to the input of any medium gain amplifier or direct to any tape, disc, or wire recorder. The coil is electrostatically shielded to minimise hum pick-up. Brand new complete with 5ft. shielded cable. FC-8 only. 16/- plus 1/6 p. & p.

MAIL ORDERS TO
(DEPT. P.), 32a COPTIC STREET, LONDON, W.C.1

Relda Radio Ltd

CALLERS WELCOME AT
87 TOTTENHAM COURT ROAD, LONDON, W.1 MUS 9606

Tel: Mitcham 6201

Open Daily to Callers

RST

All Valves Brand New and Fully Guaranteed

211 STREATHAM ROAD, MITCHAM, SURREY

Special 24 Hour Express Mail Order Service

OZ4	5/9
1A5	6/-
1A7	14/6
1D5	14/-
1D6	10/-
1H5	10/6
1L4	6/-
1LN5	4/6
1N5	10/6
1R5	9/-
1S4	8/6
1S5	9/-
1T4	4/-
1U5	10/-
2D21	8/6
2X2	5/-
3A5	12/6
3D6	14/6
3Q4	8/-
3Q5	10/6
3S4	8/-
3V4	9/-
5R4GY	9/-
5U4G	4/6
5V4	8/-
5Y3GT	8/6
5Z3	10/-
5Z4G	10/-
6A7	18/6
6A8	10/-
6AB8	9/-
6AJ8	9/6
6AK5	8/-
6AK8	7/6
6AL5	6/-
6AM5	5/-
6AM6	4/-
6AN5	7/6
6AQ5	8/3
6AQ8	9/3
6AT6	8/3
6AU6	10/-
6B7	10/-
6B8	4/-
6BA6	7/6
6BE6	7/6
6BG6G	21/-
6BJ6	7/6
6BR7	15/-
6BW6	8/6
6BW7	6/6
6BX6	6/-
6BY7	7/6
6C4	6/6
6C5GT	8/-
6C6	6/6
6C9	12/6
6C10	12/6
6CD6G	27/6
6D1	8/-
6D2	5/-
6D3	15/-
6CH6	12/-
56EGT	10/-
6F1	15/6
6F6	6/9
6F7	15/-
6F12	4/9
6F13	17/6
6F14	17/6
6F15	14/9
6F17	12/-
6F33	5/6
6H6	2/6
6J5GT	4/6
6J6	7/6
6J7GT	9/6
6K7G	3/-
6K7GT	10/6
6K8GT	12/6
6K25	19/6
6L1	15/6
6L6	7/6
6L18	12/6
6L19	21/-
6L34	10/-
6/30L2	10/-
6LD3	9/6
6LD20	15/6
6N7GT	7/6
6M1	10/6
6M2	10/6
6P1	17/6
6P25	19/6
6P28	26/-
6Q7GT	10/6
6SA7GT	7/6
6SG7	7/6
6SH7	6/6
6SJ7	5/6
6SK7	7/6
6SL7GT	6/6
6SN7GT	5/6
6U4GT	11/6
6U5	7/6
6U7	7/6
6V6G	5/-
6V6GT	8/-
6X4	5/-
6X5GT	5/-
7B7	8/-
7C5	8/-
7C6	8/-
7D5	15/-
7D6	15/-
7D8	15/-
7H7	8/-
7K7	10/6
7Q7	11/6
7R7	12/-
7S7	10/6
7Y4	7/6
8D3	4/-
9BW6	14/9
10C1	18/-
10C2	27/10
10F1	26/2
10F3	17/6
10F9	12/6
10LD3	12/6
10LD11	15/-
10P13	21/-
10P14	20/-
11D3	17/6
11D5	17/6
12A6	6/6
12AH8	10/-
12AT6	9/-
12AT7	8/-
12AU7	9/-
12AX7	9/6
12BA6	9/-
12BE6	9/6
12E1	17/6
12J7GT	9/6
12K7GT	8/6
12K8GT	12/6
12Q7GT	8/6
12SA7	8/-
12SC7	8/-
12SG7	8/6
12SH7	4/-
12SJ7	4/-
12SK7	8/-
12SQ7	11/6
12SN7	17/6
12Z3	15/-
13D3	12/6
14H7	12/6
14R7	12/6
14S7	21/-
15A2	17/6
15D2	23/9
19AQ5	10/6
19BG6G	24/4
20D1	12/6
20D2	23/-
20F2	26/6
20L1	26/6
20P1	26/-
20P3	23/-
20P5	22/6
25L6GT	9/6
25Y5	10/-
25Z4	9/6
25Z5	9/6
25Z6	10/6
27SU	17/6
30	13/6
30C1	12/6
30FS	11/6
30FL1	10/6
30L1	11/6
30P4	22/-
30P12	11/6
30P16	10/-
30PL1	15/-
32	13/6
35A5	15/-
35L6GT	10/6
35W4	8/-
35Z3	10/-
35Z4	7/6
35Z5	9/6
40SUA	15/-
41STH	23/6
42	15/-
43	15/-
50C5	15/-
50CD6G	21/-
50L6GT	9/-
61BT	17/6
61SPT	17/6
62BT	17/6
75	12/6
77	12/6
78	12/6
80	10/-
85A2	12/6
150B2	12/6
150B3	15/-
185BT	32/-
303	7/6
304	7/6
305	7/6
328	7/6
329	7/6
807	7/6
955	4/-
5763	17/6
9002	7/6
9003	7/6
AC4/PEN	25/-
AC5/PEN	22/6
AC6	21/-
ACTP	32/-
ACHL	12/6
AC/PEN	17/6
ACTH1	34/9
ACVP1	17/6
ACVP2	17/6
AC2/PEN	21/-
AC2 PENDD	21/-
AZ1	15/6
AZ31	10/6
B36	21/-
B65	8/6
B152	8/6
B309	9/6
B329	9/6
B339	9/6
B719	9/6
CBL1	17/6
CBL31	21/-
CCH35	21/-
CL4	12/6
CL33	18/6
CY1	15/9
CY31	15/9
D41	12/6
D42	12/6
D63	3/6
D77	5/6
D152	6/-
DAC32	10/6
DAF91	7/6
DF33	10/6
DF91	4/-
DF92	7/-
DF96	9/6
DF97	9/6
DH63	10/-
DH76	7/6
DH77	8/3
DH107	13/6
DH719	7/6
DK91	9/-
DK92	9/6
DK96	10/-
DL33	9/-
DL35	12/6
DL92	8/6
DL94	9/-
DL96	9/6
EA50	2/-
EABC80	7/6
EAC91	7/6
EAF42	10/-
EB41	7/6
EB91	5/-
EBC33	4/-
EBC41	9/6
EBF80	9/6
EBF89	9/-
EBL21	22/-
EBL31	21/6
EC90	9/6
EC91	9/6
ECC31	10/-
ECC32	10/-
ECC33	5/-
ECC34	15/-
ECC35	8/-
ECC40	21/-
ECC81	8/-
ECC82	9/6
ECC83	9/6
ECC84	9/6
ECC85	9/6
ECC91	5/6
ECF80	12/6
ECF82	12/6
ECH21	22/-
ECH42	10/-
ECH81	9/-
ECH83	12/6
ECL80	9/-
ECL83	12/6
EF9	21/-
EF22	17/6
EF36	7/6
EF37	8/6
EF37A	8/6
EF39	4/-
EF40	15/-
EF41	9/3
AF42	10/6
EF50(E)	3/6
EF50(A)	4/-
EF80	6/-
EF85	6/6
EF86	11/-
EF89	10/-
EF91	4/9
EF92	5/-
EF93	7/6
EF95	15/-
EL31	12/6
EL32	5/-
EL33	12/6
EL35	12/6
EL37	18/6
EL38	23/9
EL41	10/6
EL42	10/-
EL81	14/9
EL84	7/-
EL85	10/6
EL90	8/6
EL91	5/-
EM80	10/-
EM81	10/-
EY81	10/6
EY84	10/6
EY86	9/6
EY91	9/-
EZ35	7/-
EZ40	7/6
EZ41	7/6
EZ80	7/6
EZ81	7/6
EZ90	7/6
FC2	21/-
FC13	17/6
FC13C	21/-
FW4,500	10/-
FW4,800	10/-
GZ30	10/6
GZ32	11/6
GZ34	13/6
H30	5/6
H63	9/6
HBC90	9/6
HL92	6/6
HL133DD	10/-
HL23	12/6
H23DD	10/6
HL41	12/6
HL41DD	13/6
HL42DD	13/6
HY90	8/-
IW4/350	10/-
IW4/500	10/-
KBC32	9/6
KF35	8/6
KL32	10/6
KLL32	11/6
KL35	9/6
KT2	7/6
KT32	10/-
KT33C	10/-
KT36	28/6
KT41	22/6
KT44	13/6
KT55	22/6
KT61	18/6
KT63	8/6
KT66	17/6
KT71	9/-
KT74	12/6
KT76	12/6
KT101	25/-
KTW62	7/6
KTW63	7/6
KTZ41	8/-
KTZ63	10/-
L63	4/9
LN309	15/-
LZ319	12/6
MH4	8/6
MHD4	17/6
MHL	10/-
MKT4 (5/7)	17/6
MS4B	17/6
MSP4	17/6
MU14	9/-
MX40	17/6
N18	8/-
N19	8/-
N37	18/6
N78	17/6
N108	18/-
N142	9/6
N147	18/6
N150	10/-
N153	11/6
N309	11/6
N329	10/-
N727	7/6
N729	8/-
P2	10/-
PCC84	9/6
PCF80	10/6
PCF82	9/6
PCL82	11/6
PCL83	12/6
PENA4	17/6
PENB4	17/6
PEN4DD	22/6
PL33	18/6
PL38	23/9
PL81	14/9
PL82	8/-
PL83	10/6
PL820	21/-
PM2A	12/6
PM2HL	14/-
PM22A	13/6
PM24M	21/6
PM202	16/-
PY31	16/6
PY32	15/6
PY80	8/-
PY81	7/6
PY82	8/-
PY83	8/6
PZ30	18/6
QP25	14/6
QP230	17/6
QP21	12/6
R10	21/-
R19	19/6
SD6	8/6
SP4	14/6
SP41	3/6
SP42	12/6
SP61	3/6
T41	22/6
TDD4	17/6
TDD13C	17/6
TH41	23/9
TP22	17/6
TP25	17/6
U14	15/9
U16	10/-
U18/20	10/-
U22	10/-
U24	29/6
U25	14/-
U26	12/6
U31	9/6
U33	21/-
U35	21/-
U37	25/-
U45	21/-
U47	21/-
U50	8/6
U52	7/-
U76	7/6
U78	7/-
U142	8/-
U145	15/-
U147	7/-
U153	9/6
U191	20/-
U251	17/6
U281	20/-
U282	22/-
U301	22/6
U329	17/6
U339	19/-
U403	11/6
U404	10/-
U801	29/-
U4020	15/6
UABC80	8/-
UAF42	9/6
UB41	9/-
UBC41	9/6
UBF80	9/6
UBF89	8/6
UCC85	10/-
UCH42	9/-
UCH81	9/-
UCL82	12/6
UCL83	13/6
UF41	9/-
UF42	11/6
UF80	9/-
UF85	9/-
UF89	8/-
UL41	8/-
UL44	24/6
UL46	21/-
UL84	9/6
UU6	20/11
UU7	15/-
UU8	26/-
UY21	15/6
UY41	7/6
UY85	7/6
VP2B	17/6
VP4B	17/6
W17	8/6
W76	7/-
W77	5/-
W81	6/-
W142	9/-
W719	7/6
W727	7/6
X18	11/6
X61M	21/-
X65	23/9
X66	21/-
X78	21/-
X79	21/-
Y61	10/6
Y63	9/-
Z21	12/6
Z63	7/6
Z66	19/6
Z77	4/9
Z152	8/6
Z719	7/6
ZD152	9/6

METAL RECTIFIERS

RM1	6/-	18RA 1-1-8-1	4/6	16RE 2-1-8-1	8/6
RM2	8/-	18RA 1-1-16-1	6/6	18RA 1-2-8-1	11/-
RM3	9/-	16RC 1-1-16-1	88/6	14A86	17/-
RM4	16/6	14RA 1-2-8-2	18/-	14A97	23/6
RM5	22/-	14RA 1-2-8-2	21/-	14A100	24/-

SPECIAL OFFER

1T4 4/-, 6K8 8/-, 6K7G 3/-, 6V6G 5/-, EBC33 4/-, EF39 4/-, EF80 6/-, EF91 4/9, 6X5G 5/-, 5U4G 4/6.

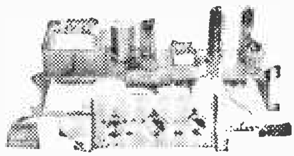
TERMS OF BUSINESS C.W.O. or C.O.D. 2/9 PACKING CHARGE ON ALL C.O.D. ORDERS. POSTAGE 3d. PER VALVE

OBSOLETE VALVES A SPECIALITY. QUOTATIONS GIVEN ON ANY TYPE NOT LISTED.

DEPT. P.W.I.

HARVERSON SURPLUS CO. LTD.

MONAURAL AMPLIFIER



This amplifier as illustrated, made by a leading manufacturer. Mullard valves—ECC83, EL84 x EL84, EZ80. Bass Treble and Volume on remote panel. Elegant Knobs. OUR PRICE one month only £4.16.6 plus P. & P. 3/6.

STEREOPHONIC AMPLIFIER £5.10.0

Complete with 2 Loudspeakers Plus 4/6 P. & P.

This is a compact amplifier embodying the latest features and giving a high standard of reproduction, with ample volume. Supplied complete with valves (ECL82, ECL82, EZ80), panel, knobs, etc., and two specially selected 3Ω matched loudspeakers. We only have a few, and we will never be able to repeat this offer at such a low price. Don't risk disappointment. Order now.

HARVERSON SUPERHET 4 KIT

A medium and long wave superhet, incorporating two I.F. stages modern B9 valves (UCH81, UBF89, UCL83, U785), built-in ferrite rod aerial. All you need supplied from theoretical wiring diagram to last nut and bolt (main components ready mounted), including an attractive contemporary styled cream plastic cabinet with gold trimmings. Size 11¼ x 6¼ x 6¼in.

PRICE £6.12.6 Post 3/6

RECTIFIERS FOR BATTERY CHARGERS

12 v. 1 amp. ...	5/-
12 v. 2 amp. ...	8/-
12 v. 3 amp. ...	10/-
12 v. 4 amp. ...	14/-
12 v. 5 amp. ...	16/-

P. & P. 6d.

TRANSISTOR BARGAINS

ALL MULLARD FIRST GRADE

OC71	8/-
OC72	12/-
OC72 Matched Pair	25/-
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OC45 Blue Spot	15/-
OC44	15/6
SB30S Semi Conductor	10/6
OA41 Diode	3/6

Postage on all above 6d.

SPECIAL OFFER

DON'T MISS THIS

MULLARD O.C.76... ... 10/6

MATCHED PAIR £1.0.0

Post and packing 6d.

TRANSISTOR RECORD PLAYER CASE

A few only—Transistor record player cases in light grey cloth—complete with motor board. Size: 12 x 8 x 6in. 18/6 each. P. & P. 1/9.

COSSOR C.R.T. SNIP

108K 10-inch. New and boxed, 15/-, plus 6/- P. & P.

75K 10-inch. New and boxed, 15/-, plus 6/- P. & P.

ION TRAP MAGNETS

To suit the above, 2/9 each. P. & P. 3d.

SLOW MOTION TUNERS

500-500 Twin gang condensers with geared slow motion drive. 3/6 ea. 36/- per doz. P. & P. 6d.

WIRE WOUND POTS

12 Wire wound Colvern Pots —all different values P. & P. 9d. 10/6

THIS MONTH'S BARGAIN!

SUPERHET CHASSIS

Complete and ready for your cabinet, 4 valve superhet chassis, complete with valves, ferrite aerial, dial and knobs. Valve line-up—UCH81, UBF89, UCL83, UY85. Long and Medium wave coverage.

PRICE £4.19.6 P. & P. 3/6.

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Super quality heavily woven fret, 54 inches wide. Usual price 50/- per yard. P. & P. 1/-. OUR PRICE 12/6 per yard.

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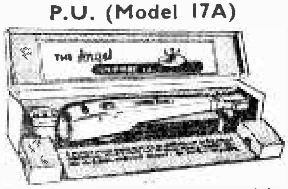
THE WORLD FAMOUS E.M.I. ANGEL TRANSCRIPTION P.U. (Model 17A)



A Pick-up for the connoisseur originally priced at £17.10.0. The last remaining few offered at £4.10.0 Plus P. & P. 5/-.

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ACOS HIGH G.... ...	17/6
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RONETTE	18/6
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P. & P. 1/-.

RECORD CHANGERS

GARRARD		
RC 98 Mk. 4H.	4-speed autochanger	£16.10.0
RC 120/D Mk.2	,, ,,	£9. 0. 0
RC 120 Mk.4D	,, ,,	£9. 0. 0
RC 120 Mk.4H	,, ,,	£9. 0. 0
RC 121 Mk.1	,, ,,	£11.0. 6
RC 121 Mk.4H	,, ,,	£11.0. 6
RC 121/40 Mk.2	,, ,,	£11.0. 6
COLLARO		
RC 54	4-speed autochanger	£6.19. 6
RC 594	,, ,,	£7.19. 6
Conquest	,, ,,	£6.12. 6
Challenger	,, ,,	£7.19. 6
B.S.R.		
Monarch UA8	4-speed autochanger	£6.19. 6
TU8	4-speed single player less pick up	£2.10. 0

NOTE: Any of the above with Stereo Cartridge and Fittings, 16/- extra. Carriage and ins. on each of above 5/- extra.

TAPE DECKS

LATEST B.S.R. MONARDECK (single speed) 3¾in. per sec., simple control, uses 5¾in. spools .... £7. 5. 0 plus 5/6 carriage and insurance (tapes extra).

TRUVOX MARK III TAPE DECK. New and Boxed .... £10. 6. 6 Plus 6/- carr. and ins. (tapes extra).

CYLDON 12 CHANNEL TURRET TUNERS

New purchase offered at still lower price. I.F. 33-38 Mc/s. Complete with PCC84 and PCF80 valves and 8 sets of Coils for 5 Band I Channels and 8, 9, 10 Band III. New and unused. Value over £7. OUR PRICE, post paid 32/6

MIDGET I.F. TRANS & COILS

A Pair of midget 465 kc/s I.F. transformers, plus LW and MW coils. OUR PRICE 10/- per set. P. & P. 1/9.

Set of I.F. transformers for transistor superhet. 12/6. P. & P. 1/9.

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50 mixed P.F. Condensers and 50 mixed Resistors. An assortment of useful values. All popular sizes—all new—a must for the serviceman and constructor. ONLY 10/- P. & P. 1/-.

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EAF42	9/6
EB91	4/6
EBC33	6/9
EBC41	8/9
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EBF89	9/6
ECC81	8/-
ECC82	7/6
ECC83	9/-
ECC84	10/-
ECC85	9/6
ECF80	12/-

ECF82	10/6
ECH42	9/6
ECH81	9/-
ECL80	9/6
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EF41	9/6
EF50	4/-
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EF86	12/6
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EF91	5/9
EF91(BVA)	9/-
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EL32	4/6
EL33	14/-
EL41	9/-

EL84	9/-
EL91	4/6
EM34	9/6
EM80	9/6
EM81	10/6
EY51	9/6
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MX40	12/6
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OZ4	5/6
P61	3/6
PCC84	8/6
PCC85	11/6
PCF80	8/9

PCF82	11/6
PCL82	11/6
PCL83	13/6
PL36	14/6
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PX25	12/6
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U25	13/6
U26	10/-
U50	8/-
UABC80	9/-
UAF42	9/6
UBC41	8/6
UBC81	11/4

UBF80	9/-
UCC84	10/11
UCC85	9/6
UCH42	9/6
UCH81	9/6
UCL82	11/6
UCL83	13/6
UF85	9/-
UF89	9/-
UL41	9/-
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1S4	10/6

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1T4	5/6
3D6	5/-
3Q4	7/6
3Q5GT	9/6
3S4	7/6
3V4	8/-
4D1	3/-
5R4GY	8/6
5U4G	6/-
5V4	11/6
5Y3G	8/-
5Y3GT	7/6
5Z4G	9/-
6A7	10/-
6A8G	9/-
6AK5	5/-
6AL5	4/-
6AM5	7/6
6AM6	4/-
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6AT6	8/6
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6BE6	7/6
6BH6	9/-
6BJ6	9/-
6BW6	9/-
6C4	4/6

6C5GT	6/6
6C6	5/-
6D6	5/-
6CH6	8/6
6F6G	7/-
6F6M	7/6
6F1	14/-
6F15	14/-
6J5GT	5/-
6J5M	6/6
6J6	5/6
6J7G	6/6
6K7G	4/-
6K7M	6/9
6K8G	6/6
6K7GT	5/9
6K8GT	10/-
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6L6M	9/6
6L18	11/6
6N7GT	7/6
6Q7G	7/6
6Q7GT	9/6
6SK7	6/-
6SL7GT	8/-
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6SQ7	9/3
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6V6GT	7/9
6X4	7/6
6X5G	7/-
6X5GT	7/-
6/30L2	12/6
7B6	10/6
7B7	8/6
7C5	8/-
7C6	8/-
7H7	8/-
7S7	9/6
7Y4	8/6
10F1	12/6
10P13	23/3
12A6	5/-
12AH8	12/-
12AT7	7/6
12AU7	8/-
12AX7	8/-
12BA6	9/-
12BE6	9/-
12C8	7/-
12J7GT	10/6
12K7GT	6/6
12K8GT	13/6
12K8M	13/-
12Q7GT	6/6

12SK7	6/-
12SL7	8/-
12SM7GT	10/-
15D2	7/9
25A6	9/-
26L6GT	10/-
25Y5	9/9
25Z4	9/6
25Z5	8/-
25Z6	10/-
30FL1	10/6
30L15	23/3
30P4	15/-
30P12	12/6
30PL1	12/6
35L6GT	10/-
35Z4GT	8/-
35Z5GT	9/-
42	8/-
50L6GT	8/6
75	10/6
80	8/6
142BT	3/6
210DDT	4/6
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Best Quality Recording Tape

1,200ft. on 7in. spool, 21/-.
850ft. on 5¾in. spool, 18/6.
600ft. on 5in. spool, 13/9.
200ft. on 3¼in. spool, 5/3.

COLLARO JUNIOR

Single 4-speed Record Player Unit in cream, complete with pick-up fitted turnover cartridge. Special Price 75/- each. Post 3/6.

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Alpha range of Guaranteed Bridge Rectifiers, suitable for Battery Chargers 6 and 8 volt output:

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3 amp. 10/-
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6 Transistor Superhet
Osmore Dualwave Ferrite Rod Aerial 10/-
Transistor Oscillator Coil and I.F. Transformers 22/6.
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2 Bank 60pF Trimmer 1/10.

Printed Circuit Version of the PW Pocket Superhet. All components available from stock. Complete Kit £9.15.0. Full detailed shopping list, point to point wiring diagram, fully illustrated, 1/6.

Coil Set (Osc. and 3 I.F.T.s)	22/6
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Hardware Kit	4/6
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Speaker	19/10
Case	7/6
Complete Kit of Condensers	15/-
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Trimmers (2)	2/8

All above components are brand new and are fully guaranteed.

Ardente volume control with switch 10/6.
Ardente wavechange switch, 3 position 3/9.
Celestion 2½in. 3 ohms speaker 26/8.
Diode OA81 4/-.
Send for our Detailed Price List

T.S.L. Subminiature Components

Solid Dilectric Tuning Condenser Type PVC-2M Capacity Aerial 196pF OSC 87pF, size 1 x 1 x ½in., 17/6 each.

I.F. Transformers, set of 3 and Oscillator coil, size of each $\frac{7}{16}$in. x $\frac{7}{16}$in. x ½in. high, per set 21/-.

Driver Transformer type TR 190/EIP: ratio 2 : 1 + 1, size ⅝ x ½ x ½in., 6/3 each.

Output Transformer type TR 190/EIE, ratio 5.3 to 1, Primary Impedance 240 ohms. Secondary 10 ohms, Max Output 800 MW, size [illegible] x ⅝ x $\frac{9}{16}$in., 6/3 each.

TSL-Lorenz Loudspeakers, 2¾in. diameter speaker designed for miniature receivers, 4/500 mW, impedance 10 ohms, Freq. response 120-14,500 c/s., price 25/-

Elstone Multi-Ratio Output Transformer, 10 watts. 23/-.

Westinghouse LW9 Rectifier, 250v, 250mA, 19/6.

WB Stentorian HF 1012, 10 watts, 95/- ea.

BSR Monarch UA8, Record Changer. £6.19.6.

Scotch Recording Tape 150/18, 7in. spool, 50/-.

"Wireless World" Radio Valve Data Book, 5/-.

Taylor Model 127A Multi-Meter, £10.0.0.

High Resistance Headphones, 4000 ohms, 13/6.

Repanco FS3 Ferrite Slab Aerial, 7/6.

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Henley Solon Instrument Iron, Model 625 24/-.

J.B. "O" Gang Condenser, 365pF, 1 gang, 7/6.

Belling Lee Diplexer, L1338, 11/-.

Output Transformer, 5000/3 ohms, 60mA, 5/9.

10in. Elac Loudspeakers, 25/-.

Collaro Conquest with Studio Pick-up, £6.19.6.

Acos Crystal Stick Mic. 39/1, £1.19.6.

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J.B. Solid Dielectric Conds., 0.005, 4/6 ea.

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Plastic Speaker Cabinets for 5in. unit, white, 15/-.

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Pick-up Matching Trans., BSR AF333, 36/-.

Collaro Mark IV Tape Transcriptor, £17.19.6.

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Rectifier RM4, 250v, 275mA, 18/6.

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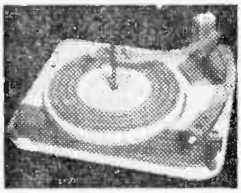
BRAND NEW RECORD CHANGERS



ONLY £8.15.0 BRAND NEW! the latest 4-speed Autochanger, B.S.R. UA14, as illustrated, few only. **OUR PRICE £8.15.0. P.P. 3/6.**

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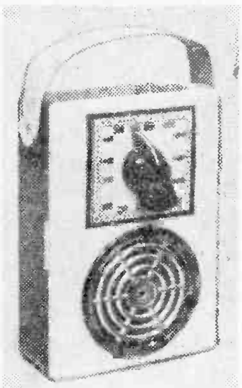
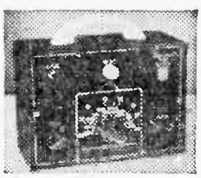


Our fabulous new 3-STAGE MINIATURE LOUDSPEAKER **27/6**

DESIGN THE "RIO" covers all medium waves including Home, Light, etc. Very reliable and lightweight. Works for months and months off a 4d. battery. Can be assembled in an hour or two. All parts can be supplied including miniature speaker and everything down to the last nut and bolt with **SIMPLE AS A.B.C. PICTORIAL STEP-BY-STEP PLANS** for ONLY 27/6, plus post and packing 1/6 (C.O.D. 2/- extra). Parts sold separately, priced parts list 1/-.

"SKYROMA" VALVE SET



39/6

The "SKYROMA" design is an old favourite and is a highly sensitive valve set with provision for adding a further stage. An exceptionally efficient radio using a unique assembly system and can be built by anyone without any radio knowledge whatever in an hour or two. Handsome **BLACK CRACKLE STEEL CASE** with specially made **BLACK AND GOLD DIAL WITH STATIONS PRINTED.** Size of radio 6¾ x 5 x 3in. Covers all medium and long waves. H.T. consumption only 1–2mA. Ideal for bedroom, garden, holidays, etc. Total building cost down to the last nut and bolt, including **SIMPLE AS A.B.C. PICTORIAL STEP-BY-STEP PLANS, ONLY 39/6**, plus post and packing 2/6 (C.O.D. 2/- extra). Parts sold separately, priced parts list 1/-.

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In moulded case. Prices include Test Prods. Batteries. Instruction Book. FULLY GUARANTEED. Also measure db. Accuracy: A.C., 3 per cent, D.C., 2 per cent.

A-10 **£4.17.6** plus 2/6 P.P.

B-20 **£6.10.0** plus 2/6 P.P.

C.O.D. 2/- extra.

A.10—2K ohms/v. on A.C. and D.C. volts (10,50,250,500 and 1000 v.); 10K and 1M ohms; ½ mA, 25 mA and 250 mA, D.C. Size: 5½ x 3⅝ x 1¾in. Weight 17 ozs.

B.20—10K ohms/v. on 0.5 v. and 2.5 v.; 4K ohms/v. on 10, 50, 250, 500 and 1000 v., A.C. and D.C. Resistance, 2K, 200K, 2M and 20M-ohms; D.C. current, 100 microA, 2.5 mA, 25 mA, 250 mA. Size: 5⅝ x 3¾ x 2¼in. Weight 24 ozs.

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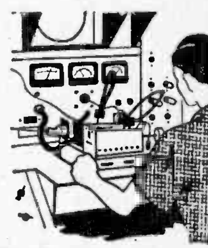

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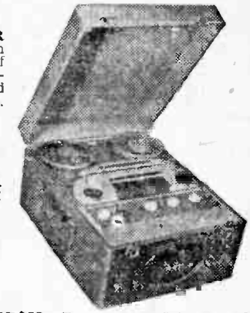
REALISM AT INCREDIBLY LOW COST. CAN BE ASSEMBLED IN HALF AN HOUR
The Recorder incorporates the Latest Collaro Studio Tape Transcriptor. The Linear LT45X High Quality Tape Amplifier listed £12.12.0 **High Flux** P.M. Speaker listed 30/-, empty Tape Spool, a Reel of Best Quality Tape listed 22/6, and a Handsome Portable carrying Cabinet with latest attractive two-tone polychrome finish, size 18 x 13 x 9in. high, listed £4.10.0, and circuit. Total cost if purchased individually approximately **£40.** Performance equal to units in the £60-£80 class. S.A.E. for leaflet.

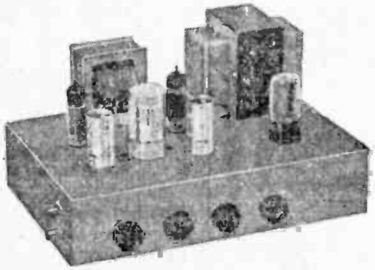


$25\frac{1}{2}$ GNS.
Carr. 17/6

H.P. TERMS. Deposit **£5.7.6** and 12 monthly payments of 2 gns. Cash price if settled in 3 months.

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 A10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, 5Y3. 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/cs. 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, GUITARS**, etc., **OUTPUT SOCKET** with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12-9-7in. For A.C. mains 200-250 v. 50 c.p.s. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis if fully punched. Full instructions and point-to-point wiring diagrams supplied. Only **8 Gns.** Carr. 10/-
(Or factory built 45/- extra).

If required louvred metal cover with 2 carrying handles can be supplied for **18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/3, and 9 monthly payments of 24/3.** Send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets, Speakers, Microphones, etc., with cash and credit terms.

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 Controls give equal variation of "left" 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. Full constructional details and price list 2/6. **8 Gns.** Carr. 10/-

DEAF AID EARPIECES. High Impedance complete with lead, 15/6.
MICROPHONE INSERTS. Crystal type, 6/9.

TELEVISION RECTIFIERS 250 v. 200 mA, small size. Only **6/9** each.
RE-ENTRANT SPEAKERS. Tannoy, 8 watt, 7.5 ohms. Only **22/6** each. **Parmeko Horn Type.** 10 watt, 15 and 200 ohm matching. **59/6.** R.C.A. 20 watt. 15 ohms or 200 ohms. **6 gns.**
COLLARO RC 457 4 SPEED MIXER AUTO-CHANGERS. Turnover Studio Pick-up head, for 200-250 v. A.C. **£7.19.6.** Carr. 4/6.
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. Power pentode output. 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.
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 **33/9.**

R.S.C. BATTERY CHARGING EQUIPMENT

All for A.C. Mains 200-250 v., 50 ccs. Guaranteed 12 months.

ASSEMBLED CHARGERS

6 v. 1 amp.	19/9
6 v. or 12 v. 1 amp.	29/9
6 v. 2 amps.	29/9
6 v. or 12 v. 2 amps.	38/9
6 v. or 12 v. 3 amps. with ammeter	59/9

Above ready for use. With mains and output leads. Carr. 3/6.

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 Resistor, Panels, Plugs, Fuses, Fuseholder and circuit. **59/9.** Carr. 4/6.

Assembled 6 v. or 12 v. 4 amps. 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.**

ASSEMBLED CHARGER 6 v. or 12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case finished attractive hammer blue. Ready for use With mains and output leads. Double Fused. Only **49/9** Carr. 3/9

BATTERY CHARGER KITS Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses. Fuse-holders, Grommets, panels and circuit. Carr. 3/6 extra.

6 v. or 12 v. 1 amp.	24/9
As above, with Ammeter	32/9
6 v. 2 amps.	25/9
6 v. or 12 v. 2 amps.	31/6
6 v. or 12 v. 2 amps. inclusive of Ammeter	42/9
6 v. or 12 v. 4 amps.	53/9

6 v. or 12 v. 4 amps. with Ammeter and variable charge rate selector. **59/9.**
CHARGER AMMETERS. 0-1.5 a., 0-3 a., 0-4 a., 0-7 a., 0-25 a., 0-60 a. **8/9.**

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

We can quote for special types singly or in any quantity.

Interleaved and Impregnated. Primaries 200-230-250 v. 50 c/s. Screened
TOP SHROUDED DROP THROUGH

250-0-250 v. 70 mA. 6.3 v. 2 a, 5 v. 2 a	17/9
350-0-350 v. 80 mA. 6.3 v. 2 a, 5 v. 2 a	18/9
250-0-250 v. 100 mA. 6.3 v. 2 a, 3 v. 1 a	19/9
250-0-250 v. 100 mA. 6.3 v. 3.5 a. C.T.	19/9
250-0-250 v. 100 mA. 6.3 v. 4 a. 5 v. 3 a	25/9
300-0-300 v. 100 mA. 6.3 v. 4 a. 5 v. 3 a	25/9
350-0-350 v. 100 mA. 6.3 v. 4 a, 5 v. 3 a	25/9
350-0-350 v. 100 mA. 6.3 v. 4 v, 4 a, C.T. 0-4-5 v. 3 a	25/9
350-0-350 v. 150 mA. 6.3 v. 4 a, 5 v. 3 a	29/9

FULLY SHROUDED UPRIGHT

250-250 v. 60 mA, 6.3 v. 2 a. 5 v. 2 a. Midget type 2½-3-3in.	17/11
250-0-250 v. 100 mA. 6.3 v. 4 a, 5 v. 3 a	26/9
300-0-300 v. 100 mA. 6.3 v. 4 a. 5 v. 3 a	26/9
350-0-350 v. 100 mA. 6.3 v. 4 a, 5 v. 3 a	26/9
300-0-300 v. 130 mA. 6.3 v. 4 a. 6.3 v. 1 a. for Mullard 510 Amplifier	35/9
350-0-350 v. 150 mA. 6.3 v. 4 a, 5 v. 3 a	35/9
425-0-425 v. 200 mA. 6.3 v. 4 a. C.T. 6.3 v. 4 a, C.T., 5 v. 3 a	49/9

FILAMENT TRANSFORMERS
All with 200-250 v. 50 c/s. primaries 6.3 v. 1.5 a. **5/9:** 6.3 v. 2 a. **7/6:** 0-4-6.3 v. 2 a. **7/9:** 12 v. 1 a. **7/11:** 6.3 v. 3 a. **8/11;** 6.3 v. 5 a, **17/6:** 12 v. 1.5 a twice, **17/3.**

OUTPUT TRANSFORMERS

Midget Battery Pentode 66:1 for 3S4, etc.	3/9
Small Pentode, 5000 Ω to 3 Ω	3/9
Small Pentode 7/8,000 Ω to 3 Ω	3/9
Standard Pentode 5,000 Ω to 3 Ω	5/6
Standard Pentode 7/8,000 Ω to 3 Ω	5/6
10,000 Ω to 3 Ω	5/6
Push-Pull 10-12 watts 6V6 to 3 Ω or 15 Ω	18/9
Push-Pull 10-12 watts to match 6V6 to 3-5-8 or 15 Ω	19/9
Push-Pull EL84 to 3 or 15 Ω	18/9
Push-Pull 15-18 watts, 6L6, KT66	22/9
Push-Pull for Mullard 510 Ultra Linear	29/9
Push-Pull 20 watts, sectionally wound 6L6, KT66 etc., to 3 to 15 Ω	47/9

ELIMINATOR TRANSFORMERS
Primaries 200-250 v. 50 c/s.

120 v. 40 mA. 5-0-5 v. 1 a.	15/9
90 v. 15 mA. 4-0-4 v. 500 mA	9/9

SMOOTHING CHOKES

150 mA. 7-10 H 250 ohms.	11/9
100 mA. 10 H 200 ohms	8/9
80 mA. 10 H 350 ohms	5/9
60 mA. 10 H 400 ohms	4/11

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s Primaries; 0-9-15 v. 1½ a. **11/9;** 0-9-15 v. 2 a., **14/9;** 0-9-15 v. 3 a. **16/9;** 0-9-15 v. 5 a, **19/6;** 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;** 0-110/120-200/230/250 v. 150 watts **27/9.**

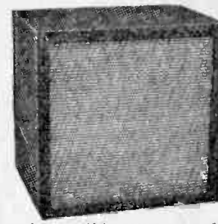
MICROPHONE TRANSFORMERS
120:1 high grade, clamped, **6/9;** 120:1 Potted, Mu-metal screened, **9/9.**

R.S.C. A12 STEREOPHONIC AMPLIFIER KIT

A complete set of parts to construct a Stereo amplifier with an undistorted output total 6 watts. For A.C. mains input of 200-250 v. Outputs for matched 2-3 ohm speakers. Sensitivity 130 m.v. Ganged Vol. and Tone Controls. Preset balance control. Full instructions and point-to-point wiring diagrams supplied. Only good quality components and latest high grade valves used. Exceptionally realistic reproduction can be obtained at ample volume for the home, as can be demonstrated in typical surroundings at our County Arcade premises. A really sensational offer.

4 Gns. Carr. and pkg. 5/-

12in. 10 WATT HIGH QUALITY LOUDSPEAKER IN POLISHED WALNUT FINISHED CABINET



Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only £4.19.6 Carr. 5/-. Terms: Deposit 11/3 and 8 monthly payments of 11/3.

12in. 20 WATT HI-FI LOUDSPEAKERS IN CABINETS. Size 18 x 18 x 18in. Finish as above. Terms: Deposit 17/9 and 9 monthly payments of 17/9. Only £7.19.6. Carr. 8/6.

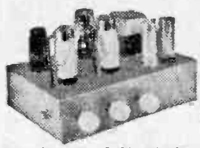
STEREO EQUIPMENT OFFER. Comprising A12 Kit, 2 matched 8in. L/Speakers, and Acos T/O Stereo head with sapphire stylus suitable most pick-ups. **£6.19.6** Carr. 7/7

PICK-UP ARMS complete with Hi-Fi turnover crystal head. Acos GP54. Limited number brand new, perfect, at approx. half price. Only 35/9.

ACOS CRYSTAL MICROPHONES. Mic40 stand or desk. Listed 45/-. Only 27/9. 39-1 Stick type. Listed 5 gns. Only 39/6.

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

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 71db. down. 15db. of Negative feedback is used. H.T. or 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 fully 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.

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, GZ33. 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/cs. 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 cover as for A8 can be supplied for 18/9. The amplifier can be supplied, factory built with 12 months' guarantee, for £13.19.6.

11 Gns. Carr. 10/-

TERMS: DEPOSIT 31/9 and 9 monthly payments of 31/9.

FULL RANGE OF LINEAR AMPLIFIERS ALWAYS IN STOCK.

R.S.C. PORTABLE GUITAR AMPLIFIERS

Junior 5 watts High Quality output. Separate Bass and Treble 'Cut' and 'Boost' controls. Sensitivity 15 m.v., Twin inputs. High Flux 8in. Loudspeaker 'built-in'. Handsome, strongly made Cabinet (size approx. 14 x 14 x 7in.) finished in attractive and durable policrome, and fitted carrying handle. H.P. Terms. Deposit £1 and 9 monthly payments of £1. **£8.19.6** Carr. 7/6

Senior 10 watts High Fidelity output. Separate Bass and Treble 'Cut' and 'Boost' controls. Twin separately controlled high gain inputs so that two instruments such as Guitar and String Bass can be used at the same time. Two loudspeakers are incorporated, a high Flux 12in. for Bass notes and a 7 x 4 in. elliptical for Treble. Cabinet is well made and finished as Junior model. Size approx. 18 x 18 x 18in. H.P. Terms. Deposit 34/9 and 9 monthly payments of 34/9. **15 Gns.** Both models for 200-250 v. A.C. mains. Carr. 10/-

SPECIAL TRANSISTOR OFFER. TS1 Brimar. Brand new. Perfect. 3 for 10/9

R.S.C. JUNIOR BASS REFLEX CABINETS. 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.

SENIOR MODEL for 12in. speakers, £6.19.6. Suitable legs with brass ferrules, 25/- per set of four.

PLESSEY DUAL CONCENTRIC 12in. 15 ohms HIGH FIDELITY SPEAKER (12,000 lines) with built-in tweeter (completely separate elliptical speaker with choke, condensers, etc.) providing extraordinarily realistic reproduction when used with our A8 or similar amplifier. Rates 10 watts. Price only £5.19.6.

P.M. SPEAKERS. 2-3 ohm. 2½in. Perdio 21/9. 5in., 17/9. 6½in. 16/9. 8in., 19/9. 8 x 5in. 25/9. 10in. 26/9. 10 x 6in. 29/9. 12in. 29/11. 10in. W.B. "Stentorian" 3 or 15 ohms type HF1012 10 watts, hi-fidelity type. Recommended for use with our A8 Amplifier. £4.10.9. 12in. Plessey 3 ohms 10 watts (12,000 lines). 59/6.

TWEETERS. Plessey 3Ω 19/9, 15Ω 25/9.

HI-FI CRYSTAL PICK-UP HEADS. (Turnover type with sapphire stylus). HGP59. Standard replacement for Garrard and B.S.R. B.S.R. Ful-fi. Garard GC2, 19/9. B.S.R. Stereo/Monaural 39/11.

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. 50 c.p.s. A.C. mains. Over-all size 11½ x 2½ x 2½in. Controls: Vol. and Tone with switch. Guaranteed 12 months. Only 59/6.

SUPERHET FEEDER UNIT. Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). Delayed A.V.C. employed. The W.Ch. Sw. incorporates Gram position. 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 of unit approx. 9-6-7in. high. Simple alignment procedure. Point-to-Point wiring diagrams, instructions and priced parts list with illustration, 2/6. Total building cost £4.15.0. For descriptive leaflet send S.A.E.

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 v. and 90 v.** This includes latest low consumption types.

Complete kit with diagrams, 39/9, or ready to use, 46/9.

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. accumulator. Complete kit of parts with diagrams and instructions, 49/9, or ready for use, 59/6.

R.S.C. 3-4 WATTS A7 HIGH-GAIN AMPLIFIER

For 200/250 v. 50 c/s. Mains input. Appearance and Specification, with exception of output wattage, as A5 amplifier. Complete Kit with diagrams, £3.15.0. Carr. 3/6.

COLLARO JUNIOR 4-speed single player units and Hi-Fi crystal pick-up with turn-over head, £3.19.6.

B.S.R. UA8 4-SPEED AUTO-CHANGERS with Stereo/Monaural pick-up head, £7.19.6. Carr. 5/-.

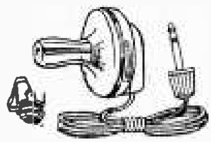
COLLARO CONQUEST 4-SPEED AUTO-CHANGER with high fidelity Studio pick-up. Latest model. For 200-250 v. 50 c.p.s. A.C. mains. Our price £6.19.6. Carr. 5/6.

TERMS: C.W.O. or C.O.D. No C.O.D. under £1. Post 1/9 extra under £2. 2/9 extra under £5. Open 9 to 6. Weds. until 1 p.m. Trade supplied. S.A.E. with all enquiries.

R.S.C. (Manchester) Ltd. **BRADFORD, MANCHESTER and LEEDS**

Mail Orders to 29-31 Moorfield Road, Leeds 12.
Callers to 5 and 7 County (Mecca) Arcade, Briggate, Leeds 1. and 8-10 Brown Street (Market Street), Manchester 2, or 56 Morley Street (next to Majestic Ballroom), Bradford.

MINIATURE EARPHONES



For Transistor Circuits: Very light weight and easy to wear, cord almost invisible, good quality production of music and voice, complete with miniature plug and socket, ready to use—correct impedance OK for red spot and similar transistors. Crystal 12/6. Magnetic 10/6. Post and insance 1/-.

SUB MINIATURE COMPONENTS

FOR TRANSISTOR SETS

- Push-pull o.p.t. and driver **17/6** pair (500 milliwatt). **12/6** pair (300 milliwatt).
- 3 IF transformers and oscillator and circuit **23/6.**
- Ferrite aerial with coils for medium and long wave and circuit.
- Smallest possible electrolytics 1/9 each. 1 mfd, 2 mf, 4 mfd, 8 mf, 10 mfd, 20 mfd, 30 mfd, 50 mfd, 100 mfd.
- Smallest ¼ watt resistors **5d.** each all popular valves.
- Miniature 0.1 mfd., 1/-. 0.06 2.04 9d., valves up to 0.025 6d. each.
- Miniature slide switch 2/-.
- Pots edgewise control **3/6.** less switch.
- Transistor holder **1/6** each.
- Set of 6 transistors for superhet in original packets guaranteed Mullard OC44, OC45, OC45, OC71 matched pair OC72, **£3.10.0.** the set.
- Set of 6 all first grade includes matched pair **45/-.**
- Oscillator and 2 I.F.—new American High Gain **35/-.**
- Red Spots **3/6.**
- White Spots **3/9.**
- Surface barriers 25 mc/s **9/6.** 50 mc/s **12/6.**
- Diodes sub miniature **2/6** and **1/-.**
- 3in. Speakers 3 ohm **18/6.**
- 3in. Speakers 80 ohm **18/6** and **19/6.**
- 2½in. Speakers 3 ohm **19/6.**
- Elliptical Speaker, 3 ohm or 35 ohm **19/6.**

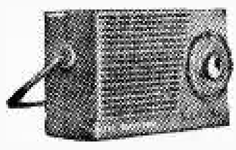
1 Watt Transistor A.F. Amplifier

Four transistors on printed circuit all wired up ready for immediate use —excellent performance from pickup, microphone or H.F. input. **£4.12.6.** post and insurance 1/6.

Crystal Mike by Acos

Model 39/1. this is ideal for tape or general amplifiers, complete with screened lead. **39/6.** plus 1/- post.

Transistor Set Cabinet

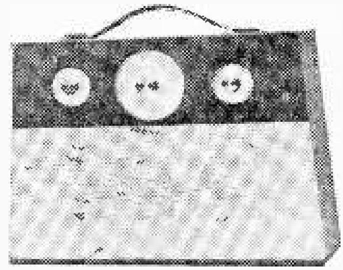


Very modern cream cabinet, size 5¼ x 3 x 1½in. with chrome handle, tuning knob and scale. Price **7/6.** plus 1/6 postage and packing.

INTRODUCING THE

"REAL COMPANION"

CAR RADIO/PORTABLE



Now available is a modern receiver quite easy to make up and with all the features of sets being sold at twice the price. The circuit has been well tried and proved and will perform well all over the country. Here at Eastbourne, recognised as a bad reception area, performance on the Light, Home and many Continental Stations including Luxemburg, is extremely good. Demonstration Models can be heard at Eastbourne and our London address.

NOTE THESE FEATURES

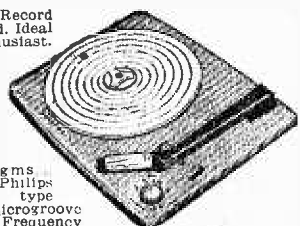
- ★ **400/500 mw. Output Push-pull.**
- ★ **6 First Grade Transistors.**
- ★ **Latest Type Superhet Circuit.**
- ★ **Medium and Long Wave.**
- ★ **Internal Ferrite aerial litz wound.**
- ★ **High "Q" coils.**
- ★ **Latest type printed circuit with components plan.**
- ★ **Slow motion tuning.**
- ★ **Car aerial attachment.**
- ★ **Two-tone cabinet.**
- ★ **High flux elliptical speaker.**
- ★ **Size 11 x 8 x 3in. approximately.**
- ★ **Easy to follow instructions.**
- ★ **12 month guarantee all components.**
- ★ **No technical knowledge required.**
- ★ **Service available at moderate charges.**

ORDER IN CONFIDENCE

Money returned in full if parcel not up to expectation and returned unassembled.

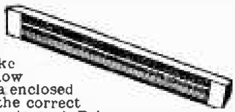
Price complete, less battery, **£8.19.6.** Battery **3/6,** plus carriage and insurance 7/6.

PHILIPS TRANSCRIPTION UNIT



Philips AG 200 Record Player, 4 speed. Ideal for the enthusiast. Pick-up arm wired for stereo, fine adjustment on all four speeds. Continuously variable pick-up, weight (2.12gms Supplied with Philips Hi-Fi crystal type AG3019 for microgroove and 78 r.p.m. Frequency response 30-15,000 c/s. Pick-up lifting and lowering device. Individually balanced heavy turntable. Muting switch. Can be used with any amplifier or radio set. Complete with monaural pick-up **£10.10.0,** or **2** gns. deposit and 20 fortnightly payments of **10/-.** Available also with stereo head diamond or sapphire stylus. Prices on request.

INFRA-RED HEATERS



Make up one of these latest type heaters ideal for bathroom, kitchen, bedroom etc. They are simple to make from our easy to follow instructions—uses silica enclosed elements designed for the correct infra-red wavelength (3 microns). Price for 750 watt element and instructions **15/6,** plus 2/6 post and insurance.

Stop Freeze ups!

Wrap our heater wire around the pipes in your loft, to prevent freeze-ups. Complete heater wire suitable for up to 50ft. of pipe, **10/-** post free. With instructions.

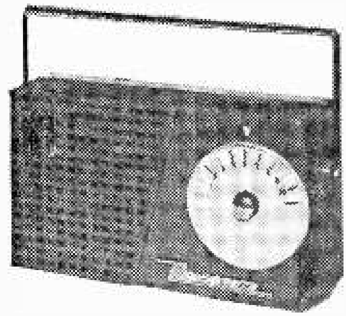
Speaker Bargain

12in. Hi-fidelity loudspeaker. High flux. Permanent magnet type with standard 3 ohm speech coil. Will handle up to 12 watts. Brand new by famous maker. Price **32/6,** plus 3/6 post and insurance.

Miniature Microphone

American made. Dynamic type, real bargain at **2/6,** plus 6d. postage.

TRANSISTOR LOUDSPEAKER POCKET RADIOS



NOW AVAILABLE WITH FIRST GRADE TRANSISTORS

Circuit comprises 2 HF transistors reflexed to equal 4 stages. Permanent germanium diode and high gain AF output stage, fitted with miniature speaker, proper tuning condenser, volume control and in case with handle as illustrated (less monogram), completely portable. No aerial or earth required. Pocket 4 uses 3 transistors and 1 diode, price 52/6, plus 2/6 post and insurance. Pocket 5 uses 4 transistors and 1 diode and has feedback control, price 67/6, plus 2/6 post and insurance.

RESULTS GUARANTEED

Nothing can be more disappointing than to find that despite care in making up, your radio just will not work or needs a long high aerial and water pipe earth. We can prove good results in all areas and we guarantee all components for 12 months. Read just a few of the hundreds of testimonials we have received from constructors who have made these sets. Send in confidence. Money refunded if parts or guarantees not up to your expectations. Plans free with parts or separately 1/6. More details S.A.E.

READ THESE TESTIMONIALS! ORIGINALS MAY BE SEEN AT THIS OFFICE

Mr. Graham, Birchington-on-Sea. "Re Pocket 4. I must say that it is all you say of it. The stations roll in, and good volume too".

Mr. T. Bell, London, S.W.11. "I have made up one of your 55/- transistorised radios and I am very pleased with the results".

Mr. A. J. Simmonds, Welling, Kent. "I purchased from you a week ago the Pocket 4 Transistor Kit. I put it together last night in 1½ hours on switching on the set, I was right on Radio Luxemburg, I must say thank you, because not only has the set a very attractive appearance, it also behaves fantastically."

Mr. N. Elliott, Pontypool. "I have completed the assembly of your Pocket 4 radio and am pleased to say that it works from the first switching on".

Mr. F. Jackson, Ickenham, Middx. "I have built the Pocket 4 and am more than pleased with the results".

Mr. G. Bamford, Ramsgate. "I find this set even better than you claim it to be and most certainly up to your usual standard of quality. I feel that nobody could fail to build it and get results. Even the first-time-ever novice, as your circuit diagrams and instructions are so clear and precise".

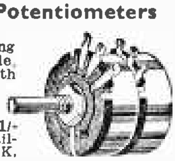
Mr. R. Belt, Newcastle-on-Tyne. "I have built your Pocket 5 Transistor set I am very pleased with it".

Mr. R. Morse, Birchington-on-Sea. "I knew nothing whatever about radio but I have just made up your transistor set from the kit of parts you sent. I am happy to say that it works perfectly and does all you claim of it. As you see, I live a good way from London, yet the B.B.C. comes in quite loud. The little set can be heard working in a good-sized room. Quite a number of other stations can be heard at night time with quite good separation. Wonderful value for money".

A.C./D.C. Multimeter Kit

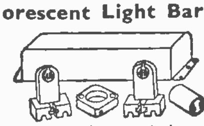
Ranges: D.C. volts 0-5, 0-50, 0-100, 0-500, 0-1,000 A.C. volts 0-5, 0-50, 0-100, 0-500, 0-1,000 D.C. milliamps 0-5, 0-100, 0-500, Ohms 0-50,000 with internal batteries. 0-500,000 with external batteries Measures A.C./D.C. volts. D.C. current and ohms. All the essential parts including metal case, 2in. moving coil meter, selected resistors, wire for shunts, range selector, switches, calibrated scale and full instructions, price 19/6, plus 2/6 post and insurance.

Morganite Potentiometers



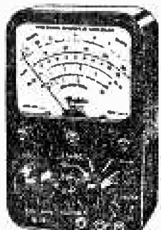
Single and 2-gang types available standard size with good length spindle, all new and boxed. **Single types,** 1/- each, values available: 5K, 10K, 25K, 50K, 100K, 250K, 1 meg., 2 meg. **Gang type** 3/- each—values available: 5K ± 5K, 100K ± 100K ½ meg. ± ½ meg. 2 meg. ± 2 meg.

Fluorescent Light Bargain



Kit of parts comprising: choke, two lamp holders, starter holder and starter. 40 watt, 19/6, 80 watt, 23/6. Plus 2/- post and insurance.

The Taylor Meter Model 127A



A pocket size meter but with a big scale and a sensitivity of 20,000 Ohms per volt D.C., therefore an ideal unit for television servicing — robustly made and complete with leads and prods—20 ranges as follows: D.C. current 50 microamps. to 1 Amp. D.C. voltages—0-1,000 volt in seven ranges (25 KV.) with external probe, optional extra. Volts A.C.—0-2,500 in six ranges. Ohms—0-20 meg. Ohm in three ranges (self-controlled). Self-contained, 3¼in. movement. Price £10 or 10/- deposit and 23 fortnightly payments of 10/-. Non-callers add 5/- carriage and insurance.

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3 Pole 6 Way	3/6
4 Pole 4 Way	3/-
6 Position Shorting	2/-
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6 Pole 3 Way	3/6
8 Pole 2 Way	2/-
9 Pole 3 Way	2/6
12 Pole 2 Way	2/-

TV Workshop Aids

E.H.T. SEALER. Apply with soldering iron. Stops corona discharge, etc. 2/6 per stick.

POLYTHENE TAPE. 2in. x 10 thou. for E.H.T. insulation up to 25 kV. 5/- per 12ft. roll.

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6C8G	5/-
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6H6GT	1/9
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6HA7	4/3
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6J5G	3/-
6J6	4/3
6J7	7/6
6K6GT	6/6
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6N7GT	6/-
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6SC7GT	6/-
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6SL7GT	6/6
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6SQ7	6/-
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Marconi CR-100 Communication Receiver. 60 kc/s to 30 Mc/s, in very good condition, £25. Carriage 30/-.

T.C.S. Receivers. Made by Collins of U.S.A. In fully guaranteed working condition. 1.5-12 mcs. Line up: 12SA7 (1), 12SQ7 (1), 12A6 (2), 12SK7 (3). Power requirements 12 v. L.T., 225 v. H.T. £11.10.0. Carriage 12/6.

Specially Built Power Pack for the above. 230 v. A.C. mains, including 6X5GT valve, £3.10.0. Carriage 5/-.

Transmitter/Receiver No. 22. 2 mc. to 8 mc. Built almost exactly as No. 19 set but much more economical in battery consumption. Complete in fully working condition with power pack for 12 v., Headgear and Microphone assembly and Key, £9.19.6. Carriage 15/-.

Brand new original spare parts for AR88 Receivers. Please write your requirements.

Low Resistance Headphones, brand new. Balanced Armature DLR, 7/6. P. & P. 1/-.

Telephone Handset. Standard G.P.O. type, new, £1. P. & P. 1/6.

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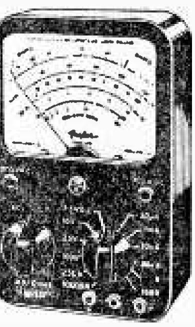
NEW PRODUCT OF TAYLOR



Model 127A Pocket size meter. Sensitivity 20,000 o.p.v. D.C. 1,000 o.p.v., A.C. 20 ranges. D.C. current 50µA to 1 amp. D.C. volts 0.3 v.—1,000 v. (25 kV by probe). A.C. volts 10 v.—1,000 v. 3 resistance ranges from 0-20 megohms (self contained). Meter 40µA 3¼in. arc. Accuracy D.C. 3% A.C. 4%, ohms 5%. Dimensions 5¾in. x 3¾in. x 1¾in. weight 14 ozs. Price £10 complete with instruction manual, test plots and clips. Leather case £1.12.0 extra.

Output Transformer in screening can give 9 different ratios 10 : 1 up to 120 : 1 for battery receivers or any high resistance pentodes used as output valves, 6/6. P. & P. 1/6.

P. C. RADIO LTD.
170 GOLDHAWK RD., W.12
Shepherds Bush 4946

Variometers for W/S No. 19. Fully tested and working, 12/6. P. & P. 2/6.

Filament Transformers. Primary 0-190-210-230-250 v. 50 C. Sec. 1 2.5 v. C.T. at 10 amps., 2 2.5 v. C.T. at 10 amps.; 3 10.5 v. C.T. at 11 amps., 3,000 v. insulation. Price £2.19.0. P. & P. 5/-. Primary 0-190-210-230-250 v., 50 C. Sec. 1 10 v. C.T. at 4.5 amps.; 2 10 v. C.T. at 4.5 amps., 4,000 v. insulation £1.16.0. P. & P. 5/-. Primary 230 v. 50/60 c. 67 v. amp. Sec. 1 6.3 v. 1-6 amps.; 2 63 v. C.T. 3 amps.; 3 6.3 v. C.T. 3 amps.; 4 6.3 v. C.T. 3 amps. £1.12.0. P. & P. 5/-.

Ferranti Transformer. Oil cooled, 20/19.5 K.V.A., 3 phase, 50 cycles. Primary 360/380/400/420/440 v. Secondary 2,700/2,900/3,100/3,300/3,500 v., 2.1 amp. Voltage regulation by simple switches on primary and secondary. Weight 1.150 lbs. **Price £125.0.0.** Carriage at cost.

Driver Transformers. Primary 500 ohms imp. Sec. to match two 805 in push-pull. £1.7.6. P. & P. 5/-.

Vibrator Unit. 12 v./160 v. 35 mA. Exceedingly well filtered and smoothed, excellent for car radios. New, including 6X5G valve and vibrator, 17/6. P. & P. 5/-.

Moving Coil Round Hand Microphone No. 13. 2¼in. dia. with press switch, 12/6. P. & P. 1/-.

Complete Set of Strong Aerial Rods (American). Screw-in type MP49, 50, 51, 52, 53, total length 15ft. 10in., top diameter 0.615in., bottom diameter 0.185in., together with matched aerial base. MP37 with ceramic insulator, ideal for car or roof insulator, £2.10.0, post free.

Stern's "Fidelity" TAPE RECORDERS

BEFORE YOU BUY —YOU SHOULD HEAR THESE RECORDERS. THEY ARE COMPARABLE TO THE MUCH HIGHER-PRICED MODELS

There are no better value-for-money Tape Recorders on the market—if you can't call and hear them, send S.A.E. for fully descriptive leaflets.

MODEL CR3/S Incorporates the new COLLARO "STUDIO" TWINTRACK 3-speed Deck H.P. Terms: Deposit £7.18.0 and 12 months of £2.17.11. **£39.10.0**

MODEL CR3/T Incorporates the very popular 3-speed COLLARO Mk. IV "TRANSCRIPTOR". Deck which has both upper and lower tape tracks. H.P. Terms: Deposit £9.10.0 and 12 months of £3.9.8. **£47.10.0**

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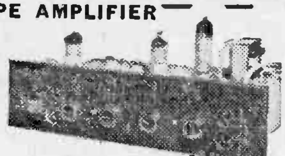
All prices quoted provide for the COMPLETE RECORDER including CRYSTAL MICROPHONE and 1,200 ft. Spool of Tape.

Each Model incorporates the highly successful HF/TR3 Amplifier (described opposite) thus ensuring truly "Hi-Fi" record and playback facilities.

TAPE AMPLIFIERS and PRE-AMPLIFIERS PRESENTED FROM MULLARD DESIGNS

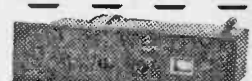
MODEL HF/TR3 TAPE AMPLIFIER

(Mullard Type "A" design)
A very high quality Amplifier incorporating 3-speed treble equalisation, using the latest FEROXCUBE POT CORE INDUCTOR. FOR COLLARO-TRUVOX-BRENELL-WEARITE or MOTEK Tape Decks, has GILSEN Output Transformer. Includes separate Power Supply Unit.



KIT OF PARTS **£12.15.0** OR ASSEMBLED **£16.10.0**
H.P. Deposit £3.6.0 and 12 months at £1.4.2.

MULLARD TYPE "C" TAPE PRE-AMPLIFIER—ERASE UNIT



The "Hi-Fi" link to add full tape recording facilities to High Fidelity home installations. Incorporates FEROXCUBE POT CORE PUSH PULL OSCILLATOR and 3-speed treble equalisation by FEROXCUBE POT CORE INDUCTOR FOR WEARITE-COLLARO-TRUVOX-BRENELL or MOTEK TAPE DECKS. Includes separate power Supply Unit.

KIT OF PARTS **£14.0.0** H.P. £3.8.0 Deposit and 12 months £1.4.11. OR ASSEMBLED **£17.0.0**
(Excluding power unit £11.15.0 and £14.10.0 respectively).

FOR THE HOME CONSTRUCTOR
SPECIAL 'COMBINED ORDER' PRICES

(a) The COLLARO "STUDIO" TAPE DECK and our Mullard Type "C" PRE-AMPLIFIER and POWER Unit Assembled and Tested **£29.10.0**
H.P. Deposit £5.18.0 and 12 months £2.3.3.
(b) As above but TYPE "C" PRE-AMPLIFIER supplied as complete KIT OF PARTS **£26.10.0**
(c) The COLLARO Mk. IV TAPE DECK and the MULLARD TYPE "C" PRE-AMPLIFIER and Power Unit assembled, tested **£35.0.0**
H.P. Deposit £7, and 12 months £2.11.4.
(d) As (c) but Type "C" as COMPLETE KIT OF PARTS **£32.0.0**
(e) The TRUVOX Mk. VI DECK and the assembled Type "C" Pre-amplifier and Power Unit.......... **£40.0.0**
H.P. Deposit £8.0.0, and 12 months £2.18.8.
(f) As above but Type "C" as complete KIT OF PARTS **£36.10.0**
(g) The BRENELL Mk. V DECK and the assembled Type "C" PRE-AMPLIFIER and POWER UNIT **£46.0.0**
H.P. Deposit £9.4.0, and 12 months £3.7.6.
(h) As (g) but Type "C" as complete KIT OF PARTS **£43.0.0**
(i) THE WEARITE 4A DECK with TYPE "C" assembled and tested.......................... **£56.0.0**
H.P. Deposit £11.4.0, and 12 months £4.2.1.
(Carriage and Insurance on above quotes 10/- extra.)

EACH OF THE ABOVE CAN BE SUPPLIED IN A PORTABLE CASE THUS FORMING A COMPLETE PORTABLE PRE-AMPLIFIER. FULL DETAILS ON REQUEST.

(a) COMPLETE KIT to build the HF/TR3 Amplifier, together with the COLLARO "STUDIO" DECK. **£25.10.0**
(b) As above but with HF/TR3 supplied ASSEMBLED and TESTED **£29.0.0**
H.P. Deposit £5.16.0, and 12 months £2.2.6.
(c) COMPLETE KIT to build the HF/TR3, together with the Mk. IV COLLARO "TRANSCRIPTOR" TAPE DECK **£30.15.0**
(£1 extra if we are required to wire up Deck Switch Banks.)
(d) As above but HF/TR3 supplied ASSEMBLED and TESTED **£34.10.0**
H.P. Deposit £7.0.0, and 12 months £2.10.5.
(£1 extra if we are/required to wire up Deck Switch Banks.)
(e) COMPLETE KIT to build the HF/TR3, together with the NEW TRUVOX Mk. VI TAPE DECK.. **£36.0.0**
(f) As above but HF/TR3 supplied ASSEMBLED and TESTED **£39.10.0**
H.P. Deposit £7.18.0, and 12 months £2.17.11.
(g) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENELL Mk. V TAPE DECK.. **£41.10.0**
(h) As above but HF/TR3 supplied ASSEMBLED and TESTED **£45.0.0**
H.P. Deposit £9.0.0, and 12 months £3.6.0.
(j) THE WEARITE 4A DECK with assembled and tested HF/TR3 Amplifier including WEARITE Head Lift Transformer.................. **£55.0.0**
H.P. Deposit £11.0.0, and 12 months £4.0.8.

Carriage and Insurance on each above is 10/- extra.
Attractive PORTABLE CASE is available to accommodate the TRUVOX or COLLARO TAPE DECKS and we offer it, together with ROLA/CELESTION 10 x 6in. LOUDSPEAKER—ACOS CRYSTAL MICROPHONE—and 1,200ft. SPOOL E.M.I. TAPE—ALL FOR £9.10.0, Carriage and Insurance 5/- extra.

A LARGE PURCHASE OF BRAND NEW AND FULLY GUARANTEED TRUVOX and GARRARD TAPE EQUIPMENT

ENABLES THESE OUTSTANDING PRICE REDUCTIONS

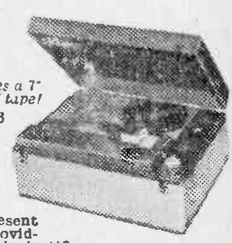
The "MODEL HF/G2R" PORTABLE TAPE RECORDER

(Original Price £33.0.0)
FOR ONLY 22 gns.

H.P. Dep. £4.14.0. 12 months £1.13.9. *(Carr. & ins. 10/- extra).* Incorporates THE LATEST GARRARD "MAGAZINE" TAPE DECK and a HIGH QUALITY AMPLIFIER which is entirely based on the very successful MULLARD TYPE "A" DESIGN and specifically developed to operate the GARRARD DECK. PRICE INCLUDES SUPPLY OF THE GARRARD TAPE MAGAZINE and a 4in. SPOOL of DOUBLE PLAY TAPE. Comprises a Twin Track Recorder operating at 3¾in/sec. speed and providing up to 1 hour 10 mins. playing time. Truly "Portable", weighs only 22 lbs. Outstanding features are excellent performance and simplicity of operation.

The "MODEL TK/MkIV" PORTABLE TAPE RECORDER

(Original Price £49.10.0)
FOR ONLY £36.10.0 *Price includes a 7" spool of EMI tape!*



H.P. Dep. £7.6.0, 12 months £2.13.6 *(Carr. and Ins. 10/- extra).*
Incorporates the Truvox MkIV Tape Deck, Rola/Celestion 9 x 5 in. Loudspeaker and the Truvox Type "K" Amplifier specifically developed by Truvox Ltd to correctly operate their MkIV Tape Deck. As a result we are able to present a highly perfected tape recorder providing sound reproduction which truly justifies the title "High Fidelity".
A **Twin Track Two Speed** model operating at 3¾ and 7½ in/sec. speeds and Incorporating **Magic Eye Indicator. Safety Button.** (Prevents accidental erasure). Ext. Speaker output, tone and volume controls.

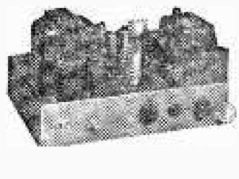
FULLY DESCRIPTIVE LEAFLETS ON ALL OF ABOVE ARE AVAILABLE—BUT PLEASE ENCLOSE S.A.E. AND STATE WHICH LEAFLET IS REQUIRED.

STERN RADIO LTD.

STERN'S MULLARD DESIGNS

Designed by MULLARD—presented by STERN'S strictly to specification

COMPLETE KIT OF PARTS— MULLARD "5-10" MAIN AMPLIFIER

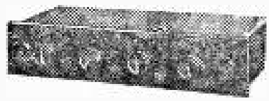


For use with the MULLARD 2-valve pre-amplifier with which undistorted power output of up to 10 watts is obtained. We supply SPECIFIED COMPONENTS AND NEW MULLARD VALVES, including PARMEKO MAINS TRANSFORMER and choice of the latest Ultra-Linear PARMEKO or the PARTRIDGE Output Transformer. PRICE COMPLETE KIT (PARMEKO Output Trans.). **£10.0.0**

Alternatively we supply ASSEMBLED and TESTED. **£11.10.0**

ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER, £1.6.0 EXTRA

MULLARD'S PRE-AMPLIFIER TONE CONTROL UNIT



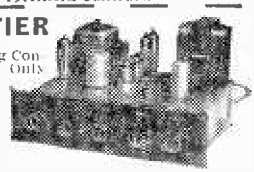
Employing two EF86 valves, and designed to operate with the MULLARD MAIN AMPLIFIERS, but also perfectly suitable for other makes.

PRICE COMPLETE KITS OF PARTS **£6.6.0** ASSEMBLED AND TESTED **£8.0.0**

Supplied strictly to MULLARD'S SPECIFICATION and incorporating:

- 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.

COMPLETE MULLARD "5-10" AMPLIFIER



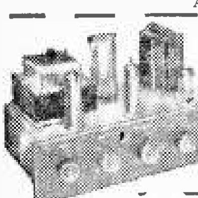
The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 watts high quality reproduction. Only Specified Components and new MULLARD VALVES are supplied including PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE ULTRA-Linear Output Transformers.

KIT OF PARTS **£11.10.0** OR ASSEMBLED and TESTED **£13.10.0**

HIRE PURCHASE (Assembled Amp. only). DEPOSIT £2.14.0 12 months at 19/10.

ABOVE incorporating PARTRIDGE OUTPUT TRANS. £1.6.0 extra.

COMPLETE MULLARD "3-3"

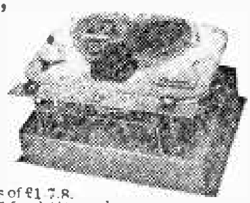


THE IDEAL AMPLIFIER FOR A SMALL HIGH QUALITY INSTALLATION PROVIDING EXCELLENT REPRODUCTION OF UP TO 3 WATTS OUTPUT

COMPLETE KIT OF PARTS **£7.10.0** OR ASSEMBLED and TESTED **£8.19.6**

(plus 6/6 carriage and insurance) H.P. Terms: Deposit £2.0.0 and 8 Months at £1.0.0. Complete to MULLARD'S SPECIFICATION including Mullard valves and a PARMEKO OUTPUT TRANSFORMER.

THE "ADD-A-DECK"



Incorporating GARRARD "MAGAZINE" TAPE and the MATCHED MODEL HF/G2P PRE-AMPLIFIER

Supplied on ONE CHASSIS (as illustrated) READY FOR USE **18 Gns.**

(Carr. & Ins. 10/- extra).

Price includes Garrard Magazine and a 4in. Spool Double Play Tape

H.P Deposit £3.16.0. and 12 months of £1.7.8.

Provides complete tape recording facilities and designed to operate through the pick-up sockets of the standard type of RADIO RECEIVER or an AMPLIFIER, from which really first class reproduction is obtained. It consists of a Twin Track Deck connected to the Pre-amplifier and operates at 3¾in/sec. speed providing up to 1 hr. 10 mins. playing time.

RECORD PLAYERS THE LATEST MODELS ARE IN STOCK, MANY AT REDUCED PRICES

SEND S.A.E. FOR ILLUSTRATED LEAFLET

B.S.R. MONARCH UA8 4-speed mixer Autochanger with Crystal Pick-up.	£6.19.6
The NEW COLLARO MODEL RP594 4-speed Single Record Player. Studio Cartridge.	£9.18.9
The NEW COLLARO C60 4-speed autochanger unit with Studio "O" pick-up	£7.19.6
The E.M.I. 4-speed Single Record Player with Crystal Pick-up.	£6.9.6
THE NEW B.S.R. Model UA12 in Stock. A4 "SPEED" MIXER AUTOCHANGER.	£8.7.6
UA12 also available incorporating the B.S.R. STEREO Pick-up, plays L.P. and 78 Records.	£10.10.0
GARRARD MODEL TA/MkII 4-speed Player fitted high output Crystal Pick-up.	£8.10.0
GARRARD MODEL RC/210. Autochanger 4-speeds. High output. Crystal Pick-up.	£10.10.0

Carriage and Insurance on each above. 5/- extra.

Dept. P.W. 109 FLEET ST., LONDON, E.C.4

Telephone: FLEET STREET 5812/3/4

PRICE REDUCTIONS

(a) The KIT OF PARTS to build both the "5-10" Main Amplifier and the 2-valve PRE-AMP CONTROL UNIT............. **£15.15.0**

(b) The "5-10" and the 2-stage PRE-AMP both ASSEMBLED and TESTED H.P. Dep. £3.16.0 and 12 months of £1.7.8......... **£18.18.0**

(c) The KIT OF PARTS to build the DUAL-CHANNEL "3-3" AMPLIFIER and the DUAL-CHANNEL PRE-AMPLIFIER CONTROL UNIT............. **£21.10.0**

(d) The DUAL-CHANNEL "3-3" AMPLIFIER and the DUAL-CHANNEL PRE-AMPLIFIER CONTROL UNIT BOTH ASSEMBLED and TESTED **£25.0.0**

H.P. Terms: Deposit £5 and 12 months of £1.16.8.

(e) THE KIT OF PARTS to build one "5-10" MAIN CHANNEL and the DUAL-CHANNEL PRE-AMP CONTROL UNIT **£21.10.0**

(f) ONE "5-10" AMPLIFIER and the DUAL-CHANNEL PRE-AMPLIFIER both ASSEMBLED and TESTED **£25.0.0**

H.P. Terms: Deposit £5, 12 months of £1.16.8.

(g) KIT OF PARTS to build Two "5-10" MAIN AMPLIFIERS (incorporating Parmeko Output Transformers) and the DUAL-CHANNEL PRE-AMPLIFIER CONTROL UNIT **£31.0.0**

(h) TWO "5-10" AMPLIFIERS and the DUAL-CHANNEL PRE-AMPLIFIER CONTROL UNIT BOTH ASSEMBLED & TESTED **£36.0.0**

H.P. Terms: Deposit £7.4.0, 12 months £2.12.0.

Carriage and Insurance 7/6 extra. Prices quoted are subject to £1.6.0 extra for Partridge Transformer.

STEREO PRE-AMPLIFIER

This model incorporates two Mullard 2-valve Pre-Amplifiers combined into a Single unit enabling it to be used for both STEREOPHONIC or MONAURAL operation. It is designed primarily to operate with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an input of 250 m/volts.

COMPLETE KIT OF PARTS **£12.10.0** ASSEMBLED AND TESTED **£15.0.0**

H.P. £3 Dep. and 12 mths. at £1.2.0

MULLARD FOUR CHANNEL MIXER UNIT

Self powered with Cathode follower output. Incorporates Two inputs for MICROPHONES One for CRYSTAL PICK UP and a fourth for RADIO or TAPE

Complete Kit of Parts **£8.8.0**

Assembled and Tested **£10.0.0**

TERMS: Deposit £2 and 12 months at 15/-.

MODEL I.L. one microphone Input matched for moving coil or Ribbon Mike. £1.17.0 extra.

Mk.11 "Fidelity" FM TUNING UNIT

An attractively presented Unit incorporating MULLARD PERMEABILITY TUNING HEART and corresponding Mullard valve line up. FOR THE CONSTRUCTOR **£10.10.0** ASSEMBLED **£14.5.0**

A SPECIAL CASH OFFER!!

This very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched P.M. SPEAKER.

For ONLY **£8.7.6** (Plus 7/6 Carr. & Ins.)

The amplifier consists of a 2-stage design incorporating 3 modern B.V.A. valves and has separate BASS and TREBLE CONTROLS.

The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Mushroom Grey Rexine.

WE ALSO SUPPLY SEPARATELY—

(a) The 2-stage (plus Rectifier) AMPLIFIER £4.2.6

(b) The PORTABLE CARRYING CASE £3.17.6

(c) 6½in. P.M. SPEAKER 18/9 Carriage and Insurance 4/- extra

Practical Wireless

VOL. XXXVI No. 649 MARCH, 1961

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Contents

The Editor will be pleased to consider articles of a practical nature. Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed: The Editor PRACTICAL WIRELESS, *George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Owing to the rapid progress in the designs of wireless apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.*

ANOTHER FREE BLUEPRINT

IN the next issue of PRACTICAL WIRELESS, the first of a new series will appear on constructing the "P.W. Roadfarer". This is an A.M./F.M. Receiver which is transistorised throughout. Its advance design allows it to be operated either from its own internal batteries or direct from the domestic mains supply. Printed circuits have been used and the construction of the receiver should therefore possess few difficulties even for the inexperienced constructor. The set is constructed in four main sections: the A.M. tuner; the F.M. tuner; the audio amplifier and the main power supply unit. The complete receiver is housed in an attractive plastic cabinet of small size which contains a ferrite rod aerial for A.M. reception and also a telescopic aerial for F.M.

Each copy of the April issue will contain a free blueprint of the "Roadfarer"—normal price 5s. 0d.—which will give the complete circuit diagram and components list and other information necessary to build the set. Be sure to order your copy NOW.

The P.W. Signal Generator

THIS issue contains the first article of a new series on the progressive construction of a wide range Signal Generator which will provide all the facilities required by the amateur radio enthusiast and will stand comparison with many of the designs for the amateur which are now on the market. The series is written by E. V. King—the author of two popular, constructional series which have previously appeared in this magazine. Whilst the performance of the Signal Generator is excellent, great care has been taken in the design to minimise the cost of construction and together with the progressive constructional system used, enables the cost of the unit to be spread over as long a time as the constructor desires. The Generator is constructed in four chassis and if required one or two chassis may be omitted if the constructor has no use for the facilities which they would provide.

Talking Books for the Blind

TALKING books for the blind have been used for some years but now a new library of tape recordings is being accumulated to replace the long-playing gramophone record system. A revolutionary type of play-back machine will be used which possesses a number of basic advantages over the present disc reproducer, the result of almost twenty-five years' research and development by the R.N.I.B. and St. Dunstan's. Amplifier, loudspeaker and drive mechanism are housed in one compact case, controls have been reduced to one On/Off—Volume switch and one Start/Stop lever.

The truly unique feature of the machine, however, is the tape cassette. Little larger in size than an average letterpress novel, this can contain up to twenty hours recorded speech. This has been achieved by the use of half-inch tape and recording on it not two tracks, as on domestic machines, but no fewer than eighteen tracks, which reduces the number of times a tape must be changed and so simplifies matters for the user.

Our next issue, dated April, will be published on March 7th

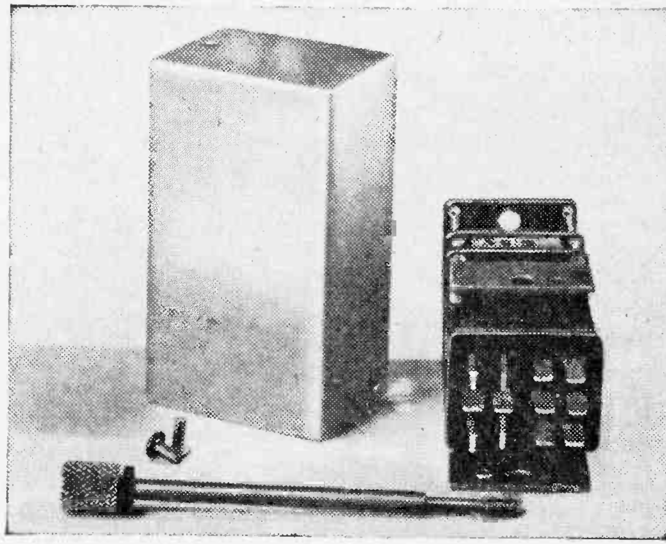
Round the World of Wireless

POTENTIAL AND CURRENT NEWS

Broadcast Receiving Licences

THE following statement shows the approximate number of Broadcast Receiving Licences in force at end of November, 1960, in respect of wireless receiving stations situated within the various Postal Regions of England, Wales, Scotland and Northern Ireland. The numbers include Licences issued to blind persons without payment.

Region	Total
London Postal	733,512
Home Counties	688,009
Midland	504,025
North Eastern	555.770
North Western	475,975
South Western	411,296
Wales and Border Counties	245,498
Total England and Wales	3,614,085
Scotland	409,088
Northern Ireland	124,137
Grand Total	4.147.310



Transistorised plug-in logic units form the basis of the electronic signal interlocking developed by Mullard Equipment Ltd. for British Railways *(see page 967).*

Factory Extensions

FACTORY extensions at Luaton Road, Dunstable, scheduled for occupation in March. 1961, are announced by Erg Industrial Corporation Ltd. The increased floor space will make it possible to increase the output of the wire wound Resistor division. Additionally, new and modern equipment for the now established Erg Transformer division will occupy a large proportion of the new extension, with an enlarged air-conditioned, constant-temperature laboratory. Test facilities covering full service requirements will be in operation to ensure the highest degree of reliability.

Erg Industrial, already serving the Electronic Industry with "Custom-built" special products, intimate that strong emphasis is being given to an immediate expansion of this service, for which highly qualified design engineers have been engaged and are solely devoted to this "Custom-built" division.

Dopplers and Automatic Direction Finders

AFTER an exhaustive evaluation, the Ministry of Aviation has selected the Marconi Doppler Navigation Type AD2300B and the Automatic Direction Finder Type AD712 for use in their new Argosy C. Mark 1 aircraft for R.A.F. Transport Command.

The doppler order is worth £552,000 and the automatic direction finder order £100,000. Ancillary equipment and spares are included in both contracts.

The AD2300B comprises the basic AD2300 sensor, the 5452 computer and the 5453 display unit. The computer processes ground speed and drift angle from the doppler sensor, together with heading information from the aircraft compass system, and presents to the pilot the aircraft's displacement from selected track and distance to go to the turning point. It also feeds steering information into the flight system and/or autopilot to enable the selected track to be maintained.

The AD712 automatic direction finder is a crystal-controlled ADF embodying a true and positive decade tuning system and a fixed loop aerial system. Frequency selection is by switch; no tuning whatever is required. This equipment is in wide use by many airlines.

Battery Firm Changes

TO achieve closer liaison between their technical, production and sales departments, Chloride Batteries Ltd. transferred the major portion of their sales headquarters from London to the head office and the principal manufacturing centre of the company at Exide Works, Clifton Junction, near Manchester, on January 2, 1961.

Mr A. C. Stewart, the present sales manager, who is approaching retirement age, will not be moving north. He will be succeeded by Mr. M. A. Griffith-Jones on completion of the move, but his services will be retained by the company in the capacity of consultant until he retires.

Export TV for Design Index

THE latest Ekco export television models — the 17in. models T737 and T738—have been accepted by the Council of Industrial Design for "Design Index". The "Design Index" already includes nearly sixty Ekco products and is Britain's record of well-designed goods from which exhibits are chosen for display in the Design Centre.

Tape Recorders for BBC

THE BBC is purchasing two three-track portable and one twin-track console Philips magnetic tape recorders for use in engineering research work.

Negotiations for the order were carried out for Philips by Mr. Terence Perkins, the company's tape recorder section manager.

Silicon npn Diffused Junction Power Transistors

THE Semiconductor department of A.E.I. Radio and Electronic Components division entered the silicon power transistor field with the introduction of three Ediswan Mazda npn diffused junction type devices. Types XC703, XC713 and XC723 are intended for a wide variety of industrial applications in equipment operating at temperatures ranging from −65°C to +175°C. They are particularly useful in power-switching circuits, oscillator regulator and pulse amplifier circuits, and as Class A and Class B push-pull audio and servo amplifiers.

They are characterised by an extremely low saturation resistance, high current and power dissipation ratings, high Beta at high current, and excellent high temperature performance up to +175°C. At 100°C they offer a range of dissipation of from 2 to 30W. They are available in standard JEDEC cans.

Direct View 3-D Picture Process

FULL-COLOUR 3-D pictures that can be "blown up" to 40in. x 30in. are now being produced for viewing without coloured spectacles or a stereoscope by a new process sponsored by Deep Vision Ltd.

This process is based on the familiar grid system in which each of the viewer's eyes sees the picture through a different set of "windows" — hundreds of extremely narrow vertical slits between invisibly fine opaque lines.

But apart from their size, the Deep Vision pictures can also be brought forward from their frames or set back in perspective —or both. And as in the case of the equally familiar lenticular system (in which vertical corrugations break up the picture into two eye-fields), they can also be made to "change".

Two more advantages are that any number of identical prints can be made in fast colours, and that as 2-D colour pictures can be made simultaneously, magazine advertising, for example, can be precisely matched in 3-D for illuminated display.

The process involves the use of a specially-designed camera which, although bulky and heavy, has no single awkward component, and so can be dismantled and reassembled in a matter of minutes for location work.

A shot takes about five seconds to complete, but considerable subjective movement can be tolerated without the picture being spoiled.

Talk-back System for New Tamar Bridge

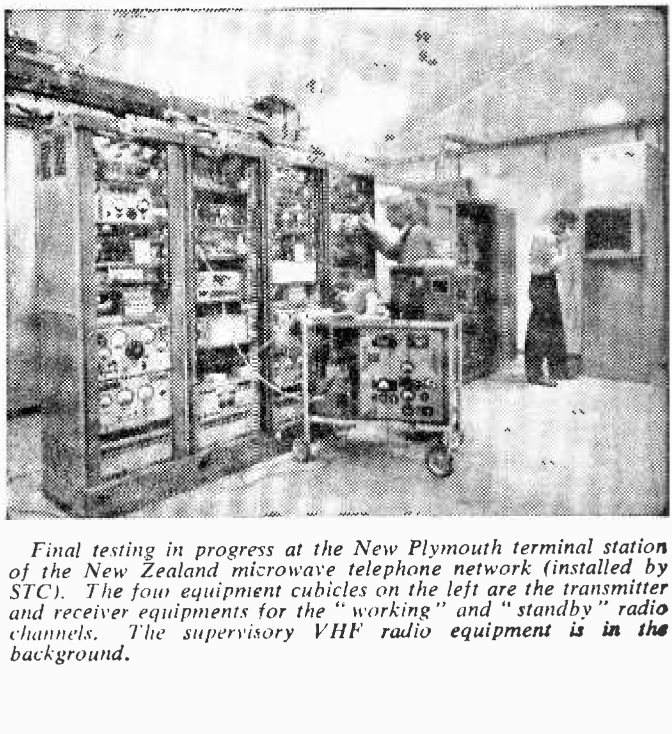
RIGGERS working high up, on and between the 250ft towers of the new Tamar Bridge - now being built by Cleveland Bridge and Engineering Co. to provide a new road link between Devon and Cornwall—keep in touch with the main control station at one end of the bridge through equipment supplied by Radio Components and Special Products Department, A.E.I. Radio and Electronic Components Division.

The twin towers of the bridge are 1,100ft apart and the distance between the top of each and two ground stations is 500ft so that communication was required over a total distance of about 2,000ft. To provide this a transistorised loudspeaking intercommunication system has been supplied. A ten-line master unit, of a type specially developed by A.E.I. to work over a post office line and therefore eminently suitable for this application, is installed in the constructor's main office at one end of the bridge.

British Railways to use Electronic Signal Interlocking

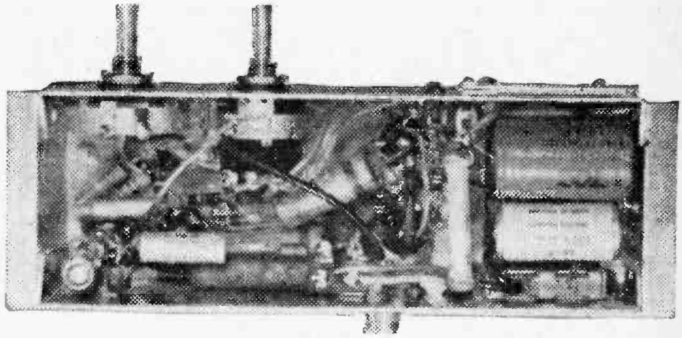
AS part of the railway's modernisation programme, the British Transport Commission has awarded a contract to Mullard Equipment Ltd. for the development of an electronic signal interlocking plant. The equipment will be the first plant using electronic interlocking to be used on British Railways and will replace the mechanical interlocking on the lever frame at Henley-on-Thames Western Region signal box. It will be installed during the early summer of 1961.

Recently the company was able to demonstrate to British Railways' signal engineers a working model of a double junction, completely controlled by the new electronic system. The technique has the substantial advantage that it employs solid state electronic circuitry throughout.



Final testing in progress at the New Plymouth terminal station of the New Zealand microwave telephone network (installed by STC). The four equipment cubicles on the left are the transmitter and receiver equipments for the "working" and "standby" radio channels. The supervisory VHF radio equipment is in the background.

A MIDGET PUSH-PULL AMPLIFIER



The component layout of this amplifier.

By V. E. Holley

THIS 4W AMPLIFIER IS ESPECIALLY SUITABLE FOR PORTABLE RECORD PLAYERS

THIS amplifier was built originally for a portable record player. Though modest in size, weight and cost, it has an output of four watts and a very acceptable standard of reproduction.

The Circuit

Fig. 1 shows the circuit; it is largely conventional. The valve, V1, is a resistance coupled pentode voltage amplifier having in its grid circuit the volume control, VR1, and a simple top-cut tone control, C1 and VR2. Matters are so arranged that in the minimum cut position, the tone control has practically no effect on the response, but there is sufficient range to enable the surface noise from the older 78rev/min shellac records to be reduced to inoffensive proportions. R3 is the bias resistor which is by-passed in the normal way by C3; R4, inserted between the

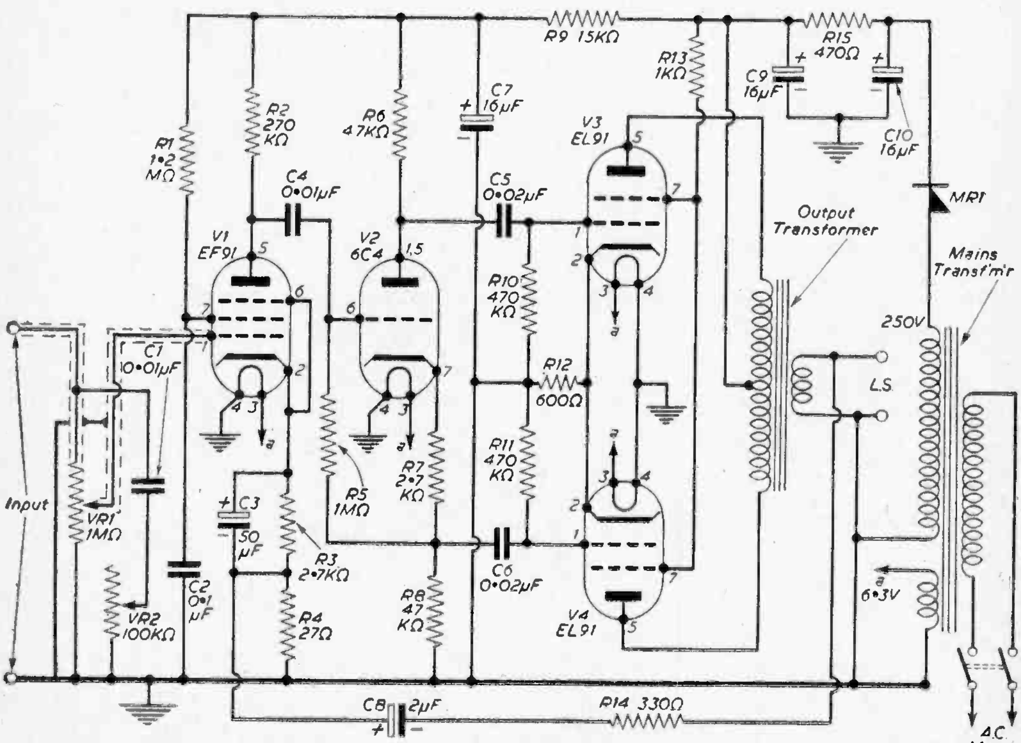


Fig. 1a.—The circuit diagram.

lower end of these components and chassis, provides a point for the injection of negative voltage feedback derived from the output transformer secondary.

Inverter

The amplified signal from V1 is passed to V2, a triode, 6C4, arranged as a phase inverter with

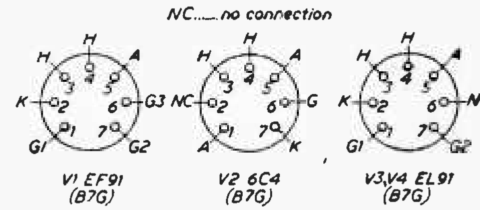


Fig. 1b (right).—The valve-base connections.

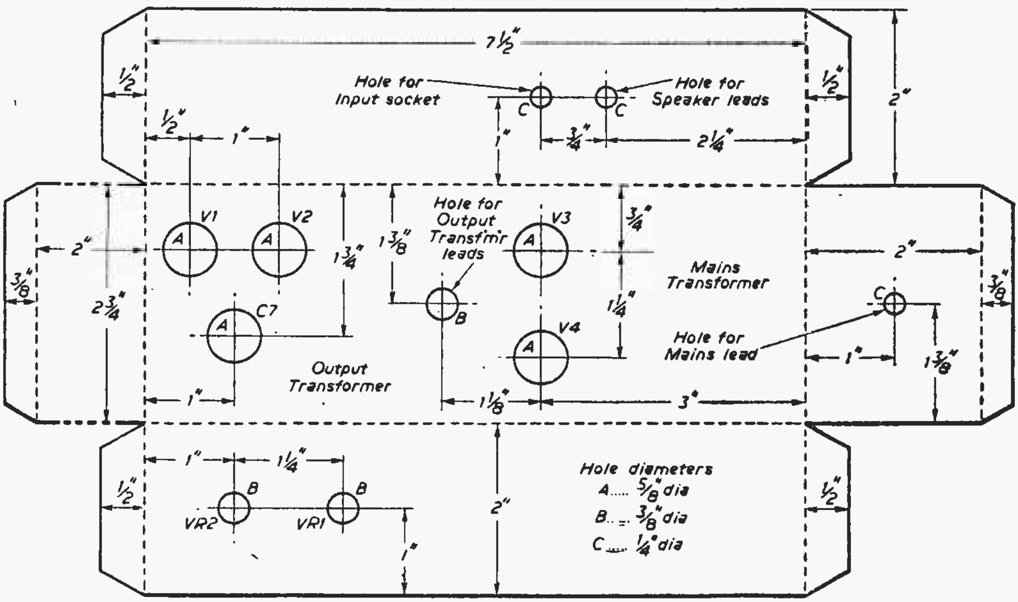


Fig. 2.—Constructional details for the chassis.

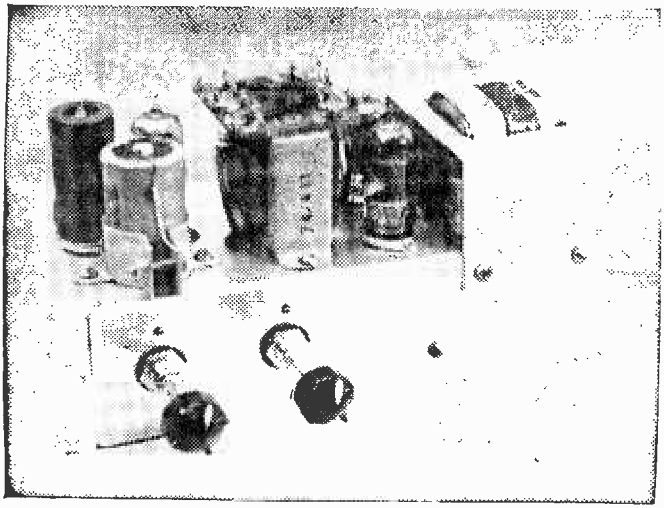
equal anode and cathode loads of 47k. Two signals, 180deg out of phase, are thereby produced for the push-pull output stage. A cathode bias resistor of 2.7k and a grid leak of 1M, returned to the junction of the bias and cathode load resistors, complete the stage. Heavy negative current feedback ensures excellent linearity though it limits the gain of the stage to 0.9 on each side, or 1.8 times overall. No de-coupling is necessary between V1 and V2.

Output Stage

Two miniature output pentodes. EL91, are employed in this stage with 250V on anodes and screens. They should be reasonably well matched but exact matching is not necessary as the common bias resistor tends to equalise them. The optimum load, anode-to-anode, is 24K, so that for adequate low frequency response, an output transformer with unusually high primary inductance is required. Such transformers are not readily available but the difficulty can be overcome by using one of lower inductance and making good the low frequency attenuation by negative feedback. Several small push-pull transformers are available commercially with a primary inductance of 40H or so and affording ratios of around 80 or 90 to 1 for operating a 3Ω speaker. As the D.C. resistance of the speaker is rather high, there is some loss of volts at the valve anodes and the resistor R13 is included in the supply to the screens so that the voltage here will not rise above that at the anodes.

Negative Feedback

Heavy negative feedback is taken from the output transformer secondary via R14 and C8, to the cathode circuit of V1. The inclusion of C8 reduces the feedback at the lower frequencies and so allows the gain of the amplifier to rise in the region in which attenuation is introduced by the output transformer. The values of C8 and R14 will need adjustment according to the characteristics of the output transformer. It is suggested that the amplifier be completed with R14 equal to 330Ω and C8 omitted, and that the best combination should then be selected after a listening test under service conditions. The optimum value for R14 will lie between 200 and 600Ω and for C8 between 2 and 8μF. The circuit is very well behaved and none of these combinations will cause instability.



The complete amplifier.

Power Supply

The mains transformer should be of the "miniature" type and should have a half wave secondary winding capable of supplying 35mA and a 6.3V, 1A heater winding. A contact cooled rectifier is adequate, and mains smoothing is provided by C9 and C10 in conjunction with R15. The smoothing is not lavish, but push-pull plus negative feedback reduces the hum to a very low level. Some additional smoothing is necessary for the supply to V1 and V2 and is provided by R9 and C7.

Construction

The prototype was built on a chassis of 18s.w.g. aluminium sheet measuring 7½in. x 2¾in. x 2in., a plan of which is given in Fig. 2. There is nothing critical about the lay-out except that to prevent inter-action between them, the mains and output transformers must be mounted so that their magnetic axes are at right angles. There is a little difficulty here if both are of clamp construction but it can be overcome by mounting the mains transformer on its side in the "drop-through" position and securing it with a strap of 18s.w.g. aluminium across the top, the normal mounting lugs being bent inwards out of the way. This method was adopted in the prototype as will be seen from the illustration. A detailed wiring diagram for the amplifier is given in Fig. 3.

Components

No special components are necessary but it is an advantage if the resistors and capacitors are on the small side. The resistors can be ¼W except R9 and R12 (½W) and R15 (1W). R6 and R8 must be a matched pair as also must be R10 and R11. If matching facilities are not available, close tolerance components must be used (5 per cent or better). All the capacitors should be 350VW D.C. except C3 and C8 for which 25VW will be adequate.

Testing

When construction is complete and before switching on, a check should be made with a meter between C10 and the chassis to see that there are no shorts in the H.T. wiring. If all is well the power can be connected and measurements taken of the voltages on the output valve anodes and screens. It should be between 240 and 250V, measured between these electrodes and the cathodes, and some adjustment may be necessary to the value of R15 to make it so, depending on the output from the mains transformer. Likewise, it may be necessary to adjust the value of R13 according to the voltage drop in the output transformer primary. If there is instability, the connections to either the primary or secondary of the output transformer should be reversed so that the feedback becomes negative. All that now remains is to decide by trial and error on the most suitable values for R14 and C8. It should perhaps be mentioned that if the amplifier is operated without feedback, the reproduction will be very

COMPONENTS LIST

Resistors (¼W unless otherwise stated):
R1—1·2M
R2—0·27M
R3—2·7k
R4—27Ω
R5—1M
R6—47k
R7—2·7k
R8—47k
R9—15k (½W)
R10—0·47M
R11—0·47M
R12—600Ω (½W)
R13—1k
R14—330Ω
R15—470Ω (1W)

Capacitors (350VW D.C. unless otherwise stated):
C1—0·01μF
C2—0·1μF
C3—50μF 25VW electrolytic
C4—0·01μF
C5—0·02μF
C6—0·02μF
C7—16μF electrolytic
C8—2μF 25VW electrolytic
C9—16μF electrolytic
C10—16μF electrolytic

Potentiometers:
VR1—1M log.
VR2—100k log.

Rectifier:
Contact cooled, 250V, 40mA

Valves:
V1—EF91, B7G base and screen
V2—6C4, B7G base.
V3, V4—EL91, B7G base

Mains transformer:
Miniature, 250V half wave, 35-40mA, 6·3V, 1A

Output transformer:
Push-pull, high inductance primary (see text). Ratio 90 to 1 for 3Ω speaker or 40 to 1 for 15Ω

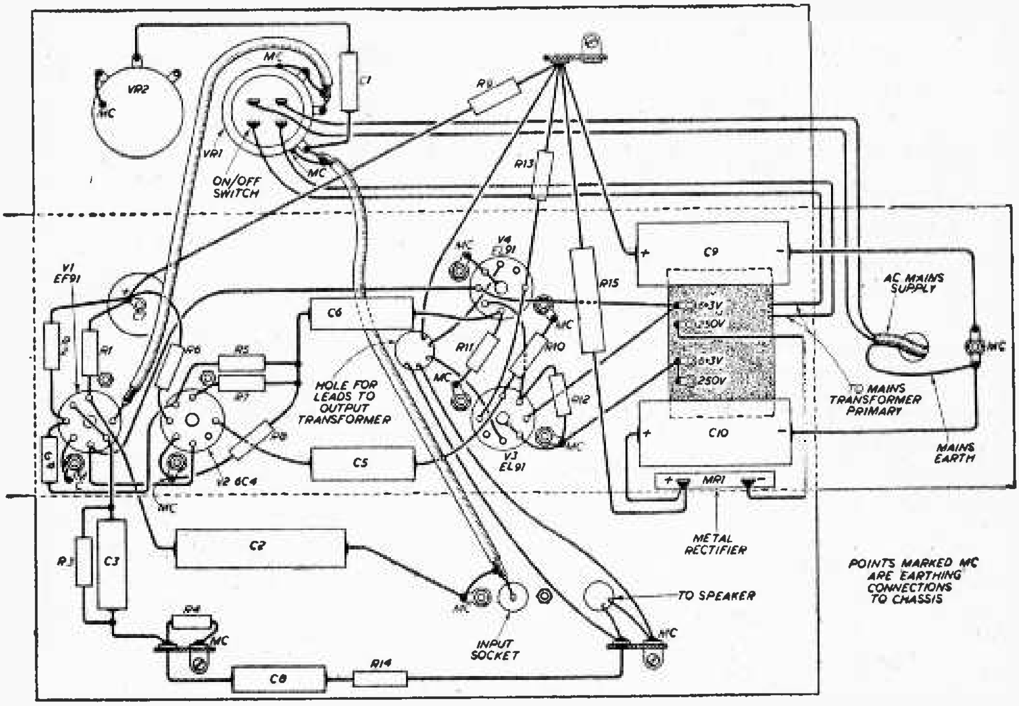


Fig. 3.—The component wiring details.

high pitched and, because the de-coupling is not generous, there may be a slight tendency to instability. These faults will disappear when the feedback circuit is connected.

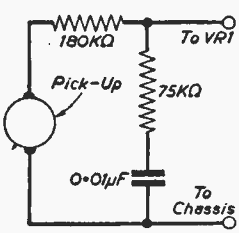


Fig. 4.—The pick-up compensation circuit.

Operation

If the amplifier is to be used with a pick-up, it will be necessary to provide some compensation for recording loss. While this could easily be incorporated in the chassis, it will usually be more convenient to fit it at the pick-up so that it is eliminated when the amplifier is used for other purposes. The output of the popular type of crystal pick-up rises in the low frequency region and it will generally be satisfactory to add external compensation at the rate of 3dB per octave below about 250c/s. This may be done with the circuit of Fig. 4.

Heartbeat Timer

An electronic heartbeat timer with no external wiring can be sewn into a patient's chest or near his heart because it has self-contained batteries. The circuitry is in a plastic envelope about 2½in. in diameter, ⅜in. thick.

The timer supplies a stimulating pulse at regular intervals to keep the heart beating regularly, where otherwise it might beat dangerously out of time, slow down or stop entirely.

This heart timer will run for five years, and has been tested on dogs for periods up to 100 days. Dr. Wm. Chardack, of the Veteran's Administration, and electronic consultant Wilson Greatbatch, of Buffalo, N.Y., U.S.A., developed the device.

Meanwhile, it was resported that RCA in America developed a heart timer using a generator strapped around the patient's chest which induces power into a device sewn inside the chest cavity.

High Power Klystron Installations

One of the 50cm commercial radar installations using the English Electric Valve Company's K347, 600kW klystron is well on the way to completion at Kastrup, Copenhagen's new international airport, which is expected to be operational some time this month. The K347 is the first high power klystron to be designed specifically for use in commercial radar and in this installation two klystrons are used with a Marconi S264A radar comprising two transmitter/receivers feeding an aerial system on a main/standby basis.

The K347 is an external cavity tuned klystron operating in the 585 to 610Mc/s frequency range and repeated tuning operations can be made, to meet changing operational requirements, without stressing or damaging the tube.

Crystal Controlled C.W. TRANSMITTERS

By G3OGR

(Continued from page 877 of the February issue)

WHEN using a doubler, make sure that the crystals chosen are of such a frequency that operation is always in the permitted bands. Provided this is remembered, a doubler will make available other frequencies, with a limited number of crystals. It is also in order to use a further doubler. This is often done to permit three band working from one crystal, for example.

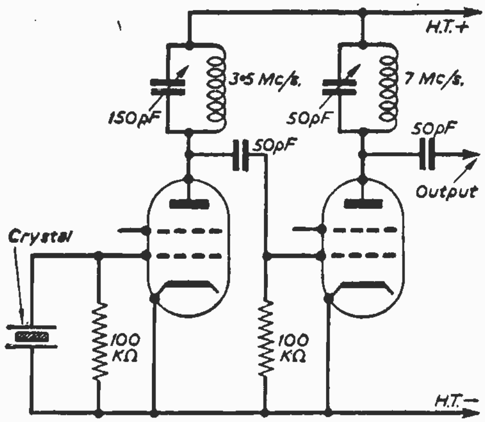


Fig. 6.—Oscillator and multiplier stages.

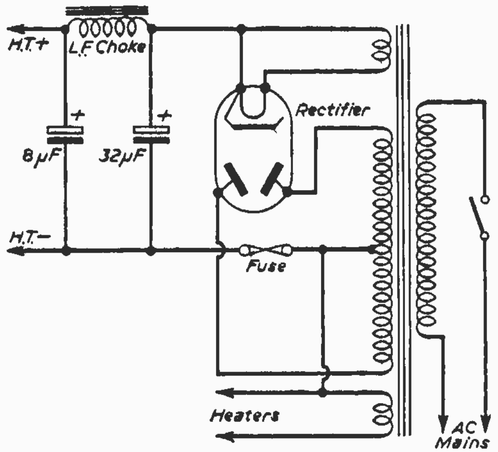


Fig. 7.—Power supply circuit for the transmitters.

Power Supplies

The circuits shown have great latitude in power supply requirements. Almost any power pack available may be used. This item can thus be arranged to suit the output wanted. Even a small receiver type supply will allow 10W or more input to a single valve transmitter.

A typical separate power pack is shown in Fig. 7. The mains transformer, choke, and rectifier should be chosen to suit the output voltage and current desired. For inputs of up to 50W or so, a 400/0/400V H.T. secondary rated at 150mA, with a 5R4GY rectifier, will be satisfactory. The choke current rating should at least equal the current drawn. The working voltage of the smoothing condensers should be rather higher than the actual H.T. voltage.

A fuse is an added safeguard against short circuits or similar defects. A 100mA or 150mA fuse will do for small power packs, with 250mA for larger supplies.

If the power pack can be disconnected, or its circuit is interrupted by keying, a 100k 5W bleeder resistor should be connected across the H.T. supply, to discharge the condensers. In some circuits the screen grid resistors will act as a bleeder.

It is usually necessary to insert a switch, so that the valve heaters may be run without H.T. being applied. When initially testing a circuit, it is advisable to apply reduced H.T. voltage, until resonance has been found. A dropping resistor may be used for this purpose.

Key Clicks

Crystal oscillators usually key well, but if key clicks are produced, the cathode or key by-pass condenser may be changed in capacity. Using a rather large capacity will tend to cause "tails" to the characters, but this depends on the current drawn by the valve.

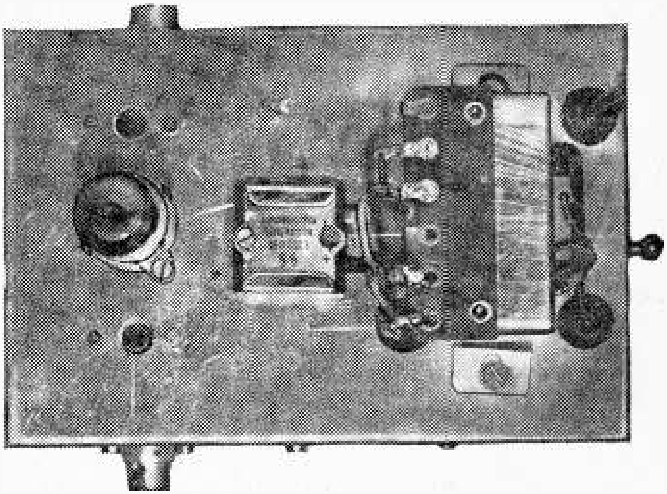
If a condenser alone is insufficient, a choke may be added in series with the key. Another condenser may then be joined directly across the key contacts.

Many operators have favourite methods of keying. The key may interrupt the cathode circuit, or may be in the H.T. negative circuit. An alternative is to use a separate transformer to obtain H.T. only, and key this in the primary. The rise and decay time can then be adjusted by modifying the smoothing condenser capacity. When keying mains and other high voltage circuits a relay is preferable, for maximum safety.

A BAND II Pre-Amp

A USEFUL ADDITION TO RECEIVERS FAR FROM THE TRANSMITTER

(Continued from page 874 of the February issue)



WHEN construction of the pre-amplifier is finished, all wiring should be checked carefully. The unit may now be switched on and if possible the H.T. and L.T. should be measured without the valve in position. If all is in order the unit should be switched off, the valve inserted and the unit switched on again. As a check, the H.T. and L.T. voltages may again be measured. Plug the downlead into the input socket and connect the output to the receiver aerial socket.

The dust cores in L2 and L4 should be altered in position for best results and finally the positions of the two coupling coils L1 and L3; movement of these coils may necessitate altering the position of the slugs again. If the slugs are loose in the coil formers they should be removed and a piece of thin elastic inserted down the threads of the former and the slug screwed in again. When the best positions for the slugs and coupling coils have been found, the coupling coils may be lightly cemented in position. (A tool for adjusting the position of the cores can be made from a plastic knitting needle.)

Alternative Coupling

If the incoming signal is very weak, it may be found that the signal from the pre-amp is less than that from the aerial direct. Whilst this may be due to L2 and L4 resonating at the wrong frequency, it is more likely that the coupling between the aerial and L2 and the receiver and L4 is not optimum. Various alternative methods of coupling may be tried instead of using the coil L1, the wire from the aerial input socket may be tapped directly on to L2 and the optimum position be determined by trial. The effect of including a small capacitor—2-10pF—may also be tried.

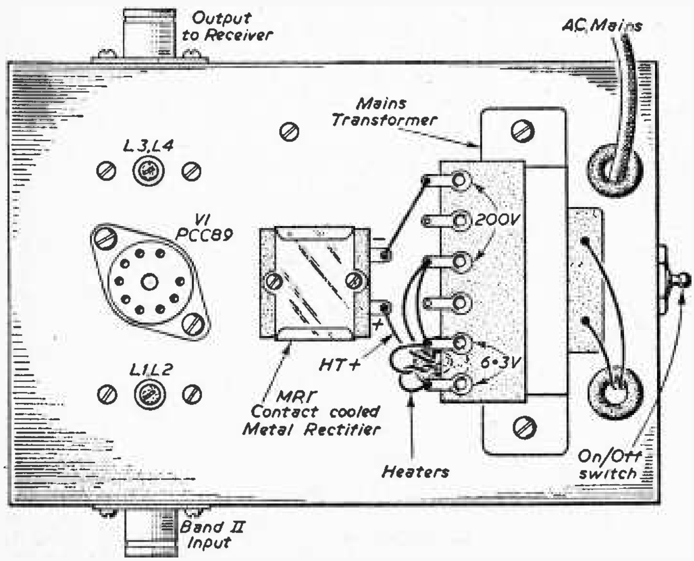


Fig. 4.—The above-chassis layout of the unit.

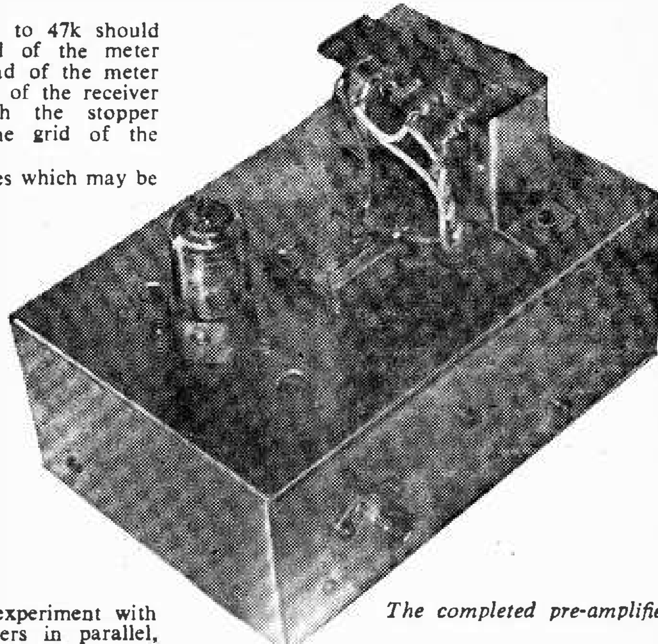
Matters are easier as far as L4 is concerned. The effect of omitting L3 and employing a small capacitor between the anode of V16 and the inner conductor of the output coaxial cable is certainly worth trying. The value of this capacitor may be again 2-10pF. If good results are obtained with the initial arrangement the number of turns on L1 and L3 may be altered in an endeavour to secure better results.

Final Adjustments

The condenser C1, which is part of the neutralising network is set for optimum results. The turns of the inductance L5 may be opened out or closed up to secure best results. Accurate alignment of the circuit is best carried out by using a sensitive meter to monitor the voltage of the limiter grid of the F.M.

receiver. A resistor of about 10 to 47k should be included at the receiver end of the meter lead. (Note that the positive lead of the meter must be connected to the chassis of the receiver and the negative lead—through the stopper resistance just mentioned—to the grid of the limiter valve.)

If it is desired to avoid the losses which may be associated with change of cable at the input socket this socket may be omitted and the aerial downlead wired directly to L1a.



The completed pre-amplifier.

Instability

Owing to the high gain of the pre-amplifier it is possible and, if construction is not particularly well carried out, likely, that instability in the pre-amplifier will be experienced. In curing this instability the positions of the output and input leads relative to each other are critical and re-arrangement will often effect a cure. The decoupling capacitors can likewise have a great effect upon the performance—particularly C6 and C7. In the event of instability, it is worth while to experiment with these condensers by putting others in parallel, perhaps connected to different earth points, until the instability is cured.

COMPONENTS LIST

Resistors:	**Capacitors:**
R1—82k.	**C1—2 to 10pF, beehive type (or similar).**
R2—82Ω.	
R3—100k 10per cent.	**C2—2pF.**
R4—180Ω.	**C3, C4, C5, C6, C7,**
R5—100k 10per cent.	**1000pF, min. ceramic.**
Valve: PCC89.	**C8—3pF ceramic.**

Power Unit Components:
Resistors, R6, 1k or to suit H.T. voltage.
Capacitors, C9 and C10, 8 to 32μF, 350VW.
Rectifier, miniature contact-cooled type for 200V r.m.s. input and rated at about 30mA.
Transformer—type used for converters, with tapped primary and 7V secondary.
Chassis: see diagram (Fig. 4.)
Solder, wire, wooden case, etc.

COIL WINDING DETAILS

	No. of turns
L1 (over L2)	**1**
L2	**7**
L3/4 (over L7)	**2**
L4	**6**

Coils are wound on ¼in. small polystyrene coil formers with purple coded dust cores. No spacing is used between turns—the coils are closewound.
L5 consists of about 15 turns of 22-26s.w.g. enamelled or DCC copper wire wound to ¼in. inside diameter.

Housing

The finished unit may be housed in a wooden box which can be fitted or placed on top of the radio receiver.

Although a great deal of heat is not generated in the unit, adequate ventilation should be assured to avoid frequency drift. During the testing, the unit can be operated direct from the mains supply but finally when it is fitted permanently to the receiver the mains supply should be taken direct from the set (after its mains switch) and then the pre-amplifier cannot be left switched on inadvertently.

Bandwidth

The damping of the input tuned circuit is such that the coil resonates over the whole of Band II and no tuning is necessary. However, it may be found that the tuning of the anode coil is sufficiently sharp to render impossible a flat response over the complete band. In this event, a damping resistor may be connected across the coil L4 in parallel with the condenser C8. It may have a value of, say, 1k to 4·7k, depending on the damping required to obtain best results. This resistor may result in some loss of signal, and if reception is such that no signal can be "wasted," then it may prove necessary to employ variable tuning in either the input or the output circuit.

Conclusion

It is worth while emphasising again that where signal strength is low a pre-amplifier such as this must be "tailored" to suit the conditions of the location concerned. To obtain maximum transfer of energy from aerial to first grid and from second anode to receiver will necessitate, in most instances, some experiment, but it will then be certain that the best use is being made of the available signal.

Valve Bias Explained

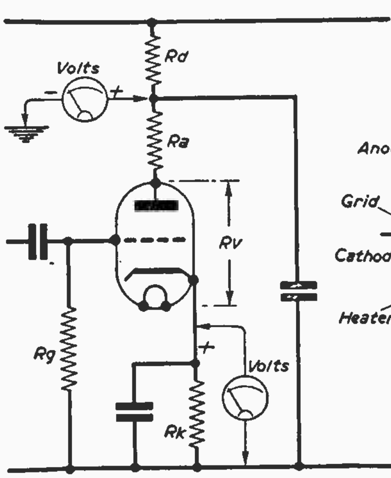
BASIC THEORY FOR THE BEGINNER

A CIRCUIT for a triode valve is shown in Fig. 1 and is representative of many audio-frequency amplifiers. At this stage let us consider the circuit purely from the D.C. point of view in relation to the resistive elements connected to the various electrodes.

The valve heater is energised either from a low voltage winding on the mains transformer or, as we will recall from the last two articles, direct from the mains through a voltage dropping resistor in series with the heaters of the remaining valves. With battery valves, of course, the heaters are powered from the L.T. battery.

It will not be out of place here to discuss in broad outline the action of a triode valve. The heater of the valve (see Fig. 2) is placed inside a hollow tube (the cathode) which is coated with a white powder such as thorium oxide. When the heater is switched on, it heats the cathode causing it to glow. The white powder as a result of the heating emits " electrons " which are tiny particles of electricity. These particles are charged negatively. Now negative charges are repelled by negative charges and attracted by positive charges. Therefore, if the anode (made up of a metal plate) is charged positively with respect to the cathode, then the electrons emitted from the cathode are attracted to the anode and travel to it. This flow of electrons constitutes a current of electricity through the valve.

The grid of the valve consists of a mesh of fine wire through which the electrons from the cathode have to pass on their way to the anode. If this grid is charged negatively with respect to the cathode, then some of the electrons travelling to the anode will be repelled and the current through the valve will be decreased. It can be seen that the current through the valve depends on the potential of the grid with respect to the cathode—the current *increases* as the grid becomes more positive (or less negative) relative to the cathode and *decreases* as it becomes less positive (or more negative).



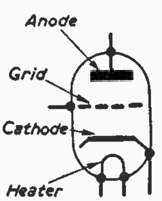


Fig. 1 (left).—A simple basic circuit for a triode valve.

Fig. 2 (right).—The conventional circuit symbol for a triode valve.

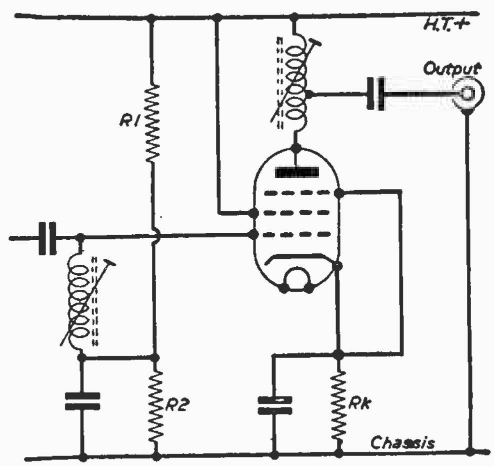


Fig. 3.—A valve bias system using both a cathode resistor and a grid potential divider.

The name " valve " is derived from the way in which the grid is used to control the flow of current, just as mechanical valves are used to control the flow of water in pipelines.

If, in Fig. 1 we assume that the grid potential is constant the conditions in the circuit are steady and the valve can be represented by a resistor of, say, Rv ohms (as indicated in Fig. 1). Thus we may consider that there are five resistors in circuit, Rd, Ra, Rv, Rk and Rg. Thus current flows through the valve of a value determined by (Rd+Ra+Rv+Rk), neglecting Rg.

Resistor Calculation

In Fig. 1 it is supposed that the H.T. line is 300V positive with respect to the chassis (H.T. negative). The circuit constants may be arranged so that with 200V at the junction of Rd and Ra, with respect to chassis, the current through the valve and resistive elements is 10mA (0·01A).

In this case, the value of Rd can easily be computed by using Ohm's law, this is, Rd=(300-200)/

(0·01). This follows because Rd is called upon to drop 100V, this being the difference between the H.T. line voltage and the required voltage at the junction of Rd and Ra. This works out to 10,000 ohms (10k). Thus, a voltmeter connected to the junction as shown in Fig. 1 would read 200V, provided Rd is 10k and the meter does not load the circuit in any way. In practice, of course, the meter acts as a load across the resistive elements and the reading as indicated is below that computed as governed by the extent of the loading.

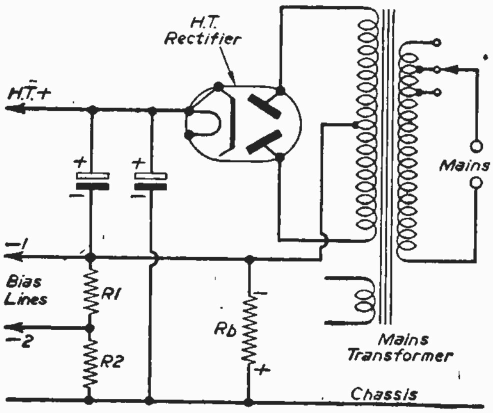


Fig. 4.—A circuit using a common bias resistor to obtain bias for all valves—the bias lines are connected to the grids of the valves through decoupling networks, and the cathodes are connected direct to chassis.

The 10mA of current is also flowing in Ra and Rk. The value given to Ra is usually decided by the operational factors of the circuit, as distinct from the D.C. or static aspect, and the same applies in some degree to Rk in the cathode circuit.

The value of Rg is usually very high, often in the region of 1M, but as current does not normally flow in this resistor, there is no potential difference across it and the grid is at chassis potential. (Use Ohm's Law: $V = Rg \times I$, $I = O$, and therefore $V = O$.) This fact is essential to the understanding of the following explanation and one which often causes confusion or bewilderment in the mind of the beginner but is easy to grasp when the principle is understood. There is no current through Rg; therefore there is no P.D. across it.

Let us suppose that Rk is 1,000 ohms, and that the circuit is set up as previously mentioned with 10mA flowing. The volts drop across Rk is then equal to $(0.01 \times 1{,}000)$ which works out to 10V. Or another way of looking at it is to multiply the current in mA by the resistance in kΩ, which in this case is (1×10), 10 volts.

The polarity of the voltage across Rk is such that the cathode is 10V positive with respect to the chassis or H.T. negative line, as shown on the circuit. The grid of the valve is connected to the H.T. negative line or chassis through Rg. This means that the cathode grid is 10V positive with respect to the chassis and grid or stating it another way, the grid is 10V negative with respect to the cathode, always provided 10 mA of current is flowing in the 1k cathode resistor.

The best way of measuring the bias voltage is by connecting a voltmeter across Rk. There will be the least error in the reading by adopting this method because the resistance of the voltmeter on the 10V range is almost certain to be far greater than the value of Rk. If it is attempted to measure the grid bias by connecting a voltmeter between the grid and cathode, then current will flow through Rg by way of the meter and the reading will be considerably less than the actual voltage.

If ever we require to discover the value of Rk for any grid bias voltage then all we do is divide the value of grid bias required by the cathode current of the valve. This, of course, is simply $R = E/I$, and where R is in ohms, I must be in amperes, but where R is in kΩ, then I must be in mA.

Where a pentode, tetrode of any other multi-electrode valve is in use, then the current through Rk is equal to the total H.T. current of the valve (i.e. anode current + screen grid current, etc).

Other curious methods are sometimes adopted to secure a bias voltage. Fig. 3, for example, shows such a method. Here is an R.F. amplifier which uses cathode bias, having Rk in the cathode circuit, but in addition has a positive potential on the control grid. Rk provides some fixed bias, but since the control grid is also connected to the junction of the potential divided R1, R2 some of the bias given by Rk is counteracted.

However, this arrangement provides a degree of compensation, and the circuit is stabilised to some degree in the event of a reduction in emission of the valve—when the white powder on the cathode begins to emit fewer electrons than before, resulting in an increase of the apparent resistance of the valve.

A Common Bias Resistor

Some receivers use a common bias resistor and have all the valve cathodes returned to chassis. The idea is shown in Fig. 4. Here Rb is the common bias resistor and is connected between the centre tap on the secondary of the mains transformer and chassis. It will be realised that the total current of the receiver flows through Rb, and a P.D., depending upon its value, is developed across it.

If the total current of the receiver is 100mA (0·1A) and Rb is 100Ω, then 10V is developed across it (i.e., $E = 0.1 \times 100$). The voltage across Rb is negative at the secondary tap with respect to chassis, so it can be used ideally as a negative bias. In some cases the potential is applied direct to the grid of a valve after passing through a suitable filter circuit, while more often it is applied across a potential divider, such as that made up of R1, R2 in Fig. 4. In this way two bias lines can be drawn off and suitably filtered individually.

Since the bias is usually applied to a high resistance circuit relating to the valve, R1 and R2 can be of fairly high value, considerably higher, in fact, than the value of Rb. This means that they have little shunting effect on Rb, which can be computed as given above.

The full bias voltage (10V in the case cited) is present on bias line 1, and the bias voltage on line 2 is governed solely by the ratio of R1, R2, as fully detailed in a previous article in this series.

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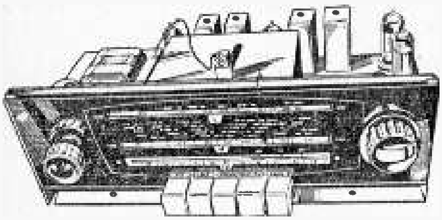

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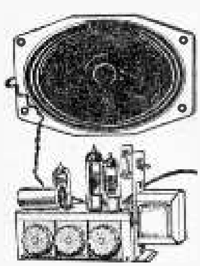

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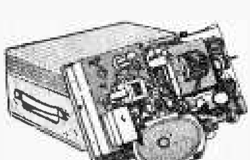

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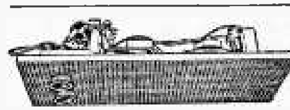

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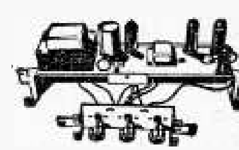

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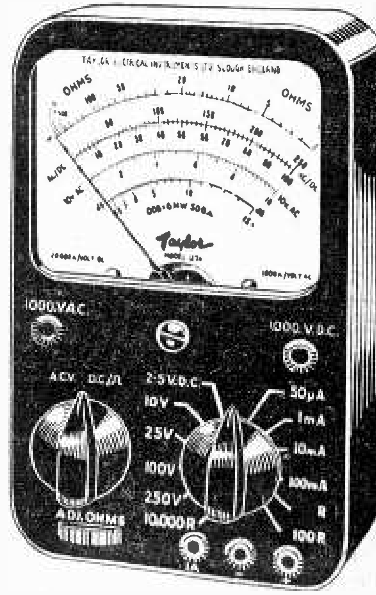

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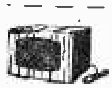

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QUARTZ CRYSTAL ETCHING

RAISING THE FREQUENCY OF A QUARTZ CRYSTAL

By J. B. Dance

THE resonant frequency of a quartz crystal can be increased somewhat by reducing the thickness of the crystal. It is not easy to alter the frequency of crystals which have gold or silver foil electrodes deposited on them (especially if the crystal is vacuum sealed), as these electrodes are usually "spluttered" on to the quartz using special apparatus. It would be difficult for the amateur to redeposit the electrodes on to the etched crystal or to connect wires to the foils. Such crystals are used mainly for frequencies below about 500kc/s. Above this frequency, rectangular quartz plates are common; the electrodes may consist of two metal plates held in position by a spring. The frequency of such crystals can be increased fairly easily by the method to be described.

Technique

There are two main methods by which the frequency of a quartz crystal can be raised, namely by grinding (lapping) or by etching. It is preferable to maintain the surface of the crystal flat to within 1/100,000 of an inch and therefore grinding creates some problems. If the crystal is not maintained perfectly flat, its activity diminishes; that is, when it is used in an oscillator circuit, the amplitude of oscillation becomes smaller and the crystal may even refuse to oscillate at all.

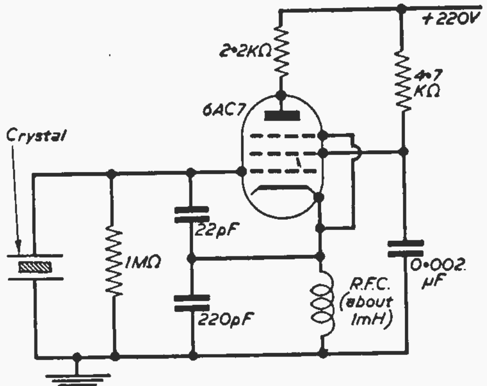


Fig. 1.—An oscillator circuit, using a crystal.

After a crystal has been ground, there is a certain optimum amount of etching which will lead to maximum activity. Ideally the amount of etching is such that the frequency is increased by etching by about the same number of kc/s as the square of the crystal frequency in Mc/s. Whilst this amount is not very critical, it is to be expected that a good commercially manufactured crystal will lose some of its activity during etching. This can usually be tolerated, however, in order to obtain a crystal of the desired frequency; otherwise preliminary grinding will be required.

Etching Materials

Quartz is chemically very similar to glass and therefore very few liquids will etch it away. Hydrofluoric acid has been used for etching, but the average person is most strongly advised to avoid the use of such an extremely dangerous liquid. A solution of ammonium bifluoride, whilst much safer, is nevertheless quite dangerous. It can be ordered from most chemists at about 7s. 6d. for ½lb. A solution containing about 1 or 2 parts of the solid in 5 parts of water should be made in a plastic container. It is quite satisfactory to place the liquid inside a sheet of polythene which is put in the mouth of a wide-necked bottle or on a "tin-lid." It is wise to use the ammonium bifluoride solution out of doors and to keep a bucket of water nearby in case the liquid should be splashed on the hand. Only a very small quantity of the etching solution is required.

A pair of tweezers for handling the crystal is essential. They should be plastic tipped so that the etching solution does not come into contact with the metal. It was found convenient to coat the points of the tweezers with a solution of polystyrene in an organic solvent, allowing it to dry before use.

Frequency Measurement

The crystal frequency should be measured as accurately as possible by means of a wave-meter or even an accurately calibrated receiver. The crystal has to be incorporated in a suitable oscillator circuit (such as that shown in Fig. 1) for frequency tests. The anode current is a measure of the crystal activity, being small with a crystal of high activity. The value of the anode current should also be found when the crystal has been removed from the circuit, as this is the value which indicates that no oscillation is taking place. The valve used was a 6AC7, but any sharp cut-off, high gm pentode such as the EF91, EF80, Z77, 6AM6, EF42 or EF54 would also have been suitable. No direct form of coupling was used between the oscillator circuit and the wave-meter, stray coupling being quite adequate.

The crystal should be removed from its holder by lifting it by the edges with tweezers, care being taken not to touch it with the fingers. If it is dirty or if it is accidentally touched with the fingers, it should be cleaned with chromic acid or with an organic solvent, as it is essential that the etching solution should come into contact with the whole of the crystal faces.

Etching Rate

The rate of etching depends on the temperature, the strength of the etching solution, the crystal frequency and the type of crystal cut. A maximum

(Continued on page 1010)

Checking Transistor Circuits

FINDING FAULTS WITHOUT INSTRUMENTS

By F. G. Roger

Checking Transistor Receivers Without Instruments

IF a transistor receiver fails to work or to give normal results, stage by stage checking will probably be the quickest way of locating the fault. The tests described here are particularly intended for constructors who have no instruments, or perhaps only a simple meter for reading voltages, etc.

A typical transistor circuit, with check points, is shown in Fig. 1. Most of the tests described can be applied to any transistor receiver, though the number of stages, and exact circuit details, will vary.

Newly-Built Sets

When the receiver has been constructed, but fails to work correctly, wiring should be carefully checked against the wiring plans or circuit. Any wrong connection, omitted lead, or short circuit can prevent the receiver working. Particular care should be taken to see that switch tags, or coil and transformer pins, are not shorted due to fragments of solder or projecting ends of wire. At the same time check that all joints are securely soldered.

If no fault is discovered, and components are new, the alignment of aerial, oscillator coil, and intermediate frequency stages may be so badly at fault that no signals can be received. If so, this can be corrected as described later. In a superhet such as that in Fig. 1, wrong alignment can make the set quite dead, though no actual wiring or component fault is present.

Transistor connections, and the pin identification of all coils and transformers, should be checked. If no fault is found, stage by stage checks can be made as will be described.

When examining wiring, assure that resistor values are correct. Colour coding is usual, and a mistake can be made in reading the values. A *slight* change in value from that specified will not usually have a severe effect, but a large error (such as in reading the number of noughts) may prevent the set working or cause very poor reception.

Resistance Checks

If a meter with "Ohms" scale is available, suspected resistors may be disconnected at one end, and measured. If a simple milliammeter is to hand, resistors can be checked with a 3V dry battery. From Ohm's Law, current will equal 3 divided by the resistor value in ohms. The result is changed to mA by multiplying by 1,000. For example, a 1k or 1,000Ω resistor in series with the meter and 3V battery will pass 0.003A, or 3mA. If no meter at all is available, suspected resistors should be checked again, to discover if any error was made in reading the values.

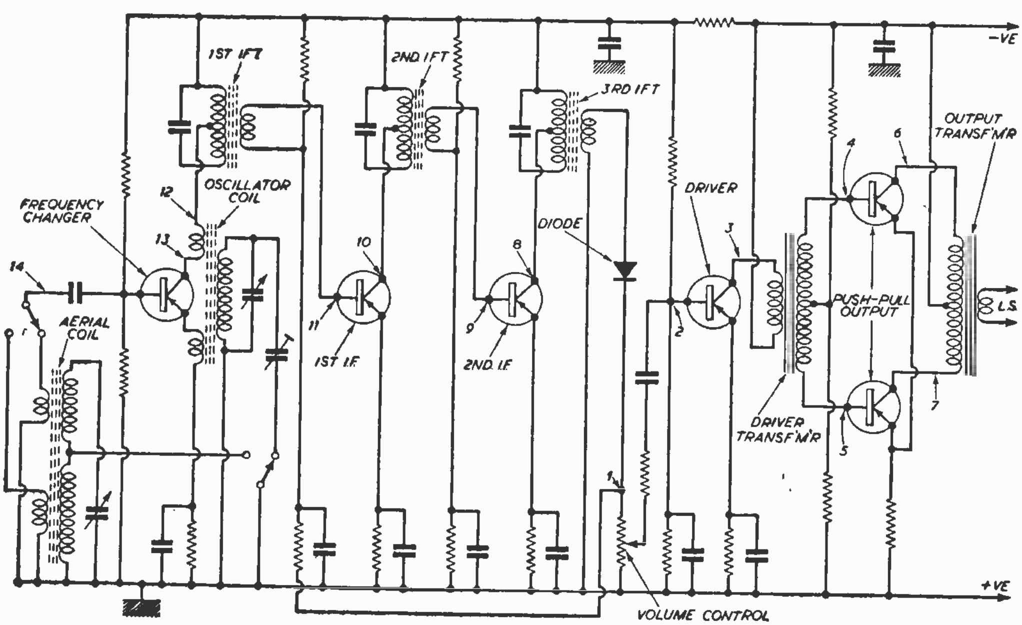


Fig. 1.—A typical transistor circuit with test points.

If these tests do not reveal any fault, stage by stage checks can be made. These checks apply both to a newly constructed receiver which has never worked correctly, and to an existing receiver which has failed.

Stage By Stage Checks

The purpose of these is to discover which stage in the receiver is at fault. Investigations are then localised to the few condensers, resistors, connections, and other items in the defective stage.

If headphones are available, they can be used to trace the audio signal. A 0·1μF or similar condenser should be included in one phone lead. Referring to Fig 1, the phones may be connected from (1) to chassis or earth line. If reception is good, the first three stages are working. Transfer one phone lead from (1) to (2). If reception ceases, the volume control or resistor and condenser between (1) and (2) are suspect. Remove the lead to (3). Signals should be considerably louder If not, the driver transistor or associated connections and parts are defective. Try the lead on (4) and (5). If there is no signal at either point that half of the driver transformer, or connections to it, should be tested. If the signal is still available at (4) and (5), check at (6) and (7). A further amplified signal should be heard. If not suspect the associated transistor.

Similar tests can easily be carried out with a TRF type receiver. When the point at which the fault is present is passed, reception will cease. Unsuspected faults can often be quickly located by this method.

For checking all stages, a source of audio and intermediate frequency signals will be extremely useful. Such signals may, of course, be obtained from a generator. But assuming that such an instrument is not available, an ordinary radio receiver may be pressed into service.

Fig. 2 shows stages in a typical battery portable or similar receiver. If a station is tuned in, an audio output will be available at point (1). Point (2) also gives an audio signal, at greater power. The usual volume control allows the signal strength to be adjusted.

Many receivers have a 465kc/s I.F., so a modulated signal at about this frequency may be taken from points (3) or (4). A short piece of flex can be used as a test lead. For audio outputs, use points (1) or (2), and include a condenser of about 0.01μF in series with the lead. For 465kc/s outputs, use points (3) or (4), and wire a 100pF or similar condenser in series with the test lead.

Mains receivers may also be used, with appropriate care, and reliable isolating condensers in the test lead. With a TRF receiver, no intermediate frequency signal will be available.

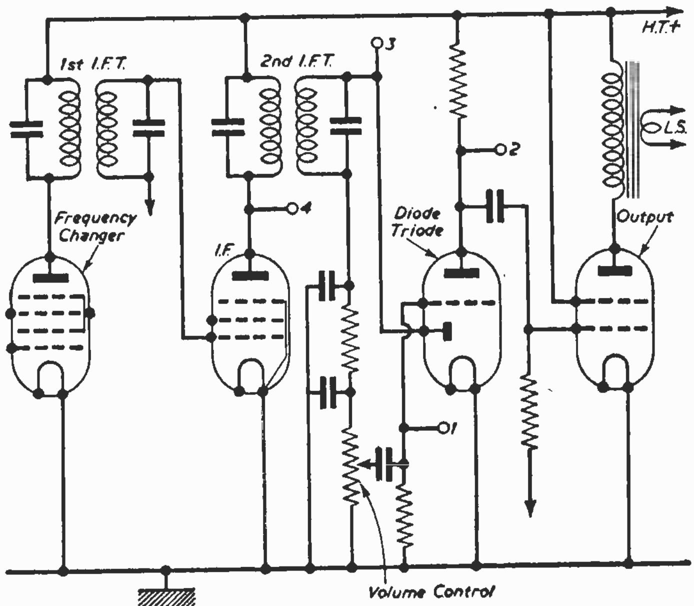


Fig. 2.—Obtaining audio and I.F. outputs from a receiver.

Method of Testing

The valve receiver is tuned to a station and switched on. For I.F. outputs, the valve receiver speaker can be muted by turning the volume control to zero. When using audio outputs, the speaker in the valve receiver must be muted. This can be achieved by connecting an equivalent resistance in its place.

To check the transistor receiver speaker and output transformer, if necessary, apply the audio signal at (6) or (7). With the A.F. signal injected at (4) or (5) volume should be increased. If the lead is removed to (3) and reception ceases, the driver transformer, or connections to it, are defective.

Taking the lead to (2) should give increased volume. If not, the driver stage is faulty. With the lead taken to point (1) output should be adjustable by means of the volume control. If not, this component, or wiring to its tags, must be checked.

When working backwards from the output stage in this way, reception will cease when the point of the defect is passed. Also look for additional volume, as each additional stage is brought in, and reduce signal strength with the valve set volume control, to avoid overloading.

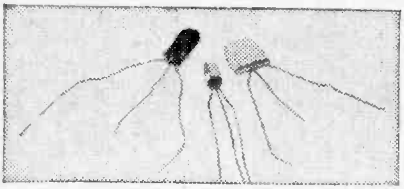
These tests will localise any defect in the audio stages of the receiver. Once this section has been cleared, or the defect found, attention can be given to the I.F. stages.

Checking I.F. Amplifiers

An intermediate frequency output is now obtained from the valve receiver, as described. The test lead is taken to point (8). If results are good, the third I.F.T. and diode are working. If signals were obtained with audio injected at (1), but not with the I.F. signal injected at (8) suspect the third I.F.T., or diode, or associated connections.

If results are obtained, transfer the lead to (9). Amplified signals should be heard. If not, suspect the second I.F. transistor, and associated resistors and wiring. If a signal is obtained, and valve receiver and transistor receiver both have a similar intermediate frequency, it should be possible to adjust the core of the third I.F.T. for maximum results.

The lead is then connected to point (10). If reception ceases, the second I.F.T., or connections



Various types and makes of transistor differ in appearance and three of the common types are shown above to facilitate identification.

to it, must be checked. When the lead is taken to (11), volume should increase. If not, suspect the first I.F. transistor, or associated components.

AVC Action

As more stages are brought into use, it will be necessary to avoid overloading the transistor receiver. A very small series condenser should be used in the test lead. This can be arranged by twisting two insulated wires together for an inch or so, and reducing the length twisted together if signals are too strong. When testing the I.F. stages, keep the transistor receiver audio volume control at maximum, and reduce volume if necessary by keeping down the strength of the signal injected.

With the lead connected at (11), or merely placed near this wire, the second and third I.F.T.s can be aligned. The lead may be transferred to (12). If reception ceases, suspect the first I.F.T. or connections to it. If results are obtained with the lead at (12) but not at (13) then the oscillator coil collector winding it defective, or the coil wrongly wired.

If the two receivers have the same intermediate frequency, and one of the transistor set, I.F.T.s cannot be adjusted for best results, connections to this transformer should be checked. The injected signal must be kept at a very low level, as explained, or the automatic volume control circuit of the receiver will make adjustment difficult.

If an intermediate frequency amplifier is suspected, it may be temporarily eliminated, with its transformer, by connecting point (11) to point (9), in the case of the first I.F. stage. Or the first I.F.T. can be eliminated by connecting point (10) to point (12), and so on. Any unused transistor should be unsoldered. One I.F. stage transistor can be compared with the other by using only one I.F. stage in this way, and trying the transistors in this stage in turn.

When the defective stage has been located, check wiring and resistor values carefully. If all components are in order, and connections are correct, the associated transistor must be suspected.

F.C. Stage

When good results are obtained with a weak signal injected at (13), but the receiver will not operate, the F.C. stage is probably defective. If the defect shows up on one waveband only, this would have immediately made the associated coil windings, switching, and wiring suspect. These items should in any case be checked, when a fault has been localised to the F.C. stage.

To eliminate the aerial circuit, lead (14) can be disconnected from the switch, and taken to an exterior tuned circuit. This can be any coil and variable condenser tunable to the medium or long wave band. The coil is returned to the earth line, or base feed network. If good reception is then possible, the aerial circuit is probably faulty.

Alternatively, an aerial may be connected to point (14). If reception is possible, the aerial circuit may be faulty, or trimming badly in error. But if neither of these tests allow any signal to be received, after the checks previously described, then the F.C. transistor is probably not oscillating. Oscillator coil connections should then be checked.

When reception is good with an aerial, but ceases when this is disconnected, lack of alignment alone may be responsible. If so, adjustment of the oscillator coil core, or aerial coils, or trimming, will remove the trouble. Remember to adjust cores at a high wavelength on each band, and trimmers at a low wavelength. Alignment is correct when no further improvement in volume is possible. As reception is improved by early adjustments, select weak stations for subsequent adjustments, to prevent the AVC action already mentioned.

Other Tests

If a new battery is not being employed, it should be checked with a meter. The correct polarity is absolutely essential. Switch, and positive and negative circuit continuity, can be checked by working along point by point from the battery.

A meter and small battery can also be used to check continuity of aerial, oscillator coil, I.F. transformer, and other windings. Disconnect one end of suspected windings first.

In most cases only a few of the tests described will be required. For example, if A.F. is applied as explained, working back from the speaker, a defect in the A.F. amplifier may be at once located. Similarly, if the A.F. amplifier is cleared, applying an I.F. signal to points (8) through to (13) will quickly show where the fault is.

A STEREO AMPLIFIER

8W WITH SINGLE-ENDED OUTPUT CIRCUITS

By R. Hindle

(Continued from page 902 of the February issue)

THE main circuit is fully conventional. R4 C1 and R12, C4 serve to decouple the first audio stages. The gain controls (VR1, VR2) are placed between the two audio stages where the signal is of the order of 1V. It will be seen that the H.T. switch connects the centre-tap of the 300–0–300V winding to earth via the indicator lamp L1 which, when the switch is in the "on" position, carries the H.T. current of the whole amplifier, or more correctly the charging current to the capacitor C8 which is of pulse form. Normal current lights this lamp quite adequately, the initial surge on switching on being evidenced by the brightness of the bulb. Excessive current will burn out this lamp, however, so that it acts as a fuse. The transformer specified has two 6·3V centre-tapped windings in addition to the winding for the rectifier heater and these are used one for each amplifier line. It is not essential to feed these from separate windings if a transformer with only one such winding is available. The "mains on" indicator lamp may be across one half of one of these windings, this being found to give quite adequate light with the lamps used. Centre taps go to earth, of course, and both sides of the heaters of the valves are floating.

The gain of this amplifier even without a pre-amplifier is likely to be adequate for the popular type of stereo cartridge of the crystal or ceramic type and the constructor may like to try it out coupled directly into this amplifier pending the production of the pre-amplifier. In this case it should be borne in mind that the crystal pick-up has to be correctly loaded in order to produce the correct frequency characteristic. The appropriate resistance is quoted by the makers and this value should be substituted for R1 and R9.

Construction

The amplifier is constructed on an aluminium chassis 12in. x 6in. x 3in. The drilling diagram was given in Fig. 3, which shows the sides of the chassis as if they were opened up. The layout shown is as on

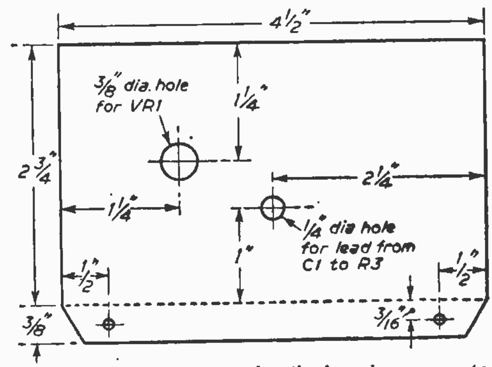
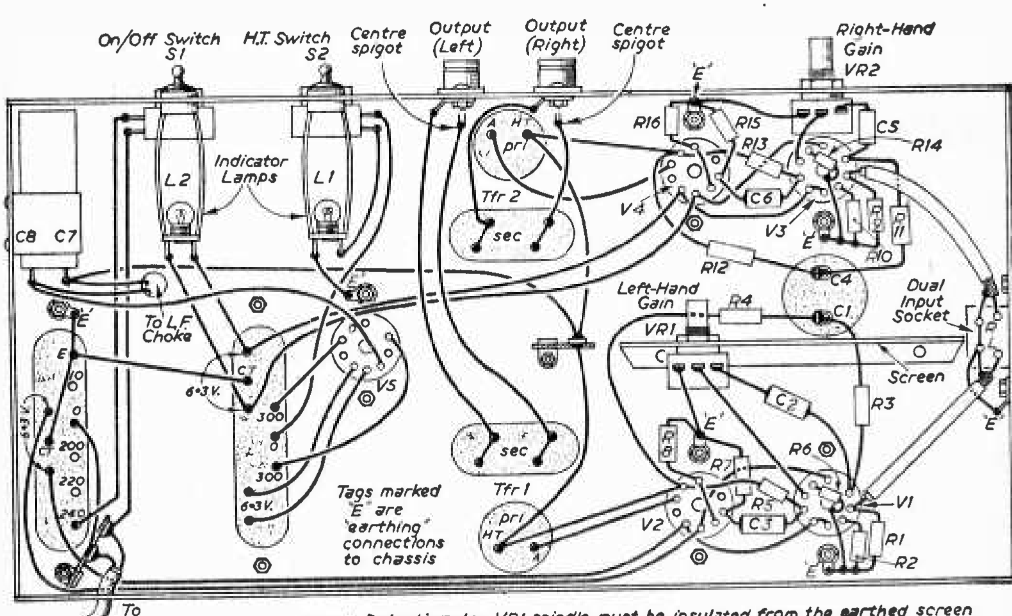
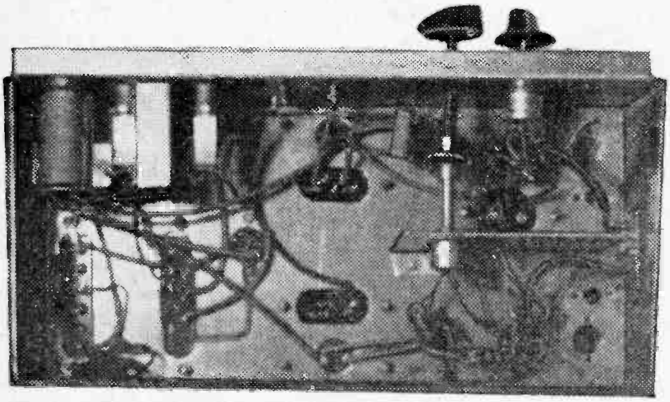


Fig. 4.—The drilling details for the screen to support the volume control.



Note : Potentiometer VR1 spindle must be insulated from the earthed screen

Fig. 5.—The under chassis wiring diagram.



The amplifier with all the wiring completed.

the outside of the chassis. The actual components to be used should be measured of course before drilling in case they are found to vary somewhat from the sizes shown. No mounting holes are drawn for valve holders and electrolytic condenser clip. The best way is to drill the hole as shown, drop in the component, turn it until the pins are in the relative positions shown on the wiring diagram (Fig. 5) remembering that this is the underneath of the chassis, and then mark the positions for the fixing bolts.

The mains and output transformers are of the shrouded type with soldering pins projecting underneath. Slots have to be cut in the chassis to allow passage for these, the method being to drill holes at each end of the slot position, then cutting away the metal between the holes. The positions for the possible additional valves are shown but not the holes themselves. The position of the screen is shown in Fig. 3, and the dimensions of the actual screen are in Fig. 4, from which the positions of the fixing screws on the main chassis can be taken.

Wiring

When the components are mounted, wiring should begin by feeding the heater supply with twin plastic flex, running this close to the chassis. A soldering tag under one of the securing bolts of each valve holder is used for all earths for the circuit associated with that valve. The only exception is the earth for the input socket which goes to a tag on one of the bolts holding this socket. All resistors are self-supporting on the valve-holders and are put as close as possible to the holder. The input lead from the socket to the valve is a short piece of coaxial cable of which the screen is earthed at the input socket end only.

If two signal lamps are to be fitted it will be found that the light from one bulb will shine through the window of the other, so obscuring the meaning of the lights, unless an aluminium shield is shaped and fitted between the lamps (or, of course, the enclosed type of signal lamp could be used).

Note that the output transformers can be used for either 15Ω or 3Ω speakers according to the connections made to the secondaries. The wiring diagram shows the two secondary windings of each transformer connected in parallel for 3Ω working. If 15Ω working is required the windings are connected in series.

The spindle of the volume control fitted to the screen is extended to the front of the chassis using a flexible coupler and a piece of bakelite rod. Bear this in mind when wiring so that there is room for the coupler. Knobs were fitted to the volume controls on the prototype, though these are really unnecessary; instead slots could be cut in the spindles for screwdriver adjustment.

This amplifier could supply 6·3V heater supply and up to 15mA of H.T. to a pre-amplifier if required. If this is needed it is suggested that an output socket be fitted at the mains transformer end of the chassis to allow easy connection.

Surrey's Most Modern Factory

The second stage in the erection of the new factory at Chessington for the Solartron Laboratory Instruments, Ltd. the electronic instrument manufacturing company of the Solartron Electronic Group, Farnborough, Hants., is now under way.

The administrative block of 25.000 sq.ft, which presently houses the instrument sales and the international division of Solartron, was occupied early in 1960. Also in this block are the instruments servicing and works training sections, together with some production facilities.

The second section of 50,000 sq.ft being built will be completed in October, 1961, and the third stage—a further expansion of 50.000 sq.ft, for which the Chessington site has available space—will be completed in three years' time. The final factory will be one of the most modern in Britain for the manufacture of electronic instruments and will employ more than 1.000 people.

The training centre, which is now incorporated in the new buildings, is claimed to be the most advanced for workers in electronics. A special study has been made of training methods, and the result is that operators are working confidently at full production at their benches after an initial training period of six weeks. The training continues from time to time in intensified courses for two years for the creation of an expert operator. In fact, training is integrated with production somewhat as is a University "sandwich" course.

The Solartron Electronic Group is a member of the Firth Cleveland Group of Companies, under the chairmanship of Mr. Charles Hayward, and currently Solartron's sales of electronic test instruments alone exceed £2,000,000 per annum, and it is planned to double this amount over the next five years.

The Solartron Group Director responsible for the Chessington factory is Mr. E. R. Ponsford, Managing Director of Solartron Laboratory Instruments, founded 13 years ago as the first Company of the Group.

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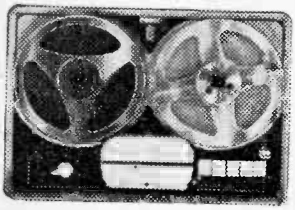

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5Y3GT	6/-	7C5	7/6	DF33	10/-	EF41	8/3	N37	10/6	UCC85	7/6
5Z4G	7/9	7C6	7/6	DF91	4/-	EF42	9/6	PCC84	7/6	UCF80	14/-
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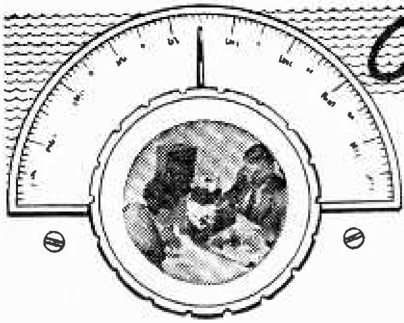
On Your Wavelength

BY THERMION



Aerial Design

ONE important feature arising out of correspondence from some of my readers was regarding the choice of aerial suitable for short-wave section. In the old days one was content to erect a large horizontal aerial system, usually running the full length of a garden, with a large mast at each end and the lead to the set was taken from one end or from the centre. This type of aerial (an inverted 'L' or a 'T') was a good all-round arrangement, and many newcomers are inclined to copy this arrangement and in spite of the all-important feature of height and insulation, and the use of the multi-stranded wire, only obtain very indifferent results. I am asked why this is. The main reason is that nowadays the majority of high-powered short-wave stations use a very high metallic mast which itself is the radiator or aerial. Under these conditions, therefore the signal is vertically polarised. As most readers know, it is desirable that the receiving aerial and the transmitting aerial should be in the same plane—compare the television aerial or the VHF aerial, for instance. The types of aerial used earlier and referred to above, are horizontal types and must naturally, therefore, be productive of inferior results. I have found that a very good aerial for all-round short-wave reception (that is, for a receiver which may be used on a large number of bands and not tied down specifically to one amateur band) consists of a vertical wire. The arrangement which I have tried out and have indeed recommended to a number of amateurs, is to fit a length of stout battening to the soffit carrying the gutter and to the end of the batten attach an insulator. One end of a length of wire should be attached to the insulator which should be at least 3ft from the walls of the house. The lower end of the wire should be anchored to a similar arrangement of batten and insulator fixed to the lower part of the house so that the wire is about 15ft long. The lead to the receiver is taken from the lower end. In the majority of cases this arrangement will be found productive of very good all-round results except in some cases, where the house acts as a screen. Except on the very short wavelengths, this should not have a very marked effect, and the only ill-effects which have been noted were in the case of very heavy rain-storms when the wall immediately behind the aerial became soaked, and signals did then drop off. If you have not tried such an arrangement, and are experiencing indifferent results in your short-wave working, perhaps you would try this scheme and let me know how you get on. I should like to stress that letters from my readers are always appreciated, especially where some scheme has been tried out and I will always be pleased to pass on the results of tests which may benefit other readers.

Rain Effects

Whilst on the subject of aerials I should like to mention a peculiar effect which was reported to me by an acquaintance. He was listening to the short-waves one evening and suddenly a ticking noise started on the band on which he was listening and he thought that it was an amateur starting up his transmitter, or a new beacon which he had not previously heard. He found, however, that the noise extended over the entire band and was not tunable. For a time he put it down to some form of electrical interference, but as it continued he began to wonder whether something was wrong with his equipment and so started to take particular notice. The ticking had an almost clockwork regularity, and was of very constant strength. Suddenly the regularity fell off and longer intervals occurred between the individual "clicks", and after a very short time they ceased. He was left wondering what had been the cause of the trouble and then continued his "searching". After a few minutes the noise started again with the constant regularity, and fortunately at that moment the wind apparently changed and he heard rain beating against his window. This gave him an idea and he looked out at his aerial and from the insulator nearest his house he saw a constant steady drip of rain. The water was running down the aerial, over the insulator to its lowest point, and then dripping from there. There was obviously some electrostatic effect taking place, and when he pushed up a length of wood to take away the drips the noise ceased, as it did when it stopped raining. The insulator, incidentally was one of the ex-government Pyrex long components and was not fractured—but it was coated with a very heavy deposit of soot. He gave it a good scrub with warm water and a detergent and at the next heavy shower it gave no trouble at all. Perhaps, therefore, if your aerial equipment has been up for some long time it might be worth while lowering it and giving it a clean up; a heavy sooty deposit could cause signal losses.

Heat Sinks

To obtain maximum efficiency from heat sinks used for power transistors, paint them dull black. Black is a much better radiator of heat, so that a small black heat sink may be much better than a larger shiny one. The principle can also be used for ordinary transistors. If a transistor is going to be near something warm, paint it with a shiny aluminium paint. If you are worried about the transistor itself heating, paint it dull black so it can easily radiate its excess heat.

A Versatile TAPE RECORDER

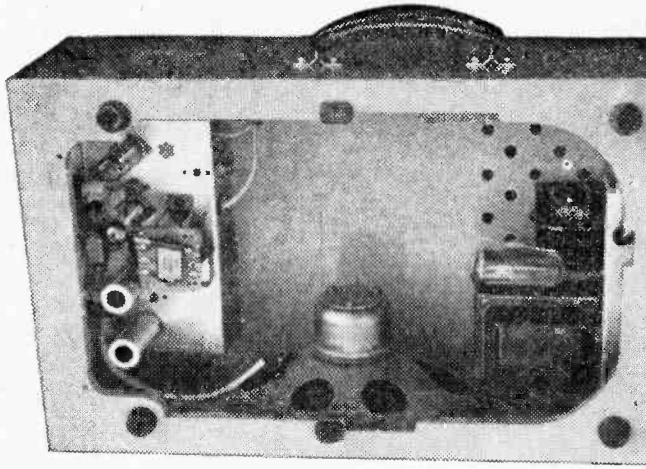
COMMENCING THE WIRING

By D. L. Woolley

(Continued from page 899 of the February issue)

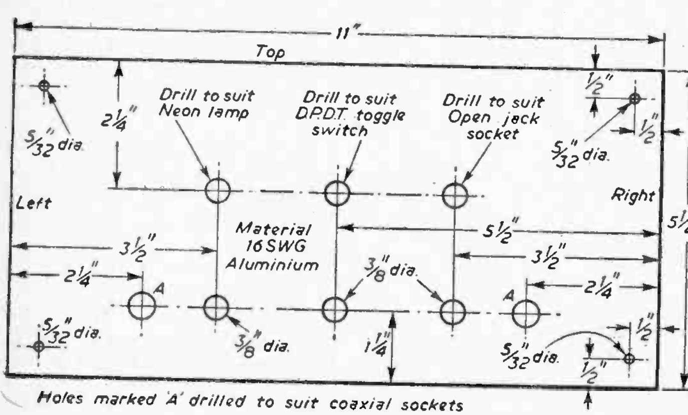
FOR the deck used by the author, the front panel should be made 11in. wide. If the record-level indicator is to be built into the recorder, the front panel should be drilled as shown in Fig 5 but if not the panel should be drilled as in Fig. 4.

For the record-level indicator (whether built into the recorder or not) a small moving-coil milliammeter is required. Any value of full-scale deflection up to a maximum of 5mA can be used. An old thermo-couple R.F. meter with the thermo-couple removed should be ideal as the scale readings are unimportant—a linear scale is not required, any calibration will do. The diameter of the meter-case should be about 2in. although up to 2½in. can be fitted on the panel. A hole to suit the meter should be cut in the panel including the three or four fixing holes required. If the depth of the meter-case is greater than 1¼in. the meter will not fit flush with the front of the panel as it will touch the second and third valves. This small difficulty can be overcome by using small stand-off washers to keep the front of the meter about ¼in. from the panel.



Drilling

When drilling the front panel it is advisable to make sure that the lower holes coincide, as near as possible, with the similar ones on the front wall of the chassis. The panel and chassis should now be cleaned with a cloth to remove all small metal particles and dust, before being put to one side.



Holes marked 'A' drilled to suit coaxial sockets

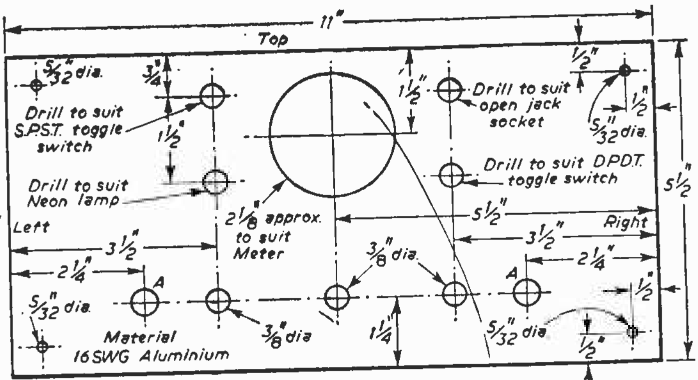
Fig. 4.—Drilling details of the front panel.

The Function Switch

As stated before, the function switch is very important. A good quality well insulated 3-pole, 3-way, 2-bank switch is required. It must be of standard size and not a miniature. This is important as the stray capacitance between tags on a miniature switch is high and such strays must be kept low in order to avoid instability and unwanted feedback.

First of all, the switch is dismantled, except for the ball-bearing mechanism, and all parts cleaned, especially the two wafers. These two wafers will, for convenience, be named Bank 1 and Bank 2. A small piece of Mumetal, radiometal or similar high-permeability metal is now needed for a screen between the two banks. Ordinary tin-plate would do the job, but not as efficiently as the Mumetal. An old cathode ray tube screen would be a suitable source of high-permeability alloy. The size of the screen is 3¼in. long by 2¼in. wide and it should be cut and drilled as shown in Fig. 6 although the measurements are nominal and depend on the size of the switch.

Holes P and Q should be drilled to suit the two fixing bolts of the switch. Two small grommet-holes are needed as shown. The switch is now built up as illustrated in Fig. 7. More details are given in Fig. 11. After bolting the switch together,

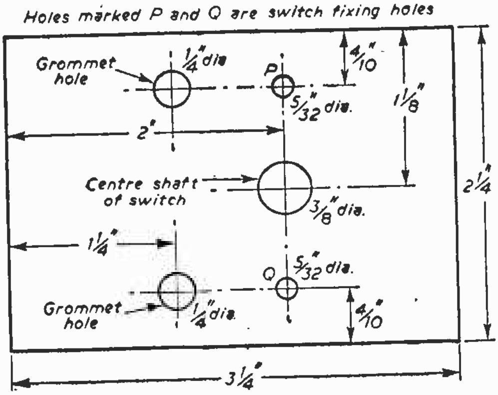


Holes marked 'A' drilled to suit coaxial sockets

Fig. 5 (above).—Alternative front panel drilling details when a record-level meter is to be included.

Fig. 6 (below).—Dimensions of the Mumetal screen for the function switch.

Holes marked P and Q are switch fixing holes



it can be partially wired. The connection from SA3 to SC3 (Fig. 2, page 898 last month) goes through the lower grommet-hole in the screen, whilst the two earthed sections on Bank 1 and Bank 2 are connected via the upper grommet-hole. It should be noted that the two banks are back-to-back and that the tags of Bank 2 face the ball-locating mechanism. In all cases SA, SB and SC, SD indicate the moving contact and the numbers 1, 2 and 3 the fixed contact being touched by the wiper. Although the switch, when described, seems a little complicated, its function and building are easy to see once one actually handles the switch and can inspect the various contacts.

Wiring the Amplifier

The most difficult part has now been completed and the actual wiring of the amplifier can be commenced. Two tag-boards are needed, one 16-way, and one 5-way. Both should have two contacts per tag and about 1¼in. between the inner tags. The larger tag-board is wired first; a complete wiring diagram is given in Fig. 10. It is best to wire in all connecting links before any actual components. Short leads of tinned-copper wire should be fixed to the lower, outer contacts, as shown, for connections to the valve-bases. About 2½in. is a convenient length to make these leads. The tag-board has been designed in such a way that no leads need cross, and each can take a direct route to the valve-base in question. As a general rule, all resistors should be fitted first, between the inner contacts followed by the capacitors between the outer contacts. Any leads likely to short or touch other tags, should be covered with thin sleeving.

Amplifier Components

A word is now needed about the components used in the amplifier. Ordinary carbon resistors are apt to be noisy in operation. If such resistors are used in a high-gain stage, any small fluctuation in the current through them is amplified and produces quite a high background noise level. Thus for resistors R1, R2, R3 and R4, good quality cracked-carbon, high-stability components should be used. This type of resistor need not be very expensive—in the prototype amplifier, all ¼W resistors were 10per cent tolerance high stability components.

C2 and C9 provide decoupling in the amplifier in conjunction with R16 and R5. These two capacitors are wire-ended tubular electrolytics, as are C1, C12, C19 and C22. Good-quality paper tubular capacitors must be used for C3, C10 and C14 as any leak in C3 and C10 will upset the biasing of valves 2 and 3, whilst a leak in C14 would pass a direct-current through the record/playback head and magnetise it. The equaliser circuit can now be built on to a small 5-way tag-board. The equaliser described uses a network of resistors and capacitors, but no inductors, as is more usual. In the recorder it was desired to use the fastest speed of 7½in. per second for recording concerts and the speed of 3¾in. per second for ordinary work. Although a speed of 1⅞in. per second is available on the tape-deck, it was decided to use this speed for private work only,

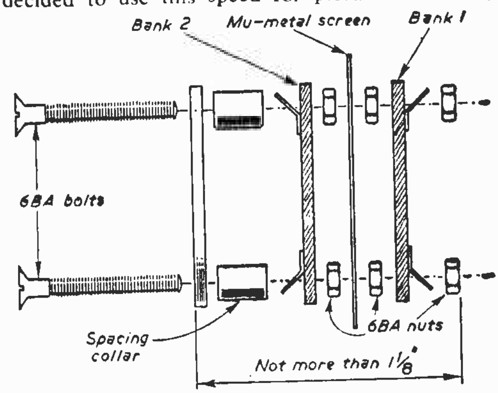


Fig. 7.—The assembly of the switch, including the Mumetal screen.

which did not require good quality at high volume. Recordings made at 1⅞in. per second are good, but only if played back quietly. High volume tends to make the noise-level in very quiet passages too much of a distraction.

Treble Boost

It will be seen from the frequency response graph that a great deal of treble boost is required above 1,500c/s. In many recorders, it is the practice to apply treble equalisation during recording and bass equalisation during playback, but for this recorder, treble boost is applied both during record and playback, whilst bass correction can be made on record or playback, or both. However, the magnetic tape is easily overloaded if too much bass equalisation is made during recording and only enough bass should be used to counteract any lack of it in the recording signal.

The circuit used for both 7½in. and 3¾in. per second was shown in Fig. 2 (page 898, Feb. issue). This circuit gives ample treble equalisation at both speeds although it must be stated that it is a compromise, providing theoretically correct equalisation at 6in. per second. R11 controls the amount of bass equalisation, and provides perfectly correct results at both speeds, being fully variable. Fig. 9 shows the approximate record/playback characteristics. The layout of the equaliser circuit and its tag-board are shown in Fig. 10. An alternative equaliser

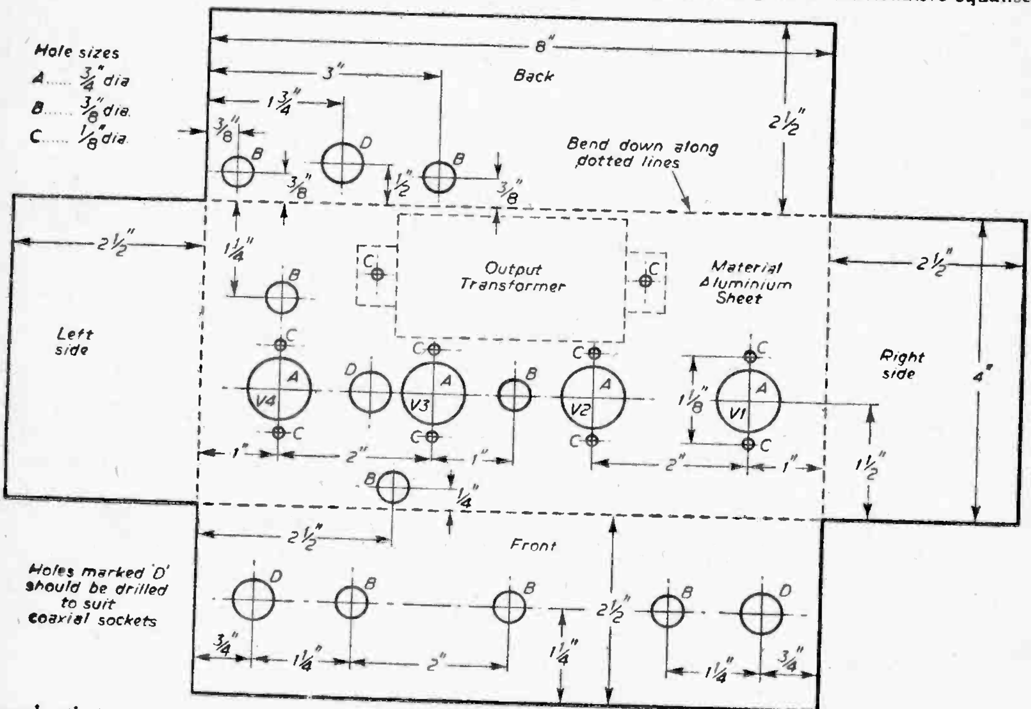


Fig. 8.—Drilling plan of the main chassis—holes for tag-strips, etc., have not been included.

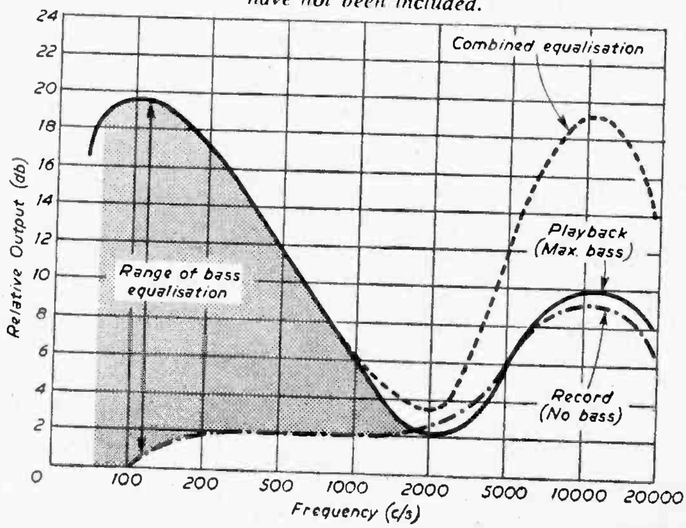


Fig. 9 (right).—Equalisation curves.

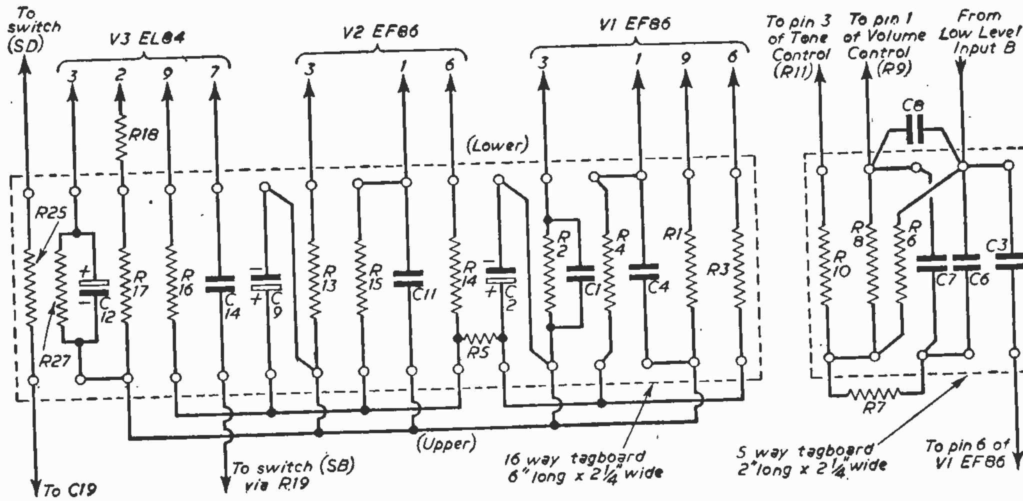


Fig. 10.—The main and equaliser circuit tag-boards.

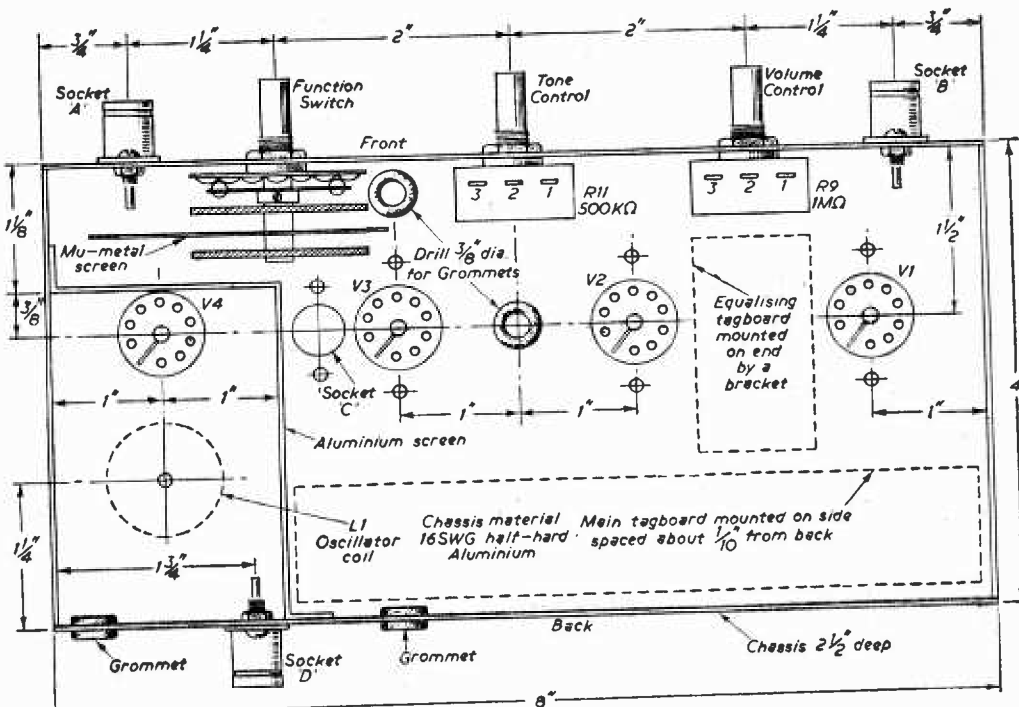


Fig. 11.—Underside view of the chassis.

circuit is shown in Fig. 12 with components from Fig. 2 to give the best equalisation at the three speeds. Either of the alternative equalisers can be built on to a 4 or 5-way tag-board. For C6a trial and error would probably give the best results, using a 300pF variable trimmer. For either type of equaliser, the tag-board should be mounted on to the chassis using a small bracket, and details are given in Fig. 13. The amplifier proper can now be built. Grommets and valve holders are put in

(Continued on 1021)

THE P.W. SIGNAL GENERATOR

MAKING THE POWER SUPPLY UNIT

By E. V. King

MANY constructors find they need a signal generator, but few eventually possess such a unit—their cost is generally too great. Although most enthusiasts cannot afford to buy a signal generator, they would nevertheless like to build one but are hampered by lack of plans. This new series has been especially prepared for the home constructor and will describe in detail the construction of a wide-range signal generator.

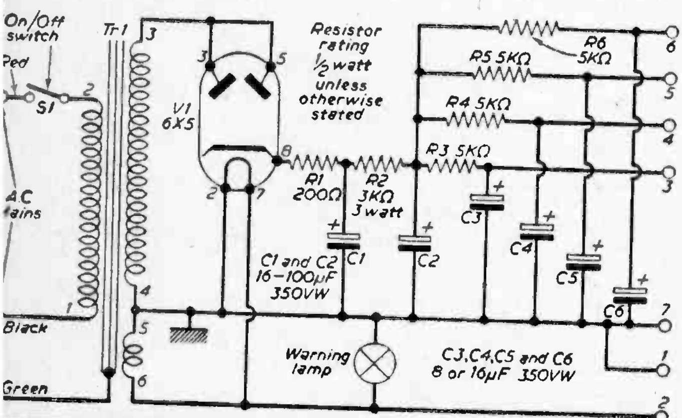


Fig. 1 (left)—The circuit of the power unit.

The chassis used for all the units are the same, basically a baking tin 6in. x 4in. x 2½in. high, and are easily obtainable. The bottom of the tin, after drilling the necessary holes for valve base, condenser and grommets, is soldered in position. The seam down one side of the tin is also soldered on both sides to give additional strength. There is no reason why readers should not make their own chassis or use aluminium instead of tin plate. If aluminium is used every earth connection to the chassis must be made via a solder tag and tight nut and bolt.

Component Positions—Outside the Chassis

Reference to Fig. 2 will show where to drill for V1 and C1/C2. The hole for V1 is 1⅛in. in diameter, and can be made with an ordinary carpenter's bit, chassis cutter, tank cutter or using small tin snips. The condenser hole will probably have to be a little larger. The valveholder may be bolted or soldered in position and the condenser clip bolted up tightly. Verify that the valveholder is an International Octal, as damage to the valve pins will be caused if the wrong one is used. Fit the valveholder so that the central "keyway" is in the position shown in Fig. 2.

The tag strip is attached to the rear of the unit by soldering as shown in Fig. 3. Make sure that tags 2 to 6 inclusive do not short to earth.

Grommets should be fitted in the holes A, B, and C. The switch S1 is fitted with the slot in the threaded portion uppermost, the switch is then "on" when pressed down. Leave plenty of thread showing outside the chassis and tighten the nut. For the position of S1 see Fig. 3.

The warning light is fitted from the inside using two nuts and bolts.

Component Positions—Inside the Chassis

Fig. 3 shows the position of the transformer. It is bolted tightly to the tin plate and should have a small strip of mild steel fitted on top of the chassis. This strip is shown shaded in Fig. 2 and the general method of mounting in Fig. 6. If this is not incorporated the unit will work well, but will give rather more hum than necessary.

A small tag strip with two isolated tags is soldered to the side of the chassis near the primary side of the transformer. (Fig. 3.)

Alternative Component Positions

If an upright-mounting transformer is used, it will have to be fitted on the top of the chassis. The component positions remain the same with the exception of the following points.

The condensers C3 to C6, which are wired in, will be inside and not outside the chassis. The transformer itself will be outside in the position shown in Fig. 8, and grommet holes will be required at E, D, and F. Another 6-tag strip (with 4 tags isolated) is required and is soldered in place inside the chassis about ¼in. from the top, as in Fig. 9. Make sure that no tags are earthed other than those at the extreme ends (i.e. 1 and 7 in Fig. 9).

All other components are fitted during the wiring process.

Wiring the Unit

It will pay the beginner dividends in both time and patience if he develops the habit from the start of checking, double checking and testing at every stage of his work. This will be explained in detail.

Refer to Figs 1, 2 and 3 as you proceed. Take the mains lead through the grommeted hole "C" and tie a knot in it. Connect the black wire to one unearthed tag of the small tag strip. Also solder one primary lead from the transformer to the same tag. Check that all soldered joints are well made, strong, and with no sharp edges. Now solder the red mains lead to any tag on S1. Solder the other primary lead to the unused tag of S1 If a three-core cable is being used, solder the green lead to the chassis. The chassis may be separately earthed if desired, but it must be earthed in some manner.

Testing the Transformer Primary

Make sure that the leads on the secondary side of the transformer are not touching anything. Plug in and switch on. A hum should be heard. If no hum is heard check the power supply, mains lead, S1 and the primary wiring.

If a loud hum is heard check that the transformer is correctly mounted with the steel strip above, and that the secondary wires are not shorting.

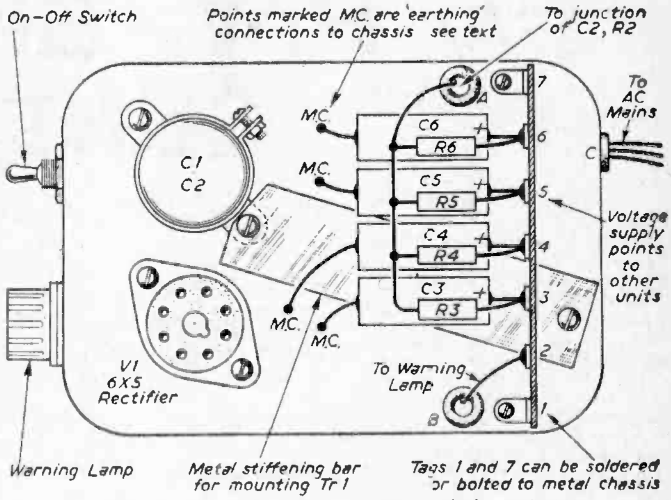
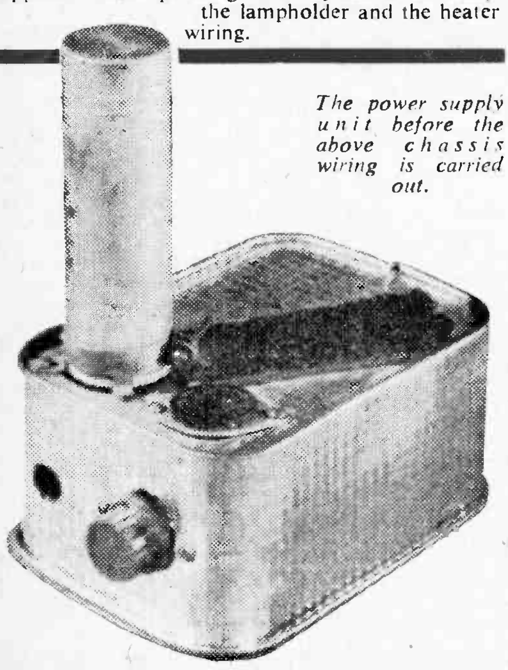


Fig. 2.—The above chassis view of the unit.

Wiring the Heater Circuit

Scrape and tin the thick 6·3V on the secondary side of the transformer; solder one to the chassis (use a large very hot iron for this joint) and connect the other to one side of the warning lamp holder. Connect the other tag of the holder to earth (always use a very hot iron for chassis connections). Screw in a low wattage, 6V lamp. Plug into the mains and switch on. Ensure that the lamp lights. If it does not and the transformer appears to be operating correctly check the lamp, the lampholder and the heater wiring.



The power supply unit before the above chassis wiring is carried out.

Refer to the valveholder and looking under it make sure you have the tags numbered correctly, sometimes this is not always easy. Be quite sure about this. Solder a wire from chassis to pins 1 and 2. Also solder a wire from pin 7 to the unearthed tag of the lampholder. Plug in the 6X5 valve and check that when connected to the mains and switched on, the heater is alight. If it is not, check the valve pin numbers and the valve itself. Take an insulated wire from the unearthed tag of the lampholder through the grommet at B and on to tag 2 above the chassis (see Fig. 2). This is the main external heater connection.

Take the lamp out of the holder and hold it between tag 2 (Fig. 2) and earth (chassis). Switch on. The lamp should light. If not, the last wire added has been wrongly connected or tag 2 is shorting to earth. Put the lamp back in the correct holder and test again.

Warning

When carrying out this procedure of building and testing, never be tempted to work with the unit plugged in. In any case, when working in a garage or other location with a concrete floor it is wise to have a thick rubber mat on the ground.

Wiring the H.T. Circuit

Temporarily connect the two red secondary leads of the transformer to a small wattage (15 or 25W) main lamp or mains neon lamp. Switch on and check that the secondary H.T. is all right. If this lamp does not light, but the one in the holder does, check that the lamp itself is not to blame, that the holder is correctly wired and fitted and that the wires are not shorting.

Disconnect the mains lamp, and connect one secondary wire to the chassis. Connect the other to pins 3 and 5 of the valveholder. If a voltmeter is available connect it on the 250V range (D.C.) to the chassis (negative) and pin 8 of the valveholder (positive). Switch on, and the meter should read about 100 to 150V D.C. The needle may quiver a little as the supply is unsmoothed. If no reading is obtained the valve is suspect.

Connect pin 8 through a resistor (R1) to one positive tag of the large electrolytic smoother C1/C2. You will need to examine this carefully as they vary somewhat in their coding. One tag is the negative pole, usually either black or colourless. Two other tags are the C1 and C2 positive tags and are usually, but not always, yellow and red. Sometimes the positive tags are red and colourless, so care is needed. Details are printed on the side of the can. if the instructions tell you that one positive connection is for the maximum ripple, that is the one to use for the connection to R1. Connect the negative tag to the chassis.

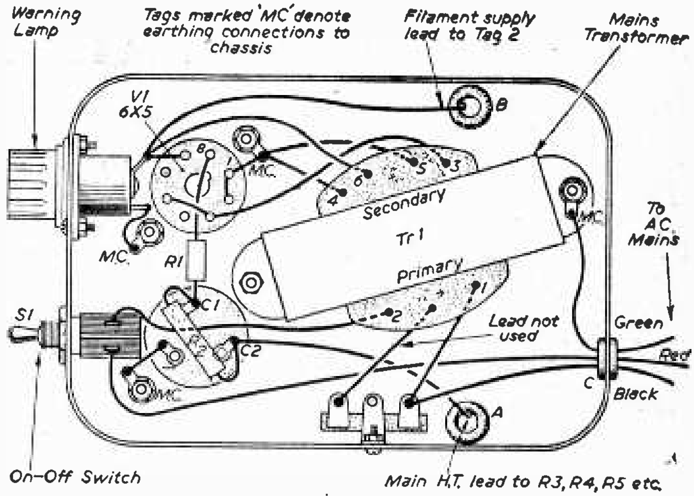


Fig. 3.—Underchassis wiring and layout.

Testing the Initial H.T. Supply

Connect the voltmeter on the same range as before, but with the positive lead on to the junction of R1 and C1. Switch on, and the D.C. voltage should be about 250 with no vibration of the needle. If not, verify that R1 is a good component and of the correct value, and that C1 is correctly connected.

Wiring the Smoothing and Decoupling Circuits

Connect R2 so that it stands in air supported on the tags of the electrolytic condenser C1/C2. Connect the voltmeter as before, but with the positive lead to the junction just made between R2 and C2. Switch on and the voltage should be about 250. Switch off. Leave for 30 seconds. Short, with an insulated screwdriver, R2 and earth (chassis) when a spark should jump, showing that the condenser C1/C2 is working properly and holding a charge. Henceforth, whenever you are working on the unit after switching it off always discharge the condensers twice at 15-second intervals before recommencing work.

Connect an insulated wire to the junction of R2 and C2, lead it through the grommet "A" and bare the end for 2½in. to allow connection to resistors R3 to R6.

With reference to Fig. 2, cut the leads to R3, 4, 5 and 6 so as to leave about ¾in. lengths on each. Solder them as shown between tags 3, 4, 5 and 6 and the bared lead. Bend them more or less upright. Switch on the supply and connect each tag (3, 4, 5 and 6) to the voltmeter positive in turn. The voltage reading will depend on the voltmeter used. Expect a drop of the following voltages from the reading previously taken at the junction of R2 and C2:

		Voltage Drop:
200Ω/V meter	...	50
500Ω/V meter	...	20
1000Ω/V meter	...	10
5000Ω/V meter	...	2
Above 5000Ω/V	...	Negligible

If one tag gives a different voltage from the others then the associated resistor may have been wrongly chosen. If any tag gives zero reading it is earthing to chassis or the resistor is completely open circuit. Check by substitution.

Now solder in the four decoupling capacitors (C3 to C6). These need not all be the same type, but the constructor must again make sure of the polarity of the connections. Solder them as shown in Fig. 2, between the tags and the chassis. Negative ends going to chassis always.

Now check the voltage at each tag again and although they may vary somewhat (10V or so) from one to another, all should give over 200V. Switch off and quickly short each in turn to chassis with an insulated screwdriver. Each should give a good sharp spark and "crackle". Remember to discharge twice at junction R2/C2 as previously explained.

Specification of the Power Unit

The unit will operate from 200 to 240V A.C. mains and gives four outputs, almost independent of each other, at about 220V (low current). A 6·3 A.C. filament supply is also available. The unit may be used for other purposes than that in mind, and readers may take H.T. at 250V at up to 50mA from the junction of R2/C2 for driving amplifiers, tuners, etc. Being small, the unit is very useful in the radio laboratory. In this unit the various outputs will be used as follows:

Tags 1 and 7, earth (chassis), this is H.T.— and one side of L.T.
Tag 3, R.F. oscillator and cathode follower;
Tag 4, L.F. 400c/s oscillator for modulation;
Tag 5, L.F. variable Wien bridge oscillator (A.F.) and crystal calibration unit;
Tag 6, amplifier for variable A.F. oscillator;
Tag 2, heater lead to all units.

Using Upright and Larger Transformers

The type of transformer used is not critical so long as the ratings are those specified in the components list. The placing and mounting of the transformer will depend on its construction but

(Continued on page 998)

STYLUS WEAR TIMER

AN EFFICIENT MEANS OF KEEPING A RECORD OF STYLI PLAYING TIME

By F. Churchill

RECORD manufacturers point out that styli may be worn and in need of replacement long before this is made apparent by increased surface noise; with consequent damage to valuable records. The recommended life of a diamond tip is about 2,000 hours, and that of a sapphire about 40 hours. There are probably some methodical enthusiasts who keep a careful note of playing times, but I suspect that most of us quickly lose the habit. By using the simple little instrument described below, it is possible to know at any time, exactly how long a particular stylus has been in use.

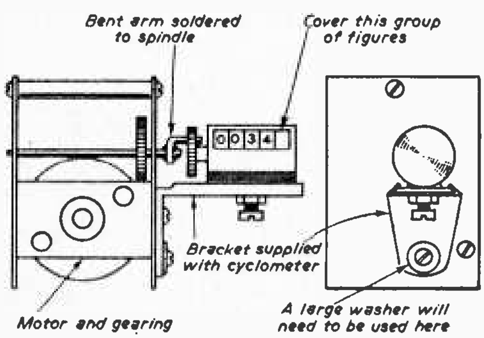


Fig. 1.—The method of coupling the motor to the cyclometer.

Components Required

The parts required are, a small "shaded-pole" synchronous motor fitted with reduction gearing giving hours instead of miles, a cyclometer or small counter, a piece of $\frac{1}{16}$in. sheet brass—2⅝in. x ¾in.—and a few 4B.A. nuts and bolts. The motor complete with suitable gearing can be obtained at moderate cost from suppliers advertising surplus equipment. (Note, an ordinary electric clock will *not* do, because it is not self-starting.) Whilst it is possible to get the counter from a similar source, if one buys a new cyclometer, this will be supplied complete with an adjustable bracket, and thus make it unnecessary to construct one from brass sheet.

Transmitting the Drive

The method of transmitting the drive from the final spindle to the counter will depend on the type of spindle fitted to the latter instrument. A true cyclometer is fitted with a "star" wheel, and this type can be driven by a bent arm fixed to the gear spindle and engaging in one of the teeth of the "star" wheel. The author's cyclometer has a spindle which is slotted at one end; consequently it was only necessary to file two flats on the end of the gearing spindle, which, when engaged with the slot, formed a positive drive.

Many of these small motors with gear-train have a spring-loaded clutch on the final spindle, to facilitate altering the hands when used as a clock. It is essential that this clutch is made inoperable, so that the drive is direct. If this is not done, there will be a tendency for the drive to slip whenever the load increases, e.g. when the figures change from 99 to 100, etc.

It is advantageous to fit a length of thin twin-flex to the existing motor leads so that the unit can be placed in any convenient position; taking care to keep well away from pick-up leads and the pre-amp, to avoid inducing hum. These leads are connected to the terminal block on the gramophone motor, so that the counter only operates when the gramophone motor is actually switched on.

As fractions of an hour are not required, it will avoid confusion if the extreme right-hand set of figures are obscured with a piece of opaque Sellotape, or by some other method.

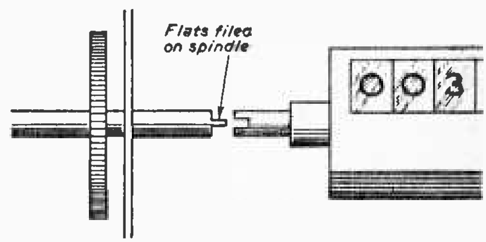


Fig. 2.—An alternative method of coupling the motor to the cyclometer.

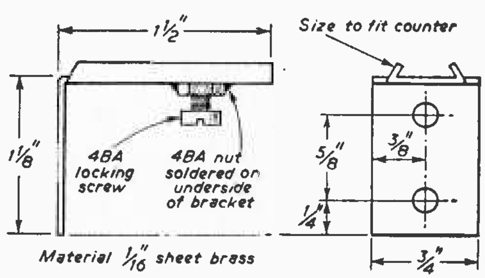


Fig. 3.—Dimensions of a suitable mounting bracket.

CORRECTION

In an advertisement for Stern Radio Ltd., which appeared in the February issue of PRACTICAL WIRELESS, the price given for "A Complete Kit of Parts for Stereo Pre-amplifiers" should have read £12 10s. 0d. and not £21 10s. 0d. as printed.

A valve voltmeter

THIS INSTRUMENT GIVES READINGS FROM 1 TO 1000V.

By J. B. Dance

IF an ordinary voltmeter is connected across two points in a circuit, it takes a certain amount of current from the circuit. The voltage across the two points will normally decrease when a current is being taken owing to the internal resistance of the circuit, and therefore the true voltage between the points when the voltmeter has been removed is not known. This error is often negligible, (e.g. when measuring power supply voltages) but it always exists and may be very large in high-resistance circuits. The error can be minimised by using a voltmeter which has a high internal resistance in comparison with the internal resistance of the circuit being measured.

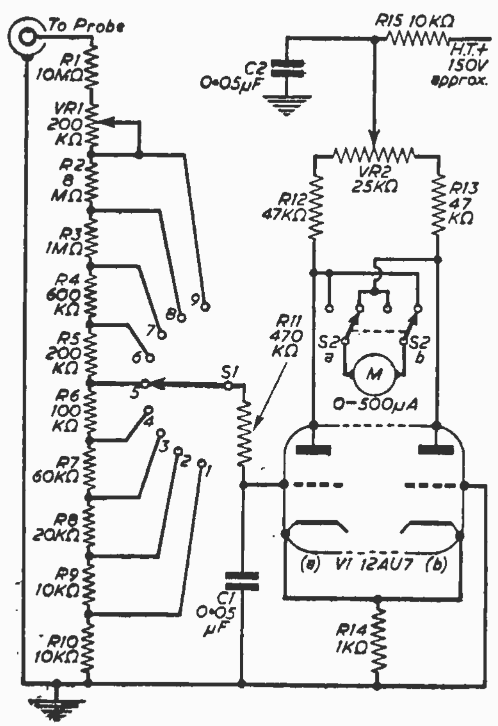


Fig. 1.—This circuit may be used over nine voltage ranges.

Moving Iron Voltmeters

Moving iron voltmeters invariably have a low internal resistance. An expensive moving coil 0–50 microammeter has an internal resistance of 20,000 Ω/V at full scale deflection when it is used as a voltmeter; even this is not high enough for some purposes, but all cheap meters have an internal resistance much lower than this.

The four main types of simple apparatus which can be used to measure voltages without taking any appreciable current are:—

1. neon bulb circuits,
2. electrostatic voltmeters,
3. potentiometer circuits,
4. valve voltmeters (including methods using cathode ray tubes).

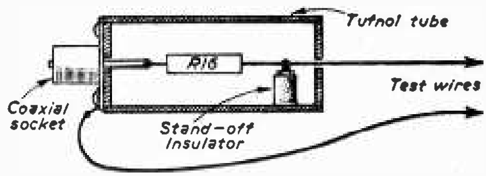


Fig. 2.—The test-probe for D.C. instruments.

Methods 1 and 2 cannot be used to measure voltages of values less than about 100V. Method 3, when used in skilled hands, is excellent, especially for low voltages, but method 4 is probably the most convenient method when quick direct readings over a large variety of ranges is required.

The circuit of a simple valve voltmeter is shown in Fig. 1. This has nine D.C. ranges shown in Table 1 (page 998), with full scale deflections varying from 1V to 1,000V. It can also be used to measure audio and radio frequency voltages below 50V. The D.C. input resistance is greater than 20M and is constant from range to range. On the one voltage range, at full scale deflection, the current taken by the instrument is about 50/1000 of a microamp (20M/V) whilst on the 1000V range the current taken is 50μA at full scale deflection (20k/V).

D.C. Probe

The probe shown in Fig. 2 is used for D.C. measurements. It is connected to the main instrument by coaxial cable. The body of the probe consists of a "Tuffnol" tube with end pieces which are glued on to the tube after the resistor (R16) and the stand-off insulator have been fitted inside the probe. The wire end of the resistor is used as one contact, the other contact being made by means of a wire connected to the outside of the coaxial cable. Coaxial connection to the main instrument is used in order to prevent hum voltage pick-up in the high resistance circuits.

Components

All of the resistors, R2 to R10 should, if possible, be high-stability components and it is desirable that they should have a tolerance of ± 1 per cent. If great accuracy is not required, however, ± 5 per cent resistors could be used. R1 and the D.C. probe resistor, R16, should be high-stability components, but their tolerance is not important. If high-stability resistors are not available, it should be possible to obtain reasonably accurate readings by using the ordinary carbon type. The unusual resistor values can be made by using two or more resistors in series or parallel combinations.

A ceramic wafer switch was used for S1, so that the unwanted leakage current would be kept to a minimum.

C1 should be selected for high leakage resistance. A good quality component should have a leakage resistance of over 2,000M.

The valve used may be a 12AU7 (B9A base) o a 6SN7 (octal), but almost any small double triode would be satisfactory providing that the constructor is willing to adjust the resistor values to suit the valve chosen.

The double-pole double-throw switch S2(a) and S2(b), in the valve anode circuits, is provided so that the meter deflection can be arranged to be in a forward direction, no matter whether the voltage applied to the grid of V1(a) is positive or negative. If a centre reading microammeter had been available the switch S2 would not have been required. The meter was calibrated from 0 to 500μA and it was therefore easy to read the voltages being measured directly in volts for all of the ranges shown in Table 1.

Principle of Operation

The voltage from the probe is fed into the potential divider resistors R1 to R10. The total resistance of the potential divider (including the resistor in the probe, R16) is constant whatever the position of S1. The range is selected so that the switch S1 taps off a voltage from the potential divider which the valve circuit is capable of measuring (a fraction of a volt). R11 and C1 filter out any alternating voltages before the input reaches the grid of the valve. VR2 is adjusted before use so that the meter reading is zero when no input is being applied.

Let us suppose that a small positive voltage is applied to the grid of V1(a). The anode current of this valve will then increase, making the anode voltage more negative with respect to the chassis. At the same time both cathodes become more positive owing to the increased current through the common cathode resistor, R14, and V1(a). This is equivalent to a negative bias on the grid of V1(b) and the current through this valve therefore decreases and its anode voltage increases. A current will therefore flow from the anode of V1(b) through the meter to the anode of V1(a). If a negative voltage is applied, the current will flow in the reverse direction.

D.C. Calibration

The instrument should be used to measure any accurately known voltage which ought to give a full scale deflection on any particular range, e.g. 100V. The value of R1 should then be adjusted until a value is found which gives almost exactly a full scale deflection on the correct range. The value of this resistor will generally be of the order of 10M. Various high-stability resistors should be tried for R1, until a value which is very nearly correct is found. The final adjustment is then made by VR1. The value of this potentiometer should be kept reasonably small in order to preserve stability.

When one range has been calibrated, all of the others should be correct providing that the tolerance of the resistors R2 to R10 is within the limits of accuracy required.

Simplified Version

The number of high-stability resistors required can be reduced by constructing an instrument having fewer ranges. The ranges can be selected to meet the requirements of the constructor, but an example of a simplified instrument is given in Fig. 3. In this circuit the ranges provided are 0 to 100V (switch position 1), 0 to 10V (position 2) and 0 to 1V (position 3).

COMPONENTS LIST

R1—10M (see text), high stability.
R2—8M ½W high stability.
R3—1M ½W high stability.
R4—600k, ½W high stability.
R5—200k ½W high stability.
R6—100k ½W high stability.
R7—60k ½W high stability.
R8—20k ½W high stability.
R9—10k ½W high stability.
R10—10k ½W high stability.
R11—470k ½W.
R12—47k 1W.
R13—47k 1W.
R14—1k ½W.
R15—10k ½W.
R16—2 to 4M high stability.
R2-R10 are 1per cent tolerance; R11-R16 20per cent tolerance.
VR1—200k preset potentiometer.
VR2—25k (or 50k) potentiometer.
C1, C2—0·05μF, 500VW.
M—0-500 microammeter.
S1—Single-pole 9-way ceramic single wafer switch.
S2—Double-pole double-throw toggle switch.
V1a and V1b—12AU7 or similar (see text).

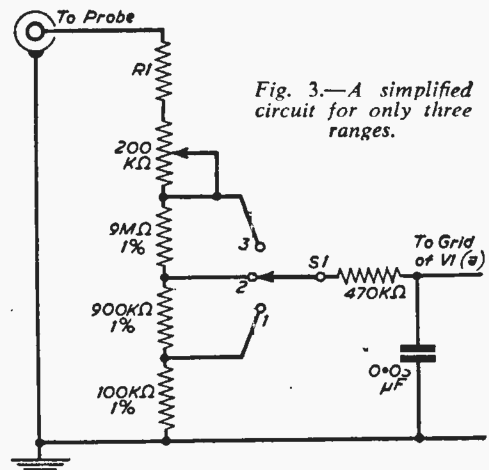


Fig. 3.—A simplified circuit for only three ranges.

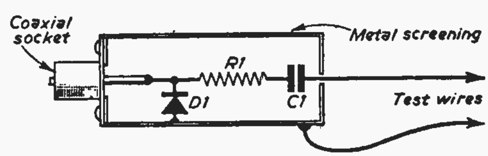


Fig. 4.—An A.C. test-probe.

A.C. Probes

A separate probe must be used for all A.C. measurements and it is desirable that different probes should be used for audio and radio frequency measurements. The circuit of an A.C. probe is shown in Fig. 4. C1 removes all D.C. from the input and the series resistor R1 prevents the diode and the capacitance of the coaxial cable from loading the circuit under test to any appreciable extent. The diode D1 shunts all negative-going pulses to the screening, whilst positive pulses are fed down the coaxial cable to the main instrument. The valve grid receives a steady positive voltage which is measured.

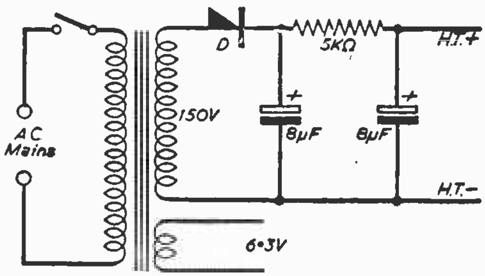


Fig. 5.—A suitable power supply unit. "D" should be 150V, 5mA, or more.

In the case of the audio probe, the value of C1 may be 0·05μF or 0·1μF, but a 500pF, ceramic condenser is much more suitable for the radio frequency probe. If one wished to make high audio and low radio frequency measurements only, it would be possible to do this with one probe by using the compromise value of about 0·002μF for C1 in Fig. 4.

The use of the resistor R1, shown in Fig. 4, not only enables the range to be accurately adjusted, but also prevents the circuit under test from being appreciably loaded by the capacitance of the coaxial cable. The average constructor will not wish to make actual measurements of radio frequencies in volts, but will only require to compare voltages (e.g. when aligning a receiver). It will therefore probably be unnecessary to calibrate the R.F. probe against a standard instrument. The audio probe can be calibrated by using suitable 50c/s voltages from transformers and a standard A.C. meter. R1 of Fig. 4 may be adjusted so that the instrument reads either peak A.C. voltages or root mean square voltages, as desired.

An OA81 is a suitable diode for both R.F. and audio probes, but care should be taken that no attempt is made to measure an A.C. voltage which has a peak value greater than about 50V. The maximum frequency at which the R.F. probe can be operated satisfactorily is not known, but it should be quite satisfactory for comparative measurements to over 10Mc/s. The minimum frequency of accurate operation of the audio probe is well below the lowest audible frequency.

TABLE I

VOLTAGE RANGES OF THE CIRCUIT SHOWN IN FIG. 1

Switch Position	Range (V)
1	0–1000
2	0–500
3	0–250
4	0–100
5	0–50
6	0–25
7	0–10
8	0–5
9	0–1

Power Supply

The instrument requires 6·3V at 0·3A for the valve heater and approximately 3mA at about 150V as H.T. This can usually be obtained most conveniently from a receiver power supply using a suitable series dropping resistor. If the receiver H.T. voltage is 250V, a 33k, ½W resistor should be used in the H.T. lead. Alternatively the power supply shown in Fig. 5 could be used.

Construction

The controls on the front panel are S1, S2, and VR2. The meter itself is also fixed there. Resistors R2 to R10 should be mounted around the switch wafer, S1. The potentiometer VR1 should be mounted on a piece of ebonite or perspex in order to minimise leakage. The insulating material used can be mounted on a hole cut in the chassis.

The P.W. Signal Generator

(Continued from page 994)

little difficulty should be encountered if the transformer maker's connection details are followed carefully in conjunction with the circuit diagram.

COMPONENTS LIST FOR POWER SUPPLY UNIT.

Resistors:
R1—220Ω ¼W.
R2—3k or 3·3k 3W.
R3—4·7k ¼W.
R4—4·7k ¼W.
R6—4·7k ¼W.

Condensers:
C1—350VW, any value between 16 and 100μF. Electrolytic.
C2—As for C1. (These are both obtained in one can.)
C3, 4, 5 and 6—Each 350VW 8 or 16μF. Electrolytic.

Chassis: 6in. x 4in. 2½in. high of tin plate or aluminium. (Prototypes use baking tins. The removable bottoms are soldered in place and form the top.)

Switch: S1 Arcolectric T600.

Transformers: Tr1. Input to suit mains (or 200/220/240V tapped). Secondary 0—250V or 0—300V at about 60mA and 6—6·3V at about 2A.
Note: Transformers with a centre tap, i.e. 250-0-250V secondary can be used, but one 250V lead must be cut short or taped and must on no account be used. This type was not used in the prototypes.

Valve: V1, 6X5. International Octal Valve base.

One or two tag strips, 5 tags not earthed, two earthed.

Warning Lamp: Arcolectric SL82/1/3 from dealers or Messrs. Arcolectric (Switches) Ltd., Central Avenue, West Molesey, Surrey.

Bulb: Any small wattage 6·3V M.E.S. type.

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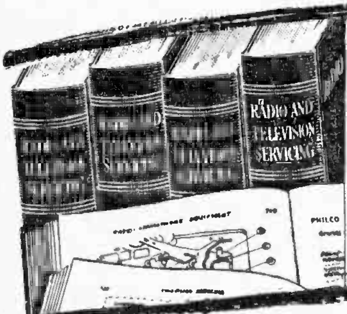

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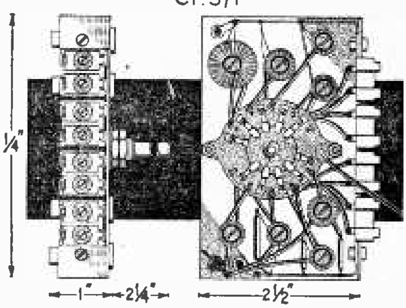

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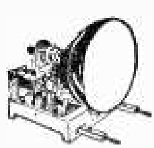

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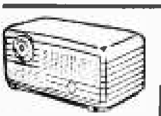

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A Capacity Tester for Small Values

THE UNKNOWN CONDENSER IS USED TO ALTER THE TUNING OF AN R.F. OSCILLATOR

By B. J. Roome

SOME types of small capacitors are not marked with their capacitance value at all, whilst the values marked on other types—especially the markings on the small waxed mica types—often become obliterated with age. In addition the meaning of the colour coding of some old types of capacitor is not always clear and the colours may not be decisive. If such capacitors are to be used in any apparatus, it is first necessary to ascertain their value. Even if the value is clearly marked, a quick check is worthwhile if the component is not new and will also disclose any open circuited or short circuited component. It is much wiser to test a doubtful component before use than to spend a very long time finding out why a completed piece of apparatus will not function.

Principles of Circuit

Fig. 1 shows a circuit which can be used for measuring the value of small condensers. V1(a) is an oscillator, working at a fixed frequency of a few megacycles. The exact frequency is unimportant providing that it is constant. The tuned circuit L/C2 determines the frequency of oscillation. The output of the oscillator is fed, via C7, into V1(b) which is a cathode follower buffer stage. This stage prevents pulling of the oscillator frequency by the test circuit. L4 couples the output from V1(b) into the test circuit which absorbs maximum power from L3 when the tuned circuit formed by L4, L5, C8, C9 and any capacitors under test (Cx or Cy for future reference), resonates at exactly the same frequency as the frequency of oscillation of V1(a).

The voltage appearing across the test circuit is detected by the germanium diode D1 and the resulting D.C. current deflects the 0–500 microammeter M1. C10 by-passes the R.F. so that it does not pass through the meter, whilst VR1 enables the current passing through the meter to be adjusted to a suitable value.

The 12AU7 is perhaps the most convenient miniature valve, but the octal based 6SN7 is quite suitable. Alternatively two separate 6C4's or 6J5's could be used. Almost any small triodes or triode connected pentodes are perfectly satisfactory. The part of the circuit on the right-hand side of the screen in Fig. 1 is placed on or near the front panel with the valve behind it.

Preliminary Adjustments

A 0–500 microammeter should be inserted between the lower end of R2 and the chassis at the point marked with a cross in Fig. 1. If no reading is obtained at first, reverse the connections of L2. The reading of the microammeter is a measure of the amplitude of oscillation of V1(a). The number of turns on L2 and the spacing of L2 from L1 should be adjusted until the ammeter in the R2 circuit reads about 100μA. The amount of feedback in the oscillator circuit is controlled by the number of turns on L2 and by its proximity to L1. Generally L2 will consist of about seven turns spaced ¼ to ½in. from L1. After adjustment, L2 should be fixed in position with polystyrene cement. R1 drops the H.T. voltage to about 100V and also decouples the anode circuit of V1(a).

C8 and C9 should then be adjusted (with no connection across the Cx or Cy terminals) until a reading is obtained on the meter M1. The trimmer C5 should be adjusted for maximum reading on M1 and it should then be set in position with a suitable cement. No further adjustment of the circuit should be required for some years.

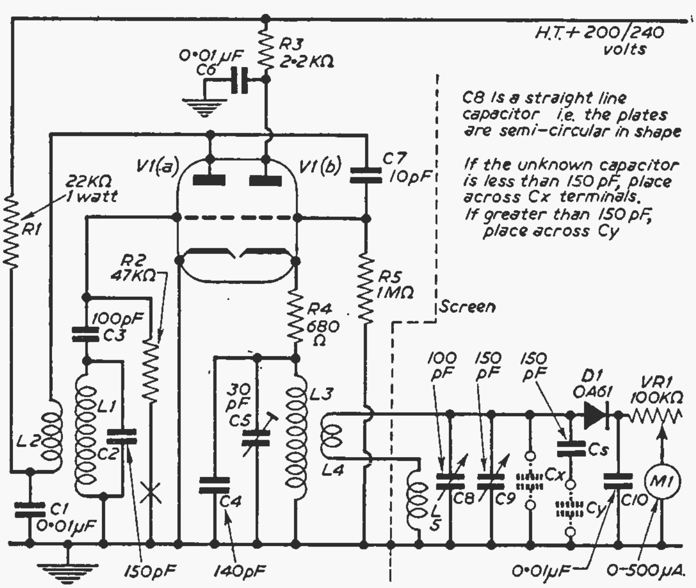


Fig. 1.—The circuit diagram.

Calibration

A fairly large type of tuning dial (calibrated from 0 to 180°) is fitted on the front panel and connected to C9. It has a vernier attachment for accurate reading to 0·1°, but this is not essential. It is advisable to arrange for the dial reading to be zero when the vanes are fully meshed.

A number of 1 or 2per cent tolerance capacitors should be used for calibration of the instrument, but 5per cent capacitors will suffice for approximate work, those used for calibrating the Cx position should all have values between 0 and 150pF.

C9 should be set so that the dial reading is zero when the vanes are fully meshed. C8 is then adjusted for resonance as shown by a maximum reading of M1. If the meter goes off the scale, the resistance of VR1 should be increased, but when C8 has been set, VR1 should be adjusted so that the meter does not read less than half scale (for accuracy). Place one of the calibrating condensers across the terminals marked Cx in Fig. 1; the meter reading falls as the circuit is now off resonance. Alter the value of C9 until resonance is again found, care being taken that C8 is not touched. The reduction in the value of C9 is then equal to the added calibrating capacitance, Cx. Note the reading of the dial connected to C9. Repeat this for other values of calibrating condensers.

A graph of Cx against the dial readings should then be plotted as accurate as possible. The graph should be almost exactly a straight line if C9 has semi-circular plates. The graph should be kept for use with the instrument.

Operation

Values of capacitors from 0 to 150pF can be measured in the following manner. Adjust C8 to resonance with the dial reading of C9 at zero. Connect the unknown, Cx across the terminals and, leaving C8 unaltered, find the C9 dial reading at the new resonance. Using this dial reading and the graph, the unknown capacitance value can be found. The result should be accurate to ±1pF or better.

Larger Values

The maximum value of the measuring condenser, C9, is 150pF, and therefore capacitance values greater than this cannot be measured by connecting the unknown directly across the Cx terminals. If however, the unknown condenser is placed across the terminals marked Cy in Fig. 1, it will be placed in series with a 150pF capacitor. The series combination will have a value of less than 150pF—in fact it will be between 75pF and 150pF—and the value of this combination can therefore be measured as before.

Thus it is possible to calculate the value of the unknown Cy, from the following equation

$$Cy=Cr.Cs/Cr-Cs$$

where Cr is the capacitance of Cy and Cs in series, it is well worthwhile calibrating the instrument for values of Cy greater than 150pF. This should be done by placing various known calibrating capacitors across the Cy terminals and plotting the values of Cy against the dial readings as before. In this case, however, the graph will not be a straight line. The graph can then be used to obtain values of unknown capacitors directly from the dial readings.

Whilst there is no definite maximum limit to the value of capacitance which can be measured, the accuracy of the measurement will fall as the value of the unknown increases above 150pF. The practical upper limit is in the region of 2,000 to 10,000pF, depending on the accuracy required and on the accuracy with which the dial can be read.

Final Check

The accuracy of the instrument and of the graph can be quickly checked by determining the capacity of two condensers separately and then determining their capacity in parallel. The latter value should be equal to the sum of the two separate capacities.

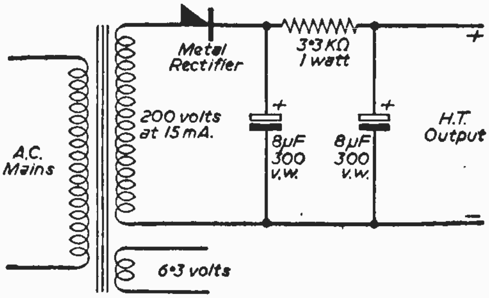


Fig. 2.—A suitable power supply circuit for the tester.

Power Supplies

The instrument requires a 6·3V heater supply at about 0·3A and an H.T. supply of 200 to 240V at about 12mA. This can usually be obtained from a receiver power pack, but if it should be desired to make a separate supply for the unit, the circuit shown in Fig. 2 is quite adequate. The metal rectifier should have a rating of not less than 300V at 15mA.

Alternatively it would be possible to use a small battery double triode (e.g. type DCC90 or 3A5) and make the unit entirely portable. The H.T. voltage could be obtained from a 90V H.T. battery, in which case R1 should be reduced to 2k. The batteries should have a very long life—almost as great as their shelf life.

COIL DATA

L1—25 turns.
L2—7 turns on chassis side of L1.
L3—25 turns.
L4—6 turns on chassis side of L3.
L5—15 turns.

All coils close-wound on formers, 0·4in. in diameter, using 32 to 36s.w.g. single silk-covered wire. The wires of all coils to be cemented in position with polystyrene solution.

HOLDING THIN WIRES

Sometimes it is difficult to hold very thin wires in ordinary alligator clips, since the wire slips through the teeth. The problem can be easily remedied by filing off the teeth. The jaws will now be flush and the tiny wire will be gripped easily, putting an end to the slipping.

PYE Microwave System for the Irish Republic

Pye Telecommunications Limited of Cambridge, with their associates Telecommunications Limited of Dublin, have received a contract for the supply and installation of a Pye Microwave system between the towns of Waterford, Wexford and Enniscorthy. They will also provide the buildings, masts and aerials and emergency power supply equipment.

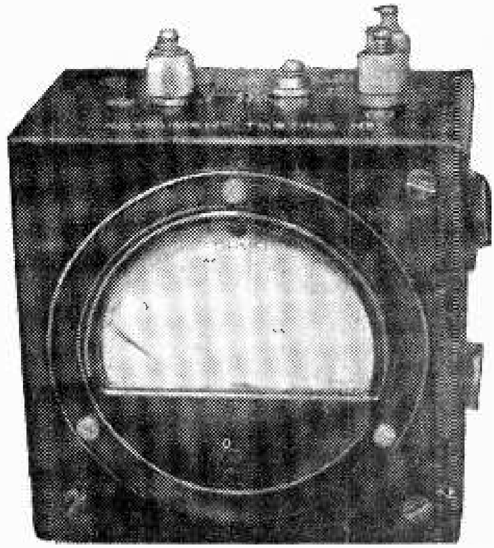
These radio links will form part of the trunk system of the Irish Republic's Telephone Service and are required to accommodate the ever-increasing traffic. The system will operate in the 7400Mc/s Band and is capable of transmitting 240 channels.

A D.C. TEST METER

A SIMPLE INSTRUMENT FOR MEASURING VOLTAGE, CURRENT AND RESISTANCE WITH EXTERNAL SHUNTS

By B. E. Wilkinson

THIS meter is not intended to be the ultimate in test meters, but rather more as a beginner's instrument or as a second one for quick checks. It has the advantages that it is very easy to make, is inexpensive and the number of ranges available is almost unlimited. This is because the series resistors or shunts used to provide the voltage or current ranges are not installed internally in the meter, and switched in as required by a range selector switch, but are made up as jacks, and are plugged in externally. It is thus possible to provide additional ranges when required. To enable those interested to select their own choice of ranges and provide the correct shunts, etc., the calculations will be given for the general case, and a set of recommended ranges.



The completed meter.

An Ex-Government Meter

The meter, which is intended to measure D.C. current, voltage and resistance to about 5k, is constructed from a robust ex-government meter, which is intended for checking cells, and measuring resistances approximately. The only indication of type is "Instrument Testing No. 1", which appears at the top, in front of the three terminals and toggle switch. These meters are currently available. The meter is enclosed in a thick, black plastic case, the movement itself being protected by a circle of thick glass and a metal plate screwed over the front. The scale is graduated in volts to 1·5 or 3.0, milliamps to 60, and ohms to infinity, 5k being the highest indicated value.

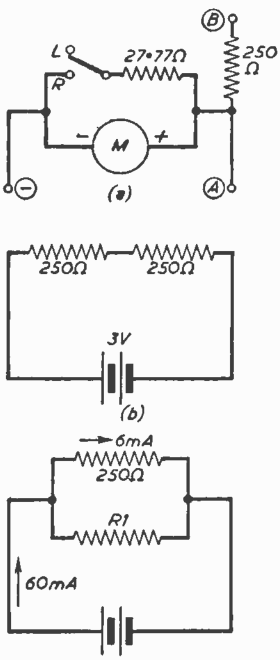


Fig. 1 (left):
(a) The circuit of the instrument.
(b) Equivalent circuit for the low voltage range.
(c) Equivalent circuit on the 60mA range.

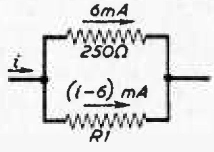
The Meter Movement

Before deciding upon the ranges required, it is necessary to know something of the meter movement. On the face for instance it states that it has a resistance of 250Ω. This is essential to calculations, but is not sufficient, for the current required for full scale deflections of the meter needle must be known. However, it will be found that a circuit diagram of the instrument as it stands is provided on the top, and is reproduced in Fig. 1a. Now, from the back of the instrument, where operating instructions are given, it is seen that with the toggle switch to (L) voltages to 3V can be measured across (–) and (B). Since voltages are being measured it is clear that the 250Ω resistor must be in series with the meter and the 27·77Ω shunt resistor must not be connected. Position (L) must therefore be with the switch open. For this voltage range then, the circuit will be similar to Fig. 1b, where the second 250Ω resistor represents the meter movement. The total resistance of the circuit is 250+250=500Ω and the applied voltage for full scale deflection is 3, so that by Ohm's law the current flowing will be·

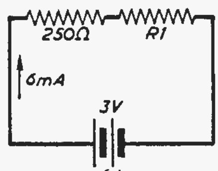
$$I=\frac{E}{R}=\frac{3}{500}=6\text{mA}$$

This then is the current required fully to deflect the meter needle, and is a basic value in the calculations. This value may be checked by considering the current-measuring range of the instrument. It will be seen that with the switch in position (R) 60mA will cause a full scale deflection between (–) and (A). This is clearly with the shunt connected but without the series 250Ω. The equivalent circuit is shown in Fig. 1c. Here 60mA are being measured, but since only 6mA may pass through the meter, 60–6=54mA must pass through the shunt. The potential difference across the meter will be E=I. R=6×250=1500mV. This must be the same as the P.D. across R (since they are in parallel), so that the value of R, will be, by Ohm's law, $R=\frac{E}{I}=\frac{1500}{54}=27{\cdot}77\Omega$, which is in fact the value of the shunt used. We are now in a position to discuss the required current and voltage ranges and the shunts and resistors necessary to provide them.

Fig. 2 (right): (a, b and c) How the shunts are calculated.



(a)



(b)

Range	Shunt	Resistor
6mA	None	—
60mA	27·77Ω	—
600mA	2·525Ω	—
3V	—	250Ω
30V	—	4750Ω
300V	—	49750V

(c)

Current Ranges

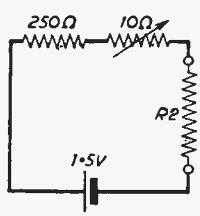
As far as current is concerned, the meter scale is graduated in milliamps to 60. The ranges considered acceptable for this sort of meter are 6, 60 and 600mA. By using multiples of 6, confusion over readings is avoided. Now, since the meter itself has a 6mA movement, the first range is achieved without a shunt. In Fig. 2a the meter is in parallel with a shunt which is to be calculated for any current flowing (i). Since the meter must only pass 6mA, the shunt must pass (i−6)mA. The potential difference is again 1500mV, and by Ohm's Law R1 will be

$$R1 = \frac{E}{I} = \frac{1500\Omega}{(i-6)}$$

(where I is in milliamps). By substituting for I in this relation it is possible to provide R1 for any desired current range (providing of course it is not less than the sensitivity of the meter movement itself). Thus for a 60mA range

$$R1 = \frac{1500}{60-6} = 27{\cdot}7\Omega$$

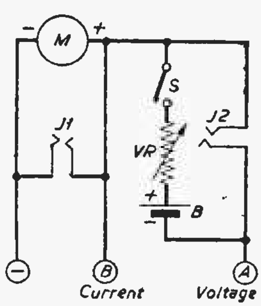
Fig. 3 (right)—Circuit of the instrument when used as an ohmmeter.



And for a 600mA range

$$R1 = \frac{1500}{600-6} = \frac{1500}{594} = 2{\cdot}252\Omega$$

Fig. 4 (right).—Complete circuit arrangement.



Voltage Ranges

Two voltage ranges are provided on the meter scale, 1·5 and 3. It is suggested that multiples of 3 be considered, i.e.: 3V, 30V and 300V, though the reader is not bound to follow these ranges. To calculate the series resistors required, Fig. 2b must be consulted, where the meter is shown in series with a resistor R1 and a voltage to be measured (V). The total circuit resistance (neglecting the source) is (250+R1), and since for full scale deflection, the current flowing must be 6mA the potential difference (V), must be given by

$$V = \frac{6(250+R1)}{1000}$$

To obtain R1

$$1000V = 1500 + 6R1$$

$$R1 = \frac{1000V - 1500}{6}$$

$$R1 = \frac{100\ (10V-15)}{6}$$

(The 1000 factor is necessary to convert milliamps into amps.)

For 3V range, the relation becomes:

$$R1 = \frac{100\ (30-15)}{6} = \frac{100\ (15)}{6} = 250\Omega$$

For a 30V range,

$$R1 = \frac{100\ (300-15)}{6} = \frac{100\ (285)}{6} = 4750\Omega$$

and for a 300V range,

$$R1 = \frac{100\ (3000-15)}{6} = \frac{100\ (2985)}{6} = 49750\Omega$$

For convenience the required values are tabulated in Fig. 2c.

No multimeter should be without a continuity test and ohm range (in fact it is frequently felt that this range is the most useful of all) and since the face is provided with a scale in ohms the opportunity can hardly be missed.

The ohmmeter, which, as will be seen later is built into the instrument, consists of a series circuit—meter, battery, and two resistors, one for adjustment and the other being measured.

Now, on the back of the instrument, instructions will be seen, a note stating that to use the ohmmeter, a cell reading 1·5V should be connected in series with the resistor under test and the (−) and (A) terminals. No adjuster is provided, because the cell is known to be 1·5V before the measurement is made, and the scale is calibrated for use with this cell and a meter resistance of 250Ω.

Therefore the meter is used as it is for measuring resistance by merely providing a 1·5V dry battery. Since at first this may provide a little more than 1·5V, it is well to use a small variable resistance (10Ω) in the circuit to provide a zeroing adjustment. In Fig. 3, the ohmmeter circuit is shown, if the cell is giving exactly 1·5V, then R1 will be adjusted to zero resistance. Suppose that for a resistance R2 (as yet unknown), a current flow of, say, 5mA. The total circuit resistance is (250+R2). Thus we may write:

$$E = I \times R \quad 1{\cdot}5 = \frac{5\ (250+R2)}{1000}$$

$$1500 = 1250 + 5R2$$

$$5R2 = 250$$

$$R2 = 50\Omega$$

It will be seen from the meter scale that a current of 5mA (50 indicated because of the internal shunt), corresponds to a resistance of 50Ω. Since the ranges of the proposed multimeter have been discussed, and the values of resistors required have been established, the actual circuit may now be considered.

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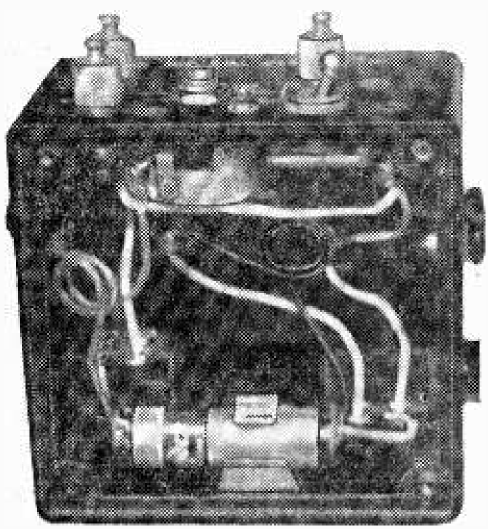
The Meter Circuit

The circuit is shown in Fig. 4. Here it will be seen that while there is no range selection switch, two jack sockets J1 and J2 are provided. J1 accepts shunts across the meter movement, so that current is measured between terminals (—) and (B). J2 accepts resistors for the voltage ranges, the terminals used being (—) and (A). When neither J1 or J2 is being used, the switch may be closed, and resistance measured between (—) and (A). The variable resistor shown is 10Ω and is for zeroing.

Constructional Details

It is now necessary to modify the instrument, and rewire it using the circuit shown in Fig. 4. The unit is held together by eight 4B.A. screws, four at the front, and four holding the back plate in position. If all of these screws are removed the wiring inside may be disconnected and removed, and the meter movement pressed out, forward. Three spring clips, attached to the meter flange by three 6B.A. screws should be removed and discarded. A thick piece of glass under the front plate and two soft-rubber rings are no longer required and should also be discarded.



A rear view of the complete instrument.

The two resistors wound on a plastic former must be removed, but should be set aside as the resistance wire with which they are wound is required. Measurement of the centre hole in the brass plate which was screwed to the front of the unit shows it to be 2·5in. in diameter. The meter itself is 2·7in. in diameter, and since it is intended to fit the meter to the plate, the hole must be enlarged by 0·1in. all the way round. This can be done quite quickly with a sharp half-round file. When the meter will fit easily through the hole, it should be lined up so that a line drawn through the centre of the scale and the needle adjustment screw is parallel with two opposite sides of the plate. Clearance holes (6B.A.) may now be drilled through the plate to mate with the corresponding holes in the meter flange. The meter may then be bolted to the plate and the plate fitted back on the case.

Looking into the back of the unit, it will be seen that this modification has moved the meter forward, and thus provided sufficient space for further components. The two jack sockets J1 and J2 may now be fitted. They are fitted, one each side of the case, by means of $\frac{1}{8}$in. holes drilled as shown in Fig. 5b which also shows the meter mounted to the front plate.

The 10Ω variable resistor for adjustment of the ohmmeter range, is fitted through a $\frac{3}{8}$in. hole drilled in the top of the case, at the intersection of two lines drawn between the centres of the (—) and (B) terminals and the switch and the (A) terminal. The shank of this resistor should be cut down to about $\frac{1}{8}$in. and a saw cut made across the diameter to accommodate a screwdriver. The ohmmeter range needs a 1·5V cell to operate the meter, and this takes the form of a single pen cell held to the bottom of the inside of the case by means of a small Terry clip. This can be seen in the photograph of the back of the instrument.

Additional Wiring

Wiring should be carried out with single-strand plastic covered wire similar to that removed from the meter initially. Fig. 5a shows the wiring system. A length of wire is connected between the (—) terminal, and the negative point of the meter. Then a wire is jointed to the positive side of the meter and one side of the toggle switch. The other side of the toggle switch is taken to one side of the 10Ω resistor. The two meter terminals are now connected to the two tags of J1, and the outermost tag of J1 is taken to the corresponding tag of J2. Terminal (B), is now taken to the positive side of the meter while terminal (A) is taken to the inner tag of J2 and the negative side of the 1·5V cell. Finally the centre tag of the resistor is taken to the positive side of the cell. In wiring, unless leads are taken to terminals, they should be soldered. The instrument is now virtually complete and the ohm range can be tested. Set the toggle switch to R and connect a piece of wire from (—) to (A). The meter should indicate zero resistance. If it tries to indicate less than zero; i.e. beyond full scale deflection, it can be set to zero by means of the 10Ω resistor. If it indicates a finite resistance, the cell is down and should be replaced. Tests can now be made using resistors up to about 5k. The rear plate of the instrument may now be screwed in position. However, it will be observed that engraved on the back are instructions which are no longer relevant, so that the back plate may be put on reversed, the four holes being countersunk slightly to receive the 4B.A. screws.

The Jacks and Test Prods

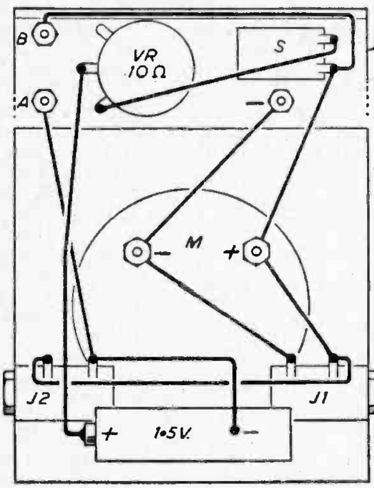
To complete the instrument, it is necessary only to provide the shunts and resistors in jacks, and the test prods. Referring to the table of Fig. 2c, we see that for the recommended ranges we require five resistors. For the current ranges the resistors are low, and are made-up from resistance wire. The resistor removed from the meter initially consists of a 27·7Ω and a 250Ω resistor. If the 27·77Ω resistor is carefully unwound avoiding kinks, as this piece of wire is required, and measured, it will be found to be almost exactly 8ft long. Thus:

$$27{\cdot}77\Omega = 8\text{ft or } 96\text{in.}$$

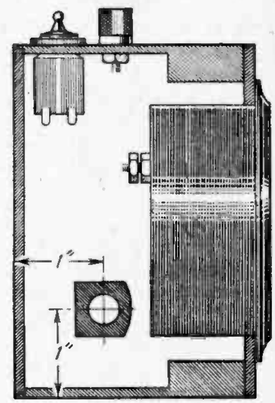
$$\therefore 1\Omega = 96/27{\cdot}77 \text{ in.}$$

$$\therefore 2{\cdot}525\Omega = \frac{96 \times 2{\cdot}525}{27{\cdot}77} = 8{\cdot}726\text{in.}$$

Thus a piece of resistance wire 8·726in. long, taken from the 250Ω winding, will provide a shunt for the 600mA current range. When using this wire, the cotton covering should be removed at each end, and the wire tinned for soldering-in. It should be remembered that the actual resistance between the two tags joined by a length of resistance wire does not include that wrapped around the tags, or tinned. Thus the length of wire cut should be slightly longer than that actually required. The jacks to which the resistances are connected are of the standard Post Office type. The resistances are connected across the two connections in the handle of the jack, and the handle replaced. No trouble should be experienced with the series resistors, but the shunts, being made of wire need some support. They may be wound upon a small Tufnol former, with small lengths of tinnned copper wire at either end to provide lead-out tags. The range provided by each jack should be typed on a small label or piece of paper and stuck to the appropriate jack by means of Sellotape. Pieces of paper with "Current" and "Voltage", should be similarly fixed to J1 and J2 respectively, on the meter case, so that confusion does not arise.



Back View Showing Wiring



Side View

Fig. 5a (left).—Rear wiring details.
Fig. 5b (right).—Side view of the completed test-meter.

Test prods are an essential part of every test meter, and should be made from flexible, stranded insulated wire. The ends connecting to the meter should be soldered to short lengths (1in. or so) of brass wire, the joint being neatly taped. The brass wire will then fit easily in the angled slots cut in the terminals. At the other ends of the leads either brass prods or crocodile clips may be fixed. The brass prods should be sleeved almost to the end, so that one does not hold the bare metal when making measurements.

The instrument should require no calibration, but it is advisable to check it either against a test meter known to be correct, or resistors and cells known also to be correct. To check, for instance, the 3V range it is necessary only to use 1·5 and 3V cells, while the 30V range may be checked with grid bias batteries, car batteries, etc. Any adjustments necessary may be effected by varying slightly the values of resistance in the appropriate jacks.

QUARTZ CRYSTAL ETCHING

(Continued from page 979)

rate of about 1kc/s per minute of immersion has been found with crystals of a frequency of about 8Mc/s, but a longer etching time per kilocycle frequency rise would probably be required for crystals of lower frequencies.

The crystal should be completely immersed in the etching solution for a comparatively short time—perhaps ten minutes—or less if a small frequency change is desired. The crystal should be removed from the etching solution with the coated tweezers, washed in two successive jars of water (not hard water) and finally dried in a current of warm (not hot) air. Alternatively, the final wash can be made with pure alcohol which is then allowed to evaporate.

The crystal is then remounted in its holder. If it is a type which is held at the corners only by the metal electrodes, care must be taken that the electrodes are replaced so that the projecting corners face the quartz crystal. The frequency of the etched crystal should be determined as accurately as possible. The rate of etching can be determined from the frequency change and an estimate can be made of the time for which the crystal should be left in the same solution in order to achieve the desired increase of frequency.

The crystal should be etched for not more than three-quarters of the calculated time and the frequency checked again. It should now be possible to calculate fairly accurately the etching time required to increase the frequency to the desired value. If the final frequency must be extremely close to the desired value, it is advisable to etch for somewhat less than the calculated time and to check the frequency several times before completing the process. With care the error in the final frequency will not be appreciably greater than that of the measuring device used—certainly less than 1kc/s.

As etching proceeds, the anode current of the oscillator (Fig. 1) will probably increase somewhat with each frequency check owing to a reduction in the activity of the crystal. The anode current should be noted at each frequency check; an increase of more than a few milliamperes may indicate that the crystal is useless. Do not forget, however, that a change in the oscillator H.T. voltage may cause a change in the anode current.

Trade News

NEW PRODUCTS AND DEVELOPMENTS

A PRECISION MOULDED MAGNETIC TAPE CASSETTE

MUSIC of just the right kind for hotel lounges, ships' lounges, restaurants, fashion houses, etc. or even factories, is provided by the "Reditune" service. Music from a library of over 7.000 titles is provided on magnetic tape which is rented with a playback machine and the required number of speakers giving the effect of a portable orchestra with a repertoire exactly suited to the requirements of the user.

Reditune Ltd. is a member of the Rediffusion group of companies.

So that the programme can be changed as needed without any skill on the part of the user, tapes are supplied in ingeniously-designed cassettes which are simply inserted into the machine as easily as posting a letter.

The cassettes are injection moulded by Ekco Plastics Ltd. in polystyrene, each cassette comprising four separate mouldings—the body, the spool base, the spool top and the lid. All except the latter are in high-impact polystyrene, the lid being moulded in transparent polystyrene. The body incorporates two precision-ground brass inserts, a spindle on which the spool turns and a further small spindle to locate an interlocking brake lever. The spool spindle is internally threaded to take the single screw which attaches the lid to the body. The successful operation of the cassette demands freedom from distortion and a high finish with complete absence of flash. A feature which calls for rigidly controlled moulding technique is the need for moulding the spool centre hole to a tolerance of 0·002in The endless magnetic tape unwinds and rewinds on the spool simultaneously and this involves considerable movement between tape and spool. To facilitate this movement, the base of the spool has 12 radially positioned graphite rods cemented to it, the tape actually resting on these rods during playing. The spool top is moulded separately and subsequently cemented in position. *(Ekco Plastics Ltd., Press Section, Southend- on-Sea, Essex.)*

PERSONAL TRANSISTOR RADIOS

TWO personal transistor radios are now being marketed by Magnavox. Specially-designed printed circuits for really sensitive long-distance reception, plus hermetically sealed long-life transistors, are included in these new models, retailing at very reasonable prices.

The "Companion" eight transistor radio features a germanium crystal rectifier and a $2\frac{1}{4}$in. PM dynamic high fidelity speaker. (Price, 13 gns., including purchase tax.) The "Pocketmate' is a six-transistor version with fine reproduction and performance. (Price, 11 gns., including purchase tax.)

Both are finished in coloured high impact plastic cases and have leather cases with carrying strap plus private listening earphones. An easel clip allows the Magnavox transistor sets to stand firm on any flat surface. *(Magnovox, 129 Mount Street, London, W1.)*

WIRE RECORDER

AN improved and longer playing version of the well-known Minifon P55 pocket-size wire recorder has been introduced by the Office Equipment Division of E.M.I. Sales and Service Ltd. Known as the Minifon P55L, it now provides a recording/playing back time of five hours. Letters, notes, and memoranda totalling more than 30,000 words can thus be recorded. It is therefore a very convenient instrument for long overseas tours by directors and senior executives, also for busy people —architects, surveyors, civil engineers and plant managers—whose work takes them out and about.

The P55L is the same compact size (4in. by $6\frac{3}{4}$in. by $1\frac{1}{2}$in.) as the Minifon Attache tape dictation machine, and it slips easily into an overcoat pocket. The recording medium is very fine (0·002in. gauge) steel wire wound on two small

A new pocket transistor radio.

plastic spools. The fineness of the wire, even compared with $\frac{1}{4}$in. wide tape, gives the exceptionally long recording time.

The frequency response is 150-3.500 c/s, the input impedance 2M. and the output impedance 40k. The low-tension battery is a 1·4V standard single cell, with a working life of up to 20 hours. The high-tension battery is of 30V, with a working life of up to 200 hours. Both batteries are, of course, contained in the compact case. *(E.M.I. Sales and Service Ltd, Blyth Road, Hayes, Middlesex.)*

Club News

REPORTS OF CURRENT ACTIVITIES

CLIFTON AMATEUR RADIO SOCIETY

Hon. Sec: C. H. Bullivant, G3DIC, 25 St. Fillans Road, London S.E.6.

Recent meetings have included talks on "DX operating" and "G.P.O. equipment" and a constructional contest which produced 16 entries. On February 24th P. Deacon, G3BCM, will speak on International Radio Regulations.

MITCHAM AND DISTRICT RADIO SOCIETY

Hon. Sec.: M. Pharaoh, G3LCH, 1 Madeira Road, Mitcham.

The G5UX Key Award was presented to G2BLa who won the 1959/60 contest for this trophy with a score of over 200 points. On January 13th a talk was given on Lifeboat Radio Equipment. The RSGB affiliated Societies Contest was held on February 5th and 6th. The Annual General Meeting will take place on Friday, 24th February.

Future Events:
April 7th—A talk by G2ZU.

PETERBOROUGH AND DISTRICT RADIO SOCIETY

Hon. Sec.: D. Byrne, G3KPO, Jersey House, Eye, Peterborough.

At their mid-winter rally held in Peterborough Technical College, members had a working demonstration of new transmitters and receivers by Mr. J. Herries, of Glasgow, who spoke on ssb techniques. Talk-in mobile stations were G3ARS/A on two metres and G3KPO/A on Top Band.

Future Events:
March 3rd—"Aerials". April 7th—Film show. May 5th—"Oscilloscopes".

REIGATE AMATEUR TRANSMITTING SOCIETY

Hon. Sec.: F. D. Thom, G3NKT, 12 Willow Road, Redhill, Surrey.

The highlight of the December meeting was a demonstration by BRS 20809 of an ex-R.A.F. morse recorder (made in 1918) which coped quite efficiently with a modern electronic bug-key. The closing date for the constructional contest was January 31st and the entries will be judged at the Annual Dinner on February 11th. This will be held at Laker's Hotel, Redhill 7 for 7-30 p.m. The tickets can be obtained from any committee member price 15/6d. It is hoped that the chief guest will be Les Knight G5LK who was formerly Secretary of the East Surrey Radio Club for many years.

SLADE RADIO SOCIETY

Hon. Sec.: C. N. Smart, 110 Woolmore Road, Erdington, Birmingham 23.

The Club Station (G3JBN) at the Church House, High Street, Erdington, Birmingham 23, is available for the use of members for constructional purposes. Thursday evening meetings will include informal discussions, operation of the Club transmitter, and instructional Morse classes. A licensed operator of G3JBN will always be in attendance on Thursday evenings. Slow Morse transmissions are radiated on the air each Monday evening from station G3AYJ on 1.9Mc/s from 8 p.m. to 8.30 p.m.

Future Events:
February 10th—A special meeting to consider alterations to rules and a discussion on D/F contests and equipment for the 1961 season.
February 24th—Sale of surplus equipment.

SUTTON COLDFIELD RADIO SOCIETY

Hon. Sec.: L. E. R. Hall, 24 Calthorpe Road, Walsall, Staffordshire.

The G3GLQ Trophy was again won by Pat Darrag for a 2m transmitter. On January 12th George Collins, among others, gave a talk on the "Applications for Cheap Valves". A discussion on a standardised design for construction as a group project entitled "Build your own Communication Receivers" was the subject of the meeting on January 26th.

Future Events:
February 9th—"Methods of Receiving CW". A discussion of and about CW with demonstration of keys oscillator, B.F.O's etc.
February 23rd—"Crystal Grinding and Etching" by John Symes.
March 9th—Club Station Night.
March 23rd—"Tape Recorders". A talk by Len Hall about some commercial and industrial uses of tape recorders.

PLYMOUTH RADIO CLUB

Hon. Sec.: R. Hooper, 2 Chestnut Road, Peverell, Plymouth.

Club meetings are held on Tuesday evenings at 7.30 p.m. at Virginia House Settlement, St. Andrews Cross.

Future Events:
February 14th—Junk Sale.
April 18th—Judging for the Ernie Hillyard Trophy.
May 2nd—Judging for the G5ZT Trophy.

WANSTEAD AND WOODFORD RADIO SOCIETY

Hon. Sec.: J. Seaman, 67 Beattyville Gardens, Ilford, Essex.

The junior section of the club now meets on Tuesday evenings and not Wednesdays. The senior section meets on Wednesdays. They are then on the air with the club call sign G3BRK. The club shack is now being reorganised with better facilities for constructional work.

WEST KENT AMATEUR RADIO SOCIETY

Hon. Sec.: H. F. Richards, 17 Reynolds Lane, Tunbridge Wells.

Meetings are held, unless otherwise stated, at Kent County Council Adult Centre, Culveden House, Culverden Park Road, Tunbridge Wells, Kent. Meetings commence at 7.30 p.m. and end at 10 p.m.

A meeting to plan club stand for Tunbridge Wells Hobbies Exhibition was held on January 13th, and a talk on Hi-Fi Techniques was given by R. Trevitt on the 27th.

Future Events:
February 10th—Film Show.
February 23rd—Visit to Crawley Radio Society to hear a lecture on the History of Radio by the Curator of the Science Museum G5CS.
March 10th—Informal meeting.
March 24th—Planning Meeting for National Field Day.

APPOINTMENTS

Belling and Lee Ltd. announce the appointment of B. M. Lee as manager of their industrial group, reporting to the company's general manager, and to the board of executive directors. This is a further step in the divisionalisation of the company into separate industrial, and domestic groups, in a programme of controlled expansion which began with the reorganisation of the sales department earlier in the year. He will be responsible for co-ordinating the production, publicity and sales of the industrial group.

Mr. Lee, who is the son of E. M. Lee, B.Sc., M.I.E.E., director and General Manager, and one of the original founders, has spent a number of years in different departments of the Company, and in other companies in the industry, in training for his new post. His appointment will relieve the directors of a considerable amount of detailed work, allowing them more time for matters of general management and planning for the future.

L. A. Norman, assistant sales manager of Stella Radio and Television Co. Ltd. since May 1960, is appointed sales manager as from January 1st, 1961.

During the thirty-two years that Mr. Norman has spent in the radio industry he has become a well-known figure. He joined Philips in their radio sales office in 1928, and after serving in the R.A.F. from 1941 until 1946, re-joined the company in charge of the Century House showroom. Shortly afterwards he represented Philips radio and television in S.E. and S.W. London and the West End.

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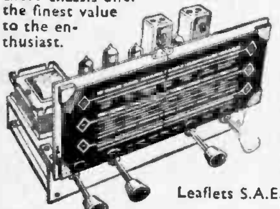

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3S4	7/6	6H6	3/6	12AU7	6/-	EBF80	10/-	EZ80	7/-	R3	7/6
3V4	7/6	6J5	5/6	12AX7	6/-	ECC84	8/-	E1148	1/-	SP61	3/6
5U4	6/-	6J6	5/6	12K7GT	6/6	ECH42	10/-	HABC80	12/-	UF41	8/6
5Y3G	6/-	6J7G	6/6	12Q7GT	6/6	ECL80	10/-			UL41	8/6
5Z4G	9/6	6K6GT	5/-	25YG5	9/6	ECL82	10/-	HVR2A	6/-	UY41	7/-
6AC7	3/6	6K7G	5/-	35L6	9/6	EF39	5/6	KT33C	10/-	U22	8/-
6AG5	5/-	6K7M	7/6	35Z4	6/6	EF41	9/-	MU14	7/6	VP23	6/6
6AL5	4/-	6K8G	6/-	807	5/-	EF80	7/-	P61	3/6	U76	6/6
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6/12 v. 3 a...	9/9	250 v. 60 m.a. ..	4/11
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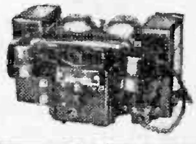

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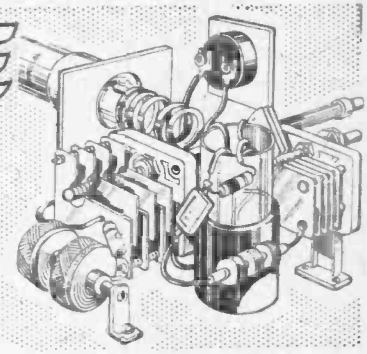

THE NATIONAL SENIOR H.R.O.

By A. W. Mann

THE Senior H.R.O. was designed and produced originally in 1935 to provide reliable communication even under adverse conditions and soon established a reputation of reliability. Based on a fundamentally sound design and built to precision standards, this high performance receiver was not cheap to produce, ranking among the more expensive representatives of its class.

Superhet Models

The Senior H.R.O. is no longer manufactured having been superseded by more up-to-date double superheterodyne models of very advanced design. The author however has had in daily use a Senior H.R.O. for some time in conjunction with a variety of aerials. This particular model has been available for some time.

Models Available

The models available on the surplus market are the H.R.O., H.R.O.–M and H.R.O.–MX, all of which apart from slight modifications are fundamentally alike. The valves used in all instances are of the UX based types.

Valve Line Up

The valve line up is as follows: the first and second R.F. amplifiers are 6D6 valves, the first and second I.F. amplifiers are 6D6 valves and the mixer valve is a 6C6. There is a separate local oscillator 6C6 valve. The detector AVC diode and first audio amplifier is a 6Q7. The beat frequency oscillator is a 6C6 valve and the power output valve is a 42.

Tuning Range

These receivers cover a very wide band of frequencies by means of a separate four-coil unit. The total range being from 10m to 6000m, nine coil units being provided. These are of the general coverage type which are not fitted with the extra band spread facilities common to the pre-war standard models.

Standard Model Bandspread

In the standard models, bandspread was accomplished by the transfer of set screws from one set of contact plates to another. By this means small padding condensers were introduced in series with the tuning condenser to reduce the tuning range, and a parallel trimmer to adjust the range to the desired part of the tuning dial.

This system enabled the user to cover the amateur bands with the more limited spread of the general coverage setting with one coil and with extra bandspread covering 400 divisions of the 500 division tuning dial. The overlap between the two coils being arranged with this idea in view.

That the surplus models are supplied only with nine general coverage coils is not the disadvantage it may appear, as the normal dial spread is sufficient to meet the requirements of the average listener, as later details relative to the main tuning arrangements will show.

Later Models

In addition to the earlier models mentioned, all of which use glass valves, later models in which the international types are used are also available. The valve line up being 6K7M, 6K7M, 6J7M, 6J7M, 6K7M, 6K7M, 6SQ7M, 6J7M, and 6V6GT/G, and the models are the H.R.O. 5T and 5R. The former being the table model and the latter the rack model.

All were manufactured during the war and are fitted with a 0-1 milliammeter instead of a calibrated S meter. According to the National Company, 0·5 designates S9 and 1mA is 40dB over S9.

Tuning Ranges

The full coverage of the H.R.O. is as follows:

Coil Set Type	L.F. Bands
J – 50	100kc/s band.
H – 100	200kc/s band.
G – 180	430kc/s band.
F – 480	960kc/s band.
E – 900	2050kc/s band.

Coil Set Type	H.F. Bands
JA–14·0	30·0Mc/s band.
JB–7	14·4Mc/s band.
JC–3·5	7·3Mc/s band.
JD–1·7	4Mc/s band.

This coverage is a most extensive one and reference to the chart mounted on each coil unit enables the operator to quickly check frequency. The calibration of each coil unit being very accurate indeed.

A Useful Suggestion

One of the bugbears met by most users of mains driven short wave receivers is frequency drift after switching on. As the coil units in the H.R.O. are below the chassis and well insulated from the heat generated in the well ventilated steel cabinet frequency drift after a twenty minutes warm-up period is negligible.

Technical Features

One of the highlights of this receiver is the four gang tuning condenser, reduction gear box and tuning dial. The condensers being of the straight line frequency type of 225pF capacity.

Instead of a common rotor shaft each condenser is completely insulated from the others. This principle of construction has considerable bearing on the stability of the receiver.

Ceramic trimmers are used in all coil units and maintain their setting, resulting in a very superior L/C ratio with constant gain through the various tuning ranges.

The tuning dial with its 20—1 ratio gear drive which includes a precision hobbed worm is spring loaded. The direct reading dial is divided into fifty divisions with apertures ten divisions apart. Ten turns of the dial are necessary to cover the full travel of the condenser rotors. This totals 500 divisions providing an effective scale length of twelve feet and alows readings to one part in five hundred. The calibration is nearly linear.

Controls

Fig. 1 shows a detailed sketch of the H.R.O., H.R.O.-M, and H.R.O.-MX type receivers.

Panel Controls

There are five controls mounted on the front panel and five switches, in addition to the tuning dial. The R.F. gain control varies the gain of the second R.F. stage and the two I.F. amplifiers. This control is also used to zero the S meter in conjunction with an internal preset potentiometer.

An A.F. gain control is also fitted. The inclusion of these two controls enables the operator, by the combination of adjustment, to obtain a most satisfactory signal to noise ratio on both strong and relatively weak signals.

Selectivity Switch

At the top-right-hand side of the panel is the selectivity switch which tunes the secondary of the first I.F. transformer and is used in conjunction with the crystal filter. When the crystal filter is not in use the selectivity control is used as an I.F. trimmer and set to a point which provides maximum volume and sensitivity.

This control in operation is a very effective one; so much so that in many instances the crystal filter is not required.

Phasing Control

Below the selectivity control is the phasing control with an integral crystal filter switch.

The crystal phasing control dial plate is graduated from 0—10. When set at zero the crystal filter is out. When at settings between 1 and 10 the crystal filter is in, and the phasing control is used to balance the crystal bridge.

Using the phasing control in conjunction with the selectivity control enables the receiver selectivity to be varied according to requirements, and interfering signals suppressed. Band width variation is from 2·5kc/s to 200c/s in the sharp position.

As the official handbook supplied with the Senior H.R.O. receivers at present available provides full details as to setting up and operating the receiver controls including the crystal filter, the author does not propose to offer further comment on the subject.

Fig. 1. shows the beat oscillator control which also has an integral on/off switch. The dial plate is also graduated from 0—10. This control clockwise switches H.T. voltage to the anode and screen of the beat oscillator valve and between 0 and 10 provides a frequency variation over a range of 10kc/s.

While the beat oscillator tunes to the I.F. frequency, when set at approximately 9, the pitch of the note can be varied as desired.

With the facilities which enable the C.W. listener to vary the pitch of the C.W. note, the beat oscillator is an asset to the amateur phone and S.W. broadcast listener in the location of the DX stations carrier wave.

Immediately above the beat frequency oscillator control is the AVC switch. This is switched to the left for AVC in and to the right for AVC out. The AVC being switched out for C.W. reception, with the beat oscillator switched in and pitch control set initially to nine on the dial plate, later to be adjusted to a pleasing note.

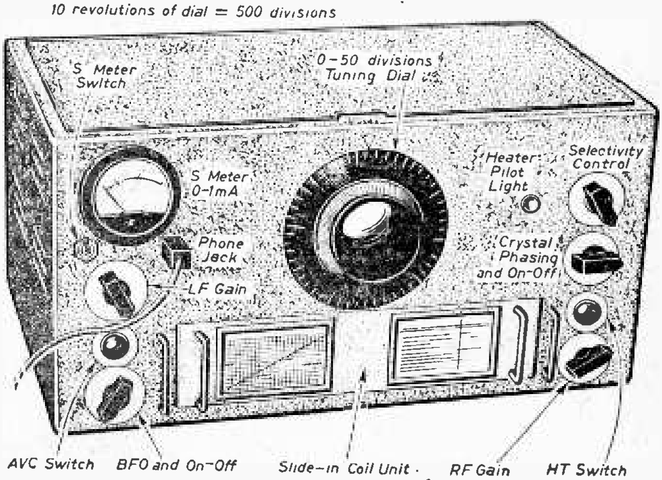

Fig. 1.—The controls of the Senior H.R.O.

L.F. Gain Control

Above the AVC switch is the L.F. gain control which also has the dial plate graduated from 0—10. Above this and slightly to the left is the S meter switch and to the right the headphones jack.

The S Meter

The S meter should always be switched out when receiving strong S.W. broadcast signals.

As previously mentioned the S meter is not as

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ATTRACTIVE TWO-TONE PORTABLE CARRYING CASE. Suitable for above amplifier and Collaro, Studio deck. Limited quantity only at 72/6 plus 3/6 P. & P.

MIC 45-1 Acos latest flat pistol-grip crystal microphone. Attractive black and gold finish. OUR PRICE 29/6 plus 1/- P. & P.

ACOS MIC 39-1. Crystal stick microphone, list price 5 gns. Our price 39/6 plus 1/6 P. & P.

MIC 40. General purpose crystal microphone with desk stand. Only 25/- plus 1/6 p. & p.

M.C. 24. Imported, crystal, attractive streamlined polished metal case, incorporates muting switch. List price 64/-. OUR PRICE 42/- only. 1/- P. & P.

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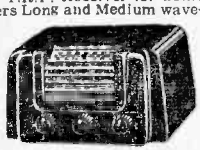

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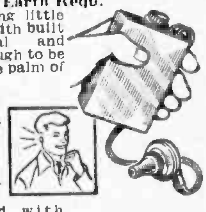

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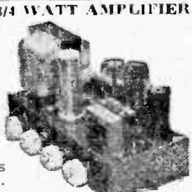

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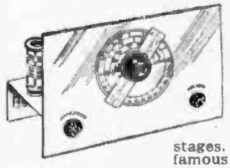

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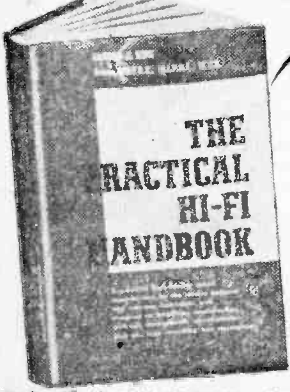

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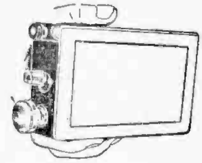
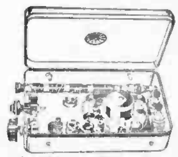
(3 Ediswan Transistors)



M/L waves. Ferrite rod aerial. Tuning condenser. Home, Light and Radio Luxemburg too. Complete kit with easy-build plans and "Sonotone" miniature earpiece. 55/-. With "Min. speaker," 49/6. Post, etc. 2/6.

NEW! "RECO" PUSH-PULL SIX KIT

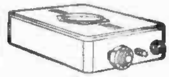
(6 Ediswan transistors and 2 diodes)



M/L waves and Trawler Band (short wave coil free on request). Tonal quality of a TRF. Performance as Transigen-3 but full loudspeaker strength. 9,000 lines 3in. loudspeaker with full-tone output. Without doubt the finest value in transistor kits today. Competitively priced at **£6/19/6**, post etc. 2/6. **M/L waves only £6/9/6.** "Am particularly pleased with Luxemburg and Trawler band reception." *H.S.B., Penzance, Cornwall.*

"RECO" TRANSIGEN-3

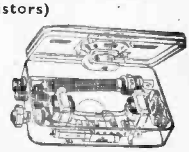
(3 Ediswan transistors)



M/L waves and T.B. High-gain ferrite rod aerial. XA104 (Ediswan) RF stage. On test (50 miles London) tuned in Home, Light, Third, AFN, Radio Luxemburg and many others at good headphone strength. A really fine transistor kit complete with easy-build diagrams, and "Sonotone" min. earpiece **69/6.** If reception conditions warrant a 3in. speaker may be fitted under speaker grille. (Case as P.P.5)

"RECO" PUSH-PULL FOUR

(4 Ediswan transistors)



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Uses latest Ediswan Transistors for sensitivity and selectivity. Improved. inbuilt ferrite rod aerial. Fitted volume/sensitivity control. Appearance as Transigen 3. Easy build diagrams. 3in. moving coil speaker. Complete kit, **£4/9/6.**

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fitted to pre-war commercial models and including dB above S9, but is a 0—1 milliammeter graduated as follows: 0, 0·2, 0·4, 0·6, 0·8, 1·0. This form of S meter is not easy to read at a glance and the operator should graph the scale with one graph from 0 to S9 and another from S9 to 10dB over S9. Alternatively the two can be combined in one graph.

Apart from its usefulness as a check on variations in signal intensity, an S meter is an adjunct which can be very useful in comparing the signal gain of one aerial and another be they of the same or different types.

This applies especially to fixed relay controlled doublets and rotary beams.

The H.R.O. S meter circuitry is in the form of a three element bridge all of which are fixed. Adjustment of the R.F. gain control brings the controlled valves to a predetermined value of A.C. resistance and the S meter needle to zero amplification will thus conform to the S meter scale.

Modification

In some instances competent amateurs have modified the H.R.O. by fitting the more modern octal valves or alternatively miniatures. The UX types fitted are, however, in plentiful supply and as it stands the H.R.O. receiver is an excellent performer more especially if used with an efficient aerial.

The sensitivity available far exceeds that which can be used in industrial locations. The judicious use of the R.F. and L.F. volume controls assuring a satisfactory signal to noise ratio on both strong and weak signals.

Noise Limiters

Most of the modern communication receivers are fitted with some form of noise limiter, but the H.R.O. models outlined in this article are not. But while such modifying devices which have been designed are effective where there is strong electrical interference with signals of average strength, what effect the addition of a noise limiter will have on sensitivity and weak signals is worth considering. This being so, a tried and proved design of noise limiter is advised which should have provision for switching out.

Aerials

Provision is made in the H.R.O. for the use of single wire fed and twin wire fed aerials. If doublets are used the jumper lead from the E terminal to chassis is removed from the earth terminal end, and the twin feeders inserted in the aerial and earth terminals. This also applies to the noise reducing type doublets and vertical rod systems which are used in conjunction with matching transformers.

Owing to its wide frequency coverage, high sensitivity and selectivity the Senior H.R.O. will meet the requirements of both the amateur bands and short wave broadcast listener.

Power Supplies

Unlike many other communication receivers the H.R.O. has no built in power supply. Type D power units which include a built in 6in. speaker are of British manufacture and are readily available. Also the original National 697 unit which does not include a speaker.

In addition are the 697AB for 105 to 120V, A.C., and the 6V vibrator, 686S.

For those who wish to use a separate loudspeaker the output is 3W at a nominal impedance of 7k, the headphone jack being for high impedance headphones.

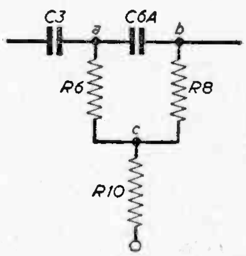
A Versatile Tape Recorder

(Continued from page 991)

place and before anything else is added, the valve heaters are wired with twisted, P.V.C. covered copper wire. After being put in place the wire should be pushed flat on to the chassis. The leads from V4 out of the chassis should be wired with flexible, plastic covered wire.

If the neon bulb to be used has its own lead it should be mounted now to save difficulty later when wiring is commenced. The switch, volume and tone controls, coaxial sockets and front panel are now added. A screened lead (with screen earthed to the earthed sections on the switch) should be taken along the angle of the chassis from SA to pin 9 of V1. SA1 and SA2 are connected to socket A and SC is connected to socket C. (Care should be taken not to overheat the centre pin of sockets A, B, C and D as the insulation may melt.)

The oscillator coil L1 and C19 are now fixed in place; L1 being attached by its plastic fixing bolt so that the three contacts of the coil are in a convenient position for wiring. Wire the oscillator section completely, except for the earthed ends of R21 and R22 which will be connected later to the earth-bar.



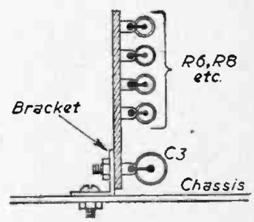


Fig. 12 (left).—An alternative equaliser circuit.

Fig. 13 (right).—The tag-board for the equaliser.

The Oscillator Screen

Bolt the oscillator screen in place, taking care not to short-out any wires. The next step is to fix the large tag-board to the back wall of the chassis by two 6BA bolts, using nuts as spacers. Using sleeving if necessary, wire the tag-board to valve holders 1, 2 and 3. The equaliser tag-board is now mounted as shown in the diagrams and wired in.

(To be continued)

Letters to the Editor

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

PUSH-PULL AMPLIFIER

SIR,—Referring to the query of J Haskell (January issue), the value of resistors for EL84 valves is about 270Ω. 5per cent tolerance, 3 to 5W. and the cathode by-pass capacitors 25μF, 12V.W. A suggestion I would like to make is that only one fixed resistor be used, the other being balanced. This ensures that the valves are balanced. If an ammeter is connected in series with the fixed resistor and by-pass capacitor, and the cathode of the valve, note the reading on the meter. Next connect the meter in series with the cathode of the other valve and the variable resistor and the by-pass capacitor, now adjust the variable resistor until the reading on the meter is the same as that for the first valve. The valves are now balanced. If the fixed resistor is 270Ω the variable resistor value should be about 500Ω.—R. DAVIES (Nottingham).

HIGH FIDELITY

SIR,—I find it most annoying that the phrase "High Fidelity" is so mis-used.

Now I see small gramophones (with atrocious reproduction, scratch, etc.) described as High Fidelity reproducers; but I had always been taught that high fidelity apparatus was large, with several speakers and far more than portable.

Now, recently I have seen a cardboard disc with a plastic outside for the grooves (which, incidentally had far worse scratch than the average 78 r.p.m. record, for it was a 45 r.p.m. record) with "Hi Fi" Disc in letters one half of an inch high on it.

Would that people would only use "High Fidelity" in its proper sense.—P. H. (Langport, Somerset).

ONE VALVER

SIR,—With reference to Mr. D. Illingworth's letter in the January issue, the internal resistance of his H.T. battery may cause a misleading voltmeter reading.

If his set continues to work while the voltmeter is connected, he can use with advantage a two cell battery for H.T. — C. H. WHITE (Ilfracombe, Devon).

CRYSTAL SET RECEPTION

SIR,—with reference to Mr. A. Radmore's letter (P.W. January), I should like to inform him that the coil I used in my crystal set was a home wound, medium-wave type and consisted of 90 turns of 22s.w.g. copper wire, on a 2in. wooden former. The detector was a germanium diode.

He may also be interested to learn that French, German and other Continental stations have been received at good strength. — D. J. CONNOLLY (Edinburgh).

MODULATION

SIR,—With reference to J. R. Miller's letter (January issue), the snag in his proposed method of modulation lies in the low plate efficiency of the final amplifier, the maximum efficiency obtainable being about 35 per cent. This is because the peak instantaneous power in a 100 per cent modulated signal is four times the carrier power. Under carrier conditions (i.e. with no modulation), the final amplifier will be producing one quarter of its maximum power output. The plate current, and therefore the power input, will be about half the maximum. The plate efficiency will therefore be only half the efficiency at maximum power, i.e. about 35 per cent. In practice the efficiency may be considerably less, since the amplifier must be operated in class AB or B.

In answer to Mr. Miller's second question, to give an output of 150W an input of 200W to 250W will be required (depending on the valve(s) used). 100W to 125W of audio will be needed for modulation. If, however, Mr. Miller means 150W input, which would give an R.F. output of 100W to 120W, 75W of audio are required. In order to allow for losses, the theoretical power output of the modulator valves should be about 20 per cent greater than the figures given above.

At 750V on the plate, a pair of 807's in class AB2 will deliver 120W into a 6950Ω load (plate to plate). At 600V, the output is 80W into 6400Ω, and may be increased to about 90W by reducing the load impedance. — D. PRICE (Cape Town, South Africa).

SIR,—Referring to Mr. J. R. Miller's letter in the January issue, I would like to explain why amplitude modulation is only carried out in the final R.R. amplifier. (Apart from the possibility of F.M. being caused by coupling or poor power supply regulation, etc.)

In most transmitters the doubling, amplifying and final stages are usually run in class "C" because of the high efficiency possible using this mode of operation (70 to 80 per cent). If modulation of intermediate stages is attempted, the

modulated R.F. waveform would be extremely distorted since the output of a class C amplifier is not directly proportional to its input.

Modulation of an early stage, followed by amplification is possible however if the succeeding stages are operated in linear class B, but the efficiency of such a stage for a modulated R.F. input is only around 35per cent, i.e. to give the same output in the final amplifier as a corresponding class C stage, the power drawn from the supply would have to be doubled (assumed to be within the valve's ratings).

To modulate 150W of R.F. the power output from the modulator valves should be around 85 to 90W to compensate for modulation transformer losses, and this can easily be supplied by 807's in AB2 with 650V on the anodes.—M. D. POLLARD (Chertsey).

RADIO MOSCOW

SIR,—I read with interest both Mr. P. J. Kennett and Mr. E. Haines's letters (January 1961) concerning Radio Moscow. Mr. Haines in his letter states that the Moscow transmitters are the most powerful in the world, this is not so. In the 49m band Moscow broadcasts on about 20 wavelengths on three of these wavelengths, to be precise 49·67, 49·59 and 49·42m, the power output is 100KW. In the other short wavebands, Moscow commands many wavelengths, e.g. in the 25m band Moscow broadcasts on 23 wavelengths, and the most powerful output on one of these wavelengths is 100KW on 25·17m in fact.

Many of the American stations are twice as powerful, e.g. radio stations KRCA, at Dixon, and WLWO at Cincinnati.

In the longwave band, on 1734m, Moscow's output is 500KW, 100KW more than our own Light programme, on 1,500m. Even this phenomenal output cannot be compared with the V.O.A. transmitters, at San Fernando, in the Phillipines, and at Okinawa in the Ryukyu chain. These stations broadcast on 263m. and 254m respectively, and both their power outputs are 1,000KW! This is twice as powerful as the known most powerful Russian transmitter.—T. ROEVES (Alcester).

SIR,—With reference to the letter of E. Haines (January 1961), I should like to state that the transmitters employed by Radio Moscow are not the most powerful in the world. The Voice of America fills this position with three transmitters each having an output of one million watts located at Munich (173kc/s), Okinawa (1180kc/s) and Manila (1140kc/s). It is possible that Radio Moscow's short-wave transmitters are more powerful than those of the Voice of America whose most powerful have an output of 200KW. However, the Voice of America is currently building a new short-wave station in North Carolina which will house six 500KW shortwave transmitters which will be in operation by the end of 1962.

Reader P. J. Kennett (January 1961), has already stated the correct facts which need not be duplicated here concerning the relay of Radio Moscow by other stations. However, it is of interest to note the following facts about the Voice of America relay stations:—

There are nine relay stations (excluding those in the U.S.A.) of which eight are land-based. The ninth is situated off the island of Rhodes in the Mediterranean and takes the form of the United States Coast Guard vessel "Courier". The others are situated in Germany, Great Britain, Greece, Ceylon, Ryukyu Islands and Philippine Islands.

Those Voice of America stations which announce a call sign are located in the U.S.A. — stations WBOU, WDSI, WLWO and WGEO in New Jersey, New York and Ohio and KNBH and KCBR in California.

The only links which the Voice of America studios in Washington have with the relay bases overseas are via the transmitting stations in the U.S.A. Should trans-Atlantic or trans-Pacific communications be impossible due to prevailing atmospheric conditions the relay bases are obliged to broadcast recorded programmes from tapes.—B. J. AYRES (Chessington, Surrey).

TRANSISTOR HOLDERS

SIR,—May I add a few comments to some of the letters and opinions expressed in the current issue of PRACTICAL WIRELESS.

E. M. Krell asks why nobody has produced a transistor holder to avoid soldering. If he cares to look through the advertisements in this or most of the other publications of a similar nature he will see them offered time and again.

F. Keating asks how to play a tape backwards. To do this he should turn his tape over as if he was going to play back the other track and then twist it so that the glossy back of the tape is running against the playback head instead of the dull-coated side.—J. G. WATT (Yorkshire).

MODULATION

SIR,—Referring to Mr Miller's letter in the January issue of PRACTICAL WIRELESS, I would like to say that modulation of an oscillator is very undesirable. It is due to F.M. that always occurs when amplitude modulation is applied directly to the frequency-controlling stage (the oscillator).

In America, at least, amplitude modulation of an oscillator is permitted only on frequencies above 144Mc/s.—V. TH. KJARTANSSON (Reykjavik, Iceland).

CRYSTALS

SIR,—In February PRACTICAL WIRELESS there is a letter from T. L. Mence who requires some Hertzite crystal. I was connected with the wireless trade from 1928 to 1938 and I have a small supply of Hertzite that we used to put into glass tubes for sales purposes.

If T. L. Mence or any other readers would like a piece (so far as my small stock allows) and cares to contact me I will let them have some if they would send a stamped addressed envelope. I have also been an amateur radio fan on and off since about 1922 and took the first PRACTICAL WIRELESS. So far back, anyway, that I can remember an issue that gave instructions for running a radio from gas.

I was very interested a month or so ago when Thermion looked back. I also remember the glass tube with practically all of a 3 valve set enclosed made by a German firm at about 1932.—B. ANDREW (37 Grimsbury Drive, Banbury, Oxfordshire).

PLAYING A TAPE BACKWARDS

SIR,—With reference to the letter "Playing a record backwards," February edition, I have two solutions. Either record on a twin track tape-recorder then remove the spools, placing them on a four track tape-recorder, one of these tracks will play the recording backwards; or record as normal and then place the left spool on the right and right on left, pick up right spool and turn over (the twist in the tape take comes before the recording head) and play.—M. BRICKWOOD (London, E7).

SIR,—I was interested to read, in the February issue, how Mr. Keating played a gramophone record "backwards," and perhaps I can help him in his efforts to play a tape recording in this manner.

He must first make a normal recording near the end of a reel of tape. The tapes are then "changed over" so that what was once the "feeder" spool becomes the "take-up" spool. The other spool (which now "feeds"), is forced to move clockwise instead of anticlockwise as it would normally do.

Although this means that the tape can now be played "backwards", it also means that the tape is being played with the insensitive side towards the head and consequently a slight lessening of volume is also noted.—J. B. DE BOER (Huddersfield).

SIR,—I would like to let Mr. Keating know how to play a tape recording in reverse. The only disadvantages are that the output of sound is reduced, and that the higher treble frequencies are lost.

Having placed full reel of tape on the feed spindle as normal, turn it over and replace on spindle. Take the leader tape and join it to the take-up spool in the normal manner. The tape can now be played in reverse, but do not attempt to rewind as the tape will unreel from the spool.

Incidentally, if the reversed tape spools are interchanged to give the same pattern of feed and take-up, then the recorded sound will be heard as normal.

I hope this will enlighten all interested parties. —D. HARTLAND (Bournemouth).

SHORT-WAVE LISTENERS' LOG—5

SHORT-WAVE listeners who are learning Morse, but cannot attend a group or class, may obtain good practice in reading by listening on the amateur bands. Many recently licensed amateurs commence working on the 80m band, and listening on frequencies around 3·5Mc/s to 3·6Mc/s will usually provide some Morse signals of only moderate speed. It is not, of course, possible to read Morse at once, even after the code has been memorised, but all practice at reading "off the air." will help to increase speed. Normally, listening and reading should not be for more than 10 or 15 minutes at a time, for a beginning. Amateur activity also varies greatly from time to time, so lack of suitable signals does not mean it is not worth trying the band again.

In addition to usual activity, broadcasts of particular interest are occasionally heard on the amateur bands. Shipping, or ship to shore, communications may be heard around 1850kc/s in the 160m band. Around 3·6Mc/s in the 80m band will often give good reception of special bulletins of particular interest to amateurs, commencing at 10 a.m. on Sundays. On the higher frequency bands it is usually possible to hear and identify transmissions from a number of distant countries, in addition to regulars such as the U.S.A. It is best to try each band at various times, as conditions change from hour to hour.

The listener who has no special short-wave set will find the 31m and 41m bands particularly satisfactory after dark. Strong signals from Prague, Rome, and other fairly near stations can be expected, with English programmes beginning at 18.00 G.M.T. Voice of America transmissions will often furnish 9-plus signals. For more distant reception, it is worth trying approximately 7·1Mc/s, as Radio Peking can easily be an R9 signal during the early evening, and gives a programme in English at 21.00 G.M.T.

It is interesting to hear the news in Special English, radiated each weekday except Saturday by the Voice of America at 19.00 and 20.00 G.M.T. Frequencies and wavelengths used include: 21·5Mc/s, 13·95m; 15·2Mc/s, 19·73m; 11·76Mc/s, 25·5m; 9·635Mc/s, 31·41m; 9·62Mc/s, 31·19m; 9·52Mc/s, 31·51m; and 6·185Mc/s, or 48·5m. Broadcasts in the international language Esperanto may also be heard, some of the transmissions being as follows: Rio de Janeiro, 30·78m and 25·48m, 09.00 to 09.30 G.M.T. Sundays; Sofia, 41·35m, 39·11m and 30 93m, 19.00 to 19.25 G.M.T. Sundays; Juiz de Fora, 60·91m, 00.45 to 01.00 G.M.T. Mondays; Bern, 48·66m and 31·46m, 17.35 to 17.40 G.M.T. Mondays; Rome, 50·34m, 41·24m and 30·9m, 17.55 to 18.10 G.M.T. Tuesdays.

Listeners who are badly troubled by untunable interference, or lack of good signal strength, may find that a simple dipole solves these problems. With a single-wire aerial, feeding the receiver from one end, static is carried to the set with the signal. But with a dipole, static is in phase in both halves of the aerial, and thus largely cancels out on reaching the twin feeder. The desired signals, on the other hand, are out of phase in the two halves of the aerial, and are thus carried to the receiver. In addition, a dipole does not have the broad-band reception characteristics of a single, end-coupled aerial wire, and this also reduces general interference very considerably.

A dipole can be made from 7/22 or similar aerial wire. Its total length is 0·95 of a half-wave —or about 66ft for the 40m band. This total length is cut in half, and an insulator is inserted. From this insulator a twin-lead or coaxial cable is taken to the receiver. One conductor of this feeder thus goes to each 33ft portion of the aerial. The whole is supported in the usual way with insulators at each end of the two 33ft horizontal top wires, the feeder descending from the centre to the receiver. Very good results will also be obtained on 20m and 10m bands.

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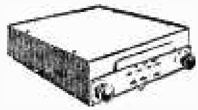

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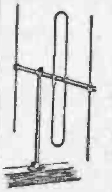

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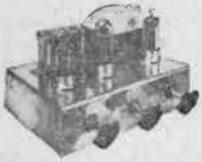

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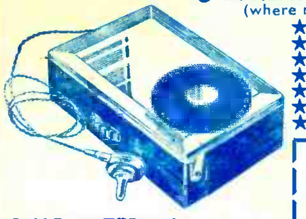

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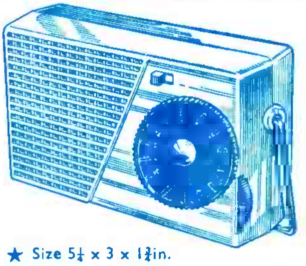

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