JANUARY 1962

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P.W. MINUETTE

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DF33	10/-
DF91	4/-
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DH63	6/-
DH77	7/-
DK32	11/6
DK91	8/-
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DL33	8/6
DL35	10/6
DL92	7/6
DL93	7/-
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DL96	8/6
EA50	2/-
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EAC91	4/-
EAF42	9/6
EB34	2/6
EB41	7/6
EB91	4/-
EBC3	21/-
EBC33	4/6
EBC41	9/-
EBC81	10/-
EBF80	8/6
EBF83	8/6
EBF89	8/6
EBL21	22/-
EBL31	21/6
ECC34	15/-
ECC35	8/-
ECC40	21/-
ECC81	5/9
ECC82	8/6
ECC83	7/6
ECC84	8/6
ECC85	8/-
ECC88	17/6
ECC91	4/-
ECF80	8/6
ECF82	8/6
ECH3	21/-
ECH21	22/-
ECH42	9/6
ECH35	10/-
ECH81	8/-
ECH83	8/6
ECL80	9/-
ECL81	10/-
ECL82	9/6
ECL83	12/-
EF6	21/-
EF9	21/-
EF22	14/-
EF36	4/-
EF37	8/-
EF37A	8/-
EF39	4/-
EF40	15/-
EF41	8/-
EF42	10/-
EF50A	4/-
EF50E	3/6
EF80	5/-
EF85	5/-
EF86	10/6
EF89	9/-
EF91	4/-
EF92	4/-
EF95	7/6
EF97	12/6
EF98	10/-
EF183	18/-
EF184	14/-
EK32	8/6
EL2	21/-
EL3	21/-
EL6	21/-
EL32	4/6
EL33	10/-
EL34	15/-
EL35	10/-
EL37	17/6
EL38	21/-
EL41	10/-
EL42	10/-
EL81	12/6
EL84	6/9
EL85	10/-
EL90	8/6
EL91	4/-
EL95	10/6
EM80	8/6
EM81	8/6
EM84	9/6
EM85	10/-
EY51	8/6
EY81	8/6
EY83	15/-
EY86	8/6
EZ35	6/-
EZ40	7/-
EZ41	7/-
EZ80	7/-
EZ81	7/-
EZ90	7/-
E1148	2/-
FC2	21/-
FC2A	21/-
FC4	15/-
FC13	21/-
FC13C	21/-
FW4/500	9/-
FW4/800	9/-
GZ30	10/6
GZ32	10/6
GZ33	19/3
GZ34	13/6
GZ37	19/3
HABC80	10/-
HL41DD	8/6
HL92	8/6
HL133DD	10/-
HN309	20/-
IW4/350	10/-
IW4/500	10/-
KT33C	8/-
KT36	17/6
KT55	17/6
KT61	9/6
KT66	15/-
KT76	10/-
KT81	15/-
KT88	21/-
L63	5/-
LN152	9/-
LN309	12/6
LZ319	12/6
MKT4	17/6
MS4B	17/6
MVSPEN	17/6
MVSPENB	17/6
MU14	9/-
MX40	15/-
N18	8/-
N37	14/-
N78	17/6
N108	18/-
N308	20/-
N339	15/-
N369	10/6
OD3	5/-
OZ4	5/6
P2	10/-
PABC80	13/-
PCC84	9/-
PCC85	9/6
PCC88	15/-
PCC89	9/6
PCF80	9/6
PCF82	7/-
PCF84	16/-
PCF86	15/-
PCL82	9/6
PCL83	12/6
CPL84	10/6
PCL85	16/-
PENA4	17/6
PENB4	17/6
PEN4DD	25/-
PEN4VA	17/6
PEN36C	21/-
PEN45	10/-
PEN45DD	22/6
PEN46	5/-
PEN453DD	27/6
PENDD4020	25/-
PL33	15/-
PL36	15/-
PL38	21/-
PL81	12/-
PL82	8/-
PL83	10/6
PL84	9/-
PL820	18/-
PM24M	13/6
PX4	15/-
PX25	25/-
PY31	15/-
PY32	12/6
PY80	7/6
PY81	7/6
PY82	7/6
PY83	8/6
PZ30	18/6
QS9510	10/-
QS15015	10/-
R2	10/-
R3	10/-
R12	8/6
R16	17/6
R19	19/-
R20	19/-
S130	7/6
SP41	3/6
SP61	3/6
SU2150	25/-
SU2150A	25/-
T41	15/-
TDD4	12/6
TDD13C	17/6
TH41	24/-
TY86F	12/6
U10	9/-
U12	9/-
U14	9/-
U22	8/-
U24	21/-
U25	12/6
U26	10/-
U27	8/-
U31	9/-
U35	17/6
U37	17/6
U43	8/6
U45	10/-
U47	12/6
U50	7/6
U52	4/-
U76	7/6
U78	4/6
U191	15/-
U251	12/6
U281	18/-
U282	19/6
U301	22/6
U329	12/6
U339	15/-
U403	10/-
U404	10/-
U801	29/-
UABC80	7/-
UAF42	8/6
UB41	7/6
UBC41	8/6
UBC81	10/-
UBF80	8/6
UBF89	7/6
UBL21	21/-
UCC84	10/6
UCC85	7/6
UCF80	13/6
UCH21	21/-
UCH42	9/6
UCH81	8/-
UCL82	10/-
UCL83	13/6
UF41	7/6
UF42	7/6
UF80	7/-
UF85	7/6
UF86	12/6
UF89	6/6
UL41	8/6
UL44	21/-
UL46	14/6
UL84	7/-
UL85	7/6
UM80	10/6
URIC	15/-
UU6	19/-
UU8	21/-
UU9	7/6
UYIN	12/6
UY21	15/6
UY41	7/6
UY85	7/-
VMS4B	12/6
VP4	15/-
VP4A	17/6
VP4B	17/6
VR10530	7/-
VR15030	7/-
VU39	9/-
VU111	2/6
VU120	2/6
W61	11/-
W76	5/-
W77	4/-
W81	6/-
W81M	6/-
X17	8/6
X18	9/-
X41	15/-
X61	12/6
X61M	22/6
X65	12/6
X76	12/6
X76M	12/6
X78	21/-
X79	21/-
Y61	10/-
Y66	9/6
Z63	7/6
Z66	10/-
Z77	4/-
Z152	5/-
ZD17	8/-
ZD152	8/6
OZ4	5/-
1A7	11/6
1C1	8/6
1C2	9/-
1C3	9/6
1C5	10/6
1D5	8/6
1D6	10/-
1H5	9/6
1L4	5/-
1LN5	4/6
1N5	9/6
1R5	7/6
1S4	8/-
1S5	7/6
1T4	4/-
1U5	5/9
2P	24/9
3A4	5/-
3A5	10/6
3Q4	8/-
3Q5	9/-
3S4	7/-
3V4	8/-
5U4	4/-
5V4	7/9
5Y3	8/6
5Y3GT	8/6
5Z4	9/6
5Z4GT	12/6
6A7	9/-
6A8G	8/6
6A8GT	13/6
6AB8	9/-
6AJ8	9/6
6AK5	5/-
6AK8	7/6
6AL5	6/-
6AM5	5/-
6AM6	4/-
6AN5	7/6
6AQ5	6/6
6AQ8	9/3
6AT6	6/-
6AU6	9/-
6B8G	3/-
6BA6	6/-
6BE6	6/-
6BG6G	17/6
6BH6	8/-
6BJ6	6/-
6BQ7A	12/6
6BR7	12/6
6BS7	12/6
6BW6	7/-
6BW7	5/-
6BX6	5/-
6C4	3/6
6C5GT	8/-
6C6	6/6
6C9	12/6
6CD6G	32/-
6CH6	10/-
6D2	4/-
6D6	5/6
6E5	10/-
6F1	10/6
6F6	6/9
6F11	10/-
6F12	4/-
6F13	10/-
6F14	10/-
6F15	12/6
6F19	12/6
6F23	10/6
6F33	5/6
6H6	2/-
6J5	4/6
6J5GT	4/6
6J6	3/6
6J7	5/-
6J7GT	7/6
6K7	2/-
6K7GT	8/6
6K8	5/-
6K8GT	9/6
6K25	18/-
6L1	13/-
6L6	7/6
6L18	10/-
6L19	17/6
6LD20	14/-
6P25	10/6
6P28	17/6
6Q7	6/6
6Q7GT	8/6
6SA7	7/-
6SG7	7/-
6SH7	6/-
6SJ7	6/6
6SK7	5/6
6SL7GT	6/-
6SN7GT	5/6
6SQ7	8/6
6U4GT	10/-
6U5G	7/6
6V6	4/6
6V6GT	8/-
6X4	4/6
6X5	4/6
6X5GT	5/-
6X6	15/-
630L2	10/-
7B5	12/6
7B6	10/-
7B7	8/6
7B8	8/-
7C5	8/-
7C7	8/-
7C7	8/-
7D3	15/-
7D5	15/-
7D6	15/-
7D8	15/-
7H7	7/6
7K7	8/6
7Q7	10/-
7R7	12/-
7S7	10/-
7Y4	7/6
8D3	4/-
9BW6	12/6
10C1	12/6
10C2	17/6
10F1	15/-
10F3	15/-
10F9	12/6
10LD11	15/-
10LD12	10/-
10P13	15/-
10P14	19/-
10P18	15/-
11D5	23/6
12A6	6/6
12AH8	9/-
12AT6	7/6
12AT7	5/-
12AU7	8/6
12AX7	7/6
12AU6	17/6
12BA6	7/6
12BE6	7/6
12BH7	10/-
12C8	8/6
12J5GT	4/-
12J7GT	8/6
12K7GT	5/-
12K8GT	10/-
12Q7GT	6/6
12SA7	8/6
12SK7	6/-
12SQ7	8/6
12SL7	8/-
12SN7	10/-
13D3	12/6
14H7	10/-
14R7	10/-
14S7	15/-
19AQ5	8/-
19B6G	21/-
20D1	10/-
20F2	17/6
20L1	17/6
20P1	25/-
20P3	25/-
20P4	22/-
20P5	25/-
21B6	12/-
25A6	8/-
25L6	8/-
25Y5	8/-
25Z4	7/6
25Z5	8/-
25Z6	8/-
27SU	17/6
30C1	9/6
30F5	10/-
30FL1	10/6
30L1	9/6
30L15	11/6
30P4	21/-
30P12	10/-
30P16	9/-
30PL1	15/-
30PL13	12/6
35L6GT	8/6
35W4	7/6
35Z3	10/6
35Z4	7/6
35Z5	8/6
40SUA	15/-
41STH	21/-
42	12/6
50C5	10/-
50L6	8/6
50CD6G	36/6
53KU	12/6
75	8/-
78	7/6
80	9/-
85AZ	12/6
185BT	30/-
305	9/6
807BR	5/-

METAL RECTIFIERS

RM1	5/3	14RA 1-2-8-2	17/6 (FC31)	14A97	25/-
RM2	7/6	16RC 1-1-16-1	8/6	14A100	27/-
RM3	7/9	14RA 1-2-8-3	19/- (FC31)	16RD 2-2-8-1	12/-
RM4	14/-	18RA 1-1-16-1	6/6 (FC116)	16RE 2-1-8-1	8/6
RM5	19/6	18RA 1-2-8-1	11/-	18RA 1-1-8-1	4/6
14A86	17/6	18RD 2-2-8-1	15/- (FC124)		

SPECIAL OFFER

EABC80 6/-, EAC91 4/-, EB91 4/-, EBF89 8/6, ECC81 5/9, ECC85 8/-, ECC91 4/-, ECH81 8/-, EBC33 4/6, EF39 4/-, EF50 3/6, EF80 5/-, EF85 5/-, EF91 4/-, DF91 4/-, EL84 6/9, PCC89 9/6, PL84 9/-, UABC80 7/-, UBF89 7/6, UF41 7/6, UL41 8/6. UF89 6/6, UL84 7/-, UY85 7/-, W81 6/-, OZ4 5/-, 5U4 4/-, 6AQ5 6/6, 6BA6 6/-, 6BE6 6/-, 6D2 4/-, 6K7 2/-, 6K8 5/-, 6L6 7/6, 6Q7 6/6, 6SL7 6/6, 6SN7 5/6, 6V6 4/6, 6X5 5/-, 8D3 4/-, 807 5/-, 12AT7 5/-, 12AH8 9/-, 12BA6 7/6, 12BE6 7/6, 12K7 5/-, 12Q7 6/6.

TERMS OF BUSINESS C.W.O. or C.O.D. 2/9 PACKING CHARGE ON ALL C.O.D. ORDERS. POSTAGE 6d. PER VALVE

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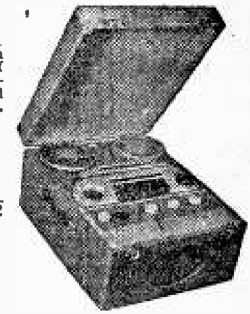
R.S.C. HI-FI TAPE RECORDER KIT

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.

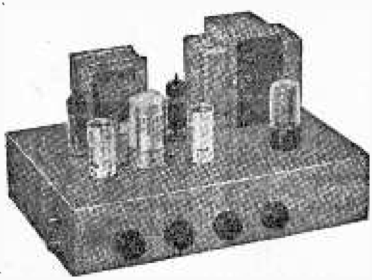


25½ GNS. Carr. 17/6

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 is fully punched. Full instructions and point-to-point wiring diagrams supplied. Only **8 Gns.** Carr. 10/- (Or factory built 51/- extra).
If required louvred metal cover with 2 carrying handles can be supplied for 18/9. **TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9, and 9 monthly payments of 24/9.** Send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets, Speakers, Microphones, etc. with cash and credit terms.

TELEVISION RECTIFIERS 250 v. 200 mA. small size. Only 6/9 each.

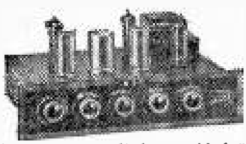
COLLARO CONQUEST 4-SPEED AUTO-CHANGER, with high fidelity Studio pick-up. Latest model. For 200-250 v. 50 c.p.s. A.C. mains. Our price £6.19.6. Carr. 5/6.

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. 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.

GL3A MINIATURE 2-3 WATT GRAM AMPLIFIER. For use with any single or auto-change unit. Output for 2-3 ohm speaker. For 200-250 v. A.C. mains. Size 11½ x 2½ x 2½in. Controls: Vol. and Tone with switch. Only 59/6.

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 "lift" and "cut". Provision is made for use as straight (monaural) 10 watt amplifier. Valve line-up ECC83, ECC83, EL84, EZ81. Outputs for 2-3 ohm speakers. Point-to-Point wiring diagrams and instructions supplied. Send S.A.E. for leaflet. **8 Gns.** Full constructional details and price list 2/6. Carr. 10/-.
Kit can be supplied assembled, ready for use, for 59/6 extra.

R.S.C. BATTERY CHARGING EQUIPMENT

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

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

DEAF AID EARPIECES. Low Impedance with lead, 8/9. High Impedance Crystal 8/9.

MICROPHONE INSERTS. Crystal type 6/9.

SOLDERING IRONS. 230-250 v. 30 watts. First quality. For Radio work. 19/9. Spare elements and bits available.

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. **69/6** Carr. 5/-. Terms: Deposit 13/3 and 5 monthly payments 13/3. 6/12 v. 3a., all facilities as above. Only 59/9, carr. 3/9.

ASSEMBLED CHARGERS
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.
6v. or 12v. 1 amp. 24/9
As above, with Ammeters 32/9
6 v. 2 amps. 25/9
6v. or 12v. 2 amps. 31/6
6 v. or 12 v. 2 amps. inclusive of Ammeter. 42/9
6 v. or 12 v. 4 amps. 49/9
6 v. or 12 v. 4 amps. with Ammeter and variable charge rate selector 59/9

CHARGER AMMETERS. 0-.15 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)

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. 2a. .. 18/9
250-0-250 v. 100 mA, 6.3 v. 2 a, 6.3 v, 1 a 21/9
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. 130 mA, 6.3 v. 4 a, 6.3 v. 1 a, for Mullard 510 Amplifier 29/9
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
350-0-350 v. 100 mA, 6.3 v. 4 v. 4 a, C.T. 0-4-5 v. 3 a. 26/9
350-0-350 v. 150 mA, 6.3 v. 4 a, 5 v. 3 a. .. 29/9

FULLY SHROUDED UPRIGHT
250-0-250 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. .. 27/9
300-0-300 v. 100 mA, 6.3 v. 4 a, 5 v. 3 a 27/11
350-0-350 v. 100 mA, 6.3 v. 4 a, 5 v. 3 a 27/11
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. 6 a, 17/6; 12 v. 1.5 a twice, 17/6.

OUTPUT TRANSFORMERS
Midget Battery Pentode 66:1 for 3S4, etc. 3/9
Small Pentode, 500Ω to 3Ω 3/9
Small Pentode 7/8,000Ω to 3Ω .. 3/9
Standard Pentode 5,000Ω to 3Ω .. 5/9
Standard Pentode 7/8,000 to 3Ω .. 5/9
10,000Ω to 3Ω 5/9
Push-Pull 8 watts, EL84, or 6V6 to 3% or matched to 15Ω 9/9
Push-Pull 10-12 watts to match 6V6 or EL84 to 3-5-8 or 15% 19/9
Following types for 3 and 15Ω speakers:
Push-Pull 10-12 watts 6V6 or EL84 .. 18/9
Push-Pull 15-18 watts, 6L6, KT66 .. 22/9
Push-Pull for Mullard 510 Ultra Linear 29/9
Push-Pull 20 watts, sectionally wound, 6L6, KT66, etc. 49/9

MIDGET MAINS
Primaries 200-250 v. 50 c/s.
250 v. 60 mA, 6.3 v. 2 a 11/9
250-0-250 v. 60 mA, 6.3 v. 2 a. 12/9
Both above size 2½ x 2½ x 2½ins.

SMOOTHING CHOKES
150 mA, 7-10H 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

PARMEKO POTTED TYPES
200 mA, 12 H 100 ohms 16/9
120 mA, 30 H 200 ohms 16/9
120 mA, 8 H 50 ohms 13/9

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, 19/9; 0-9-15 v. 6 a, 23/9; 0-9-15 v. 8 a, 28/9.

AUTO (Step up/Step down) TRANS. 0-110/120-230/250 v. 50-80 watts, 13/9; 150 watts, 27/9. 250 watts 39/9.

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

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

R.S.C. A12 STEREOPHONIC AMPLIFIER KIT WITH TWIN SPEAKERS

A complete set of parts to construct a good quality 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. **4 Gns.** Carr. and pkg. 5/-

STEREO EQUIPMENT OFFER- Comprising A12 Kit. 2 matched 8in. L/Speakers, and Acos T/O Stereo head suitable most pickups. **£6.19.6** Carr. 7/6.

PICK-UP ARMS complete with Hi-Fi turnover crystal head. Acos GP54. Limited number brand new, perfect at approx. half price. Only **29/11.**

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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 perforated cover with carrying handles can be supplied for **19/9.** The amplifier can be supplied, factory built with EL34 output valves and 12 months guarantee, for **14 Gns.**

11 Gns. Carr. 10/-

TERMS: DEPOSIT 33/9 and 9 monthly payments of **33/9.**

Suitable microphones and speakers available at competitive prices.

FULL RANGE OF LINEAR AMPLIFIERS ALWAYS IN STOCK.

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

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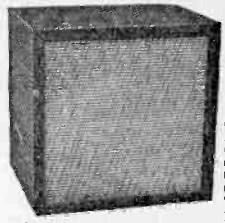
Jason FMTI V.H.F/FM Radio Tuner design. Total cost of parts including valves, Tuning dial, Escutcheon, etc. **£6.19.6.**

LINEAR L45 MINIATURE 4/5 WATT QUALITY AMPLIFIER. Suitable for use with any record playing unit, and most microphones. Negative feed-back 12db. 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. Guarant'd 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.**

12in. 10 WATT HIGH QUALITY LOUD-SPEAKER IN POLISHED WALNUT FINISHED CABINET



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SUPERHET FEEDER UNIT. Design of a high quality Radio Tuner Unit (specially suitable for use with any or our Amplifiers). Delayed A.V/C. Controls are Tuning, W/Ch. and Vol. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size 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 leaflet send S.A.E.

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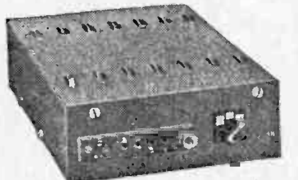

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6BW6	8/6	7Y4	7/6	35A5	21/9	DF91	3/6	ECL82	10/6	GZ33	20/5	PEN/DD		U329	14/-	X76M	14/-	TS3	15/-
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6C5	6/6	9D2	4/-	35Z3	19/1	DH63	6/6	EF9	23/10	HABC80		PL36	12/-	U404	8/6	X109	17/8	XA101	9/-
6C6	6/6	10C1	13/-	35Z4GT	6/-	DH76	5/-	EF22	14/-		13/6	PL38	27/2	U801	30/7	XD(1.5)	6/6	XA102	10/-
6C9	13/6	10C2	27/2	35Z5GT	9/-	DK32	12/-	EF36	4/-	HL2	7/6	PL81	10/6	U4020	19/1	XFG1	18/5	XA103	15/-
6C10	9/-	10F1	27/2	43	10/-	DK91	6/6	EF37A	8/-	HL23	15/8	PL82	7/6	UABC80	9/-	XFY12	9/6	XA104	18/-
6CD6G	37/5	10LD11	16/4	50C5	10/-	DK92	9/-	EF39	5/6	HL23DD	7/6	PL83	9/-	UAF42	9/6	XFY34	18/-	XB102	6/-
6CH6	9/-	10P13	15/-	50CD6G		DK96	8/6	EF40	15/-	HL42DD		PL84	13/-	UB41	12/-	XH(1.5)	6/6	XB103	6/6
6D6	6/6	10P14	19/9		37/5	DL33	9/6	EF41	9/-		19/9	PL820	19/1	UBC41	8/6	XSG(1.5)	6/6	XB104	7/-
6E5	12/6	12A6	5/-	50L6GT	9/6	DL66	17/6	EF42	10/6	HN309	25/2	PM84	17/8	UBC81	11/6	Y63	7/6	XC101	6/6

PLEASE NOTE THAT WE DO NOT SELL SECONDHAND GOODS OR MANUFACTURERS' REJECTS

LINE OUTPUT TRANSFORMERS, SCAN AND DEFLECTOR COILS

Available for Ace, Alba, Ambassador, Argosy, Armstrong, Baird, Banner, Beethoven, Bush, Champion, Columbia, Cossor, Decca, Defiant, Dynatron, Ekco, English Electric, Etronic, Ferguson, Ferranti, G.E.C., H.M.V., Invicta, K.B., Marconi, Masteradio, McCarthy, McMichael, Mullard, Murphy, Pam, Peto Scott, Philco, Philips, Pilot, Portadyne, Pye, Raymond, Regentone, R.G.D., Sobell, Stella, Ultra, Vidor, etc. Prices from 39/6. Please quote full details of model number. Quotation on receipt of S.A.E. or order C.O.D.

ALL GOODS BRAND NEW, SUBJECT TO FULL MAKERS' GUARANTEE, AND ACTUALLY IN STOCK.

VOLUME CONTROLS

Less switch 3/- each.
With D.P. switch 4/6 each.

10 K	25 K	50 K	100 K
¼ mg.	½ mg.	1 meg.	2 meg.

METAL RECTIFIERS *Full List with ratings free for S.A.E.*

DRM1B	13/-	RM-1	5/3	14A86	17/6	14B130	35/-	14RA 1-2-8-3	21/-	18RA 1-1-16-1	6/6
DRM2B	15/6	RM-2	7/6	14A97	25/-	14B261	11/6	(FC31)		(FC116)	
DRM3B	15/6	RM-3	7/9	14A100	27/-	14RA 1-2-8-2	17/6	16RD 2-2-8-1	12/-	18RA 1-2-8-1	11/-
LW7	21/-	RM-4	14/-	14A124	28/-	(FC101)		16RE 2-1-8-1	8/6	18RD 2-2-8-1	15/-
RM-0	7/11	RM-5	19/6	14A163	38/-	16RC 1-1-16-1	8/6	18RA 1-1-8-1	4/6	(FC124)	

JUST OUT. MIDGET SILICON RECTIFIERS. OUTPUT 120 VOLTS AT ½ AMP. TWO IN SERIES GIVE 240 VOLTS AT ½ AMP. NO LARGER THAN A RESISTOR. 10/6 EACH.

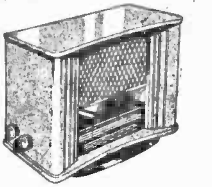
ELECTROLYTIC CONDENSERS

Standard Can						Wire-ended tubular			
32 x 32 mfd., 450 v.	5/9	60 x 250 mfd., 275 v.	9/6	200 mfd., 275 v.	4/-	8 mfd., 450 v.	1/9	8 x 8 mfd. 450 v.	3/-
50 x 50 mfd., 350 v.	7/-	100x400 mfd., 275 v.	12/6			16 mfd., 450 v.	2/9	16 x 16 mfd., 450 v.	4/-
64 x 120 mfd., 350 v.	8/3	100 mfd., 275 v.	3/-	100x200 mfd., 275 v.	9/6	32 mfd., 450 v.	3/9	32 x 32 mfd., 350 v.	4/-
								8 x 16 mfd., 450 v.	3/9

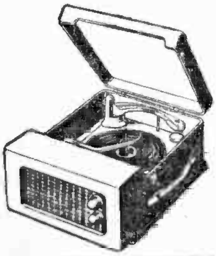
Post/packing charge 6d. per item. Orders over £3 post free. C.O.D. 2/6 extra. Full List, with Terms of Business, 6d.
Any parcel insured against damage in transit for only 6d. extra. Shop Hours 8.30-5.30. Early Closing Saturday.

COMPLETE V.H.F./A.M. RADIO FOR £12.10.0

(carr. paid)



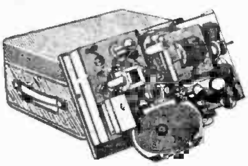
Brand new set, in superb walnut cabinet (size 19 x 8½ x 14½ in.high). Covering 80-100 Mc/s. 16-49 M., and 200-500 M. Mains trans. 200-250 v. with 2 tappings. Ferrite rod aerial for A.M. Controls: volume on/off, tone, tuning, w/change. Gram and ext. speaker position provided. Valves 12AT7, 12AH8, 6BJ6, EABC80 6BW6 and metal rectifier. Fully guaranteed. Today's Value £20.



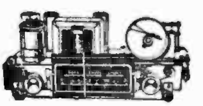
BUILD YOUR OWN RECORD PLAYER FOR £12.0.0

2v. amp 57/-; B.S.R. UA14 4-sp. autochanger £7.10.0; case 20 x 16 x 9½ins. black and cream 45/-; carr. 7/6 on any two items or the lot for £12.0.0—carr. paid. Assembled in 15 mins. Extra for 3 v. amp, 10/-.

TAPE RECORDER FOR ONLY £17.17.0 (10/- carr.)



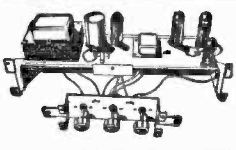
A QUALITY ARTICLE. Valves EZ80, ECC83, ECL82, DM70. Acos Crystal "mike", 850ft. Tape and extra spool. 3¾in./sec. Mike and Radio inputs; Vol. on/off tone, Ext. L.S. and Monitor. Fast forward and reverse. Cannot be accidentally erased. Magic Eye Indicator. 6 x 4in. Speaker. Cabinet 14x11½x7in. Supplied completely built and in cabinet.



SELF-POWERED VHF TUNER CHASSIS. Covering 88-95 Mc/s. Mullard permeability Tuner. Dims. 10½ x 4½ x 5in. high ECC85, EF91, EF91 and 2 diodes. Metal Rectifier. Mains transformer. Fully wired and tested. Only £7.14.0 (carr. pd.). Room dipole 10/-. 300 ohm twin feeder, 6d. yd. Tuner without power pack £6.14.0 (carr. paid).

LISTEN WITHOUT INTERFERENCE

Fully built V.H.F./F.M. Set for £8.12.0 (carr. pd.). Covers 88/95Mc/sec. Wired, aligned and tested. Mullard permeability tuner and 4 valves (ECC85, ECL82 and two EF91). 2 diodes. Cheap room dipole, 10/-. 300 ohm twin feeder, or co-axial cable, 6d. yd.

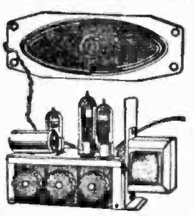


PUSH-PULL AMPLIFIER £4.15.0

(4/- Carr.)

Brand new 200-240 A.C. mains. Bass, treble and vol. controls. With valves EZ80, ECC83 and 2-EL84 giving full 8 w. Chassis 12 x 3½ x 3½in. With o.p. trans. for 2-3 ohm speaker.

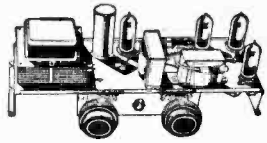
Front panel (normally screwed to chassis) may be removed and using as "flying panel".



3-VALVE AMPLIFIER (INC. RECT.). 4 watts. Valves ECC83, EL84 and EZ80. Controls, volume, bass and treble. On/off switch. (Chassis size 6½ x 3 x 2½in.) 6½in. round or 7 x 4in. elliptical speaker. Not suitable for microphone input. A.C. only. 67/-. P. & P. 3/-

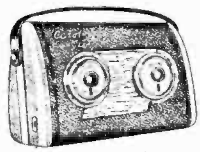
BEREC BATTERY RADIO IN MAKERS' CARTON. Valves DK96, DF96, DAF96, DL96. Two Short Wavebands 2.5 to 7 Mc/s and 6.5 to 17 Mc/s. Cabinet 12 x 7½ x 6in. ONLY £5 (2/6 p. & p.); MW and SW £5.4.0 (plus 2/6 p. & p.).

STEREO AMPLIFIER £4.15.0 (4/- p. & p.)



Brand new. 200-250 A.C. Tone and volume controls each channel. EZ80; ECC83; and 2—EL84; giving 2 x 4W. Size 12 x 3½ x 3½ins. O.P. Trans. for 2-3Ω speaker. Separate on/off switch to allow balancing to remain set.

IN TIME FOR CHRISTMAS!



A really elegant 6-transistor radio covered in sponge clean Duracour fabric, in latest two tone shades. M.W. and L.W., ferrite rod, provision for car aerial. 2-colour scale. With PP9 battery giving 300 hours use. Weighs under 4 lbs. With carrying handle. 12 x 7½in. high x 4½in. at base tapering to 2in. at top. Brand new, fully guaranteed, £10.0.0. Carr. paid. Worth £16.

SAVE 10/-. Swiss made Unic Shaver operating from 1.5 v. battery, usual price 59/8. Our price 50/- with battery. Takes U2 battery. Not a toy, but a shaver (carr. paid).

GARRARD SINGLE 4-SPEED RECORD PLAYER. TA Mark II. £9.10.0, carriage paid.

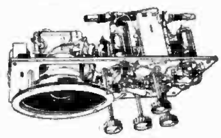
SUPERIOR GRAMOPHONE AMPLIFIER 3 valves, 4 watt

13½ x 7½in. (2½in. front to back). 3 front controls, bass, treble, vol. on-off. 6½in. circ. or 8 x 5in. speaker; UY85, UF80 and UL84. Mains trans. 200-240ac; "gold" fret front. ONLY 70/- (p.p.3/6).

NEW LOUDSPEAKER BARGAINS. Good Makes.

2-8 ohm. 13 x 8½in. 35/- (4/-); 7 x 4in. 14/6 (2/-); 6½ x 4½in. 12/6 (2/-); 10 x 6in. 25/- (3/-); 5in. 12/- (2/-); 4in. tweeter 7/6 (2/-); 7 x 5in. 17/6 (2/-) 9 x 6in. 22/- (2/6); *Postal charges bracketed.*

MAINS OPERATED RADIO CHASSIS AND AMPLIFIER OF FAMOUS MANUFACTURE



Chassis 10 x 5½ x 4in. front to back. Valves: UBC41, UCH41, UF89, UL84 with metal rectifier. 5in. speaker. Ferrite rod aerial. Tone, vol. and gram. position. Covers L. and M. waves. Limited quantity at only £6 (5/- carr.) complete with small dial. Unused and in working order.

UNREPEATABLE OFFER OF AM-FM CHASSIS AT ONLY £9.9.0 carr. pd.

A small quantity of Printed Circuit chassis by famous manufacturer. Valves UY85, UCH81, UF89, UABC80, UL84 and UCC85. O.p. trans. for 2-3 ohm speaker. Chassis 14 x 7 x 7in. Front contols concentric ,left—Vol. and Tone; right—W/c and Tuning. "Gold" centre knobs provided. 2-dial bulbs. Sockets, AE; E; Ext. sp; P.U. Mains isolating transformer free. Covers Long, Med., VHF (87-101 Mc/s). Unused slightly tarnished, but not dirty; New Mullard Valves; not our manufacture, so no guarantee. Dial in gold and brown, size 13 x 3½in.

SPECIAL OFFER OF GOODMAN 10 x 6in. SPEAKER high gauss, with doped cone specially suitable for high fidelity work. Price 27/6 (post 2/6).

CRYSTAL MICROPHONES. TSL stick mike 25/-; small hand mike made by "Acos", 18/6. Both post paid.

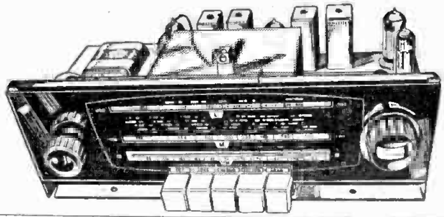
BATTERY ELIMINATOR. For 4 Low Consumption Valves (96 range), 90 v. 15mA, and 1.4 v. 125 mA, 42/6 (2/6 post). 200-250 v. A.C. Size 5½ x 3½ x 2in. Also for 250 mA, 1.4 v. and 90 v. 15 mA at same price.

AUTOMATIC RECORD CHANGERS. ALL 4-SPEED WITH TURN-OVER CRYSTAL CARTRIDGE (carr. 5/- extra). Latest UA14, £7.10.0. Collaro C.60 Studio model, plays any records, 7-12in. only £7.15.0. Motor board for UA8, UA14 or Collaro 3/6 (post 1/6). Both UA14 and C.60 fitted monaural cartridge but wired for stereo.

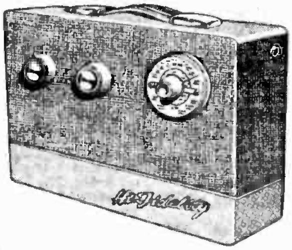
BRAND NEW AM/FM (V.H.F.) RADIOGRAM CHASSIS AT £14 (Carriage Paid)

Tapped input 200-225 v. and 226-250 v. A.C. ONLY.
Chassis size 15 x 6¾ x 5½in. high. New manufacture. 12 m'ths guarantee.
Dial 14½ x 4in. in black and gold.
Pick-up. Extension Speaker. Ae., E., hd Dipole Sockets. Five "piano" push buttons—OFF L.W., M.W., F.M. and Gram. Aligned and tested With all valves and O.P. Transformer. Tone Control Fitted.
Covers 1,000—1,900 M.; 200-500 M.; 88-98 Mc/s.
Valves EZ80 rect., ECH81, EF89, EABC80, EL84, ECC85.
Speaker and Cabinet to fit chassis (table model), **47/6** (post 2/6).
10 x 6in. ELLIPTICAL SPEAKER. **20/-**, to purchasers of this chassis.
TERMS:—(Chassis) £5 down and 5 Monthly Payments of £2, or with Cabinet and Speaker £5.10.0 down and 6 Monthly Payments of £2.
Cheap Room Dipole **10/-**. Feeder 6d. yard.

This chassis is an ideal partner for the radiogram cabinet appearing on this page.



THE "CANTATA" 6-TRANSISTOR AND DIODE PORTABLE



COMPLETE KIT FOR ONLY

£7.19.6

(post 3/6)

★ 500mW push-pull output.
★ Ferrite rod aerial.
★ Car aerial socket and coil.
★ M.W. and L.W. full coverage.
★ Operates on two 4.5v cells.
★ Printed circuit board 8½ x 2¾ in.
★ All holes drilled and component positions marked on reverse side of board.
★ Booklet of full instructions 2/6 for 16p. (refunded on purchase of kit).
★ Size 9 x 3¾ x 7in.
★ 8 x 2½in. P.M. high quality speaker.
★ Attractive Vinair covered cabinet, two tone.
★ Two batteries 5/6 the pair.
★ High Sensitivity.
★ Good selectivity.
★ Mullard transistors OC44, 2 x OC45, OC81D, and 2x OC81.
★ Top grade Weymouth Radio coils and transformers.
★ Alignment service if required **17/6** (inc. post).
★ Write for list of prices.
★ All parts supplied separately.
★ Note the total cost—no extras at all.
★ Built in two hours.

MINIATURISED COMPONENTS FOR TRANSISTOR SET. 3 I.F. trans. 7/16in. sq. x 9/16in.; 2-gang 165pF plus 65pF; ¾ x ¾ x ½in.; input and output trans. each 9/16in. cube; osc. coil. THE LOT for **34/-** (post 2/-).

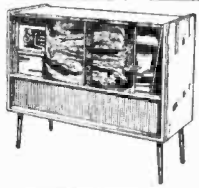
TRANSISTORS. Top Grade. Two matched OC78: 1—OC78D; 1—OC44 (yellow); 2—OC45 (orange and blue). THE LOT of 6 for **37/6** (registered 1/- extra).

AERIALS

Combined B.B.C. (Single Dipole) **and Band 3 I.T.A.** (5-Element) **Aerial,** with chimney lashings and Stand-off Arm **£3.15.0.**
I.T.A. (Band 3) Aerials, for clipping to existing mast of dimaeter 1in. to 2in. Alternatively with wall-fixing plate at same price; 3 element **£1.2.0,** 5 element **£1.10.0,** 8 element **£2.10.0.** 11 element **£3.2.6.** Chimney lashings and Stand-off Arm 20/- extra for each of above.
Loft Mounting I.T.A. Aerials, 3 element **20/-**, 5 element **26/-**. Larger aerials for I.T.A. and B.B.C. can be supplied to special order.
Double 6 Element I.T.A. Plus B.B.C. "H" Aerial with 10ft. pole and double chimney lashings, **£8.10.0.**
All the above aerials are carriage paid.
An **I.T.A. Table Top Aerial** with amazing performance. The Wolsey Hi-Q at **19/6** (2/6 post). Good reception up to 20 miles. Cross-over unit in base with socket for B.B.C. aerial. Slightly tarnished at **12/6** (2/6 postage).

PERSPEX. 15 x 12 x ⅛in., tinted blue/grey, **6/6**; 12½ x 9¾ x ⅛in., Clear, **5/-**; 16 x 14 x 3/16ins., Clear **7/6.** Postage 2/- on 1; 3/- on 2 or more; 6 post paid.

SUPERB CONTEMPORARY CABINET

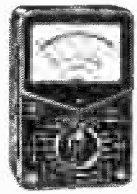


Fitted with 3 sliding doors providing room for Radio. Autochanger, 4 speakers, and record storage. Size 38 x 24in. high (plus legs 8in.) x 16in. Polished walnut.

PRICE **15 Gns.**

Free delivery in London area.
35/- carriage elsewhere.

THE "CABY" TEST METERS



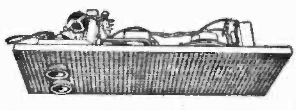
Prices include **Test Prods, Batteries, Instruction Book.** Also measure dB. Accuracy: A.C., 3 per cent, D.C., 2 per cent.

A-10 **£4.17.6** B-20 **£6.10.0**

A.10—2K ohms/v. on A.C. and D.C. volts (10, 50, 250, 500 and 1000 v.); 10K and 1M ohms; ½mA, 25 mA and 250 mA. D.C. Size; 5½ x 3½ x 1½in. Weight 17 oz.

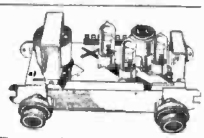
B.20—10K ohms/v. on 0.5 v. and 2.5 v.; 4K ohms/v. on 10, 50, 250, 500 and 1000 v., A.C. and D.C. Resistance, 2K, 200K, 2M and 20M ohms; D.C. current, 100 microA, 2.5 mA, 25 mA, 250 mA. Size 5¾ x 3¾ x 2½in. Weight 24 oz.

GRAMOPHONE AMPLIFIER



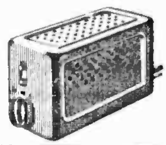
With 5in. SPEAKER. Baffle 12½ x 6in. EZ40 and EL41. Tone and Volume On/Off switch. Two Knobs. Ready to play. Useful for Stereo. ONLY **57/-**. post 3/-.

3-VALVE AMPLIFIER (INC. RECT.). 2½ watts. ECC83, ECL82 and EZ80. Controls, volume bass and treble. On/off switch. Overall size 12 x 4 x 4½in. over valves. Mains and O.P. trans. and 6½ x 4½in. Celestion speaker. Suitable for microphone input and for guitar amplifier. A.C. only.



70/- P. & P. 4/-.

"READY TO USE" ITA CONVERTER Direct switching ITA to BBC. metal rectifier, co-axial plug. Can be fitted in 5-10 mins., and needs no alteration to your set. ALL AREAS. ALL SETS. ALL CHANNELS. 12 months' guarantee (3 months on valves).
Separate gain controls. Valves ECF80 and ECC84. Switch positions OFF—ITA—BBC. Bakelite moulded cabinet, 8½ x 4 x 6in. 70/- (3/- P. & P.).



PANEL OF 7 POTS. 10 x 1½in.—4 x 1M & 3 x 2M. 4/- (post 1/-).

6 DIFFERENT PRE-SET POTS. 2K to 500K. 3/- (post 1/3).

SIEMENS-HALSKE RECTIFIERS. 250 v. 50 mA. ½ wave, 6/6. post paid.

Send 6d. (stamps will do) for 20 page illustrated catalogue. All New Goods. Delivered by return. Terms: One-third down and balance plus **12/6** in four equal monthly payments. Postage with down payment (C.O.D. 2/- extra). **See Special Terms for A.M./F.M. Chassis**

ALL ITEMS GUARANTEED 12 MONTHS—B.V.A. VALVES 3 MONTHS.

GLADSTONE RADIO "SCALA", CAMP ROAD, FARNBOROUGH, HANTS.

Farnborough 3371

Also at 247 New Road, Portsmouth, Hants, and 56 Stokes Croft, Bristol 1.
Farnborough closed Saturday. Portsmouth and Bristol closed Wednesday.
Posted Orders to Farnborough Please.

ALPHA

Valves by return post

AZ1	10/-
AZ31	10/-
DAF96	8/-
DF96	8/-
DK96	8/-
DL96	8/-
EABC80	9/-
EAF42	9/6
EB91	4/6
EBC33	6/9
EBC41	8/9
EBC90	8/6
EBC91	8/6
EBF80	9/9
EBF83	13/11
EBF89	9/6
EBL21	23/3
EBL31	23/3
EC90	4/6
EC91	15/11
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
ECL82	10/6
ECL83	15/-
EF36	3/6
EF41	9/6
EF50	5/-
EF50SYL	7/-
EF80	7/-
EF85	7/-
EF86	12/6
EF89	8/9
EF91	5/9
EF91(BVA)	7/6
EF92	6/-
EF183	15/-
EF184	15/-
EK32	7/-
EL33	10/-
EL41	9/-
EL84	9/-
EL91	4/6
EM34	9/6
EM80	9/6
EM81	10/6
EY51	9/6
EY86	10/-
EZ80	7/6
EZ41	7/6
EZ80	7/-
EZ81	7/6
FC13	5/6
FW4/500	10/-
GZ32	11/6
HL23DD	8/6
HL42DD	10/-
KT2	5/-
KT33C	6/-
KT61	10/-
KTW61	6/6
MX40	12/6
OZ4	4/6
PCC84	12/-
PCC85	8/6
PCF80	8/9
PCF82	11/6
PCL83	13/6
PCL84	10/-
PL36	13/6
PL81	11/-
PL82	8/6
PL83	9/6
PL84	9/6
PX25	12/6
PY80	7/6
PY81	8/6
PY82	7/-
PY83	8/6
PEN4VA	10/-
PEN25	5/-
PEN45	8/-
SP4	5/-
TP22	8/-
U10	9/6
U25	13/6
U26	12/-
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/-
UL84	9/-
UU6	19/3
UY1N	12/6
UY41	6/6
UY85	7/-
VP23	5/-
VR105/30	8/-
VR150/30	7/6
VU39 (MU 12/14)	8/9
Y63	7/6
1A7GT	13/6
1C2	11/6
1C5GT	12/6
1H5GT	9/-
1N5	10/6
1R5	7/6
1S5	6/6
1T4	5/6
3D6	5/-
3Q4	7/6
3Q5GT	9/6
3S4	7/6
3V4	8/-
4D1	3/-
5R4GY	9/6
5U4G	5/-
5V4	11/6
5Y3G	8/-
5Y3GT	7/6
5Z4G	9/-
6A7	10/-
6A8G	9/-
6AK5	5/-
6AL5	4/-
6AM5	7/6
6AM6	4/-
6AQ5	7/6
6AT6	8/6
6BA6	7/6
6BE6	7/6
6BH6	9/-
6BJ6	9/-
6BW6	9/-
6C4	4/6
6C5GT	6/6
6C6	5/-
6D6	5/-
6CH6	7/6
6F6G	7/-
6F6M	7/6
6J5GT	5/-
6J5M	6/6
6J6	4/-
6J7G	6/6
6K7G	3/6
6K7M	6/9
6K8G	6/6
6K7GT	5/9
6K8GT	10/-
6L6G	8/-
6L6M	9/6
6L18	11/6
6N7GT	7/6
6Q7G	7/6
6Q7GT	9/6
6SK7	6/-
6SL7GT	8/-
6SN7GT	7/6
6SQ7	9/3
6U4GT	12/-
6V6G	5/-
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	6/6
10F1	12/6
10P13	22/3
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/-
12SN7GT	10/-
15D2	7/9
25A6G	8/-
25L6GT	10/-
25Z4	9/6
25Z5	7/-
25Z6	10/-
30FL1	10/6
30L15	23/3
30P4	15/-
30P12	12/6
30PL1	12/6
35L6GT	10/-
25Y5	9/-
35Z4GT	8/-
42	8/-
35Z5GT	9/6
50L6GT	8/6
75	10/6
80	8/6
142BT	3/6
210DDT	4/6
210VPT	3/6

Expanded Metal, 12 x 12in. 5/- each.
B.S.R. Monarch UA14 Record Changer. £6.19.6.
Collaro Studio Tape Deck. £10.19.6.
Tygan, 4/- square foot. 10 patterns available, send 1/- stamps.
AerialiteGoldenWandRoomAerial 17/6
12ft x 2in. Alloy Mast for aerials, 20/- each, Callers only.
Pre-set Potentiometers 2·5K, 50K, 100K, 1 Meg, etc. 1/9 each.
Cabinet Lid Stays. 6d. each.
Assorted Knobs, various colours. 2/- doz.
Dial Bulbs, 6.3v. MES, 4/- doz. Box of 50, 12/6.
Potentiometers Single Pole Switch, 2 Meg, 100K, 500K, 1 Meg. etc. 1/- each.
Assorted Mains Dropping Resistances, 6 for 3/6.
Pneumatic Lid Stays, 2/6 each.
Spade Terminals, white and black, 1/6 doz.
Cabinet Lid Hinges, Bronze, 1/9 doz.
Insulated Sleeving, 2/6 bundle.
Toggle Switches, D.P.D.T. and S.P.D.T., 1/9 each.
Flash Lamp Bulbs, 2.5v, 12/6 per 100.
Semi-airspaced Co-axial Cable, Brown or Cream, 6d. yd.
British 4-pin Paxolin Valveholders, 2/- doz.
4-valve B7G Portable Angle Chassis, ready drilled, 1/6 each.
Switch, 3 pole, 3 way, 3 bank, 2/3 each.
Microphone Inserts, 1½in. diam., 7/6 each.
Transistors, OC169, 10/6; OC77, 10/-; OC201, 12/6.
Ferrite Rod Aerial and Coil, 3/6 each.
Solid Dielectric Condensers, 0.0001mFd, 0.0003mFd, 0.0005mFd, 4/9 each.
Acos Microphone, MIC 45, 25/6; MIC 40, 19/6.
B.S.R. Turnover Cartridges, TC8M and TC8H, 29/9 each.
T.S.L. Speaker Units, LPH70 25/- each and LPH45 25/- each.
Repanco, XT6 10/-, XT7 10/-, TT9 12/6, TT10 12/6.
Crystal Set Coil, Type DRX1, 2/6 each.
Dual Range High Gain Coil, 4/- each.
Wavechange Switches, 3P 3W, 4P 3W, 3P, 4W, 2P 6W, 1P 12W, 3/- each.
Panel Paint, Black, 3/- tin.

All parts for "Practical Wireless" Mini-amplifier available from stock.
Transistors, V6/R2 9/3, OC71 6/6, OC72 8/-, OC75 8/- each.
Ardente Transformers, D240 10/-, D1001 12/-.
Garrard Cartridge, GC2/PA, 15/6 each.
Stylus Pressure Gauge by Garrard, 20/3 each.
Battery Charger Transformer for 2, 6 and 12 volt batteries, 4 amp., 21/-.
Output Transformer, 5000/3 ohms. 60mA, 5/9 each.
L.T. Metal Rectifiers for Battery Chargers 2 amp 7/-, 3 amp 10/-, 4 amp 12/6, 5 amp 14/6
Plessey 10 x 6in. PM Speaker Unit, 21/-.
Crystal Microphone, Type BM3 for hand, desk or floor stand use, 45/- each.
B.S.R. AF333 Pick-up Matching Transformer, 36/-.
High Resistance Headphones, 4000 ohms 13/6 pair.
CCIR Calibration and Test Tape, 49/6 reel.
Diodes, OA70 3/-, OA5 3/-, OA10 4/-, OA81 3/-.
Set of Transistors comprising 1 OC44, 2 OC45, 1 OC81D, 2 OC81, 37/6 set.
Silicone Rectifier, Type 1WP5, 125 v. RMS, 2 connected in series in half-wave circuit, output current 500mA, 16/6 pair.
Empty Tape Spools, 3in. 1/6, 5in. 2/-, 7in. 3/- each.
Continental Screened Jack Plug, 3/6 ea.
Solon Instrument Iron, 25 watts, 24/- ea.
Litesold Soldering Iron, 240 v. 10 watts, 3/32in. Permabit. 21/6 each.
Steadfast 6 in one File Set. An ideal too for model makers, radio constructors, etc. 10/6 each.
Repanco One Valve Receiver, complete in every detail, 45/-.
Collaro Studio C60, 4-speed Automatic Record Changer, £7.19.6.
PIFCO Radio Meter, 32/6.
Midget I.F. Transformers, 465 kc/s, 9/- pair.
4-Pin Vibrators, 6 v., 8/6 ea.; 12 v., 2/6 ea
Tubular Copper Rods, 12in. long, 4/- doz.
Solder, 1 lb. reel, 7/6.
2-Gang Condensers, 500pF, Standard 7/6, Midget 7/6.

Paxolin Sheet, $\frac{1}{16}$in. thick, 6 x 6in. 1/-, 12 x 6in. 2/-, 12 x 12in. 4/-.
Grelco 10-way Connector Strip, 1/- each.
Garrard TA Mark II 4-speed Single Player, £8.10.0.
Heater Transformer, 6.3 v. 1½ amps, 6/9 each.
Rectifiers, 14A86 17/6, 14A97 21/-, 14A100 21/-.
Loudspeaker Unit, 7 x 4in. Goodmans, 15/6 each.
Collaro Junior 4-speed Turntable and Pick-up, 75/-.
Acos Crystal Stick Microphone, MIC 39/1, 37/6 each.
B.S.R. Monarch GU6, 4-speed Gramophone Unit on Motorboard, 11 x 8½in., £4.19.6.
Telefunken Stereo High Fidelity Amplifier, £8.8.0.
BIB Recording Tape Slicer, 18/6.
P.W. Transistor "Six", printed circuit version, £8.15.0.
"Wireless World" Radio Valve Data, 7th edition, 6/-.
Transistor, 1 watt Amp., ready built, 72/6.
Sub-miniature 2-way Jack Plug and Socket, 2/6 pair.
Personal Earphones, Crystal High Imp. 8/-, Magnetic Low Imp. 8/-.
J.B. "00" Twin Condenser, 12/6 each.
Hunts W99 Condensers, 0.001mFd, 0.01mFd, 0.02mFd, 0.04mFd, 9d. each.
Signal Lamp Fittings, MES Holder available with Red, Green, Clear and Amber Glass, 2/3 each.
Aluminium Chassis, 6 x 4 x 2½in. 4/6 each; 12 x 5 x 2½in. 6/9 each.
Standard Can Condenser, 32 x 32 x 32mFd, 350 v., 2/9 each.
Aerialite Video "V", All Stations TV FM Indoor Aerial, 23/6.

CATALOGUE
OUR 1962 CATALOGUE IS NOW AVAILABLE. PLEASE SEND 1/- IN STAMPS FOR YOUR COPY. TRADE CATALOGUE ALSO AVAILABLE. FOR WHICH PLEASE ATTACH YOUR BUSINESS LETTER HEADING.

ALPHA RADIO SUPPLY CO.

103 LEEDS TERRACE
WINTOUN STREET
LEEDS 7

TERMS: Cash with Order or C.O.D. Postage and Packing Charges extra. Single valves 9d., Minimum Parcel Post charges 2/-. Please include sufficient postage with your order. Minimum C.O.D. fees and postage 3/6. These Postal Rates apply to U.K. only. For full terms of business see inside cover of catalogue. Personal Shoppers 9 a.m. to 5 p.m. Mon. to Friday, Saturday 10 a.m. to 1 p.m.

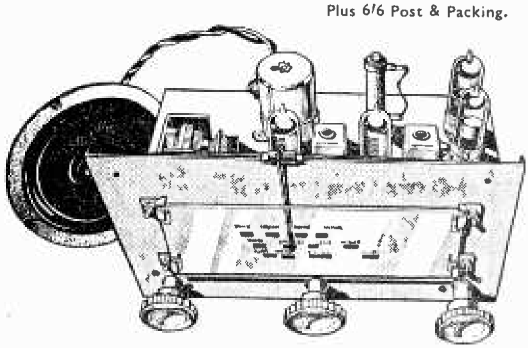
HARVERSON SURPLUS CO. LTD.

PLEASE TURN OVER FOR ADDRESS AND MORE BARGAINS

2 BAND SUPERHET CHASSIS with Speaker

ONLY £4.19.6

Plus 6/6 Post & Packing.



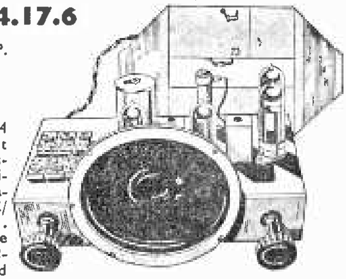
A quality 4 valve AC/DC superhet chassis made by a world famous manufacturer. Long and Medium wave coverage. Fitted with a cord and drum reduction tuning drive and attractive illuminated glass dial (size 6¼ x 2¼in.). Controls: Volume on/off, tuning and wave change. The receiver is self-powered, employing a mains dropper and a valve rectifier. Chassis dimensions 6¼ x 9 x 5¼in. high. Supplied complete with a good quality 5-inch loudspeaker, valves (UCH42, UAF42, UL41, UY41), AC/DC mains input lead, ivory knobs, etc.

DON'T HESITATE, ORDER NOW! This unbeatable bargain is bound to sell out quickly at only £4.19.6, plus 6/6 post and packing.

4 STATION PRESET CHASSIS with Speaker

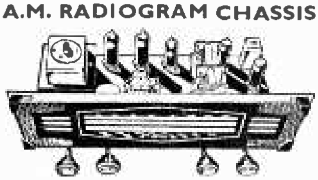
ONLY £4.17.6

Plus 6/6 P. & P.



A compact, 4 station preset mains transportable receiver for operation from AC/DC mains. Two simple controls, volume on/off and 4 position station selector. The latter is set to Light Programme (Long Wave), Third Programme, Home Service and Light Programme (Medium Wave), but may of course be adjusted to alternative selections if required. A frame aerial with throw-out extension is supplied, making this receiver ideal as a general purpose transportable set for the home. A fully smoothed power supply is provided from AC/DC mains input by a mains dropper and a valve rectifier. The good tonal qualities are assisted by the provision of a quality 5in. speaker, which is ready-mounted on the chassis (this is easily detachable if alternative positioning is required). Valve line up, UCH42, UAF42, UL41, UY41. This chassis (size 9 x 6¼ x 5¼in. high) is supplied complete with valves, knobs, mains lead, aerial, etc. It is beautifully made by a famous maker, and is a first-class buy at the rock bottom price of only **£4.17.6**, plus 6/6 post and packing.

A.M. RADIOGRAM CHASSIS



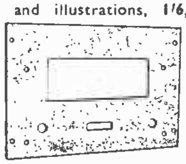
A chassis of distinction, by a famous maker. Covering Long, Med. and Short Waves, plus gram position, this chassis (size 15½ x 7 x 6½in. high) incorporates the latest circuitry, using fully delayed A.V.C., and negative feedback. Controls: Tone, Vol. On/Off, W/Change (L.M.S. and Gram), Tuning. Tapped input 200-250 v. A.C. only. An attractive brown and gold illuminated dial with matching knobs, make this one of the most handsome, in addition to being one of the best performing chassis yet offered. Complete with valves (ECH81, EF89, EBC81, EL84, EZ81), knobs, output transformer, leads, etc. OUR PRICE ONLY **£9.19.6** plus 4/6 post & packing.

HARVERSONS' F.M. TUNER

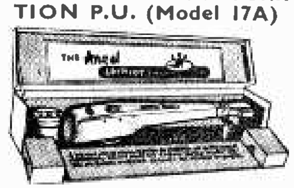
At last a quality F.M. Tuner Kit at a price you can afford. Just look at these fine features which are usually associated with equipment at twice the price.

★ F.M. Tuning Head by famous maker. ★ Guaranteed Non-drift. ★ Permeability Tuning. ★ Frequency coverage 88-100 Mc/s. ★ OA81 Balanced Diode Output. ★ Two I.F. Stages and Discriminator. ★ Attractive maroon and gold dial (7 x 3in. glass). ★ Self powered, using a good quality mains transformer and valve rectifier. ★ Valves used ECC85, two EF80's, and EZ80 (rectifier). ★ Fully drilled chassis. ★ Everything supplied, down to the last nut and bolt. ★ Size of completed tuner 8 x 6 x 5¼in. ★ All parts sold separately. Plus 8/6 P.P. and Ins. **£4.19.6** Circuit diagram and illustrations, 1/6, post free.

NOW AVAILABLE A robust cabinet made from heavy gauge metal which has been specially designed to house the above F.M. Tuner. Beautifully finished in a choice of glossy hammer green, or hammer grey enamel, or black crackle. The front panel (illustrated) has holes for control spindles, and apertures for tuning dial and magic eye. PRICE **25/-** P. & P. 1/9. (Front panel only 10/6, P.P. 9d.).



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 £5.15.0, plus P. & P. 5/-.

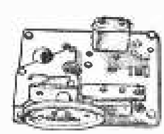
MAINS PORTABLE SOLDERING IRON

Probably one of the most outstanding soldering instruments yet produced, this iron has a detachable handle which can be placed over the bit and barrel, enabling it to be carried in complete safety even when hot. The provision of an extremely stable 30w element makes this ideal for transistor and all similar lightweight applications. Brand new in P.V.C. bag, with lead and plug. ONLY 18/9, plus 1/3 P. & P.

MINIATURE EARPHONE WITH CORD SUB-MINIATURE PLUG AND SOCKET

A deaf aid type earpiece of top grade quality. Gives an exceptionally crisp reproduction of both speech and music. Brand new and fully guaranteed. Two types available. CR-5 high impedance crystal, MR-4 low impedance magnetic. Either type. ONLY **7/6** Plus 1/- P. & P.

F.M. TUNER HEAD



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

HARVERSON SURPLUS CO. LTD.

Introducing HARVERSON'S Monaural Amplifier Kit

39/6

In response to numerous requests from delighted purchasers of our "SUPER STEREO KIT" we have produced a "MONAURAL AMPLIFIER" on similar lines.

★ A UCL 82 valve provides a triode amplifying stage, and a pentode output stage (3 watts), enabling good amplification and sparkling reproduction to be combined with physical compactness (amplifier size, 7 x $3\frac{1}{4}$ x $6\frac{1}{4}$in. high).

★ Modern circuitry design, good quality O.P. transformer (to match 3Ω) keep hum and distortion to a low level.

★ The controls, volume on/off, and tone, are complete with attractive cream and gold knobs.

★ The amplifier has a built-in fully smoothed power supply, using a good quality mains transformer (A.C. mains only) and metal rectifier.

★ All you need is supplied including easy to follow instructions which guarantee good results for the beginner and expert. All components, leads, chassis, valve, knobs, etc., are first grade items by prominent manufacturers.

OUR PRICE **39/6**
Plus 4/6 Post and Packing

5in. LOUDSPEAKER TO SUIT 14/6 EXTRA
ALL PARTS SOLD SEPARATELY

BARGAIN MONTH FOR TRANSISTORS

POWER				
OC36	10/-		GET15	9/-
OC44	9/-		GET15 (matched pr.) ...	16/6
OC45	8/-		GET102...	7/6
OC71	5/-		XA103	8/6
OC75	6/6		PXA101	9/6
OC76	6/6		PXA102	9/6
OC78	6/6		DIODE	
OC78D	6/6		OA81	3/-

Please add 6d. postage for each transistor.

TRANSISTOR SPEAKER

Western Electric 3Ω or 80Ω speaker. Size $2\frac{1}{2} \times \frac{15}{16}$in. deep. 12/6 p.p. 1/-.

SUPERHET CHASSIS—less Valves & Cabinet

Modern AC/DC chassis with printed circuit and ferrite rod aerial. Although not completely built, the main components are mounted. L. & M. wave coverage. 4 valves (UBF89, UCL83, UCH81, UY85). Everything supplied except valves and cabinet. With speaker and simple instructions. **£3.6.6** plus 3/6 P. & P.

COIL and TRANSFORMER SET FOR TRANSISTOR SUPERHET

3 I.F. Transformers, one oscillator coil, one driver transformer, and wound ferrite aerial (Med., Long and aerial coupling) **28/6** complete, post 1/-. 6 transistor printed circuit board to match **8/6**, post 9d Circuit diagram 1/6 extra.

CONDENSER/RESISTOR PARCEL

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/-.

THE HARVERSON 6 TRANSISTOR & DIODE SUPERHET KIT

A first class 2 wave band transistor superhet in kit form.

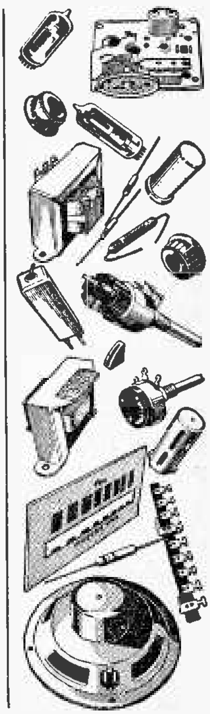
★ Printed circuit panel (size $8\frac{1}{8}$ x $2\frac{3}{4}$ins.)
★ 3 Pre-aligned I.F. Transformers.
★ Output Transformer.
★ 5 inch 5 Ω Speaker.
★ High gain Ferrite rod aerial.
★ First grade G.E.C. transistors.
★ Car aerial socket.
★ Push/Pull output.

All parts down to the minutest item with simple instructions. ONLY

£6.19.6 Plus 2/6 P. & P.

Cabinet to Suit (if available) 15/- extra.

THE HARVERSON COMPLETE F.M./V.H.F. RECEIVER KIT £6.19.6



AT LAST—A COMPLETE F.M. RECEIVER IN KIT FORM! Specially designed with the home constructor in mind, this kit enables the construction of a completely self-contained V.H.F. receiver, at fraction of the normal cost of comparable equipment. This is basically a quality self-powered F.M., tuner plus 2 separate audio amplifier stages, and output transformer and speaker.

★ F.M. Tuning Head by famous maker.
★ Guaranteed Non-drift.
★ Permeability Tuning.
★ Frequency coverage 88-100 Mc/s.
★ OA81 Balanced Diode Output.
★ Two I.F. Stage and Discriminator.
★ Self powered using a good quality mains transformer and valve rectifier.
★ Valves used ECC85, two EF80's, ECL82 and EZ80 (rectifier).
★ Fully drilled chassis.
★ Good quality speaker.
★ Well designed output transformer.
★ Attractive maroon and gold glass dial.
★ Two output stages (using ECL82).
★ Everything supplied, down to the last nut and bolt.
★ Compact size.
★ All parts sold separately.

OUR PRICE **£6.19.6** Plus 4/6 P. & P.

RELDA OFFERS THE GREATEST VALUE IN MINIATURE COMPONENTS FOR THE 'KIT FAN'

MINIATURE DP/DT SLIDE WAVE-CHANGE SWITCH 2/6 each.

MAINS 3 AMP. DP/DT TOGGLE SWITCH with on/off plate. 4/- each.

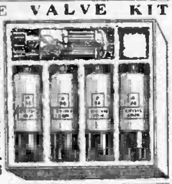
TRANSISTOR SPECIAL! 5K. EDGEWISE MINIATURE VOLUME CONTROL MODEL K2. 16. with switch and ivory knob. As used in all miniature transistor radios. 4/6 each.

LAPEL MICROPHONE M178

Precision engineered Crystal Microphone—for lapel or hand use. Only 1¼in. diameter. Exceptionally sensitive. Chrome plated case and clip includes 5ft. shielded cable. **Only 17/6.**

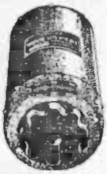
CRYSTAL MICROPHONE INSERTS MODEL MC.1. Precision disc type crystal microphone cartridge. Output:—53dB. Response: 100—6,000 c.p.s. PRICE 6/6.

SPARE VALVE KIT



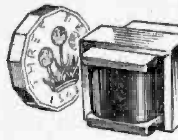
Here's a gift for all 38 and 18 Set owners! Case containing 4 ARP12 & 1 ATP4 valves. Only 10/- P. & P. 2/6

AERIAL VARIOMETERS

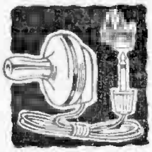


These magnificent instruments will enable you to receive maximum signal strength on all S.W. receivers. Precision calibrated control 12/6. P. & P. 2/6.

SUB-MINIATURE TRANSFORMERS



Here is outstanding value in transistor transformers consisting of one Driver Transformer and one Output Transformer. Ideal pair for miniature transistor portables, etc. Driver Model LT44: Primary: 20k. Secondary: 1k. Centre Tapped. Ratio: 5 : 1. Output Model LT700: Primary: 1.2K. Centre Tapped. Output: 3.2 ohms. Ratio: 2 : 1. Complete with detailed instructions. Only 9/6 per pair. P. & P. 1/6.



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. crystal
MR-4 Low imp. magnetic **8/-** Each Post 1/-

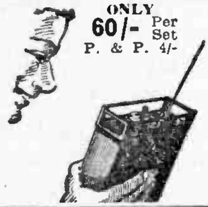
JUST ARRIVED!
A "MUST" FOR EVERY TRANSISTOR SET OWNER!

9V. BATTERY CHARGER AND A.C. ELIMINATOR MODEL LA.6P

Save those batteries during the winter by running your transistor set direct from A.C. Mains. Reactivate all your old 9V batteries.

Unit contains neon indicator and standard battery connections with nearly 2 yards of mains lead and plug. Also snap cord for connection to set.

LIMITED QUANTITY OFFERED FOR THE FIRST TIME IN THIS COUNTRY! **29/6** P. & P. 1/6



ONLY **60/-** Per Set P. & P. 4/-

PORTABLE TRANS/RECEIVER SETS

Consisting of trans/receiver covering 7.4-9 Mc/s range up to 10 miles, complete with 5 valves headphones, microphone, junction box and 6ft. telescopic aerial. Only requires 120 v. and 3 v. dry battery. **TWO FOR £6.** Post Free. **SPECIAL 135 V. H.T. BATTERIES.** Ideal for above. 12/6 each.

PS.35. SUB-MINIATURE PLUG AND SOCKET

Two-way bakelite barrel Jack plug only 1in. long. Socket only ¾in. long. 3/6 per pair. Post paid.

CH.305 CHROME MINIATURE PLUGS AND SOCKETS

Size: plug barrel 1". socket ½". These will give your equipment that expert finish! 3/6 Per Set.

SLIM RADIO PLUGS AND SOCKETS. Two-way, black bakelite, solder terminal PLUG and STURDY standard SOCKET. 5/6 per pair. Post Paid. Panel mounting, neat finish.

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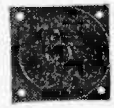

A miniature Hi-Fi speaker that outperformsallothers. Designed to meet today's requirements for transistor, miniature and sub-miniature applications. Size 2¼in. sq. x 1in. deep. Voice coil impedance: 8 ohms. Freq. range: 150-5000 c/s. Power: 200mW. 16/6.

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12 v. input, 500 v. output at 65 mA. or 6v. input 250 output at 75 mA.
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All Transistor 2-STATION INTERCOM and Baby Alarm

MODEL TI.302

12 Gns.

Complete with battery and 60 ft. of wire.

Here is an Intercom system for both calling and conversing which uses the highest quality transistors and is operated from a single battery. May be used for multi-purpose applications especially where there is no local electrical supply and also where voltage fluctuations are severe. Specially suited for use in offices manufacturing plants, hotels, restaurants, residences and wherever conversation is required between two or more locations. Ideal Baby Alarm. Brief Spec: 3 transistors, 200 mW output, 9 v. battery, built-in 2¼in. speakers. The Master station incorporates individual volume control to ensure perfect speech reproduction. The Sub-station incorporates a unique "buzzing" call system which ensures maximum efficiency. *S.A.E. for further details.*

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World coverage on these famous Communication Receivers. They are the simplest type to use yet bring in stations that will amaze you. The ideal domestic receiver for medium wave during the day with Amateur stations at night. **All have been converted to 230 v. A.C. mains and are guaranteed to work immediately.** Incorporate Wave Switch. Audio gain aerial trimmer, high and low tone control, station locking device, aerial and earth inputs, speaker output sockets, etc. Size 17 x 8 x 9½in. Black crackle finish front panel. On demonstration at 87 Tottenham Court Road.

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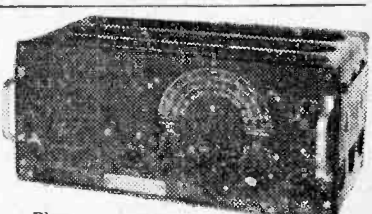

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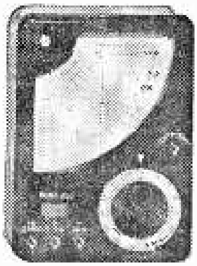
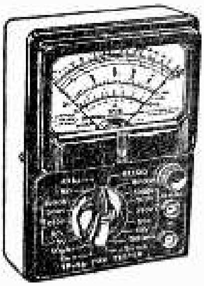


MODEL 200H (Illus. on right). 20,000 ohms per volt, 20 ranges comprising AC volts, 5 ranges up to 1,000V DC volts, 6 ranges up to 2.5KV, DC current, 3 ranges up to 26 ohms, resistance, 2 ranges up to 6 meg, capacity 2 ranges up to .1, decibels —20 to +22. Scale cornerwise to the equivalent of 4in. movement is a pocket size instrument measuring 4½ x 3½ x 1in. Complete with test prods, battery and operating instructions, price £6.19.3, post free.

MODEL TE10. Similar in size and appearance to 200H except that this is 10,000 ohms per volt and maximum DC volts 1,200 instead of 2.5K, also no capacity range. Price £5.19.6. Post free.



MODEL TPS5. (Illus. on left). 20,000 ohms per volt, DC volts, 5 ranges up to 1,000 AC volts, 5 ranges up to 1,000, resistance, 2 ranges up to 10 meg., capacity 2 ranges up to .1 decibels —20 to +26. One switch control, really beautifully made precision instrument, size only 3½ x 5¼ x 1⅛in., price only £5.19.6. Post free.

MODEL TP10. Similar in size and appearance to TPS5, but sensitivity 2,000 ohms per volt, price £3.19.6. Post free.

MODEL U1. A robust instrument of 1,000 ohms per volt sensitivity, AC/DC volts up to 1,000. DC current up to 500, resistance up to 200K, size 5¼ x 3½ x 2⅛ins. complete with test prods, single switch control, large easily read scale, price only £2.19.6. Post free.

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All components for a

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that really works!

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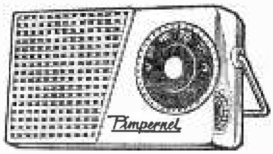

This remarkable little receiver uses 5 transistors and 2 diodes, 3in. Moving Coil Speaker, Tuning Condenser, Volume Control with On/Off switch, latest type circuitry giving excellent station separation and ample volume at good tone. Push-pull output circuit ensures long life from PP4 battery.

All components included for Medium Wave operation in handsome plastic case with carrying handle as illustrated.

Demonstrations at all branches

Circuit diagram FREE with parts or 2/- separately.

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Fully punched printed circuit board	6/6
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The "GOOD COMPANION"

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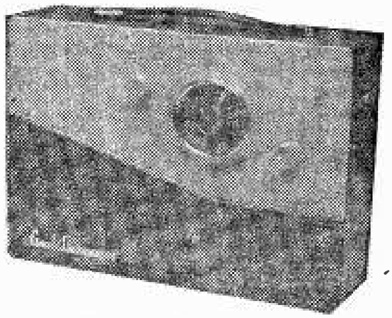

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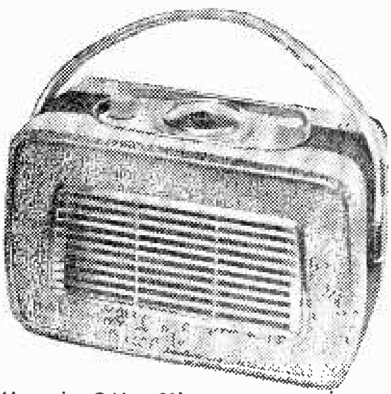
Circuit employs six transistors and two diodes, it incorporates all latest refinements, and oscillator I.F. Transformers are pre-aligned so no instruments are necessary. Anyone who can solder competently can make this set. The instructions are fully comprehensive with plenty of illustrations. Service is available in the unlikely event of your getting into difficulties. All components fully guartd.



Alternative Cabinet 20/- extra.

Price of all components and cabinet to make set as illustrated

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Post and insurance 5/-. Battery 3/6 extra.

POCKET COMPANION

should now be ready for constructors. Constructional details 2/6, or all parts complete

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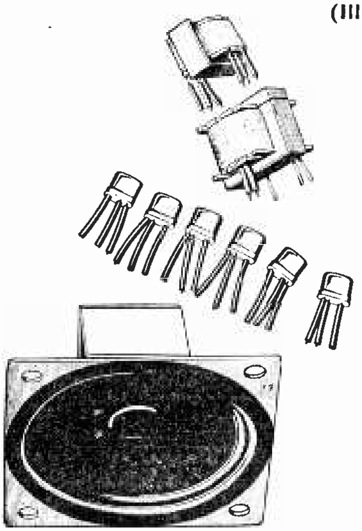

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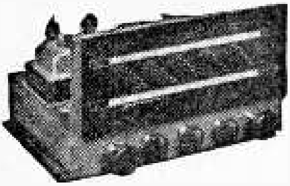

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1T4	6/-	6N7M	6/-	EB91	6/-	HABC80	
2X2	3/6	6Q7G	8/6	EBC33	8/6		12/6
3S4	7/6	6SA7	6/-	EBC41	8/6	HVR2A	6/6
3V4	7/6	6SJ7M	6/6	EBF80	10/-	MU14	9/-
5U4	7/6	6SN7	6/6	ECC84	9/6	PCC84	9/6
5Y3	7/6	6V6G	6/6	ECF80	9/6	PCF80	9/6
5Z4	9/6	6X4	7/6	ECH42	10/6	PCL82	11/6
6AM6	5/-	6X5	6/6	ECL80	10/6	PEN25	6/6
6B8	5/-	12A6	7/6	ECL82	10/6	PL81	12/6
6BE6	7/6	12AT7	8/-	EF39	5/6	PL82	10/6
6BH6	9/6	12AU7	8/-	EF41	9/6	PY80	7/6
6BW6	9/6	12AX7	8/-	EF50	5/6	PY81	9/6
6D8	6/-	12BE6	8/-	EF80	8/-	PY82	7/6
6F6	7/6	12K7	6/6	EF86	12/6	SP61	3/6
6H6	3/6	12Q7	6/6	EF92	5/6	UBC41	9/6
6J5	5/6	35L6	9/-	EL32	5/6	UCH42	9/6
6J6	5/6	35Z4	7/6	EL41	9/6	UF41	9/6
6J7G	6/6	80	9/6	EL84	8/6	UL41	9/6
6K6GT	6/6	807	5/6	EY51	9/6	UY41	8/-
6K7G	5/-	954	1/6	EZ40	7/6	U22	8/-

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

NEW ELECTROLYTICS — FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350V	2/-	50/350V	5/6	16/45V	5/-
2/350V	2/3	100/25V	3/-	32/350V	4/-
4/450V	2/3	250/25V	3/-	100/270V	5/6
8/450V	2/3	500/12V	3/-	2,000/6V	4/-
8/500V	2/9	8+8/450V	3/6	5,000/6V	5/-
16/450V	3/-	8+8/500V	5/-	32+32/350V	5/-
16/500V	4/-	8+16/450V	3/9	32+32/450V	6/-
32/450V	3/9	8+16/500V	5/6	32+32+32/350V	7/-
25/25V	1/9	16+16/450V	4/3	50+50/350V	7/-
50/25V	2/-	16+16/500V	6/-	64+120/350V	11/6
50/50V	2/-	32+32/350V	4/6	100+200/275V	12/6

C.R.T. BOOSTER TRANSFORMERS

For Cathode Ray Tubes having heater cathode short circuit and for C.R. Tubes with falling emission. Full instructions supplied.

Type A. Optional 25% and 50% Boost. 2V or 4V or 6.3V or 10.8V or 13.3V. Mains input. 12/6

TYPE A2. High quality, low capacity. 10/15pF. Optional boost 25%, 50%, 75%. Mains input. 16/6

Type B. Mains input. Low capacity. Multi output 2, 4, 6.3, 10 and 13V. Boost 25% and 50%. This transformer is suitable for all TV tubes. 21/- each.

COMPLETE RADIO
£4.19.6 post free

4 Mullard valves, 5in. speakers, frame aerial. 4 pre-set stations. 1 long, 3 med. wave. **Superhet Circuit.**
Size 9 x 6 x 5¼in. high. Tested ready for use. 200/250 v. A.C.—D.C. Mains.

Post 2/- each.

MAINS TRANSFORMERS 200/250 v. A.C.
STANDARD, 250-0-250, 80 mA, 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a. 5 v. 2 a. or 4 v. 2 a., 22/6; ditto, 350-0-350 .. 29/6
MINIATURE 200 v. 20 mA, 6.3 v. 1a. .. 10/6
MIDGET, 220 v. 45 mA, 6.3 v. 2 a. .. 15/6
SMALL, 220-0-220, 50 mA, 6.3 v. 2a. .. 17/6
STD., 250-0-250, 65 mA, 6.3 v. 3.5 a. .. 17/6
HEATER TRANS. 6.3 v, 1½ amp. .. 7/6
Ditto, tapped sec. 2, 4, 6.3 v., 1½ amp. 8/6
Ditto, sec. 6.3 v. 3 amp... .. .. 10/6
GENERAL PURPOSE LOW VOLTAGE. 2a, 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24, 30 v. 22/6
AUTO TRANS. 0110, 240 v. 150 w. .. 22/6
Ditto, 500 w. 82/6

O.P. TRANSFORMERS. Heavy Duty 50 mA, 4/6. Multiratio, push-pull, 7/6. Ditto, 10 w., 15/6. Miniature, 384m etc., 4/6. **L.F. CHOKES** 15/10H. 60/65 mA, 5/-; 10 H. 85 mA, 10/6; 10 H., 150 mA, 14/-.

TELEVISION REPLACEMENT Line Output Transformers from 45/- each, New Stock

and other timebase components
Most makes available
S.A.E. with all enquiries.

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

BOOKS

40 Circuits for Germanium Diodes 3/-
"W.W" Radio Valve Data. 6/-.
High Fidelity Speaker Enclosure, 5/-
Valve and TV Tube Equivalents, 9/6.
TV Fault Finding, 5/-.
Quality Amplifiers, 4/6.
Radio Valve Guide. Books 1, 2, 3 or 4, 5/- each.
Transistor Superhet Receivers, 7/6.

CRYSTAL MIKE INSERT

by Acos 8/6
Precision engineered.
Size only 1⅛in. dia. x ¼in.

ACOS CRYSTAL MIKE 40 .. 25/-
DE LUXE STICK MIKE .. 35/-

LOUDSPEAKER P.M. 3 OHM. 2½, 3, 4in. 19/6, 5in. Rola, 17/6; 8in. Plessey, 19/6. 7in. x 4in. Plessey, 18/-; 6½in. Rola, 18/6. 10 x 6in. 27/6. 10in. Rola, 30/-. 4in. Tweeter, 25/-. 12in. R.A. 30/-; 13½ x 8in. 45/-.
STENTORIAN HF1012. 10in. 3-15 ohms, 10 w., 95/-.

BAKER SELHURST LOUDSPEAKERS

12in. Baker 15w. Stalwart 3 or 15 ohms, 45-13,000 c.p.s. .. 90/-
12in. Baker ditto, foam suspension, 15 ohms, 40-13,500 c.p.s. .. £6
12in. Stereo, 12 w., 35-16,000 c.p.s. .. £8
12in. Baker Ultra Twelve, 20 c.p.s. to 25 kc/s. £17.10
15in. Bass Auditorium Mk.II, 35 w. .. £15

CRYSTAL DIODE G.E.C., 2/-. GEX34, 4/-.
HIGH RESISTANCE PHONES. 4,000 ohms, 15/- pr.
MIKE TRANSF. 50 : 1, 3/9 ea.; 100 : 1, Potted, 10/6.
SWITCH CLEANER. Fluid squirt spout, 4/3 tin.
TWIN GANG TUNING CONDENSERS. 365 pF. miniature 1in. x 1½in. x 1¾in., 10/-. 500pF Standard with trimmers, 9/-; midget, 7/6; with trimmers, 9/-
SINGLE, 50 pF, 2/6; 75 pF, 100 pF, 160 pF, 5/6. Solid dielectric 100, 300, 500 pF, 3/6.
CONDENSERS. New Stock. 0.001 mfd. 7 kV; T.C.C., 5/6; Ditto, 20 kV., 9/6; 0.1 mfd., 7 kV., 9/6. Tubular 500 v. 0.001 to 0.05 mfd., 9d., 0.1, 1/-; 0.25, 1/6; 0.5/500 v., 1/9; 0.1/350 v., 9d; 0.01/2,000 v. 0.1/1,000 v., 1/9; 0.1 mfd., 2,000 volts, 3/6.
CERAMIC CONDS. 500 v., 0.3 pF to 0.01 mfd., 9d.
SILVER MICA CONDENSERS. 10% 5 pF to 500 pF, 1/-; 600 pF to 3,000 pF, 1/3. Close tolerance (± 1 pF) 1.5 pF to 47 pF, 1/6. Ditto 1% 50 pF to 815 pF, 1/9; 1,000 pF to 5,000 pF, 2/-.

465 kc/s SIGNAL GENERATOR Total cost 15/-. Uses B.F.O. Unit. ZA 30038 ready made. **POCKET SIZE** 2½ x 4½ x 1in. Slight modifications required, full instructions supplied. Battery 7/6 extra 69V+1½V. Details S.A.E.

Wavechange Switches. 2 p. 2-way, 3 p. 2-way, short spindle, 2/6; 8 p. 4-way 2 wafer, long spindle, 6/6; 2 p. 6-way, 4 p. 2-way, 4 p. 3-way, long spindle, 3/6; 6 p. 4-way, 1 p. 2-way, long spindle, 3/6;
Wavechange "MAKITS". Wafers available: 1 p. 12 wafer, 2 p. 6 wafer, 3 p. 4 wafer, 4 p. 3 wafer, 6 p. 2 wafer, 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer, 16/-; additional wafers up to 14, 3/6 each extra.
Toggle Switches, s.p., 2/-; d.p., 3/6; d.p.d.t., 4/-.

JASON FM TUNER COIL SET, 29/-. H.F. coil, aerial coil, oscillator coil, two i.f. transformers 10.7 Mc/s, detector transformer and heater choke. Circuit and component book using four 6AM6, 2/6. Complete Jason FMT.1 Kit. Jason chassis with calibrated dial, components and 4 valves, £6.5.0.

Valveholders. Pax. int. oct., 4d. EA50, 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, and 7 pin, 1/-. MOULDED Mazda and int. oct., 6d.; B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6. B9A with can, 1/9. Ceramic, EF50, B7G, B9A, int. oct., 1/-. 7BG, B9A caps, 1/- each.

"A MERRY CHRISTMAS TO ALL

RADIO COMPONENT

Our written guarantee with every purchase.

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

Volume Controls

Long spindles. Midget 5 K ohms to 2 Meg.

No. Sw.	D.P.Sw.
3/-	4/6

Linear or Log Tracks.

80 ohm CABLE COAX

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

TRIPLEXERS Bands I, II, III 12/6
COAX PLUG .. 1/- **LEAD SOCKET** .. 2/-
PANEL SOCKETS 1/- **OUTLET BOXES** 4/6
BALANCED TWIN FEEDER yd. 6d. 80 or 300 ohms.
DITTO SCREENED per yd. 1/6. 80 ohms only.
WIRE-WOUND POTS, 3 WATT. Pre-set Min. TV Type. All values 10 ohms to 25 K., 3/- ea. 30 K., 50 K., 4/-. (Carbon 30 K., to 2 meg., 3/-.)
WIRE-WOUND 4 WATT Pots. Long Spindle. Values, 50 ohms to 50 K., 6/6; 100 K., 7/6.

TRIMMERS, Ceramic. 30, 50, 70 pF., 9d.; 100 pF., 150 pF., 1/3; 250 pF., 1/6; 500 pF., 750 pF., 1/9.
RESISTORS. Preferred values. 10 ohms to 10 meg., ¼ w., 4d.; ½ w., 4d.; 1 w., 6d.; 1½ w., 8d.; 2 w., 1/-.
HIGH STABILITY. ½ w., 1%, 2/-. Preferred values. 10 Ω to 10 meg. Ditto 5%, 100 Ω to 5 meg., 9d.

WIRE-WOUND RESISTORS 25 ohms—10,000 ohms

5 watt	1/3
10 watt	1/6
15 watt	2/-
12.5K to 50K 10w	3/-

AMERICAN "BRAND FIVE" PLASTIC RECORDING TAPE

			Spare Plastic Reels
Double Play	7in. reel, 2,400ft	60/-	
	5in. reel, 1,200ft	37/6	
Long Play	7in. reel, 1,800ft	35/-	
	5¾in. reel, 1,200ft	23/6	3in. 1/6
	5in. reel, 900ft	18/6	4in. 2/-
			5in. 2/-
Standard	7in. reel, 1,200ft	25/-	5¾in. 2/-
	5in. reel, 600ft	16/-	7in. 2/6

"Instant" Bulk Tape Eraser and Head Defluxer, 200/250 v. A.C., 27/6. Leaflet, S.A.E.

Neon Mains Tester Screwdriver, 5/-.
Solder Radiograde, 4d. yd., ½lb. 5/-.
Black Crackle Paint. Air drying, 3/- tin.

HIGH GAIN TV PRE-AMPLIFIERS BAND I B.B.C.

Tunable channels 1 to 5. Gain 18db. ECC84 valve. Kit price 29/6 or 49/6 with power pack. Details 6d. (PCC84 valves if preferred.)
BAND III I.T.A.—Same prices. Tunable channels 8 to 13. Gain 17dB.

Paxolin Panels, 10 x 8in., 1/6.
Miniature Contact Cooled Rectifiers. 250V 50mA, 7/6; 250V 60mA, 8/6; 250V 85mA, 9/6; 200mA, 21/-; 300mA, 27/6.
Selenium Rect. 300V 85mA, 7/6.
Coils. Wearite "P" type, 3/- each. Osmor Midget "Q" type, adj. dust core, from 4/- each. All ranges.
Teletron D.W.R. L. and Med. T.R.F. with reaction, 3/6.
Ferrite Rod Aerials. M.W., 8/9; M. and L., 12/6.
Osmor Ferrite Rod Aerials. L. and M. for transistor circuits, 10/- each.
Ferrite Rods, 8 x ⅜in., 2/6.
H.F. Chokes, 2/6.
T.R.F. Coils, A/HF, 7/- pair; HAX. 3/-, DRR2, 4/-.

Aluminium Chassis, 18 s.w.g. Plain, undrilled. 4 sides, riveted corners, lattice fixing holes, 2½in. sides, 7 x 4in. 4/6; 9 x 7in., 5/9; 11 x 7in., 6/9; 13 x 9in., 8/6; 14 x 11in., 10/6; 15 x 14in., 12/6; 18 x 16 x 3in., 16/6.
Aluminium Panels, 18 s.w.g., 12 x 12in. 4/6; 14 x 9in., 4/-; 12 x 8in., 3/-; 10 x 7in., 2/3.

AUTOCHANGER ACCESSORIES

Suitable player cabinets (except 4 H.F.) 49/6
Amplifier player cabinets (except 4 H.F.) 63/-
2-valve amplifier and 6½in. speaker 95/-
3-valve amplifier and 6½in. speaker 105/-
Wired and tested ready for use with above.

QUALITY 2-STAGE HI-FI AMPLIFIER.

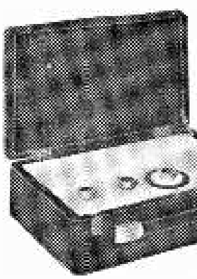
A.C. only 200-250V. Valves ECL82 and EZ80. 3 watt quality output. Mullard tone circuits, bass boost, treble and volume controls. Separate engraved Perspex front-panel with deluxe finish. Heavy duty output transformer 3 ohm. Shrouded mains transformer. Stove enamelled chassis size 6 x 5 x 3in. **Bargain price £4.10.0.** Circuit supplied.

JACKS. English open circuit, 2/6. Closed circuit, 4/3. Grundig type, 3 pin, 1/3.
JACK PLUGS. English, 3/-. Grundig, 3 pin, 3/6.
Wirewound Ext. Speaker Control, 10Ω, 3/-.
ALADDIN FORMERS and cores. ¼in., 8d.; ⅜in., 10d.
0.3in. FORMERS 5937 or 8 and cans TV1 or 2, ½in. sq. x 2½in. or ½in. sq. x 1½in., 2/- with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6-1, 2, 3.
SOLON IRON, 25W, 200V or 230V, 24/-.
MAINS DROPPER. 3 x 1½in. With adjustable sliders. 0.3A, 1,000 ohms, 4/3; 0.2A, 1,000 ohms, 4/3.
LINE CORD. 0.3A 60 ohms per foot, 0.2A 100 ohms per foot, 2-way, 1/- per foot; 3-way 1/- per foot.
MIKE TRANS. 50-1, 3/9; 100:1, potted, 10/6
P.V.C. Conn. Wire, 8 colours, single or stranded, 2d. yd. Sleeving, 1.2mm, 2d.; 4mm, 3d.; 6mm, 5d. yd.
Speaker Fret. Gold cloth, 17 x 25in., 5/-; 25 x 35in., 10/-. **Tygan,** 52in. wide, 10/-; 26in. wide, 5/- ft. Samples, S.A.E.
Expanded Metal, Gold. 12 x 12in., 6/-.

I.F. TRANSFORMERS 7/6 pair

465 kc/s slug tuning miniature can 1½ x ¾ x ¾in. High Q and good band width. Data sheet supplied.

"REGENT" 4 VALVE



"96" RANGE VALVES
KIT PRICE **£6. 6. 0.**
carr. 4/-

PRINTED CIRCUIT BATTERY PORTABLE KIT

Medium and long wave. Powerful 7 x 4in. high Flux Speaker. T.C.C. Printed Circuit and condensers. Components of finest quality clearly identified with assembly instructions. Osmor Ferrite Aerial Coils. Rexine covered attache case cabinet. Size 12in. x 8in. x 4in. Batteries used B126 (L5512) and AD35 (L5040), 10/- extra. Instructions 9d. (free with kit). Mains Unit ready made for above 39/6. Sold separately. Details free.

MONARCH RECORD PLAYER

BUILD IT YOURSELF using 4-SPEED BSR MONARCH AUTOCHANGER READY BUILT 3W. AMPLIFIER, HANDSOME PORTABLE CASE. HIGH FLUX LOUDSPEAKER. FULL INSTRUCTIONS SUPPLIED.
Carr. and ins. 5/-. Total Price **£12.10.0**

RECORD PLAYER BARGAINS

Post 2/- each.

4 Speed Autochangers:

BSR, U.A.14	£7.10.0
Collaro Autochanger	£7.19.6
Garrard "Slimline"	£8.17.6
Garrard RC209	£9. 9.0
Garrard RC210	£10.10.0

4 speed Single Players:

Garrard TA Mk. II	£8. 8.0
Model 4SP	£6.17.6
Garrard 4 HF Transcription	£17.19.6

Garrard Stereo Heads £2 extra.
All Sapphire Stylii available from 6/-.

ARDENTE TRANSISTOR TRANSFORMERS

Type D3035, 7.3 CT: Push Pull to 3 ohms for OC72, etc., 1 x ¾ x ¾in., 9/6.
Type D3034, 1.75: 1 CT. Push Pull Driver for OC72, etc., 1 x ¾ x ¾in., 9/6.
Type D3058, 11.5:1 Output to 3 ohms for OC72, etc., 1 x ¾ x ¾in., 9/6.
Type D167, 18.2:1 Output to 3 ohms for OC72, etc., ¾ x ½ x ½in., 12/-.
Type D239, 4.5:1 Driver Transformer, ½ x ½ x ½in., 10/-.
Type D240 8.5:1 Driver Transformer, ¾ x ½ x ½in., 10/-.

ARDENTE TRANSISTOR VOLUME CONTROLS

Type VC1545, 5K with switch, dia. 0.9in., 8/-
Type VC1760, 5K with switch, dia. 0.7in., 10/6
Deaf aid ear piece xtal or magnetic 7/6.

WEYRAD

COILS AND TRANSFORMERS FOR A 2-WAVE TRANSISTOR SUPERHET WITH PRINTED CIRCUIT AND FERRITE ROD AERIAL

Long and Medium Wave Aerial—RA2W. On 6in. rod, 7/16in. diameter, 208pF tuning, 12/6.
Oscillator Coil P50/1AC. Medium wave. For 176pF tuning, 5/4.
1st and 2nd I.F. Transformers—P50/2CC. 470 kc/s, 11/16in. diameter by ¾in. high, 5/7.
3rd I.F. Transformers—P50/3CC, to feed diode detector, 6/-.
Driver Transformer—LFDT2. 1 5/16 x ¾ x 1¾in., 9/6.
Printed Circuit—PCA1. Size 2¾ x 8¼in. Ready drilled and printed with component positions, 9/6.
7 x 4in., 35 ohm Speaker, 25/-.
These components are approved by transistor makers and performance is guaranteed.
Constructor's Booklet 2/-.

NEW MULLARD TRANSISTORS

Audio	OC71 6/-	R.F.	OC44	10/6
	OC72 7/6		OC45	9/6

Sub-miniature Electrolytics (15V). 1µF, 2µF, 4µF, 5µF, 8µF, 25µF, 50µF, 100µF, 2/6. Diodes OA71, OA81, 3/-. GEX 34, 4/-.

B.B.C. Pocket 2 Transistor. M.W. and L.W. Radio Kit, 32/6. Phones 7/6 or deaf aid earpiece, 7/6.

"P.W." POCKET 6 TRANSISTOR KIT MK.II WITH LATEST OSMOR MODIFICATIONS. ALL PARTS, PRINTED CIRCUIT AND CABINET. OSMOR DESIGNED KIT. £8.15.0.

READERS OF PRACTICAL WIRELESS"

SPECIALISTS

P. and P. charge 1/-, over £3 post free. *C.O.D. 2/-.*

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Practical Wireless

Vol. XXXVII No. 659 JANUARY, 1962.

Editorial and Advertisement Offices:

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Contents

RADIO AS A HOBBY

IT is not so many years ago that the man who had a radio set was regarded by his neighbours as a "scientific genius", and was able to entertain, as well as mystify, by demonstrating his apparatus. Many converts were made for the hobby and, when broadcasting started, the number of radio hobbyists grew until it assumed such proportions that it almost rivalled photography. As it grew, periodicals appeared devoted to the hobby and at one time there were a dozen of these, and it was noteworthy that the majority of constructors were middle-aged. Youth at the time was unable to take part in view of the expense and lack of knowledge or interest and the subject appeared too technical to follow. As time went on, the hobby began to die, and one by one the periodicals and magazines disappeared from the market, whilst the number of stores dealing in radio components also gradually reduced. After the war, however, there was a marked revival, not only on account of the many radio "experts" who left the armed forces, but because of the many valuable items of ex-government equipment which were released for general sale. The hobby again took on a healthy outlook and, although the technique was more involved, schools began to devote classes and instruction to certain aspects and thus the younger generation became interested.

Today, radio construction as a hobby is probably in as good a position as it was before the decrease just prior to the war. Transistors have come into such wide use that many schoolboys now have their own pocket portables which they have made up and carry about with them, and on the Christmas market will be found constructional toys which embrace not only simple transistor equipment but also various types of electronic equipment. The attendance at the recent Radio Hobbies Exhibition last month (November) showed an interest even greater than before, and it was interesting to note the age-groups and how they have changed from pre-war days.

Our recent "Tutor" series has been started up in a number of schools and the many letters which we have received show that there is a very great development of interest in radio and its associated fields. Broadcasting and television are no longer regarded as scientific marvels but are part of everyday life, and the forthcoming year should see even greater developments, as the growing field of enthusiasts must lead to new ideas.

A FILM SHOW

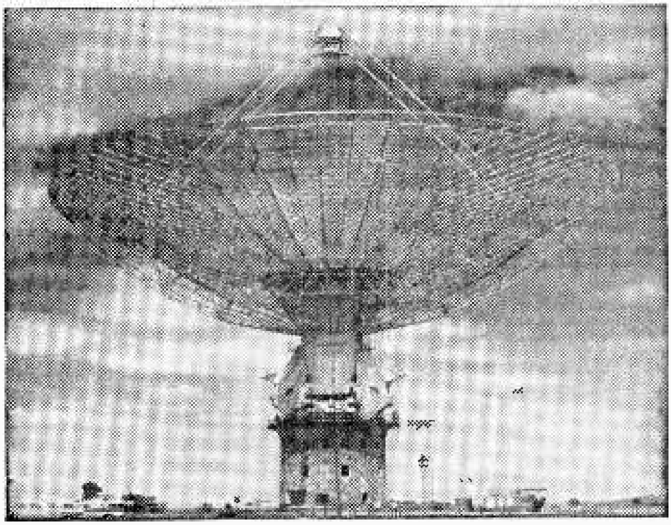
ANOTHER film show has been arranged in collaboration with Mullard Ltd. It will be held at Caxton Hall, Westminster, and readers are invited to send for their free tickets which are now available from these offices. The films will be shown on Friday, February 2nd, 1962, and the programme will begin at 7.30 p.m. When applying for tickets, enclose a stamped and addressed envelope (at least 3½in. x 6in.). Mark your envelope "Caxton Hall" in the top left-hand corner.

The films to be shown are *Special Quality Valves*, which deals with valves made to withstand vibration and shock, and *Transistors*, which deals with the "everyday" uses of transistors.

Our next issue dated February, will be published on January 5th

Round the World of Wireless

POTENTIAL AND CURRENT NEWS



This new radio telescope is in New South Wales, Australia. Although slightly smaller than the Jodrell Bank telescope, it is expected to give better performance.

Broadcast Receiving Licences

THE following statement shows the approximate number of Broadcast Receiving Licences in force at the end of September, 1961, 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	683.155
Home Counties	640,703
Midland	468,168
North Eastern	500,260
North Western	430,608
South Western	378,859
Wales and Border Counties ..	221,640
Total England and Wales	3,323,393
Scotland	367,644
Northern Ireland	115,449
Grand Total	3,806,486

The Indian Industries Fair

THE Indian Industries Fair which opened in New Delhi on 14th November will last for six weeks.

AEI'S contribution both to the Indian industrial revolution and to power developments throughout the world form the main theme of their stand which takes up 2,000sq. ft.

Working models, photographs, films and other devices will be used to show some of the 3,500 types of equipment which AEI makes and supplies to all parts of the world. Dominating the central section, which deals with the part AEI is playing in the Indian industrial revolution, is a large map giving the location of eight main projects with which the company has been concerned. One of these is the giant heavy electrical plant being built in Bhopal by the Indian Government. Stress here is laid on the special training scheme which AEI is establishing for this project, which enables 3,000 men to be trained at a time. Other important schemes are the Durgapur Steel Works, where AEI as a member of the British Consortium known as ISCON has supplied five 90MW generator sets; and electric railway and traction developments including those in Bombay and Calcutta.

Surrounding the Indian section is a perimeter display giving a comprehensive guide to AEI activities throughout the world. An illuminated map pin-points the company's 70 factories and four research laboratories in the United Kingdom and a rotating drum, with the flags of the nations to which equipment has been supplied, gives details of work in five continents. Turbo-generator sets up to 550MW supplied for British power stations; electric units for British Railways and London's Underground; turbo-electric propulsion for British ships and power stations for Spain are some European examples.

Asian work shown includes generating equipment and electric trains for India; a gas turbine power station for Iran; synchronous condensers for Ceylon and generator sets for Burma, Singapore and Hong Kong. African work is represented by electric locomotives and mine winders for South Africa; water wheel alternators for Uganda, and generating and distribution equipment for the Kariba Dam in Rhodesia. Work carried out in Australasia which will be shown are circuit breakers, power transformers and electric locomotives supplied to New South Wales and New Zealand. For the Americas there are switchgear, transformers and generators for the Argentine, turbo-generators and telephone cables for Canada and railway electrification and electric trains for Brazil.

Radio Telescope in Australia

THE new Radio Telescope at Parkes, New South Wales, 240 miles West of Sydney, Australia, was opened on 31st October. The picture on this page shows the "dish" in the parked position which will be necessary when winds are over 25m.p.h. The "dish" is 210ft in diameter and although this is 40ft less than the Jodrell Bank telescope, the Australian telescope is expected to give a better performance, as the "hydrogen line" had not been discovered at the time the British instrument was being designed. It cannot therefore, like the Australian one, be used at full aperture down to a wavelength of 21cm., but the new telescope is designed to have a surface accuracy of $\pm\frac{1}{4}$in. under all temperature variations and winds up to 10m.p.h. It can be steered to an accuracy of one minute of arc. The tower is 39ft in diameter, 42ft high and the total weight on the foundations is 1,750 tons. The actual reflective surface is made of 1,300 small mesh panels on the face of the "dish". The cost of the telescope was shared between the Australian Government, the Carnegie Corporation, the Rockefeller Foundation of New York and private Australian subscribers.

Multichannel Radio System for Ghana

A CONTRACT by the Ghana Posts and Telegraphs authorities for the supply and installation of a twin-path VHF multichannel radio telephone system to link the Volta River dam area with Accra, the capital, has been awarded to Marconi's Wireless Telegraph Company Ltd.

The route, which was surveyed by Marconi's under a separate contract, will run from Accra to Tema and then to Akosombo, where the dam is being built.

Between Accra and Tema a super-high-frequency (7,000Mc/s) link will be built which will have a maximum telephone capacity of 300 channels. The route from Tema to Akosombo will be via a repeater station at Ningo Hill and will have a maximum capacity of 48 telephone channels, although initially 12 channels will be used along the whole route, with full facilities for telephone, telegraph and teleprinter services. The Ningo Hill repeater will be unattended, with duplicate diesel-electric power supplies and automatic changeover in the event of failure.

At Akosombo a mobile radio system is to be provided under the contract to enable engineers working on the dam to effect communication into the radio link. In addition a telephone subscriber network is to be supplied and installed in the Akosombo area and this will be connected to the main radio link and also the mobile radio system. Full channel access will be provided at Tema and telephone exchanges are to be supplied for this station and also for the Accra terminal.

Also in Ghana

ON October 27th, President Nkrumah performed the ceremonial opening of Ghana's new external broadcasting station—the most modern short wave broadcasting system on the African Continent—which with its four 100kW transmitters, is capable of world coverage.

The entire project—the specially-designed station buildings, the transmitters and ancillary equipment, the masts, aerial and feeder systems and the complete studio link equipment—was the responsibility of Marconi's Wireless Telegraph Company Ltd., who were awarded the contract by the Ghana Government.

The station, which is at Tema, near Accra, is built in the form of a hollow square, with a spacious rectangular courtyard occupying the enclosed area. The buildings have been specially designed to cope with earthquake shocks and the effects of solar heat and salt-laden air. A microwave radio link connects the studios at Accra with the transmitters at Tema.

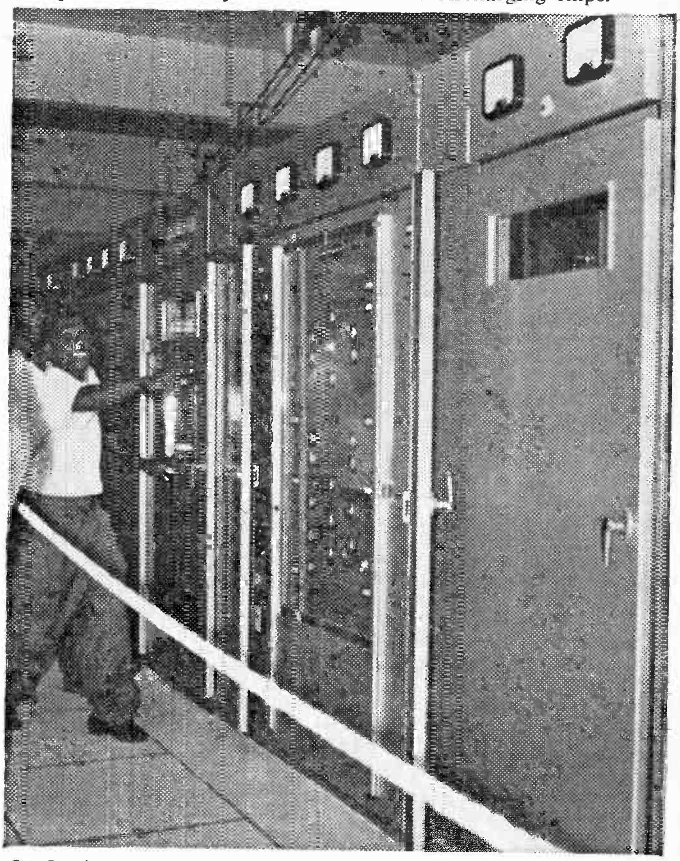
Marconi's are also supplying technical staff for the supervision and maintenance of the station for a period of four years and are also training personnel of the Ghana Broadcasting System both at the station and at the Company's Chelmsford Works.

Electronic Telephone Exchange for Hull Docks

A 20-line electronic exchange for the British Transport Dock Department in their grain silo at Hull is to be installed by Pye Telecommunications.

The exchange is to be installed in a location where high dust levels make electronic switching particularly suitable. Special T.M.C. heavy-duty telephones will also be used in the silo to minimise the effect of dust.

Pye mobile radio equipment has also been supplied for communication between the grain silo office and the floating elevators at work discharging ships.



On October 27th President Nkrumah officially opened Ghana's new high power short wave broadcasting station, at Tema, near Accra.

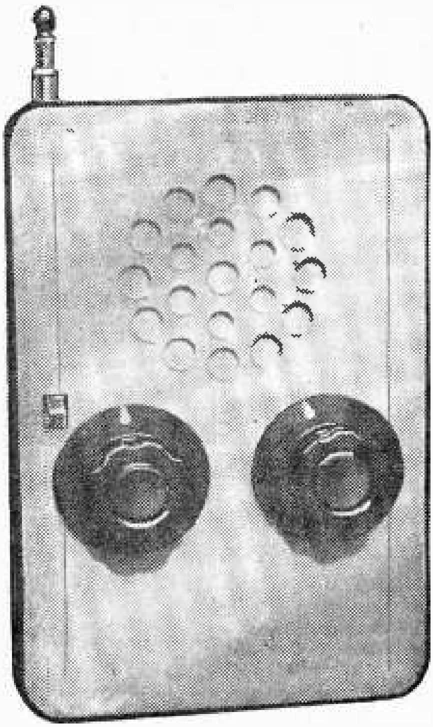
The station, which comprises four 100kW transmitters, is the most modern broadcasting system in Africa and capable of world-wide coverage. This picture shows a view of part of the Transmitting Hall.

A TRF

POCKET PORTABLE RECEIVER

WITH

FOUR TRANSISTORS



P.W. MINUETTE

By F. G. Rayer

THE TRF type of receiver is much easier to construct than a superhet, and does not require any form of trimming or alignment whatsoever. It is thus particularly suitable for use when a straightforward circuit giving reception of local stations only is required. The circuit shown in Fig. 1 has four transistors, and gives very good speaker results, in these circumstances.

Circuit

The first transistor operates as detector, with regeneration, which considerably increases sensitivity. It is followed by a driver and push-pull output stages, with 2½in. speaker. It was found that sufficient volume was often obtained with the ferrite slab internal aerial only. However, to permit more distant reception, a telescopic chrome aerial is incorporated. This is about 6in. long when closed, and extends to about 36in. The receiver is so made that it can stand upright, with the aerial vertical.

When the extended aerial is not in use, the receiver can be placed flat, or upright, and should be turned for maximum signal pick-up in the usual way. If preferred, the extending aerial may be omitted. It is also in order to use a few feet of thin insulated flex for an aerial instead, when the ferrite slab gives insufficient volume. It should generally be possible to obtain sufficient volume without extending the rod, or using an external aerial, except in areas where signal strength is poor.

Ferrite Slab

This is shown in Fig. 2, and is approximately 3in. x ¾in. x ⅛in. The larger winding has 52 turns, with tapping 2 made 11 turns from end 3. A space of ⅛in. is left, and six further turns are wound on in the same direction. Both windings are of 28s.w.g. DCC wire, which is easy to use. The tapping is made by baring the wire, and soldering on a lead. A small piece of insulating material under this joint will prevent any possible shorts to adjacent turns. The ends of the windings can be secured with adhesive, or tape. The windings should not be painted, waxed, or covered with adhesive.

A ferrite rod or slab with a ready-made Litz medium wave winding could be used instead. The small additional winding can be of any wire of about 32s.w.g. to 24s.w.g. Enamelled wire should be wound on a layer of paper.

Two mounts are cut from ebonite or similar material, and slotted to take the slab. These

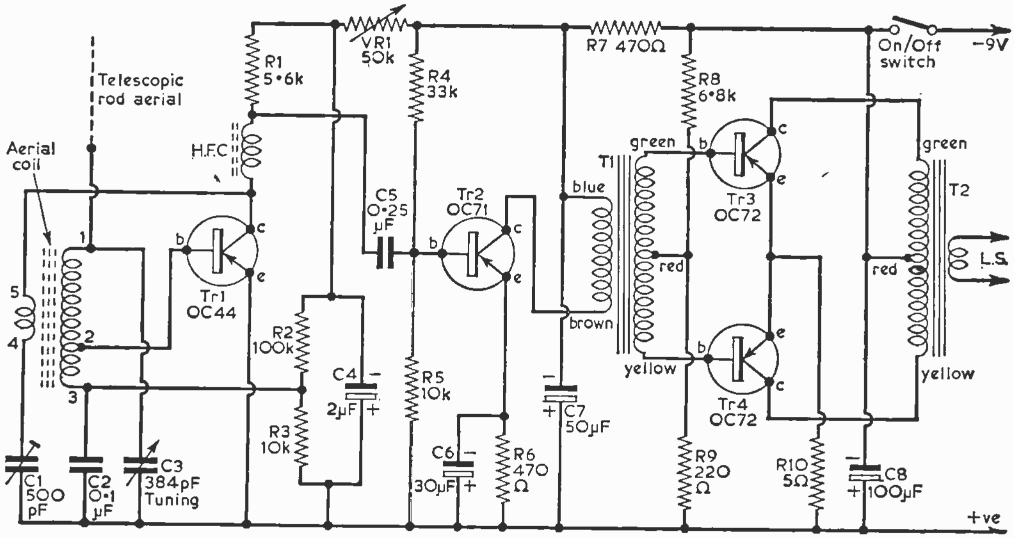


Fig. 1—The circuit of the receiver.

mounts are secured to the panel with countersunk screws, which can be self-tapping into holes in the mounts. Adhesive is placed on the slab and mounts, and the slab inserted in the slots.

Receiver Case

This is easily obtainable and is a popular plastic "lunch box" approximately 4½in. x 6¾in. x 1⅝in.

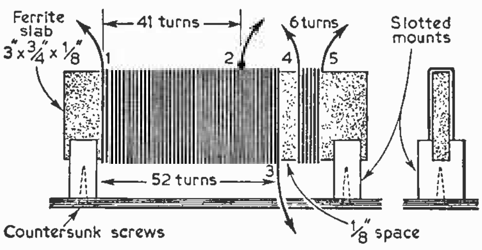


Fig. 2 (above)—The construction of the ferrite slab aerial.

There is enough free space to make construction easy, and to allow alternative components to be used.

The case is drilled to form a speaker fret, as shown in Fig. 3. Two circles are drawn, one of ½in. radius, and one of 1in. radius. The small circle is divided into six, and the large circle into twelve. This can be done with compasses. Small pilot holes are then drilled, being positioned as accurately as possible. Six holes about $\frac{5}{16}$in. in diameter are then drilled, and thirteen holes about ⅜in. in diameter.

The case should be supported upon a block of wood while drilling. The drills should be sharp, and only light pressure should be used. Holes about ⅜in. in diameter are then drilled for the controls, and the slot is made for the switch. This can be done by drilling one or two small holes, and squaring up with a small file.

After removing any fragments, paint the case on the *inside* with the desired colour. A quick-

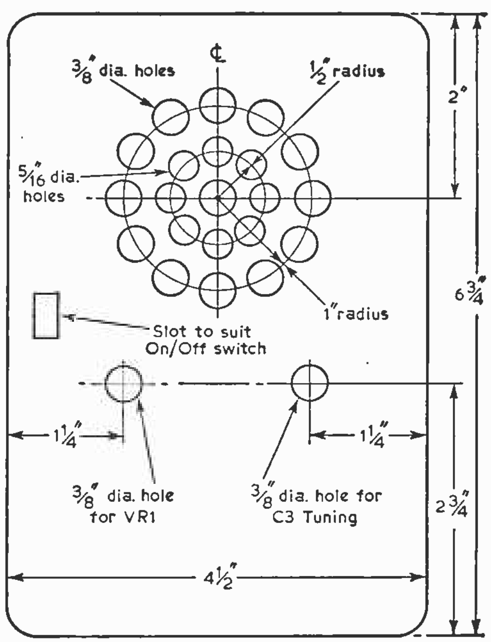


Fig. 3 (right)—The drilling details of the case.

drying enamel or paint will be most suitable.

When the receiver is finished the back is held on by a single screw, near the centre, which enters a threaded bush screwed to the receiver panel. Removing this single screw allows the back to be taken off to change the battery.

Receiver Panel

The receiver is constructed on a paxolin panel 4½in. x 6½in., and can be tested complete, with speaker, before inserting it in the case. When inserted, it is held in by the nut on the bush of the 50k potentiometer, and by a small bolt near the tuning condenser spindle hole.

Fig. 4 shows the receiver panel inside the case. It is, of course, only inserted when finished and tested.

The tuning condenser is a 2-gang air-spaced miniature type, as this is readily available for transistor receivers. Both sections are in parallel, making a total of about 384pF. This condenser is held to the panel by three short 4B.A. countersunk screws. Subsequently, one screw is removed, and passes through a hole in the case, to hold the receiver, as described. Care is necessary that these screws are not too long, or they will short circuit the condenser, or bend its plates. A 500pF solid dielectric may be used instead, with a small reduction in efficiency. If so, the fixing nuts of the 50k potentiometer and 500pF condenser will secure the receiver in its case.

The speaker is secured with countersunk 6B.A. bolts. Extra nuts, or spacing sleeves, are used with two bolts, so that the 5-tag strip shown in Fig. 4 can be fixed in position.

(To be continued)

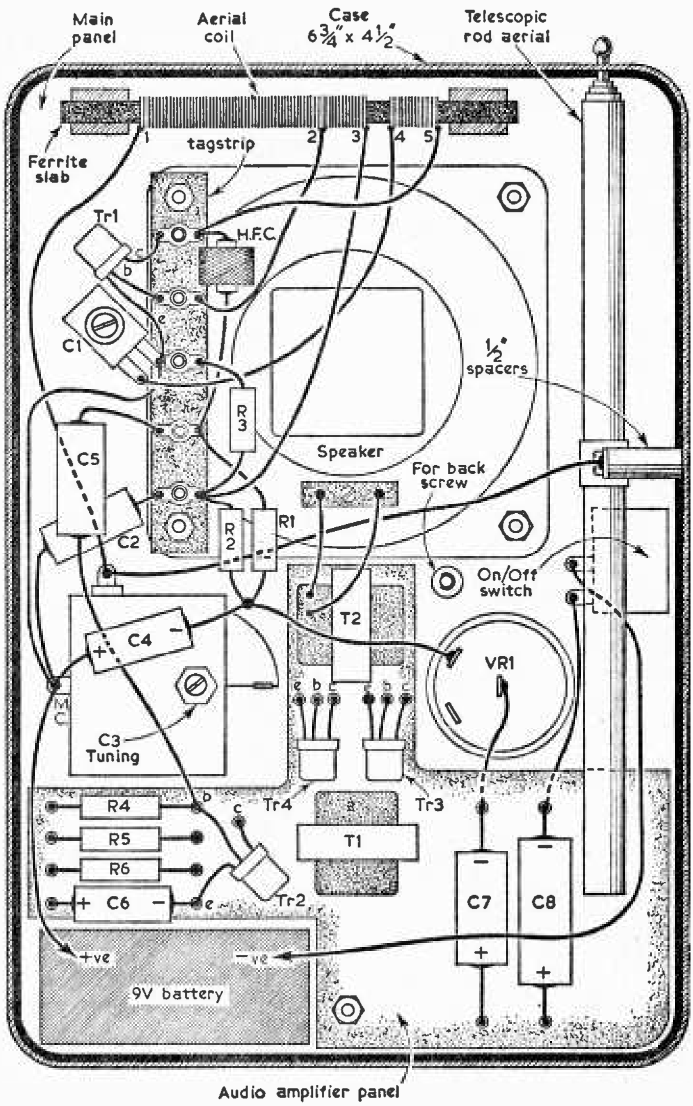


Fig. 4—The internal layout of components.

COMPONENT LIST

Resistors
R1 5·6k
R2 100k
R3 10k
R4 33k
R5 10k
R6 470Ω
R7 470Ω
R8 6·8k
R9 220Ω
R10 5Ω

Capacitors
C1 500pF trimmer
C2 0·1μF
C3 384pF tuning
C4 2μF elec.
C5 0·25μF
C6 30μF elec.
C7 50μF elec.
C8 100μF elec.

C3 is a 2-gang condenser (J.B.)

VR1 50k
Tr1 OC44 Tr2 OC71 Tr3, 4 OC72
T1 Driver transformer PW/DT (Osmor)
T2 Output transformer PW/OT (Osmor)
On/off switch, 2½in. loudspeaker, whip aerial, case, knobs, etc.

High Sensitivity Bridge

A CIRCUIT WITH AMPLIFIED NULL INDICATOR

By M. A. Harris

(Continued from page 737 of the December issue)

LAST month it was decided that calibration could be executed easily with the use of little more than a protractor and a slide rule.

The protractor should be a large one—which gives greater accuracy—the 6in. diameter type gives graduations every half degree. A 360° protractor is advantageous, although a 180° type will do.

The slide rule is for division and multiplication. Log. tables will suffice although this will take a longer time. If the constructor possesses neither of these, the required calculations can be carried out by hand, and it is here where the most patience is required.

The first thing to do is to find the total angle of travel of the pointer on the balance knob. In the prototype this was 310° (see Fig. 7). This angle will be designated θ (theta) since different potentiometers have different total angles of travel. When the resistance (or capacitance) to be measured is equal to the standard employed, the balance point will be when the pointer is at an angle of $\theta/2$ from the zero or datum line (in a clockwise direction). If the test resistance is $\frac{1}{10}$th of the standard, the balance point will be when the angle is

$$(1/10)/(1+1/10) \times \theta^\circ$$
$$=1/11\,\theta^\circ$$

Similarly when the test resistance is 10 times that of the standard the balance will be $10/11\theta^\circ$.

Cut out a piece of paper 10in. in diameter, and mark on it the datum line, $1/11\theta$, $\theta/2$, $10/11\theta$ and θ. The calculations can be done by slide rule (the quickest), log tables or by long-hand.

Let, for sake of argument, the standard be 100Ω. Then the balance point when 10Ω is across the test terminals will be $1/11\theta$.

For 20Ω, the balance point will be

$$\frac{20}{20+100}\,\theta = \tfrac{1}{6}\theta$$

For 30Ω, the balance point will be

$$\frac{30}{30+100}\,\theta$$ and so on.

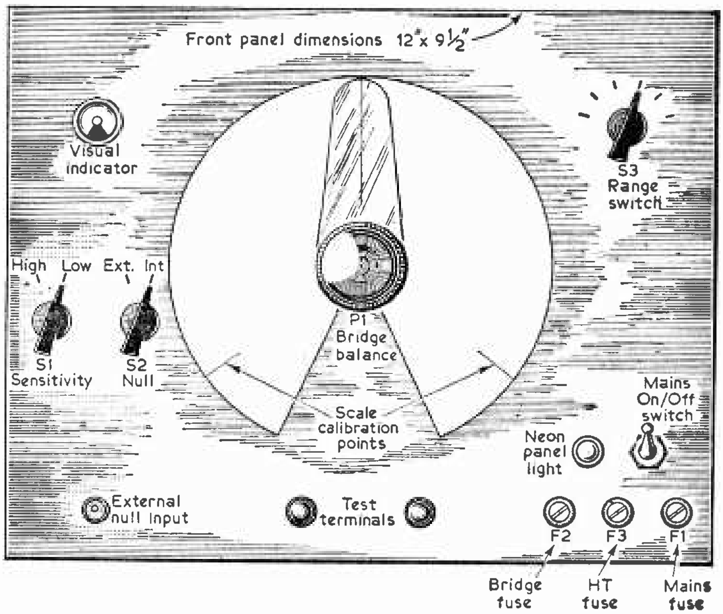


Fig. 5—The layout of the front panel.

For 200Ω, the balance point will be

$$\frac{200}{200+100}\,\theta = \tfrac{2}{3}\theta$$

For 300Ω, the balance point will be

$$\frac{300}{300+100}\,\theta$$ and so on.

The values at which these calculations are made are as follows:—

8Ω } overlap.	60Ω	400Ω
9Ω } overlap.	70Ω	500Ω
10Ω	80Ω	600Ω
15Ω	90Ω	700Ω
20Ω	100Ω	800Ω
30Ω	150Ω	900Ω
40Ω	200Ω	1kΩ
50Ω	300Ω	1·5kΩ } overlap.
		2kΩ } overlap.

The other resistance ranges will be 1k—100k and 100k—10M.

The overlap is provided at each end to facilitate readings of resistance at the extreme ends of the scale. When all these angles have been worked out, they are then transferred to the scale. The scale markings should, if reasonable care has been taken, be accurate, and for greater accuracy, intermediate values can be worked out and drawn in.

Reciprocal Scale

For the capacitance ranges, the values of C are the exact reciprocals of R.

e.g. if balance with a standard R of 100Ω were 10Ω, the same balance with a standard C of 100pF would be 1000pF. In other words, if, with a standard R a balance point R1 were obtained, with a standard C, the same balance point would represent a capacity of C×R/R1.

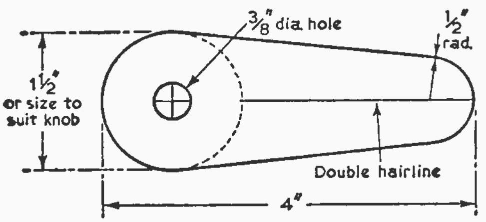


Fig. 6—The dimensions of the cursor.

So for all the values of R plotted, the values of C are equal to 1/R. A good idea is to mark the C scale in a different colour from the R scale. The scale card should be carefully placed over the balance potentiometer spindle, and glued into position. A coat of clear varnish will prevent dirty fingermarks appearing.

To obtain an accurate 1μF capacitor

Switch to the 1μF range. Select any 1μF condenser and measure its value on the 1μF range (near the right-hand end). Switch to the 10.000pF range and measure its value again (near the left-hand end). This answer will be the accurate one. Consequently the actual value of the nominal 1μF condenser can be calculated.

Let the true value of the 0·1μF capacitor (as measured on 10,000pF range)=C.

Let the apparent value of the 0·1μF capacitor, as measured on the 1μF range be C1.

Then the true value of the nominally 1μF condenser is

$$(C/C1 \times 1)\mu F$$

If the true value of this nominally 1μF condenser is under 1μF, all very well and good, otherwise

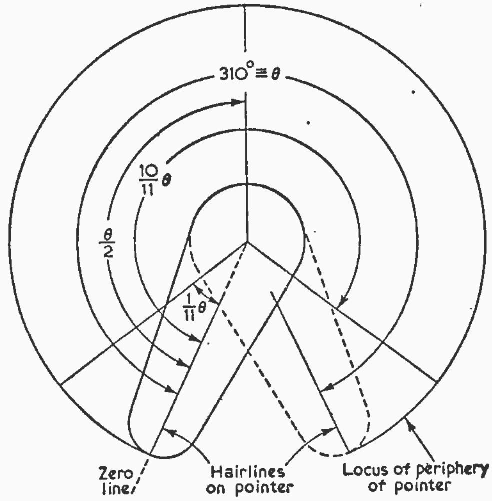


Fig. 7—The method of marking the scale.

continue trying different 1μF condensers until one is obtained that is under 1μF. From simple subtraction, the value of the condenser to be placed in parallel with it is obtained, so making the value exactly 1μF. (Condensers in parallel add up.) If desired, the balance point can be set (i.e., what it should be) and a trimmer placed across the nominally 1μF condenser, and this trimmer adjusted until the magic eye shows a balance (i.e., eye fully open).

The instrument is now complete and ready for use. It is a good idea to use a 3ft piece of twin flex with crocodile clips on the end, so that rapid measurements are obtained. One word of warning, however, on the low capacitance range, the self-capacitance of the flex will have to be taken into account. This is easily done by leaving the crocodile clips unconnected and taking a balance reading. Then from whatever value of balance is obtained when measuring a condenser, this value obtained for the self-capacitance is simply subtracted.

Conclusion

This instrument has been in use for the last six months and has proved reliable, and repaid for itself many times over, in the time saved by its use. ■

All about CATHODE-FOLLOWER circuits

By E. McLoughlin

PRINCIPLES AND USES OF THIS TYPE OF CIRCUIT

ALMOST every experimenter who is not a complete newcomer to radio will have heard of, and doubtless even used, cathode-follower circuits. He will have some idea of their purpose and their principle. He will probably know that a cathode-follower circuit delivers an output voltage approximately equal to the input voltage, but at a much lower impedance level, so that more current and power can be drawn at the output without the voltage collapsing. He will very likely have heard that "the output impedance is the reciprocal of the mutual conductance of the valve", yet he may have been puzzled by the fact that output cathode resistors used (see Fig. 1, a typical basic cathode-follower) normally need to be several thousand ohms, which is much greater than the reciprocal of the mutual conductance of a modern valve which is about 5mA/V for a triode, giving only 200Ω as the reciprocal; naturally, we must express the reciprocal in Volts/Amps, not V/mA, to obtain a result in Ohms! Now all these facts mentioned are perfectly true; the difficulty lies in their proper understanding, i.e. *exactly* what is meant, how the facts fit in with each other, and how practical use may be made of them.

The author must apologise now for having to use some mathematics at this stage, but it will be kept as brief and simple as possible. It is absolutely necessary to understand the processes involved in a cathode-follower clearly, before being able to grasp its practical applications to full advantage.

Basic Circuit and Principles

We will, for the moment, ignore the question of the correct D.C. conditions for maintaining the proper or desired operating point. We assume that somehow this is realised, and leave its discussion for later in this article. The voltages Vin (input at the grid, between grid and chassis, as usual) and Vout (between chassis and cathode, output voltage) in Fig. 1 are supposed to be r.m.s. A.C. voltages applied, which represent the active signal interesting us. For the purposes of the following simple mathematics, they may be treated as if they were D.C. voltage differences, and thus the familiar versions of Ohm's Law may be used freely.

If Vin is made more positive (taking now a small part of a cycle of the A.C. waveform), valve current will increase, and thus the cathode voltage, i.e. Vout, will also follow in that it goes more positive, too, and, vice versa, on the negative half cycles. Thus, the input and output voltages are in phase; they follow each other; hence the name. As far as grid and cathode are concerned, it is the *difference* of the input and output voltages which is actually operative as the input signal *to the valve*. It is quite obvious from a glance at Fig. 1, that input and output voltages are in *series opposition* between grid and cathode of the valve.

We thus have the signal (Vin—Vout) as input to the valve between grid and cathode.

Let gm be the mutual conductance of the valve.

Then, by the definition of mutual conductance, this input signal will cause an anode *current* signal equal to,

$$(V_{in} - V_{out})\,gm$$

which must flow through the cathode resistor R_K, across which it thus causes a signal *voltage* drop, given simply by Ohm's Law, as

$$R_K(V_{in} - V_{out})gm$$

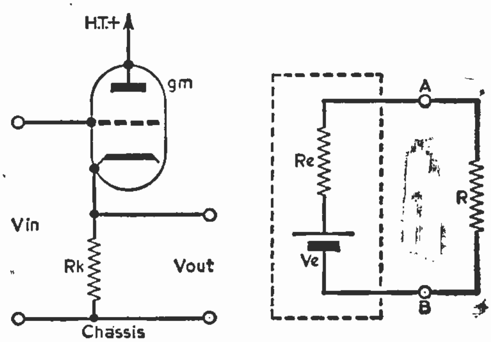


Fig. 1 (left)—The basic cathode-follower circuit.

Fig. 2 (right)—A diagram to explain the internal impedance of the cathode-follower.

But this voltage drop *is* the output signal, Vout, to which we may equate it, and thus arrive at the fundamental cathode-follower equation:—

$$V_{out} = R_K.gm\ (V_{in} - V_{out})$$

Simply rearranging this to a more useful form, we obtain

$$V_{out} = V_{in}\left\{\frac{gm.R_K}{1+gm.R_K}\right\}$$

Now R_K is typically 10k, and gm is typically 5mA/V. This makes the factor

$$\frac{gm.R_K}{1+gm.R_K} = \frac{50}{51}$$

which is virtually *one*. Thus, under these conditions, to all intents and purposes,

Vout = Vin

which is the already mentioned basic property of the cathode-follower.

The Question of the Output Impedance

Fig. 2 shows a simple battery (within the dotted-line box) connected to an external load, the resistor R. The EMF of the battery is represented by Ve, and the internal resistance of the battery itself is represented by Re within the dotted box, and may be called the output impedance of the battery. It is responsible for the fall of output terminal voltage of the battery (measured across A B) with increasing external load current drawn, because the greater this load current the greater will be the voltage drop lost across the internal Re.

In particular, when the load current drawn has been increased so that the external load resistance has been reduced *to equal the internal Re of the battery*, then half the EMF is lost inside the battery, and half is present externally across the load. It can be shown that, under these conditions, the *maximum possible power* is being obtained *externally* from the battery. For this reason, the condition is called "matched". Matching is a question of extracting maximum *power*, and has nothing directly to do with voltage or current maxima.

Other Sources

Now so far this discussion has been for a simple battery as example, to avoid all confusion. But the same principles obviously hold for any source of voltage, current, or power. We will call such sources, be they batteries, accumulators, valves, dynamos, etc. simply "generators". Every generator has a certain fixed EMF, and a certain *internal* resistance, Re, which may be called its "output impedance", or "internal impedance".

As one more example of a practical nature, before applying this discussion to the cathode-follower, we may consider the process of matching a loudspeaker to an output valve. We are interested in obtaining the maximum *power* into the speaker, because the power determines the ultimate loudness of the sound produced. Power is the product of voltage and current: the individual values are only of secondary importance as long as the product is as large as possible. The output valve is here functioning as generator, and has a definite internal resistance (the anode resistance of the valve). If we now make the external load resistance (the loudspeaker) too small, then a large amount of total power is certainly generated, but almost all of it will be uselessly dissipated in the larger internal resistance of the valve. On the other hand, if the external load resistance is too large, it will certainly receive most of the power generated, because now the valve's internal resistance is that much smaller in proportion, but the power generated will be small, because of the high total resistance. In between is the optimum position, where the external load receives the maximum possible power, and, as already said, simple mathematics shows that this condition is invariably achieved when the external load is equal to the internal resistance of the generator; the condition called "matched". As is familiar to all constructors, if the actual coil impedance of the speaker is not of the required value dictated by the valve, a suitable transformer must be used. On this subject, a detailed article appeared recently in these pages and thus it is not necessary to go into this question again here (see "About Loudspeakers" in the October 1961 issue).

Output Impedance of the Cathode-Follower

For the purposes of defining the Output Impedance or Internal Impedance of a cathode-follower, we must treat it as a "generator" with an EMF equal to the input voltage Vin (Fig. 1) with which we are supplying it. We have seen that the output voltage, Vout (Fig. 1) is very slightly *less* than the input voltage. This slight loss is due to the effective internal impedance of the cathode-follower for which we are looking, and as usual, we can define or measure the internal impedance on the basis of this internal voltage-drop loss.

The very simplest way of all, for determining the internal impedance of the cathode-follower, is to

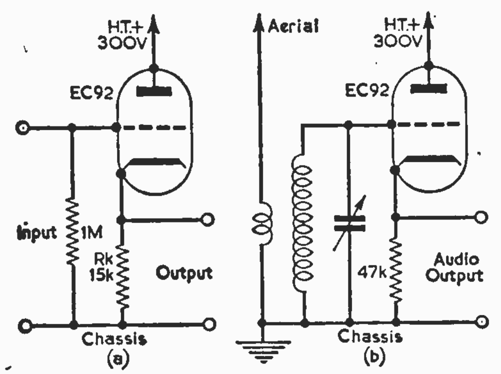


Fig. 3 (a)—High-amplitude cathode-follower circuit.
Fig. 3 (b)—An infinite impedance detector.

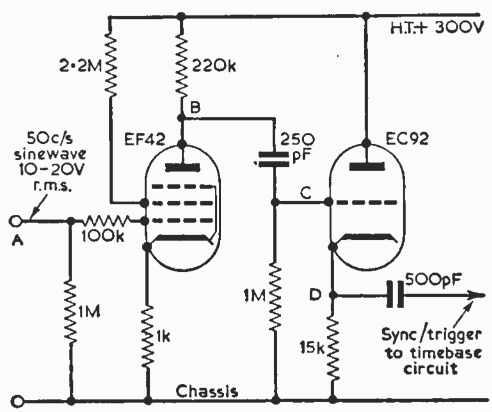


Fig. 4—A timebase sync former with cathode-follower output.

consider the *matched condition*. As explained above, the load voltage is then half of the EMF, i.e. Vout is then only equal to *half* of Vin, because the value of R_K has been reduced drastically until it is equal to the internal impedance Z.

Taking again the basic cathode follower equation which we found,

$$\text{Vout} = \text{Vin}\left\{\frac{gm.R_K}{1+gm.R_K}\right\}$$

we now find for the present condition, putting R_K=Z and putting Vout=half of Vin:—

$$\tfrac{1}{2}\text{Vin} = \text{Vin}\left\{\frac{gm.Z}{1+gm.Z}\right\}, \quad \text{giving } 1+gm.Z=2gm.Z \quad \text{i.e. } gm.Z=1 \quad \text{i.e. } Z=1/gm$$

It is thus apparent now exactly what is meant by the familiar statement that "the output impedance

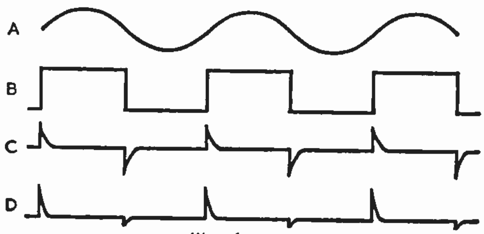


Fig. 5—Waveforms of the circuit in Fig. 4.

of a cathode-follower is equal to the reciprocal of the mutual conductance of the valve used." It means that we can reduce the value of the cathode resistance R_K in Fig. 1, which represents the external *output load,* down to the reciprocal of the mutual conductance of the valve used before 50% of the input voltage is lost. Naturally, if we are interested in maintaining as near 100% of the voltage as possible, the load resistor R_K must be very much larger, as it normally is. This is the usual application of the cathode-follower. But if we are interested in obtaining as much *power* output as possible, then the very much smaller value for R_K, equal to the reciprocal of the mutual conductance of the valve, must be used.

It is thus necessary to divide the following survey of the practical applications of the cathode-follower into two distinct categories:—

(1) 1:1 voltage transfer: R_K much greater than 1/gm

Under these conditions the benefit derived from the circuit is simply that the output voltage is to a large degree independent of the load, i.e. the output voltage remains virtually constant and equal to the input voltage, regardless of large fluctuations in the load resistance. The power output is very small, and not of interest for such applications.

(2) Maximum power output at low impedance without the use of a transformer: R_K equal to 1/gm

It must be mentioned that, in case (1), by making the value of R_K suitably large, and using a sufficiently high H.T. voltage, the signal amplitude which can be handled is very great indeed. This is because the input and output voltages are almost equal, the difference being very small, yet this alone represents the actual signal reaching the grid-cathode path of the valve. It is a good "rule-of-thumb" that the maximum peak-to-peak signal amplitude capable of being handled is equal to half the H.T. voltage used, provided that the output load resistance is not less than some 50 times the reciprocal of the mutual conductance of the valve used.

High Amplitude Signal Cathode-Followers

We will now consider typical uses of high-amplitude cathode-followers, handling signal inputs of some 150V. (Note that it is necessary to ensure operation within the heater-cathode voltage rating of the valve used, when building such a circuit.) Fig. 3a shows a typical circuit, with component values. The D.C. operation point must now be considered. In the circuit shown, this is quite close to cut-off, because only a small anode current can flow before a high effective bias is developed across R_K functioning in the usual way as cathode bias resistor. With this circuit as it stands, a negligibly small negative-going input signal suffices to cut the valve off, giving a negative output signal equal at the most to the grid-base of the valve. However, a positive-going input signal gives correspondingly great positive output signals. The circuit is thus selective of polarity, which simply means that it rectifies, and it may be familiar as the "infinite impedance detector". An infinite impedance detector circuit can handle very large signal amplitudes if necessary, yet causes virtually no damping on the tuned circuit from which it receives its input because it does not run into grid-current. Hence the name "infinite impedance", this referring to the *input*. The output impedance is, of course, of the usual low nature typical of the cathode-follower.

Triggering

Apart from use as an R.F. detector in radios and tuners, the infinite impedance detector circuit of Fig. 3(b) has other uses which emphasize its signal-handling capabilities more strongly. In television timebases, oscilloscope timebases, radar timebases, and a host of other pulse-circuits, it is often required to trigger off a sawtooth oscillator, or other pulse-circuit at definite times. For this, voltage "kicks" of high amplitude (some 100V or more), usually positive, are required for the synchronisation process. Very often these kicks are obtained from the mains frequency or from the sync pulses from a television video waveform. Let us suppose, for example, that they originate from the mains sine wave of 50c/s. The sine wave is first squared, by driving a pentode very hard with it (see Fig. 4), and then "differentiated" by

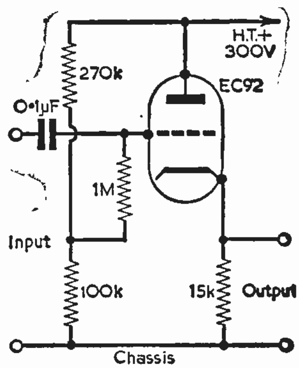


Fig. 6—A cathode-follower circuit, capable of handling peak 75V signals (positive or negative).

(Continued on page 808)

POWER for Transistors

By J. Anderson

A WORKSHOP POWER PACK OR MAINS CONVERTER FOR TRANSISTORISED EQUIPMENT

MANY constructors must at times, like the author, feel a pang of despair when looking at the many batteries and mercury cells which have been used in order to supply experimental transistor units for short periods. The unit about to be described was made to give any voltage from 0 to 12, or 0 to 20. depending on the transformer used, at up to 100mA, free from hum, and it was designed to be sufficiently flexible to be used in the workshop or used as a mains converter when a portable set was being used at home for any length of time.

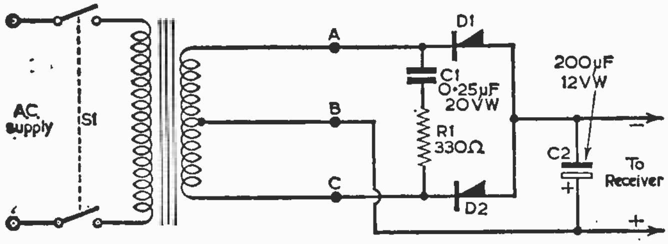


Fig. 1—This circuit is suitable for running a transistor portable receiver from the mains supply (see text).

Power Source

The power for the unit can be derived from the mains supply, or from some suitable source of power such as the relay-operating circuits in many transmitters, these giving a steady 12V at high current: alternatively, although it will limit the power of the unit somewhat, as well as its range, the unit can be supplied from the heater circuit of an existing set, providing that the circuit is able to supply the current needed.

The main component in the unit is the transformer—if a small heater transformer is all that is available, then it can be used, but this will probably limit the maximum output of the supply unit to 6·3V (or to the output of the transformer). The serious constructor may well consider it worth while to wind his own 20V-0-20V centre-tapped transformer, but in the author's case a small domestic electric bell transformer was found, giving about 24V output from the secondary with a good current rating, and, incidentally, it was inexpensive.

Rectification of the output from the transformer is accomplished by two diodes, the type used in this case being GJ-7M, although any small rectifier rated at about 30V 250mA will fulfil the purpose admirably.

Size

Owing to the low voltage of the output, miniature transistor components can be used for R1, C1 and C2. The majority of the

(Continued on page 824)

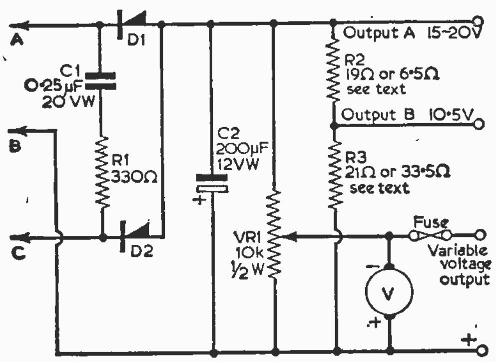


Fig. 2—A workshop supply unit with variable outputs.

COMPONENTS LIST

Resistors:
- *R1 330 Ω ½W*
- *R2 19 Ω for 20V transformer; 6·5 Ω for 12V transformer*
- *R3 21 Ω for 20V transformer; 33·5 Ω for 12V transformer*
- *VR1 10k ½W*

Capacitors:
- *C1 0·25 µF 20VW (minimum)*
- *C2 200 µF 12VW electrolytic*

Rectifiers:
- *D1 and D2 GJ-7M*

Meter:
- *V 25V FSD DC meter*

Switch:
- *S1 DPST, mains on/off switch*

Transformer:
- *Mains primary; secondary centre-tapped (20V-0-20V etc.—see text)*

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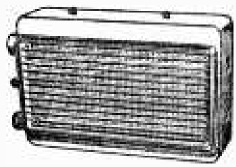

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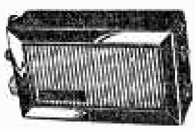

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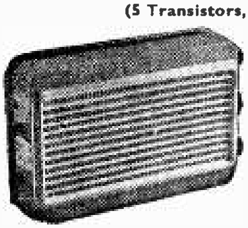

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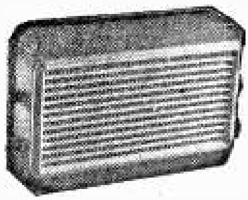

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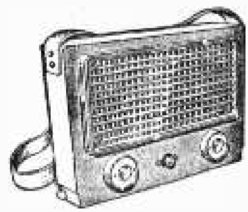

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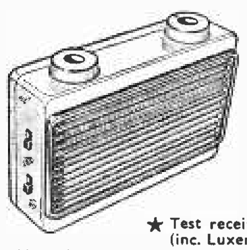

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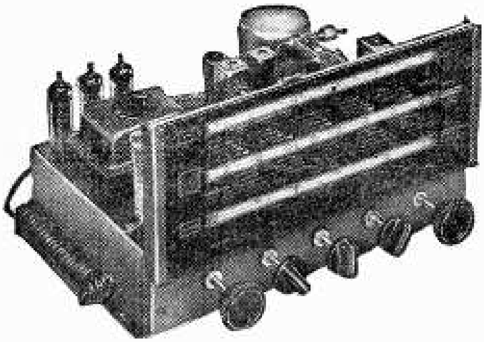

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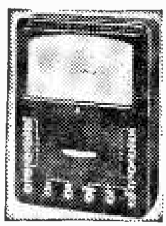

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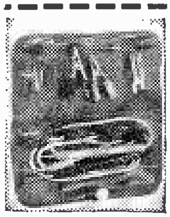

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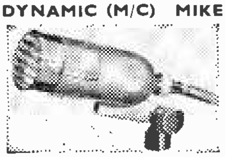

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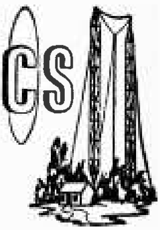


A "SENTRY" UNIT

By J. Brown

THIS small unit was primarily designed for R.F. indication. For field strength indication it is usual to have a circuit similar to Fig. 1, but this becomes more of a hindrance than a help to the enthusiast with a multiband transmitter, as coils have to be changed for each band.

The Choke Method

After various experiments, it was found that a normal 2·5μH choke of the R.F. type would suffice for all bands. This meant that a readable indication was obtainable without having to change any coils, etc., or even having to tune for the maximum reading.

The purpose of this unit is not to obtain actual measurement of R.F., only to give some indication. It was found that the choke method was sufficient for 160m to 30Mc/s; to achieve a higher reading it is only necessary to couple the unit more tightly to the source of R.F., or have a longer pick-up wire connected to the junction of RFC1/D1 (Fig. 5).

With this arrangement any changes in R.F. were made visible e.g. increase or decrease of the R.F. could be seen when any component or valve changes were made. Also the effect of the drive to the final P.A. was obvious, and exact tuning was possible when using a π output. Beam and other aerials could also be adjusted for maximum output.

A further modification of this instrument was to use a pair of headphones in place of the meter, thus making the unit a " phone monitor ". A switch arrangement was used to change from meter to audio (Fig. 3). On trial it was found the audio was very pronounced and so a carbon potentiometer was added to control the amount of rectified R.F. ti either the phones or the meter.

This was a very useful addition as faults in the modulator/speech amplifier, such as hum, etc., could be found very simply, and even effects of component changes could be heard.

This unit was found of great use when TVI (audio breakthrough) was experienced. It was found to be mains-borne, by investigation with the pick-up wire on the monitor unit (running it along the electrical system of the house). The transmitter was set up for normal use, the modulator switched on with the microphone connected and stood near a clock. The R.F. was then modulated by the ticking. When the pick-up wire of the unit was placed near the house wiring, the ticking was heard, so, obviously, the TVI was mains-borne. Chokes with their associated condensers (ceramic type) in the modulator and the P.A. mains transformer leads removed the TVI.

Another version of the unit is given in Fig. 4. This is very useful for many purposes, Parasitic oscillations can be found: these appear on the

(Continued on page 854)

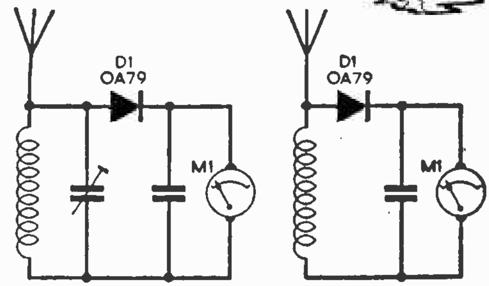
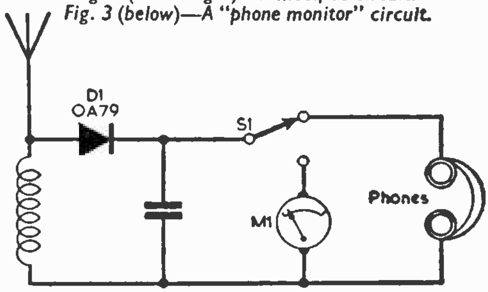


Fig. 1 (above left)—A field strength indicator circuit.
Fig. 2 (above right)—A modified circuit.
Fig. 3 (below)—A "phone monitor" circuit.



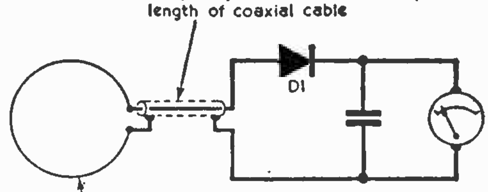
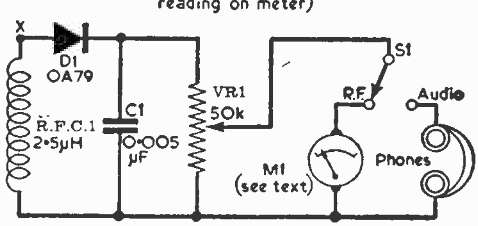


Fig. 4 (above)—Another version of the unit this is useful for picking up parasitic oscillations.
Fig. 5 (below)—The circuit of the final design.

At point "X" an 8" length of wire is enough for monitoring, otherwise use a piece of flex (sufficient to obtain a reading on meter)



Short-wave Listeners' Log

MOST interest on the short wave bands is probably in Dx (long distance) reception. For best results, it is necessary to keep in mind which bands are most likely to provide signals from various remote parts of the world, or to listen on wavelengths which have been chosen according to the time of day.

It will be found that it is almost always possible to tune in some Dx signals of interest, at nearly any hour. But if reception of very distant stations in some particular area is in view, it will usually be necessary to choose a time and band to suit.

Enthusiastic S.W. listeners who intend to receive as many countries as possible make a point of switching on to certain bands, so as to make the best use of conditions. An example is the reception of Australian stations. In the early morning, some will generally be audible, and when conditions are good, even a one- or two-valver can be sufficient to pick them up. But at other times of day reception from this area will generally be impossible.

As the list of times to be given covers 24 hours, it is worth noting that amateur band activity is usually at its highest at weekends, and some listening periods should often be possible then.

The times given are GMT, and there is easily a latitude of half an hour to an hour either way, according to conditions. But, on the whole, it will usually be most satisfactory to tune to the bands indicated, at the times given. The choice of bands is for Dx reception, not for European and other near stations.

06.00–08.30: 1·8Mc/s and 3·5Mc/s bands: North America and Canada (unusual for these bands). 7Mc/s band: North America to Pacific coast. 14Mc/s band: world wide, including Australia, New Zealand and remote Pacific Dx. 21Mc/s band: Australia, Far East, South Africa.

08.00–10.30: 14Mc/s: Pacific islands, but Australian area probably fading out. 21Mc/s: Panama area, South America, South Africa, and still possibly world wide reception.

10.00–Noon: 21/14Mc/s: Still active, with Pacific area and Far East when conditions are good. Also Africa and occasional Central and South Americas.

Noon–14.30: 14Mc/s: Relatively inactive, but North America may begin coming in towards the end of the period. 21Mc/s: North America, Canada, Greenland, and occasional South Africa and other Dx.

14.00–18.00: 14Mc/s: Near East beginning to fade out, or completely gone. Many stations from North American area beginning to come up. 21Mc/s: Occasional good reception from many parts of the world, but American stations most likely.

17.30–20.00: 14Mc/s: Good for world wide reception, but often congested with American transmissions, which make reception of more remote stations difficult. Should easily provide dozens of new countries for beginning a log. 21Mc/s band: Interesting scattered Dx sometimes, but often high noise level.

20.00–Midnight: 14Mc/s band: Central and South America, and beginning to extend into the Pacific area. 21Mc/s: similar, but often less trouble from North American interference.

Midnight–04·00: 14Mc/s: Beginning to open out for world wide reception, and giving improved reception from South America, and South Pacific area, extending out towards the New Zealand area. South America may become audible on 7Mc/s, while towards the end of this period North America may become audible on the 3·5Mc/s band.

04.00–06.30: 14Mc/s: Reception extending to include Australia and New Zealand, but world wide reception possible. 21Mc/s: Australia and Far East areas beginning to come in, and occasional long distance reception on 3·5Mc/s and even 1·8Mc/s beginning to arise.

It will be seen that for general Dx listening, the 14Mc/s and 21Mc/s bands will usually be of interest. When Dx stations are to be logged on the broadcast bands, somewhat similar results will be obtained. For example, the 19m and 17m bands are very near the 20m (14Mc/s) amateur band, and propagation is similar. The 25m band is also very useful for long distance results. The 31m and 41m bands will become very active towards nightfall, and during the hours of darkness until midnight, and the 25m band will begin to open out towards the Australian region with early morning.

All about CATHODE-FOLLOWER circuits

(Continued from page 803)

using a very small coupling condenser to the next stage. The result is a series of negative and positive kicks, alternately, one pair for each original sine wave cycle. We do not want the negative ones, and these are automatically rejected by the cathode-follower (see Fig. 5) as explained above. The positive ones appear at the cathode output with full amplitude, and can trigger the timebase, as desired. The very low output impedance of the cathode-follower effectively decouples the subsequent proceedings in the timebase from the foregoing circuitry.

If we desire to pass on both negative and positive signals through the cathode-follower, giving preference to neither, being interested solely in the high signal amplitude handling capacity and low output impedance, then we must use a D.C. operating point of the circuit which lies more positive than in Fig. 3a. The necessary modification is shown in Fig. 6. Here the grid leak of the cathode-follower is taken on to an H.T. bleeder to a point positive with respect to chassis by an amount somewhat greater than the maximum amplitude of *negative* signals with which it is desired to cope. The positive signals will then take care of themselves automatically, provided the sum of maximum positive and negative amplitudes does not exceed about half the H.T. voltage. If it does exceed this, then a higher H.T. voltage must be used, if the valve is rated to withstand it.

(To be continued)

How Transistors Work

By B. N. Rolfe

A BASIC, NON-MATHEMATICAL EXPLANATION

THERE is no reason whatsoever why a transistor circuit should cause confusion. Theoretically, a transistor is considerably less complex than a valve. Indeed, it has only three elements while even the simplest of valves—the triode—has four elements, namely, the anode, grid, cathode and heater. A transistor has no heater, but it has elements (or electrodes) which are much related to the triode valve. It has a base instead of a grid, an emitter instead of a cathode, and a collector instead of an anode. There are transistors which have four elements, rather like the four essential elements of a tetrode valve, but to date these are few and far between and need not be considered.

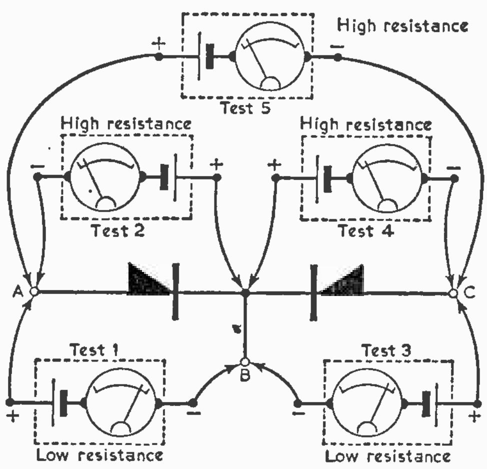


Fig. 1—How a series of ohmmeter tests indicates that a transistor contains two diodes connected in series opposition. (Test 6 is the same as Test 5, but with the ohmmeter leads transposed.)

Theory

We are left, therefore, with the semiconductor equivalent of a triode valve, so, no matter how technical the circuit, it always revolves around a simple three-element device. It is not intended in this series of articles to delve into the basic theory of transistors. The conception of positive and negative current carriers and the like is adequately dealt with in other literature, and there are many good books on the theory of semiconductors.

Two Diodes

If we had no previous knowledge of transistors and were given a three-wire device and told that it was a transistor, and we were also handed an ohmmeter and told to find out as much as possible about the transistor by making resistance checks, it would not take us very long to discover that within a transistor exist two diodes, or rectifiers. We would also eventually discover that the diodes are connected in series opposition. If we were to draw a diagram of our findings it would look like Fig. 1.

We know, of course, that an ohmmeter is nothing more than a voltmeter connected in series with a battery, and that when the two terminals are connected together the voltmeter is effectively connected across the battery. Full deflection is given on a dial scaled in "ohms" by adjusting a variable resistor labelled "set zero". Thus, when a resistor is connected across the terminals, the pointer reads something less than full-scale (because of the voltage dropped across the resistor) which is read off the "ohms" calibration as some definite value.

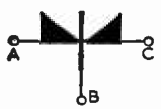
Polarity of Terminals

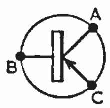
The ohmmeter terminals are polarised by the battery (positive and negative), so the ohmmeter therefore provides a source of voltage as well as resistance measurement. This is exactly what is required for examining semiconductors, which are designed to have a low resistance to current passing in the "forward" direction and a high resistance to current passing in the "reverse" direction. It should be noted, however, that the "positive", or red, terminal on some multimeters when set to "ohms" may not be connected to the positive side of the internal battery. It is as well to check this before becoming involved in resistance checks on semiconductors.

To return to Fig. 1. With the positive terminal of the ohmmeter connected to wire A and the negative terminal to wire B there is a "low resistance" reading, as shown by Test 1. This indicates that current from the ohmmeter battery is flowing through the diode in the forward direction, and this is indicated by the direction of the "arrow" on the diode (or rectifier) symbol. Current in this context is the *conventional* flow from positive to negative and *not* electron flow, which is from negative to positive.

Diodes

When the ohmmeter connections are reversed, then we obtain a high resistance reading, as shown by Test 2. This indicates that current from the ohmmeter battery is flowing through the diode in the reverse direction, where it comes up against opposition. (Of course, in a perfect diode or rectifier there would be zero resistance to current in the forward direction and infinite resistance to current in the reverse direction, but as no diode is perfect, there will always be a low, but definite resistance to forward current and a large, but not infinite, resistance to reverse current, depending on the type of semiconductor. The ratio of reverse to forward resistance can be used as a measure to assess the quality of a semiconductor—as we shall see later.)





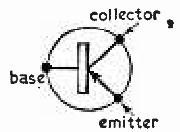


Fig. 2 (left)—Although there are two junctions in a transistor, it has one element which is common to both of them (shown at B).

Fig. 3 (centre)—The conventional transistor symbol using "A", "B" and "C", as in Figs. 1 and 2.

Fig. 4 (right)—The conventional symbol with the elements identified.

We discover the other diode section by connecting the ohmmeter between wires B and C, first to give the resistance to forward current (Test 3) and then to give the resistance to the reverse current (Test 4). We see from the forward current tests (Tests 1 and 3) that there is no need to remove the negative ohmmeter connection from wire B, and that forward resistance is given on each diode section simply by changing the ohmmeter positive from wire A to wire C. This in itself reveals that the two diodes must be connected in opposition.

Further proof of this is given, however, by Tests 5 and 6, for whichever way round the ohmmeter is connected across wires A and C there is always a high resistance, indicating that reverse current flows when the battery is connected in both polarities. This could only happen with diodes connected in opposition.

Transistor Make-up

We have so far proved that a transistor contains two diode sections, and it is unlikely whether we would find out much more about a transistor given just a transistor and an ohmmeter. It is possible to find out more with this simple instrument, but assuming that we knew nothing at all about a transistor when we started, additional information would be found more by luck than by technical ability.

Common Electrode

It is true that a transistor has two diode sections connected in opposition, but one "electrode" is common to both diodes, and the common electrode is that connected to wire B, as would be expected. We may thus redraw the circuit of Fig. 1 as shown in Fig. 2, which shows clearly the common electrode on wire B.

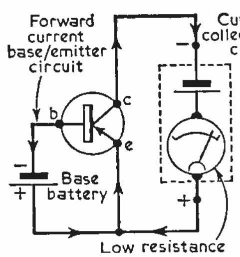
For reasons unknown to the author, the transistor symbol took on a slightly different form from that in Fig. 2, and this is shown in Fig. 3. Here the common element is at B and the two "outside" elements at A and C. One of the "outside" elements is given an arrow head simply to distinguish it from the other one. To be symbolically accurate, of course, each outside element should be given an arrow-head to conform with the build-up from the symbol in Fig. 2, but, since each "diode junction" has a different function, it is essential to be able to differentiate one from the other, and the use of a single arrow-head permits this.

Transistor Elements

We must now abandon our earlier A B C identification and instead use the correct terms for the transistor elements. We have done this in Fig. 4, which reveals that the common element is called the "base", the element with the arrow-head the "emitter" and the element without the arrow-head the "collector".

Transistor Biasing Arrangements

In practical transistor circuits, the base is biased negatively with respect to the emitter, as shown in Fig. 5. It will be seen, therefore, that the base-emitter diode junction is polarised for forward current. This means that the circuit is now equivalent to a low resistance and, as a consequence, passes a current (from the battery) of a value limited by the base-emitter junction resistance, any resistance in the external circuit and the battery voltage.



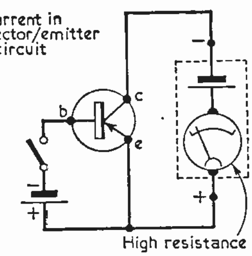


Fig. 5 (left)—The action of forward current in the base-emitter circuit gives a reduction in the apparent resistance between the collector and emitter.

Fig. 6 (right)—When the base current in Fig. 5 is switched off, the resistance between the collector and emitter increases. (This was also shown in Test 5 of Fig. 1).

Furthermore, the collector is also connected to a negative voltage with respect to the emitter. It will be recalled that our previous ohmmeter tests between the two "outside" elements (now called collector and emitter) showed that no matter which way round the voltage source was connected there was always a high resistance between them. However, owing to the *forward* current in the base-emitter circuit, the conditions between the collector and emitter are now severely modified, for instead of there being a high resistance between them, an ohmmeter connected negative to collector and positive to emitter would register a relatively low resistance, as shown in Fig. 5.

Change in Resistance

By keeping the ohmmeter connected and switching off the base-emitter forward current, the ohmmeter would change from a low to a high reading, as shown in Fig. 6. Indeed, the apparent resistance as registered on the ohmmeter would alter depending on the actual base-emitter current. Within limits, the greater the current the smaller the apparent resistance—maximum base voltage gives maximum collector current and zero base voltage gives zero collector current (or nearly so as there is always some leakage in semiconductors).

In a transistor, therefore, a change in collector current is promoted by a change in base current (or voltage, since a voltage change gives a current change in the base circuit). This is rather like a valve, where a change in control grid voltage causes a change in anode current. It is because of this similarity that the base of a transistor is sometimes likened to the grid of a triode valve and the collector to the anode. Similarly, the emitter corresponds to the cathode.

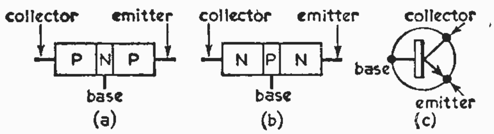
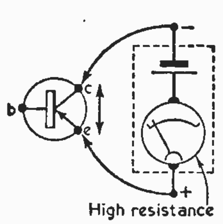


Fig. 7—The basic physical construction of (a) a pnp transistor, and (b) an npn transistor. In (c) is given the symbol for an npn transistor—the emitter arrow points in the opposite direction to the arrow in the symbol for a pnp transistor.

Basic Concept

A good book on semiconductor theory will reveal why collector current is promoted by the current in the base-emitter junction. One would learn that "holes" flowing from emitter to base diffuse through the base, and when they arrive in proximity to the collector are attracted into the collector by its negative voltage, thereby giving collector current.



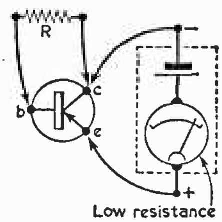


Fig. 8 (left)—Transistor leakage test.

Fig. 9 (right)—Using an ohmmeter and a resistor to check effective D.C. gain.

The term "hole" is a convenient way of expressing a positive charge as distinct from the negative charge of an electron. A "hole" is said to be produced when an atom of the semiconducting material is short of a "free" electron, and this condition is purposely arranged in *p*-type semiconducting materials. The "hole" or positive charge is then available for conduction.

This happens when the "hole" is filled by a "free" electron from an adjacent atom which, when it fills the hole, leaves another hole behind it. This hole in turn is filled by another electron from another atom, again leaving a corresponding hole, and so the process continues.

It will be understood from this brief description that the series of holes appears to be moving in a direction opposite to that of the electrons. Transistors are made of two types of semiconducting material, a material which uses holes to give a mobile positive flow called "*p*" (for positive) type, and a material which uses electrons for negative conduction called "*n*" (for negative type). Either a wafer of *n*-type material in sandwiched between two pieces of *p*-type material to make a *pnp* transistor or a wafer of *p*-type material is sandwiched between two pieces of *n*-type material to make an *npn* transistor as shown in Fig. 7.

The majority of transistors used at present in this country are of the *pnp* variety. Transistors of the *npn* variety are used in certain switching applications, though there is reason to believe that they may also be used more extensively in domestic equipment in the future, as they are already used in America.

How npn Transistors Differ in Circuit

Transistors of the *npn* type differ basically from *pnp* types by being connected to the supply voltages the other way round, with the base and collector being connected to a positive source with respect to emitter, instead of a negative source, as is required with *pnp* types.

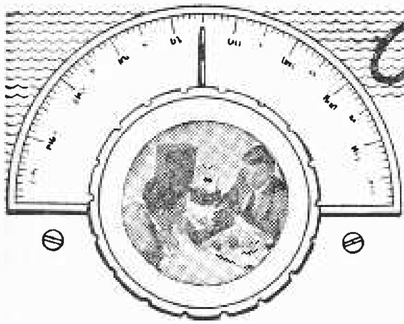
Transistors of the *npn* type are symbolised by the arrow on the emitter pointing away from the base, as shown in Fig. 7(c).

A Further Ohmmeter Test

If we reproduce Test 5 of Fig. 1 on a transistor, as shown in Fig. 8, we would again prove that a high resistance exists between collector and emitter whichever way round the meter is connected, though we may find that the resistance is slightly greater when the negative of the meter is connected to the collector than when the positive of the meter is connected to it. However, if we set the arrangement with the negative of the meter to the collector and the positive to the emitter the resistance should be very high.

Now, if we connect a resistor between the collector and base, as shown in Fig. 9, the resistance should fall to a relatively low value, provided the transistor is in good order. Indeed, this represents a very good transistor test since, in effect, the ratio of resistance change corresponds to the D.C. gain of the transistor. The resistor effectively applies a negative bias to the base with respect to the emitter and thus causes conduction to take place between the emitter and collector. For most small transistors a resistor of about 33,000Ω (33k) is suitable, but it is not desirable for this or other transistor resistance measurements to be undertaken if the ohmmeter contains a battery in excess of 1·5V. A higher voltage may result in excessive current through the diode junctions which could cause a breakdown.

(To be continued)



On Your Wavelength

BY THERMION

I MUST thank the very many readers who wrote to me recently, after I had mentioned a "well-known reverend gentleman" who was responsible for some unorthodox circuits in the very early days of radio. I am indeed most pleased to hear that he is still alive and well and is living happily in retirement in the country. Many of these readers had used the circuit which I referred to, built around two audio transformers, and substantiated the very many claims which were made at the time—mainly in regard to the response to low organ notes.

The gentleman in question is still regarded as a foremost authority on the organ and Mr. Lucas of Tachbrook tells me that letters from him still appear at intervals in various organ periodicals. What a pity that we do not still have experimenters of this calibre still with us—or is there now no need for these experimental hook-ups?

Many readers, presumably of the older school, still state that they preferred the early days because of the scope which was afforded for experimental work, and although we have recently seen the introduction of the transistor, I feel that the opinions of a large number are to be respected —there is not so much scope with this particular component, at least not in the pure radio field.

In the field of computers and similar equipment, no doubt there is a vast territory still to be explored and perhaps many will find their hobby will offer fruitful experiments along these lines.

Test Gear

What is the minimum which could be used to furnish a radio experimenter's workshop? I am tempted to ask this as I have had one or two letters asking me to make my recommendations on this question, each of the readers making some proviso regarding expense This is a very difficult thing to decide—leaving out for the moment the question of money. One might say, providing no quantitive analyses and so on are to be made, a really reliable all-purpose testmeter would be sufficient. Others would hold, however, that a bridge or a tester for capacities and resistances is a must, and no really reliable experiments could be carried out without first making certain that components being used are the correct values.

In this connection one reader tells me that he uses a home-made neon tester and a £75 tester (the property of his employer). When he first started testing components he dug out 42 condensers from his spares box and only three were fit to use! He says he had also found that the colour code on resistors appears to be what he calls "a practical joke".

He instances a case where he bought six 47k components (with a silver band) which. when bridged, measured between 62k and 80k. He says he has lost all faith in colour codes. I do not feel that this is general and it is certainly not my experience, and I do test all such items before I make up experimental lay-outs. But I do agree that if you want to be sure of success when making experimental equipment, it is best to make sure that every item is sound and its value is as marked, before using it. In this way, you save disappointment and limit the amount of checking which has to be done if the item fails to function as specified or as one desires.

Peculiar Faults

I have before mentioned some of the weird faults which are experienced from time-to-time in both radio and television equipment, but I was very interested to hear the other day of a new one—experienced in a service laboratory by a skilled engineer. He was actually servicing a television receiver at the time and noted that he was repeatedly feeling the effects of a mild electric shock, although not using any screwdriver etc., at the time. When he approached the C.R. tube the usual symptoms of entering a strong electrostatic field were noted, and although he kept his hands in his pockets the trouble still persisted. I had heard previously where a bunch of keys in a pocket had been sufficient to pick up a stray field and in this case a very similar arrangement was responsible for the symptoms which were experienced. The engineer was wearing a tie which had a metallic thread running through it as part of the pattern and when he leant towards the set, these threads became charged and produced the effects which he had noticed. Had he been wearing rubber soled shoes no doubt nothing would have been noted, but in this particular case the usual unforeseen chain of circumstances came into play. He was not wearing rubber soles, and the lino in the workshop had been taken up for replacement; as a friend said, when told of the occurrence, with radio "You never can tell"! I should be glad to hear of similar unexplained or unexplainable instances.

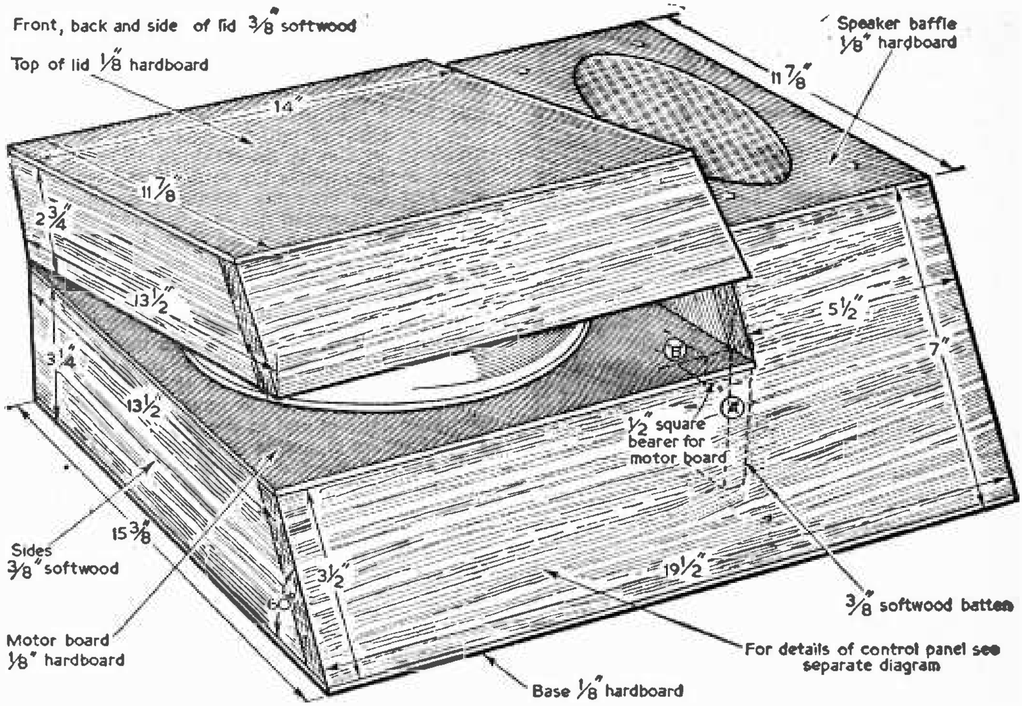


Fig. 20—General dimensions of the cabinet.

A cabinet for the CITIZEN

(Continued from page 720 of the December issue)

THE two sections of the "Citizen"—the I.F. amplifier and the oscillator—when correctly connected, form a superhet tuner which may be used with any suitable amplifier as a superhet receiver. Such an amplifier is the "Mini-Amp", a unit constructed on the same lines as the two "Citizen" units, and described in the November issue of P.W. [Details for connecting the three units will be given next month.—Ed.]

When the constructor has all three units built, one thing further remains to be done before he may congratulate himself on his success with this new receiver. A cabinet must be built to house the "Citizen", the amplifier, loudspeaker, the batteries and all the other various switches and controls.

Some readers may be individualists and will therefore want to make a cabinet to suit their own tastes and requirements. But for those to whom originality in design comes with difficulty, we recommend them to follow the instructions given in this article, which will result in each becoming the proud possessor of a cabinet, which although simple in construction is, we consider, modern in appearance.

The reader will note that our design incorporates a record deck, which is connected to the audio amplifier section of the receiver. This feature alters the title of the complete set from "radio" to "portable radiogram", which is an instrument not met with very often, even on the commercial market.

Construction

Most of the material to be used in the construction of the cabinet is ⅜in. thick softwood; which is readily obtainable from any wood merchant. It is sold in standard widths, but as there is no piece of exactly the same dimensions as any other, there is little point in demanding wood of any particular width. Indeed it will be

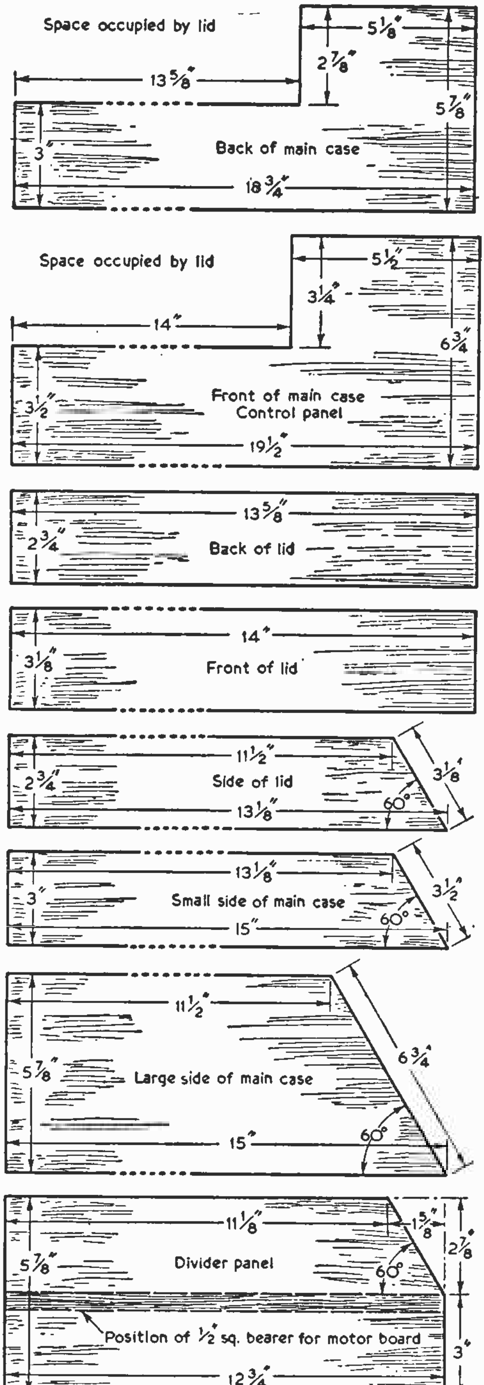


Fig. 21—Dimensions of the softwood sections of the cabinet. (Note: the lid requires only three sides—see Fig. 20.)

found less troublesome and less expensive to ask for off-cuts of softwood.

Fig. 20 is fairly self-explanatory so far as the dimensions of the parts are concerned. The control panel will have to be cut from a piece 19½in. x 6¾in. It will be seen from the diagram that part of this is cut away to allow the motor board to drop below the level of the loudspeaker, and that this cut-away portion measures 14in. x 3¼in. This part need not be discarded as waste, as it only needs an ⅛in. to be planed off for it to be used as the front portion of the lid. (The ⅛in. is the allowance required by the thickness of the motor board.) When cutting the back—which has similar, but not identical dimensions to the control panel—the cut-away portion may be used for the back of the lid in a similar fashion to that used when making the front of the lid.

Fig. 20 only gives general dimensions of the complete cabinet and so the reader should refer to Fig. 21 where diagrams of all the individual pieces of softwood needed are given with their exact measurements. It must be noted, that the upper and lower edges of the control panel and the front part of the lid, have to be planed to an angle of 60° to the vertical to allow for the slope of the front panel.

The "divider", which is shown in detail in Fig. 21, separates the section of the cabinet which contains the loudspeaker from the record-deck section, and it also gives added strength to the whole construction as it will, at a later stage, be joined to the back, front and base of the cabinet. The divider is shown in Fig. 20 by dotted lines. and is labelled 'A' and referred to as "⅜in. softwood batten". To this divider, a batten of ½in. square wood is glued to support the motor board ('B' in Fig. 20; this runs the complete length of 'A' in the position shown. It will be seen from the diagram, that 'A' is not sawn to follow the slope of the control panel: this is to allow room for the component group-board which will eventually be positioned there (see Fig. 22).

The motor board is a rectangular piece of ⅛in. hardboard, 14in. x 13½in. A hole will have to be cut to suit the motor and speed control of the record deck. A smaller hole will also have to be drilled to take the support of the pick-up (Fig. 23).

The loudspeaker baffle is also of ⅛in. hardboard and measures 11⅞in. x 5½in., and has an aperture cut to suit the loudspeaker (we suggest that for best performance with consideration to the design of the cabinet, an elliptical speaker is to be preferred). Expanded aluminium may be used to cover the aperture, and a convenient method of mounting the loudspeaker, is to sandwich the aluminium between the baffle and speaker when bolting the latter piece of equipment to the hardboard. It is also advisable to insert a strip of foam rubber or similar substance between the loudspeaker and the aluminium and to tighten the nuts and bolts holding it as far as possible. This will prevent cabinet vibration and acoustic feedback from becoming annoying. The reader will appreciate, from inspection of Fig. 23, that the motor board and loudspeaker baffle may be conveniently cut from one piece, of hardboard.

The top of the lid and the base are cut from the same thickness of hardboard as the preceding two parts, and measure 14in. x 11⅞in. and 19½in. x 15⅛in. respectively.

All parts of the cabinet should now be planed and sandpapered so that, when they are assembled and held with a few panel pins, they meet one another without any overlapping.

The sides, front and back of the cabinet may at this point, be finally assembled. A satisfactory way of joining the parts, is to glue them with one of the modern contact adhesives now on the market. A few panel pins may be used as well to give added strength, if the constructor thinks it necessary. The divider may now be "dropped" into position between the control panel and the back and glued there.

The lid is assembled in a similar fashion to the main cabinet, but it is at this point that the question of hinging the lid must be dealt with. A "hidden" hinge is the obvious solution, but if the constructor considers this beyond his ability, a hinge, simply screwed on to the back of the cabinet and the back of the lid, will not necessarily spoil the appearance of the finished case, being to the rear of the instrument.

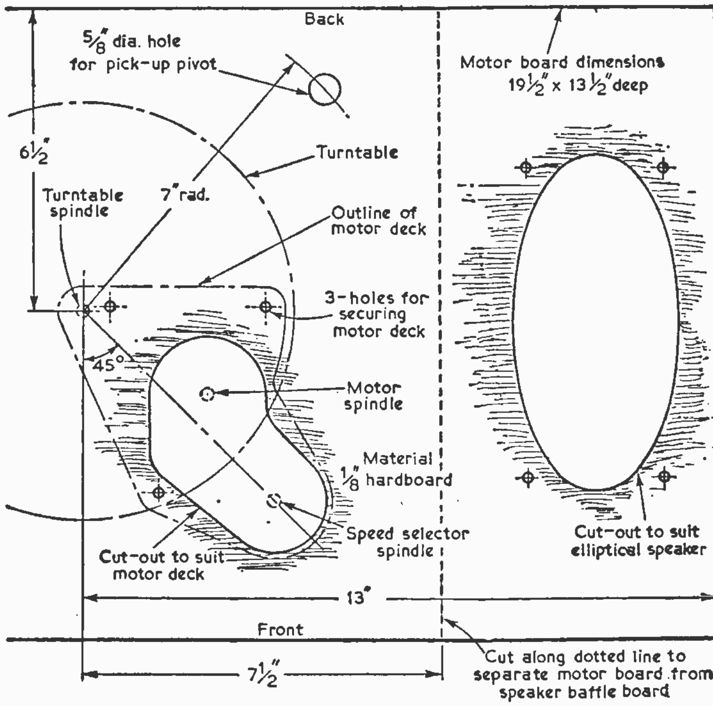


Fig. 23—Dimensions of the motor board and its cut-outs.

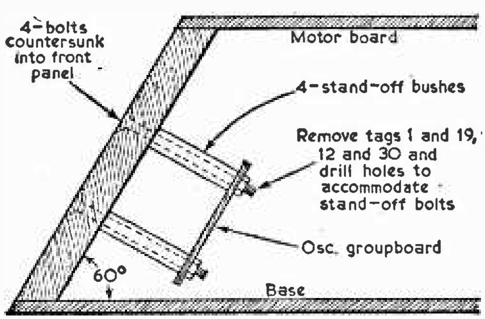


Fig. 22—The method of mounting the oscillator group board on the front panel of the cabinet.

Three wood screws secure the motor unit to the motor board and the pick-up is held by a nut which is supplied with it, to suit the thread on the supporting column. The "arm rest', which is also supplied with the pick-up, is fixed to the motor board in any convenient position. It is not necessary, at this juncture, to place the turntable on its spindle, and as it is easier to handle the motor board without it, it is best secured at a later stage. The motor board should now be glued in position.

The speaker baffle, with the loudspeaker and the grille already in place, is now pinned and glued to the cabinet.

The lid should be fitted at this stage so that it will protect the motor and pick-up when the whole cabinet is turned over when wiring begins.

(To be continued)

MATERIALS REQUIRED

Approximately 7ft. of softwood, 7in. wide (or an equivalent length in off-cuts).
Four pieces of $\frac{1}{8}$ in. hardboard :— $19\frac{1}{2}$ in. x $15\frac{3}{8}$ in., 14 in. x $13\frac{1}{2}$ in., 14 in. x $11\frac{7}{8}$ in. and $11\frac{7}{8}$ in. x $5\frac{1}{2}$ in.
EMI 985 record player deck (battery operated version) and pick-up to match.
Elliptical Loudspeaker
PP9 batteries.
Control knobs, hinges, loudspeaker grille, etc.

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Improving the All-band TRF

ADDING AN R.F. STAGE

By J. L. Wain

(Continued from page 715 of the December issue)

INSTRUCTIONS on mounting C8 to the front panel concluded the article last month. The band-spread condenser (C8) is fitted with a slow-motion drive and, for appearance sake, the pointer is placed behind the panel and viewed through an aperture. A piece of ⅛in. Perspex is used to cover the aperture in the front panel. This was marked out with a scriber and compasses and cut out with the aid of a coping saw, but a fret saw will probably do the job just as well. The edges can be bevelled with a file and draw-filed, then finished with fine emery paper, to give a professional effect.

Another piece of aluminium 7½in. x 6in. was next cut to shape and fitted behind the aperture so that a suitable dial could be affixed. A short length of heavy gauge wire is painted red to act as a pointer. It should be suitably bent so it can be fixed to the slow-motion drive, and have a clearance of about $\frac{1}{16}$in. from the front panel.

COMPONENTS LIST

Resistors (½W, 10%)

R1	22k	R2	2·2M
R3	470k	R4	100Ω
R5, R6	100k	R7	22k
R8, R9	47k	R10	270k
R11	270Ω	R12	3·3k

VR1 100k pot.—R.F. gain
VR2 50k pot.—Reaction.
VR3 500k pot.—Volume
VR4 25k pot.—Top cut

Condensers:

C1 50pF variable condenser (with isolated spindle if an aluminium panel is being used)
C2 300pF variable condenser
C3, C4, C5 0·1 μF
C7 100pF
C8 10pF
C6 50pF
C9 500pF
C10, C13 0·01 μF
C11 16μF 350VW
C12 8μF 350VW
C14, C15 25μF, 25VW
C16 2000pF
C17 0·05μF
C18 0·1μF
C19 16μF 350VW
C20 8μF 350VW
C21 0·1μF 350VW

LF smoothing choke

Output transformer to suit loudspeaker

Mains transformer 5V 2A, 6·3V 2A, 250V 60mA

S1A, S1B 2-pole, 5-way wave-change switch

S2 3-pole, 4-way wave-change switch

S3 S.P.S.T. switch (mains off-on)

S4, S5 S.P.S.T. switches

Valves EF39, 6J7, 6S5, 6V6, 5Z4

Coils

The detector coil switching is straightforward (see Fig. 1). Three short-wave coils were used and one medium.

The detector coils are wound on 1¼in. formers and are as follows: for 18m to 30m, 11 turns of 22s.w.g. enamelled copper wire occupying 1½in. with the cathode tap half a turn from the earthed end, and six turns for the primary.

The 30m to 60m coil is wound with 20 turns of 22s.w.g. wire occupying 1½in. with the tapping three-quarters of a turn from earthed end and with 16 turns for the primary.

For 60m to 100m, 35 turns of 24s.w.g. are used, with the tap 1½ turns from the earthed end, and with 20 turns for the primary.

The medium wave coil is wound with 93 turns of 32s.w.g. wire with the tap three turns from the earthed end and with 50 turns for the primary.

The primaries of all the coils can be wound with 26-30s.w.g. wire, and about ¼in. should be left between this winding and the earthed end of the tuned section.

The short-wave aerial coils are wound on ½in. formers with dust cores: for 18m to 30m, 20 turns of 24s.w.g.; 30m to 60m, 30 turns of 26s.w.g.; 60m to 100m, 50 turns of 26s.w.g.

The medium wave aerial coil was made from a small I.F. transformer.

Finishing the Set

The front panel was given a black crackle finish and transfers were used to put the necessary wording under each control. Ordinary clear Perspex protractors, with a piece of white paper behind them were used as dials, for the band-set and aerial coil tuning. The completed receiver was installed in an aluminium case with power pack, L.S. and amplifier sockets mounted at the side. If desired, there is ample room to instal a small speaker at the side of the receiver.

To operate the set, turn the aerial switch to R3 position, and advance the reaction control so that the set is just on the point of oscillation. Tuning is carried out by the 15pF condenser and the 100pF bandset condenser can be moved ten degrees at a time, breaking each waveband into smaller wavebands, which are covered with the 10pF condenser. ■

RECORDING LEVEL INDICATORS

MONITORING MODULATION DEPTH

By J. Smith

THE most well-known type of recording level indicator is the "magic eye" which makes use of a cathode ray tuning indicator. The magic eye will close or open with an increase of grid voltage; some of the modern types open with an increase in voltage whilst others, of the older variety, close. Amongst those most often used are the 6E5, 6U5/6G5, EM34 and the more recently developed EM80, EM81, UM80 and the DM70. The latter has a 1·4V filament and lends itself to use in battery-operated recorders.

In the magic eye system, two types of circuit are probably the most common. Fig. 1 shows the circuit where the grid of the magic eye is connected to an audio connection in the recorder. The circuit of Fig. 2 is generally found connected to the recording output valve; the diode (OA80) is to remove the H.F. bias supply and give a slight delay to the magic eye shadow. The audio passes to the grid of the eye and the effect of the audio (without the bias) is seen on the magic eye. The values given are to be taken as approximate — they depend on the type of circuits used in the recorder. The diode used should have a high reverse resistance. It should also be noted that the fluctuations in modulation shown with the circuit of Fig. 2 will not be so obvious as with the circuit of Fig. 1. The valve shown is the 6E5 or equivalent; other valves will work excellently, but the EM34 would require more components than the 6E5 since it is a "clover leaf" type having more segments to the indication.

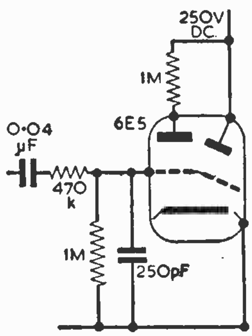


Fig. 1—In this circuit, the grid of the magic eye is connected to an audio connection in the recorder.

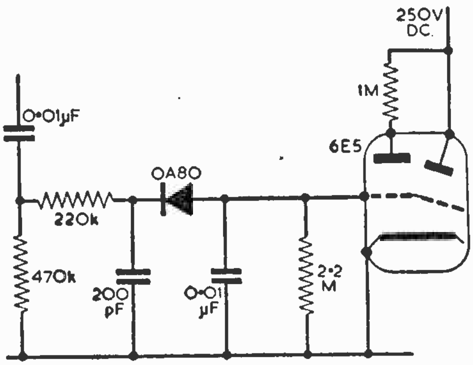
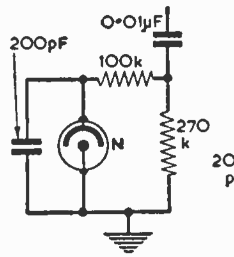


Fig. 2—This circuit is usually connected to the recording output.



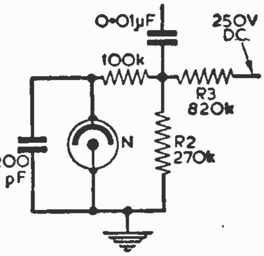


Fig. 3—A simple indicator circuit using a neon.
Fig. 4—A neon indicator circuit with bias.

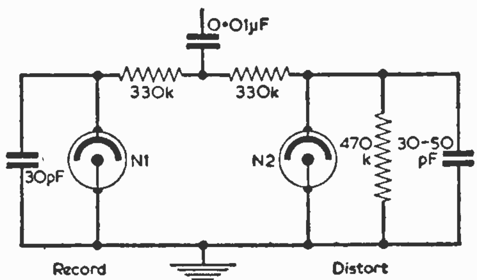
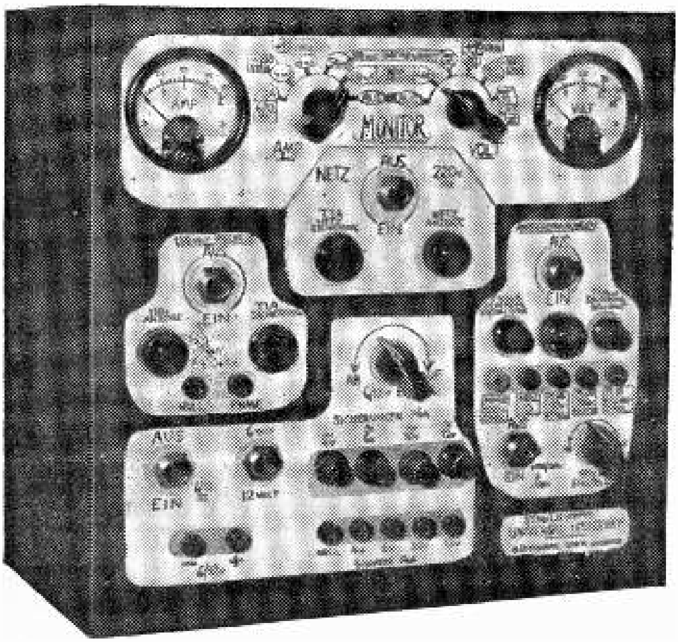


Fig. 5—A circuit using two neons; one for record and one for over-record.

Another type of level indicator uses neons. Here, a simple neon is connected in the circuit and flashes according to the audio level. Fig. 3 shows a simple circuit. This is connected to the audio valve feeding the recording head and the neon chosen has a much lower extinction voltage than firing voltage. If the audio is not sufficient to ignite the neon, bias can be introduced by a D.C. voltage (see Fig. 4). Another version uses two neons, one for record and one for "over-record". Sometimes, these are known as "Record" and "Distort" neons, one neon lighting on peaks corresponding to correct modulation level and the other lighting on levels which would result in over-recording. In Fig. 5, N1 is the "record neon", which flashes only on peaks, and N2 is the "over-record" or "distort" neon. In this circuit, N2 requires a much higher audio voltage than N1 before it flashes. ■

Experimenter's POWER-P

By M. L. Michaelis



The author's unit

A UNIT FOR THE ADVANCED C(
CONSTRUCTION IS TO BE DESCI
OF THE THEORETICAL DEVELOP

THIS design uses, as a starting point, the excellent stabilised power supply described in the August 1961 issue by J. W. Adams.

Modifications and Additions to Basic Circuit

The stabilised H.T. power supply in the August 1961 issue contains all the essentials for an effective and efficient unit, but no more than that. In a more advanced unit, which is the subject of this article, the following points should receive consideration:—

(a) The power supply will be used for experimental work, to feed power to "breadboard" circuits under test. Under such circumstances short-circuits can often occur, and some measure of protection against these is desirable.

Upon shorting the output of Mr Adams's circuit, several hundred milliamperes were found to flow, which could rapidly damage the valves. Fuses in the output would give some measure of protection, but the difference between rated current and immediate fusing current is too great, so that a fuse does not give sufficient protection against partial short-circuits. Apart from this, there is the trouble and expense of repeatedly renewing blown fuses.

The author's aim in the present circuit was to make the unit electronically self-limiting, so that the short-circuit output current is little more than the maximum rated current, and thus shorting the output terminals for even considerable periods can do no damage. This aim has been achieved.

(b) The present circuit has been devised for using only a single series valve, an EL34, instead of two 6L6 valves in parallel. The valve rectifier has been replaced by small flat metal rectifiers. These measures reduce heating and save considerable space, so that the new circuit items could be added, and their heat-dissipation tolerated, without undue increase in size of the whole apparatus.

(c) The circuit has been trimmed to give adequate voltage and current output for all normal purposes, yet use a normal 350-0-350V H.T. winding on the transformer, which is easily obtainable.

(d) A stabilised negative grid-bias output of approximately 100V has been added.

(e) A separate extra H.T. output of approximately 300V at 50mA has also been added. This is not stabilised, and serves to feed all parts of apparatus not requiring stabilised H.T. The stabilised output is therefore fully decoupled from other parts of the circuit, and is not loaded higher than is really necessary. This makes the whole power supply even more versatile for the experimental workshop.

(f) Not only have A.C. 6·3V heaters been catered for, but A.C. outputs of a number of other common heater voltages are provided. Also a smoothed D.C. heater output is supplied.

Modified Stabilised H.T. Supply

The circuit of Fig. 1 was connected up experimentally. The two 6L6 valves of Mr. Adams have been replaced by a single EL34, and his EF80 is replaced by one half of an ECC83, the other half of which is to be used later for the short-circuit limiting function. In this circuit, the stabilisation is good up to 75mA to 100mA at all output voltages from 150 to 300. The internal impedance of 1150Ω, which the transformer, rectifier and smoothing alone had, has been reduced to about 50Ω, representing a stabilisation factor of about 23 (ratio of internal impedance of power supply before stabilisation to that after stabilisation). This is adequate for the normal experimenter.

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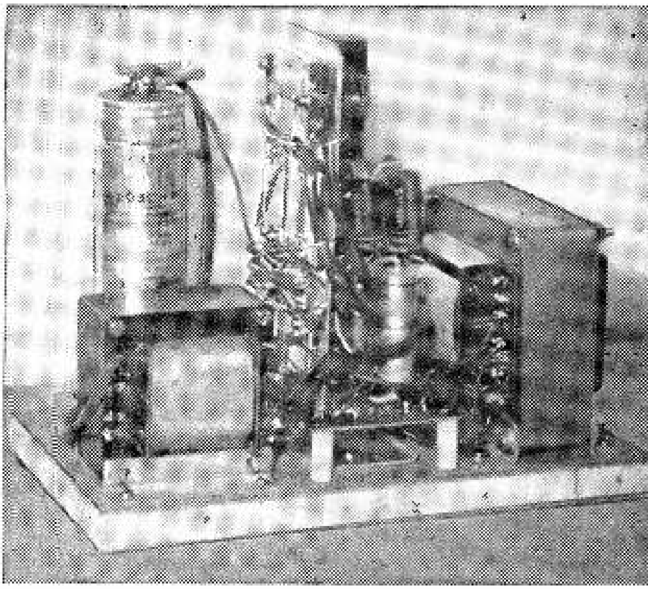

The baseboard construction employed in the unit

The short-circuit current was found to be dangerously excessive.

Attempt to add Short-Circuit Current Limiter

In Fig. 2 is shown the first and simple attempt made to give the circuit self-limiting properties for short-circuits. This attempt failed, for reasons shortly to be explained. Nevertheless, the theoretical idea was as follows:—

The cathode of the left-hand half of the ECC83 is 7V positive relative to chassis due to the zener diode, ZD, and the grid is returned to earth (chassis). This suffices to cut off this half of the valve, and it does not affect the circuit at all, until the output current has risen sufficiently to give a voltage drop across R1 sufficient to cut on the left-hand part of the ECC83. Anode current then flows through R2 as well, to give extra bias to the EL34, to limit the excessive output current.

Now this circuit functioned partially, in that the current into partially shorted output loads was not as great as previously, but it completely failed to reduce the full-short-circuit current at all. The reason for this is now obvious. When the output is completely shorted, the EL34 cathode is shorted to chassis, so that the ECC83 has no H.T. voltage, and thus cannot perform. In order to provide bias for the EL34 when the output is shorted, the left-hand anode of the ECC83 will necessarily have to go negative to chassis, and this it can do only if the cathode is made still more negative. Thus the short-circuit limiter circuit requires a supply of about 100V negative, and this had to be added. The extra expense of doing this was negligible, because this negative 100V supply was intended anyway as an additional output.

Final, Effective, Short-Circuit Limiter

The resulting circuit, after final adjustment of circuit values to their optimum, is shown in Fig. 3.

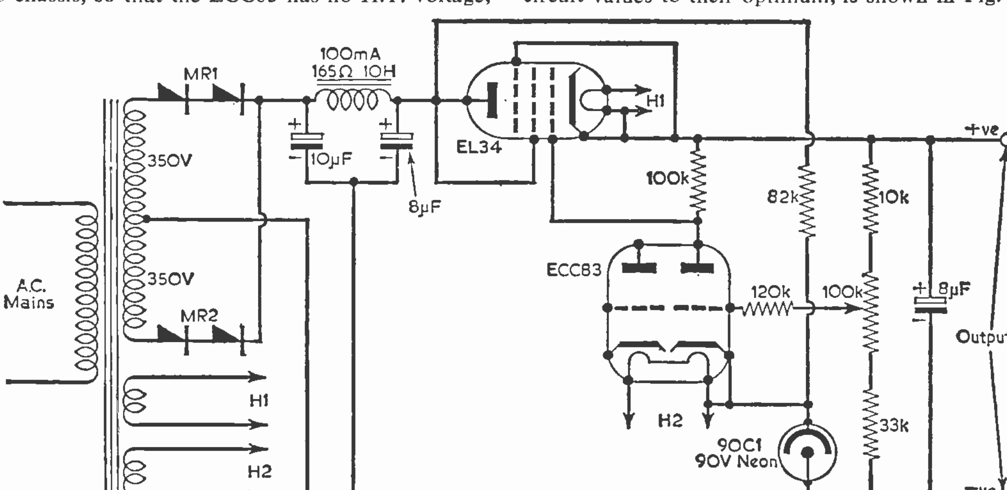

Fig. 1—The basic stabilising circuit without any form of current limiting device.

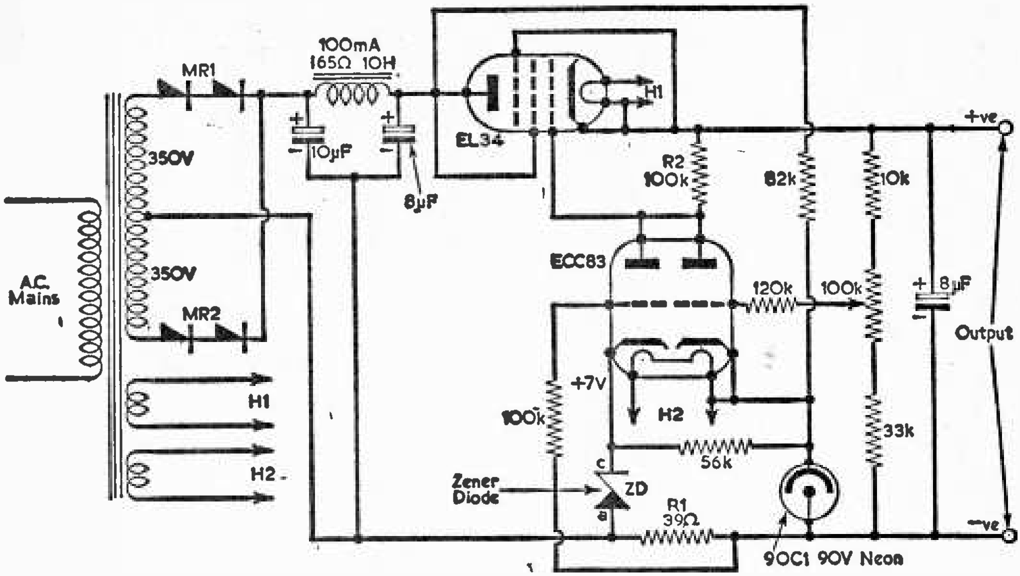

Fig. 2—The basic circuit with the addition of a current limiting device (which proved unsuccessful—see text).

The performance of this circuit is shown in Fig. 4, and is very pleasing indeed. Within the rated output current range for all voltages from 150 to 300 the stabilisation is good, representing an internal impedance of about 40Ω. As soon as the rated current of 100mA is exceeded, the internal impedance rises to 12,500Ω, and limits the short-circuit current to a mere 120mA under all circumstances, which is still within the peak rating of all components.

The two neons N2 and N3 supply two voltages negative to chassis, of about 90 and 108 volts respectively. The smaller is fed to the cathode and the larger to the grid of the limiter-half of the ECC83, thus normally cutting it off.

The output current flows through R1, causing a voltage drop across it which raises the grid voltage of the limiter-half of the ECC83. The value of R1 is so chosen that at about 100mA output current the limiter valve just reaches cut-on.

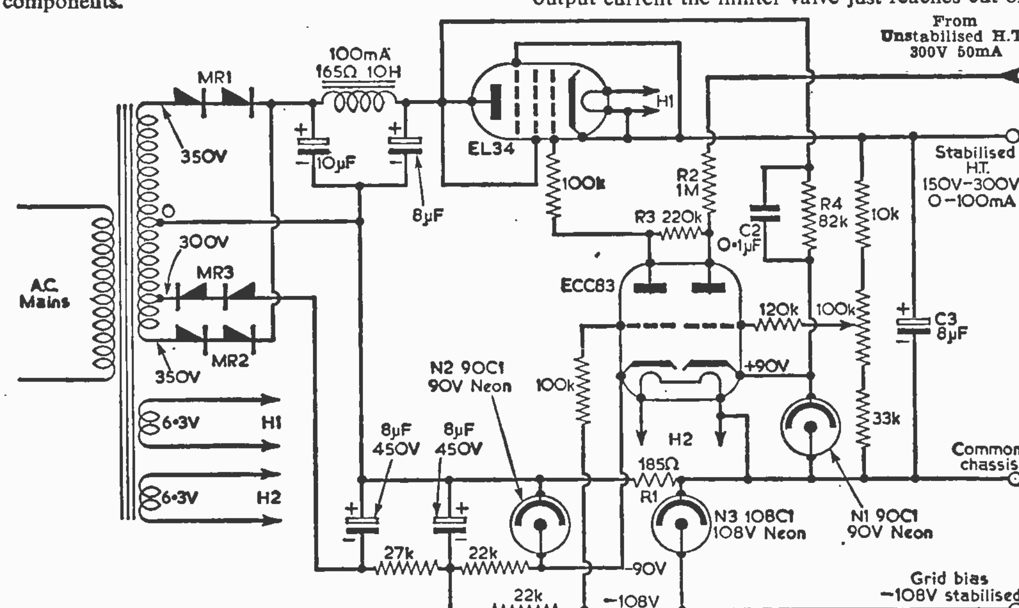

Fig. 3—The advanced stabilising circuit with the addition of an effective current limiting circuit.

At 120mA output current, the limiter valve anode current has risen sufficiently to drive the anode about 14V negative to chassis, which is the bias required to limit the EL34 to 120mA. This represents the short-circuit current, which can never be exceeded.

The very large value for R2 was found to be essential for two reasons. Firstly, the voltage at the anode of the limiter triode section in the limiting condition is very low and thus only small anode current can flow. But this small anode current must cause a drop across R2 right from plus 350V down to minus 14V. Thus, R2 must be very large. Secondly, for the lower output voltages, the right-hand anode of the ECC83 must go down below such output voltages, and this is required to be achieved for small anode current, so that the right-hand grid of the ECC83 may still be sufficiently negative to prevent grid current, which would otherwise disturb the voltage-comparison, and thus destroy the voltage-regulation at the lower voltages. Again, the requirement is that R2 be large. The value of 1M, shown in Fig. 3, was found to be optimum.

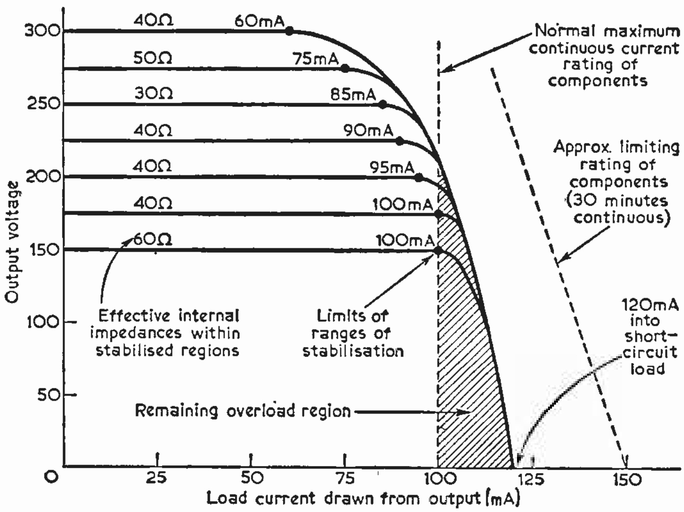

Fig. 4—Performance graph of the circuit of Fig. 3 with R1 having a value of 185 Ω. (When R1 was made 150 Ω, merely the overload region was increased, so that the short circuit current was 147mA; when R1 was made 200 Ω, the overload region was entirely removed, and the short circuit current was only 110mA, or less. However, cut-off then encroaches on the available stabilised region. It may thus be seen that R1 is critical and that 185 Ω is the optimum value.)
The 50c/s ripple of the output was 0·25% r.m.s. approximately, regardless of the voltage or loading.

Independent Supply

It is seen that the already mentioned further output, the unstabilised 300V H.T. output, has been used to feed the ECC83 as well. This ensures that the ECC83 always has a high and independent H.T. supply, even when the stabilised H.T. output is low; thus the ECC83 can always amplify well, which very considerably improved the stabilisation of the lower stabilised output voltages.

A separate small mains transformer is used in the final circuit, to be given next month, and contributes to the high decoupling, so that really sensitive apparatus may be fed from the two supplies simultaneously without interference. The assortment of heater windings present on the two transformers enables the provision of the already mentioned generous range of heater voltages to be made.

Some slight tendency to indefinite instability was present until R3 was inserted. There remained a definite oscillation at 10kc/s over certain ranges of output current, and this was traced with the oscilloscope, and found to be a sawtooth of small amplitude between R4, the neon, N1, and the stray capacities. It was found that C2 shunted across R4 removed all inclination for such oscillation. It was not found necessary to shunt such condensers across the feed resistors of the other neons, but in the final circuit to be described in the second part of this article, they will be included for safety.

Measurement of Characteristics of Final Circuit

Fig. 4 shows the static D.C. performance of the final circuit graphically. There are, however, other features apart from the static D.C. performance, which are of vital importance in deciding the ultimate value of a power supply. The chief of these is the dynamic internal impedance, which determines the r.m.s. output voltage ripple caused when fluctuating (A.C.) current is drawn, e.g. the anode current of a valve heavily driven with a sine wave at the grid. This just mentioned example provides the simplest way of measuring this dynamic internal impedance of a power supply, as shown in Fig. 5. R5 is chosen to be approximately equal to the expected dynamic impedance, R. The 6V6 valve is fed with a sine wave from a signal generator, of amplitude within the undistorted range of amplification. Via a suitable condenser, an oscilloscope is connected first between A and chassis, then between B and chassis, and the ratio of the heights of the two waveforms is observed. The ratio A divided by B is clearly equal to the ratio (R plus R5) divided by R, so that the dynamic internal impedance of the power supply, R, is easily calculated to be

$$\text{R5 divided by } \frac{A}{B} - 1 \text{ ohms.}$$

The dynamic impedance is not necessarily equal to the static D.C. internal impedance, since the power supply contains not only resistors but also condensers and inductances, which make the A.C. behaviour in general different from the D.C. behaviour. Too large a value for **C3** in Fig. 3

can give the voltage-stabilisation too large a time-constant, so that in fact the low-frequency performance may suffer. On the other hand, too small a value of C3 will block even the higher frequencies inadequately. Thus there is a definite optimum value for C3, which one may consider that one has reached when the low-frequency dynamic impedance is equal approximately to the static D.C. internal impedance, and when this dynamic impedance falls steadily, without a maximum at any frequency, as the frequency is increased. The value shown for C3, 8μF, was found to be optimum with the components used. If there is a maximum in the dynamic impedance at a certain frequency, due to incorrect choice of C3, then it is under certain circumstances possible

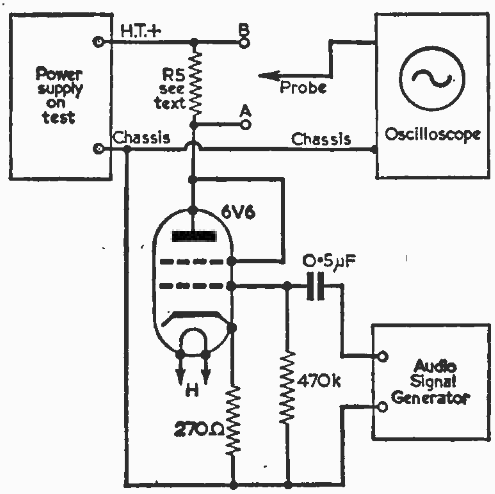

Fig. 5—Method of measuring dynamic internal impedance.

that instability could be caused at that frequency. This instability could manifest itself merely as undue distortion of waves containing that frequency, in an amplifier fed from the power supply, which could prove very puzzling if one were not aware of this point.

Variation of conditions

The circuit of Fig. 3 was found to have the same value of about 40Ω, for the dynamic internal impedance, as was found for the D.C. static internal impedance, for all frequencies up to about 1kc/s, and for all frequencies above 2kc/s it was well under 20Ω.

It is the dynamic internal impedance which is finally decisive for the degree of non-interference of various items of apparatus fed simultaneously from the power supply. It represents the remaining common coupling resistance between the various circuits fed. Thus it is desirable that it be made as small as possible.

The static D.C. internal impedance is simply given at all times for any range of output current as voltage fall over the range (volts) divided by length of the range (mA), multiplied by a thousand. The result is in ohms.

A further characteristic of importance is the extent of stabilisation against mains voltage fluctuation. With the circuit of Fig. 3 it was found that 25% fluctuation of mains voltage, even rapidly, or very slowly, produced no output fluctuations exceeding about 2%, for any set output voltage or current within the rated ranges. There is thus a stabilisation factor of 25 divided by 2, i.e. about 12, present with respect to mains voltage fluctuation. For smaller mains voltage fluctuations, the output fluctuations were even smaller. A 10% mains voltage fluctuation produced only ⅓% output fluctuation in most cases, representing a stabilisation factor of 30.

Ripple

A final important characteristic is the remaining mains ripple. It is not possible to make measurements here on a breadboard lash-up, as hum is there introduced on to the grids of the ECC83 regulator valve, which could well be less in a final layout. But, as a matter of interest, the r.m.s. ripple in the experimental circuit was found to be 0·25% at all output voltages and currents. This is easily measured with a calibrated oscilloscope connected in parallel with the output terminals.

(To be continued)

POWER FOR TRANSISTORS

(Continued from page 804)

components, therefore, are small, and, as the unit will not have to handle any excessive current, it may be fitted into a small box without much fear of overheating. In the original, the unit was housed in a small metal box obtained from a tobacconist (it was originally a lighter fuel tube container which was not only small but had sufficient strength to withstand the average workshop accident, and would fit into the battery space in most portable receivers with little trouble). The container should be metal, otherwise if it were placed in a receiver, the hum from the transformer would be collected by the receiver and appear in the A.F. output. If it is wished to make an existing transistor portable receiver into a mains-operated set, then the circuit shown in Fig. 1 is advisable, but if the unit is to be used for experimental purposes, then the circuit of Fig. 2 is advisable, and a voltmeter can be connected into it, as well as a milliammeter if desired, either in the case or by means of wander-plug sockets.

The output of the unit can be derived through a potential divider network, as shown, or through a suitable variable resistance, but it is advisable to connect either a current-operated fuse or a meter overload-trip into the unit so that only the current needed and no more can be drawn, in order to protect the transistors.

The output allows for permanent sockets for 1·5V and 10·5V, as these are needed by several of the currently popular transistor testers.

It is most important that the output voltage of the unit should be adjusted to suit the transistor set with which it is to be used. It would be as well to monitor the output voltage on load with a suitable meter.

FAULTS IN VHF/F.M. RECEIVERS 3—The Final Stages

By G. J. King

(Continued from page 729 of the December issue)

IN last month's instalment we considered the I.F. stages. We now come to the final stages of the combined A.M./F.M. receiver, namely the detector, A.F. amplifier, output and rectifier. These stages are given in the circuit in Fig. 9. Valve V4 (EABC80) is a multi-electrode device developed specially for combined A.M./F.M. receivers. As in the circuit, it is usually employed as A.M. detector AGC ratio detector for F.M. and A.F. amplifier for both services.

The EL84, V5, is a high-slope output valve, the EZ80, V7, is the H.T. rectifier and the EM34, V6, is the magic-eye tuning indicator.

Two I.F. Transformers

The second I.F. transformer (IFT2) is a composite component which carries both the ratio detector windings for F.M. and the ordinary A.M. windings for feeding the diode detector. When the set is switched to A.M. the ratio detector primary (L27) offers a low impedance to the A.M. I.F. signals which are thus developed across the primary of the A.M. I.F. transformer (L25) and induced into the secondary (L26). The A.M. I.F. signals thus arrive at the A.M. detector diode, which is on pin 6 of V4.

The A.M. detector load is R27 and the associated reservoir capacitor is C56. It is across this load that the A.M. A.F. is developed, and this is conveyed via switch S1b, the bass control and the volume control to the grid of the triode section of V4. The signals are amplified by that valve and reappear across the anode load R24.

A.M. AGC

Some of the I.F. signal at the primary of the A.M. I.F. transformer (L25) is fed through C50 to the rectifier WX6. A D.C. voltage is developed across the rectifier load R19, the value of which is proportional to the signal strength. This voltage is negative with respect to chassis and is filtered by R18 and applied as a control bias to the AGC controlled valves.

Moreover, the D.C. component of the detected signal across the detector load R27 is conveyed to the grid of the magic-eye through R29 and R40. This causes the "eye" to close when the set is properly on tune. C66 is simply a decoupling or filter capacitor to remove any I.F. signal that may be present at the grid of the "eye."

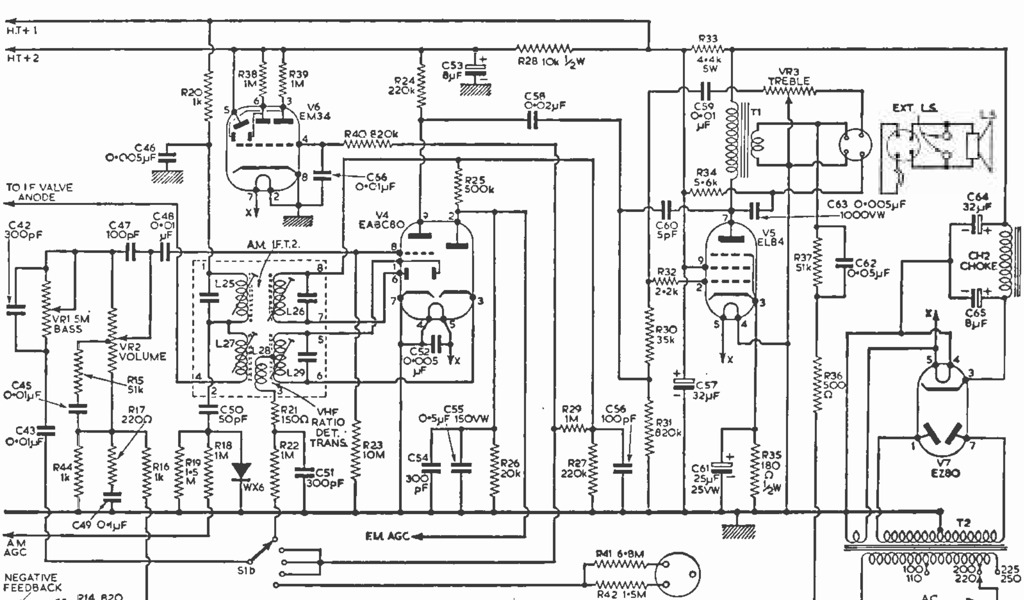

Fig. 9—The circuit diagram of the detector, AGC, A.F., output and rectifier stages of a combined A.M./F.M. receiver.

The Ratio Detector

When the set is switched to F.M., the A.M. I.F. transformer primary (L25) offers a low impedance to the F.M. I.F. signal which is thus developed across the ratio detector transformer primary (L27) and induced into L28 and L29. The F.M. I.F. signal is applied across the cathode and anode of two separate diode sections in accordance with normal ratio detector practice, and to facilitate the description of this section of the circuit the ratio detector has been extracted from Fig. 9 and redrawn in Fig. 10 with the same component references.

From this it is easy to see how the ratio detector is derived. L28 is the ordinary tertiary winding in the ratio detector transformer, while R26 is the ratio detector D.C. load. C55 is the time-constant capacitor, while C54 in parallel eliminates unwanted I.F. signal. The detected F.M. signal is developed across C51, in series with the tertiary winding, and this is fed through the filter R22, switch S1b, the bass control and the volume control to the grid of the triode section in V4, the same as with the detected A.M. signal. Switch S1b is ganged with the A.M./F.M. changeover switch, of course, and simply selects the output from the detector which is in use. The required de-emphasis is given by the time-constant of C51 and R22 in the A.F. feed circuit.

F.M. AGC

The voltage across the ratio detector D.C. load resistor R26 is used, relative to chassis, as an F.M. AGC potential. This voltage is negative with respect to chassis and is at a maximum when the F.M. signal is correctly tuned.

A fraction of the same voltage is taken through R25, R29 and R40 to operate the magic-eye tuning indicator on F.M.

A.F. Circuits

From the foregoing description it will be understood that so far as the triode A.F. amplifier stage is concerned this receives the detected audio whether it be A.M. or F.M. derived. The amplified A.F. is developed across the triode anode load R24 in each case and from there is fed to the control grid of the output valve through C58, R30 and R32.

A small amount of negative feedback is provided by the anode to grid coupling capacitor C60. As this feedback occurs mostly at high audio frequencies, the arrangement gives a degree of tone compensation. The high-frequency speaker is energised from the anode of the output valve through C63 and the power here is controlled by VR3 which is in fact the treble control. A full negative feedback loop is also provided from the secondary of the speaker transformer to the grid of the A.F. triode via R36, R37 and C62.

Power Supply

In this particular set, a double-wound mains transformer provides complete mains isolation and full-wave rectification is employed. C65 is the rectifier reservoir capacitor and smoothing is accomplished by the choke CH2 and the smoothing electrolytic C64. To remove all traces of hum and to provide the required H.T. distribution, additional filter circuits are incorporated, such as R33 and C57 and R28 and C53.

The heaters of all the valves, including the rectifier, are energised from a 6·3V winding on the mains transformer. One side of this power source is connected to chassis while the other side is common to all heaters.

No Signals

Complete failure of both services is sometimes caused by trouble in the EL84. This is immediately indicated by the magic-eye tuning indicator operating normally when the set is tuned over either A.M. or F.M. stations. Such a symptom would, of course, indicate that all stages prior to the A.F. amplifier, including the detectors, are working correctly. Since the detectors are working it is unusual for the triode A.F. amplifier to be at fault, so the most likely cause of the trouble is the output valve or associated components, such as the speaker transformer.

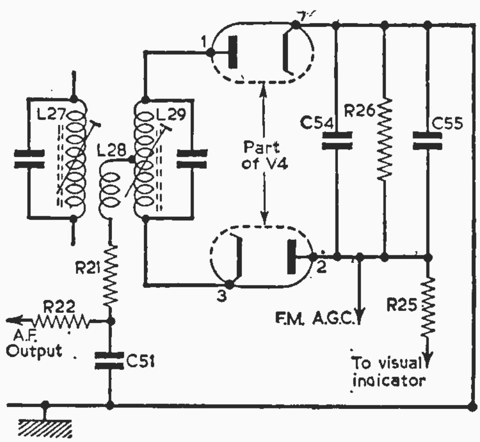

Fig. 10—The ratio detector section from the receiver shown in Fig. 9 with the same component references.

Low Sensitivity

One receiver brought in for service with "low sensitivity" was subjected to the usual tests and very little could be found wrong. The emission of the valves was slightly below normal, but replacements did not help matters. It was later observed that the I.F. valve appeared to be hotter than normal. The bias was checked and the control grid was found to be slightly positive with respect to the cathode. A check on the AGC line eventually brought to light a leak in the capacitor coupling the AGC rectifier to the I.F. signal source. In Fig. 9 this would be C50, and as it is connected to a point of H.T. positive, as well as signal, a leak would reflect a positive voltage on the AGC line and thus on to the control grids of the controlled valves. The action of the rectifier prevented a high rise in positive voltage, but that which found its way to the valve grids was sufficient to destroy the normal sensitivity.

(To be continued)

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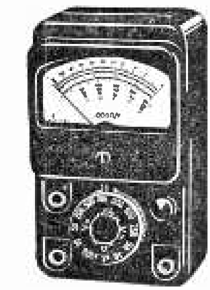

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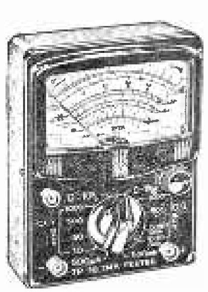
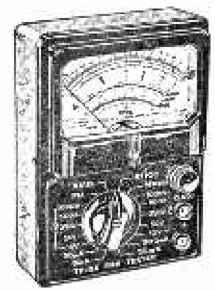


2,000 O.P.V. Model TP-10. Reads A.C. & D.C. Volts up to 1,000; D.C. Current to 500mA; Resistance to 1 Meg; Capacitance to 1μF; Decibels from —20 to +36; Output jack for Audio Measurements. Size 3½in. x 5 x 1¼in.
£3.19.6



20,000 O.P.V. Model TP-5S. Reads voltages up to 1,000 D.C. at 20,000 Ohms per volt and A.C. at 10,000 o.p.v.; D.C. Current to 500mA; Resistance to 10 Megs; Capacitance to 0.1μF; Decibels from —20 to +36. Size 3½in. x 5¼in. x 1¾in.
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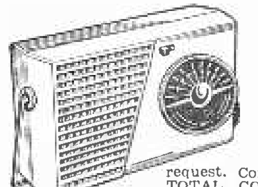

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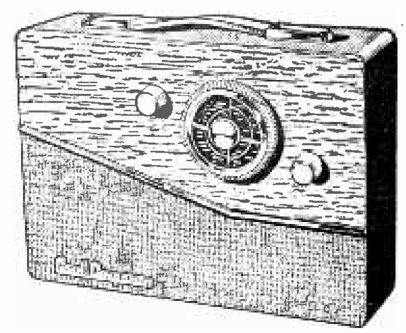

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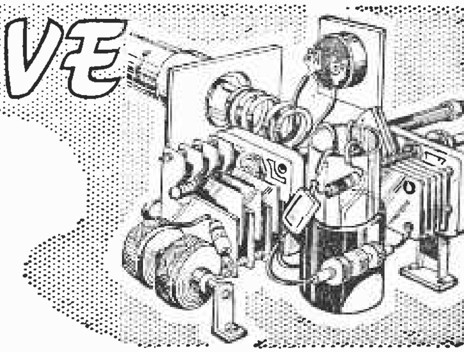


A PRACTICAL PRE-SELECTOR

By A. Sydenham

FOR reasons of economy, pre-mixer R.F. amplifying stages are often omitted from superhets of comparatively simple design. TRF receivers often have only one such stage preceding the detector and because of this sensitivity is frequently of a low order.

Effects

The benefits that result from the inclusion of a tuned R.F. stage are well known, the addition being particularly desirable in the case of a superheterodyne where the first valve operates as a frequency changer, since not only is sensitivity increased enormously but also interference forms common to this type of receiver are minimised.

Many constructors and SWL's acknowledge the need for a tuned R.F. stage in their equipment but realise that, from a practical viewpoint, the inclusion is not easy since a complete rebuild might be necessitated.

A simpler method of obtaining the R.F. gain desired is to use a pre-selector, the additional controls of which add little complication to tuning.

Requirements

The following features are desirable in a pre-selector:

(1) It should be capable of providing adequate R.F. gain.
(2) The gain it provides should be controllable.
(3) It should be stable in operation.
(4) Differing aerial constants should not affect the calibration of its scale.
(5) The output impedance should be of a value suitable for feeding into the aerial/earth sockets of the receiver with which it is to be used.

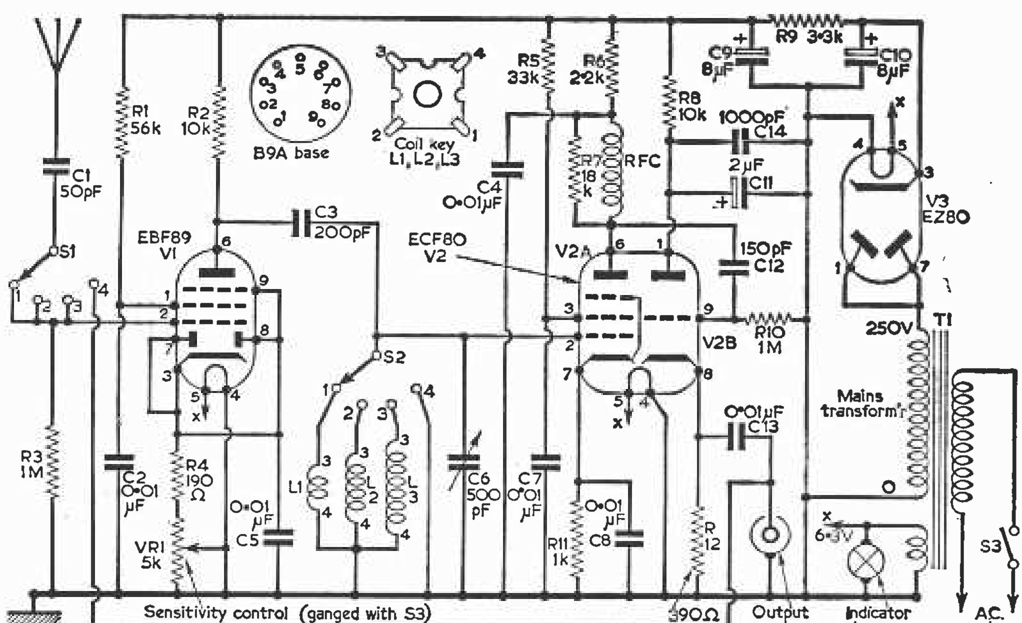


Fig. 1—The complete circuit.

(6) It should be entirely independent of the main receiver and facilities for completely switching it out of circuit should be included.

A unit meeting the above requirements is presented here and the circuit may be seen in Fig. 1.

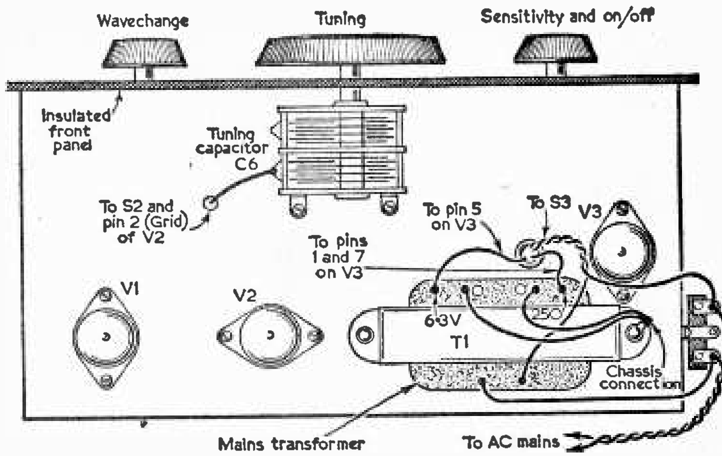
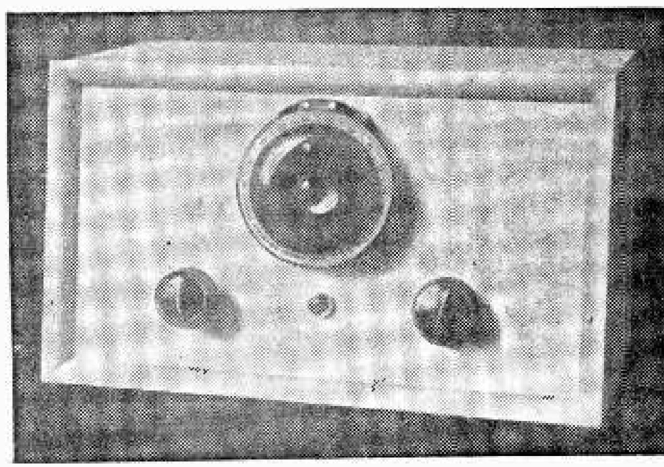


Fig. 2a—The above-chassis layout.

The heart of the pre-selector is V2A and its associated circuitry which is sandwiched between an input and an output stage. The input stage, V1, provides a certain small amount of gain, but its main function it to act as a buffer in addition to providing variable gain facilities. Tuned circuits are associated with the grid circuit of V2A, C6 tuning the particular coil selected by S2. V2B is merely a cathode-follower stage that makes available an output impedance suitable for feeding to the receiver with which the unit is to be used.



The pre-selector unit

Band Selection

For band selection purposes a 2-pole, 4-way rotary switch, S1, S2, is fitted, this being built from a "Makit" assembly comprising wafer, spacers, shafting etc. A less expensive method, but one

(Continued on page 833)

COMPONENTS LIST

Resistors: ½W except where stated

R1	56k	R8	10k 1W
R2	10k	R9	3·3k 1W
R3	1M	R10	1M
R4	190 Ω	R11	1k
R5	33k	R12	390 Ω
R6	2·2k	VR1	5k pot and switch
R7	18k		

Condensers

C1 50pF mica
C2, C7, C8 0·01 µF ceramic or paper
C3 200pF mica
C4 0·01 µF ceramic or paper
C5 0·01 µF ceramic or paper
C6 500pF (nominal)
C9 8 µF 350W electrolytic
C10 8 µF 350VW electrolytic
C11 2 µF 275VW electrolytic
C12 150pF ceramic or mica
C13 0·01 µF ceramic or paper
C14 1·000 pF ceramic

Coils

L1 Osmor QA1
L2 Osmor QA3
L3 Osmor QA4

Valves

V1 EBF89 V2 ECF80 V3 EZ80

Mains Transformer: Mains input. Output: 0-250V 25mA, 6·3V 1A
R.F. Choke: QC1 (Osmor)
Wavechange switch: S1 and S2 (see text)
Chassis: 8in x 4in. x 2in.
Miscellaneous:
Lens and bush—1 hole fixing, ⅜in. dia. (Bulgin D190)
Panel light holder and bulb—6·3V, 0·15A
Valve bases (3) B9A
Dial and drive—see text
Aerial/earth socket strip
Coaxial plug and flush mounting socket
Aerial/earth plugs; Spire clips (3)
Material for cabinet, solder, tags, wire, etc.
Tag strips—one 8-way, one 3-way

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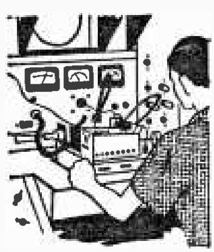

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PYE:	(New)	(Used)	(New)	(Used)
V4, VT4, V7	52/6	35/–	55/–	35/–
VT7, CTM4	52/6	35/–	55/–	35/–
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DH77	4/6	EF80	4/6	PCF86	14/6	U191	9/-	5Z4	10/-	12AT7	4/6
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EBC41	7/6	EY51	7/9	PY32	10/-	UCH21	12/3	6F33	6/3	30L1	7/-
EBF80	7/6	EY86	7/6	PY80	6/-	UCH42	7/-	6L1	12/-	30P4	10/9
EBF89	8/3	EZ40	6/3	PY81	6/-	UCH81	8/3	6L6	9/9	30P12	7/6
EBL31	20/-	EZ41	6/9	PY82	6/-	UCL83	12/6	6V6	5/-	52KU	10/-
ECC81	4/6	EZ80	6/-	PY83	8/-	UF42	8/9	6L18	8/-	53KU	10/-
ECC82	5/6	GZ32	8/9	PY88	12/-	UL41	7/-	6L19	12/-	54KU	8/6
ECC83	6/3	GZ34	12/6	PZ30	8/-	UL46	7/-	6SN7	4/6	185BT	14/-

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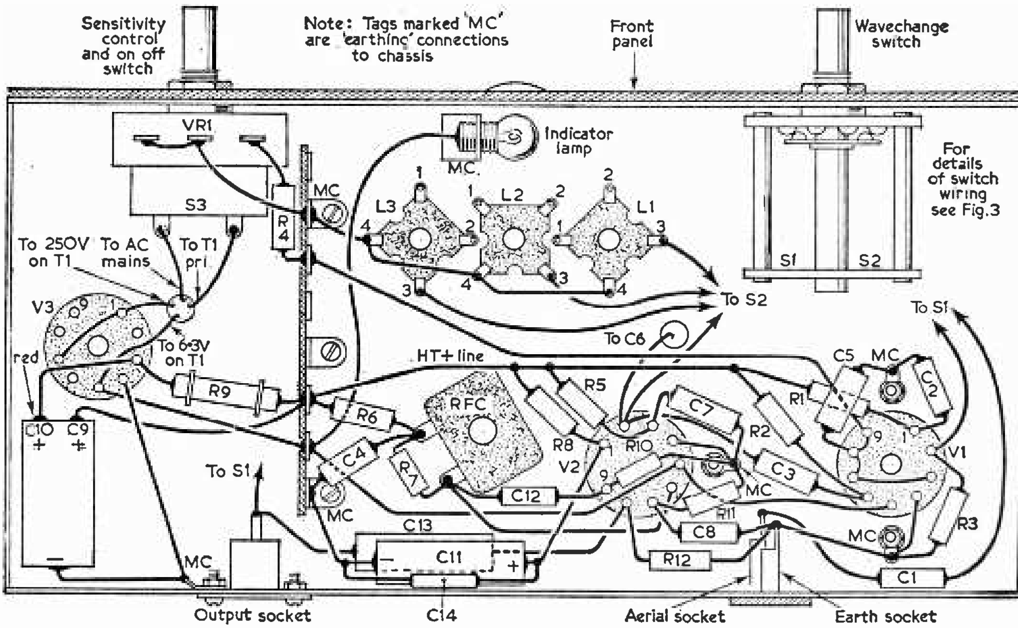


Fig. 2b—The under-chassis layout and wiring diagram.

(Continued from page 830)

that limits the number of "ways" available is to use a minature rotary switch and the manner in which a conventional 3-pole, 4-way type of this pattern can be used is shown in Fig. 3. In the prototype, S2 selects from three coils in the short wavebands, the fourth position being used in conjunction with S1 to mute the unit and simultaneously connect the aerial direct to the main receiver.

Suitable coils of the type used in the prototype may be selected to suit individual requirements. Alternatively, home-wound coils may be used since no ganging problems arise. More than three coils may be accommodated by using a switch with sufficient " ways " after allowing for one to be used for muting, etc.

Tuning Mechanism

A slow motion drive is used to facilitate ease of tuning and no bandspread condenser is fitted. The tuning mechanism used in the prototype was taken from an RF27 unit of ex-Service origin, but a Jackson 4489 or Eddystone 843 could also be employed, these having reduction ratios of approximately 6:1 and 10:1 respectively. A twin gang tuning condenser is fitted, one section being left disconnected.

The Power Supply Section

This is quite simple, V3 being used as a half-wave rectifier in association with a mains isolating transformer T1, which makes the chassis safe to handle. No fuses are fitted to the prototype, but it might be beneficial to wire a 2·5V torch bulb in series with the secondary winding of T1 at the " earthy " end to protect the apparatus somewhat should a fault occur such as a heater/cathode short circuit in V3 which would cause an excessive current flow. Filtering and smoothing are given by R9, C9 and C10.

Layout

Both above and below chassis layout are given in Figs. 2a and b respectively, and as may be seen the amount of above-chassis wring is very small. To minimise self pick-up the coils and switching are contained beneath the chassis where they are automatically screened by the chassis " box".

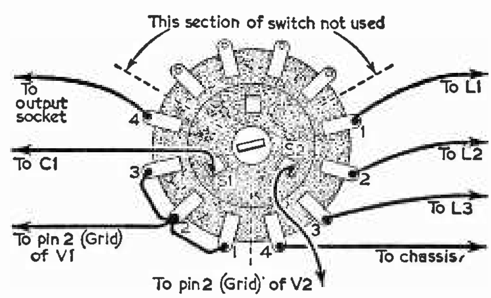


Fig. 3—Utilising a 3-pole, 4-way, rotary switch for band selection.

Constructional Notes

In the wiring diagrams, the positions of minor components might be seen to differ slightly from those shown in the illustrations, the reason being that it would not otherwise be possible to show the precise location with the wiring on a single diagram. Slight rearrangements are not important provided that leads associated with the anode circuit of V2A are not allowed to come too close to those of the grid circuit or unwanted oscillations might result.

(To be continued)

universal SHUNTS

A SIMPLE UNIT WHICH MAY BE USED TO EXTEND THE RANGE OF MULTIMETERS

By R. Traynor

MANY articles have been published recently on the construction of multimeters, all of which require the purchase or construction of shunts. If the constructor wishes to use a meter having a resistance or full scale deflection other than that specified, then new values must be calculated, and since these shunts are often of very low value and each one must be calculated with a fair degree of accuracy, this can become quite tedious.

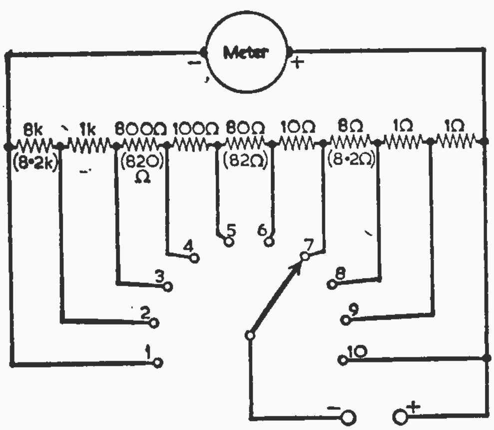


Fig. 1—A circuit of a switched universal shunt. The figures in brackets are preferred values of components which may be used if extreme accuracy is not essential.

A simple method of avoiding these calculations and of cutting the cost by using standard components is by means of the universal shunt, an arrangement used in many commercial multimeters.

This shunt consists of a number of fixed resistors of different value joined in series and the whole connected across the meter terminals. By means of a selector switch any value of resistance can be selected, thus varying the multiplying power. One of the advantages of this arrangement is that there need be no relationship between the values of the resistors and the meter resistance. The multiplying power of a shunt is given by

$$n = \frac{(\text{Meter resistance} + \text{Shunt resistance})}{\text{Shunt resistance}}$$

With the universal shunt the sum (M + S) is a constant, therefore the multiplying power of the shunt is inversely proportional to the shunt resistance and

$$n = \left(\frac{\text{Shunt resistance}}{\text{Multiplying resistance}}\right) + 1$$

The connections are shown in Fig. 1, which shows the values of typical resistors and the multiplying power at each switch position. In the example shown, the total resistance across the meter is 10,000Ω, which has negligible shunting effect. If we assume a meter having an f.s.d. of 100μA, then, in switch position 1, with no shunting effect, the meter reads 100μA. In switch position 10 the meter is out of circuit. The other switch positions will read as shown in Table 1.

Table 1

Switch Position	Multiplying Factor	f.s.d.
1	1	100 μA
2	5	500 μA
3	10	1mA
4	50	5mA
5	100	10mA
6	500	50mA
7	1000	100mA
8	5000	0·5A
9	10,000	1A

If extreme accuracy is not required, the constructor may use preferred value components of say 5% as shown in Fig. 1. This will still give an accuracy of better than 1%, which is quite good enough for most applications. ■

Improving Broadcast Receivers

By K. Berry

A SMALL INVESTMENT IN A FEW NEW COMPONENTS WILL REJUVENATE AN OLD SET

MANY radio enthusiasts use standard broadcast receivers for their own or their families' entertainment. The purpose of this article is to show a few simple ways in which the performance of ordinary broadcast receivers can easily be improved. Some or all of these ideas can save money, since they will enable an old and "tired" set to give a performance comparable with that of a new receiver.

The application of one or more of these modifications will give you a receiver that is better than anything you could buy these days for £20 or so. If you decide to incorporate one or more of these ideas, do not stop there; when you have completed your electrical improvements, spend a little time (and perhaps money!) on cleaning and renovating

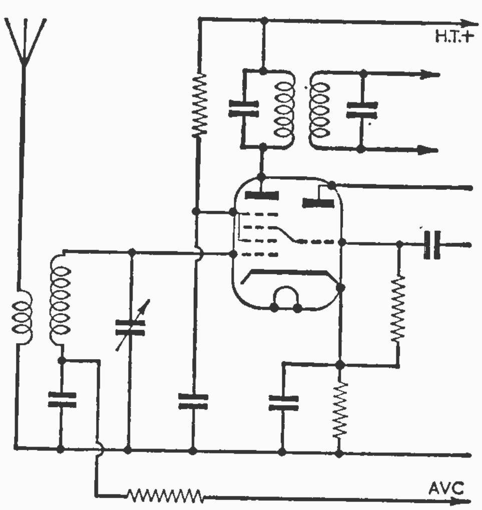


Fig. 1—A typical receiver input circuit.

the appearance of the set. If one or more dial lights are defective, then replace them. If the loudspeaker aperture covering material is soiled, replace it—perhaps with gilt anodised aluminium. Do consider fitting a fresh set of knobs—the addition of a modern style of knob can do wonders to the appearance of a set. Finally give the case a good clean and polish it. Attentions such as these will give the family visible evidence that the radio really is better! But seriously, do not spend three or four hours working on the inside of the receiver and then completely neglect the external appearance.

Increased Sensitivity

A frequently felt need is the desire for a more sensitive receiver. There are two ways of achieving this. One is to add gain before the frequency changer (R.F. gain) by means of an R.F. stage, the other is to add gain after the frequency changer (I.F. gain) by means of an additional I.F. amplifier

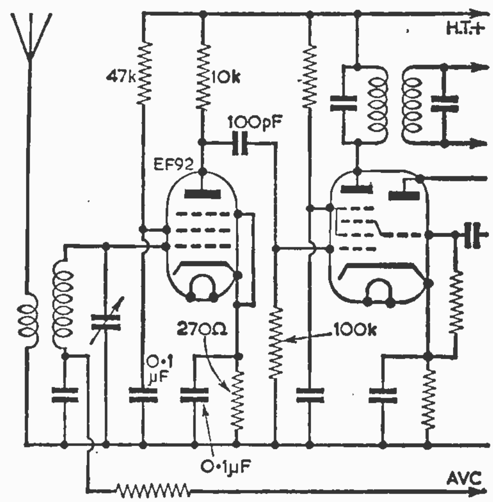
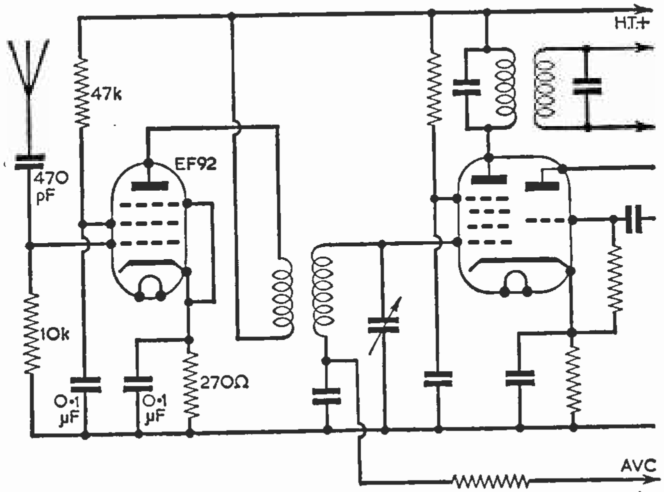


Fig. 2—The circuit of Fig. 1 with an R.F. stage added.

stage. There are advantages and disadvantages to each method, and these are tabulated on page 838. The best compromise is, perhaps, to add both. It should be noted that the added R.F. stage will be of the "aperoidic" or untuned variety. This is of necessity since the addition of a tuned R.F. stage would involve replacement of the existing tuning capacitor by one with an extra section and fitting extra coils and their associated bandswitching—altogether too complicated a job.

It is probably worthwhile to amplify the comments in the table regarding the selectivity question. The I.F. selectivity of receivers varies from make to make and model to model. Some receivers have, by design, a fairly wide I.F., whilst others are designed to have as narrow an I.F. as can be tolerated. Furthermore, some listeners live

Fig. 3 (right)—Another improvement to the circuit; this time the R.F. stage is before the original tuning coils.



in areas of good reception where there is little adjacent channel interference to BBC stations, thus permitting the use of a wide I.F. passband, whereas other, less fortunate listeners live in areas wherein reception of BBC stations is spoilt by strong adjacent signals, or they often listen to foreign broadcasting stations, in which case a narrow I.F. passband is essential. Thus, for some people, a decrease in I.F. passband would be an advantage—whilst for others it could be a little disadvantageous

(Continued on page 853)

Table 1

Untuned R.F. Stage	*Tuned I.F. Stage*
Extra gain.	Tuned amplifier gives more gain.
Improvement in Signal/Noise ratio.	Signal/Noise ratio very slightly worsened.
No increase in selectivity with its attendant side-band cutting.	May cause side-band cutting due to increase in selectivity.
Few components required.	More components required.
No additional selectivity	Increase in selectivity gives better separation of stations.
Normally no instability problems.	Possibility of I.F. instability due to large increase in I.F. gain.

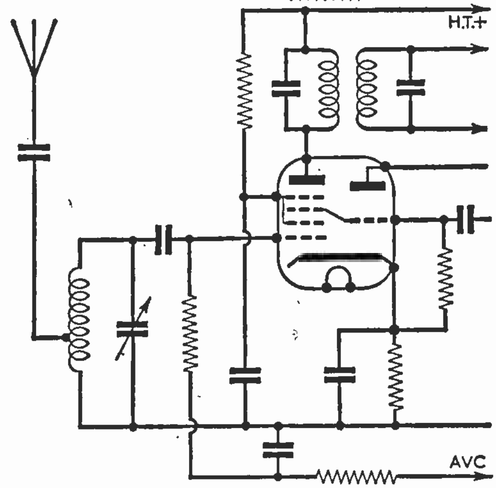


Fig. 4 (above)—A typical receiver input circuit which does not employ an aerial coupling coil.

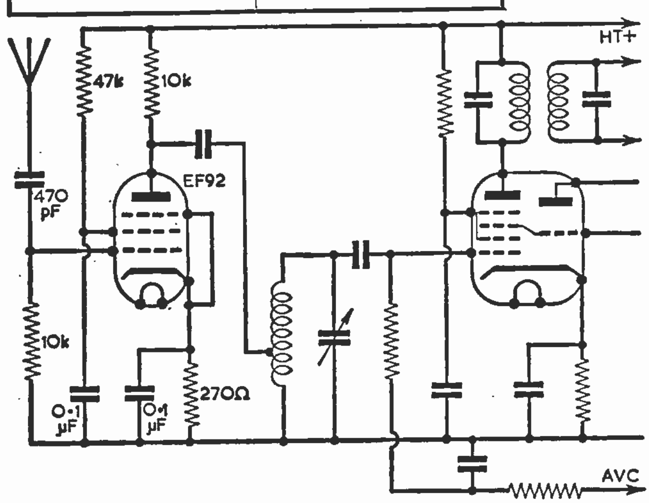
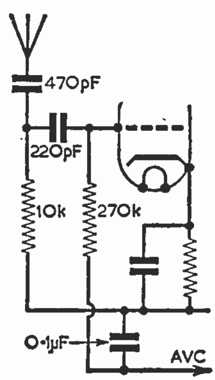


Fig. 5 (left)—A suitable improvement for the circuit of Fig. 4.

Fig. 6 (right)—A method of applying AVC.



Trade News

NEW RADIO FOR THE U.K.

SIX new models have been added recently to the 1961/62 range of Zenith radios now available in this country.

The Royal 500H de Luxe pocket transistor has eight plug-in transistors and employs a 5in. x 3in. speaker, powered by a new ceramic magnet.

The Royal 500 H is housed in a nylon case of modern design with a gold front. It is available in three colours—ebony, white and two-tone grey—and costs £33 13s. 6d., plus £11 17s. 9d. purchase tax.

Another new addition is the Royal 400, a seven transistor pocket radio, which has the same 5in. x 3in. speaker and maximum audio output of 200ΩmW. It is available in several colours and costs £28 8s. 10d., plus £8 19s. 6d. purchase tax.

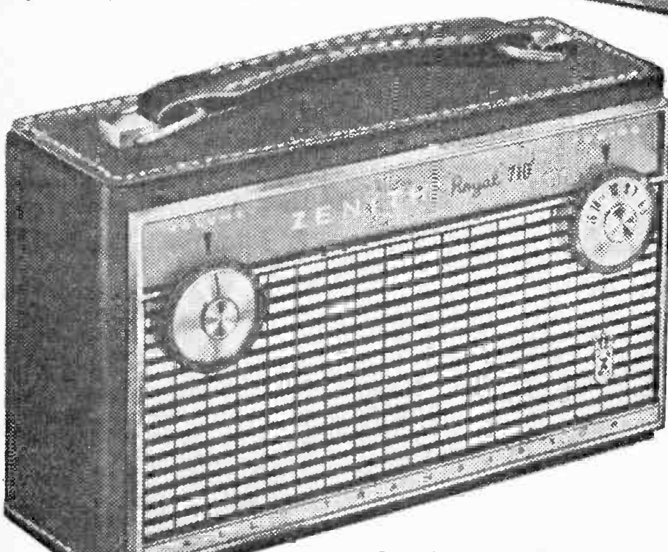
Another newcomer, the Royal 710LG, has 500mW of undistorted audio output. Using seven transistors, it is powered with torch batteries, providing up to 350 hours of operation. It has a 4in. loudspeaker and costs £32 13s. 8d., plus £11 10s. 9d. purchase tax.

These and other Zenith radios are distributed in this country by *United Mercantile Co. Ltd., 13-14 Queen Street, Mayfair, London.*

RADIO SIGNAL PROBE

A NEW 'Lab-Craft' radio signal has been designed for fault tracing and functions as a wide-band modulated signal generator.

(Above)—The Lab-Craft radio signal probe—Model 704.



One of the new Zenith radios available in this country.

Two outputs are provided; a direct output at the sockets and a radiated signal from a plug-in ferrite rod aerial.

The amplitude of the direct output is controlled by a attenuator so that relative stage gains can be determined.

The model 704 is one of the range of service equipment manufactured by *Lab-Craft Ltd., 38 Ilford Lane, Ilford, Essex.*

RECHARGEABLE BATTERY

A NEW rechargeable battery, manufactured by Electronics and Automation (London) Ltd., is being marketed. It is the size of two U2 standard cells, is charged by removing a cap, which simultaneously switches in the internal rectifier and also completely isolates the battery electrically. The two 5A pins revealed are then plugged directly into a mains socket.

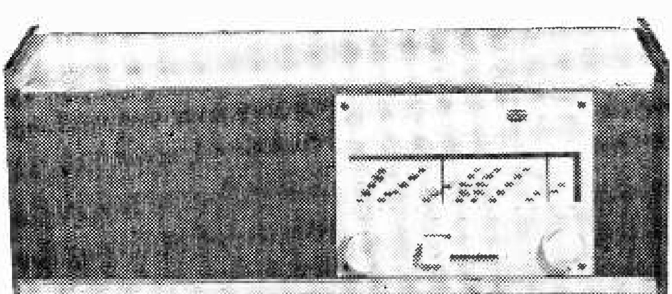
Being completely self-contained, no connections, wires, trickle-chargers or other equipment are required. The battery is guaranteed by the makers for one year.

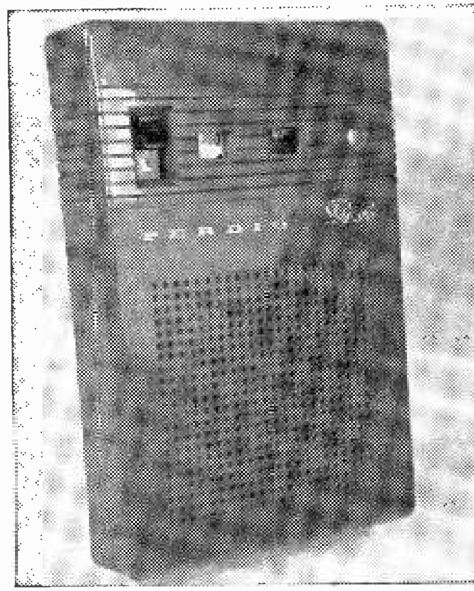
The Etromat is encased in a very robust plastic. It may be left for months in a torch-case. There is no corrosion, because the storage section is completely, hermetically sealed and contains no chemicals to corrode the metal contact base.

Since the battery is constructed for recharging from 110V to 250V supplies, it may be used anywhere. The life of one recharge is the same as that of the replaceable type of battery. The charging time at 250V is 14 hours and at 110V 20 hours.

No matter the voltage (from 2·5V to 6V) or the type, the battery is always the same size.
Electronics and Automation (London) Ltd., Maxwell House, Arundel Street, London, W.C.2.

(Above)—The Etromat rechargeable torch battery.
(Below)—The Sky Prince transistor radio made by Ever Ready Limited.





This is one of the latest Perdio transistor receivers. Presented in a two-tone plastic case, it covers long and medium wavebands. The "Mini Six", as this receiver is known, uses a 9V battery and as an audio output 200mW. It is completely portable and employs six transistors.
The model number is PR24, and the set is made by Perdio Ltd., Perdio House, Bonhill Street, London, E.C.2.

A NEW TRANSISTOR RECEIVER

THE "Sky Prince" receiver employs six transistors, and an 8in. × 5in. elliptical speaker gives one watt output. Up to 400 service hours can be expected from the one battery.

An important feature of the Sky Prince is that it can be carried easily from room to room as there are no leads and plugs to disconnect.

Full coverage of long and medium waves is afforded, plus external aerial socket and external speaker socket. The Sky Prince cost 18½ guineas and is made by *The Ever Ready Company Limited, Hercules Place, Holloway, London, N.7.*

NEW RANGE OF MINIATURE SOLDERING INSTRUMENTS

THE Oryx range of soldering instruments has recently been extended to include instruments with voltages up to 230/250. A variety of tips are available with 6 to 20W output. Replaceable tips are available and the heavy duty elements quickly provide a tip temperature up to 932°F, depending on the model.

The sole distributors of Oryx products are *W. Greenwood Electronics Limited, of 667 Finchley Road, London, N.W.2.*

The BASS Reflex Cabinet

THEORY AND PRACTICAL DESIGN

By J. B. Dance

ONE of the most difficult problems encountered in the design of "Hi-Fi" equipment is that of obtaining a level and undistorted bass response. For this reason the design of the loudspeaker cabinet should be undertaken most carefully.

Unmounted Loudspeaker

The vibrating cone of a moving coil loudspeaker is small compared with the wavelength of low frequency sounds in air. If a loudspeaker is used at low frequencies without any baffle whatsoever, the air which is pushed forward by the loudspeaker cone will merely pass around the outside of the loudspeaker to fill the partial vacuum created at the rear of the cone. Similarly when the cone moves backwards, air will pass from the rear to the front of the loudspeaker.

The loudspeaker cone is intended to set the whole of the air in the room in vibration, but if no baffle is used, the air slips around the edges of the loudspeaker at low frequencies and the effect on the air in the room is very small indeed. The air currents (i.e. the sounds) are thus short circuited. The use of a baffle will prevent this short circuiting of the air currents provided that the baffle is not so small that the air can pass easily around the outside of it from the front to the back of the loudspeaker and vice-versa at the frequency in question.

High Frequencies

At high frequencies, however, the movements of the cone are so rapid that there is not enough time for the air to move between the back and front of the loudspeaker and so to equalise completely the pressures before the direction of movement of the loudspeaker cone has been reversed.

One has only to compare the sound from an unmounted loudspeaker with the sound from a properly mounted loudspeaker to appreciate that the unmounted loudspeaker produces almost negligible sound when the input frequency is low. The volume of the middle frequencies is also much less than that from a correctly mounted loudspeaker. This effect is very prominent with a large unmounted loudspeaker, but is even worse with a small unmounted loudspeaker, as the air can pass from the back to the front of the cone much more easily and quickly than in the case of a large loudspeaker.

Loudspeaker Resonance

The resonance curve of a typical loudspeaker of nominal impedance 15Ω is shown in Fig. 1. In this graph the actual impedance of the loudspeaker in ohms is plotted against the input frequency. The graph covers only bass frequencies; the impedance rises somewhat at high frequencies. The peak, in the case shown at 65c/s, is at the natural resonant frequency of the loudspeaker; that is, at the frequency at which the loudspeaker cone vibrates if the cone is gently tapped with the finger. The loudspeaker cone will vibrate with a very large amplitude if quite a small input of this particular frequency is applied to the loudspeaker terminals.

Bass Reflex

A simple system which gives an equally satisfactory performance consists of a plain, closed, cabinet with an opening at the front: the volume of the cabinet and opening are so calculated that the air inside the cabinet resonates with the air in the vent at the same frequency as that of the fundamental resonance of the loudspeaker used. The sound emerging from the vent is in phase with that from the loudspeaker cone. Hence the bass reflex cabinet is also known as the acoustical phase inverter.

The size of the loudspeaker cabinet required for this arrangement can be appreciably reduced by fitting a pipe or wooden column which projects back into the cabinet from the opening at the front as shown in Fig. 2. The opening below the loudspeaker opening is known as the vent.

Design

The first problem one meets when designing a bass reflex cabinet is that of calculating the size of the enclosure and vent which will enable the cabinet to resonate at the same frequency as the loudspeaker. In order to do this, one must know the fundamental resonant frequency of the loudspeaker. The manufacturers of all good loudspeakers supply a nominal value for the resonant frequency. However, this frequency usually decreases by about 10% to 15% after the loudspeaker has been in use for some hours. This decrease occurs because the suspension becomes weaker after a few hours of use.

It is therefore best to measure the resonant frequency of the loudspeaker experimentally if possible, not when the loudspeaker is quite new, but when it has been used for about twenty hours or so fastened to a temporary mounting and used at reasonably high power. The value obtained can then be used in the calculation. If for any reason the frequency is not measured experimentally, the manufacturer's figure may be used, but it is wise to reduce this figure by up to 10% to allow for the suspension becoming slightly weaker with use.

Experimental Determination

The fundamental resonant frequency of the loudspeaker may be determined experimentally in the following way. An audio signal generator should be used to feed an audio power amplifier connected to the unmounted loudspeaker under test. An A.C. ammeter should be placed in one of the leads to the loudspeaker as shown in Fig. 3. The input power from the amplifier to the loudspeaker should not exceed a small fraction of a watt and therefore a reasonably sensitive ammeter should be used, say 0-½A. The amplitude of the cone movement should be checked (by touching the cone) to make sure that it is not too large.

As the signal generator is tuned and its output kept fairly constant, the current passing through the loudspeaker and indicated by the ammeter will be found to have a definite minimum value at the loudspeaker resonant frequency. This frequency can then be read from the scale of the audio generator.

The Helmholtz Resonator

The cabinet resonates in the same way as a Helmholtz resonator. (If one blows across the top of a suitable bottle, a similar resonance effect can be noticed.) The theory of the Helmholtz resonator has been worked out in detail and it can be shown that the resonant frequency is determined by the volume of the enclosure itself and by the dimensions of the opening or vent. The air in the enclosure acts in a way similar to that of a condenser in an electrical resonant circuit and the air in the vent resembles an inductance. In the same way that various combinations of inductance and capacitance can resonate at the same frequency, it is found that Helmholtz resonators or loudspeaker cabinets can be designed to operate at the same frequency and yet have different vent sizes and internal volumes. Once the vent size is chosen, however, there is only one particular volume which the interior of the cabinet can have if it is to resonate at the same frequency as that of the loudspeaker cone.

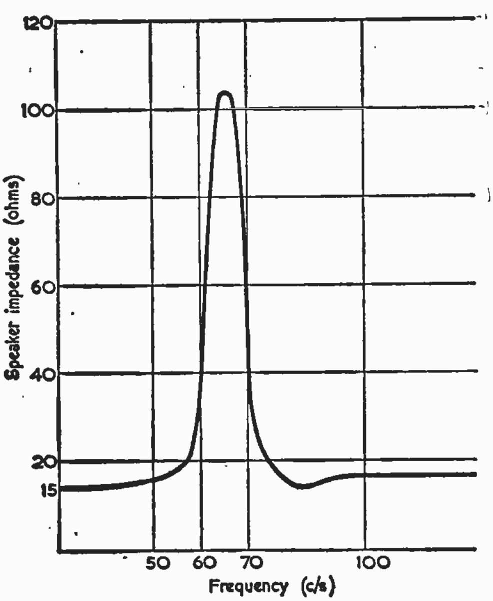


Fig. 1—A typical resonance curve for a 15Ω speaker with a 65c/s resonance.

Formula

According to Rayleigh, the resonant frequency of a Helmholtz resonator is

$$f = \frac{v}{2\pi} \sqrt{\left\{ \frac{A}{C(L + \frac{1}{2}\sqrt{[\pi A]})} \right\}}$$

where v=the speed of sound in inches per second.

$\pi = 3{\cdot}142$.

A=Cross sectional area of vent in square inches.

C=Volume of air in the cabinet in cubic inches.

L=Length of vent in inches (including thickness of front panel).

This equation can be squared all through and transposed to enable us to obtain the cabinet volume.

$$C = \frac{V^2 {\cdot} A}{4\pi^2 f^2 (L + \frac{1}{2}\sqrt{[\pi {\cdot} A]})}$$

Substituting for the value for the velocity of sound (13,500 inches per sec.) and for π

$$C = \frac{4{,}614{,}000A}{f^2(L + 0{\cdot}886\sqrt{A})}$$

The Vent

Before the calculation can be continued, the dimensions of the vent must be decided. Opinions differ somewhat as to the most satisfactory values for these. It is generally agreed that the vent should not extend too far into the cabinet, and that the length of the vent tunnel should not be greater than about one twelfth of the wavelength of the resonant frequency of the loudspeaker cone; neither should the length of the vent be so great that it extends more than half way between the front and back of the loudspeaker. It is not even necessary to make a vent tunnel at all, for if one merely cuts a hole in the front panel, one will have a vent of a length equal to the thickness of the front panel. If this course is adopted, however, the cabinet will have to be considerably larger than is necessary if it is to resonate at the desired frequency. Wood is expensive and space in a room is scarce, so a vent tunnel is usually employed. It can be seen from the equations that a long vent will enable a smaller cabinet to be used.

The size of the vent hole is also important; i.e. its cross sectional area, A. Some experts advise that the area of the vent should be equal to the area of the effective part of the loudspeaker cone at low frequencies, whilst others think that any reasonable area (say between one half and double the effective loudspeaker cone area) will give satisfactory results. The effective cone area is the area of the sides of the cone (not including the corrugated suspension at the edge) projected on to an imaginary circle at the front of the loudspeaker.

The area of the vent appears in both the numerator and denominator of the above equations, but the term in the numerator is most important; the use of a small vent area will therefore

(Continued on page 849)

(Continued from page 846)

enable a smaller cabinet to be used than the use of a large vent, other things being equal. The vent can be of any shape, but will normally be of rectangular cross section to simplify construction of the tunnel. Circular vents are sometimes used.

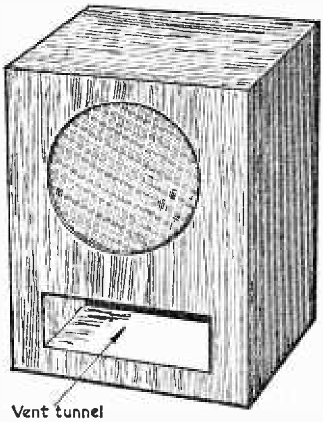


Fig. 2—A bass reflex cabinet showing the rectangular vent and tunnel beneath the speaker.

Design Example

Let us suppose that we wish to design a bass reflex cabinet for use with a loudspeaker of a nominal diameter of 10in. which has a fundamental resonant frequency, measured as described, of 65c/s.

It is first necessary to insert values for the length and cross sectional area of the vent in the equation in order to try to design a cabinet of suitable dimensions.

Let us assume that the vent is to be 5in. long and that the cross sectional area of the vent opening is to be equal to the area of the effective part of the loudspeaker cone. The average 10in. loudspeaker will have an effective cone diameter of about 8·5in. and an effective cone radius of half this value, i.e. 4·25in. The area of the vent will equal πr^2; where $r=4{\cdot}25$ and $\pi=3{\cdot}142$; the area=56·75sq. in.

Calculation

Putting these values into the last equation:—

$$C = \frac{4{,}614{,}000 \times 56{\cdot}75}{(65)^2(5+0{\cdot}886\sqrt{[56{\cdot}75]})}$$

$$C = \frac{61{,}980}{(5+6{\cdot}67)} = 5311\text{cu. in.}$$

This is the volume of air which should be enclosed in the cabinet and does not include the volume of air and wood in the vent. In order to obtain a value for the total volume of the inside of the cabinet, it is necessary to add to the above figure the following quantities:—

(1) The volume of the vent (i.e. the external volume of the vent as seen from inside the cabinet including the volume of air and the wood from which the vent is made).

(2) The volume of the loudspeaker. The presence of the loudspeaker reduces the volume of air in the cabinet. If the volume of the loudspeaker is quoted by the makers, this figure should be used. Otherwise the approximate volume of the loudspeaker can be obtained from the data given in Table 1.

(3) The estimated volume of any wooden struts which are to be used to strengthen the cabinet. About 100cu. in. may be allowed for a fairly small cabinet and more for a large one.

(4) As it is much easier to reduce the volume of the completed cabinet by fastening a block of wood in it than it is to raise the frequency by extending the vent inwards, it is wise to add an additional hundred cubic inches or so which can be kept in reserve. In the design being considered, the volume of air in the vent tunnel is 56·75 x 4·25 which is about 241cu.in. if the wood is to be ¾in. thick. About 80cu.in. may be allowed for the wood of the vent tunnel. From Table 1, the volume of the 10in. loudspeaker will be approximately 400cu.in.

Adding these quantities to the 5311cu.in. obtained above, we find that the total internal volume of the cabinet should be approximately 6232cu.in.

Possible Shapes

A number of different shapes of cabinet can be used to satisfy the condition that the total internal volume must be approximately 6232cu.in. The vertical height of the cabinet must be great enough to accommodate the loudspeaker and vent above one another. It is therefore wise to start by estimating the approximate minimum height. For this surpose let us assume that the vent area of 56·75sq.in. is to be obtained by making a hole 6in. in vertical height and 9·46in. in length in the front of the cabinet. Allow minimum dimensions of:—

top of the cabinet to top of the loudspeaker	1in.
distance across loudspeaker, allowing space for fixing	11in.
distance from the bottom of the loudspeaker to the top of the vent	2in.
distance across vent	6in.
distance between bottom of vent and bottom of cabinet	2in.
Therefore, the total minimum height of the cabinet is	22in.

Nominal Diameter of Loudspeaker (Inches)	Approximate volume of air displaced by speaker (Cubic Inches)
6	150
8	250
10	400
12	630
15	1350
18	2400

Table 1—The average volume of air displaced by typical loudspeakers of various sizes.

The vertical height must therefore be at least 22in. Similarly the breadth should be at least 12in. to accommodate the loudspeaker and vent easily. The depth of the cabinet must be at least 10in. or the requirement that the vent tunnel length must not exceed half the length of the cabinet will not be met.

Three lengths must now be chosen which are possible values for the length, width and height. These values must be compatible with the foregoing requirements and when all three lengths, expressed in inches, are multiplied together the result must be approximately 6232cu.in. Some examples of the possible dimensions are:—

$29\frac{1}{2} \times 15 \times 14 = 6205$cu.in.
$26 \times 16 \times 15 = 6240$cu.in.
$24 \times 20 \times 13 = 6240$cu.in.
$25 \times 18 \times 14 = 6300$cu.in.

There are, of course, many other possibilities and the constructor must now make his own choice from the possible dimensions. As the tunnel will not extend half way through the cabinet, the calculation could be carried out again with a longer tunnel length to obtain the smallest possible cabinet size.

Without Tunnel

It is interesting to compare the above results with the dimensions which would have been necessary if no tunnel had been employed. The length of the vent would then have been equal to the thickness of the wood used for the front panel, say $\frac{3}{4}$in. The equation would then be:—

$$C = \frac{61{,}980}{(0{\cdot}75+6{\cdot}67)} = 8354\text{cu. in.}$$

The volume of the vent is now zero. Adding the volume of the loudspeaker, the estimated volume of the supporting struts and the reserve volume to the 8354cu.in. obtained above, we find the total internal cabinet volume to be 8954cu.in.

Thus, the omission of the internal vent tunnel requires the volume to be increased from some 6200cu.in. to some 8954cu.in. One of the sets of possible cabinet dimensions with a 5in. vent tunnel was $29\frac{1}{2}$in. x 15in. x 14in.; without the tunnel this would have to be increased to $42\frac{3}{4}$in. x 15in. x 14in. or to some similar dimensions. Thus much more wood would be required and the cost of the cabinet might easily be increased by 50%.

It must be emphasised that the dimensions quoted above are all internal dimensions. The external dimensions of the cabinet will be larger than the internal dimensions by the thickness of the wood used.

Other Loudspeakers

The results obtained above apply to a loudspeaker with a resonant frequency of 65c/s. If a loudspeaker with a fundamental resonant frequency of half this value were used, namely one resonating at 32·5c/s, the volume of air enclosed in the cabinet should be four times as great. Thus the cabinet will be very much larger; it will also require much more support or the use of thicker wood if undesirable vibrations are not going to take place. Thus the cost of the cabinet is increased enormously, but a much better bass response should be obtained.

If the loudspeaker had a resonant frequency of 32·5c/s and all other factors were as stated in the previous example a typical size for the cabinet would be 40in. x 30in. x 21in. with a 5in. tunnel fitted to the vent. At this stage, it would be well worth while performing the calculation again with a longer tunnel in order to reduce the size of the cabinet. One cannot choose a suitable value for the vent until the calculation has been completed and one knows the cabinet depth; it is therefore necessary to insert an estimate for the length of the vent in order to find the approximate cabinet dimensions. The calculation can then be repeated when the exact vent length has been chosen.

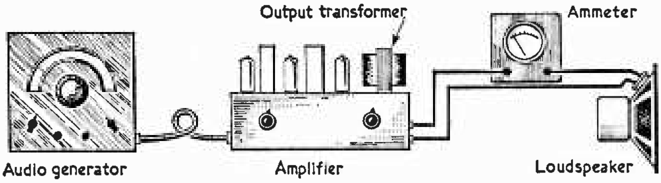


Fig. 3—Determining the fundamental resonant frequency of a loudspeaker.

Construction

Cabinets are normally made of wood, but brick and concrete can be used very successfully. Assuming wood is to be used, it should be quite thick—at least half an inch for the smaller cabinets, but a thickness of an inch is desirable for the larger ones. Cabinets are made in which the walls consist of a double thickness of wood, the space between the inner and outer walls being filled with sand. Such cabinets are extremely heavy but comparatively cheap to build and certainly very effective.

It is desirable to fix adjoining pieces of wood together with glue and also with screws placed three or four inches apart. A hundred or so screws at least will be required. Countersunk screws should be employed, as they can then be fitted with their heads below the surface of the wood. Plastic wood can be used to cover the heads of the screws. The plastic wood used should be chosen to match the colour of the other wood as closely as possible and it should be applied layer by layer, allowing each layer to set before the next one is applied. The plastic wood should finally protrude slightly above the level of the cabinet before it is rubbed down with fine sandpaper. The back of the cabinet should be screwed in position using sufficient screws, but it should not be glued or it will not be easy to make any necessary adjustments.

Strengthening

It is most important that the panels be strengthened with an adequate number of supporting strips of thick wood. Many poorly constructed cabinets are almost useless owing to wall vibration at large inputs. The amount of supporting struts required varies greatly with the size of the cabinet, thickness of the wood used, etc. and no definite guide can be given.

(To be continued)

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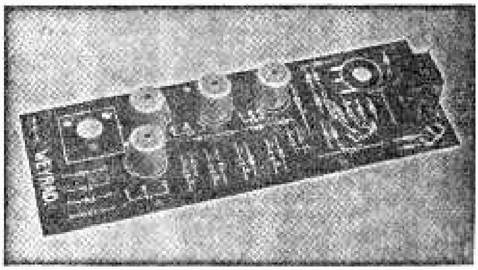

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Letters to the Editor

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

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

F. M. QUALITY

SIR,—I wonder if any of your readers feel, as I do, that the quality of the received VHF/F.M. transmissions of the BBC is somewhat lacking? It seems to me that the lower frequencies are thinned out in some way so that the roundness of tone is missing. I had the opportunity of checking a good Continental receiver the other day, which had the facilities of separate A.M. and F.M. tuners, with a piano-key type switch, so that, for instance, the Home Service could be set up on both M.W. A.M. and VHF/F.M. and the switch could select either almost instantaneously. As might be expected, the direct comparison gave a much extended clean top on the VHF section, but when this good top was reduced (with a top-cutting tone control) to about the level of the A.M. response, the thinness of the lower frequencies was very marked. BBC TV A.M. sound does not seem to suffer in this way, so I have a feeling that the ratio detector system in common use is falling down on the job somewhere —what do other readers think?—B. D. VAN DER SYDE (Parkstone).

METAL CABINETS

SIR,—I am an ardent reader of your excellent magazine, as like many amateurs I have constructed various pieces of test equipment as described in your pages. However, I find in the trade sections a distinct lack of any metal cabinets—an essential for signal oscillators, etc—and month after month I scan through the adverts hoping to see a selection of these cabinets being offered in various shapes, sizes and finishes, but to no avail. Isn't it apparent to the suppliers, that a real need is set up by every amateur who strongly desires to build equipment equivalent or sometimes superior in performance to that of commercial offerings and yet still posessing a professional finish?—T. H. HUGHES (Rhondda).

SEMI-CONDUCTOR RATING

SIR,—Owing to the increasing use of semi-conductor rectifiers in power supply units, I feel that the warning should again be sounded concerning PIV (peak inverse voltage) ratings. A very common mistake is to reckon that, under "surge" conditions, i.e. should the load be accidentally disconnected the PIV across the rectifier would only rise to 1·414 times the r.m.s. output of the secondary (or, in the case of a full-wave rectifier, of the half-secondary) of the mains transformer. Actually, of course, reckoning the negative peak voltage the PIV rises to 2·828 times the output of the transformer so that in practice the minimum PIV rating to be chosen would be for safety three times the output of the secondary (or half secondary as the case may be) of the mains transformer. To give an example, using two rectifiers in a full wave circuit and a transformer secondary giving 350-0-350V, the PIV across each rectifier could rise to no less than $50 \times 2{\cdot}828 = 989{\cdot}8$V and in the half-wave condition using a small 250V transformer the PIV could, if the load were momentarily disconnected, rise to the high figure of $250 \times 2{\cdot}828 = 707$V. I feel that this warning should be kept in mind to avoid expensive breakdowns and even, under certain circumstances, serious danger. — A. T. FARRER (Newcastle-upon-Tyne).

IMPROVING BROADCAST RECEIVERS

(Continued from page 838)

in that it would lead to a reduction in the highest audio (modulation) frequency which can be received. This little exposition on I.F. passband may be a little confusing to some, so it is best summarised by saying that for most purposes any reduction in I.F. passband is very acceptable these days in view of the overcrowded state of the medium waveband whilst additional gain is always welcome.

Increased R.F. Gain by Untuned R.F. Amplifier

A typical receiver input circuit is shown in Fig. 1. This is shown again in Fig. 2 with the addition of an R.F. stage between the original signal tuned circuit and the mixer, whilst in Fig. 3, the R.F. stage is placed before the original tuning coils, the former aerial coupling coil now being connected into the anode circuit of the R.F. amplifier. There is little to choose between the two methods. The first method is perhaps neater, but the second method may be easier to achieve—particularly from the layout point of view.

R.C. Amplifier

In Fig. 4 is shown a receiver input circuit which does not employ an aerial coupling coil; for this type of circuit the additional amplifier must be added as in Figs. 2 or 5. Note that the method shown in Fig. 5 may equally well be used with a receiver which does have an aerial coupling coil. It is in fact just a R.C. amplifier with a low load resistor to give a good H.F. response, i.e. it is virtually a video amplifier.

(To be continued)

Club News

REPORTS OF CURRENT ACTIVITIES

BRADFORD RADIO SOCIETY
Hon. Sec.: M. T. Powell, G3NNO, 28 Gledhow Avenue, Roundhay, Leeds 8.

"Modern Methods of communication", by E. M. Price was the subject of the meeting for November 15th. A "junk" sale was held on the 28th of the same month.

Future Events:
December 12th—"The development of time measurement", given by W. Barton.
January 2nd—D. M. Pratt talks on "Amateur receiver construction."
January 16th—"Electronic Organs", by A. R. Bailey.

BURSLEM AMATEUR RADIO CLUB
Hon. Sec.: W. Luscott, 36 Rothsay Avenue, Sneyd Green, Hanley, Stoke-on-Trent.

On October 1st, twenty club members enjoyed a tour of the BBC'S television station at Sutton Coldfield. On October 18th, A. J. Hodgkinson gave a demonstration and lecture on the G2 D.A.F. SSB receiver.

"Aerials and Propagation" was the subject of the lecture of the November meeting and was given by Peter Jones.

Future Event:
December 20th—"Silvered mica capacitors", by H. D. Hemmer.

BURTON-UPON-TRENT AND DISTRICT RADIO SOCIETY
Hon. Sec.: J. Adkin, 25 Huntingdon Road, Stapenhill, Burton-upon-Trent, Staffordshire.

R. Harrison gave a talk on "Constrictors and inductance" on October 11th; and on November 8th, the club held its annual dinner at the Midland Hotel.

Future Events:
December 13th—J. Elliott talks on valves and how they work.
January 10th—W. Hazeldeau will give a talk on aerials for receiving and transmitting.

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

Members had a busy November this year, starting with a surplus sale on the 1st. On the 15th, G. Morgan gave a lecture entitled, "Electronics as applied to telecommunications". A stereophonic tape demonstration was given for members on the 22nd November, and on the 25th, the annual trip to the International Hobbies Exhibition was held. The month ended with "Open evening" at the society's club rooms.

For the first meeting in December, another surplus sale held on the 6th.

Future Event:
December 13th—Open Night.

MITCHAM AND DISTRICT RADIO SOCIETY
Hon. Sec.: M. Pharaoh, G3LCH, 1 Madeira Road, Mitcham.

The society's transmitter, which took part in the Boy Scouts' International Jamboree-on-the-Air, was operated from the headquarters of the 3rd Mitcham, Woodland Way, Mitcham.

"The manufacture and development of capacitors" was the title of the talk given by A. E. Lesse, on October 20th, and on Friday, November 3rd, R. C. Hills talked on "Aerials".

PETERBOROUGH AND DISTRICT RADIO SOCIETY
Hon. Sec.: D. Byrne, G3KPO, Jersey House, Eye, Peterborough.

At the first meeting of the winter session, Mr. R. Houltby spoke on direction finding, and the construction of special top-band portable receivers for competing in D.F. contests.

The annual general meeting was held on November 3rd, and the Christmas party on December 1st.

Future Event:
January 5th—A talk on aerials.

ROTHERHAM RADIO CLUB
Hon. Sec.: S. J. Scarbrough, 25 Crawshaw Avenue, Sheffield 8

The winter programme began on October 4th, with an interesting and informative talk given by R. Moore, on transistors and transistorised equipment.

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

Recently, members have enjoyed two demonstrations of high-fidelity stereophonic sound, one in October and the other in November. Mr. K. Gunary gave a talk on October 20th, called "Rectifier locomotives for industrial frequency A.C. railway traction".

The annual general meeting was held on November 17th, and on December 1st members heard a lecture on D.F. developments.

SPEN VALLEY AMATEUR RADIO SOCIETY
Hon. Sec.: N. Pride, 100 Raikes Lane, Birstall, Nr. Leeds.

"Amateur radio receiver alignment" was discussed by H. A. Mathias at the meeting on October 11th. On November 8th members met the zonal representative of the R.S.G.B. "Interference problems" was the subject of J. C. Belcher's lecture on November 22nd.

Future Events:
December 20th—Brains Trust.
January 3rd—Rag Chew.

TRANSMITTING TOPICS

(Continued from page 807)

meter as small readings and sometimes the needle kicks up and down. The effects of neutralising a P.A. stage can also be seen simply by slipping the loop over the P.A. valve (with the H.T. off, of course), and tuning the P.A. The oscillations will show up on the meter and the neutralising can be carried out in the usual way—adding a capacity from anode to grid (to overcome the "Miller" effect). Although neutralising is usually carried out by watching the grid drive meter, a finer degree of control can be obtained by using the simple unit in Fig. 4.

If the loop coil is applied to a circuit which is in an oscillatory state, the meter will read, providing it is not coupled so as to stop the actual oscillation. The final design (see Fig. 5) was built up in a Bakelite case, but could be well built up in a "tin". Fig. 5 gives the final circuit which is simple to construct, requires no calibration and no tuning. The circuit is simple and untuned (RFC1 and D1); C1 removes any R.F. content in the rectified R.F. and the output is fed to VR1, a carbon potentiometer which controls the output to both meter and to the phones (this was found a great asset and can be adjusted to a particular reading on the scale, for adjustment changes to be seen easily).

To use for R.F. indications it is only necessary to place the pick-up wire near the feeder system—even inches away—until a favourable reading is obtained on the meter scale, adjusting VR1 if necessary. Any change in the actual R.F. output is clearly seen by a change in the reading. To use the unit as a monitor for 'phone working, set it up as above and adjust VR1 with the switch set to the audio position and the gain adjusted for comfortable listening. For use as a field strength comparator, sometimes the pick-wire has to be replaced by a longer wire or even by a short aerial.

For the meter, a 1mA movement is preferred but other meters of lower or higher sensitivities may be used. Obviously, the lower the f.s.d. of the meter, the further away from the R.F. source can it be used. R.F. meters with the thermocouple removed would be suitable, but the sensitivity would be less as these generally have an f.s.d. of about 2mA.

Understanding POWER Supplies

THE FULL-WAVE RECTIFIER CIRCUIT

(Continued from page 712 of the December issue)

By A. Foord

LAST month the diode valve and the half-wave rectifier circuit were considered.

The Full Wave Rectifier Circuit

The half wave circuit suffers from the following disadvantages: It only charges the reservoir capacitor during every positive wave. If the full wave circuit—as shown in Fig 9—is used, the operation is very similar.

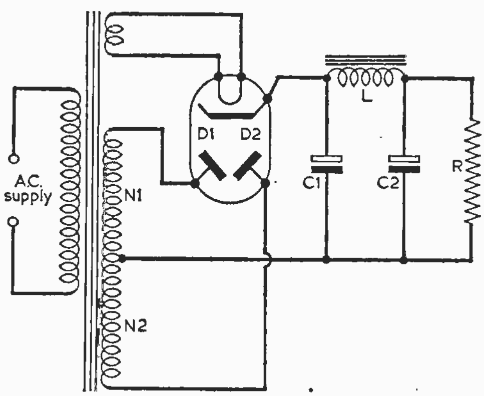

Fig. 9—A complete H.T. full-wave rectifier circuit.

The circuit can be regarded as two separate diodes—D1 and D2—fed from their own windings—N1 and N2—but having a common load R, and components C1, C2 and L. Alternate half waves are rectified in turn as each becomes positive to the centre tap. Fig 10 shows the output voltage without the output reservoir capacitor C1. Fig. 11 shows the output voltage with a reservoir capacitor. In this case the action of the components is similar to the half wave circuit, but now they are more effective because the principal hum component is now 100c/s instead of 50c/s. Consequently L and C2 do not have to be so large for the same ripple voltage as they were in the previous circuit.

Most mains transformers are fitted with an earthed copper screen between primary and secondary. Its purpose is to prevent radio frequency signals being passed on from the mains and, although the ends of the screen may overlap, they should not touch, or the screen will consist of a shorted turn, and the transformer will overheat.

The Full Wave Bridge Circuit

The full wave bridge circuit is shown in Fig. 12. Although valves can be used in this circuit, metal rectifiers are normally employed, thus overcoming the difficulty of separate heater supplies. Figs. 13a and b show that whatever the polarity of the supply the voltage across the load is always the same. In the absence of any reservoir capacitor the average output voltage is 0·636 of the peak input voltage. This circuit is commonly used for instruments as well as for H.T. supplies, as it gives full wave rectification without the use of a centre-tapped transformer, and therefore saves turns and space on the transformer.

The Voltage Doubler Circuit

The action is again evident by considering the paths of alternate half waves. It can be seen that both capacitors are being charged in the same direction to the full peak voltage of the supply. (This is shown in Fig. 14.) It will also be seen that the capacitors are connected in series with the load.

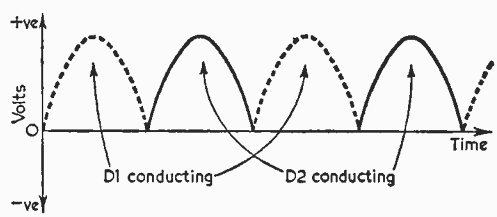

Fig. 10—This represents the output voltage from a full-wave supply, without a reservoir capacitor or smoothing components.

To indicate the advantage of the voltage doubler circuit, an A.C. input of 125V would probably give a D.C. output of 300V on load. With a bridge circuit, the input voltage would have to be about 300V root mean square (r.m.s) while for the same output (300V), a full wave C.T. circuit would have to provide about 600V r.m.s. overall. (Of course, the power taken from the supply would be the same, it is only the current that alters.)

When using the voltage doubler, the transformer windings must be thicker to carry the extra current, but this would be more than compensated by the reduced number of turns.

Metal Rectifiers

Metal rectifiers can be used instead of valves in all the circuits shown here. Indeed, their use is almost essential in some of the circuits. They have several advantages, of which the most important is that they have no heater supply. They can therefore be connected anywhere in a circuit without heater insulation difficulties. In addition they have an infinite life unless overloaded. They can be manufactured in very small sizes and have a high efficiency (about 80%). Metal rectifiers

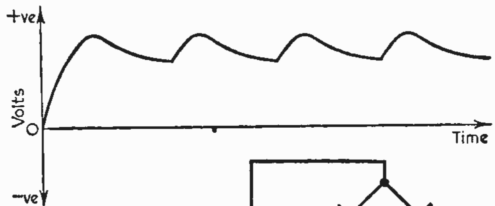

Fig. 11 (above)—The output voltage from a full-wave circuit with a reservoir capacitor.

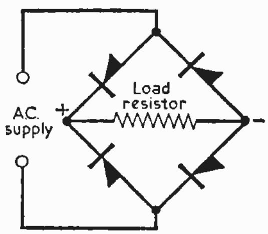

Fig. 12 (right)—A full-wave bridge circuit.

have an oxide coating, and it is this oxide that has a high resistance one way and a low one the other. In this way they rectify; but their action is not perfect, since they have a small reverse current. The rectifier has a maximum reverse voltage which it will withstand, but if this is exceeded the oxide film breaks down; but a number of elements can be connected in series to withstand any high voltage.

There are three types of metal rectifiers used in power supplies, copper, selenium and silicon.

The Copper Oxide Rectifier

This type has a disc of copper as the element. One side only has an oxide coating and contact is made with this oxide by means of a lead disc. Electrons flow best from the copper into the oxide.

The Selenium Rectifier

The metal used in this type, instead of copper, is an aluminium or nickel-plated steel disc, which is plated on one side with a thin layer of selenium. In this case the current flows easily from the aluminium or steel into the selenium.

The Silicon Rectifier

This is a development of the study of semi-conductors, and uses silicon in its construction. Because of the nature of its construction it has a very low forward resistance. It is therefore able to rectify a large current without dissipating much heat, or dropping much voltage. This forms an extremely efficient and compact rectifier, and unlike the other types of rectifier no cooling fins are required.

Conclusions

It is possible, when working out power supply voltages, to make accurate calculations for the effects of reservoir and smoothing components on output voltage and hum; but it is usually better for the home constructor to work more by trial and error. By increasing the reservoir capacitor, the H.T. is raised, while by increasing the inductance or the smoothing capacitor, the hum is reduced. If the reservoir capacitor is increased in value, make sure that it is not more than the

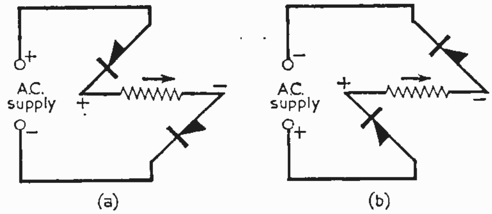

Fig. 13 (above)—These diagrams represent the actions of the bridge circuit of Fig. 12. Whatever the supply polarity, the load current is always in the same direction.

maximum permitted by the valve or rectifier manufacturer and that an adequate series resistance is in circuit with the rectifier. (This is to prevent large surges which could damage the valve or rectifier.)

In general, for a given r.m.s. input of xV, the bridge fullwave and halfwave circuits, give about xV D.C. output; while the voltage doubler gives about $2x$V D.C. output. This is only approximate, but gives an approximation of the output which may be expected from power supply. ■

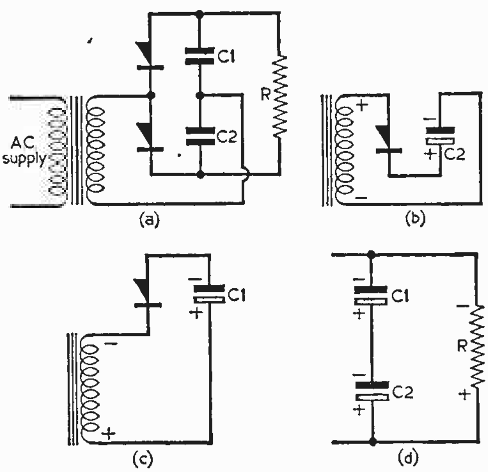

Fig. 14 (a)—The complete voltage doubler circuit.
(b)—When the supply voltage is as shown in the diagram, C2 is charged.
(c)—When the supply is reversed, C1 is charged as shown.
(d)—This shows that the charges on C1 and C2 are in series and discharge through the load resistor R.

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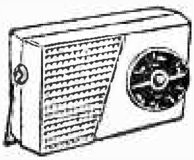

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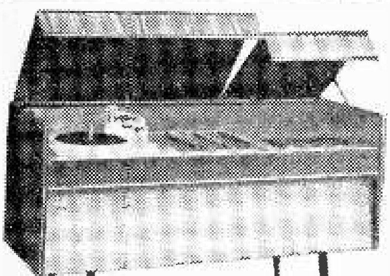

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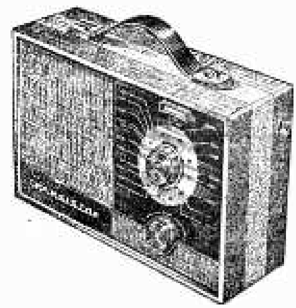

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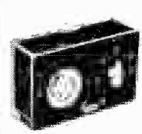

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The NEW 'SAVOY' 4-TRANSISTOR

SELF-CONTAINED
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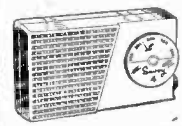
WITH MOVING COIL SPEAKER



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95/- Plus battery 2/- extra
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Practical Wireless

—BLUEPRINT— —SERVICE—

ALL OF these blueprints are drawn full-size and although the issues containing descriptions of these sets are now out of print, constructional details are available free with each blueprint except for the PW Monophonic Electronic Organ and the PW Roadfarer.

The Index letters which precede the Blueprint Number indicate the periodical in which the description appeared. Thus PW refers to PRACTICAL WIRELESS; AW to *Amateur Wireless* and WM to *Wireless Magazine*.

Send (preferably) a postal order to cover the cost of the Blueprint (stamps over 6d. unacceptable) to PRACTICAL WIRELESS, Blueprint Dept., George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2

SPECIAL NOTE

THE following blueprints include some pre-war designs and are kept in circulation for those constructors who wish to make use of old components which they may have in their spares box. *The majority of the components for these receivers are no longer stocked by retailers.*

Title	*Number*	*Price*
CRYSTAL SETS		
Junior Crystal Set	PW94	2/-
Dual-wave Crystal Diode	PW95	2/6
STRAIGHT SETS		
Battery Operated		
Modern One-valver	PW96	2/6
All-dry Three	PW97	3/6
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SUPERHETS		
A.C. Band-pass Three	PW99	4/-
A.C. Coronet-4	PW100	4/-
A.C./D.C. Coronet	PW101	4/-
The PW Pocket Superhet	——	5/-
MISCELLANEOUS		
The PW 3-speed Autogram	—	8/-
The PW Monophonic Electronic Organ (*No constructional details are available with this blueprint*)	—	8/-
The PW Roadfarer (*No constructional details are available with this blueprint*)	—	5/-
TELEVISION		
The PT Band III converter	—	1/6

Title	*Number*	*Price*
A.C. Fury Four	PW20	2/6
Experimenter's Short Wave	PW30a	2/6
Midget Short Wave Two	PW38a	2/6
Band-Spread Three (Battery)	PW68	2/6
Crystal Receiver	PW71	2/-
Signet Two (Battery)	PW76	2/6
Simple S.W. One-valver	PW88	2/6
Pyramid One-valver	PW93	2/6
BBC Special One-valver	AW387	2/6
Short-Wave Two	AW429	2/6
Short-Wave World Beater	AW436	3/6
Standard Four Valve S.W.	WM383	3/6
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Listener's 5-Watt Amplifier	WM392	3/6

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PRACTICAL WIRELESS, JANUARY, 1962

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£7.10.0 P.P. 2/-.

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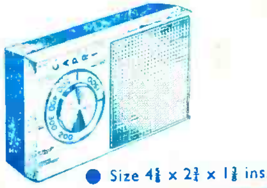

● Size 4⅜ x 2¾ x 1⅜ ins.

6-TRANSISTOR SUPERHET
- Push-Pull Output.
- 6 Mullard Transistors.
- Printed Circuit.
- Illustrated Building Instructions.
- Amazing Sensitivity.
- Housed in attractive two-tone moulded cabinet with mesh grill.

REALLY POCKET SIZE !

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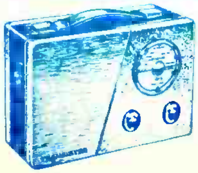

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● Full coverage on Medium and Long wavebands. Excellent quality with full station separation. Car aerial socket.

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- 250mW Push-Pull Output.
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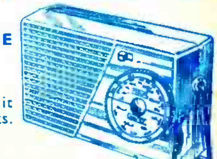
- Illustrated Plans.

A new printed circuit design fully tunable on both wavebands. Guaranteed reception of Continental and local stations including Luxembourg, anywhere with full station separation. Fitted Car Aerial and Earpiece Sockets.



Size 5¼ x 3 x 1¾in.

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After Sales Service and Guarantee
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NO EXTERNAL AERIAL OR EARTH—3-TRANSISTOR and 2 DIODES

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Personal Pocket Radio with 5 stages giving clear reception on medium wave, amateur top band and shipping.

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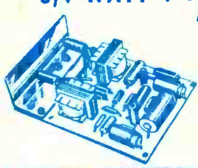
79/6 P.P. 1/6
Everything Supplied

- Easy to follow instructions with pictorial layout free on request.
- **Reception of Radio Luxembourg guaranteed.**

3/4 WATT 4 TRANSISTOR AMPLIFIER



- I watt peak output.

±3db 70c/s to 12 kc/s.

Output to 3 ohm speaker

9 volt operated.

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- High "Q" Internal Ferrite Aerial.
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SUPPLIED COMPLETE WITH MICROPHONE, BATTERIES, PERSONAL PHONE AND TAPE.

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7) C