MAY 1962

Practical WIRELESS

2/-

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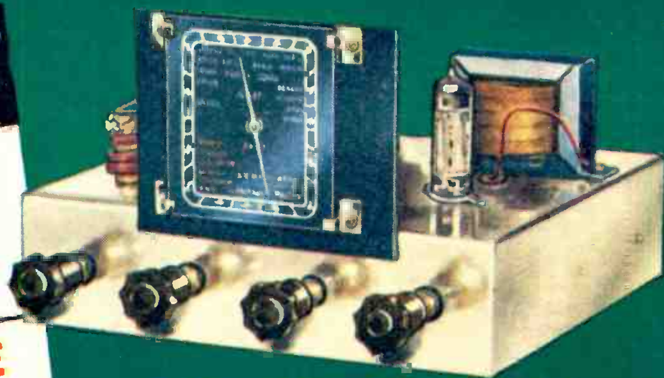
DOUBLE-SIDED BLUEPRINT for

★ TWO-VALVE M.W./L.W. MAINS RECEIVER

★ 6-TRANSISTOR BATTERY SUPERHET



THE P.W. BRITANNIC TWO

THE P.W. MERCURY SIX

Tel: Mitcham 6201
Open Daily to Callers

RST

All Valves Brand New and Fully Guaranteed

211 STREATHAM ROAD, MITCHAM, SURREY

Special 24 Hour Express Mail Order Service

Valve	Price
AC2PEN	21/-
AC2PEN DD	21/-
ACTP	32/-
ACVP1	17/6
AZ1	15/-
AZ31	10/-
B36	10/-
C1C	12/6
CBL31	21/-
CCH35	21/-
CL33	18/6
CY1	15/-
CY31	15/9
D77	4/-
DAC32	9/6
DAF91	7/6
DAF96	8/9
DCC90	14/6
DF33	10/-
DF91	4/-
DF92	7/-
DF96	8/6
DF97	9/6
DH63	6/-
DH77	7/-
DK32	11/6
DK91	8/-
DK92	8/6
DK96	8/6
DL33	8/6
DL35	10/6
DL92	7/6
DL93	7/-
DL94	8/-
DL96	8/6
EA50	2/-
EABC80	6/-
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
EBL1	22/6
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/-
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FC2A	21/-
FC4	15/-
FC13	21/-
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FW4/500	9/-
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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
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MVSPEN	17/6
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MU14	9/-
MX40	15/-
N18	8/-
N37	14/-
N78	17/6
N108	18/-
N308	20/-
N339	30/-
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
PCL84	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/-
5130	7/6
SP41	3/6
SP61	3/6
SU2150	25/-
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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
UY1N	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	4/-
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	7/6
6X5GT	8/6
6X6	15/-
630L2	10/-
7B5	12/6
7B6	10/-
7B7	8/6
7B8	8/-
7C5	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/-
1457	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	16/-
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/-
85A2	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 3/6, 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.

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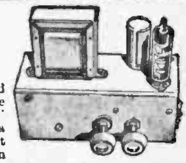
CHILD'S NURSERY LAMP

A child's night light of unusual design. Contemporary styled lampholder of robust construction finished in either red or yellow. Entirely safe (bulb socket shielded from "prying fingers") complete with flex and a push-button switch. 200/250 volts A.C. only. The low-consumption bulb element is made in the shape of either flowers or angel fish and when switched on, glows in fluorescent colours (the flowers pink with green leaves, or the fish green with purple weed). Made by a famous manufacturer and originally priced at 29/6. *Please state lampholder colour preference, and whether fish or flower element is required.*

OUR BARGAIN PRICE ONLY **10/9** plus 9d. post and packing.

HARVERSON'S Monaural Amplifier Kit



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 3½ x 6½in. 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, 4/6 plus post and packing. **39/6**

5in. LOUDSPEAKER TO SUIT. 14/6 EXTRA—All parts sold separately.

COIL AND TRANSFORMER SET FOR TRANSISTOR S'HET

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

E.M.I. 4-SPEED PLAYER AND PICK-UP

Heavy 8½in. metal turntable. Low flutter performance. 200/250V shaded motor with tap at 80V for amplifier valve filament if required. Turnover LP/78 head. PRICE **89/6** Plus 4/6 P. & P.

SPECIAL OFFER ...
6 TRANSISTOR RADIO IN KIT FORM

Limited quantity of new ex-manufacturer's parts to make a 6 transistor 2 wave s'het chassis. Ideal portable or table radio. All parts including transistors, ferrite aerial, printed circuit, etc., but excluding speaker and cabinet. Few Only. P. & P. 2/6 **£4.5.0**
Simple instrs. 1/6 (Free with kit).

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.

MIDGET 2 GANG CONDENSERS

Polystyrene cased, with built-in trimmers. Size 1 x 1 x ⅞ins. Not used, but removed from printed circuit boards.
UNBEATABLE VALUE for 2. P. & P. 1/-. **9/-**

Push Button Transistor Switch

A 3-button switch, specially designed for transistor radios. Button functions provided are on-off, long and medium wave. The back of switch is also equipped with a rack for mounting a ferrite Aerial. Easily worth 15/-. OUR PRICE ONLY **5/6** P. & P. 1/-.

HARVERSONS F.M. TUNERS

★ F.M. UNIT MARK II ★

MK.II F.M. Tuner, combines quailty with simple construction. The refinements and performance achieved equal many commercial models at twice the price. Attractive metal front panel in a choice of black crackle, or green or grey glossy hammer enamel.
★ Tuning Head by famous maker. ★ Guaranteed Non-drift. ★ Permeability Tuning. ★ Frequency coverage 88-100 Mc/s. ★ OA81 Balanced Diode Output. ★ Magic eye tuning. ★ Two I.F. Stages and Discriminator. ★ Maroon and gold dial (7 x 3in. glass). ★ Self-powered, using a quality mains transformer. ★ Valves used ECC85, two EF80's. EZ80 (rectifier) and magic eye. ★ Fully drilled chassis. ★ Everything supplied down to the last nut and bolt. P. & P. 10/-. **£6.12.6**
★ All parts sold separately. Circuit diagram and illustrations, 1/6, post free.

★ F.M. UNIT MARK I ★

The basic design is similar to our Mark II Unit but does not incorporate some of the lavish refinements. Emphasis placed on simple construction puts this within the capabilities of the novice. Coverage 88-100 Mc/s. Self-powered, All parts with 4 valves, glass dial and simple instructions. All parts sold separately. ONLY **£4.19.6** Plus 8/6 P. & P.

METAL CASE FOR THE ABOVE. Robust construction (using front panel as supplied with out Mark II unit). Finished in a choice of black crackle, or green or grey hammer enamel.
25/- P. & P. 1/9. (Front panel only 10/6. P. & P. 9d.).

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

A Complete F.M. Receiver in Kit Form, designed with the home constructor in mind. This is basically a quality self-powered F.M. tuner similar to the above plus 2 separate audio amplifier stages (using ECL82) on one chassis. Valves used ECC85, two EF80's, ECL82 and EZ80 (rect.). Everything supplied, down to the last nut and bolt. Compact size. All parts sold separately, including output transformer and quality speaker.
OUR PRICE **£6.19.6** Plus 4/6 P. & P.

6 TRANSISTOR & DIODE SUPERHET

A first-class 2 wave band transistor superhet in kit form.
★ Printed circuit panel (size 8½ x 2¾ins). ★ 3 Pre-aligned I.F. transformers. ★ O.P. transformer. ★ 5in. 5Ω speaker. ★ High gain ferrite rod aerial. ★ First grade G.E.C transistors. ★ Car aerial socket. ★ Push/pull output. ★ All parts sold separately. *All parts down to the minutest item with simple instructions.*
ONLY **£4.19.6** Plus 2/6 P. & P.

CYLDON TV TUNERS

All channels, 38 Mc/s I.F. Complete with valves. P. & P. 2/6. **32/6**
As above but with F.M. Channel. P. & P. 2/6. **45/-**
Latest Push-button Types. P. & P. 2/6. **59/6**

TABLE RADIO CABINET

A quality table radio cabinet which cost the manufacturers 35/- each to make). The positions of the controls make it ideal for housing our 6 Transistor Superhet described above. Beautifully finished in walnut and tygan. ONLY Plus 1/6 P. & P. ins. **18/6**

CONDENSER/RESISTOR PARCEL

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

54in. Loudspeaker Silk

Heavily woven in ivory and gold. Originally 35/- per yard. OUR PRICE. 13/6 per yard length. P. & P. 1/6.

AUDITRON HI-FI TAPE RECORDER KIT

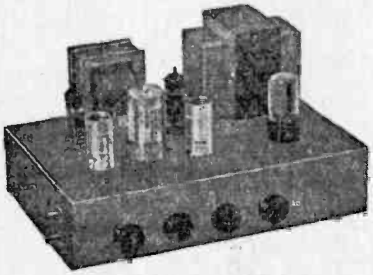
REALISM AT INCREDIBLY LOW COST. CAN BE ASSEMBLED IN HALF AN HOUR
The Recorder incorporates the Latest Collaro Studio Tape Transcriptor. The Audiotron High Quality Tape Amplifier listed £12.12.0 High Flux P.M. Speaker listed 30/-, empty Tape Spool, a Reel of Best quality Tape listed 22/6, and a Handsome Portable carrying Cabinet with latest attractive-two tone polychrome finish, size 14¼ x 15 x 8¼in. 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/s. Six negative feedback loops. Hum level 60 D.B. down. ONLY 23 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For **STANDARD** or **LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, 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.

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

A complete set of parts for the construction of a stereophonic amplifier giving 5 watts high quality output on each channel (total 10 watts). Sensitivity is 50 millivolts, suitable for all crystal stereo heads. Ganged Bass and Treble Control give equal variation of "lift" and "cut". Provision is made for use as straight (monaural)10 watt amplifier. Valve line-up ECC83, ECC83, EL84, EL84, EZ81. Outputs for 2-3 ohmspeakers. 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.

BRADMATIC RECORDING HEADS. High Impedance Record/Playback 22/-. Low Impedance Erase, 12/6.

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. BATTERY CHARGING EQUIPMENT

All for AC. 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. 59/6. Carr. 4/6.

PARMEKO POTTED CHOKES

200 mA. 12 H 100 ohms	16/9
120 mA. 30 H 200 ohms	16/9
120 mA. 8 H 10 ohms	13/9

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

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

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

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. 9/6.

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

Interleaved and Impregnated. Primaries 200-230-250 v. 50 c/s. Screened

TOP SHROUDED DROP THROUGH

250-0-250v. 70mA. 6.3v. 2a. 6.3v 2a	17/9
350-0-350v. 80mA. 6.3v. 2a. 5v. 2a	18/9
250-0-250v. 100mA. 6.3v. 2a. 6.3v. 1a	21/9
250-0-250v. 100mA. 6.3v. 3.5a. C.T.	19/9
250-0-250v. 100mA. 6.3v. 4a. 5v. 3a	25/9
300-0-300v. 130mA. 6.3v. 4a. 6.3v. 1a. for Mullard 510 Amplifier	29/9
300-0-300v. 100mA. 6.3v. 4a. 5v. 3a	26/9
350-0-350v. 100mA. 6.3v. 4a. 5v. 3a	26/9
350-0-350v. 150mA. 6.3v. 4a. 0-5-6.3v. 3a	29/9

FULLY SHROUDED UPRIGHT

250-250v. 60mA. 6.3v. 2a. 0-5-6.3v. 2a. Midget type 2½-3-3in.	17/11
250-0-250v. 100mA. 6.3v. 4a. 5v. 3a	27/9
300-0-300v. 100mA. 6.3v. 4a. 5v. 3a	27/11
300-0-300v. 130mA. 6.3v. 4a. C.T. 6.3v. 1a. for Mullard Amplifier	33/9
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FULLY SHROUDED (continued)—

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450-0-450v. 250mA. 6.3v. 4a C.T. 5v. 3a.	69/9

OUTPUT TRANSFORMERS

Midget Battery Pentode 66:1 for 3S4, etc.	3/9
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Small Pentode 7/8,000 Ω to 3 Ω	3/9
Standard Pentode 5,000 Ω to 3 Ω	5/9
Standard Pentode 7/8,000 to 3 Ω	5/9
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Both above size 2½ x 2½ x 2½ins.

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SMOOTHING CHOKES

150 mA. 7-10H 250 ohms	11/9
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60 mA. 10 H 400 ohms	4/11

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R.S.C. (M/c) Ltd. SHEFFIELD, HULL, 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/s. A.C. Mains and has output for 3 and 15 ohm speakers. Complete kit of parts with fully punched chassis and point-to-point wiring diagrams and instructions. If required perforated cover with carrying handles can be supplied for **19/9.** The amplifier can be supplied, factory built with EL34 output valves and 12 months guarantee, for **14 Gns.**

11 Gns. Carr. 10/-

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

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Jason FMTI V.H.F/FM Radio Tuner design. Total costs 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/s. Output for 2-3 ohm speaker. Three miniature Mullard valves used. Size of unit only 7-5-5½in. high. Guaranteed for 12 months. Only **£5.19.6.** Send S.A.E. for illustrated leaflet. Terms: Deposit **22/6** and 5 monthly payments of **22/6.**

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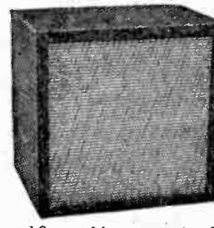

Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only **£4.19.6** Carr. 5/-. Terms: Deposit **11/3** and 8 monthly payments of **11/3.**

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

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

R.S.C. PORTABLE GUITABLE AMPLIFIERS. (For 200-250v. A.C. Mains)
Junior 5 watts High Quality output. Separate Bass and Treble "Cut" and "Boost" controls. Sensitivity 15 m.v., Twin inputs. High Flux 8in. Loudspeaker "built-in". Handsome, strongly made Cabinet (size approx. 14 x 14 x 7in.) finished in attractive and durable policrome, and fitted carrying handle. Terms, Deposit £1 and 9 monthly payments of £1. **£8.19.6** Carr. 10/-

Senior 10 watts High Fidelity output Separate Bass and Treble "Cut" and "Boost" controls. Twin separately controlled high gain inputs so that two instruments such as Guitar and String Bass can be used at the same time. Two loudspeakers are incorporated, a high Flux 12in. for Bass notes and a 7 x 4 in. elliptical for Treble. Cabinet is well made and finished as Junior model. Size approx. 18 x 18 x 9in. **15 Gns.** H.P. Terms. Deposit **34/9** and 9 monthly payments of **34/9.** Carr. 10/-.
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R.S.C. BASS REFLEX CABINETS, JUNIOR MODEL. Specially designed for W.B. HF1012 Speaker, but suitable for any good quality 10in. speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18 x 12 x 10in. Handsome appearance. Ensure superb reproduction for only **£3.19.6.**
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PLESSEY DUAL CONCENTRIC 12in. 15 ohms HIGH FIDELITY SPEAKER (12,000 lines) with built-in tweeter (completely separate elliptical speaker with choke, condensers, etc.) providing extra-ordinarily realistic reproduction when used with our A11 or similar amplifier. Rated 10 watts. Price only **£5.19.6.**
P.M. SPEAKERS. 2-3 ohm. 2½in. Perdio **21/9.** 5in., **17/9.** 6½in., **16/9.** 8in. **19/9.** 8 x 5in. **25/9.** 10in. **26/9.** 10 x 6in. **29/9.** 12in. **29/11.** 10in. W.B. "Stentorian" 3 or 15 ohms type HF1012 10 watts, hi-fidelity type. Recommended for use with our A11 Amplifier. **£4.12.9.** 12in. R.A. 3 ohms 10 watts (12,000 lines). **59/6.**
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HI-FI CRYSTAL PICK-UP HEADS. (Turnover type with sapphire stylus.) Acos. Standard replacement for Garrard, B.S.R. and Collaro. **19/9.** Acos Stereo-Monaural **49/9.** Ronette Stereo/Monaural **59/6.**
R.S.C. EQUIPMENT CABINET. Dimensions and outer appearance identical with Standard Bass Reflex Cabinet. Top hinged. Bass board adjustable. Will take Tape Deck or Player Unit, and Amplifier plus F.M. or A.M./F.M. Unit. Only **6 gns.**
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.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces battery supplying 1.4 v. and 90 v. where A.C. mains 200-250v. 50 c/s is available. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** This includes latest low consumption types.

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Complete kit with diagrams, **39/9,** or ready to use, **46/6.**

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

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1G6	17/6	6F33	7/6	12AT7	6/-	90AG	67/6	DM70	7/6	EF83	13/6	KL35	8/6	PY82	7/-	UCH42	9/6	CG10E	4/-
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1LN5	5/-	6J7G	6/-	12BE6	9/-	101	13/6	EA76	9/6	EF91	4/6	KT36	30/7	QP25	14/6	UF41	9/-	GET103	5/6
1N5GT	10/6	6J7GT	10/6	12BH7	21/10	150B2	18/-	EABC80	9/-	EF92	4/6	KT41	23/10	QS150/15		UF42	12/6	GET111	9/10
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1S4	9/-	6K7GT	6/-	12J7GT	9/6	304	10/6	EAF42	9/-	EF98	13/7	KT61	12/6	R12	9/-	UF85	9/-	OA70	3/-
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1T4	3/6	6K8G	6/6	12K7GT	5/6	807	7/6	EB41	8/6	EF184	12/6	KT66	15/-	R19	20/5	UF89	9/-	OA79	3/-
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3A5	10/6	6L7GT	7/6	12SG7	7/-	7193	5/-	EBC81	8/-	EL34	15/-	KTZ41	8/-	SP41	3/6	UM4	17/9	OA210	11/-
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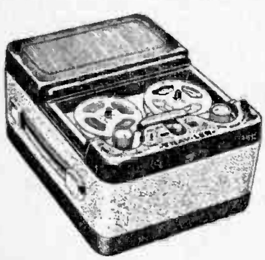
3Q4	7/6	6N7	8/-	12SK7	6/-	AC/PEN		EBF89	9/6	EL42	10/6	MHL4	7/6	SU25	27/2	URIC	19/1	OC19	48/-
3Q5GT	9/6	6P28	27/2	12SQ7	11/6	5-pin	23/10	EBL1	30/6	EL81	17/-	MHLD6	12/6	T41	9/-	UU6	20/5	OC22	28/-
3S4	7/-	6Q7G	6/6	12SR7	8/6	7-pin	15/-	EBL21	23/10	EL83	20/5	ML4	8/6	TDD4	12/6	UU8	27/2	OC23	87/-
3V4	7/6	6Q7GT	11/-	12Y4	10/6	AC2PEN/		EBL31	23/10	EL84	7/6	MS4B	23/10	TH41	27/2	UY1N	19/1	OC26	25/-
5R4GY	17/6	6R7G	10/-	19AQ5	10/6	DD	12/6	EC52	5/6	EL85	14/4	MU12/14	8/-	TP22	15/-	UY21	17/-	OC28	25/-
5U4G	6/6	6SA7GT	8/6	19H1	10/-	AC6PEN	7/6	EC54	6/-	EL86	17/9	N37	23/10	TP25	15/-	UY41	7/6	OC29	45/-
5V4G	10/-	6SC7	7/6	20D1	15/8	AC/TP	34/-	EC70	12/6	EL91	5/-	N78	20/5	TY86F	13/7	UY85	7/-	OC35	25/6
5Y3	6/6	6SG7GT	8/-	20F2	27/2	ATP4	5/-	EC81	27/6	EL95	10/6	N108	23/10	U12/14	8/6	VMP4G	15/-	OC44	11/-
5Z3	20/5	6SH7GT	8/-	20L1	27/2	AZ1	19/1	EC92	13/7	EL820	19/1	N308	21/2	U16	10/-	VMS4B	15/-	OC45	10/-
5Z4G	9/-	6SJ7GT	8/-	20P1	27/2	AZ31	10/-	ECC32	5/6	EL821	27/2	N339	15/-	U19	48/6	VP2	12/6	OC65	22/6
6A7	10/6	6SK7GT	6/-	20P3	23/10	AZ41	14/4	ECC33	8/6	EL822	19/6	P61	3/6	U22	8/-	VP4	15/-	OC66	25/-
6A8	9/-	6SL7GT	6/6	20P4	27/2	B36	15/-	ECC34	25/3	EM34	9/6	PABC80	14/4	U24	30/7	VP4B	23/10	OC70	6/6
6AC7	4/-	6SN7GT	5/6	20P5	23/10	BL63	7/6	ECC35	8/6	EM71	23/10	PCC84	8/-	U25	18/5	VP13C	7/-	OC71	6/6
6AG5	5/6	6SQ7GT	9/-	25A6G	10/6	C1	12/6	ECC40	23/10	EM80	9/-	PCC85	9/6	U26	10/-	VP23	6/6	OC72	9/-
6AG7	7/6	6SS7GT	8/-	25L6GT	11/6	C1C	12/6	ECC81	6/-	EM81	9/-	PCC88	18/-	U31	9/6	VP41	6/-	OC73	16/-
6AK5	8/-	6U4GT	12/6	25Z4G	9/6	CBL1	27/2	ECC82	6/6	EM84	10/6	PCC89	11/6	U33	27/2	VR105	8/-	OC75	8/-
6AL5	4/-	6U5G	7/6	25Z5	9/6	CBL31	23/10	ECC83	7/6	EM85	17/9	PCF80	8/-	U35	27/2	VR150	7/6	OC77	15/-
6AM6	4/6	6U7G	8/6	25Z6G	20/5	CCH35	23/10	ECC84	9/-	EN31	53/-	PCF82	10/6	U37	27/2	VT61A	5/-	OC78	8/-
6AQ5	7/6	6V6G	7/-	27SU	20/5	CK506	6/6	ECC85	8/6	EY51	9/-	PCF84	17/-	U45	13/6	VT501	5/-	OC81	8/-
6AT6	7/-	6V6GTG	8/-	28D7	7/-	CL33	19/9	ECC88	18/-	EY83	17/-	PCF86	15/-	U50	6/6	W76	5/6	OC139	24/-
6AU6	10/-	6X4	5/-	30C1	8/-	CV63	10/6	ECF80	10/6	EY84	14/-	PCL82	10/-	U52	6/6	W81M	6/-	OC170	13/6
6B8	5/-	6X5GT	6/-	30C15	17/-	CY1	19/1	ECF82	10/6	EY86	9/-	PCL83	10/6	U54	20/5	W107	19/1	OC171	14/6
6BA6	7/6	6/30L2	10/-	30F5	6/-	CY31	11/-	ECF86	20/5	EZ35	6/-	PCL84	12/6	U76	6/-	W729	20/5	OC200	16/6
6BE6	6/-	7B7	8/6	30FL1	10/-	D15	10/6	ECF804	20/-	EZ40	7/-	PCL85	17/-	U191	17/-	X41	15/-	OC203	24/-
6BG6G	23/10	7C5	8/-	30FL12	19/1	DAC32	10/6	ECH3	27/2	EZ41	7/-	PCL86	17/-	U201	17/-	X61(C)	12/6	OCP71	29/6
6BH6	8/-	7C6	8/-	30L1	8/-	DAF91	6/-	ECH21	23/10	EZ80	7/-	PENA4	23/10	U251	14/-	X63	9/-	TP2	40/-
6BJ6	6/-	7H7	8/-	30L15	11/6	DAF96	8/6	ECH35	6/6	EZ81	7/-	PEN25	4/6	U281	20/5	X65	12/6	TS1	10/-
6BQ7A	15/-	7R7	12/6	30P4	12/-	DD41	14/4	ECH42	9/6	FC4	15/-	PEN45	19/6	U282	23/2	X66	12/6	TS2	12/6
6BR7	12/6	7S7	9/6	30P12	7/6	DET25	7/6	ECH81	9/-	FW4/500	8/6	PEN46	7/6	U301	23/10	X76M	14/-	TS3	15/-
6BR8	19/1	7Y4	7/6	30PL1	10/6	DF33	10/6	ECH83	14/4	FW4/800	8/6	PEN383		U329	14/-	X78	23/10	TS4	24/-
6BW6	8/6	8D2	3/6	30PL13	13/6	DF66	15/-	ECL80	9/-	GU50	41/6		23/10	U339	17/-	X79	23/10	V30/10P	28/6
6BW7	6/-	9BW6	15/8	35A5	21/10	DF91	3/6	ECL82	10/6	GZ30	9/-	PEN/DD		U403	17/-	X109	17/9	VC/R2	9/3
6C4	5/-	9D2	4/-	35L6GT	9/6	DF96	8/6	ECL83	19/9	GZ32	10/-	4020	34/-	U404	8/6	XD(1.5)	6/6	XA101	9/-
6C5	6/6	10C1	13/-	35W4	7/6	DF97	9/-	ECL86	17/-	GZ33	20/5	PL33	19/9	U801	30/7	XFG1	18/5	XA102	10/-
6C6	6/6	10C2	27/2	35Z3	19/1	DH63	6/6	EF9	23/10	GZ34	14/-	PL36	12/-	U4020	19/1	XFY12	9/6	XA103	15/-
6C9	13/6	10F1	27/2	35Z4GT	6/-	DH76	5/-	EF22	14/-	GZ37	20/5	PL38	27/2	UABC80	9/-	XFY34	18/-	XA104	18/-
6CD6G	37/5	10LD11	16/4	35Z5GT	9/-	DK32	12/-	EF36	4/-	HABC80		PL81	10/6	UAF42	9/6	XH(1.5)	6/6	XB102	6/-
6CH6	9/-	10P13	15/-	43	10/-	DK91	6/6	EF37A	8/-		13/6	PL82	7/6	UB41	12/-	XSG(1.5)	6/6	XB103	6/6
6CW4	24/-	10P14	19/9	50C5	10/-	DK92	9/-	EF39	5/6	HL2	7/6	PL83	9/-	UBC41	8/6	Y63	7/6	XB104	7/-
6D6	6/6	12A6	5/-	50CD6G		DK96	8/6	EF40	15/-	HL23	15/8	PL84	13/-	UBC81	11/8	Z66	17/6	XC101	6/6
6E5	12/6	12A8	16/6		37/5	DL33	9/6	EF41	9/-	HL23DD	7/6	PL820	19/1	UBF80	9/-	Z77	4/6	XC131	16/-

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



SENSATIONAL OFFER!

Brand new, fully portable transistor tape recorders. Size 10 x 8 x 5in. Weight 9 lbs. Playing time 44 mins. Battery life 50 hours. Rewind time 2½ mins., 7 x 4in. high-flux speaker. Record level indicator. Speaker switch. Pause control. All the features of a full size machine. Complete with tape and dynamic microphone. Reduced from £30 to only 16½ gns. Batteries extra. Carriage/insurance 10/-.

METAL RECTIFIERS. DRM1B 13/-. DRM2B and DRM3B 15/6, LW7 21/-, RMO 7/11. RM1 5/3. RM2 7/6. RM3 7/9, RM4 14/-, RM5 19/6. 14A86 17/6, 14A97 25/-, 14A100 27/-, 14A124 28/-. 14A163 33/-, 14B130 35/-, 14B261 11/6, FC101 17/6. 16RC.1.1.16.1 8/6, FC31 21/-. 16RD.2.2.8.1 12/-. 16RE.2.1.8.1 8/6, 18RA.1.1.8.1 4/6, 18RA.1.2.8.1 11/-. FC116 6/6. FC124 15/-, LW15 25/-.
ELECTROLYTIC CONDENSERS. Can types. 32 x 32/450v. 5/9, 50 x 50/350v. 7/- 64 x 120/350v. 8/3. 60 x 250/275v. 9/6. 100 x 400/275v. 12/6, 100/275v. 3/-, 200/275v. 4/-. 100x 200/275v. 9/6. Tubular types: 8/450v. 1/9, 16/450v. 2/9. 32/450v. 3/9, 8 x 8/450v. 3/-, 16x 16/450v. 4/-, 32 x 32/350v. 4/-, 8 x 16/450v. 3/9.
P.M. SPEAKERS. 3 ohm types. 2½" 17/-, 5" 15/6, 6½" 17/-, 7 x 4" 15/-. 10" 27/-. 12" 29/6, 2½" 80 ohms 17/6. 12" Auditorium with latest foam plastic suspension, handles 15 watts. Aluminium re-entry dome, 15 ohms. £8.8.0. 12" Quality type. Handles 15 watts, 15 ohms. £5.5.0. Post 2/- each.

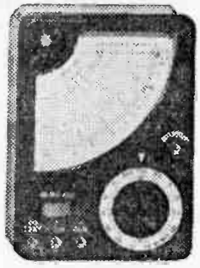
ALL GOODS BRAND NEW, SUBJECT TO FULL GUARANTEE, AND ACTUALLY IN STOCK.

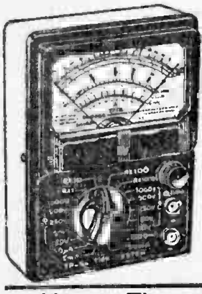
Post packing charge 6d. per item except where stated. Orders over £3 post free. C.O.D. 2/6 extra. Full List with Terms of Business, 6d. Any parcel insured against damage in transit for only 6d. extra. Shop Hours 8.30-5.30. Early Closing Saturday 1 p.m.

MULTI-METER BARGAINS!

MODEL 200H (Illus. on right). 20,000 ohms per volt, 20 ranges comprising A.C. volts, 5 ranges up to 1,000V D.C. volts, 6 ranges up to 2.5KV, C.C. current, 3 ranges up to 26 ohms, resistance, 2 ranges up to 6 meg. capacity 2 ranges up to 0.1, decibels —20 to +22. Scale cornerwise to the equivalent of 4 in. movement is a pocket size instrument measuring 4½ x 3½ x 1in. Complete with test prods, battery and operating instructions, price **£6.19.6,** post free.

MODEL EP10K. Similar in size and appearance to 200H except that this is 10,000 ohms per volt and maximum D.C. volts 1,200 instead of 2.5K, also no capacity range. Price **£5.19.6.** Post free.





ALL METERS BRAND NEW AND FULLY GUARANTEED

MODEL TP5S. (Illus. on left). 20,000 ohms per volt, D.C. volts, 5 ranges up to 1,000 A.C. volts, 5 ranges up to 1,000 resistance, 2 ranges up to 10 meg., capacity 2 ranges up to 0.1 decibels —20 to +26. One switch control really beautifully made precision instrument, size only 3½ x 5½ x 1⅜in., price only **£5.19.6.** Post free.

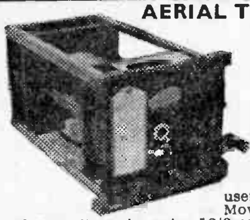
MODEL TP10. Similar in size and appearance to TP5S, but sensitivity 2,000 ohms per volt, price **£3.19.6.** Post free.

MODEL U1. A robust instrument of 1,000 ohms per volt sensitivity. A.C./D.C. volts up to 1,000. D.C. current up to 500, resistance up to 200K, size 5¼ x 3½ x 2¾ins. complete with test prods, single switch control, large easily read scale, price only **£2.19.6.** Post free.

15 amp Thermostat

Adjustable over a fairly wide range of temperatures, suitable for wall mounting to control heating. Exceptional bargain at 9/6, plus 1/- post and insurance.
Suitable crackle finished case 7/6 extra.

AERIAL TUNING UNIT

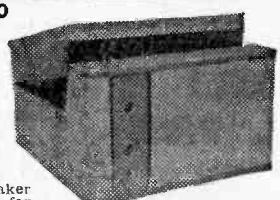


This comprises variometer in the form of silver plated coil, contact being made by geared wheel controlled by the handle in the front. The position of the wheel is indicated by a veedermeter fitted in the front. The unit also contains many useful spares including Moving Coil Meter. Limited quantity only, price 12/6 each, post and ins. 3/6

1½W Transistor Amplifier

4 transistors including two in push-pull—input for crystal or magnetic microphone for pick-up—feed back loops—sensitivity 5 m/v—output 1½ watt peak into 35 ohm speaker. Speakers available. Price 62/6. Postage and Insurance 2/6.

PHILCO STEREO RECORD PLAYER CABINET



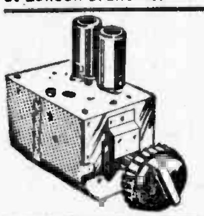
A beautifully made fabric covered cabinet 17 x 15 x 9½in., designed to take amplifier, autochanger and two speakers, top speaker being removable for stereo. Must have cost at least £4 each to make, available at the special snip price of 45/-, plus 5/- carriage and insurance.

Several other Philco cabinets are available to callers at London branches.

Transistorised Stethoscope

Trace signal right through, Radio, T.V., Tape amplifier: Hi-Fi, etc.—simplest way to fault-find—carry it like a fountain pen—all parts including transistor barrel crystal, everything except battery, 12/6 plus 1/6, data included or separately 1/6. Or complete with deaf aid type earphone, 20/-.

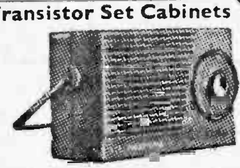
BRAYHEAD TURRET TUNER



complete with Band 1 and Band 3 coils. New but removed from unused equipment. Less valves 15/- each or with valves 25/- each. Post 2/6.

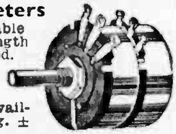
Knobs 3/6 extra.

Transistor Set Cabinets



Very modern cream cabinet, size 5¼ x 3 x 1⅞in. with chrome handle, tuning knob and scale. Price 7/6, plus 1/6 postage and packing.
Special quotations for quantities.

Morganite Potentiometers



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

CLEARING DEPOT!

MORE unused, good quality equipment being offered at very keen prices!

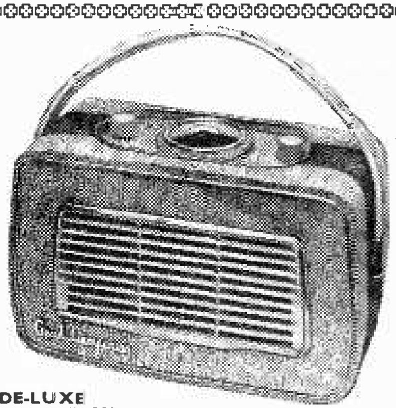
- **Transistor output transformer,** to match OC81 into 3 ohm, 4/6.
- **Small Bakelite cabinet,** suit table radio of any type 6/6, plus 2/- postage and insurance.
- **Potmeters** long spindle, no switch, following values available all **1/6.** Each 25K ½ meg. 50K 1 meg. 100K 2 meg. Ditto with SP switch, 2/- each.
- **Crystals.** American make two pin plug any type, 10/- doz. our assortment.
- **Fortiphone** transformer, type N23, for transistor circuits, 5/-.
- **3 valve amplifier** for portable record player, £2.10.0 complete.
- **Potmeters wire wound,** standard size, following values:—1K, 5K, 25K, 100 ohm, 220 ohm, 50 ohm, all 2/- each.
- **Electrolytic condensers,** standard size 1,000 MFD 6 v. 3/3. 100 MFD 200 v. 2/6. 250 MFD 200 v. 2/6. 32 MFD 350 v. 1/10. 16 MFD 350 v. 1/6. 8 MFD 350 v. 1/3. 8 MFD 150 v. 1/-. 4 MFD 150 v. 1/-. 12 MFD 50 v. 9d. 50 MFD 6 v. 9d. 25 MFD 25 v. 9d. 100 + 200 MFD 250 v. 3/6. 8 + 16 MFD 350 v. 2/6. 32 + 32 MFD 375 v. 3/3.
- **Flat TRS** cable for electric wiring, 3/029 3 core 1/-. 3/029 twin with earth. 9d., 3/029 twin, 8d., 3/029 single 4½d. 7/029 twin, 1/-, 7/029 3 core, 1/3. 7/036 twin, 2/-, 7/036 3 core, 2/6. 7/044 2 core, 2/6. All prices are per yard.
- **Thermistors,** type No. not known, 6/- per doz.
- **Wonder plug** connector for extending leads, 6/- per doz.
- **Moving Coil Meter,** flush 2in. 0-350 RF, 6/6.
- **Set of coils** for Long and Medium Wave radio with circuit, 5/6.
- **¼in. spindle connectors,** metal with grub screws, 4/6 per doz.
- **Knobs instrument** type, medium size, 9d. each.
- **Slow Motion Drive,** epicyclic 1/6.
- **Resistors,** 1½ watt 100 assorted comprise two each of 50 values covers good range up to 2 meg., 10/-.
- **TCC metal pack condensers,** 1 MFD 500 v. 3/-. 0.5 MFD 500 v. 2/-. 0.25 MFD 500 v. 1/9. 0.25 MFD 350 v. 1/6. 0.1 MFD 100 v. 1/9. 0.01 MFD 1,000 v. 1/-. 0.005 MFD 1,000 v. 1/3. 0.002 MFD 500 v. 1/-.
- **Carbon pile regulators,** 9/- each.
- **Midget coils.** double tuned with dust cores, frequency not known, useful for rewinding, 6/- per doz.
- **VCR 139 A,** cathode ray tube, 19/6 each. Plus 2/- post and insurance.
- **465 KC miniature I.F.** transformers, potted, 5/- a pair.
- **Wonder plugs** lockable types, 6/- per doz.
- **High to low headphone adapters,** 2/6 each.
- **Stand-off insulator porcelain with brass** insets, threaded 2 BA, 1/6.
- **High voltage tubular condensers,** 0.1 MFD 2,500 v. Bakelite cased, 2/6.
- **Thermal delay switch,** 6.3 v. operated, 6/6 vacuum type, 2/9 open type.
- **Heater Transformers,** 6.3 v. 3/4 amps., unused but soiled, 6/- each.
- **B7G Valve Holder** with skirt for screening can, 6/- doz., less skirt 5/- doz.
- **TV Cabinet** 14in., modern design, must have cost at least £4 to make, the plywood is worth more than our give away price of 9/6 each, plus 4/6 carriage and insurance.

Please include enough for postage and request "Clearing Depot List", for details of many other items.

Britain's MOST Popular Portable . . .

The "GOOD COMPANION"

CAR RADIO & PORTABLE



DE-LUXE CABINET 20/- extra

One of the finest of its kind available. The design is the combined efforts of our technicians and of those of several of the leading manufacturers in the country, and the resulting set has a performance as good as if not superior to those selling at £20 and more. *It has the eight transistor set performance.* Features include **American Philco R.F. transistors and Mullard A.F. transistors**—Q.P.P. output giving 750 mW—full coverage on Medium and Long—very fine tuning arrangement—excellent reception of difficult stations like 208—variable feed-back control—full tonal qualities—really superior looking cabinet size 11 x 8 x 3in. approximately—car aerial attachment—several months' operation from battery costing only **3/6.**

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 guar.

Price of all components and Standard Cabinet £9.19.6 **Post and Insurance 5/- Battery 3/6 extra.**

MK2 CIRCUIT

uses latest ceramic transfilters in place of the normal I.F. transformers. This saves alignment problems and improves performance. **Price 10/- extra.**

AGENTS

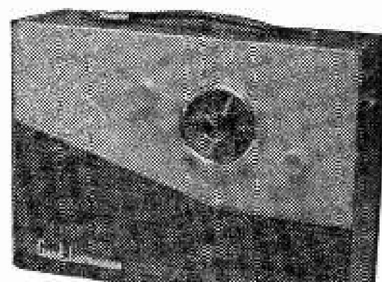
wanted to build up our Companion Receivers. Send addressed envelope for full particulars to Eastbourne.

The "POCKET COMPANION"

This is without doubt the most modern and best pocket set available. It uses the very latest I.F. transfilters, Philco R.F. transistors, airspaced tuning condenser in Superhet circuit covering M.W. and L.W. Complete building cost £6.15.0. Battery 2/- Post and Ins. 2/6. Data free with parts or separately 2/6.

The "TREMENDO COMPANION"

If you don't mind the battery consumption being a little higher and you want really big output then order The "Tremendo". This has an undistorted output of almost 1¼ watts and is probably the most powerful home constructor set available today. Complete building cost of this is **£10.15.0,** which includes the transfilter (Mk. II circuit) batteries cost 3/6 (two required).



STANDARD CABINET

All components for the

IMPROVED PIMPERNEL

5 Transistor Radio

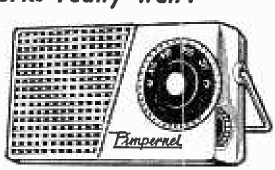
that works really well!

ONLY

69/6

Postage and Insurance 2/6

Battery 2/-



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

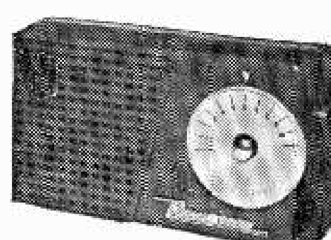
Circuit diagram FREE with parts or 2/- separately.

OPTIONAL EXTRAS

All components and switch for Long Waves	8/6
Motif "Pimpernel"	2/-

THE POCKET "4"

Proved without doubt the easiest of all to make!



Circuit comprises 2 HF transistors reflexed to equal 4 stages. Permanent germanium diode and high gain AF output stage, fitted with miniature speaker. Proper tuning condenser, volume control and in case with handle as illustrated (less monogram), completely portable. **No aerial or earth required.**

Pocket 4 uses 3 transistors and 1 diode, price **42/6,** plus 2/6 post and insurance.

Pocket 5 uses 4 transistors and 1 diode and has feedback control, price 55/-, plus 2/6 post and insurance.

Prices are for medium wave models, long or medium versions 6/6 extra.

GOOD RESULTS EVERYWHERE

Nothing can be more disappointing than to find that despite care in making up, your radio just will not work or needs a long high aerial and water pipe earth. We can prove good results in all areas and we guarantee all components for 12 months. Hundreds of testimonials received. Send in confidence. Plans free with parts, or separately 1/6. Demonstrations at all branches.

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THE MOST COMPREHENSIVE COMPETITIVE VALVE LIST IN THE COUNTRY

10% DISCOUNT SPECIAL OFFER TO PURCHASERS of any SIX VALVES marked in black type (15% in dozen). Post: 1 valve, 6d., 2-11, 1/-.

NEW LOW PRICES GUARANTEED 3 MONTHS

FREE TRANSIT INSURANCE. All valves are new or of fully guaranteed ex-Government or ex-equipment origin. Satisfaction or Money back Guarantee on goods if returned unused within 14 days.

OZ4	5/-	6J5GT	4/-	12E1	17/6	DF96	7/3	EM80	7/9	SU25	16/-
1A5GT	5/-	6J6	4/-	12J7GT	9/-	DH63	6/-	EM81	8/6	SU2150	4/6
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3A4	4/9	6LD12	6/9	20L1	16/-		8/-	GZ34	12/6	U78	5/-
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5Z4	11/-	6SN7GT	4/6	30FL1	9/6	EBL21	12/6	KT61	8/6	UBF89	7/6
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6A8GT	13/6	6X4	5/-	35T	25/-	ECC35	6/-	L63	2/9	UCH81	12/-
6AB8	7/-	6X5G	5/-	35W4	6/9	ECC40	14/-	LN152	7/-	UCL82	9/-
6AC7	3/8	6X5GT	5/6	35Z4GT	5/6	ECC81	5/6	MU14	7/6	UCL83	13/6
6AG5	3/-	6Y6G	7/6	35Z5GT	8/-	ECC82	6/-	N37	11/-	UF41	7/6
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6D2	3/-	10P14	9/-	B36	7/9	EF80	4/9	PL83	6/6	W81	7/3
6D3	9/6	10P18	7/-	CIC	9/6	EF85	6/6	PL84	8/-	X61M	11/-
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6F6G	5/9	12AD6	17/-	CCH35	14/-	EF91	3/-	PX25	9/6	X66	11/-
6F12	3/-	12AE6	13/9	CL33	9/6	EF92	4/6	PY31	9/-	X76M	11/-
6F13	6/9	12AH8	9/-	CY31	9/-	EF96	3/-	PY32	10/-	X78	21/-
6F14	9/6	12AT6	7/6	D77	3/6	EL32	4/6	PY80	6/9	X79	16/6
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6F23	6/6	12AX6	6/6	DAF91	4/6	EL42	8/9	PZ30	9/6	Z66	9/6
6F32	6/6	12BA6	7/6	DAF96	7/3	EL83	11/-	R18	11/-	Z152	4/9
6F33	6/6	12BE6	7/6	DET19	2/9	EL84	7/-	R19	11/-	Z719	4/9
6J5	4/3	12BH7	9/9	DF33	9/9	EL91	4/-	SP41	2/6	ZD152	7/9
6J5G	3/-	12C8	6/6	DF91	3/6	EM34	7/6	SP61	2/6		

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HIGHEST QUALITY— COMPARE OUR PRICES

GUARANTEED

Carr. & Ins. 12/6.

MOST MULLARD, MAZDA, COSSOR, EMITRON, EMISCOPE, BRIMAR, FERRANTI TYPES, PROCESSED IN OUR OWN FACTORY.

	Guaranteed 6 Months	Guaranteed 12 Months
12in.	£2. 0.0	£3. 5.0
14in.	£2.10.0	£3.15.0
15/17in.	£3. 5.0	£4.10.0
21in.	£3.15.0	£5.15.0

NEW TYPES
MW 31/74 £4-0-0
MW 36/24 £5-0-0
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13 CHANNEL T.V.s

Table Models. Famous Makes. Absolutely Complete. These sets are unequalled in value due to huge purchase direct from source. They are untested, and not guaranteed to be in working order. Carr. etc., 15/-.

12in. **£2.19.0** 14in **£4.19.0**

4-speed Record Players

Latest Turntable, together with lightweight Staar Galaxy dual sapphire crystal turnover pick-up head. Amazing value (pick-up only 19/-). Carr. 3/-. **£3.10.0**

100 RESISTORS 6/6
100 CONDENSERS 10/-

Miniature Ceramic and Silver Mica Condensers, 3pF to 5,500 pF. LIST VALUE OVER £5.

CO-AX standard and low loss, 25 yds., 12/6; 50 yds., 22/6; 100 yds., 42/6. Co-ax Plugs 1/3. Wall outlet boxes 3/6.

P.V.C. CONNECTING WIRE. 100 yds., 30 mil: Special Price 7/6. 200 yds., 30 mil: special price, 12/6. 25ft. Coil, 1/-, 5 Coils different colours, 4/-.

HEADPHONES. Ex-Govt. quality with Jack-plugs, 7/6, pair. P.P. 1/6.

ACETATE TAPE. The highest quality, guaranteed. 5in. 600ft., 15/-, 5¾in. 1,200ft., 21/6, 7in. 1,200ft., 23/6, 7in. 1,800ft., 32/6. Also new empty spools, 3in., 1/9, 5in., 3/-, 5¾in., 3/6 7in., 4/6.

CONDENSERS. 25 mixed. Electrolytic. Many popular sizes. List value £5. Our price 10/-.

UA20 AUTOCHANGERS. Latest B.S.R. 10 mixed records. Brand new. Unrepeatable £6.19.0. Also UA14, "A Proven Choice", £7.19.0. P.P. 4/-.

NEW SPEAKER CABINETS. Covered in attractive Rexine. Gold metal front, 11/-. Or complete with Speaker, 19/-. P.P. 1/6.

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LOUDSPEAKERS. Unsurpassed in quality and price, 2½in., 13/-. 5in., 16/-. 8in., 19/-, 7 x 4in., 18/-, 8 x 3in., 19/-, 8 x 6in., 21/-. These are brand new.

MIRROR GALVONOMETERS. Evershed and Vignoles, 45 second swing high sensitivity, heavy gunmetal cases with spares in transit case. Unused, £3.10.0. A "MUST" for School Laboratories.

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GOLD SPEAKER FRET. 8½ x 15, 3/6; 6 x 18, 3/6; 7½ x 12, 2/6; 5 x 11, 2/-.

GARRARD "Slimline". The very latest Compact Autochanger, Brand New, £8.19.0. Also GARRARD 209, £9.17.6. P.P. 4/-.

MULTI-METERS. "Jennen" Model 200H. D.C. Voltage. 5-25-50-250-500-2.5K (20,000 ohms per V.) A.C. Voltage. 10-50-100-500-1000 volts, (10,000 ohms per V). A.C./D.C. Current. 0-50-µA, 0-2.5 m.a.-0-250 m.a. £5.19.0 Jemco Model M.T.-316. D.C. voltage. 0-10-50-250-500-1000 volts. (20,000 ohms per V.). A.C. voltage. 0-10-50-250-500-1000 volts, (5,000 ohms per V.). D.C. current. 0-50µA. 0-25-500 m.a., £5.19.0.

TRANSISTOR INTERCOM. High sensitivity, complete with batteries, usually £9, DISCOUNT PRICE £7.15.0.

TRAV—LER TAPE RECORDER Superior, Transistorized, Portable Fast Rewind, Built-in High Output Speaker. Unrepeatable, Listed 29 gns. OUR PRICE 15 gns.

MICROPHONES. "Eagle" 100C, With stand 49/6
T.S.L. Crystal Stick .. do. 35/-
"Jennen-Crown" M.C.-110 do. 45/-
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3 MONTHS' GUARANTEE
EY51 SHORT ENDS **4/6**
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PICK-UP CARTRIDGES. "Acos" 65.3, 22/6. "Sonotone", 17/-. "Steig and Reuter", 17/6. Power Point, 17/-.

GET 15. G.E.C. high power, contact cooled, manufacturers matched pair transistors, with push-pull input and output transformers. Knock out price 29/-. P.P. 1/6.

AERIAL. Oscillator Coils, Long and Medium Wave, 4/6 pair.
METERS. 0-25 amp, 9/-, 0-300 milliamps, 12/6, 0-500 m.a., 12/6, 0-30 m.a., 12/6, 0-1 m.a., 25/-, 0-50 micro-amps, 45/-.

IVORY/GOLD KNOBS. ¼in. Grub Screw, 1in. diameter, half price, 1/-, 5 for 4/6. 1½in., 1/3, 5 for 5/-.

RECORDERS. "Verdik" 4 Track Deck, Collaro 3 Speed Transcription, Superior reproduction, Streamlined Portable Case. Complete with Mike. Market value approx. £45. OUR SPECIAL PRICE 29 gns.

A.M./F.M. RADIOS. Latest Super German press button, long, medium, short and F.M., normally approx. £30. OUR SPECIAL DISCOUNT PRICE 19 gns.

ALL WAVE TRANSISTOR. Terrifically sensitive on short wave. Due to fortunate purchase, we can offer at 18 gns. ONLY.

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Post: 2 lbs. 2/-, 4 lbs. 2/6, 7 lbs. 3/6, 15 lbs. 4/- etc. No C.O.D. ALL ITEMS LESS 5% AND POST FREE IN DOZENS. (Callers always welcome). LIST OF 1000 SNIPS, 6d.

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ALPHA

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				EF85	7/-	EZ80	7/-	PY81	8/6	UCL83	13/6	3Q4	7/6	6BE6	7/6	6V6GT	7/9	12BA6	9/-
				EF86	12/6	EZ81	7/6	PY82	7/-	UF85	9/-	3Q5GT	9/6	6BH6	9/-	6X4	7/6	12BE6	9/-
				EF89	8/9	GZ32	11/6	PY83	8/6	UF89	9/-	3S4	7/6	6BJ6	9/-	6X5G	7/-	12K7GT	6/6
AZ1	10/-	ECC82	7/6	EF91	5/9	KT61	10/-	U25	13/6	UL41	9/-	3V4	8/-	6BW6	9/-	6/30L2	12/6	12K8GT	13/6
AZ31	10/-	ECC83	9/-	EF92	6/-	PCC84	12/-	U26	12/-	UL84	9/-	5U4G	5/-	6C4	4/6	7B6	10/6	12Q7GT	6/6
DAF96	8/-	ECC84	10/-	EL33	10/-	PCC85	8/6	U50	8/-	UY41	6/6	5V4	11/6	6CH6	7/6	7B7	8/6	12SL7	8/-
DF96	8/-	ECC85	9/6	EL41	9/-	PCF80	8/9	UABC80	9/-	UY85	7/-	5Y3G	8/-	6J6	4/-	7C5	8/-	25Z4	9/6
DK96	8/-	ECF80	12/-	EL84	9/-	PCF82	11/6	UAF42	9/6	1A7GT	13/6	5Y3GT	7/6	6J7G	6/6	7C6	8/-	30FL1	10/6
DL96	8/-	ECF82	10/6	EL91	4/6	PCL83	13/6	UBC41	8/6	1C2	11/6	5Z4G	9/-	6K7G	3/6	7H7	8/-	30L15	23/3
EABC80	9/-	ECH42	9/6	EM34	9/6	PCL84	10/-	UBC81	11/4	1C5GT	12/6	6A7	10/-	6K8G	6/6	7S7	9/6	30P4	15/-
EAF42	9/6	ECH81	9/-	EM80	9/6	PL36	13/6	UBF80	9/-	1H5GT	9/-	6AL5	4/-	6L6M	9/6	7Y4	6/6	30P12	12/6
EB91	4/6	ECL80	9/6	EM81	10/6	PL81	11/-	UCC84	10/11	1N5	10/6	6AM5	7/6	6L18	11/6	10F1	12/6	36L6GT	10/-
EBC41	8/9	ECL82	10/6	EY51	9/6	PL82	8/6	UCC85	9/6	1R5	7/6	6AM6	4/-	6Q7G	7/6	12AH8	12/-	35Z4GT	8/-
EBF80	9/9	ECL83	15/-	EY86	10/-	PL83	9/6	UCH42	9/6	1S5	6/6	6AQ5	7/6	6SN7GT	7/6	12AT7	7/6	35Z5GT	9/6
ECC81	8/-	EF41	9/6	EZ40	7/6	PL84	9/6	UCH81	9/6	1T4	5/6	6AT6	8/6	6U4GT	12/-	12AU7	8/-	80	8/6

TRANSISTORS

OC28	10/-	OC78	8/-
OC44	11/-	OC81	8/-
OC45	10/-	OC84	11/-
OC70	6/6	OC170	13/6
OC71	6/6	OC171	14/6
OC72	8/-	V6/2R	9/3
OC73	16/-	PX102	5/-
OC75	8/-	XB102	7/6
OC77	8/-		

G.E.C. 51 similar to OC72 3/6.
Matched pairs—2xOC72 16/-. 2xOC78 16/-.

GERMANIUM DIODES

OA70	3/-	OA73	3/-	OA79	3/9
OA81	3/-	OA85	3/-	OA91	3/6
OA95	3/6	CG6E	4/-	CG12E	4/-
GEX34	4/-	GD9	4/-	GD4	4/-

BTH XD201 1/-.
Set of six transistors, 1 x OC44, 2 x OC45, 1 x OC81D, 2 x OC81, 37/6 set.

METAL RECTIFIERS

Battery Charger Types, 12 volt. 2 amp 7/-, 3 amp 10/-, 4 amp 12/6, 5 amp 14/6.

MICROPHONES

Acos Mic. 39/1. Stick Type 37/6.
Table Stand for above 7/6.
Floor Stand Adaptor 12/6.
TSL Type M1 Dual Impedance Microphone with High (50,000 ohms) or Low (200 ohms) matching, 84/-.
TSL Stick Microphone MX3 35/-.
Acos Mic.40 19/6. Acos Mic.45 29/6.
Microphone Model BM3 45/-.
Table Stand to suit above 12/6.

RECORD PLAYER CASES

Baseboard cut suitable for a BSR UA14, available in red, turquoise, grey and black/yellow. 63/- each.
Amplifier and Loudspeaker to suit above, 79/6.

RECORDING TAPE

5in. reel, 600ft., Acetate	13/6
5in. reel, 900ft., PVC	21/-
7in. reel, 1200ft., Acetate	23/-
7in. reel, 1800ft., PVC	37/6

Transistor Driver and Output Transformers, 10/6 pair.

Small Reset Counter by Veeder Root Ltd., up to 999, 12/- each.

Caby Multi-Range Test Meter Model M1. A.C./D.C. 6 v., 30 v., 120 v., 600 v., 1200 v. D.C. amps 30 m/a; 300 m/a. Resistance 0–10,000 ohms. Price 54/-, inclusive of test prods, instructions and batteries.

Westinghouse Contact Cooled Rectifier. 16RD 2-2-7-1, 5/-.

MULTI-RANGE TEST METERS

Pifco All in One Radio Meter, 32/6. Test Master Model 200H, 20,000 ohms per volt, £6.19.6.
Caby Model A10, £4.17.0.
Caby Model B20, £6.10.0.
Taylor Model 127A, £10.10.0.

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.

Westinghouse LW13, 17/6. LW9, 16/6.

Mains Transformer, 250 HT Sec. Half wave. Standard primary 240 v., 6.3 v., 1 amp LT, 10/- each.

Pick-up Cartridges—BSR TC8H, 29/9, BSR TC8M, 29/9, BSR TC8S, 45/1. Acos GP67/1, 23/9, Acos GP67/2, 23/9, Acos 73/1, 32/6, Garrard GC2, 23/3, Garrard GC8, 20/3, Garrard GCS10, 34/6, Garrard EV26, 37/8, Philips AG3016, 21/-, Philips AG3063, 30/-, Ronette for Collaro Studio P, T and O, 39/9.

Repanco Miniature Doubled Tuned I.F. Transformers. 455 to 475 Kc/s, boxed with circuit, 6/9 each.

EMI 9 v. battery operated 4 speed turntable unit, complete with pick-up heavy 8¾in. diameter metal turntable, ivory finish with red turntable mat., £5.9.6.

CHI, 2.5 millihenry choke, wound on Ferrite Core with wire ends, 2/6.

Repanco New Range of Miniature Transistor Transformers, ¾ × ⅝ × ⅜in.
TT45 Driver Transformer, 5/- each.
TT46 Push-pull output transformer to a 3 ohm speaker, 5/- each.
TT47 Driver transformer, for single ended output stage, matching to a 35 ohm speaker, 5/- each.
TT49 L.F. coupling transformer, 5/- each.

"PRACTICAL WIRELESS" POCKET TRANSISTOR SUPERHET

The New Version in a re-designed Cabinet with Carrying Strap.
Components Price List: Coil Set (Osc. and 3 I.F.'s), 22/-; Driver Transformer, Type PW/DT, 8/3; Output Transformer, Type PW/OT, 8/-; Ferrite Rod Aerial, Type PW/FR, 8/6; Printed Circuit Board, 7/6; 2 Gang Capacitor, Type '00', 12/6; Volume Control, Type V.C. 1545, 8/-; Switch, 3/6; Hardware (Screws, nuts, washers, spacers, battery clips, cable cradles, cable studs, cable strapping), 4/-; Transistors, Type YC (Set of 6), Xtal Diode, Type GD9, 43/-; Speaker, 17/10; Case, 12/6; Capacitors, 15/-; Resistors, 5/-; Trimmers, Type MT31/4A (3 required), 3/9; Constructional leaflet and "Blown-up" circuit diagram, 1/6.
COMPLETE KIT £7.19.6.

Heater Transformer, Standard 240 v. primary 6.3 volt 1½ amp., 6/9. 6.3 volt 3 amp, 10/-.

Output Transformers: 10,000/3 ohms 40 mA, 4/6; 5,000/3 ohms 40 mA, 4/6; 5,000/3 ohms 60 mA, 5/9.

Weymouth Transistor Coils. P50/1AC Osc., 5/4; P50/2CC I.F. 5/7; P/50/3CC I.F., 6/-.

Printed Circuit Board, 9/-; Driver Transformer, 9/3; Ferrite Rod RA2W, 12/6.

Clarostat Potentiometer, Type 37, less switch, values from 5K ohm to 2 Meg., 2/10 each. As above with DPs, 4/6 each.

Write for detailed price list of components for circuits described in this magazine.

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.

STERN'S MULLARD DESIGNS

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

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

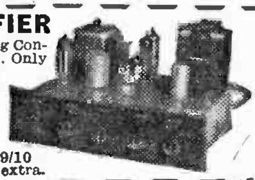
For use with the MULLARD 2-valve pre-amplifier with which undistorted power output of up to 10 watts is obtained. We supply **SPECIFIED COMPONENTS AND NEW MULLARD VALVES,** including **PARMEKO MAINS TRANSFORMER** and choice of the latest Ultra-Linear **PARMEKO** or the **PARTRIDGE** Output Transformer.
COMPLETE KIT OF PARTS (PARMEKO Output Trans.). **£10.0.0**
Alternatively we supply ASSEMBLED and TESTED. **£11.10.0** INCORPORATING PARTRIDGE OUTPUT TRANSFORMER, £1.6.0 EXTRA.

MULLARD'S PREAMPLIFIER TONE CONTROL UNIT

Employing two EF86 valves, and designed to operate with the MULLARD **MAIN AMPLIFIERS,** but also perfectly suitable for other makes.
PRICE COMPLETE KITS OF PARTS **£6.6.0** ASSEMBLED AND TESTED **£8.0.0**
Supplied strictly to **MULLARD'S SPECIFICATION** and incorporating:

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

COMPLETE MULLARD "5-10" AMPLIFIER

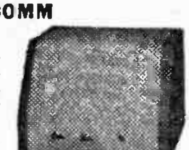


The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 watts high quality reproduction. Only Specified Components and new **MULLARD VALVES** are supplied including **PARMEKO MAINS TRANSFORMERS** and choice of the latest **PARMEKO** or **PARTRIDGE** ULTRA-Linear Output Transformers.
KIT OF PARTS **£11.10.0** OR ASSEMBLED and TESTED **£13.10.0**
H.P. Dep. £2.6.0, 12 months at 17/-. Dep. £2.14.0 12 months at 19/10
ABOVE incorporating PARTRIDGE OUTPUT TRANS. £1.6.0 extra.

COMPLETE MULLARD "3-3"

THE IDEAL AMPLIFIER FOR A SMALL HIGH QUALITY INSTALLATION PROVIDING EXCELLENT REPRODUCTION OF UP TO 3 WATTS OUTPUT
COMPLETE KIT OF PARTS **£7.10.0** OR ASSEMBLED and TESTED **£8.19.6**
(plus 6/6 carriage and insurance) H.P. Terms: Deposit £2.0.0 and 8 months at £1.0.0. Complete to MULLARD'S SPECIFICATION including Mullard valves and a **PARMEKO OUTPUT TRANSFORMER.**

STERN'S INTER-COMM BABY ALARM



A small versatile Unit employing the new MULLARD ECL86 valve and designed to provide two (or three) way conversation up to extreme distances. Operates from A.C. mains 200 to 250 Volts.

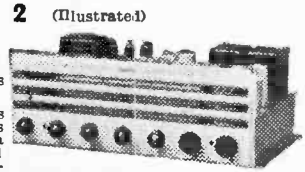
PRICES . . . MASTER UNIT and ONE EXTENSION

KIT OF PARTS **£6.17.6** ASSEMBLED AND TESTED **£8.0.0**
Consists of a MASTER UNIT, size only 8¼ x 5¼ x 6in. and ONE EXTENSION (a second extension may be added to any time). The Master Unit incorporates switching and power supply and with the chassis completely isolated from the mains is operated in absolute safety. Cases covered in quality leatherette.

ARMSTRONG RADIOGRAM CHASSIS

FULL RANGE IN STOCK. please enclose S.A.E. for leaflets.

STEREO 12 MK. 2 (Illustrated)



£44.15.0
Deposit £9.0.0, 12 months at £3.5.7
The most complete chassis ever produced, combines AM and FM Tuners, a Stereo Control Unit and two High Fidelity Amplifiers in one compact unit, provide a total of 16 watts for both mono and stereo. Other features include: inputs for tape recording, play back, pick-ups and stereo radio (should this come about); separate wide range bass and treble controls and balance control.

STEREO 55 **£33.15.0**

Deposit £6.15.0, 12 months at £2.9.6
A junior version of the Stereo 12 Mk. 2 providing ten watts output, five watts from each amplifier and covering the VHF and Medium wavebands.

COMBINED ORDER PRICE REDUCTIONS

(a) The KIT OF PARTS to build both the "5-10" Main Amplifier and the 2-valve PRE-AMP CONTROL UNIT H.P. Dep. £3.7.0 and 12 months at £1.2.9.......... **£15.15.0**
(b) The "5-10" and the 2-stage PRE-AMP both ASSEMBLED and TESTED H.P. Dep. £3.16.0 and 12 months of £1.7.8.......... **£18.18.0**
With Partridge O/put Transformer £1.6.0 extra.

RECORD PLAYERS

The Latest Models are in stock, many at reduced prices.
Send S.A.E. For Illustrated Leaflet.

THE NEW GARRARD "AUTO-SLIM" 4-speed Autochanger with Crystal Pick-up **£8.10.0**

COLLARO "JUNIOR" 4 SPEED SINGLE RECORD PLAYER with separate Crystal Pick-up Carriage and Insurance 5/- **£3.15.0**
Above Pick-up separately for £1.6.6

The **NEW COLLARO** C60 4-speed Autochanger unit with Studio "O" Pick-up...... **£7.19.6**

The **E.M.I.** 4-speed Single Record Player with crystal Pick-up **£6.9.6**

B.S.R. MODEL UA14. A 4-speed mixer Autochanger with Crystal Pick-up **£7.10.0**
Available incorporating the **B.S.R. STEREO Pick-up,** plays L.P. and 78 Records **£8.13.10**

GARRARD MODEL TA/MkII 4-speed Player fitted high output Crystal Pick-up.. **£8.10.0**

GARRARD MODEL RC210. Autochanger 4-speeds. High output. Crystal Pick-up.. **£9.19.6**

Carriage and Insurance on each above 5/- extra.

SPECIAL CASH OFFER

This very attractive **PORTABLE AMPLIFIER CASE** together with a good quality **GRAM AMPLIFIER** and a matched **P.M. SPEAKER.**
ALL for ONLY **£8.7.6** (Plus 7/6 Carr. & Ins.)
The Amplifier consists of a 2-stage design incorporating 3 modern B.V.A. valves and has separate BASS and TREBLE CONTROLS.
The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Mushroom Grey Rexine.
WE ALSO SUPPLY SEPARATELY—
(a) The 2-stage (plus Rectifier) **AMPLIFIER** **£4.2.6**
(b) The **PORTABLE CARRYING CASE** **£3.17.6**
(c) 6½in. **P.M. SPEAKER** 18/9. Carriage and Insurance 4/- **extra.**

MULLARD FOUR CHANNEL MIXER UNIT

Self powered with Cathode follower output. Incorporates Two inputs for MICROPHONES One for CRYSTAL PICK UP and a fourth for RADIO or TAPE
Complete Kit of Parts **£8.8.0**
Assembled and Tested **£10.0.0**
TERMS: Deposit £2 and 12 months at 15/-.
MODEL I.L. one microphone Input matched for moving coil or Ribbon Mike. £1.17.0 extra.

JUBILEE MK. 2 £31.15.0

Deposit £6.7.0 12 months at £2.6.7
A Hi-Fi mono chassis giving eight watts push-pull output and covering VHF, medium and long bands. Tape recording and play back inputs.

AF208 £23.15.0

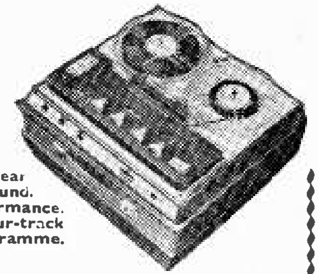
Deposit £4.15.0 12 months at £1.14.10
An AM/FM chassis providing 5 watts output and covering the full VHF and medium wavebands. Tape recording and playback inputs.

STERN RADIO LTD.

Dept. P.W. 109 FLEET ST., LONDON, E.C.4
Telephone. FLEET STREET 5812/3/4

TRUVOX 80

TAPE EQUIPMENT SERIES



This newly developed range of Truvox equipment is the fruit of more than twelve year experience in fulfilling the requirements of the enthusiastic listener to recorded sound. The precise construction and finish of the range ensures an outstanding performance. Complete Recorders, Decks and Tape Units—signal the entry of Truvox into the four-track field. Top quality allied to economy, is the result of this development programme.

MODEL R82

A complete Twin Track MONO PORTABLE TAPE RECORDER **£57.15.0**
Deposit £11.11.0, and 12 months of £4.4.8

MODEL R84

A complete Four Track Mono Portable Tape Recorder incorporating outputs for STEREO reproduction **£61.19.0**
Deposit £12.8.0, and 12 months of £4.10.10.

Two Recorders, beautifully styled: equipped with every modern feature and facility. 7in. reels, interlocked push buttons, input mixing, superimposition, auto-stop, instant mechanical brakes, fast wind and rewind. Twin independent inputs, 4 watts output, 3 ohm and 15 ohm ext. speaker matching, two hi-fi connections and monitor speaker switch. (Stereo outlet on R84 models).

Recorders supplied with 1200 ft. tape, spare reel, stick microphone and recording lead.

"SERIES 80" TAPE DECKS are available separately MODEL D82

Incorporating TWIN TRACK HEADS **£26.5.0**
Deposit £5.5.0, and 12 months at £3.11.10.

MODEL D84

With FOUR TRACK HEADS and Track Switch for MONO/STEREO operation **£29.8.0**
Deposit £6.0.0, and 12 months of £2.2.11.

These decks are ruggedly constructed, beautifully styled and precision engineered for outstanding dependability. Three motors, 7in. reels, speed selector/off switch for 7½ and 3¾ i.p.s. Instant mechanical brakes, fast wind and rewind (60 secs. per 1200 ft.). Push button operated with perfect interlock. Numerical counter. Pause lever, for short or long stops. Efficient hublocs for true and silent running of spools. Outstanding head performance. Auto stop available as optional extra.

FULLY DESCRIPTIVE LEAFLETS FREELY AVAILABLE

MODEL PD82

Complete Twin Track Mono Recorder-Preamplifier Unit **£42.0.0**
Deposit £8.8.0, and 12 months of £3.1.7.

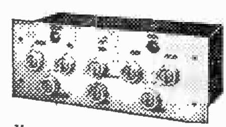
MODEL PD84

Complete Four Track Mono Recorder-Preamplifier Unit incorporating outlets for STEREO reproduction **£46.0.0**
Deposit £9.4.0, and 12 months of £3.7.6.

Two self-contained units, self-powered to add full tape facilities to existing sound reproducing installations (high fidelity equipment, radiograms, record reproducers, or good radio receivers). Comprising a Series 80 Tape Deck, plus integral record amplifier, play-back pre-amplifier and push-pull erase/bias oscillator, ready for easy connection.

The Unit is built to high fidelity standard. Frequency response is 40-20,000 c.p.s. at 7½ i.p.s. and 40-12,000 c.p.s. at 3¾ i.p.s. Two independently controlled inputs for programme mixing. Superimposition for adding commentaries. Auto stop. Two output connections; 1 v. at 47K ohms and up to 10 v. at 250K ohms to match any ancillary equipment.

DUAL CHANNEL PREAMPLIFIER

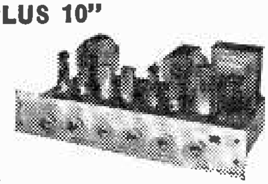


Incorporates two Mullard 2-valve Preamplifiers combined into a Single unit enabling it to be used for both **STEREOPHONIC** or **MONAURAL** operation. It is designed primarily to operate with our range of **MULLARD MAIN AMPLIFIERS** but will also operate equally well with any make of Amplifiers requiring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

COMPLETE KIT OF PARTS **£12.10.0**
H.P. £2.10.0 & 12 mths. at 18/4

ASSEMBLED AND TESTED **£15.0.0**
H.P. £3.0.0 & 12 mths. at £1.2.0

MULLARD'S "10 PLUS 10" STEREO POWER AMPLIFIER



A high fidelity design based on the famous Mullard "5-10". Provides up to 10 watts (per channel) Superb reproduction. Frequency response flat to within 3 db from c/s. to 60 Kc/s at 50Ww. Total Harmonic Distortion at 10 watts 0.1%.

PRICE:

(a) ASSEMBLED COMPLETE AMPLIFIER, including CONTROL UNIT (as Illustrated)...... **£21.0.0**
Deposit £4.4.0, 12 months at £1.10.10.

(b) A complete KIT of PARTS...................... **£18.10.0**
Deposit £3.14.0, 12 months at £1.7.2.

Built to the very highest technical standards and presented strictly to MULLARD'S specification. Incorporates complete Mullard valve line-up including two of the new valves, type ECL86, in each channel. Two specially designed GILSON OUTPUT TRANSFORMERS with 20% taps are used for ultra linear operation.

The matching CONTROL UNIT is designed to be either attached to the Amplifier (as Illustrated) or can be detached for separate mounting on a Cabinet panel. Provides inputs for CRYSTAL PICK-UPS, RADIO TUNING UNIT, and TAPE RELAY.

AS AUDIO SPECIALISTS WE CONFIDENTLY RECOMMEND THIS DESIGN. It is a MUST to the serious minded sound enthusiast.

We also supply the assembled MAIN AMPLIFIER only (excludes control unit) for operation with our DUAL CHANNEL PREAMPLIFIER. this provides for a more versatile or elaborate installation and would be essential if a low output Magnetic Pick-Up, such as the Decca, is to be used.

PRICE:

(a) THE ASSEMBLED MAIN AMPLIFIER with the ASSEMBLED DUAL CHANNEL PREAMPLIFIER **£30.0.0**
Deposit £6.0.0. 12 months at £2.4.0.

(b) A complete KIT of PARTS for both Units........ **£26.0.0**
Deposit £5.4.0, 12 months at £1.18.2.

Illustrated and Descriptive Brochure available. Please enclose S.A.E.

STEREO "TWIN THREE" AMPLIFIER with specially designed PORTABLE CASE

A most compact portable design consisting of TWIN CHANNEL AMPLIFIER based on the latest design by MULLARD LTD., incorporating top grade Output Transformers, and the new audio Triode-Pentode Valves Mullard E.C.L.86 Separate Bass and Treble controls. Suitable for use with Crystal Pick Ups, and capable of genuine high quality reproduction up to 3 Watts per channel. An attractive and contemporary portable Case in two tone colours. The unique feature of the design is the loudspeaker mounting. Two 8 x 5in. p.m. elliptical loudspeakers are separately baffled and mounted in the lid, which is detachable, allowing for each speaker to be individually positioned. A versatile stereo arrangement tested and guaranteed which can be assembled in the minimum of time.

PRICE for the ASSEMBLED AMPLIFIER. Two 8 x 5in. ROLA SPEAKERS and PORTABLE CASE **£14.0.0**
Deposit £2.16.0, 12 months at £1.0.6.

ASSEMBLED AMPLIFIER supplied for........ **£7.15.0**

8 x 5in. ROLA LOUDSPEAKERS (3 ohms) each. **£1.1.0**

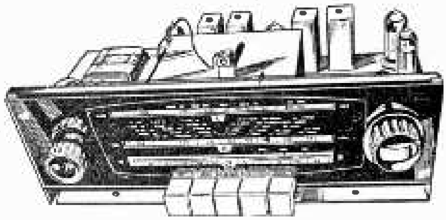
PORTABLE CASE................................ **£5.0.0**

A CHOICE OF SINGLE RECORD PLAYERS and AUTOCHANGERS is available from Stock (Send S.A.E. for details

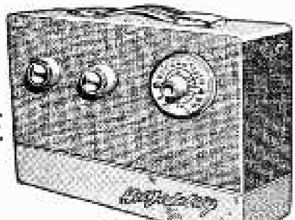
STERN RADIO LTD.

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

A.C. ONLY. Chassis size 15 x 6¾ x 5½ in. high. New manufacture. Dial 14½ x 4in. in black and gold.
Pick-up. Ext. Speaker. Ae., E., and Dipole Sockets. Five push buttons—OFF L.W., M.W., F.M. and Gram. Aligned and tested O.P. Transformer. Tone Control. 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 for V.H.F. 10/-. Feeder 6d. yard.
Circuit diagram 2s. 6d.



THE "CANTATA" 6-TRANSISTOR AND DIODE PORTABLE



COMPLETE KIT FOR ONLY

£7.19.6

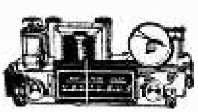
(post 3/6) NO EXTRAS

- ★ 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 2¾in.
- ★ 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 3½ 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 2 x 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. ★ Built in two hours.

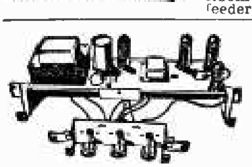
5 **Transistor Kit** giving 400 m.w., generally similar to "Cantata" and in same case, only £6, carr. paid.

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 5/- (post 1/6). Both UA14 and C.60 fitted monaural cartridge but wired for stereo. Motor board, 3/6 post paid when purchased with autochanger.

BEREC BATTERY RADIO IN MAKER'S CARTON. Valves DK96, DF96, DAF96, DL96. Two Short Wavebands 16 to 49 M. and 25 to 75 M. Cabinet 12 x 7½ x 6in. **ONLY £5** (2/6 p. & p.); MW and SW, £5.4.0 (plus 2/6 p. & p.).



SELF-POWERED VHF TUNER CHASSIS. Covering 88-95 Mc/s. Mullard permability 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.



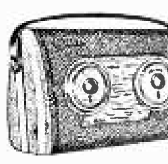
PUSH-PULL AMPLIFIER £5.5.0

(5/- 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 used as "flying panel". Stereo version 2 x 4 w. same price.

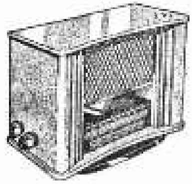
THIS SUPERB SET FOR £10

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. Carr. paid. Worth £16.



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 14½in. high). Covering 88-100 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.

COLLARO STUDIO TAPE TRANSCRIPTOR. 3 MOTORS, 3 SPEED. 1⅞, 3¾ and 7½ I.P.S. Push buttons. £10.17.6 (10/- carr.) incl. spool.

SUPERIOR GRAMOPHONE AMPLIFIER 3 valves, 4 watt

13½ x 7½in. (2¾in. front to back). 3 front controls, bass, treble, vol. on-off, 6½in. round speaker; UY85, UF80 and UL84. Mains trans. 200-240ac; "gold" fret front. ONLY 70/- (p.p. 3/6).

GRAMOPHONE AMPLIFIER
With 5in. SPEAKER Baffle 12½ x 6in. UCL82 and Rectifier, Tone and Volume On/Off switch. Two Knobs. Ready to play. Useful for Stereo. ONLY 57/-, post 3/-.

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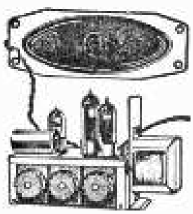

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Practical Wireless

Vol. XXXVIII No. 663 MAY, 1962

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Contents

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

OUR LATEST BLUEPRINT

EVERY copy of this issue contains another free double-sided blueprint. The two sides cover Design No. 2—a two-valve mains TRF for the comparative beginner—and Design No. 5—a more advanced set, a transistorised battery superhet.

The Britannic Two is a straightforward receiver intended as an introduction to mains valve techniques and circuitry. Only two valves are used, with a metal rectifier for H.T. rectification. The first valve is, however. two valves in one which makes the set, in effect, a three-valve type. Whilst the simplicity of the circuit and construction makes the set suitable for those constructors who have only dealt with very simple sets so far, results are nevertheless very good even though long range reception of Continental stations cannot be expected.

The Mercury Six is a six-transistor superhet which has been designed to fit in a new and improved plastic case. The receiver is not of the miniature type and should be welcomed by those readers who are not confident of building a small pocket sized set. Also, the receiver is provided with a loudspeaker of larger size than usual—another feature which will be attractive to those constructors who find that the quality from miniature loudspeakers is not pleasing to their ear.

Both of these receivers cover both medium and long waves so that readers out of range of the medium wave Light Programme can hear it on long waves.

NEXT MONTH

We shall be including another free double-sided blueprint in every copy of the June issue—covering Design No. 3 and Design No. 6. The former. Design No. 3, is a seven-transistor pocket superhet and the latter a hi-fi switch-tuned F.M. tuner. The demand for the June issue will be great; order your copy now.

CLUB REPORTS

We would like to remind club secretaries that they should send their reports in the style in which we print them. Although we always try to include all items of club news which are sent to us, the space which we can allow for them is limited and whenever we are forced to exclude one or two items, because of the lack of space, it is those which are badly written and not in our style which are left out. Therefore all news items should, if possible, be typed.

It should also be noted that reports should reach us well in advance of the date of publication. This means that we should receive notices not later than the 10th of the month for publication in the following month's issue. Secretaries should also take care to ensure that any "future events" listed will not have taken place when the issue is on sale.

We have always fostered the growth of the club movement and the space devoted to reports is entirely free. In return, we feel it is reasonable for secretaries to co-operate with us.

Our next issue dated June, will be published on May 4th.

Round the World of Wireless

POTENTIAL AND CURRENT NEWS

Broadcast Receiving Licences

THE following statement shows the approximate number of Broadcast Receiving Licences in force at the end of January, 1962, 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	653,563
Home Counties	602,615
Midland	445,070
North Eastern	471,348
North Western	404,833
South Western	358,693
Wales and Border Counties	208,771
Total England and Wales	3,144,893
Scotland	340,416
Northern Ireland	109,789
Grand Total	3,595,098

New Admiralty W/T Station in Mauritius

FOLLOWING the two big radio communication installations at the Admiralty W/T stations at Inskip and Forest Moor, Marconi's have now almost completed contracts in connection with another Admiralty station, this time in Mauritius.

The Mauritius project consists of a transmitting installation at Bigara, a receiving installation at Tombeau Bay and a communications centre at Vacoas.

Whilst George E. Taylor (Overseas) Ltd. are responsible to the Admiralty for the electrical and mechanical installation of the Mauritius station as the main contractor, and were responsible for the installation of all aerials, co-axial feeders and power cables, they have placed a sub-contract with Marconi's for the installation of the major portion of the radio equipment. A separate order has been entrusted to the company directly by the Admiralty for "testing and putting to work". Nearly all the transmitting and receiving equipment, including the provision of VHF multichannel radio links for communication between the three sites, has been supplied by Marconi's under separate Admiralty contracts.

The police authorities in Aden are seen here at a demonstration of a Marconi traffic radar installation.

Traffic Radar

THE Portable Electronic Traffic Analyser (PETA) equipment by Marconi's is now in widespread use by the police forces of Britain. Thirty constabularies have purchased Marconi traffic radar and the majority of the equipments are in day-to-day use.

The steady growth of "PETA" sales—sixty-two sets have been sold to date—reflects the confidence of police authorities in the equipment as a saver of lives and a valuable aid in reducing the number of injury accidents on British roads.

The general police strategy is to use the radar speed check as a deterrent, and not as a trap. Motorists are usually warned by road signs placed prominently at county boundaries and in some cases also by notices displayed on either side of the actual monitoring point.

Denmark Frees Power Exchange

DENMARK'S intention to liberalise supplies of electricity from other Western European countries has been notified to the Organisation for Economic Co-operation and Development Organisation by the Danish Delegation. Denmark thus joins Austria, Belgium, France, Germany, Italy, Luxembourg, the Netherlands, Spain, Sweden and Switzerland, which already freely exchange supplies of electric power.

Free exchange of power between these countries takes two forms: "occasional" exchange, with the purpose of avoiding wastage of hydro-power or of providing emergency supplies to a network on which a technical breakdown has occurred; and "seasonal supplies", which electricity undertakings are not bound by contract to provide for more than six consecutive months.

Intercomm for Ferrying Aircraft

EIGHT sets of Ultra Electronics intercomm equipment have been ordered by Aviation Traders (Engineering) Ltd., for their ATL/98 "Carvair" aircraft.

The "Carvair", a DC4 conversion, has been ordered by Channel Air Bridge, a sister company of Aviation Traders (Engineering), who will operate the aircraft from next month on their car-ferry services to Rotterdam and also, from April, to Basle, Geneva and Strasburg.

Ultra Electronics Ltd., have previously supplied intercomms for ten other aircraft in the British United Airways group, to which Channel Air Bridge and Aviation Traders (Engineering) Ltd. belong.

Skylark Trials

TELEMETRY equipment made by Associated Electrical Industries Ltd. was used in a recent firing of a "Skylark" High Altitude Research Rocket in trials at the Woomera Range in Australia. The rocket was successfully fired to a height of over 80 miles and the instrumentation head subsequently recovered.

During the flight of the rocket valuable scientific data was transmitted to the ground by means of the AEI Type 450 Telemetry equipment used. This equipment functioned perfectly throughout the flight which was over 800 seconds in duration.

E.E.V. in Paris

AT the recent "Salon International des Composants Electroniques" held from 16th to 20th February, 1962, in Paris, the English Electric Valve Co. Ltd., was one of the exhibitors. The Company's French Agents, Etablissements Tranchant, arranged the display of products. This included high power magnetrons, klystrons, television camera tubes, T.W.T.'s, power triodes and examples from the major part of the range of specialised valves and tubes manufactured by the English Electric Valve Co. Ltd.

Tour of Europe

IN a bid to increase its already substantial trade with Europe, Avo Limited of Westminster a Metal Industries Group subsidiary) is to send a demonstration van on an extended tour of Belgium, Holland, Denmark, Sweden and Norway. The tour started on 16th March and will last until the end of May and possibly longer.

The complete range of Avo's electrical, electronic and nucleonic measuring intruments will be carried and demonstrations will be given to Government departments, technical colleges and industrial concerns.

Products in the nucleonic field will include radiation monitoring equipment, portable survey meters and D.C. amplifiers for the measurement of minute currents associated with ionisation chambers.

Electronic equipment on show will include valve characteristic meters, transistor analysers, valve voltmeters and signal generators.

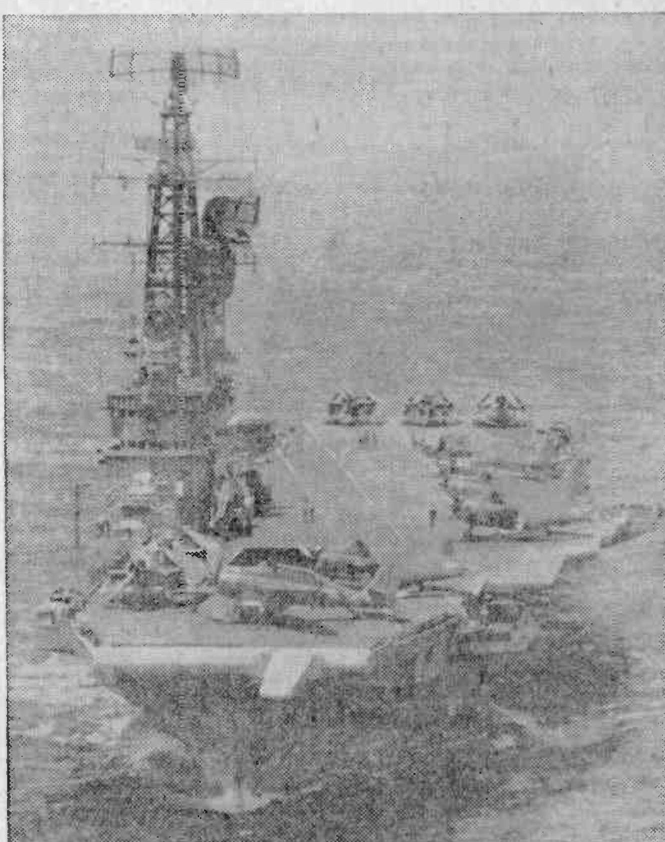
Newfoundland-Canada Cable Link

EQUIPMENT worth more than a quarter of a million pounds has been supplied by AEI for the Cantat B submarine cable system between Newfoundland and the Canadian mainland. This section of the round-the-world Commonwealth telephone cable project was recently inaugurated by the Queen. Installed at each end of this 450-mile link is AEI apparatus enabling up to 120 telephone conversations to take place simultaneously in the section, and equipment to feed power to the 20 submerged repeaters along the cable.

The submarine cable link, of which the terminal equipment forms a part, is the longest 120-channel link at present in existence. The terminal equipment has been supplied to the order of the Canadian Overseas Telecommunications Corporation by the Telecommunication Transmission Department of AEI Telecommunications Division. The equipment for power supply and cable frequency translation has been supplied by the same Department as subcontractors to Submarine Cables Limited (owned jointly by AEI and BICC), who have supplied and laid the submarine cable and repeaters.

Navy Order

A CONTRACT has been signed by Marconi's with the Royal Netherlands Navy for the supply of seventy-two 1kW broadband linear radio frequency amplifiers for the re-equipping of the fleet. These amplifiers are similar to those already being supplied in quantity to the British Admiralty.



H.NL.M. aircraft carrier "Karel Doorman", the keyship of the Royal Netherlands Navy (see "Navy Order" above).

Practical Wireless BRITANNIC

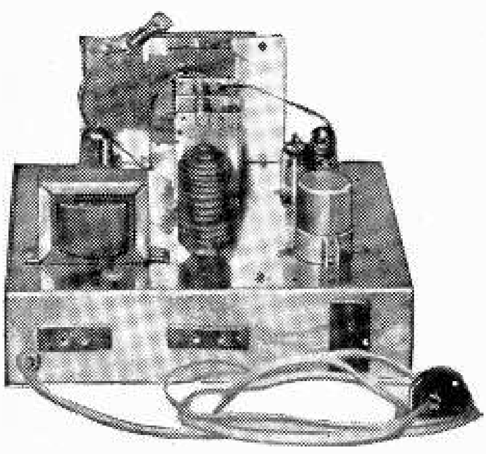
A TWO-VALVE MAINS TRF FOR THE BEGINNER

THE receiver uses comparatively few components and is easy to construct, yet the specification is kept as simple as possible consistent with good results so that the novice constructor can attempt the design with confidence.

Circuit Details

The principle of "straight" TRF radio circuitry, rather than the superhet type, is the choice in this design, but, in a great many locations, the use of a single tuned circuit between the aerial and the detector valve, even when reaction is used, is incapable of satisfactory separation of closely spaced stations, particularly on the medium waveband after dark. A stage of tuned R.F. amplification is therefore essential, and the use of a modern "double" valve, the ECF80, which comprises an R.F. pentode and triode in one envelope, enables the functions of R.F. amplifier and grid leak detector to be combined in the first valve (V1 of Fig. 1—see Blueprint 2).

The demodulated output, which also receives a degree of A.F. amplification in the triode section of V1, is then fed by resistance-capacity coupling to the high slope output valve V2, which is an EL84. It will be found that this combination gives adequate volume from local BBC stations and the principal Continental transmitters on long and medium waves.



A view of the completed receiver.

Variable volume control is provided by VR1 between the detector and output stages, and a simple but effective "top-cut" tone control is provided in the output circuit of V2 by means of VR2 and C8; this, of course, is operative on both "radio" and "gram" reproduction.

Switching

Wavechange switching is accomplished by two poles "a" and "b" of the 4-pole, 3-way switch S1. In the "Long Wave" position, the switches across the R.F. and detector coils L1 and L2 are "open", and the whole of the tuned winding is in circuit. In the "Medium Wave" position, both switches are "closed", thus retaining in circuit the parts of the inductances of L1 and L2 required for medium waveband coverage. In the third, "gram" position, S1a and S1b are again in the "open" (Long Wave) position, as the risk of radio break-through by induction between wiring is less likely in this position. The third "pole" of the function switch—S1c—simultaneously performs the switching from "radio" to "gram". In the M.W. and L.W. position, the control grid of the triode portion of V1 is connected to the grid leak capacitor C5, thus giving radio reception, but in the third, "gram" position, the control grid is connected to the "live" side of the gramophone pick-up input (the other side of the gram input being connected to the chassis line of the receiver permanently).

In order to ensure maximum efficiency and distortion-free amplification of the triode section of V1 when working on "gram", the fourth pole of the function switch—S1d—is arranged to disconnect the valve cathode from "earth", as used in the "grid leak detector" method of working, and to switch in the self-biasing resistor/capacitor combination R4 and C4. Although this may sound a little complicated, in actual practice it is not at all difficult to wire up, and by referring to Figs. 2, 3, and 5 (on Blueprint 2) the constructor should experience no difficulty.

Equalisation

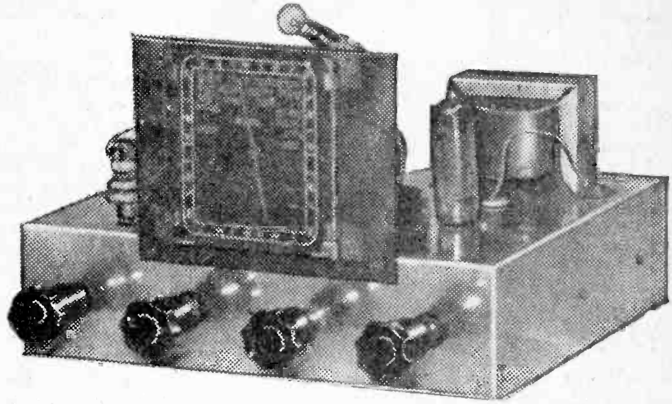
As there is ample amplification available, a fixed frequency correction circuit, comprising C11, C12, R7 and R8, is wired across the pick-up input sockets. This will be found to give a good compromise compensation for most types of records, particularly the modern L.P.'s and E.P.'s, but of course there is no reason why the constructor should not experiment with circuit values at this point, or indeed incorporate a different type of frequency correction circuit.

In some areas, where the general level of radio signal strengths is low, the need may be felt for some slight increase in sensitivity, and this can be very simply arranged by deliberately introducing a fixed amount of "positive feedback" (reaction) between the detector and R.F. stages. To do this, a short length, say 3in., of plastic-covered flex

BLUEPRINT 2

TWO

By J. B. Willmott



should be soldered to each of the top contacts (fixed plates) of VC1 and VC2, and twisted together. If the wires are twisted together until the receiver is just on the point of sustained oscillation at the highest wavelength (condenser vanes fully meshed) on the medium waveband, a very useful increase in gain will be obtained on all wavelengths.

Power Requirements

The power supply arrangements, in view of the economical current consumption of a receiver of this type, are very simple. A double wound mains transformer, of the type used in small "gram amplifiers" or TV pre-amplifiers, will be adequate. Half-wave rectification is by means of metal rectifier MR1 and smoothing is carried out by the resistor R6 and double-section electrolytic C9A and C9B; it will thus be found that the hum level of the completed receiver is very low.

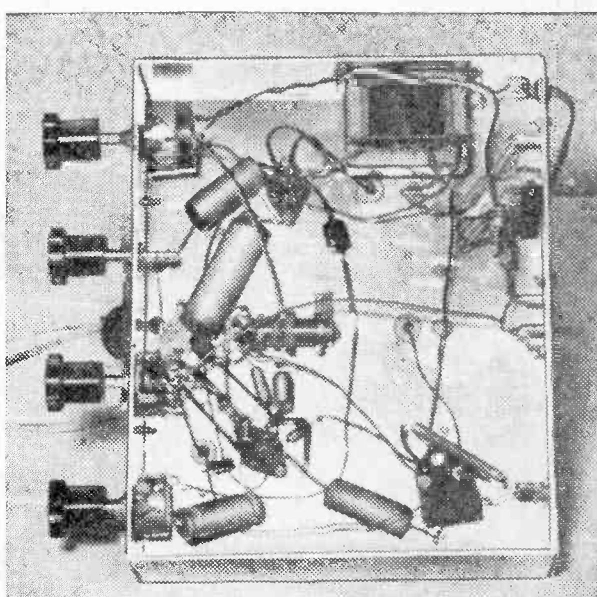
The chassis measures 10in. x 8in. x 2½in., this being a standard size readily obtainable from several suppliers; all positions and sizes of holes to be drilled are given in Fig. 8, but some will depend on the particular parts purchased. This work can be carried out with an ordinary hand drill, with bits to suit 4B.A. and 6B.A. clearance holes; the ⅜in. control spindle and lead carrying holes are most easily made with a chassis punch of the appropriate size, as are the two ¾in. holes to accommodate the valveholders. However, if punches are not available, a smaller hole (or holes) can be drilled in the desired position, and enlarged with a round file.

Marking Out the Chassis

It is a good plan to use the mains transformer and the valveholders as "templates" when marking out their fixing holes, and care should be taken to ensure that the orientation of the valveholders is such that short and direct wiring will be facilitated (see Fig. 2).

Having completed the drilling, check with Figs. 2, 3 and 8 to see that nothing has been overlooked — there are few things more annoying than to find that when most of the components have been bolted down, a vital hole has been missed, and everything has to come off to allow drilling to take place.

It is recommended that the components be mounted in the following order: first of all the valveholders for V1 and V2. These are secured with 6B.A. bolts and nuts, and a soldering tag should be included on the bolt nearest pins 1 and 9 in each case. Next mount the 2-gang tuning capacitor VC1 and 2, using 4B.A. bolts and nuts. Always handle this component with the vanes fully meshed, to lessen the risk of damage. Now insert the cord spindle drive, volume control, tone control, and switch S1 through their respective holes in the front runner of the chassis, securing them tightly in place with the nuts provided. Place the drive drum on the tuning capacitor spindle, so that its groove is in line with the driving cord holes in



An under-chassis view.

the chassis. Hook the tension spring on to the drive drum (see Fig. 7), and thread the drive cord as shown, not forgetting to pass it twice round the drive spindle to ensure a firm "drive" without slipping. Knot the cord so that the tension spring is slightly extended, then test the movement of the whole mechanism. It should be possible to swing the tuning condenser from the fully open to fully meshed position with no binding or slipping. The metal scaleplate can now be fitted, making sure that the condenser spindle passes cleanly through the central hole provided, and the pointer fixed on the tuning capacitor spindle. Adjust the pointer so that it lies exactly horizontal when the plates of the condenser are fully meshed. The glass is fixed to the inside of the cabinet when the receiver is completed, or, alternatively, simple clamps can be made up from springy brass, and bolted to corner holes in the dial backplate, so as to hold the glass in position when the receiver is out of its cabinet. (The dial and drive assembly can be obtained from the makers of the coils L1 and L2—Osmor Radio Ltd., 418 Brighton Road, South Croydon, Surrey.)

Returning now to assembly of components, the next item to be bolted down should be the mains transformer. This can be followed by the metal rectifier, which should be mounted as shown in Fig. 3, and the double electrolytic C9A/B, secured by its fixing clip, on top of the chassis with its connecting tag projecting below. The aerial/earth socket strip and the input sockets for the gram input can now be mounted on the rear chassis runner and also the loudspeaker sockets. Next, mount the tuning coils. The aerial coil (L1) is mounted above the chassis, and the detector coil (L2) below

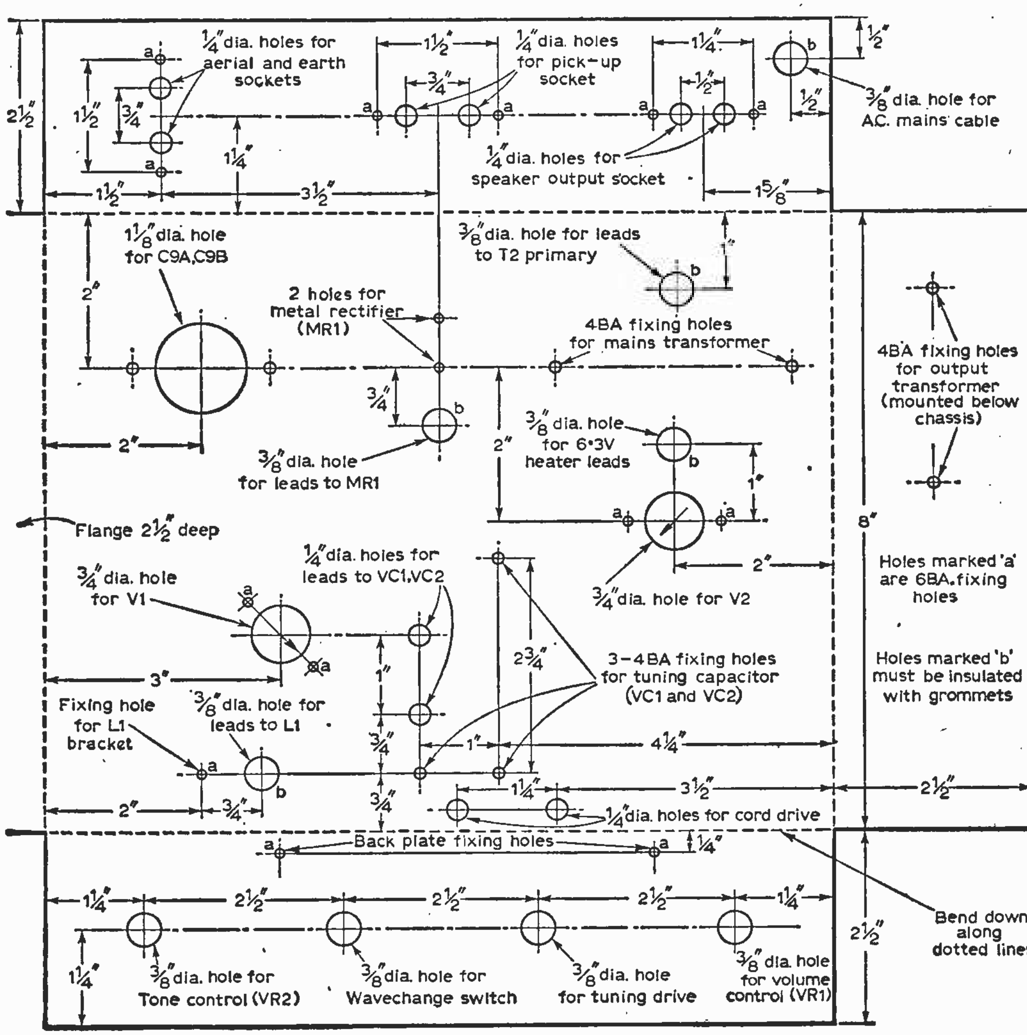


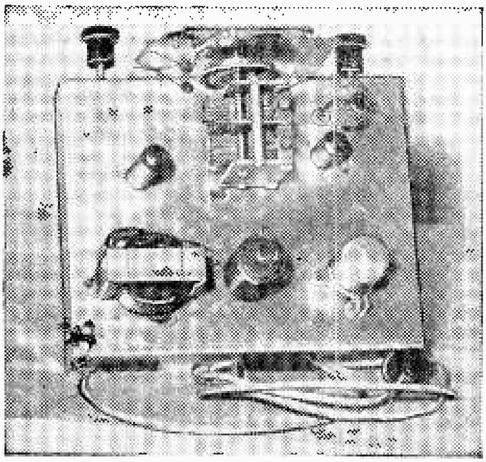
Fig. 8—The chassis drilling details.

the chassis to minimise risk of unwanted interaction. Both coils are mounted on an aluminium bracket (see Fig. 6).

Finally, mount the loudspeaker output transformer in the position shown. Check that everything is in place, and that the valveholders and coil tags are orientated as shown in Fig. 2.

Wiring Considerations

Wiring is straightforward for the most part. but certain points are worthy of note. The electrolytic condensers must be connected with their correct polarity, and this is given both in Fig. 1, the circuit diagram, and in Fig. 2, the underchassis wiring diagram. The double electrolytic condenser



An above-chassis view.

C9A/B will be found to have a red tag and a yellow tag—the red tag is the positive connection of C9B and is connected to MR1 and R6, and the yellow tag is the positive tag of C9A and is connected to R3, R10, R1, etc.

Certain leads associated with V1B and V2 need to be made with screened cables—proper audio screened cable should be used rather than television coaxial cable. These screened cables are clearly indicated in both Figs. 1 and 2.

The wiring of S1 is shown in Fig. 5, rather than on Fig. 2, in order to clarify the connections needed; wires going to S1 in Fig. 2 have been shown with arrowheads.

Each connection made when wiring up the receiver should be "ticked off" on the circuit diagram as it is made to reduce the risk of wiring errors. When wiring has been completed, but before switching on the set, it is advisable to check with an ohmmeter that there are no short circuits existing between the H.T. positive line *yellow* tag of C9) and chassis, and that the mains and output transformer windings have been correctly indentified and wired.

Testing the Set

Connect a suitable loudspeaker to the "L.S." sockets; a good quality 8in. diameter component is well worth while, as the standard of reproduction obtainable from this simple receiver is of a high order, particularly on "gram". Turn the wave-change switch fully anti-clockwise (to the "gram" position), insert V1 in the left-hand valveholder, and V2 in the right-hand one. Insert the mains plug, and switch on by operating VR1 until the switch "clicks". The pilot bulb should light up immediately, and in a few seconds, the heaters of V1 and V2 should be seen to glow normally.

Advance the volume control to about half-way, and touch the blade of a screwdriver on the "live" pick-up socket. A loud hum should be heard from the loudspeaker. On turning the wavechange switch to either of the other two positions (Medium or Long Wave Radio) this hum should cease, whilst operation of the tone control VR2 should enable a perceptible change in "pitch" of the hum to be discerned.

Alignment

First connect an aerial and earth to the sockets at the rear of the set. Turn S1 to the Medium Wave position and tune to a station at the high wavelength end of the scale—in the evenings, the Third Programme on 464m would be suitable. Adjust the core in L2 so that the chosen programme is received at its correct position on the tuning scale. Then, adjust the core in L1 for maximum volume.

Tune to a station at the low wavelength end of the scale—for example, the Light Programme on 247m or Radio Luxembourg on 208m. Now adjust the trimmer (TC2) on top of VC2 so that the chosen station tunes in its correct position on the tuning scale. Then, adjust TC1 (the trimmer on top of VC1) for maximum volume.

The above two sets of adjustments at the high and low wavelengths ends of the tuning scale should now be repeated until the stations at each end tune at about their correct positions on the tuning scale.

When this Medium Wave alignment has been completed, it should be found, on switching to Long Waves, that the Light Programme on 1,500m tunes at about the correct position.

If there are any signs of R.F. instability, i.e., a tendency for the receiver to go into uncontrollable oscillation at certain (or perhaps all) settings of the dial, this indicates unwanted coupling between the R.F. amplifier and detector circuits, resulting from closely coupled wiring. Owing to the fact that all connections to both "halves" of V1 are brought out at the base, a little more care in wiring, to ensure separation of grid and anode connections, is necessary than when using the older "octal" type valves with top grid connections. If tidying up the wiring fails to secure stability; the effect of increasing R2 to 1·5k or even 2k can be tried. An increase of R1 to 100k can also be tried, although in both cases there will be some slight loss of sensitivity. Naturally, a simple TRF circuit of this sort can only be expected to "pull in" the more powerful broadcasting stations, and this it will do on a simple indoor aerial of the picture rail variety.

Having checked the receiver for satisfactory radio operation, the way is now clear for a trial run connected to a suitable gramophone pick-up, preferably a high output crystal type, when an extremely pleasing standard of reproduction should be obtained, with an output more than adequate for domestic requirements. ■

How to make A.C. AMMETERS

USING READILY AVAILABLE TRANSFORMERS TO GIVE LINEAR SCALES ON HOME-BUILT METERS

By S. W. Hunt

IT is a great advantage to be able to measure alternating current accurately in the experimenter's workshop. Conventional A.C. ammeters are usually either of the moving-iron type, or of the hot-wire or thermocouple types. All of these have the great disadvantage of a very cramped scale at the beginning, and thereafter a rather extended scale, so that the useful range within the calibration of any instrument is rather limited. The moving-iron instruments have the further great disadvantage that they are all too often incapable of being calibrated with any scale having more than a few indicatory figures. This is because the pointer-movement of the cheaper moving-iron meters likely to be found in the hands of the amateur is almost always rather ill-defined. The familiar cheap pocket-voltmeters and milliammeters, with prods direct on the round case, are nearly always of this inferior moving-iron type, and the reader will be familiar with the fact that little more than indicatory readings are possible with such instruments.

Applications

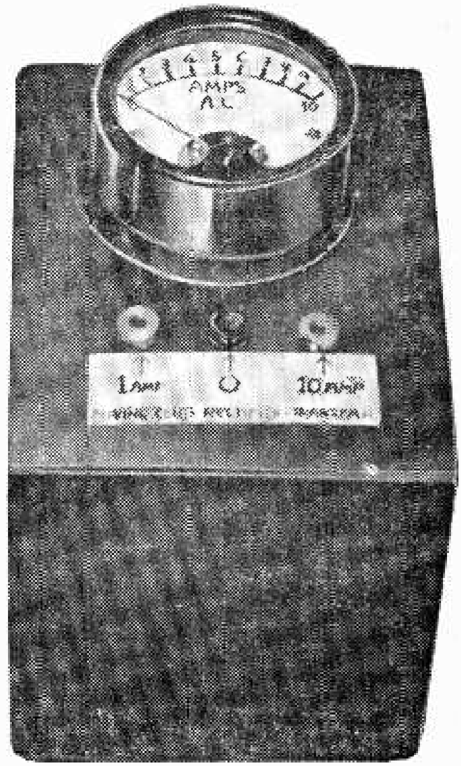
There are many applications where such primitive alternating current meters are inadequate. As examples, the following may be mentioned:

(a) to check heater-currents of valves, especially in heater-chains;
(b) to measure the current consumption of equipment connected to the A.C. mains;
(c) to measure the current consumption of A.C. relays, motors, bells, buzzers, etc.

In all of these cases, reliable indications on a clear scale are required, and this scale should be as linear as possible—i.e., equal increases of current should produce equal increases of deflection at all parts of the scale.

To meet these requirements, it is desirable to be able to adapt a moving-coil meter, to read A.C. amps on a linear scale. This feature is not normally included on commercial nor amateur multimeters; such meters very often have A.C. volts ranges, but no A.C. amps ranges. This article describes the method of adaptation of a moving-coil meter to read A.C. amps. The discussion will be in three parts:

(a) general principle and method of calculating the size of the required components;



One of the author's completed instruments.

(b) description of the author's meter, having two ranges, 0 to 1A, and 0 to 10A A.C., using a 0·75mA f.s.d. moving-coil meter. This instrument will be described in detail, with calculations in full, as an example of the general principles outlined in (a);
(c) discussion of procedure to be adopted if the A.C. ammeter is to be in the form of an addition to an existing multimeter, instead of being self-contained.

General Principles

An ammeter must have a very low net resistance, so that it does not hinder the current it measures. This means that the voltage drop across the ammeter must be very small—only a small fraction of a volt. This small voltage is not normally sufficient to operate a meter-rectifier properly; so that if a moving-coil meter with rectifier were simply connected across the calculated shunt, erratic readings, very non-linear readings, or no readings at all would be obtained. This is the reason why such ranges are normally absent on familiar multimeters.

It is thus essential to use a voltage of about 1 to 5, for proper operation of a meter-rectifier, but to keep to a mere fraction of a volt across the main current shunt from which the meter circuit is driven. The obvious solution to this problem lies in the use of a transformer between the shunt and the meter-rectifier. This must be a step-up transformer, and a ratio of 1:100 is normally adequate. The author has built several of these units, some as self-contained units (as described below), some as additions to existing multimeters, and one as a permanent fixture on the mains distribution panel in his workshop, indicating at all times the total mains current consumption in the workshop. For all of these instruments, a small heater transformer was used. A type with 230V primary and 6·3V secondary tapped at 4V, and rated at 1A or even less, is admirable for the purpose. There is no reason why the constructor should not use a much larger transformer out of the spares box if desired, except that this would make the meter unnecessarily clumsy. A miniature bell transformer would also serve the purpose, except that no ratio as high as 1:100 is normally present on such—but it would be a simple matter to reduce the number of turns on the secondary appropriately. It would also be quite in order to use a small output transformer, as long as a ratio of at least 1:100 is present on it. But, as said, the author has used small heater transformers throughout. Using the 4V and 6·3V tappings we have a 2·3V winding, which gives exactly the desired ratio of 1:100 with the 230V primary.

Complete Circuit

Fig. 1 now shows the complete circuit resulting from the above considerations. Voltages of the order of a twentieth of a volt from the main shunt R1 are stepped up to about five volts through the transformer. Using a moving-coil meter of 1mA f.s.d. after addition of the damper R3, and a value of 5000Ω for the multiplier, R2, these components together with the rectifier function as an A.C. voltmeter covering 0 to 5V. The damper R3 is essential, to provide electrical damping which causes the pointer of the meter to come to rest within a tolerable time, instead of swinging about for long periods. This damper should have a value of about two to three times the internal resistance of the meter. Together with the the meter it forms a closed circuit of relatively low resistance, which permits induced current from the meter to flow appreciably. Whilst the pointer of a moving-coil meter is still moving, the meter acts as a dynamo, generating a voltage. On closed circuit through R3, this voltage causes current to flow, and this current in turn will try to cause a meter deflection. This deflection will be in the opposing sense to the pointer movement, which generated the current—i.e., it will tend to bring the pointer rapidly to rest, which was our purpose in including R3. Of course, such dampers reduce the net sensitivity of the meter, by the ordinary rules of shunting meters, but this has to be disregarded. The initial sensitivity of the meter must be adequate. A 500μA or 750μA meter shunted to 1mA f.s.d is normally ideal, and easily obtainable. A 2mA f.s.d. movement, shunted to about 3mA or 4mA f.s.d. by means of R3, is also usable. It is not advisable to use meters with an initial sensitivity poorer than 2mA f.s.d. as troubles with non-linearity are then likely. Meters with initial sensitivities better than 0·5mA f.s.d. are of course usable, but then more sensitive than necessary and thus unnecessarily fragile.

Calculating Component Values

Matters are not quite so simple as the above discussion would lead one to suppose. There are losses of voltage in the circuit which have to be allowed for in calculating exact circuit values for a practical meter. The chief and most serious of these losses are the voltage drops across the D.C. resistances of the transformer windings. These must be calculated, as shown below, and allowed for in calculating the required shunt R1. Less serious are losses due to the rectifier characteristic and magnetic leakage of the transformer. These are initially ignored, and then corrected for in the finished meter by means of making R2 a pre-set potentiometer, and adjusting this whilst the meter is operated in series with a standard meter, or with a known current. Lacking any better standard, the completed meter may be connected for this purpose in series with various mains appliances to the mains. For appliances of known wattage, the current is known. Alternatively, the completed meter may be connected in series with a resistance of a few ohms to a voltage supply of a few volts A.C. The voltage drop across the series resistance may be measured with an ordinary A.C. voltmeter, whence, by Ohm's Law, the current flowing in the circuit is known, and thus R2 can be set accordingly.

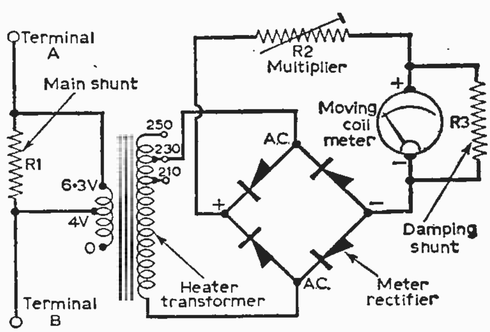


Fig. 1—The complete basic circuit of the A.C. ammeter described in this article.

Equivalent Circuits

It is possible, for our present purposes, to represent our transformer as an "ideal perfect transformer" (perfect coupling, no leakage, zero D.C. resistances of windings)—with the "faults" of the actual transformer depicted by appropriate virtual external "components". Thus the resistors

R4 and R5 (Fig. 2) appear in series with the two windings, and represent (and are equal to) the respective D.C. resistances of the windings. These resistances R4 and R5 should be measured as accurately as possible, by means of passing a suitable *direct* current through them (do not exceed the rating of the transformer), and measuring the voltage drop produced, using a good millivoltmeter. The voltage drop (millivolts) divided by the current flowing (milliamps) gives the winding resistance in ohms.

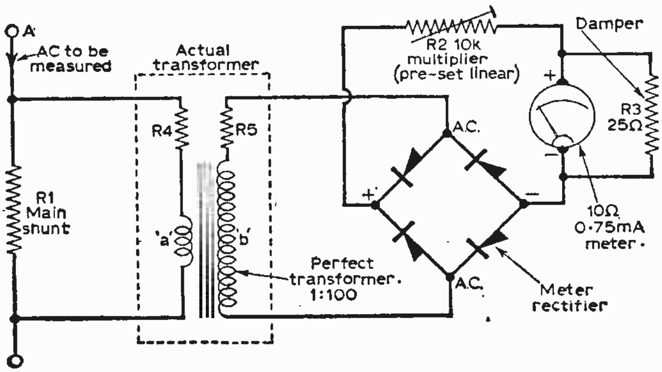


Fig. 2—The equivalent circuit of Fig. 1 for calculations.
For f.s.d.: Winding 'b'—5V at 5000Ω impedance.
Winding 'a'—0.05V at 0.5Ω impedance (= 100mA).

R5 is virtually in series with the actually present external resistor R2. The sum should be equal to 5k to give a 5V meter action with a 1mA f.s.d. meter. A meter of somewhat greater sensitivity than this must be used and shunted with R3 to give 1mA f.s.d. The author used a 0.75mA f.s.d. meter of 10Ω internal resistance, and made R3 equal to 25Ω. This gave near enough 1mA f.s.d.; great accuracy is not needed at this stage because final adjustment is made, as said, with R2, and several remaining errors can be corrected simultaneously with this.

Having proceeded thus far, we can reckon with 5V appearing at the winding "b" of the perfect transformer in Fig. 2 when the meter is showing full-scale. The perfect transformer is of ratio exactly 1:100 so that one twentieth of a volt exists across winding "a" of the perfect transformer for full scale deflection.

Now, as far as the main shunt R1 is concerned, we may replace the perfect transformer winding "a", and all subsequent resistance simply according to the normal rules of impedance transformation of a transformer, as will already be familiar from the matching of loudspeakers to output valves with a transformer. A transformer multiplies or divides the impedance by *the square* of the factor by which it multiplies or divides the voltage, i.e. by the square of its turns ratio. We have a circuit of 5000Ω connected to winding "b" of the perfect transformer, and the turns ratio is 100, thus the impedance ratio is 10,000. Thus the 5,000Ω appear divided by ten thousand at winding "a", i.e. as half an ohm. We may thus replace everything except R1 and R4 by a resistor of half an ohm, across which we need one-twentieth of a volt for full-scale deflection, i.e. 100mA must flow through it at full scale deflection.

The circuit has now come down to Fig. 3, in which everything is known except the main shunt R1, which can therefore be calculated. The applicable formula appears with Fig. 3 also.

The following details of the meter built by the author, serve as an example of the principle outlined above. An A.P.W.2878 surplus meter movement was selected. This is a moving coil meter with 10Ω internal resistance, and 0·75mA full-scale deflection. It is obtainable in surplus stores and bears a square-law scale 0 to 100 labelled "Radiation Meter". A 25Ω 2% wire-wound resistor should be fitted as damper, R3 which brings this meter to approx 1mA f.s.d. A 10k linear pre-set potentiometer is fitted as R2.

A small half-amp heater transformer was used, and the main primary D.C. resistance was about 250Ω for this transformer and the D.C. resistance, R4 between the 4V and 6·3V tap was found to be 1·175Ω.

The resulting value for the main shunt, R1, required for a 1A full-scale range, according to the formula in Fig. 3, thus comes out of 0·186Ω. Now, a second range, with 10A full-scale, was desired. it is useless to switch shunts, as the total impedance is so low that random contact resistance of the switch would cause erratic errors. Thus the 0·186Ω shunt was tapped for a 10A range, in the manner of the well known universal shunts. This tap in fact split the shunt R1, into two shunts in series, R1a and R1b: both in series constitute the 0·186Ω for the 1A range and the smaller portion only, which was calculated to 0·0186Ω, was for the 10A range.

(To be continued)

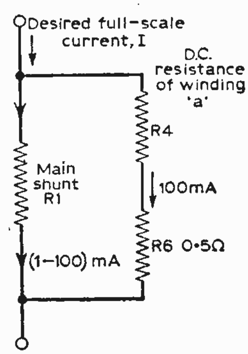


Fig. 3—The effective circuit for calculating the main shunt (winding 'a' of Fig. 3 has been replaced by R6).
Calculation of the main shunt:

$$\frac{R4 + R6}{R1} = \frac{I - 100}{100}$$

Now $R6 = 0.5\Omega$; *therefore* $R1 = \left(\frac{100R4 + 50}{I - 100}\right)\Omega$

where I is the desired FSD current in mA, and R4 is the D.C. resistance of winding 'a' in Ω. (Obviously, I must be at least 100mA, which represents the maximum final sensitivity.)

How Transistors Work

By B. N. Rolfe

(Continued from page 1138 of the April issue)

A BASIC NON-MATHEMATICAL EXPLANATION

AT this stage it would, perhaps, be desirable to investigate in a little more detail the effect that temperature has on transistors. Much has been written about the temperature sensitivity of transistors and how excessive temperature, such as the heat from a soldering iron can ruin them. Also, how the heat from a bench lamp can alter the characteristics of a transistorised circuit and cause rather bewildering voltage and current readings during the course of fault tracing in a transistor receiver. All these things are perfectly true and should be heeded.

Ratings

Transistors possess what is known as a "maximum power rating", which applies essentially to the collector junction. This rating, of course, is the product of the collector current and voltage, and is rather like the anode power rating (or anode dissipation) of a valve. With a transistor, however, collector current and voltage are rather critical, and will be dealt with later.

The maximum power rating of the collector (often called maximum collector dissipation) is very much related to the temperature of the junction. It will be recalled from previous articles in this series that the collector junction is subjected to a reverse bias and that collector current flows only when there is a forward current in the base circuit.

When there is no base current, then there should be only very little collector current, and in fact, the collector current which exists at that time is called "reverse leakage current"—rather like the reverse current which occurs in an ordinary germanium diode when it is connected for reverse conduction.

This current is due essentially to "minority carriers" at the junction (these will be considered in detail later). However, when there is a forward current in the base/emitter junction there occurs a diffusion of "positive holes" into the collector/base junction, which have the effect of increasing the density of minority carriers and thus cause an increase in collector current. To a point, depending on the type of transistor, the collector current increases with increase in base/emitter current.

Effect of Temperature on Minority Carriers

A perfect transistor junction would be one which passed no reverse current whatever. Unfortunately, the perfect is never possible, and there is an extra shortcoming in a transistor junction in that the reverse current increases with increase in temperature. Thus, if we consider a transistor circuit with zero base/emitter current with a microammeter in the collector circuit, as shown in Fig. 20, at normal room temperature there would be a small reverse leakage current, which, would increase considerably with increase of temperature of the transistor.

The maximum junction temperature for most small transistors is of the order of 75°C. At higher temperatures, the efficiency of the transistor falls and, as the temperature is still further increased, the transistor no longer behaves as a semi-conductor but turns into an ordinary conductor. This happens because a rise in temperature causes what is termed "thermal agitation" within the make-up of the germanium crystal. Electrons are freed from their normal orbits and thus contribute to current flow.

What is a Semi-conductor?

Before dealing with the more practical matters associated with transistors and their circuits, it will be instructive to consider a little of the theory of transistors, as this will help to a clearer understanding of the various factors discussed in the foregoing paragraphs.

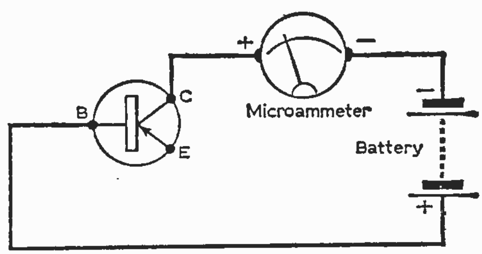


Fig. 20—At normal room temperatures, a small reverse leakage current flows in the base/collector junction when there is zero base/emitter current (see text).

An ordinary thermionic valve requires a vacuum in which to operate; electrons are emitted by the cathode and are attracted to a positively charged anode through a vacuum. A control grid is inserted between the cathode and anode to control the flow of electrons and hence the anode current.

A transistor, on the other hand, does not require a vacuum, but works instead in a perfect insulator in which is introduced certain impurities as a means of controlling the flow of current. The perfect insulator used is usually germanium, which is a crystal, and in its perfectly pure state the electrons of each atom are tightly "bonded" together. This means that there are no free electrons. It will be recalled that a flow of electricity constitutes a movement of free electrons in the conductor. Best conductors are those which have most free electrons, like copper, silver and similar metals, while the best insulators are those with the least free electrons, such as rubber, glass, mica, germanium and so on. The free electrons are caused to move in a conductor by its being subjected to a difference in electrical potential (in volts) between its ends. The free electrons then flow from negative to positive, since electrons are attracted by a positive charge. The idea is illustrated in Fig. 21.

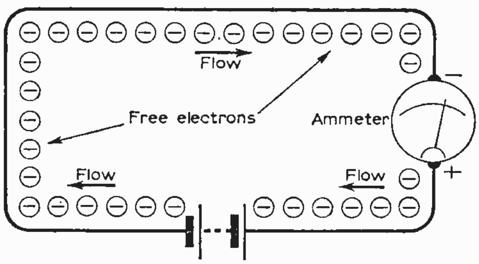
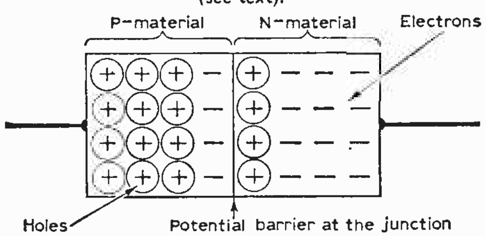


Fig. 21 (above)—Movement of free electrons constitutes a current of electricity.

Fig. 22 (below)—Operation of the crystal diode (see text).



There is no perfect insulator, but pure germanium approaches the ideal. Like all atoms, an atom of pure germanium features a central, positively charged, "nucleus" surrounded by electrons in orbit—rather like the planetary system, where the nucleus is the sun and the electrons the orbiting planets. The number of electrons in orbit is equal to the positive charge of the nucleus, and the atom has zero overall charge since the negative electrons exactly cancel out the positive charge of the nucleus.

Bonding

Germanium has four orbiting electrons to each atom, and the lattice-like structure of the crystal is achieved because the electrons of one atom share the orbit path of the electrons of an adjacent atom. In this way the atoms are "bonded" together and there are no free electrons for ordinary conduction. However, controlled conduction is implemented by the introduction of a little impurity into the germanium. Arsenic is such an impurity with five orbiting electrons to each of its atoms. What happens is that an atom of germanium in the crystal lattice is replaced by an atom of arsenic, and only four of the arsenic electrons pair-up with the four electrons of an adjacent germanium atom. This leaves one electron per arsenic atom which is not paired and which is free for ordinary conduction.

Conduction is, of course, limited by the number of free electrons so created, and for that reason the material is called a "semi-conductor". Also, since conduction is by way of electrons which are negative, the semi-conductor is called "n-type"—*n* for *n*egative.

P-type Material

A different type of semi-conductor is produced by the introduction of an impurity with only three orbiting electrons, such as indium. The effect here is that the three indium electrons pair with three of the electrons of an adjacent germanium atom, leaving one germanium electron per indium atom without an electron partner.

This electron deficiency is called a "positive hole": the term "hole" is used to denote that there is a vacancy for an electron. Such vacancies continue to exist within the crystal, and conduction is said to be by way of a movement of holes. When such a material is subjected to an electric potential a hole is filled by an electron from an adjacent atom. This move leaves a hole behind which itself is filled by an electron from another atom, and so the process continues—a movement of electrons from negative to positive and an apparent movement of holes from positive to negative.

Since the holes move in the opposite direction to electrons they are said to be "positive" current carriers, and for that reason semi-conductor material of such nature is called "*p*-type"—*p* for *p*ositive.

It may be said, therefore, that semi-conductors possess a conductivity which falls somewhere between that of conductors and insulators, but unlike the latter materials—the conductivity of which decreases with increase in temperature—semi-conductors *increase* in conductivity with increase in temperature. This is because some of the orbiting electrons are "agitated" out of their orbits due to the rise in temperature, and are thus available—rather like free electrons—to contribute to conduction.

We are now back almost to where we started, but it is essential that we complete the story in terms of semi-conductor junctions and transistors.

p-n Junction

When a piece of germanium is processed at one end for *p*-type and at the other end for *n*-type the current carriers in each type of semi-conductor diffuse in either direction across the junction. The holes from the *p*-region diffuse into the *n*-region and the electrons from the *n*-region diffuse into the *p*-region. A condition of equilibrium results whereby a "potential barrier" occurs across the *junction*. This potential is created because the *p*-material acquires a negative charge due to its loss of holes, while the *n*-material acquires a positive charge due to its loss of electrons. The effect is shown in Fig. 22.

(Continued on page 38)

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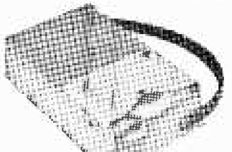

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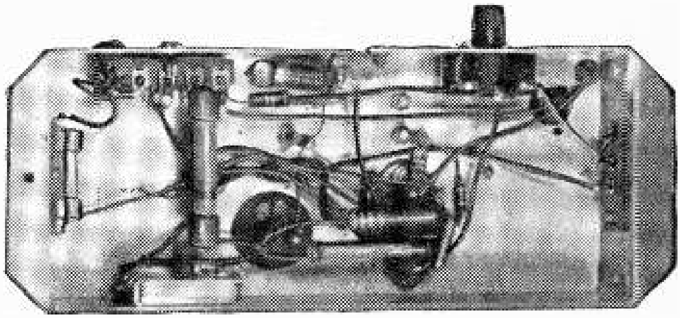
photo-electric CONTROL unit

AN INEXPENSIVE INSTRUMENT WITH MANY APPLICATIONS

By V. E. Holley

ORIGINALLY, this device was built to announce the arrival of customers in business premises normally open to the street, which it did by sounding a buzzer at the rear of the building. It has many other uses and will, in fact, enable any electrical or electro-mechanical operation to be controlled by a beam of light. The circuit is simple and the parts are few.



An underside view of the unit.

Signal Circuit

The valve, V1, in Fig. 1, is a photo-electric tube, type 90CV. It is a vacuum tube with a cathode of caesium on oxidised silver and as its peak sensitivity lies in the near infra-red region, it is more responsive to artificial light than to natural daylight. The anode is supplied with a positive voltage of about 70 and when the cathode is illuminated, a small current flows through the load resistor, R1. Depending on the degree of illumination and the exposed area of the cathode, up to 10V can be developed across the load; a practical working level is about half this figure.

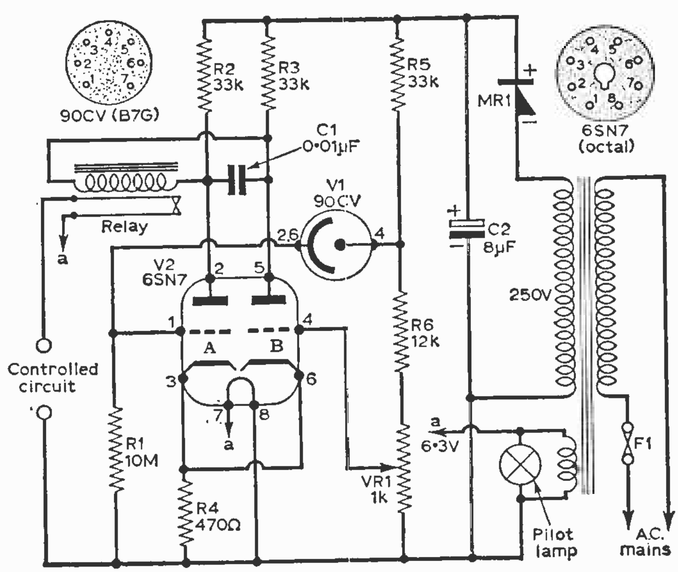


Fig. 1—The circuit of the unit.

Control Circuit

The double triode valve, V2, operates a relay. The two anodes are supplied through the 33k resistors R2 and R3 and bias is provided by R4 which is common to both cathodes. A relay is connected between the two anodes. It will be seen that R2, R3, the two triodes and the relay form a bridge circuit which, under static conditions with zero voltage on the grids, is balanced so that no current flows through the relay. Each half of V2 then draws a current of 5·5mA and the anode voltages are about 110. The load resistor for V1 is also the grid resistor for V2A and when a positive voltage is produced across it by illumination, the current through V2A increases, the common cathode voltage rises correspondingly and reduces the current through V2B. The bridge is unbalanced and a current flows through the relay connected across the centre of it. Capacitor C1 absorbs any inductive surges occurring across the relay.

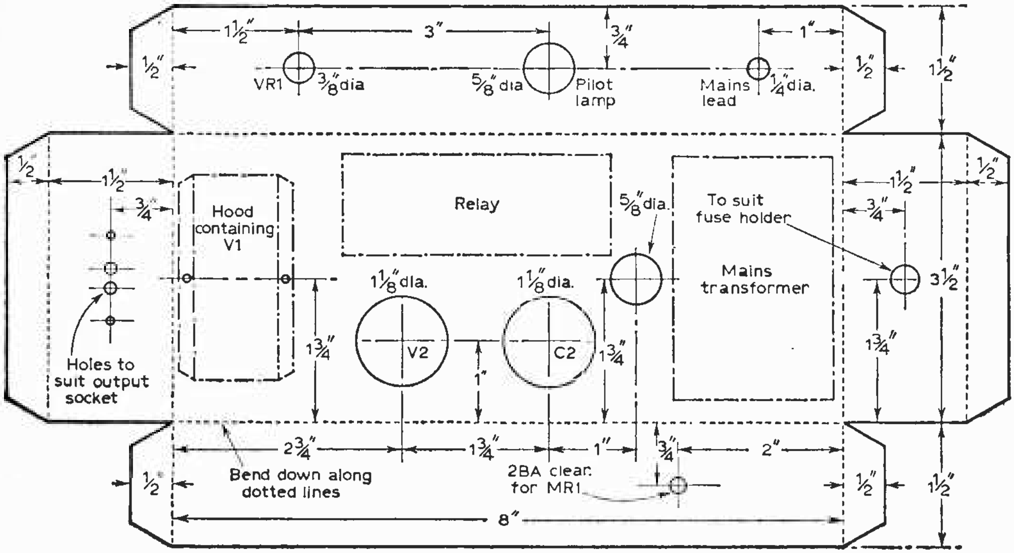


Fig. 2—The drilling details of the main chassis.

Under the conditions described, the relay energises when light falls on V1, but the usefulness of the unit is much increased by arranging that it can, at will, be made to energise when illumination ceases. This is easily achieved by applying a positive voltage to the grid of V2B to unbalance the bridge so that illumination restores the balance and de-energises the relay; VR1 provides a variable positive voltage for this purpose. The closing of the relay makes available at the output socket a 6·3V supply for operation of a buzzer or other electro-mechanical device.

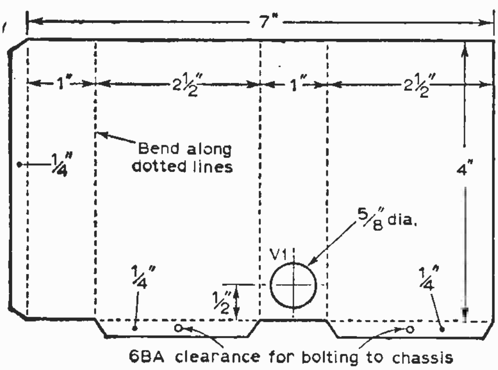


Fig. 3—Details of the "hood" for V1.

Power Supply

The unit requires about 20mA at 250V—290V in addition to a supply at 6·3V A.C. for the valve heater and pilot light and any external service for which this voltage is required. A total current of 2A will usually be enough. This is supplied by a miniature mains transformer having a half wave H.T. winding. A contact-cooled rectifier and a reservoir capacitor of 8μF provide the H.T. supply; no smoothing is needed. A potential divider consisting of R5, R6 and VR1 provides a 70V anode supply for V1 and a voltage variable from 0 to 6 for the grid of V2B. It is important that the voltage at the lower end of R5 does not exceed 70, because if it does, the maximum "dark" anode voltage of V1, which is 100, will be exceeded when first switching on and before the cathode of V2 warms up and draws current.

Construction

The device may be constructed in any convenient form and, if desired, V1 can be a separate plug-in unit. The form here described is suitable for most general purposes and requires a chassis of 18s.w.g. aluminium sheet about 8in. × 3½in. × 1½in. as shown in Fig. 2. The service for which it is required may in some cases dictate the type of relay but generally a simple inexpensive type having an operating current of about 3mA will serve well. The resistance of the energising coil is not important. The resistors are not in themselves critical though they have a

COMPONENTS LIST

Resistors: (high stability)

R1 10M	***R4 470Ω***
R2 33k	***R5 33k***
R3 33k	***R6 12k***

Capacitors:

C1 0·01μF ***C2 8μF elec.***

V1 90CV photo-electric tube ***V2 6SN7***

VR1 1k potentiometer

Mains transformer, 6·3V bulb, relay, 100mA fuse (anti-surge), fuseholder, aluminium chassis, valveholders, tag strips, etc.

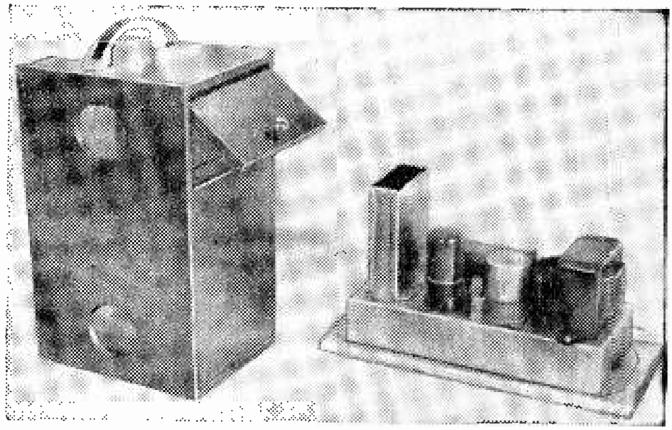
MR1 metal rectifier

rather critical relation one with the other, and the values given should be used; R2 and R3 should be reasonably well matched. Because the unit may be switched on unattended for long periods, it is essential that it should be properly fused. In addition to the 100mA fuse in the chassis it is advisable that the supply be taken through an outlet or 13A plug fused at 1 or 2A as a safeguard against a fault in the connecting cable.

Although the 90CV is a relatively insensitive tube, precautions are necessary to exclude random light. It is accordingly fitted inside a hood, the measurements of which are given in Fig. 3. Suitable material for this is 20s.w.g. aluminium sheet or 24s.w.g. tin plate. With this hood, painted matt black inside, the unit will operate satisfactorily in a well-lit room so long as it is not pointed directly at a light or a highly reflective surface, or at a window in daylight. Details of the wiring and connections are given in Fig. 4.

Testing and Adjustment

When the unit has been wired up, check first with V1 removed and zero voltage at the grid of V2B, that the voltage at the lower end of R5 does not exceed 100 on first switching on; if it does, R5 must be increased. It is unlikely that any alteration will be needed unless the supply voltage exceeds 300. If the relay is to be energised on illumination, there is nothing more to be done apart from replacing V1. If the reverse is required, keep V1 unilluminated and apply a gradually increasing positive voltage to V2B grid by adjustment of VR1 till the relay closes. As a guide to performance, satisfactory operation should be secured from a lighted match held an inch or so from the end of the hood or from a focusing torch at a distance of 10ft. to 15ft., depending on the efficiency of the torch.



The complete unit and its cabinet.

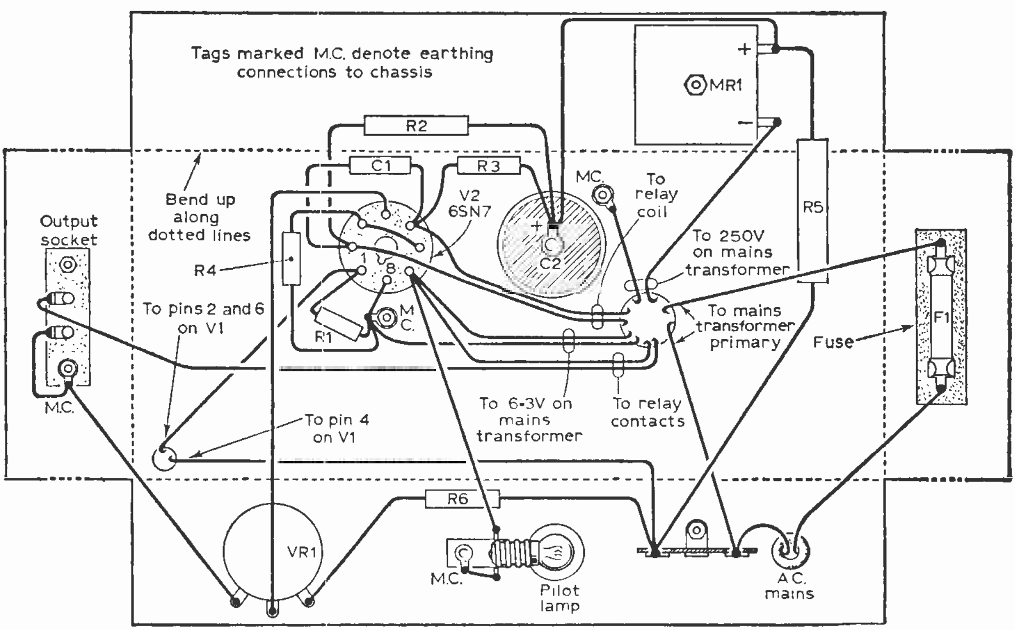


Fig. 4—The underchassis wiring diagram.

Signal Source

A suitable operating signal for distances up to 8ft. or so can be produced from a 6·3V 0·3A dial light arranged to produce a well focused beam. Nothing expensive in the way of lenses or reflectors is needed; good results can be had with a lens from a cheap pocket torch and no reflector. If secret operation is required, the beam may be coloured red without loss of range, when it will be invisible under most conditions so long as it is not allowed to strike reflecting surfaces and the stray light is reduced to a minimum. Fig. 5 shows a suitable arrangement for this purpose. Here, lamp, lens and red filter are enclosed in a box which is extended forward four to six inches to contain the stray light and the beam is allowed to pass out through a hole in the distant end about ⅝in. in diameter. The interior of the box should be painted matt black. The 6·3V supply for the lamp may be taken from the heater circuit of the control unit.

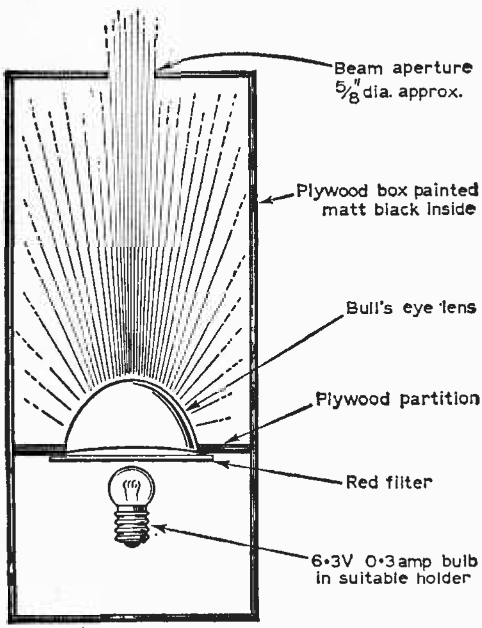


Fig. 5—The construction of a suitable light source.

Application

In addition to acting as a warning device, the unit has, with minor variations, given good service in other directions. Its most useful role is perhaps in conjunction with a simple electro-mechanical counter (for example, the electronic digital counter) where it has been used for such diverse purposes as time and motion study and counting peaches on a fruit grader. In this last application it was made to divert the flow of fruits from one channel to another after a predetermined number had passed the control point. No doubt other applications will suggest themselves to the reader.

Housing the Unit

In the form here described, the unit can conveniently be housed in a plywood box about 10in. × 4½in. × 6in. The chassis should be bolted to a baseboard of ⅜in. ply, and the remainder of the box fitted over it as a cover. Ventilation is required and can be provided by cutting some 2in. diameter holes in the sides and covering them with perforated zinc secured on the inside with impact adhesive. Holes are required in the cover for the mains lead, the pilot light and the output socket and for screwdriver access to VR1. Photo tubes deteriorate if exposed to light when not in operation, so part of the top of the cover should be in the form of a hinged door above the tube hood, which can be closed when switching off. A couple of panel-pins driven through the sides into the "door" close to one end will serve as hinges. ■

Photocell Details

Base	B7G
Max. anode supply voltage	100
Max. dark current at 100V	0·05μA
Max. cathode current ...	10μA
Sensitivity in μA/lumen ...	20
Cathode area in cm^2 ...	3·1

HOW TRANSISTORS WORK

(Continued from page 32)

Now, if a battery is connected across the junction so that the positive side is connected to the *p*-material and the negative side to the *n*-material, the current carriers in each material will again start diffusing across the junction. This produces a current flow in the *forward direction*, as would be expected.

However, if the battery connections are reversed, the potential barrier at the junction is reinforced, and in an ideal case there should be no current flow. In practice, though, a small reverse leakage current flows. This is because of the inevitable presence of electrons in the *p*-material and holes in the *n*-material. These reversed current carriers are called "minority carriers", as previously intimated. They increase in density with increase in temperature, and thus cause the reverse leakage current to increase as the junction warms up—see Fig. 20.

The Transistor

We already know that the transistor has two junctions. A *pnp* transistor consists of a very thin region of *n*-material sandwiched between two regions of *p*-material, while an *npn* transistor consists of a very thin region of *p*-material sandwiched between two regions of *n*-material.

The filling of the sandwich is called the base, while the outside pieces are called emitter and collector respectively (basic details were given in the first article of this series). We thus have two junctions—the emitter/base junction and the collector/base junction.

The former is biased for forward conduction (emitter positive with respect to the base), while the latter is biased for reversed conduction (collector negative with respect to the base).

(To be continued)

Experimenter's POWER-PACK

(Continued from page 1114 of the April issue)

By M. L. Michaelis

AS stated on page 1112 of the April issue (following the details of rectifier nomenclature), about 400 to 500V appears at the anode of V1. Now V2 supplies V1 with the correct bias to give the necessary voltage drop across V1 (see page 907, February issue) to keep the voltage at its cathode, i.e. at the stabilised H.T. output terminals, at a pre-set level. This pre-set level is determined by VR1, and is always such that the resulting output voltage causes a voltage at the slider of VR1 on the bleeder R16, VR1, R17 approximately equal to the operating voltage of the reference neon V3 (90V). This neon is fed from the anode of V1 via R14 and the anti-oscillation condenser C8. V2A serves to compare the voltage at the slider of VR1 with the neon V3, changing its anode current and thus the bias on V1 in the appropriate sense if any error is detected. V2A and V1 thus constitute a D.C. difference-amplifier with virtually total negative feedback. C7 makes the negative feedback even greater for A.C., so that any alternating voltages, regardless of their origin, are strongly damped out. This cancels hum from the transformer, rectifier and smoothing; it also cancels hum introduced into V2, and finally it strongly cancels alternating voltages of any frequency coming back into the power supply from the external load. The net effect is that C7 reduces the dynamic A.C. internal impedance of the power supply to well under one ohm at all normal frequencies, effecting virtually complete decoupling of various items of equipment connected simultaneously to the output, and reducing the remaining hum-ripple to negligible proportions.

V2B is normally cut off by about 10V bias, and is thus fully inoperative as long as the H.T. supply is not overloaded. Its cathode is taken to a stabilised negative 90V supply from V4, and its grid to a stabilised negative supply of about 100V from V5. The negative 10V difference cuts V2B off. Now, the output load current must flow through R9 and VR3, and the voltage drop across this parallel combination adds itself in series to

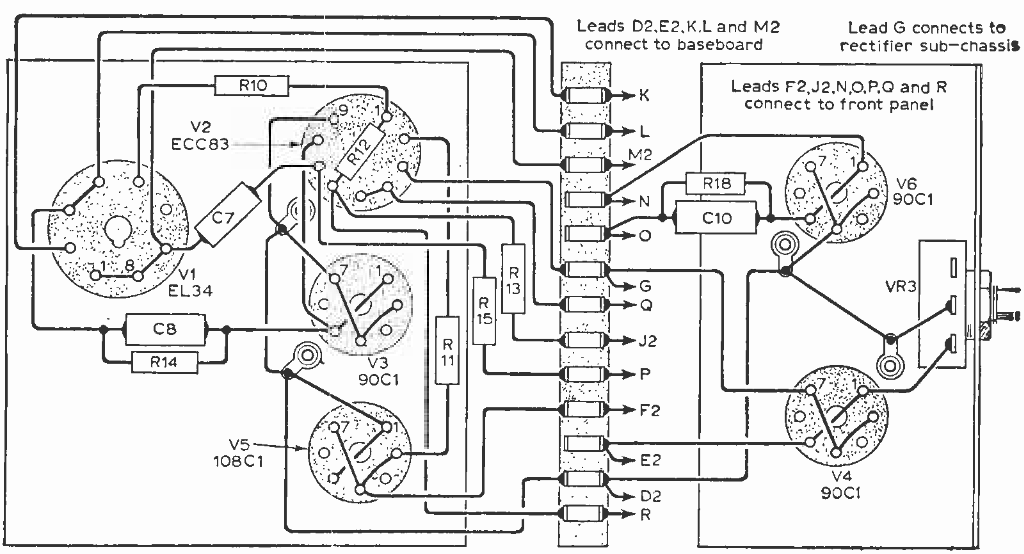


Fig. 13—Wiring diagram of the valve chassis.

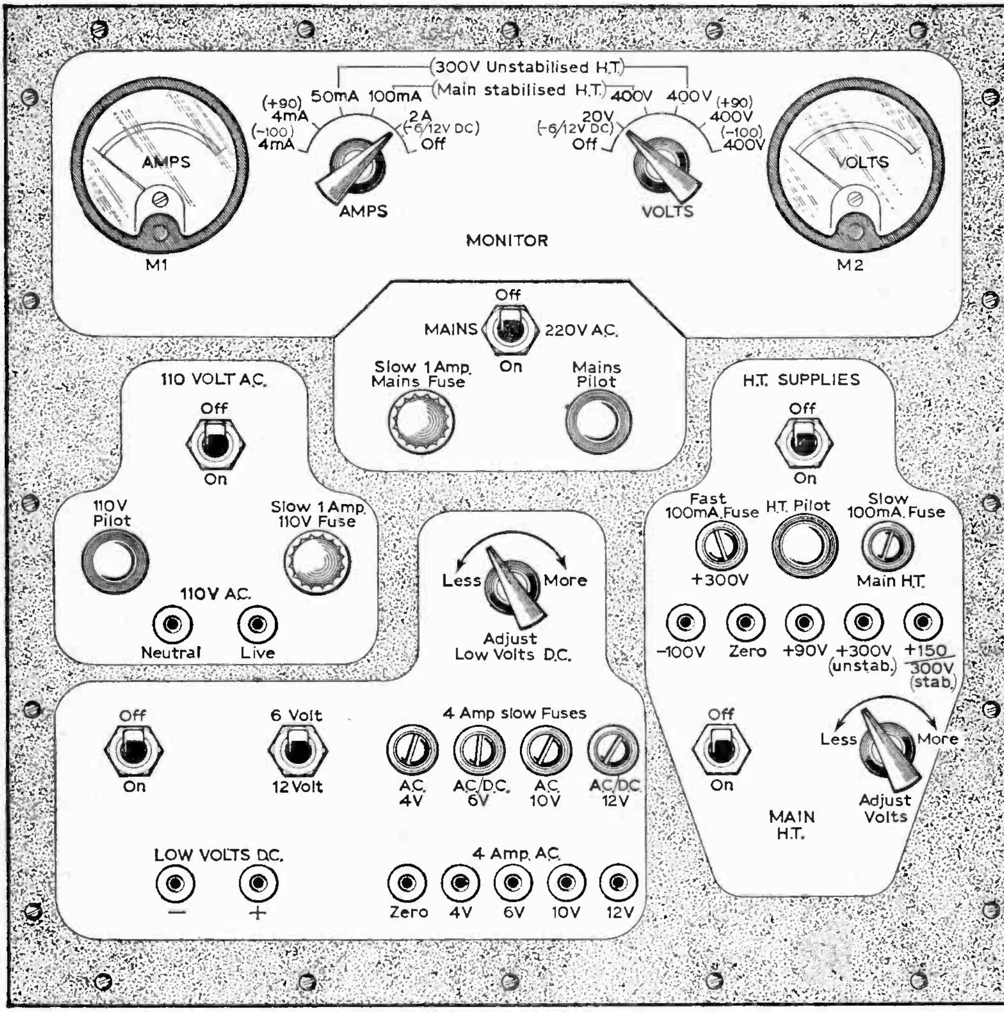


Fig. 14—The front panel of the completed power pack.

the negative 90V supply, drawing the cathode of V2B down with it. VR3 is adjusted with a screwdriver until the short-circuit current is 120mA. At 100mA output current, the cathode of V2B has fallen sufficiently for the valve to reach cut-on, and the consequent flow of anode current biases V1 to prevent further rise of current. The result is that, as soon as the rated maximum load of 100mA is tending to be exceeded, the voltage rapidly collapses with increasing load, so that even the full short-circuit current is only 120mA. A slow 100mA fuse is incorporated, which is rated to blow within five minutes at 120mA. Thus a complete short-circuit load does no damage to the power supply, yet is cut off after about five minutes if not removed by hand before then. These characteristics are virtually ideal for an H.T. supply for experimental purposes:

(a) High degree of voltage stabilisation within the rated current range.
(b) Strong limiting of short circuit current to non-dangerous value.
(c) No damage and no fuses blowing when accidental short-period short-circuit made.
(d) Fuse protection against prolonged short-circuit.

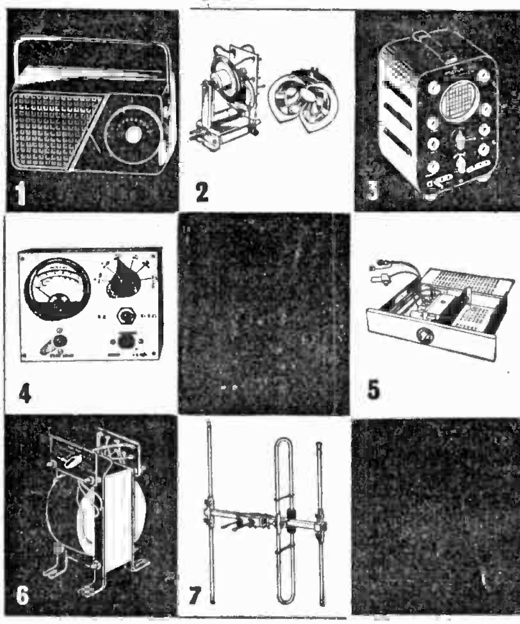
Other H.T./Bias Outputs

The negative 100V stabilised supply of V5 is available also externally. The negative 90V supply of V4 is not useful externally, as, on account of R9, it is not stabilised with respect to chassis, and is thus not taken to any external terminal.

D3, C11, C12 and R19 provide an unstabilised H.T. supply of about 300V. This is used to feed

(Continued on page 43)

CHECK with these BARGAINS



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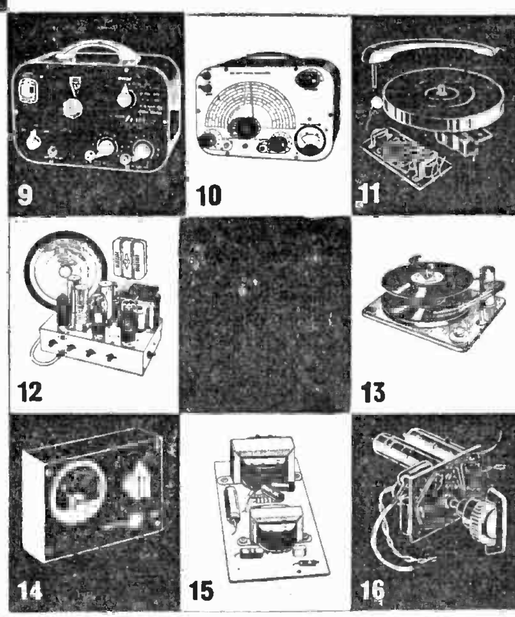

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(Continued from page 40)

H.T. to V2 (ahead of its fuse, so that V1 does not lose bias if the 300V unstabilised fuse is blown), and (subsequent to its fuse), to feed the corresponding output terminals, and the plus 90V stabilised bias supply (valve V6). It is possible to do away with V6 altogether, taking the plus 90V

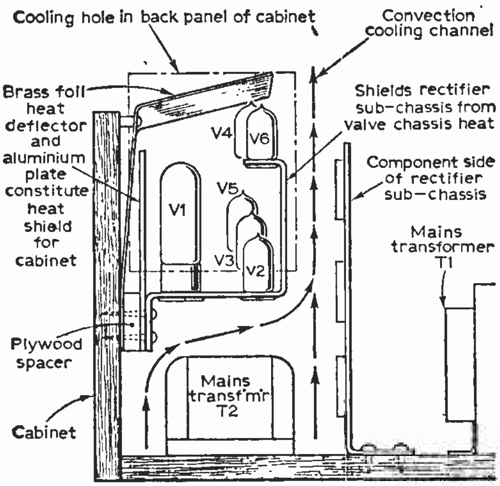


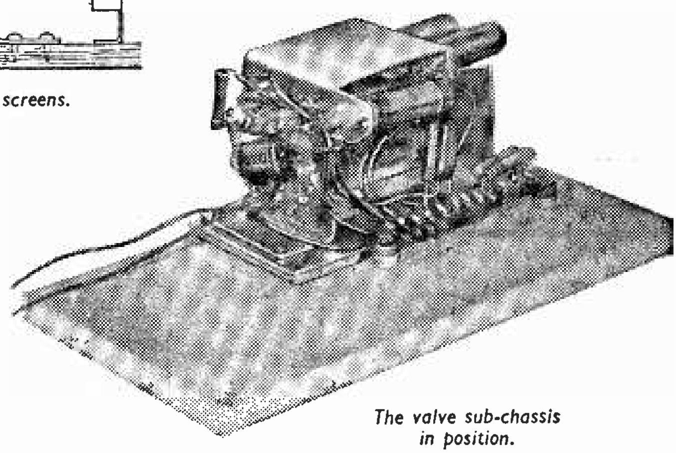
Fig. 15—The valve chassis heat screens.

output from V3, but this was found to impair the stabilisation of the main stabilised H.T. output somewhat, giving some degree of interaction between the two outputs. This is not the case with V5, which can serve its double purpose of biasing V2B as well as providing a minus 100V output, without any disadvantages, because V2B is normally cut off anyway.

The 300V unstabilised output is intended for operating stock items of equipment such as valve voltmeters, etc., whilst the main stabilised output feeds experimental circuits. Thus only the latter output requires the special short-circuit protection described above. The stock equipment is assumed to be normally in good working order, and thus more simple fuse protection suffices. Although the full short-circuit current of the unstabilised 300V output is only 125mA, on account of R19, the discharge surge of C12 blows the fuse at once upon shorting the output. A fast 100mA fuse is used, however, so that the 125mA current alone also suffices to blow the fuse within a few seconds if the short is present before switching on, in which case C12 would never receive any charge.

Thus, it may safely be said that the power supply is fully protected against overloads and short circuits. Overloads either blow the fuses within a tolerable time, or do no damage. On the other hand, they do not continually blow fuses on mere momentary accidental short circuits liable to occur during experimental work. The whole power supply is thus admirably adapted to the needs of the experimenter's workshop, and was in fact envisaged, designed and built to meet just these needs in the author's experimental workshop.

(A supplementary article on the Experimenter's Power Pack will appear shortly.—Ed.). ■



The valve sub-chassis in position.

For the deaf in church

THIRTEEN deaf aids have been installed in the Parish Church of St. Matthew, Rugby, as well as a public address system. The work was carried out by Associated Electrical Industries Ltd.

A number of seats in the church are reserved for deaf aids and appropriately marked. The equipment—a single headphone on an arm—can be had on request from a warden who will link it up and plug it in.

The public address system can be used from four points, the pulpit, lectern, reading desk and prayer desk. Every effort has been made to make the equipment as unobtrusive as possible. The four microphones are hidden from view and the main twin cable is concealed in the flooring. Wiring on the lectern has been hidden inside the Church's handsome brass eagle.

The microphones can be faded in and out as required and the volume control is in an amplifier cabinet alongside the organ.

The equipment was dedicated on 14th January, by the Vicar of St. Matthews and the Rural Dean of Rugby, the Reverend Canon E. Liddell Paine.

The equipment was supplied and installed by Sound Equipment Group of the AEI Electronic Apparatus Division.

A direct-reading FREQUENCY-METER

FINAL ADJUSTMENTS AND CALIBRATION

By E. Dexter

(Continued from page 1121 of the April issue)

CONTINUING with the description of the circuit of this instrument, the monostable multivibrator circuit (V5) is now outlined.

The Monostable Multivibrator Circuit, V5

This stage is the real frequency-measuring heart of this instrument. It is also the most critical stage, and the most difficult to make operate. It is thus of advantage to build it last of all, making certain first that all previous stages are working correctly. The triode on pins 1, 2, 3 conducts heavily in the resting state, as the grid leak, R28,

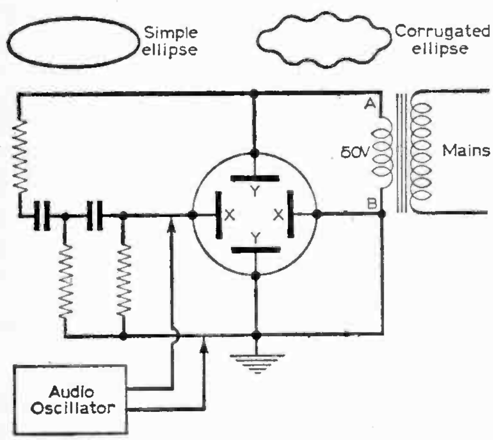


Fig. 6a—Calibration of an audio oscillator against the mains supply frequency. By applying a 50V A.C. waveform to the X and Y plates (in conjunction with suitable phase-shifting networks), an ellipse can be obtained on the screen of an oscilloscope.

When the output of the audio oscillator is also connected, the ellipse becomes corrugated (as indicated) and this corrugated ellipse will appear stationary if the frequency of the audio oscillator is an integral multiple of the mains frequency. This method covers up to about 500c/s or 1kc/s. For higher frequencies, an oscillator is tuned to 500c/s or 1kc/s and then used in place of the mains-derived waveform in the above circuit and connected to points A and B (see text).

is returned to H.T. positive. Consequently, the cathodes are at a high potential, higher by more than the grid base than the potential of grid pin 7 set on the slider of VR2. Consequently the triode section (pins 6, 7, 8) rests cut off, and C19 is at the full H.T. voltage, with zero meter current. If now one of the trigger pulses from the differentiated square wave as discussed above arrives via C11 to grid pin 7, it lifts this grid momentarily above cut-on. The resulting start of anode current in R23 results in a voltage drop across this resistor, which is fed, via the condenser selected by Sla, to grid pin 2, thus reducing current in this triode section. The cathodes thus fall in potential which is equivalent to a further rise of grid pin 7 voltage, so that the process is cumulative and the triode (on pins 1, 2, 3) is rapidly cut off, and the other triode (normally resting cut off) is now drawing a *definite current,* depending only upon its own circuit conditions, and in no way dependent on the previous stages which merely initiated the process. This definite current flows until the condenser selected by Sla has charged sufficiently through R28 to allow grid pin 2 to cut on again. The cumulative process then takes place in reverse, back to the initial resting state, which is stable until a new trigger arrives. The condenser selected by Sla discharges again, by virtue of grid current at pin 2 and through R23. Thus all *electrons* collected by anode pin 6 finally reach C19; some were used during the response-pulse to charge the condenser selected on Sla, but are returned soon after to C19 (this is the reason for the negative spike and tail after the response-pulse, in the waveform shown for the junction of R24 and R25—page 47).

Independent Registration in V5

We now see that one definite pulse of current into C19, representing a clearly-defined quantity of charge, results for every trigger received at grid pin 7. The size of this is determined by conditions in the circuit of V5, and, in particular, the duration is determined by R28 and the capacity selected by Sla. The charge is in no way whatsoever dependent on the previous stages, given certain conditions discussed below. Thus registration in V5 is necessarily fully independent of the original input waveform at V1, provided transformation into trigger pulses at grid pin 7 of V5 has been successfully achieved, *merely the* *frequency* of the input to V1 has any effect on events in V5, this then determining the corresponding number of the well-defined pulses of current which pass per second into C19. It is thus obvious that the number of electrons (charge) per second received by C19 is *directly proportional* to the input frequency to V1, but in no other way dependent upon the input to V1. C19 is thus called the "frequency-integrating condenser".

It may seem very strange that the capacity of C19 in no way affects the accuracy, and it does not matter if the capacity is somewhat unstable and non-constant. Thus a perfectly simple small electrolytic of ordinary tolerance is satisfactory for C19. The reason for this is that we are not interested in measuring the accumulated charge in terms of a voltage produced on C19 (in which case the exact capacity would, of course, be vital for accuracy), but merely wish to use C19 as a form of "storage depot" to accumulate the charge on the fast pulses, too fast to operate the moving coil meter direct, and then to pass it on to the meter on the slower time constant of about one-third of a second dictated by C19 and R16. The only ultimate requirement demanded of C19 is thus that it really does pass the whole charge received from V5 anode pin 6 ultimately through the meter, and no more and no less. In other words, C19 must not leak unduly. The circuit details are seen to be such that leakage current of C19 must pass through the meter, so that a faulty component for C19 will show up at once in that the meter reading will not return to zero.

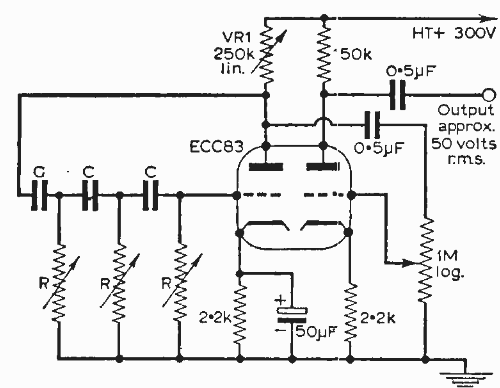


Fig. 6b—A simple sine wave audio oscillator which can be used for either of the audio oscillators required for the procedure illustrated in Fig. 6a. VR1 should be adjusted for the "best" sine wave. The frequency of operation is given by

$$f=\frac{1}{2\pi\sqrt{(6)}\,.\,C.R}\text{ c/s where } C \text{ is in } \mu F \text{ and } R \text{ in } M\Omega.$$

Leakage Current

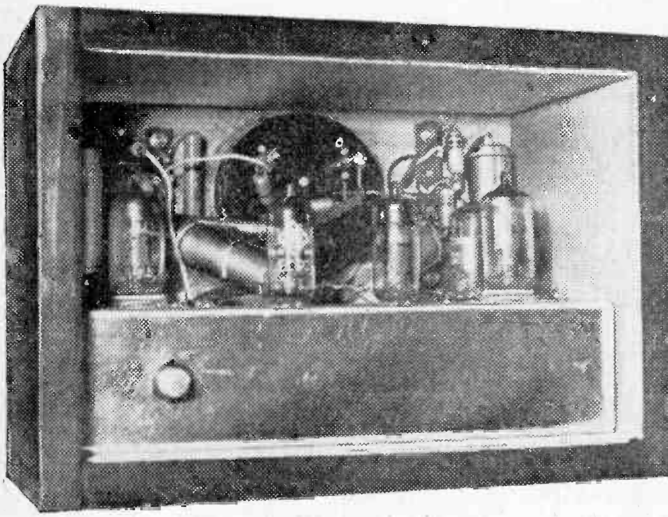
Contrary to what one reads and hears so frequently, that the leakage current of a 32μF electrolytic is normally about a milliamp or so, which would give permanent full-scale deflection of the meter here used, that is *not* so. Under modern standards of component manufacture, the author considers any electrolytic having even a few per cent of this leakage figure to be of definitely inferior quality. He has had long experience of modern electrolytics, and found leakages so small that charges can be held for many hours. It is possible and normal that C19 will cause a deviation from zero on the meter, to a just visible extent, and if this persists after the initial operating hours, it may be corrected with the zeroing-screw on the meter, frequency readings being in no way affected in their accuracy.

With a new electrolytic, or upon first switching the instrument on after a period of rest, large leakage current flows to charge and reform C19. Thus the meter always goes over hard to full scale upon first switching on, returning to zero a little later. A second jump to full scale may or may not take place as V5 warms up and seeks its resting state. Such behaviour is fully normal, but could damage the meter if not cared for. This is the reason for the inclusion of the zener diode D2. This makes it impossible for excessive current to flow through the meter. This protection is also needed for a third reason, namely if a frequency much greater than that giving full scale deflection were applied on any range this could also cause excessive current through the meter.

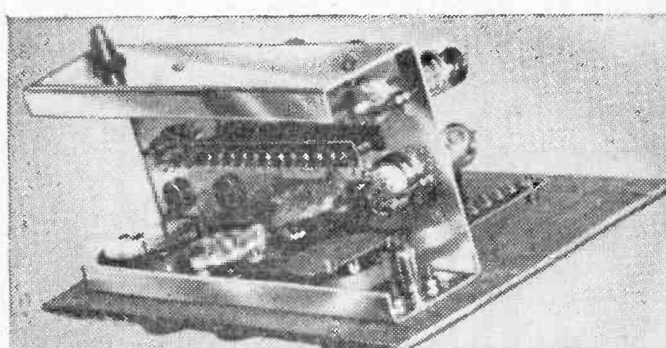
The Zener Diode for Meter Protection

The zener diode is chosen with a zener voltage of 12, and a maximum zener current of 150mA, i.e. all that R29 will pass even in the event of a total short circuit. A zener diode has the property of behaving as a normal diode in the forward direction (positive anode) but passing as much current as necessary to keep the voltage across it at no more than the zener voltage in the reverse direction (anode negative) as soon as this voltage would have been exceeded, were it an ideal normal diode. This device is thus ideal for protecting meters against excessive current, the circuitry described in this article showing a quite typical arrangement for this form of application. R15 shunts the meter, to damp pointer oscillations, giving a final sensitivity in the region of 1mA f.s.d. R16 thus converts the meter to a voltmeter of about 10V f.s.d., and the 12V zener diode is connected across the points at which the 10V would need to be applied. It thus prevents the voltage rising above 12 across these points. Any current in excess of just over full scale deflection of the meter is thus harmlessly shunted off through the zener diode. The constructor can make R15 himself from resistance wire, and trim the exact value so that meter current is limited to only very slightly more than full-scale for the zener diode used. The zener diode also prevents all reverse-current surges which would drive the meter pointer backwards against the stop, because for such it conducts immediately at zero voltage, the same as any other diode. Thus, reverse surges when C19 discharges through the meter circuitry into the other stages of the circuit upon switching off the instrument pass primarily through the zener diode and not through the meter. *The constructor is warned not to operate this circuit without the proper zener diode in position,* as otherwise there is serious danger of destruction of the meter.

It should be pointed out that some types of zener diode pass a small current prior to attaining the full zener voltage, which would make itself felt as slight non-linearity of frequency scale in the instrument here described, taking the form of cramping of the upper end of the scale to a small extent. This can be distinguished from stray-capacity effects in V5 circuitry giving a similar form of non-linearity, because the latter is present chiefly on the highest ranges, whereas the former will be equally present on all ranges. The remedy in all cases is proper calibration of initial scales against inputs of known frequency, which should not be omitted if any good degree of accuracy is desired.



Rear view of the completed meter.



Underchassis view of the meter during assembly.

Monitoring Facilities and Correction for Calibration

The charge per response-pulse produced in V5 in response to input triggers is, as already mentioned, determined *solely* by conditions prevailing in V5 circuitry. *Deliberate* alterations are made solely with the range switch S1a, all other alterations or fluctuations are unwanted and random, and *must* be capable of compensation if the whole circuit is to be of ultimately useful accuracy and reliability.

Such random fluctuations will include effects of changing H.T. voltage, ageing of V5, thermal drift in resistors, etc. Accordingly, a method of comparing against the mains frequency by switching the heater voltage into V1 on a fifth position on S1b, is provided. The arrangement of R30, C2 and R3 was found necessary in this feed line to avoid instability otherwise resulting from the close coupling of V1 and V5 through the wafers of S1a/S1b, and the arrangement is also seen to be such that no 50c/s voltage is present anywhere on S1a/S1b in other settings of this switch, as otherwise the excellently low noise figures of the pre-amplifier would be seriously impaired with hum.

50c/s Frequency Check

At the same time as S1b switches the mains frequency to V1, S1a is repeating the 50c/s f.s.d. range, so that it is merely required to turn the meter shunt VR3 until exactly full-scale deflection is obtained. All fluctuations, whatever their origin, which may have occurred since original calibration of the meter scale, are thereby cancelled, and the original calibration holds true again, and may be checked again as often as necessary. Within limits, it is thus not necessary to use any particular exact H.T. voltage, as deviations can be corrected with VR3. However, the design voltage is 300, and a stabilised supply of this voltage is naturally the ideal. All voltages marked on the wiring diagrams, given to assist the constructor in judging for proper operating conditions, refer to 300V H.T. supply, and were made with a valve voltmeter against chassis. Adjustment of VR2 is necessary at each different H.T. voltage.

Choice of Range Condensers

The check against the mains frequency described above will naturally fix the 50c/s range without further comment, but we also require this correction then to hold for all the ranges. The condition for this to be achieved is obviously good stability in the range condensers C12 to C15, and proper adjustment of these initially against each other and against their respective scales when performing initial calibration against known frequencies.

The ultimate accuracy of the whole instrument will thus depend upon the quality of C12 to C15, and the care with which initial padding of these with parallel condensers is made and the meter scales calibrated against known frequencies.

Initial Calibration

The writer feels it necessary to point out a method of calibrating any variable audio oscillator against the mains frequency, provided a simple oscilloscope with access to all deflector plates of the cathode ray tube is available. Alternatively, a simple cathode ray tube may be purchased for a few shillings from advertisers in this magazine, and fitted with nothing more than a rudimentary power supply and focusing arrangement. Timebases are not needed, nor is a Y-amplifier, provided the audio oscillator output is at least 10V or so.

This method of calibration can be used in cases where any form of calibrated audio oscillator or reliable set of reference-frequencies is out of reach of the experimenter.

The mains-derived voltage of about 50 to 100 r.m.s. from a transformer secondary is fed direct to the Y-plates, and also to the X-plates via phase-shifting R/C couplings as showwn in Fig. 6a. The transformer voltage and condenser values should be found by trial and error to give an ellipse of suitable size and "openness" on the screen. The sine wave output of the audio oscillator is then also fed to the X-plates as shown in Fig. 6, resulting in a corrugated ellipse. The audio oscillator is tuned until the corrugated ellipse ceases to rotate, which will be found for any oscillator frequency which is an exact multiple N of the mains frequency, and N is given by counting the number of complete sine waves forming the corrugation on the stationary ellipse. If the ellipse is slowly rotating, the number of revolutions per second gives the beat frequency, i.e. the error in cycles per second, in this measurement. It should be possible to use this method up to about the tenth to twentieth harmonic of the mains, i.e. some 500c/s to 1kc/s.

To continue, a second fixed oscillator should be rigged up (Fig 6b includes a circuit for this which may be made up rapidly from the spares box), and tuned to exactly 500c/s or 1kc/s by means of the above method. This is then used in place of the mains to produce the ellipse, and the main oscillator then tuned further to obtain further check-points up to many kc/s, at intervals of 500c/s. The main oscillator can be feeding the cathode ray tube, the instrument of this article, and any other apparatus to be calibrated, all simultaneously, and the appropriate points marked in on the scales as the ellipse comes to rest each time. It is not necessary to count the corrugations on the ellipse each time, but merely to tune the oscillator slowly upwards, and each time the ellipse comes to rest, then it is known to correspond to the next harmonic of the ellipse frequency.

This procedure may seem tedious, but it need be made only once and for all, as it necessarily provides the experimenter with a permanent audio standard in his workshop.

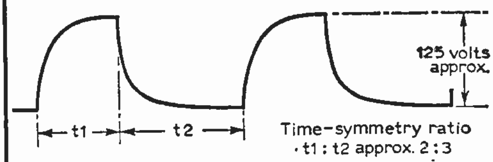
Trigger Input to V5

It is necessary to experiment with the exact value for C11. This should be large enough for secure operation of V5, yet no larger than necessary.

WAVEFORMS

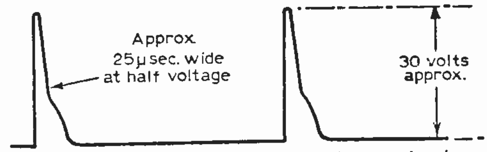
I—Pre-amplifier gain full on; input at least 1V r.m.s., and a sine wave of about 500c/s frequency.

(a) *Waveform at cathode of V1⅛.*



(b) *Waveform at output socket SK2: square wave.*

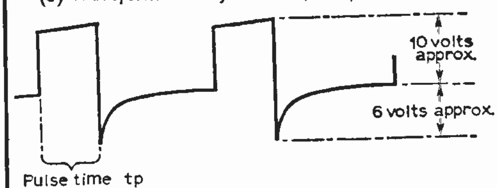
(c) *Waveform at output socket SK3 (trigger output):*



One trigger pulse per cycle of sinewave input.

II—Pre-amplifier gain full on; input at least 1V r.m.s. sinewave; frequency to be half f.s.d. on each range in turn.

(d) *Waveform at the junction of R24/R25*



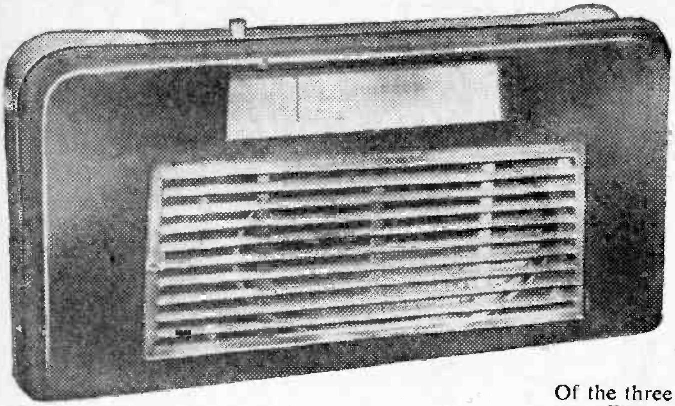
Here, tp is *independent* of input frequency on any range being dependent only on the range set (R28 and choice of capacitor on S1a).

The pulse time tp should be set to equal the time of one-third of one cycle of the frequency desired to give f.s.d. Observe the waveform on an oscilloscope, and adjust the value of R28 until this condition is satisfied (see text). The adjusted value of R28 should satisfy the condition on all ranges.

PRE-AMPLIFIER TEST

Gain full on; feed in 150mV r.m.s. sine wave signal at about 500c/s and observe on an oscilloscope the waveform developed across a 5·6k resistor across SK2. This should be 15V r.m.s. undistorted. Greater input gives output distortion. Change load resistor to 56k; maximum undistorted input/output should now be 250mV/25V r.m.s. The meter should operate for any signal input exceeding 100mV r.m.s.

VR2 should be set to about 30° of turn below the point where anode pin 6 of V5 begins to draw current, indicated by a permanent small reading on the meter. This small current commences 30° above the correct setting of VR2, whilst if VR2 is then turned up still further, self-oscillation of V5 starts, resulting in full-scale meter deflection. This adjustment of VR2 should be made with no input signal at V1. *(Continued on page 78)*



Practical Wir
MERC

A SIX TRANSISTOR BATTERY SUPERHET RECEIVER

THIS receiver is not of the miniature type, and this avoids the difficulties which can arise when components and wiring have to fit in the minimum space. It is thus rather easier to construct than a miniature receiver. Performance is very good indeed, especially as a large loudspeaker can be accommodated, and the ferrite rod aerial is well clear of other parts. The receiver is light, completely portable, and of about average size for non-miniature transistor portables. A ready-made cabinet is available, so the finished set has a satisfactory and modern appearance.

The whole receiver is constructed on a single insulated panel, with the larger components at the rear, and most wiring and small components at the front. All wiring and components can be seen, and this simplifies checking and testing. When the receiver is finished and tested, it can be inserted into the cabinet as a single unit. This, and the fact that there is plenty of space for wiring and parts, should make the receiver suitable for constructors who have not had experience of building miniaturised designs. A further difficulty sometimes experienced is the correct trimming and alignment of a superhet type receiver, so full details of this are included.

Circuit Notes (see Blueprint 5)

The complete circuit is shown in Fig. 1, and it is recommended that the component values given should be followed. Only in the case of the by-pass condensers is there much possible latitude in values. The first transistor emitter by-pass condenser (0·01μF in parallel with 3·9k) should not be changed in value. With the two intermediate frequency stages, emitter by-pass condensers are 0·1μF and 0·5μF. This is larger than often used, but materially helps to avoid troublesome whistles due to oscillation in these stages.

Each I.F. transformer has five pins, of which only four are used. Bare leads or parts should not be allowed to touch the unused pins. The fixed condenser shown wired to pin 2 of each transformer is incorporated inside the can, by the maker and may be ignored. These three condensers have no values marked in Fig. 1, and will not be found on the wiring plan.

Of the three 60pF trimmers, TC1 will be adjusted on medium waves, and TC2 and TC3 on long waves. The adjustment of TC2 and TC3 has no effect whatsoever on medium waves.

With the output stage, the value of the base resistor R18, and emitter resistor R19, are chosen to suit the pair of output transistors used.

Component Tolerances

Although, on the blueprint, tolerances of resistors are given as 20%, or 10%, 10% components are to be recommended and are in fact more readily available. R17 and R18 should preferably be of 5% tolerance. Capacitor values are not critical except for C7 and C10, which should be of 2% tolerance.

Transistors and Diode

The receiver will give very good results with Mullard transistors. An OC44 is suitable for Tr1, two OC45's for Tr2 and Tr3, with an OC71 for Tr4, and a matched pair of OC72's for Tr5 and Tr6. With these transistors, the red spot indicates the collector lead, other leads being as in Fig. 4.

The diode should be a reliable one of named manufacture, such as the Mullard OA81. A cheap surplus diode in poor condition can cause a great loss of signal strength and sensitivity.

It is possible to use different transistors in driver and output stages, but these would usually need some change in resistor values, and perhaps different driver and output transformers.

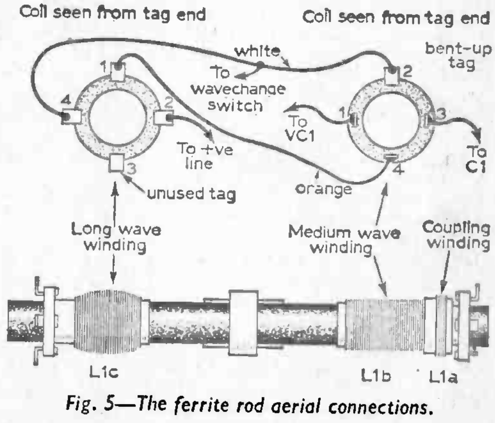


Fig. 5—The ferrite rod aerial connections.

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BLUEPRINT 5

By F. G. Rayer

Insulated Panel

This is paxolin, and 11¼in. x 5⅝in. x ⅛in. (3/16in.). The top corners are rounded, as in Fig. 3, so that the panel may be inserted in the case with clearance all round. An oval aperture 3¼in. x 5½in. is cut for the speaker. This can be carried out by drawing a pencil line round the speaker, then removing the speaker and drawing the oval about ¼in. smaller all round. Drill one or more holes to introduce a fine-toothed pad-saw or similar blade, cut out the oval, and clean up the edges with half-round file.

Drill ⅜in. holes for the volume control and tuning drive spindle bushes. Position these carefully so that the control wheels will project correctly through the slots in the case.

Small holes to clear the transistor leads can then be drilled as shown in Fig. 3, but no parts are fitted until all drilling is finished.

The tuning condenser is mounted with three countersunk 4B.A. bolts. These bolts must be very short, to avoid damaging or shorting the condenser. Make the clearance hole for the spindle large enough, so that the condenser can lie flat on the panel, and not raised by the ball-bearing retaining ring.

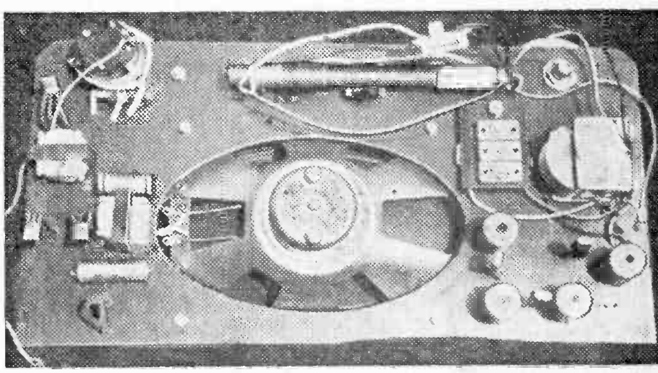
The drive cord will pass round two pulleys, on 4B.A. bolts. Locate the right hand pulley (Fig. 2) so that the cord to which the pointer is attached runs parallel with the top of the panel. The cord will be given one complete turn round the driving spindle. Nylon cord is not much recommended, as it will not give a very good grip here. The pulleys should turn freely on their bolts, and the bolts are locked in place by having one nut each side of the panel.

The oscillator coil and I.F. transformer have pins, and earth tags. Correct drilling can easily be found by pressing a piece of paper against the pins, and then using this as a template for marking the panel. An ⅛in. drill will easily give clearance, but check that each coil or transformer can be inserted. If drilling has been inaccurate, enlarge the holes as necessary with a small round file. A 1/16in. drill will be suitable for the earth tags.

Drill 1/16in. holes for the 100μF and 50μF condensers (C15 and C11), and also for the driver and output transformer leads, which pass straight down through the panel. The three holes A, B and C are also needed near the volume control, and a hole for the ferrite rod mounting.

Loudspeaker Mounting

This should be prepared, but the loudspeaker should not be fitted to the panel until wiring is otherwise finished. A piece of hardboard 7½in. x 4¼in. is placed inside the cabinet, and is marked with an aperture to match that in the cabinet front. This is easily done by pencilling round inside the opening. Also mark the four screw holes in the cabinet on to the hardboard, and run a 1/16in. drill through these points, so that the screws will start easily. The hardboard is bevelled slightly, with a rasp or glasspaper, so that it lies flat against the curved inside of the cabinet.



The receiver complete except for its cabinet.

The oval marked on the hardboard is sawn out, the loudspeaker placed so that it matches this, and the positions of the four 6B.A. bolts, which secure the loudspeaker to the hardboard, are marked. These holes are drilled, and countersunk at the front (a few turns with a larger drill will do this).

The loudspeaker is secured with four countersunk 6B.A. bolts, each 1¼in. to 1½in. long. Place two nuts about ½in. apart on each bolt. The bolts pass through the four holes in the paxolin panel, and another nut is run on each.

A check can be made to see that the receiver will fit in the cabinet. If the tuning wheels are a little too near the front or back, they may be moved slightly on their spindles, or the nuts on the 1¼in. bolts can be re-adjusted, until the panel comes in the correct position, when the hardboard is right against the inside of the cabinet front.

Rear of Panel

With the loudspeaker assembly removed, all the parts shown in Fig. 3 can be mounted. There is no point in cutting the transistor leads very short. It will be convenient if three pieces of 1mm sleeving each ½in. long are cut for each transistor, and placed on the leads. This will prevent shorts here, and give ½in. of lead above the panel, so that there is no danger of breaking any of the wires off. Ensure that each transistor is used in its correct position, and place emitter, base and collector leads as shown by e, b and c in Figs. 2 and 3.

The oscillator coil has a spot to show pin 1, and the pins are positioned as in Fig. 2. The first and second I.F. transformers are coded white, and the third I.F.T. is coded blue.

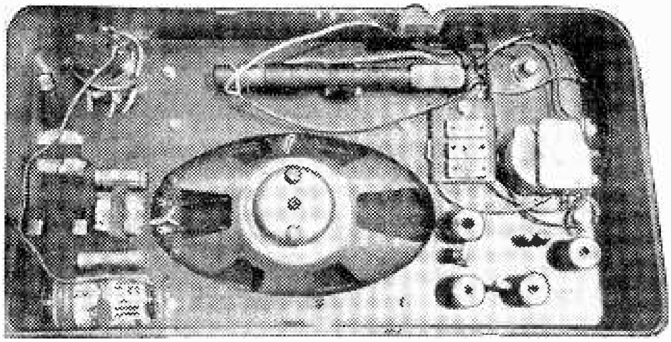
The three 60pF trimmers are attached to a piece of paxolin about 1¼in. x 1¾in. This is done by drilling clearance holes for the trimmer tags and adjusting screws. Solder leads to the trimmer tags as in Fig. 3 and mount the assembly on the bolt holding one pulley, using an additional nut.

It is as well to leave the ferrite rod until last, to prevent any damage to the windings. Check that the 50μF and 100μF condensers are inserted with positive and negative leads as in Fig. 3.

Front of Panel Wiring

Fig. 2 shows the wiring, and the resistors and other small parts. There is plenty of clearance, and no need to keep each wire and component tight against the panel. All leads should be protected with insulated sleeving.

All the following points may first be joined together; the 'can' tags of the oscillator coil and I.F. transformers, gang condenser frame, 6B.A. tag to earth the loudspeaker, positive tags of the 100μF and 50μF condensers, and the switch, tag C, and the metal case of the 5k volume control.



The receiver installed in the cabinet.

The oscillator and I.F. stages, up to the diode occupy the left of the panel, in Fig. 2. The audio amplifier (driver and output stages) are at the right.

Transistor connections can be checked against the following:—

Tr1: Emitter to 1 on oscillator coil; base to C1 and junction of R1 and R2; collector to 6 on oscillator coil

Tr2: Emitter to C6 and R6; base to 1 on 1st. I.F. transformer; collector to 3 on 2nd. I.F. transformer.

Tr3: Emitter to C9 and R11; base to 1 on 2nd. I.F. transformer; collector to 3 on 3rd. I.F. transformer.

Tr4: Emitter to C14 negative tag and R16; base to negative tag of C13 and the junction of R13 and R15; collector to 'Brown' on driver transformer.

Tr5: Emitter to R19; base to green lead of driver transformer; collector to green lead of output transformer.

Tr6: Emitter to R19; base to yellow lead of driver transformer; collector to yellow lead of output transformer.

Solder all transistor leads rapidly, keeping the iron in contact with the joint only for a second or so, and removing it quickly. An electric iron with an ⅛in. or $\frac{3}{16}$in. bit will be convenient, and will be at the correct temperature if it has been switched on long enough. Use cored solder, applying this to the joint, not to the iron.

A few leads pass through the panel. Three go to the volume control, and are marked A, B and C in both Figs. 2 and 3. One lead goes from the condenser frame to the "positive" line, as described. Another lead goes from the fixed condenser C4 to pin 4 of the oscillator coil. There is also a lead from the condenser C1 to 3 on the aerial.

Aerial and Wavechange Switch

The ferrite rod is held by a fastening which passes round it and the mounting cradle, which is secured to the panel by a 4B.A. bolt. In Fig. 3, the medium wave section is at the right, and the long wave section at the left.

Connections are numbered in Figs. 1, 3 and 5 (Fig. 5 is on page 48). Tag 1 is the beginning of the M.W. section, and goes to the 208pF section of the gang condenser; that is, the front plates tag. Tag 2 is the end of the M.W. section, and goes to tag 4, which is the beginning of the L.W. section. Tag 2 on the L.W. section is returned to the gang condenser frame, or earth line.

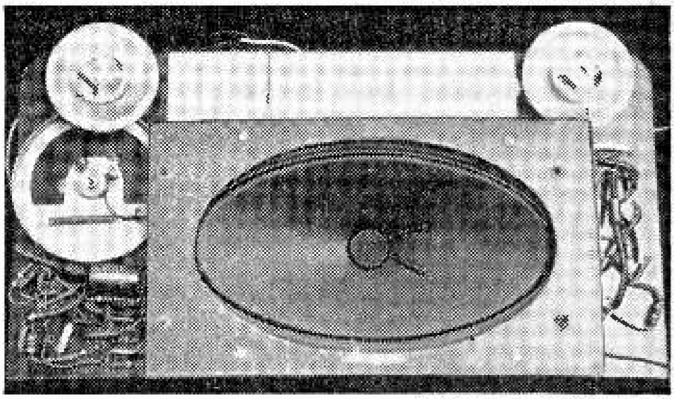
The 0·04μF condenser (C1) goes to the M.W. coupling winding, tag 3 and tag 4 (the end of this winding) is wired to tag 1 on the L.W. winding, which is a tapping.

Leads are best of thin flex, so that the windings can be slid along the rod. It is not very likely that trouble should arise in connecting the windings, but if any difficulty is experienced, note that the receiver can be tested on M.W. with the L.W. section entirely disconnected. To do this, temporarily wire tags 2 and 4 of the M.W. section to the receiver earth line (condenser frame).

If any difficulty arises on L.W. only, check that the tapping 1 on the L.W. section is electrically near the "earthed" end of the coil (tag 2). This will not be so if the leads to tags 2 and 4 are reversed in error. Beginning from point 1 on the

M.W. coil, and proceeding to tag 2, then to tag 4 on the L.W. section, and thence to tag 2 on the L.W. section, all turns should be seen to be wound in the same direction. This will not be so if one section is placed on the rod the wrong way round, or if the leads to tags 1 and 2 on the M.W. section, or to tags 4 and 2 on the L.W. section, are reversed. Any errors of this type will cause difficulty on long waves, but not on medium waves.

Two small bolts hold the wavechange switch in the cabinet slot. Use short flexible leads to the switch, connecting it as in Fig. 3. It is easiest to solder a flexible lead to trimmer TC2 for this purpose, before mounting the trimmer assembly.



The front of the receiver with the cabinet removed.

Wiring should be checked against the diagrams. It is also worthwhile checking that the values of colour-coded resistors have been read correctly. The speaker assembly is then added by inserting the four bolts through the holes in the panel, and securing with nuts. The output transformer secondary leads are then soldered to the speaker tags.

Use 6in. lengths of thin flex for the battery leads, taking care to solder the correct clip to each lead, so that positive goes to the on/off switch (earth line) and negative to the 100μF (C15) condenser, as in Fig. 2 and Fig. 3.

I.F. Circuit Alignment

It is useful to connect a meter, reading up to about 15mA or 20mA, in one battery lead, for initial tests. When the set is switched on, this meter should show about 6mA to 10mA, the exact current depending on individual components. If the meter shows a high current, some wiring or other fault exists, and should be looked for at once. Do not leave the set switched on with a large current flowing.

If a signal generator is available, set this to 470kc/s, and place the output lead of the generator near the collector lead of Tr1. Then adjust the three I.F. transformer cores for maximum output. The modulation tone of the generator should be heard clearly in the speaker, and the reading of the meter in circuit should rise to 15mA or more. Keep signal strength down by reducing the generator output, or taking the output lead a little way from the receiver.

All adjustments in the receiver should be made with a fully insulated tool. This can be made from a strip of paxolin, or an insulated rod, filed to engage with the cores and trimmers. It is impossible to align the set properly with a metal tool, even if it has an insulated handle.

If no signal generator is available, tune in any station which can be heard. Then adjust the I.F. transformer cores for maximum volume. All three transformers should "tune in" quite sharply, with all cores in a reasonable position. That is, not so far unscrewed that they are in danger of falling out, and not screwed right in out of sight.

When the three I.F. transformer cores have been adjusted in this way, leave them untouched during subsequent alignment.

Medium Waves

Put the switch in the M.W. position. That is, towards the left, in Fig. 3. The only adjustments to be made, with the set switched to medium waves in this way, will be to the oscillator coil core, trimmer TC1 (see Fig. 3) and the position of the M.W. winding on the ferrite rod.

Tune in a station of fairly low wavelength (200m to 250m) and unscrew TC1. As TC1 is unscrewed, keep the station in tune by slightly closing the tuning condenser. If volume slowly improves as this is done, then begins to fall, leave TC1 at the setting giving best volume.

If volume is best with TC1 screwed fully down, push the M.W. winding slightly further on the rod, and repeat as above. If volume is best with TC1 fully unscrewed, draw the M.W. section slightly off the rod, and repeat as described.

When reception here seems good, tune to a high wavelength station (around 400m to 450m or 500m). Slowly adjust the oscillator coil core, meanwhile keeping the station in tune, by manipulation of the tuning wheel. A setting for the core should be found which gives best results. Also try moving the M.W. section on the ferrite rod slightly, if necessary, for best results.

The receiver should now perform well over the M.W. band. However, one set of adjustments will influence the other, so trim up again at a low wavelength, and repeat once or twice, as described, until no further improvement seems possible.

Initially, it may be necessary to choose powerful local stations, to obtain alignment which is approximately correct, but, as alignment proceeds, sensitivity will increase considerably. Weak distant stations should then be used for final adjustment, as with these it will be easier to find the exact, optimum position for trimmers, etc.

Do not choose powerful stations for final adjustment, with the volume control turned back to keep volume down, as this will make the work difficult.

(Continued on page 54)

SERVICING TAPE RECORDERS

EQUALISATION AND RECORDING SPEEDS

(Continued from page 1145 of the April issue)

By T. S. Smith

AS mentioned in the previous article in this series, the recording-level indicator gives a useful check on the recording circuits—if a recording cannot be made and the indicator works normally, the fault probably lies in the recording head feed and switching circuits such as the equalisation network and switches "D" and "A" in the circuit (page 1123, last month). If the machine also fails to replay, the record/replay head could be open-circuited.

Poor quality recordings may originate from a defect in the "record/replay" equalisation switching, such as switches "C" and "H" in the circuit. Poor reproduction of a tape recording may be caused by a similar fault.

In the type of circuit shown, a definite defect in V4 stage would cause failure of both the bias oscillator and replay output stage. The symptoms would be no replay and severe recording distortion, accompanied by erase failure. The recording distortion, of course, would only be revealed by playing the tape on another recorder, in which the replay sections were working correctly.

Frequency Response

The overall frequency response of a tape record can never be perfectly "flat". Let us take the case of a perfectly flat recording amplifier through which a tape record is made. The recording amplifier is coupled to the recording head in such a way that the recording *current* is constant at all frequencies. This is called "constant-current" recording, and is adopted in almost all recorders.

Let us now suppose that the tape is passing the recording head at a constant speed and that an audio signal is applied to the input of the recording amplifier, and also that the signal can be varied in frequency from the very low end of the spectrum into the very high end at a constant level.

Characteristic

This means that, irrespective of frequency, the signal current in the recording head will always be the same. The general set-up with frequency characteristics is given in Fig. 6. Here the signal source is produced by an audio generator, and if this test is ever performed it is most important to ensure that the signal level from the generator remains the same as the frequency is altered.

Now, if a recording is made at various frequencies over the audio spectrum from, say, about 40c/s to 10,000c/s, and the recording is played back again through a replay amplifier with a perfectly flat frequency response with some means of monitoring the output in terms of level, a rather unusual effect will be observed.

Top and Bass Cut

From below 2,000c/s or thereabouts the output will fall at the rate of about 6dB per octave. Maximum output will occur at about 2,000c/s (depending on the tape speed), and the output will again fall at higher frequencies. The set-up for observing this effect is shown in Fig. 7 (a) and the resulting recording/replay response is shown in Fig. 7 (b).

The bass cut occurs because the rate of change of magnetic flux at the replay head decreases with decrease of frequency. It should be remembered, of course, that the replay head is rather like a dynamo, the output of which increases with increase in speed of the rotor. The dynamo gives an output which is approximately proportional to the rate of change of magnetic flux, which is caused by the rotor revolving.

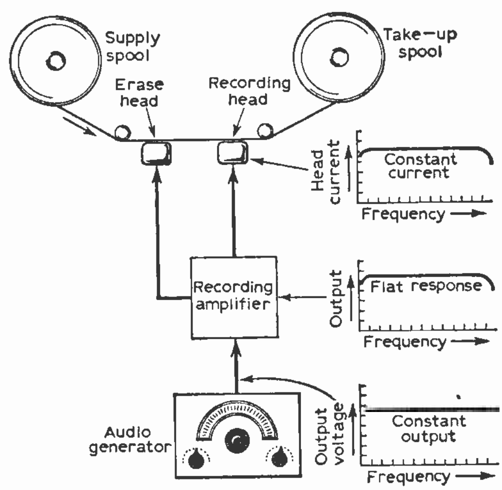


Fig. 6—The arrangement of tape recorder, amplifier and audio signal generator for producing a constant-current recording over the audio-frequency spectrum.

The rate of change of magnetic flux at the replay head is, of course, a function of the frequency of the recorded sound. The higher the frequency, the greater the rate of change of flux and the greater the output voltage from the replay head winding. Thus, the output goes on increasing at the consistent rate of 6dB per octave of frequency increase until it reaches a peak.

Gap Width

The output then starts falling very rapidly for an entirely different reason. Actually, there is more than one reason for this. One is inherent to the recording process in that the very short "magnets" which are produced on the tape at high frequency tend to demagnetise themselves, which happens normally with very short magnets. Another reason has something to do with the gap size of the replay head—the smaller the gap, the better the high-frequency response. This is because a very small gap is shorter than the very small magnets impressed upon the tape at high frequencies, whereas a gap of larger dimensions may approach the size of the recorded magnets and thus give very little or zero output as the frequency is raised.

Other reasons are related to the "coercivity" of the tape and the speed of the tape past the recording and replay heads. Tape coercivity is a measure of the ability of the tape to resist demagnetisation, so a tape of relatively high coercivity is likely to result in an improvement in high-frequency response, owing to the reduced risk of demagnetisation of the higher frequency magnets. Most modern tapes have a fairly high coercivity value.

Recording Speed

Speed is most important so far as the high-frequency performance is concerned. Far better recordings can be made at a tape speed of 15in./sec than at, for instance, 3¾in./sec or lower. Professional recordists use tape speeds of 15in./sec and 30in./sec while the home recordist usually has to make do with a top speed of 7½in./sec. This should not be taken to mean that high-quality recording cannot be made at the lower speeds. Indeed, with recent improvements in tape, gap dimensions and equalisation, recordings containing frequencies up to about 10,000c/s are possible at 7½in./sec. The very low speeds, however, are essentially unsuitable for recording high-quality music and are used mainly for speech and dictation purposes.

Constant-Current Recording

In most domestic-type recorders the replay output valve is often also employed as the recording amplifier valve, and a circuit after the style of that shown in Fig. 8 is often evolved. Here V1 is the replay output valve with T1 as the output transformer. On "replay", switch S1 connects the loudspeaker across the secondary of the transformer in the ordinary way. A further switch usually at point "X" on the diagram, disconnects the record/replay head from the output valve and connects it in place across the input of the replay amplifier. The output stage then works in the normal manner, its signal being received at the control grid.

On "record", however, S1 connects the load resistor R2 across the secondary of the output transformer and the recording head is connected to the network comprising C1 and R1. The loudspeaker, of course, is also disconnected by S1. Bias is applied to the recording head through R3 and C2. Now, when the recording signal is applied to the control grid of V1, a fairly high peak A.F. voltage occurs across the primary of T1. The output stage is loaded by R2 so there is no possibility of damage to the output valve or the output transformer.

Varying Impedance

The recording head contains mostly inductance due to its winding, plus a little resistance. It will thus have an impedance value which increases with increase of frequency of the signal applied

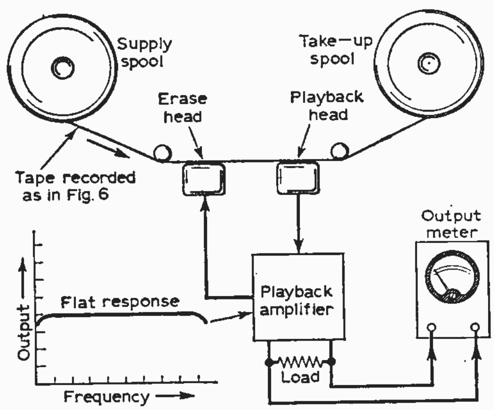


Fig. 7(a)

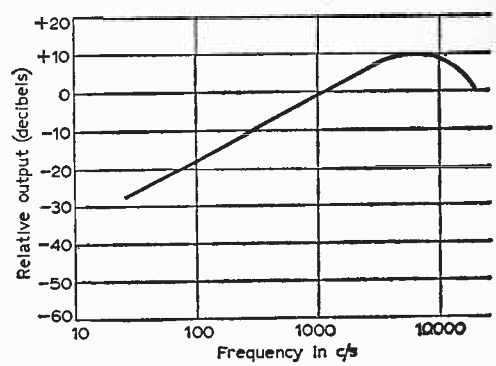


Fig. 7(b)

If a tape, recorded as shown in Fig. 6, were replayed as shown at 7(a), and the output monitored on an output meter, a graph of relative output against frequency would appear as shown at 7(b).

from the output stage. A typical high impedance recording head may have an inductance in the region of 0·8H. Excluding winding resistance, this would give an impedance of 500Ω at 100c/s and 50,000Ω at 10,000c/s.

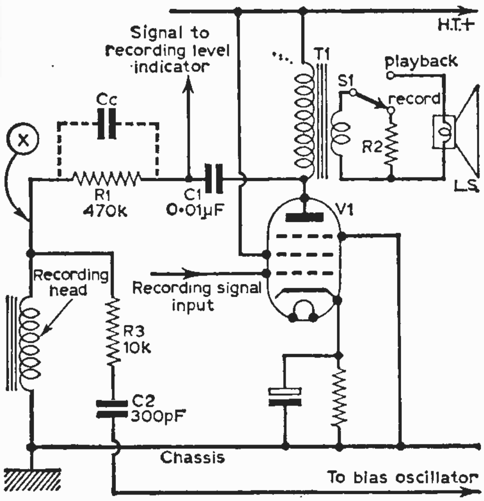


Fig. 8—A circuit diagram giving the essential elements for constant-current recording.

However, since this is fed over such a range of frequencies via a high value resistor R1 (470k), the varying impedance is almost totally swamped by the resistor, and so far as the signal source of the anode is concerned, there is a total impedance variation of only 470,500Ω to 520,000Ω, representing the very small ratio of about 1·2:1. Without R1 there would be a variation of 500Ω to 50,000Ω, which represents a ratio of 100:1.

Clearly, then, the source provides an almost constant current into the recording head network. What really happens, of course, is that the *voltage* across the recording head rises with frequency (as the impedance rises), but because the impedance rises at the same time, the current remains constant.

Series Resistor Value

The value of R1 is selected to suit the impedance of the recording head, and when it becomes necessary to replace this component, one of equal resistance must be used. If the resistor increases in value, the constant current function will not be destroyed, but the current in the head will be decreased and under-recording will result.

A decrease in value will upset the constant current characteristics and will probably cause over-recording at the lower frequencies. The bias may also be disturbed, since some of the bias signal will be shunted by the relatively low impedance of the source (i.e., valve anode circuit).

Capacitor C1 in the network is essentially to block D.C. However, its impedance *increases* with increase in frequency and thus tends to reduce the recording level a little towards the high-frequency end of the audio spectrum. This is not unduly troublesome, for, in effect, this is the same as giving a little bass boost to the recording, and some circuits may require this.

On the other hand, it may be necessary to provide a little more recording current at the higher frequencies to compensate for some of the high-frequency losses occurring in the overall system. This is sometimes accomplished by connecting a capacitor of suitable value across the recording head feed resistor, as shown by the broken line in Fig. 8. ■

MERCURY SIX

(Continued from page 51)

L.W. Band

Put the switch in the L.W. position (towards the right in Fig. 3) and tune in the Light Programme on 1500m. Adjust TC2 until this station falls at roughly the centre of the band. Adjust TC3 for best volume.

It should then be possible to receive some overseas long wave transmissions. Choose one near the low wavelength end of the band (tuning condenser open) and re-adjust TC2 and TC3 as necessary, for best volume.

Then, locate a station towards the high wavelength end of the band, and move the long wave section of the aerial along the rod, for best volume.

These stages can be repeated as necessary, to bring about any final improvement.

Important Notes

The alignment procedure may seem very difficult, but in practice it is not generally so. Remember that an insulated tool, as described, *must* be used. If all wiring is correct, local stations should usually be heard at reasonable volume almost at once. This gives a signal for initial tests. Deal with the circuits in the order given—I.F. stages, medium waves, then long waves.

With a meter connected as described, the "no signal" current will probably be around 7mA or 8mA, but may be a little outside these limits. If the current is much under 6mA, and the speech and music sound distorted, R18 is probably too low in value for the transistors used. This would be possible if a different pair from those mentioned were fitted.

The extent to which the meter reading rises will depend on the volume, and will be around 10mA to 15mA for average purpose, but may be up to 25mA or more for maximum volume. If R18 is too high in value, current peaks will be much heavier than necessary.

Cabinet Fitting

The receiver is inserted from behind, with the control wheels projecting through the slots. Adjust the position of the receiver until the wheels can turn correctly, then screw the receiver in place. This is done by passing four countersunk screws through the holes in the cabinet front, and driving them into the hardboard.

To hold the battery in position, thread a piece of fairly stout elastic through two holes in the panel. This will take either the square type of 9V transistor battery, or the slightly smaller round 9V type of battery. ■

FAULTS IN VHF/F.M. RECEIVERS

6—TRANSISTOR DETECTOR AND A.F. STAGES

By G. J. King

(Continued from page 1050 of the March issue)

UNLIKE their valve counterparts, transistorised A.M./F.M. receivers usually feature two stages arranged exclusively for the amplification of the I.F. signals. This means that when the set is switched to "F.M." there are three stages of I.F. amplification, since the A.M. mixer then operates as an extra stage. It will be recalled that such switching was dealt with in Part 5 of this series (in the March issue), and that the circuit in Fig. 13 dealt with the A.M. frequency changer (I.F. amplifier on F.M.) and the first I.F. stage.

Fig. 11 in Part 4 (February issue) showed the transistorised VHF/F.M. tuner; Fig. 15 of this months article, gives the final I.F. detector and A.F. stages of a typical set, so the complete circuit of the receiver can be formed by joining together the sections of Figs. 11, 13, and 15.

a replacement is of identical type. A transistor with a lower frequency cut-off would very much impair the overall gain on F.M., while one of different characteristics, although possessing the required frequency performance, might upset the I.F. tuning and neutralising.

Common I.F. Stage

Tr5 of Fig. 15 is the I.F. amplifier which is common to both F.M. and A.M. It is fed from the series-connected I.F. transformers at the base, and is loaded at the collector by the primaries of the ratio detector transformer (for F.M.) and the final A.M. I.F. transformer. The base is stabilised by the potential-divider R1/R2, and R3 is the emitter resistor. A small amount of degenerative feedback is applied between emitter and base by the capacitive-divider C1 and C2.

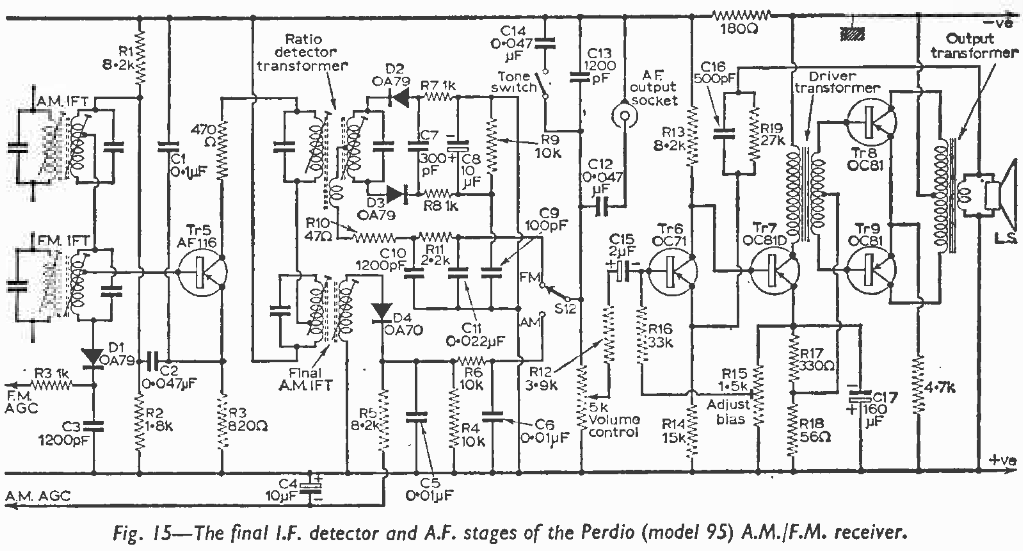


Fig. 15—The final I.F. detector and A.F. stages of the Perdio (model 95) A.M./F.M. receiver.

At this stage it should be noted that while a large percentage of transistor VHF/F.M. sets adopt the framework described in the last three articles, a smaller number use two separate I.F. channels—one for A.M. and the other for F.M. Apart from the composite I.F. stages, however, the operation of the various stages is almost identical to that of those already described.

Stages which are required to amplify the F.M. I.F. use transistors which provide a worthwhile gain at the F.M. I.F. of 10·7Mc/s. The Mullard AF116 is a transistor popular for this position, and it is important to ensure that the transistor used as

A little of the I.F. at the secondary of the F.M. I.F. transformer is rectified by diode D1 and fed back through R3 to the VHF tuner R.F. base circuit. This gives a form of F.M. AGC and prevents the I.F. amplifier from being overloaded by strong F.M. signals.

A.M. Detector

When the I.F. stages are carrying A.M. signals, the amplified A.M. I.F. is developed across the primary of the final A.M. I.F. transformer, induced into the secondary and thus applied to the A.M. detector diode D4. The audio signal is developed across the load resistor R4. Across this load also occurs a direct voltage of a strength depending on the amplitude of the I.F. signal, and this voltage is used as AGC on the I.F. stage preceding Tr5 (see Fig. 13, March issue) on A.M. only.

Condenser C5 removes spurious I.F. signal at the load, and further filtering is provided by R6 and C6. The audio output is then fed to the A.M./F.M. change-over switch S12, and from there it is fed to the volume control.

Ratio Detector

When the set is switched to " F.M. ", the F.M. I.F. signal is developed across the primary of the ratio detector transformer (10·7Mc/s), induced into the tapped secondary and applied to the ratio detector D2 and D3. The load is R9 and the "stabilising capacitor" is C8. This combination gives a fairly long time-constant and thus makes the detector insensitive to A.M. interference. A constant direct voltage occurs across R9/C8 of a strength dependent on the amplitude of the F.M. I.F. signal.

The audio load of the ratio detector is C10, and the F.M.-derived audio output is fed to the other terminal on S12 through R11, which, in association with C11, provides de-emphasis to balance the pre-emphasis applied at the F.M. station.

The low value resistor R10 limits the currents in the diodes on strong signals and in this way prevents the diodes falling too much out of balance, which might otherwise happen with a consequent impairment of A.M. limiting on very strong F.M. signals.

Resistors R7 and R8 in the diode circuit act as a resistive "swamp" and thus mask the differences in forward resistances of the two diodes. Without these components, it would be difficult to balance the ratio detector, but in some sets a variable resistor is used in one diode circuit, and the idea is to adjust this for minimum output when an A.M. signal is injected into the tuner or I.F. stages. C9 is really in parallel with the load and stabilising capacitor, and its purpose is to remove any I.F. signals which may be present at this point.

The Audio Stages

Clearly, then, either the A.M. or F.M. audio signal is present across the volume control. With the set under discussion, this audio signal is taken to an output socket through the isolating capacitor C12. This is useful for the signal is of very good quality at this point and may thus be used for applying to the "radio input" of a tape recorder or hi-fi amplifier as a signal source.

Fixed tone control (for the best equalising) is provided by C13, and additional "top-cut" can be switched in by the "tone control" switch. This simply puts an extra capacitor in parallel with the fixed tone control capacitor.

The audio output from across the volume control is fed to the base of the first A.F. transistor (Tr6) through R12 and C15. Tr6 works in fairly conventional common emitter mode, with R13 as the collector load and R15 as the emitter resistor. However, the collector is direct-coupled to the base of the "driver" transistor Tr7 and, likewise, the base circuit of the push-pull pair (Tr8 and Tr9) is direct coupled to the emitter circuit of Tr7. With all the audio transistors coupled in this manner, a means is provided whereby adjustment to the base current of Tr6 gives corresponding changes in the static conditions of the remaining transistors. Moreover, improved thermal stabilising also results.

Bias for Tr6

It will be seen that the base of Tr6 is not connected to a conventional resistive potential-divider, but instead is biased from the P.D. across the "adjust bias" pre-set R15, via R16. The voltage across R15 is given partly by the emitter current of Tr7 and partly by the voltage drop across the emitter resistors of Tr7—R17 and R18.

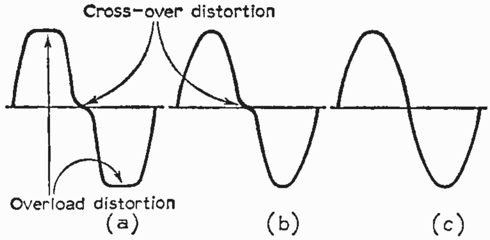


Fig. 16—The waveform (a) shows overload and crossover distortion. The input signal should be reduced to clear the overload distortion (b), and the "adjust bias" pre-set should be set to eliminate crossover distortion (c).

Now, when R15 is adjusted, there occurs a change in Tr6 collector current, which is reflected into Tr7 as a change in base current. This changes the voltage drop across Tr7 emitter resistors, and as the voltage here is partly responsible for the base current of Tr6, a very efficient stabilising effect results, as may be required to stabilise the effects of temperature change of the transistors.

The change of potential at the junction of R17/R18 is reflected into the base circuit of Tr8 and Tr9 as a change of base current. This is useful because now R15 may be used initially to set the operating point of the push-pull pair. This is accomplished by feeding a 2kc/s sine wave signal into the A.F. output socket and monitoring the output on an oscilloscope connected across the loudspeaker terminals. A milliameter is also connected in series with the battery positive lead.

Adjustment

The audio output from the generator should be adjusted in level to avoid overload distortion and R15 should then be adjusted to eliminate cross-over distortion of the output stage. There may be two points over the range of R15 where the latter occurs, but the point finally chosen should be that where the total receiver current does not exceed 15mA.

In Fig. 16 is shown a series of waveforms which may be obtained; (a) shows overload distortion accompanied by crossover distortion; (b) shows crossover distortion only; and (c) shows the sine wave which should result when R15 is correctly adjusted, and which should be almost a replica of the input waveform.

(Continued on page 62)

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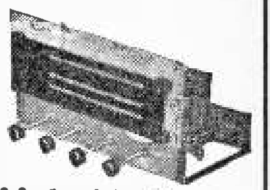

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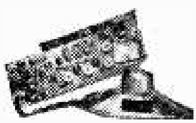

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7 x 3½in. speaker **15/6** carr. 1/6 | Two-tone Cabinets **25/-** Carr. 2/6 | 3d. stamp for full details, circuit and instructions 1/6

RECORD PLAYER CABINETS

Cabinet Price **£3.3.0**

Carr. & Ins. 5/-.

Contemporary style, rexine covered cabinet in mottled red and white polka dot. Size 18½ x 13½ x ht. 8½in., fitted with all accessories including baffle board and anodised metal fret. Space available for all modern amplifiers and autochangers, etc. Uncut record player mounting board 14 x 13in. supplied.

2-VALVE 2-WATT AMPLIFIER Twin stage ECL82 with vol. and neg. feedback Tone control. A.C. 200/250 v. with knobs, etc., ready wired to fit above cabinet. **£2.17.6.** P. & P. 1/6.

6in. Spkr. & Trans., 22/-. P. & P. 2/-.

TYGAN FRET (contemp. pat.) 12 x 12in. 2/-, 12 x 18in. 3/-, 12 x 24in. 4/-, 18 x 24in. 6/-, etc.

Speaker Fret — Expanded bronze anodised metal 8x8in. 2/3, 12 x 8in. 3/-, 12 x 12in. 4/6, 12 x 16in. 6/-, 24 x 12in. 9/-, 36 x 12in. 13/6, etc., etc.

Electrolytics All Types New Stock

TUBULAR		CAN TYPES	
25/25V	1/9	8+8/450V	4/6
50/12V	1/9	8+16/450V	5/-
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100/25V	2/-	50+50/350V	6/6
8/450V	2/3	60+250/275V	12/6
16/450V	3/6	100+200/275V	12/6
16+16/45V	5/6		
32+32/450V	6/6		

RECORDING TAPE—Special Offer

Famous American Columbia (CBS) Premier Quality Tape at NEW REDUCED PRICES. A genuine recommended Quality Tape—TRY IT! Brand new, boxed and fully guaranteed. Fitted with leader and stop foils.

	Standard	Long Play	Double Play
5in.	600ft. 15/-	900ft. 18/6	1,200ft 31/6
5¾in.	900ft. 17/6	1,200ft. 22/6	1,800ft. 39/6
7in.	1,200ft. 21/-	1,800ft. 32/6	2,400ft. 47/6

P. & P. per reel 1/-, 6d. on each additional reel.

SPECIAL BARGAIN 3in. mfrs. Tape 225ft. 5/6. P. & P. 6d.

Plastic Tape Reels .. 3in. 2/6, 5in. 3/-, 5¾in. 3/3, 7in. 3/6

BSR TAPE RECORDER KIT £16 10s.

Latest 5-valve circuit based on Mullard's design. Magic eye and tone controls. Printed Circuit. Radio and Mike inputs. A sensitive, quality recorder at special Unit Kit prices.

Ampli. Kit 90/-
4 Valves 37/6
Power Pack 38/6

BSR MONARDECK TAPE UNIT £8.10.0

Send 3d. stamp for full details. Handbook, circuit and instructions 2/6.

Condensers—Silver Mica. All values, 2pF to 1,000pF, **6d.** each. Ditto, Ceramics **9d.** Tub. 450V T.C.C., etc., 0.001 mfd. to 0.01 and 0.1/350V., **9d.** 0.02-0.1/500V **1/-.** 0.25 Hunts **1/6.** 0.5 T.C.C. **1/9,** etc., etc. **Close Tol. S/Micas**—10% 5pF-500pF **8d.** 600-5,000pF **1/-.** 1% 2pF-100pF **9d.** 100pF-500pF **11d.** 575pF-5,000pF **1/6. Resistors—Full Range** 10 ohms-10 megohms 20% ¼ and ½W **3d.**, ¼W **5d.** (Midget type modern rating) 1W **6d.**, 2W **9d.** **Hi-Stab** 10% ¼W **5d.**, ½W **7d.** 5% ¼W **9d.**, 1% ¼W **1/6.**

TRANSISTOR COMPONENTS

Midget I.F.'s—465 Kc/s, 9/16in. dia. **5/6**
Osc. Coil—M/W, 9/16in. dia. **5/3**
Osc. Coil—M. & L.W. **5/9**
Midget Drive Trans. 3.5:1 **6/9**
Midget O/Put Trans. P.P. to 3 ohms. **6/9.**
Ferrite Aerial M. & L.W., **Car aerial coil. 9/3.**
Elect. Condensers—Midget Type 1 mfd-50mfd ea. **1/9.** 100 mfd. **2/-;** 12V wkg.
Condensers—.01mfd. to .03mfd, **9d.:** .05mfd. .1mfd. **1/-;** .25mfd. **1/3;** .5 mfd. **1/6.**
Tuning Condensers—JB"00" 208 pF+176pF with Trimmers, **10/6.** Ditto less Trimmers, built-in slow motion. **10/6.**
Speakers P.M.—2½in. E.M.I. 3 ohms **17/6.** 7 x 4in. Plessey 35 ohms. **23/6.**
Ear Plug Phones—Min. Continental type. 3ft. lead, jack plug and socket. High Imp. **8/-.** Low Imp. **7/6.**

ENAMELLED COPPER WIRE—¼lb. reels, 14g-20g, **2/6;** 22g-28g. **3/-;** 30g-40g. **3/9.** Other gauges quoted for.

Speakers P.M.—3 ohms 2½in. Elac. 17/6. 3½in. Goodmans 18/6. 5in. Rola 17/6. 6in. Elac 18/6. 7 x 4in. Goodmans, 18/6. 8in. Rola 20/-. 10in. R. x A. 25/-. 10 x 6in. Goodmans 25/-. E.M.I. Tweeter 29/6.

Ersin Multicore Solder 60/40 3d. per yard. ½lb. 2/6, etc.

COAX 80 OHM CABLE High grade low loss Cellular air spaced Polythene—¼in. diameter. Stranded cond. Famous mfrs. **Now only 6d. per yard. Bargain Prices—Special Lengths—**
20 yds. 9/-. P. & P. 1/6.
40 yds. 17/6. P. & P. 2/-.
60 yds. 25/-. P. & P. 3/-.
Coax Plugs 1/-. Sockets 1/-. Couplers 1/3. Outlet Boxes 4/6.

Volume Controls—5K-2 Meg-ohms. 3in. Spindles Morganite Midget Type. 1½in. diam. Guar. 1 year. LOG or LIN ratios less Sw. 3/-. DP. Sw. 4/3. Twin Stereo less Sw. 6/6. DP Sw. 8/-.

W/W Resistors 25 ohms to 10K, 5W **1/3**, 10W **1/6**, 15W **2/-.** **Preset T/V Pots. W/W** 25 ohms -50 K 3/-. 50 K-2 Meg. (Carbon) 3/-.

VALVES

New Boxed — All Guaranteed

1T4	6/-	ECC83	8/-	PCC84	9/6
1R5	7/6	ECL82	10/6	PCF80	9/6
1S5	7/6	ECL80	10/6	PCL83	12/6
3S4	7/6	EF80	8/-	PCL84	12/6
3V4	7/6	EF86	12/6	PL81	12/6
DAF96	9/-	EL84	8/6	PL82	9/6
DF96	9/-	EY51	9/6	PL83	10/6
DK96	9/-	EY86	10/-	PY32	12/6
DL96	9/-	EZ81	7/6	PY81	9/6
ECC81	8/-	GZ32	12/6	PY82	7/6
ECC82	8/-	EM81	9/6	U25	12/6

TRANSISTOR BARGAINS

Brand New—BVA 1st Grade

OC44	10/6	874	9/6
OC45	9/6	GET114	6/6
OC81	7/6	OC72	7/6
2/OC81	15/6	OC70	5/6
XA102	10/-	OC71	6/-
XA101	9/6	OC78	7/6
XB103	7/6	GEX34	2/9
XC101	8/6	OA70	2/9
873	9/-	OA81	2/9

SB305 Surface Barrier Type 9/6 each. *All Post Free.*

Send for detailed bargain lists, 3d. stamp.
We manufacture all types Radio Mains Transf. Chokes, Quality O/P Trans., etc. Enquiries invited for Specials, Prototypes for small production runs. Quotation by return.

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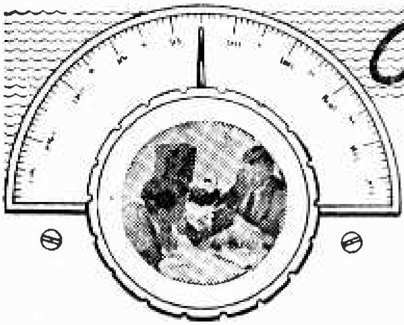
70 Brigstock Rd., Thornton Heath., Surrey. THO 2188. *Hours: 9 a.m.-6 p.m., 1 p.m. Wed. Terms C.W.O. or C.O.D. Post and Packing up to ½lb 9d.; 1lb., 1/3; 3lb. 2/3; 5lb., 2/9; 8lb., 3/6.*



On Your Wavelength

BY THERMION

Radio Cooking

I HAVE just heard that the miniature transistorised radio has now reached the realm of the kitchen—a new cooker which has recently been introduced has a transistor set built into the splash plate at the back. The idea apparently is to provide the house-wife with a radio set to which she can listen while doing her chores and which cannot be removed from the kitchen. The loudspeaker is at the side of the cooker and the set is insulated against moisture and heat. If this idea catches on, no doubt we shall see transistor sets in many other seemingly unlikely places.

Nomenclature

Talking of the transistor radio sets reminds me that for some time, I have been meaning to put in a plea for the correct use of the word 'transistor' by the lay press. It now seems that this word no longer means the actual tiny electronic gadget, but a transistorised radio set. I often hear my non-technical friends talk of buying a 'transistor' when they mean a complete set and not just one of the parts.

I think that non-technical advertising people are to blame for giving too much prominence to the transistor side of miniature sets, although I cannot remember actually seeing an advertisement in the national press for a 'Transistor'.

A New Light Bulb

Although sales campaigns for electric light bulbs are still carrying on, it seems to me that nothing really new has appeared for some time. The two most recent developments have been the introduction of a new shape for the envelope of the bulb, and the use of an opal type of coating inside the bulb for the better diffusion of light. The only other development has been rather negative—the coiled coil filament, once very popular, has now been rejected as causing more rapid failure.

However, now a boost to the common electric light bulb appears to be imminent—a new type has been announced which has two filaments in one envelope. These two filaments can be switched on singly or together to give three degrees of brightness. This procedure varies the current taken by the bulb to give ratings of 60W, 100W and 160W.

The bulb has a special base cap with three contacts, but at the time of writing it is believed that no British manufacturer produces a suitable three-contact lampholder. The reason for the marketing of this new bulb is stated to be the increased number of imports of American and Canadian table and floor standard lamps with the appropriate switched lampholders.

Volumetric Radar

Aircraft speeds continue to increase, and more and more are in the skies at once; at the same time, methods of tracking planes must be improved both in efficiency and speed and ease of operation. Radar is the answer of course but until recently it seemed that conventional techniques would not be able to cope indefinitely. The major limitation arose from the fact that the plan position and aircraft heights were found on separate equipments such as a fan beam and nodding height finder. Thus, to track aircraft flying at high speeds and rapidly changing heights, duplication of equipments would be needed, making the system unwieldy and expensive.

Volumetric radar is now being introduced—a technique originally designed to meet defence needs. Basically, the system works by using a number of radar beams stacked one above the other. Information of plan position is gained by adding signals from all the beams. However, an aircraft flying at a given height will give a stronger signal from one or two particular beams and this can be used to determine the height.

In effect, this method divides the air space under observation into layers and, by suitable techniques, one layer at a time can be used for a plan position display thus reducing the radar operator's task. Height finding is also more rapid and accurate.

How much more informative radar is these days; let us hope that more and better systems will be evolved for coping with the increasing traffic and reduce even further the numbers of accidents.

'Cordless' Telephone Switchboards

Rapidly gaining favour in large firms are electronic 'cordless' telephone switchboards. These have a number of advantages over conventional switchboards; for instance, only one telephone is required at each extension for both internal and external calls, and local calls may be dialled direct after dialling a simple code to obtain a GPO line without the need for the operator's services.

Connections are made by the operator simply by using key switches instead of the more familiar cords and jack-plugs, and in some instances, the operator 'dials' calls simply by pressing numbered buttons. Another feature is the attractive appearance of the switchboard and its small size, and where multiple position boards must be installed, less space will be taken up, resulting in more room for the operators.

Club News

REPORTS OF CURRENT ACTIVITIES

AMATEUR RADIO SOCIETY OF CHESHAM AND DISTRICT
Hon. Sec.: Capt. C. G. Stephenson, G3CLJ, 21 Lynton Road, Chesham, Buckinghamshire.

The first R.A.E. course for 1962, which commenced on February 6th, is being supported with enthusiasm by members. Construction and transmitter modification is, at the moment, taking second place to redecoration which is being carried out by members at the society's headquarters.

BARNSLEY AND DISTRICT AMATEUR RADIO CLUB
Hon. Sec.: P. Carbutt, G2AFV, 19 Warner Road, Barnsley, Yorkshire.

On February 23rd, members attended a lecture given by H. H. Eyre, on high frequency crystal filters. A sale of members' surplus equipment was held on March 9th and on the 23rd, J. Kruse gave a lecture on hi-fi speakers.

Future Events:
April 13th—Workshop practice, by J. Walker.
April 27th—VFO/CO mixers, by W. Lee.

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

The meeting on February 27th was taken up by a display of members' equipment. On March 13th members attended a lecture by G3LZW about audio amplifiers. The Annual General Meeting was held on March 27th.

Future Events:
April 10th—Spares sale.
April 25th—Field day arrangements.

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

The A.G.M. of the society was held on February 7th, when the new committee of officers was elected. On February, 11th the G5YY Trophy was competed for, and on 14th a discussion on reflectors was lead by S. Swindell. The annual dinner and dance was held on February 17th and on the 28th members enjoyed a film show.

Future Events:
April 11th—Advanced work on two metres, by T. Douglas.
April 29th—Trentham Gardens Mobile rally.

EXETER AMATEUR RADIO SOCIETY
Hon. Sec.: S. Line, 46 Roseland Crescent, Hearitree, Exeter, Devon.

At the meeting on February 6th, J. White gave an interesting talk and demonstration of his top band transmitter/receiver and his VHF receiver.

The society meets on the first Tuesday of each month and meetings begin at 8 p.m.

HALIFAX AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: G. Sunter, 24 Booth Fold, Luddenden Foot, Halifax, Yorkshire.

On March 6th members heard a talk, given by G3MAX, on the conversion of surplus. March 20th was a ragchew night and on April 3rd G3IBN gave some aerial demonstrations.

Future Events:
April 17th—Ragchew.
May 8th—Life on two metres, by G5YV.

MIDLAND AMATEUR RADIO SOCIETY
Hon. Sec.: G. H. Grayer, G3NAQ, 103 Vicarage Road, West Bromwich, Staffordshire.

The North Midlands Mobile Rally, which is being organised by this society, will be held at Trentham Gardens, Trentham, on Sunday, April 29th.

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

Recent activities have included a demonstration of tape recorders given by T. Fawthrop. On March 21st members heard a talk by G3GJV on his mobile equipment.

Future Event:
April 18th—Annual General Meeting.

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

At the February meeting, G3DAF gave a lecture on "Christmas Island." His talk was illustrated with coloured slides. Arrangements have been made for a rally at Skegness in June.

PLYMOUTH RADIO CLUB
Hon. Sec.: R. Hooper, 2 Chestnut Road, Peverell, Plymouth, Devon.

A spares sale was held at the clubroom on March 20th. The judging for the G5ZT Trophy was carried out on April 3rd.

Future Event:
May 8th—Annual General Meeting.

PRESTON AMATEUR RADIO SOCIETY
Hon. Sec.: W. K. Beazley, 9 Thorngate, Penwortham, Preston, Lancashire.

The society meets on the second and fourth Tuesdays of each month and the meetings begin at 7.30 p.m.

On March 13th, W. H. Brown, G3NQX, gave a talk on masts and towers.

ROYSTON AND DISTRICT RADIO CLUB
Hon. Sec.: H. E. Taynor, G3NAH, 103 Cross Lane, Royston, near Barnsley, Yorkshire.

The club's newly completed H.F. band transmitter is now operating on 80, 40 and 20m. VFO as applied to a top band transmitter was the subject of the lecture given on February 15th, and on March 15th the subject was electrical installation and supply.

Future Event:
April 19th—Modulator for a top band transmitter.

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

On February 28th, aerial problems was discussed by A. R. Bailey, and on March 14th L. Dougherty gave a lecture on radio astronomy. At the meeting on March 28th, G3ADQ gave a talk on single side band.

Future Events:
April 11th—Railway signalling.
April 25th—Simple maths, by L. Stevenson.

STOKE-ON-TRENT AMATEUR RADIO SOCIETY
Hon. Sec.: J. Brindley, G3DML, 40 Milehouse Lane, Newcastle, Staffordshire.

The RSGB has confirmed the re-election of G3COY to the posts of affiliated society representative for Stoke-on-Trent Amateur Radio Society, and town representative for the RSGB in Stoke-on-Trent.

The society will again be co-operating with the Midlands Amateur Radio Society for the annual mobile rally at Trentham Gardens. Details of this and other events were discussed at the AGM held on March 22nd.

FAULTS IN VHF/F.M. RECEIVERS

(Continued from page 58)

Very few A.M.-only transistor portables feature such fine detail in the audio stages, but this is desirable in F.M. sets if full advantage is to be taken of the high quality reproduction which F.M. is able to provide.

Feedback

A further aid to quality is the negative voltage feedback loop in Fig. 15. This is from the secondary of the speaker transformer, via R19, back to the emitter of the first A.F. transistor Tr6. The capacitor (C16) across R19 provides frequency selectivity in the feedback loop, and gives more feedback at the higher frequencies than at the lower ones.

Previous articles in this series have embraced both valve and transitor F.M. sets, and have given various ideas for obtaining the best results; the next and concluding article will deal with final points on servicing.

(To be continued)

RETURN-OF-POST SERVICE

We offer a really efficient Mail Order Service on all items stocked. All cash orders are dealt with on the day of receipt.
★ Hire purchase orders are subject to slight delay but this is kept to the absolute minimum

● "P.W. BLUEPRINTS" Nos. 1, 2, 4 & 5

Fully detailed list available for the "International Short Wave Two", "Regency Portable", "Mains Receiver" and "Six Transistor Set".

● ILLUSTRATED LISTS

Illustrated lists are available on LOUDSPEAKERS, TAPE DECKS, TEST GEAR, RECORDING TAPES, GRAMOPHONE EQUIPMENT, AMPLIFIERS. Any will be sent free upon request.

● OUTPUT TRANSFORMERS

GILSON: W0696A, W0696B, 50/6, post 2/6. W0710, 55/6, post 2/6. W0892, 62/3, post free; W0767, 27/-, post 1/6. W01796A, 57/6, post 2/6.
PARTRIDGE: P3667, 60/-, post free. P4014, 98/6, post free; P4131, 60/-, post free; P3591A, 99/-, post free; P5202, P5203, 95/-, post free; P4133, 52/6, post 2/6; P4073, 45/-, post 2/6.
PARMEKO: P2641, 28/-, post 2/-.

● MAINS TRANSFORMERS

GILSON: W0741AB, 63/-, post free; W0839, 48/9, post 2/9; W01328, 58/6, post 3/6.
PARTRIDGE: H300/110, 77/6, post free; P4132, 84/-, post free; P3877, £6, post free; P4013, 86/-, post free.
ELSTONE: MT/MU, 45/-, post 3/3; MT3/M, 35/-, post 3/-.
PARMEKO: P2631, 32/3, post 2/9.

● "P.W. TUTOR"

Everything in stock. Stage 1 including brand new light-weight headphones, 39/6. Less headphones, 23/6. Stage 2 19/-; Stage 3 21/6. Stage 4 11/6. All Stages 1 to 4 £4.8.6. Less headphones £3.13.6. All post free. Please note that the hardboard, wood, Terry Clips and cement not included. All items available separately—send for list.

● TRANSISTORISE YOUR CRYSTAL SET

We have two new designs for Transistor amplifiers which can be used to greatly improve the signal from any crystal set. Leaflet available.
RLD4 Kit. One stage 12/- post free.
RLD5 Kit. Two stage 21/- post free.
The kits are easy to build and very detailed instructions are supplied.

● MULLARD CATHODE RAY TUBES

ALL AT THE NEW REDUCED PRICES

We supply both Mullard Radiant Screen (brand new factory fresh) and Mullard Lumenar (re-builds by Mullard with re-claimed bulbs—all other parts brand new). List of types available with prices and hire purchase terms.

● TRANSISTORS

MULLARD. Reduced prices. Current production types, not rejects. All in makers' boxes.
OC44, 11/-; OC45, 10/-; OC70 and OC71, 6/6; OC72, 8/-; OC72 Matched Pairs 16/-; OC78, 8/-; OC81, 8/-; OC170, 13/6; OC171, 14/6. Postage 3d. on each transistor.

★ *JASON FM TUNER KITS—PRICES SLASHED* ★

Send for details FMT1, FMT2, FMT3, MERCURY 2 and JTV2, all available.

● STEREO COMPONENTS

Morganite ganged potentiometers as specified for the Mullard circuits. ● Log/Anti-Log, 500k, 1 meg., 2 meg. ● Log/Log, 50k, 250k, 1 meg., 2 meg. ● Lin/Lin 250k, 500k, 1 meg. All 10/6 each. Pick-up cartridges, B.S.R. TC8S £2.5.11. Turn-over type for Stereo. L.P. and 78 records. List of all components for Mullard Stereo Designs is available.

● LOUDSPEAKERS

GOODMANS: Axiom 110 10in. £5.2.0; Axiom 112 10in. £8.14.0; Axiette 8in. £6.15.0; Axiom 300 12in. £11.5.9; Axiom 400 12in. £16.1.0; Audiom 60 Bass, 12in. £9.12.9; Trebax Tweeter £6.4.0; CX 500 Cross-over Unit £1.19.0.
WHITELEY: HF 1016 10in. £8.4.0; HF 1012 10in. £5.2.6; HF816 8in. £7.0.9; T816 8in. £6.10.0; T10 Tweeter £4.8.3; T359 Tweeter £1.15.10; CX3000 Cross-over unit £1.11.6; CX1500 Cross-over unit £2.0.0. H.P. Terms available.

● AMPLIFIER KITS

We have full stocks of all components for the Mullard 510, Mullard 3-3, Mullard 2 and 3 Valve Pre-amp. Mullard Stereo, Mullard Mixer, GEC 912 Plus. Fully detailed list on any of these sent upon request.
Instructional Manuals: All Mullard Audio Circuits in "Circuits for Audio Amplifiers". 9/5. GEC912. 4/6. All post free.

● TAPE RECORDING EQUIPMENT

TAPE DECKS

ALL CARRIAGE FREE	Cash Price	Hire Purchase Deposit	Mthly/Pmts.
B.S.R. TD2	£8.19.6	£1.16.6	12 of 13/7
Latest COLLARO Studio	£12.19.6	£2.12.6	12 of 19/-

TAPE AMPLIFIERS

We now stock the Martin Recorder Kits. These are partly assembled kits for complete tape recorders. The Amplifier Printed Circuit panels are completely wired, but the assembly of this and external components is left to the constructor. Very complete instructions are supplied. Send for leaflet.
MODEL C for Collaro Studio Deck £11.11.0.
MODEL B for BSR TD2 Deck, £8.8.0.
CARRYING CASES. Smart carrying cases are available to take the above amplifiers and decks. Fitted with speaker.
For Model C Amplifier and Collaro Deck, £5.5.0.
For Model B Amplifier and BSR Deck, £4.4.0.
H.P. Terms available for amplifiers, cases and decks.

TAPE PRE-AMPLIFIERS

ARMSTRONG PABO-3. This is a ready made version of the Mullard Tape C Pre-amplifier. Price £16.16.0. Hire Purchase Deposit £3.8.0, and 12 monthly payments of £1.4.7.
MULLARD TAPE C PRE-AMPLIFIER. We stock complete kits and all components. Send for list.
MARTIN. Pre-amp kit for Collaro Studio Deck £8.8.0.

★ *"P.W. MINI-AMP" AND "CITIZEN"* ★

We can supply kits in accordance with the P.W. articles. **Full instructions supplied FREE with each kit.**
Send for fully detailed Parts List.

● GRAMOPHONE EQUIPMENT

ALL LATEST MODELS ALL POST FREE	Cash Price	Hire Purchase Deposit	Mthly/Pmts.	
RECORD CHANGERS				
GARRARD AUTOSLIM (GC8 PU)	£8.5.0	£1.13.0	12 of	12/8
COLLARO C60 (GP67 PU) ..	£8.5.0	£1.13.0	12 of	12/8
B.S.R. UA14 (TC8 PU) ..	£7.19.6	£1.12.6	12 of	12/3
B.S.R. UA14 Monarch (TC8S Stereo/LP/78) ..	£8.19.6	£1.16.6	12 of	13/7
SINGLE RECORD PLAYERS				
GREENCOAT 45 UNIT (Battery 9v.)	£5. 8.0	£1.11.0	3 of	£1.9.0
GARRARD TA (GC8 PU)	£8.10.0	£1.14.0	12 of	13/-
B.S.R. TU12 (TC8 PU) ..	£4.10.0	£1. 5.0	3 of	£1.5.0
TRANSCRIPTION UNITS				
GARRARD 4HF (GC8PU)	£18.18.0	£3.16.0	12 of	£1.7.8
PHILIPS AG1016	£14. 3.6	£2.17.6	12 of	£1.0.9

Many of the above can be supplied for stereo working. See our Gramophone Equipment List for details.

● "BRAND FIVE" RECORDING TAPE

Standard Play: 600ft. (5"), 16/-; 1,200ft. (7") 25/-.
Long Play: 900ft. (5"), 18/6; 1200ft. (5¾"), 23/6; 1800ft. (7"), 35/-.
Double Play: 1200ft. (5"), 37/6; 2400ft. (7"), 60/-. (All Post Free.)

● LATEST TEST METERS

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PC15

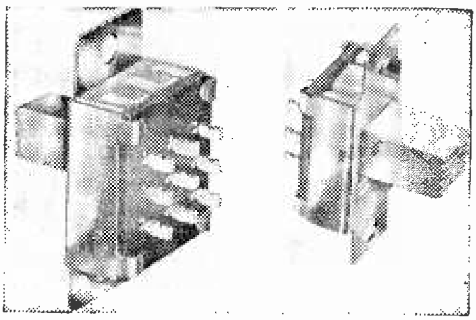
Trade News

MINIATURE SLIDER SWITCHES

TWO miniature slider switches, Types S5 and S6, primarily designed for use in the radio and television field have been introduced by the Plessey Company Limited.

Both types have "make-before-break" contacts operated by sliding a plastic button. "Break-before-make" contacts can be supplied if required.

Type S5 is a 2-pole 2-position, and Type S6 a 3-pole 2-position switch; in each case the moving contacts are fitted inside the operating button and are thus completely protected from external damage.



Two new switches from Plessey Ltd.

Both types have identical specifications, differing only in the switching facilities provided. The frame is of cadmium plated steel and both moving and fixed contacts are in hard brass, silver plated.

The switches are made by *The Plessey Company Limited, Ilford, Essex.*

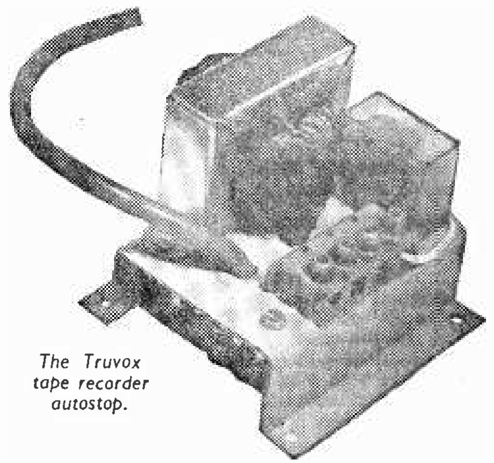
AUTOMATIC TAPE STOP

THE DA.83—made by Truvox—is an automatic stop for tape recorders designed to stop the motors as soon as the metal foil or metallised portion at the end of the tape reaches the tape guides.

The Autostop—as it is called—embodies a relay the purpose of which is to switch off the tape deck motors when the end of the tape is reached. The relay receives its impulse from a voltage applied between two tape guides or pillars on the tape deck.

The unit has its own independent and self-contained power supply which delivers approximately 20V D.C.

The relay operates when an electric circuit is completed by the tape foil coming between the guides or pillars, one of which is insulated and the other in metallic contact with the tape deck. To resume normal operation after the Autostop has worked, all that needs to be done is to switch off momentarily. The tape stop is made by *Truvox Limited, Neasden Lane, London, N.W.10.*

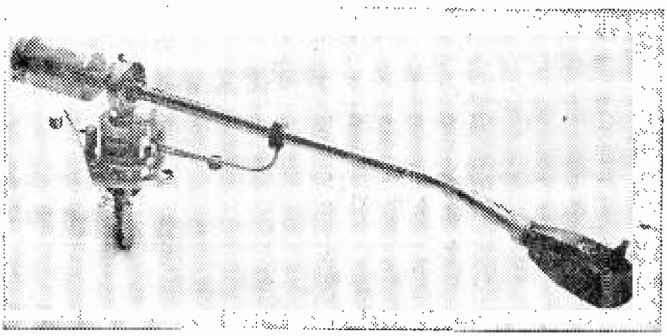


The Truvox tape recorder autostop.

PICK-UP ARM

THE Council of Industrial Design in London recently chose the S.M.E. precision pick-up arm (models 3012 and 3009) for a Design Centre Award.

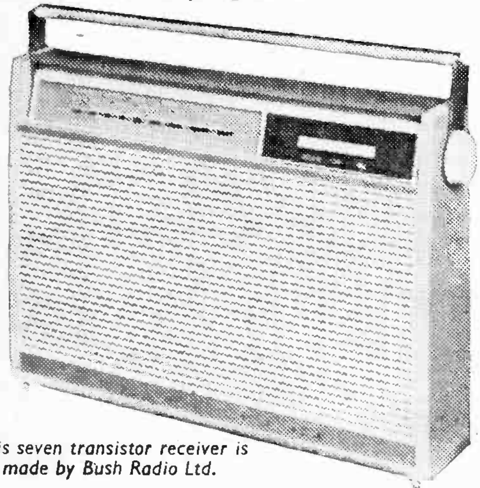
The pillar is of hardened steel and the tone arm is of stainless steel, made non-resonant by an internal lining of fibre wood. All the bearings are totally enclosed and the pivot friction is very small. The mass is balanced longitudinally and laterally and the lowering control is hydraulically damped to reduce the risk of damage to the stylus and record.



The S.M.E. precision pick-up arm.

The two models are approximately 9in. and 12in. in length and cost £18 15s. 0d. and £20 12s. 6d. respectively (purchase tax extra).

S.M.E. Limited, Steyning, Sussex.



This seven transistor receiver is made by Bush Radio Ltd.

TRANSISTOR RADIO

THE T.R.102 is a new 7 transistor radio recently introduced by Bush Radio. This receiver has two original features, the first being that it is turned "on" and "off" by opening and closing the scale cover, and the second is that a touch on the tuning knob illuminates the pointer scale.

It covers both medium and long wavebands and the waveband selection is by push button and a third button gives maximum/minimum treble tone.

The moulded cabinet is in cream, with a turquoise scale cover and red and black scale. A ferrite rod aerial is built into the set and a socket is provided for connecting an external aerial. A socket is also provided to connect an earphone for private listening.

The T.R.102 costs 21½ guineas and is made by *Bush Radio Ltd., Power Road, Chiswick, London, W.4.*

NEW RECORD PLAYER

A NEW and improved version of the model RP392, "Nine-Octave" record player has just been released by Ekco.

Provision is made for the instant addition of stereophonic facilities by the interchange of pick-up heads and the connection of a separate stereo unit by means of a single plug-in lead.

The Model RP392 provides high-fidelity reproduction of all records manually or automatically. The 8W amplifier ensures an ample reserve of sound output, while the push-pull output stage has a frequency response covering nine octaves (30c/s to 16kc/s). Independent bass and treble controls are incorporated and a switched amplifier input socket allows reproduction from a tape recorder, microphone or radio.

The cabinet is finished in scratch-resistant walnut veneers with a woven plastics speaker grille.

The price of the record player is 55 guineas and it is made by *Ekco Radio and Television Ltd., Southend-on-Sea, Essex.*

NEW RANGE OF INSTRUMENTS

A NEW range of instruments made up from standard Lektrokit components is announced by A.P.T. Electronic Industries Limited. The first units in the range are two decade resistors (type LKU-211 and LKU-221), a decade capacitor (type LKU-111), and a capacitor box (type LKU-121).

The units are intended both for industrial applications, and also as medium accuracy instruments for use in universities, technical colleges and schools.

The two decade resistors cover the ranges 1Ω to 1·11k (LKU-211), and 1k to 1·11M (LKU-221). Each unit comprises three decades controlled by 12-way switches, which give a short-circuit and an open-circuit position in addtion to ten equal increments of resistance.

The decade capacitor covers the range 50pF to 0·111μF. The unit comprises a continuously variable air-spaced capacitor for the range 50pF to 1000pF, in parallel with two switched decades using high-grade polystyrene film capacitors, for the higher values. The switched decades cover the ranges 1,000pF to 10,000pF, and 10,000pF to 100,000pF (0·1μF).

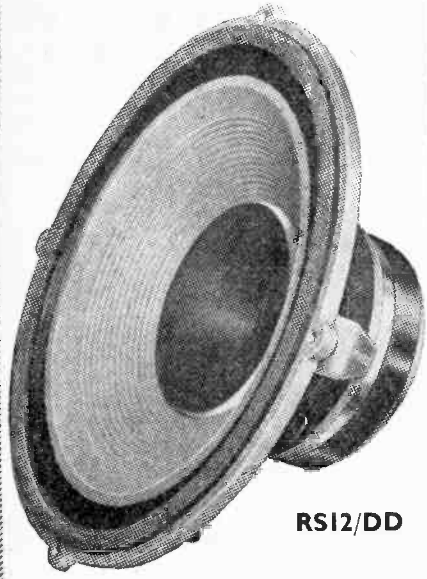
The capacitor box provides various values of capacitance commonly met with in circuit design, from 0·05μF to 28μF. The unit consists of a number of individual capacitors, each controlled by its own on/off switch, which brings the capacitor into circuit when required.

All the units are designed to form part of a uniform range of inexpensive but sturdy instruments and are of the same size. The cases are made up from standard components of the Lektrokit chassis construction system, and are intended for operation with the panel horizontal.

The Lektrokit chassis construction system consists of a range of simple and inexpensive components which can be assembled using screws and nuts, to make electronic chassis of any shape or size likely to be met with in most laboratory or small production requirements.

A.P.T. Electronic Industries Ltd., Byfleet, Surrey.

A Decade Resistor from the new range of Lektrokit units.



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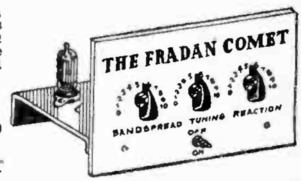

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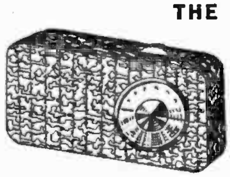

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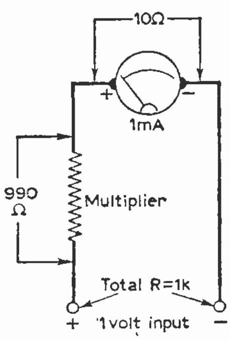
Using your MULTIMETER

THE USE OF THE MULTIMETER IN RADIO CONSTRUCTION AND SERVICING

By G. J. King

THE multimeter (sometimes called "multirange meter") has many applications in the fields of radio construction and servicing, and is probably one of the most useful pieces of single test equipment ever evolved. This is the basic instrument which should be in the possession of all keen experimenters, since without it or an array of separate test meters, very little can be done. A good instrument will tell almost all there is to know about the fundamental operation of a radio set, whether it be of commercial origin or home constructed.

There are many instruments from which to choose, ranging from a few pounds to many tens of pounds, but in all cases the heart of the instrument is the moving-coil movement. This is essentially a current measuring device. That is, it gives a reading in proportion to the amount of current flowing in its moving coil. The most useful meter movements are those which provide maximum deflection of the pointer for the smallest amount of current.



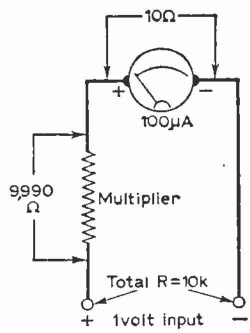


Fig. 1 (left)—The basic voltmeter circuit, showing how the use of a 1mA movement provides a sensitivity of 1,000 Ω/V. The multiplier is set for a full-scale deflection of 1V.

Fig. 2 (right)—By the use of a 100μA movement the sensitivity is increased to 10,000 Ω/V. Again, the multiplier is set to give a full-scale deflection of 1V.

All moving coil meters require some current to cause the pointer to move, and when making measurements on radio equipment it is essential that the smallest possible current is taken from the circuit under test. The meter is operated, of course, by the test circuits, and if a lot of current is required to move a pointer then it follows that the circuits under test will be expected to supply, in some cases, a current considerably in excess of that for which they were originally designed.

Certain circuits can provide the extra current to operate even the most inefficient of movements without any trouble, but other circuits cannot supply even a few microamperes of extra current. The amount of current required by a movement to provide full-scale deflection of the pointer is a measure of the movement's sensitivity. Some meters require 10mA or more, while others give full-scale deflection with a current of less than 1mA

Instruments of low sensitivity are ideal for certain power applications where an extra few milliamperes will be unnoticed, but with all radio work, a meter of the very highest sensitivity should be chosen. No meter will have a sufficiently low sensitivity as to damage the circuits under test. What happens is that the meter "loads" the test circuits so that the voltage present with the meter connected (and as recorded by the meter) falls to a value considerably below that present with the meter removed.

Thus, although a reading may be given, it may be of little use as it is grossly incorrect owing to the loading of the meter. To fit in with this aspect of loading, instrument sensitivities are often given in terms of "ohms-per-volt," or ohms/volt (Ω/V): that is, the total amount of resistance present between the terminals of a voltmeter in relation to the full-scale voltage. For example, a meter with a sensitivity of 1,000Ω/V would have a resistance across its terminals of 1,000Ω on the "1V" range, 2,500Ω on the "2.5V" range, 100,000Ω on the "100V" range and so on. The resistance value as determined by the voltage selected thus shunts the circuit under test when the instrument is applied to make a measurement, and in very high resistance test circuits, there is almost a total "swamp" effect caused by the meter, thereby seriously modifying the circuit's normal operation.

Multiplier Resistor

The terminal resistance of a voltmeter is equal to the sum of the resistance of the movement and the value of the series-connected multiplier resistor. The multiplier resistor value is computed so that the total terminal resistance passes the current required to give full-scale deflection on the movement. For example, if the movement has a full-scale deflection of 1mA, then to give full-scale deflection when 1V is applied, the total resistance must equal the voltage divided by the current, in volts and amperes respectively when the resistance is in ohms, or in volts and milliamperes when the resistance is in thousands of ohms (i.e. kilohms). This would be 1,000Ω. A little of this is made up by the resistance of the movement and the remainder by the multiplier resistor, as shown in Fig. 1.

This is where the sensitivity "loading factor" comes in, for, with a 1mA movement arranged with a multiplier to give 1V full-scale deflection (f.s.d.) the sensitivity is 1mA/V. The sensitivity is exactly the same, of course, if the multiplier is arranged to give a full-scale deflection of, say, 100V. The total terminal resistance would be 100,000Ω against 100V full-scale deflection (still 1,000 ohms/volt).

On the other hand, a movement with a full-scale deflection of, say, 100μA (0.1mA) would require a total terminal resistance of 10,000Ω to give full-scale deflection on 1V, see Fig. 2. This would produce a sensitivity of 10,000Ω/V. Similarly a 10μA (0.01mA) movement would result in a sensitivity of 100,000Ω/V.

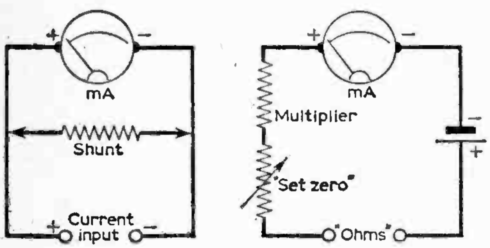


Fig. 3 (left)—For current measurements, the movement is shunted by a resistor, called a "shunt". Fig. 4 (right)—The basic circuit of the "ohms" section of a multimeter.

Clearly then, when making voltage tests in high resistance circuits, the instrument should be adjusted to the highest possible range, consistent with a useful deflection, for then the loading is minimised.

Now that transistor circuits demand the measurement of very small voltages, the lowest voltage range should not be much greater than 1V, whereas 1,000V represents a good full-scale top range. Intermediate ranges of 5V, 10V, 100V, 250V and 500V are useful.

The minimum sensitivity should not be less than 10,000Ω/V, but if possible an even higher sensitivity is desirable, as we have already seen. The cost of instruments rises considerably with increase of sensitivity, so the final choice may be dictated by the pocket rather than technical desirability.

It should be remembered that there are some extremely good meters available, particularly on the surplus market, with a sensitivity of 1,000Ω/V or less. These can prove very useful for certain tests, but if they are ever used to measure voltages in high resistance circuits, their limitations must be kept fully in mind.

Current Readings

It usually follows that a multimeter with a high sensitivity (in terms of Ω/V) will measure smaller direct currents than a similar instrument with a lower sensitivity. The reason for this has already been dealt with, and that is the higher sensitivity is brought about by the use of a more sensitive movement, i.e., one which will give full-scale deflection with a small current.

When a multimeter is switched to the current ranges, the movement is applied directly across the terminals, and the various current ranges are given by the connection of "shunt resistors" of suitable value across the movement terminals, as shown in Fig. 3. Even on the lowest current range a shunt is often used, but it is usually of fairly high resistance to swamp variations in movement resistance in production. This shunt is often variable in some way as a calibrating device.

Resistance Ranges

Resistance is measured on a multimeter by connecting a battery in series with a multiplier resistor, and having a variable resistor—labelled "set zero"—to allow full-scale deflection to be set when the meter leads are connected together. The scale is calibrated directly in "ohms," and if a resistor is connected between the test leads the deflection will be something less than full-scale, depending on the value of the test resistor (see Fig. 4).

Again, the highest resistance measurement possible is governed by the sensitivity of the instrument. The battery, which is invariably accommodated inside the instrument housing, also has a bearing on top resistance measurements, and some instruments have two or more resistance ranges, brought about by the use of different shunts or battery voltages or both.

A.C. Ranges

There are three basic types of multimeter. Firstly, the D.C.-only version, which measures D.C. voltage and current and possibly resistance. Secondly, the type which measures D.C. voltage and current, resistance and A.C. voltage only. And thirdly, the truly "universal" instrument, which measures voltage (A.C. and D.C.), current (A.C. and D.C.), resistance and possibly capacitance and inductance.

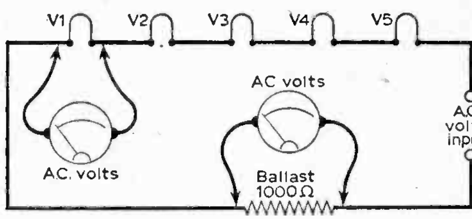


Fig. 5—By measuring the A.C. voltage across a valve heater or ballast resistor, the current may be found by Ohm's law (see text).

In radio work, A.C. current usually requires to be measured in heater chains and similar circuits, but the same information can be obtained by an A.C. voltage measurement across a valve heater or ballast resistor, and then computing the circuit current from Ohm's law (i.e. current equals the voltage measured across the resistor divided by the value of the resistor)—see Fig. 5.

[*An article on adding A.C. current ranges to multimeters appears on page 28.*—Ed.]

(*To be continued*)

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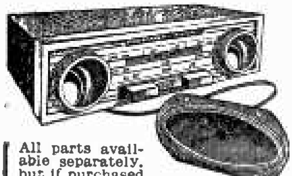

All parts available separately, but if purchased at one time, the whole will be supplied at a special inclusive price of only **£10.19.6** Plus 4/- P. & P.

Parts list and comprehensive instruction booklet 2/6, post free. (Deducted from cost if complete parcel purchased later.)

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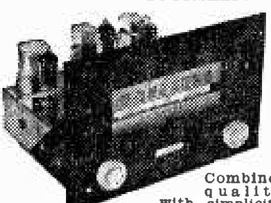

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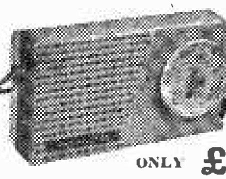

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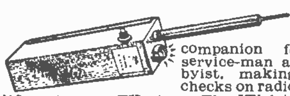

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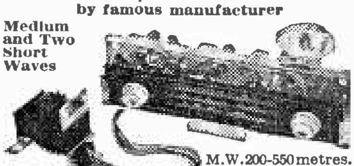

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(Calibrated also in k/cs and M/cs.)

A five valve superhet chassis—ECH81, EF89, EBC81, EL84 and EZ80 for A.C. mains, 90/110/200/230/250 v. Four watts output, negative feedback. Push-button selection of gram, and wavechange. Volume on/off. Tone and Tuning controls. Tropicalised high grade mains and output transformers, separate from main chassis, reduce hum and heat to a minimum. Attractive dial printed in Black, Gold and Red. Chassis dimensions 15in. long x 6in. deep x 7in. high. (This includes mounting brackets which can be removed and reduces the depth to 5½in.). Dial aperture 13½ x 3in.

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400 Milliwatt Output

To build yourself, Medium and Long Waves—Push-Pull Superhet A. V. C. Perfect Car Radio reception Size 10in. x 6⅝in. x 4½in. at base tapering to 4in. at top. Very attractive two-tone grey Vynide covered cabinet with black and gold printed escutcheon plate, cream and gold knobs, handle and cabinet fittings ★ Weight—with long-life 7½ v. battery—4½ lb. ★ Mullard high-grade transistors throughout. ★ High-Flux 7in. x 4in. Elliptical Speaker. ★ Slow motion tuning. ★ Co-axial socket at rear for direct connection to Car Radio Aerial. ★ Improved reception by use of five-section plated telescopic aerial disappearing into Cabinet when closed. 34in. above Cabinet when fully extended. Construction simplified by Bakelite chassis board with the following components already mounted: I.F. Transformers (3), Oscillator Coil, Trimmer Bank, Output Transformer, Interstage Transformer, Aerial Brackets and Earth Bar. SPECIAL INCLUSIVE PRICE for all required components. Full assembly instructions—nothing more to buy—is £9.19.6, plus 3/6 P. & P. Alignment service available. Full assembly instructions and individually priced parts list, are available separately. 2/6. Post Free.

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Our Sensitive 5 Stage (4 transistor plus diode) pocket transistor receiver, for full medium wave reception—with the following outstanding features:

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SPECIAL FEATURES! Supplied with jack socket and plug for direct connection to crystal microphone for use as baby alarm—without any modification! also for direct connection to crystal pick-up for use as a gramophone amplifier! Supplied complete with recessed socket for direct connection to car aerial!

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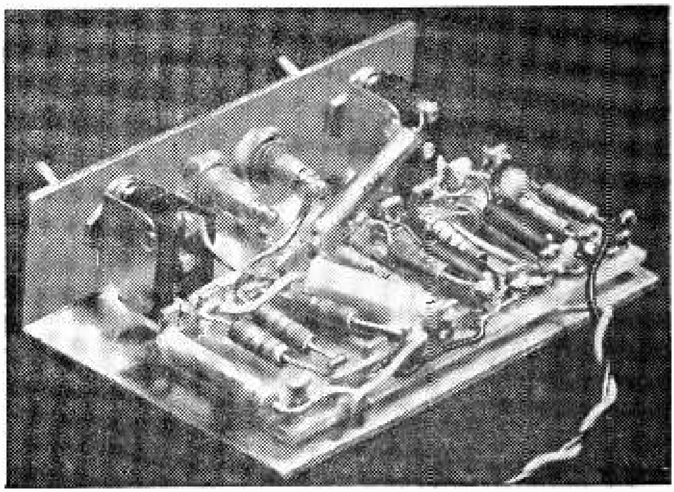
Transistorised SQUARE WAVE Generator

AN INEXPENSIVE INSTRUMENT FOR USE WITH AN OSCILLOSCOPE

By A. Foord

A SQUARE wave consists of a fundamental sine wave with the addition of all the odd harmonics. In theory, all the odd harmonics up to infinity are included in a perfect square wave, but in practice this is never realised. The harmonics in the case of this generator do, however, extend well into the R.F. band. This property of the square wave renders it a considerable asset for quick fault finding in radio receivers and A.F. amplifiers, since it can be injected at any point of any stage, and will give an output at the loudspeaker.

If an oscilloscope is available a great deal of information can be obtained about the frequency response of an A.F. amplifier and by observing the output of the amplifier most of its faults can be determined. For example, in Fig. 1(a) the input square wave is shown. In Fig. 1(b) the rounded leading edges show that the amplifier has a poor high frequency response, and the waveform of Fig. 1(c) shows an even greater deterioration of H.F. response. Low frequency deficiency is shown in Fig. 1(d), while L.F. phase distortion is shown in Fig. 1(e).



The completed unit.

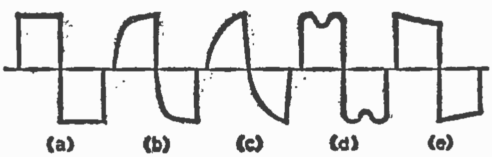


Fig. 1—If an oscilloscope is available an A.F. amplifier may be tested by applying a square wave input and observing the output on the oscilloscope.

The Circuit

The circuit used by the author is shown in Fig. 2 and consists of a conventional multivibrator. With S1 open, the unit produces an excellent square wave at a fundamental frequency of 6kc/s. With S1 closed, the unit produces a square wave at a frequency of 440c/s with a mark-space ratio of 3:1. These are shown in Fig. 3(a) and (b) respectively. These frequencies are only nominal, and may be slightly different due to component tolerances and the battery voltage used. The unit will operate from a 1·5V to 9V supply, and the data beneath Fig. 2 shows the actual results obtained with a 6V battery supply.

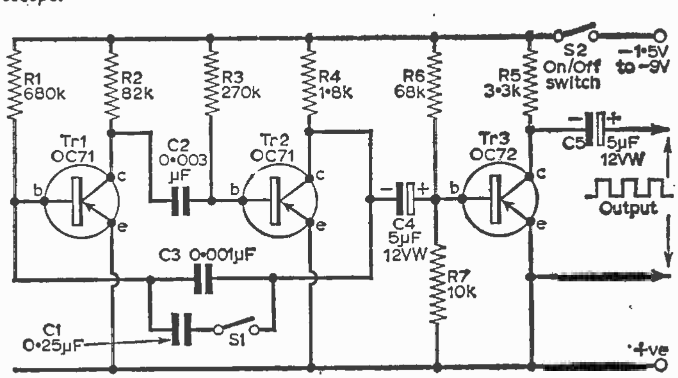


Fig. 2—The circuit of the generator. With S1 open, the frequency is 6.6kc/s and the mark-space ratio 1 : 1; with S1 closed, the frequency is 460c/s and the mark-space ratio 3 : 1. Current consumption is about 2.5mA and the output 5V peak-to-peak.

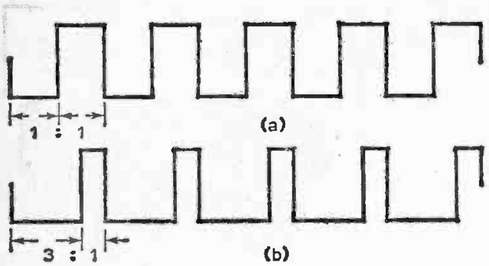


Fig. 3—a—The output waveform with S1 open; b—the output waveform with S1 closed.

COMPONENTS LIST

Resistors:	
R1 680k	R5 3·3k
R2 82k	R6 68k
R3 270k	R7 10k
R4 1·8k	
Capacitors:	
C1 0·25μF	C4 5μF 12VW elec.
C2 0·003μF	C5 5μF 12VW elec.
C3 0·001μF	
Tr1, Tr2 OC71's	
Tr3 OC72	
S1, S2 On/off switches	
Battery (see text), tag board, etc.	

The square wave is produced by Tr1 and Tr2. It is then passed into Tr3 and is shaped and limited. If the constructor is not too particular about the shape of the wave, Tr3 may be omitted as the action of Tr3 can only be seen on an oscilloscope. In this case, the output would be taken from the positive side of C4.

Construction

The construction used by the author is shown in Fig. 4. The tag-board used was a ten-way type, and the transistors can be wired up so that they fit neatly down between the components on the tag-board. A compact unit could be made in a small case if a 1·5V cell were used for power. ■

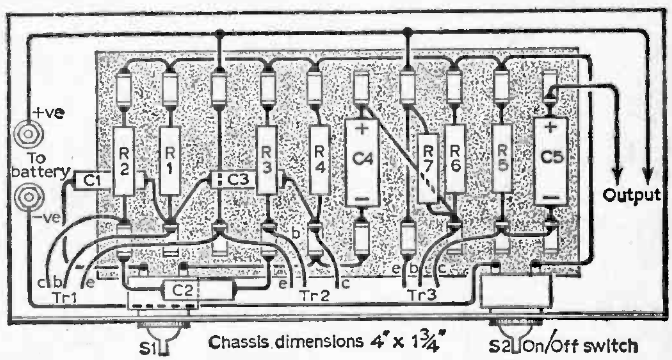


Fig. 4—The component layout and wiring diagram.

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Will detect all types of metal. Complete equipment with instructions. 39/6. Carr. 10/6. Batteries 8/- extra.

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12/18v. 2½A.	6/9	24/36v. 4A.	18/6
12/18v. 4A.	9/9	24/36v. 10A.	45/-
12/18v. 5A.	12/6	24/36v. 15A.	47/6
12/18v. 6A.	13/6	48/60v. 2A.	18/6
12/18v. 10A.	22/6	48/60v. 10A.	82/6
12/18v. 15A.	37/6	PLEASE ADD	
24/36v. 1A.	9/6	POSTAGE.	

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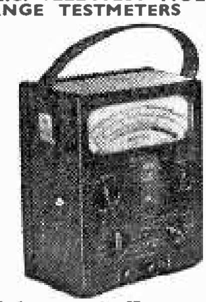

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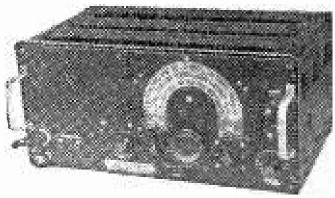

R.C.A. AR88 L.F. RECEIVERS
World famous 14 valve receiver. Frequency coverage on six bands 75-550kc/s and 1.5-30 Mc/s. Variable selectivity, crystal, B.F.O., mechanical bandspread, noise limiter, etc. Operation 110/200/250V A.C. output for phone or 3Ω speaker. Supplied in perfect working order. £32.10.0 ea. Carr. 30/-.

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Senior Model, table or rack mounting. Supplied with a full set of 9 coils covering 50kc/s-30Mc/s. Special features include: S meter, crystal phasing, B.F.O. etc. Output for phones or speaker. Supplied fully tested, superb condition throughout. 21 Gns. Carr. 10/-. Power units available 59/6 extra.

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14 valves. Frequency coverage on 6 bands 550 Kc/s—32 Mc/s. Variable selectivity, crystal, B.F.O., mechanical bandspread, noise limiter, etc. Operation 110/200/250 volt A.C. Output for phone or speaker. £35 each. Carriage 30/-.

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Type PX1/1. Sub-miniature, wire ended. Extremely sensitive. 12/6 each. P. & P. 6d. Data supplied.

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Complete with Lead, Jack and Plug. Available High (crystal) or Low (mag.) imp. 5/- each. P. & P. 6d.

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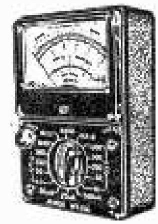

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Letters to the Editor

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 the cover.

SOLDERING TRANSISTORS

SIR,—Since the use of transistors has become so popular and the number of circuits published so many and varied, it is often necessary for real enthusiasts like myself to make use of the same transistors while experimenting with different circuits. I have found that by using short lengths of rubber-covered flex of different colours for collector, base and emitter positions, I can avoid the use of the soldering iron on the actual transistors. I merely pull out three or four strands of wire from the lengths of coloured flex, solder one end of each into position and then slip the actual leads of the transistors into the "open" ends of the flex—the removal of a few strands of the original wires makes this an easy matter, but good contact is assured. Using this method the transistor leads may be shortened to half-an-inch or so without risking any damage from over-heating.

I hope this tip may prove useful to other readers. —C. J. SHANNON (Southampton).

VINTAGE MODELS

SIR,—In reply to Mr. Forwarch's letter in the February issue, I would like to say that I also have—and enjoy listening to—an old American radio. It is a Weston which was given to me during the second World War. At that time it had just been reconditioned and now it is still in working order. Although only a four-valve set, it gives a better tone than nearly every modern set that I have heard.

I would like to correspond with any other Weston owners.—P. G. THOMAS, 6 Eton Ave., Heston, Middlesex.

SIR,—I am greatly interested in the correspondence you receive concerning vintage receivers. I have a Portadyne, five valve, mains model A72, purchased new in 1934 for 11 guineas. The set is still in daily use and all the valves are the originals and the only replacements have been a couple of volume controls and one condenser. The quality is still very good, apart from slight mains hum.

I also have a Portadyne six valve portable model PB6, which I bought last year at the local market for five shillings, complete with eliminator. The set was in working order and has been in constant use in my cellar workshop. The only problem is keeping an accumulator constantly on charge to cope with the drain of six valves.

The set owned by Mr. Munro ("On Your Wavelength," March issue) brings back happy memories. My uncle was a great A.J.S. motor-cycle enthusiast, and I well remember visiting him and being shown the latest marvel, an A.J.S. radio, exactly as shown in Mr. Munro's photograph, the only difference being that there was a large frame aerial on top.—D. ROBINSON (Bootle).

F.M. QUALITY

SIR,—I am a regular reader of PRACTICAL WIRELESS, and feel that I must write and say that I strongly disagree with the correspondents who state that their vintage A.M. receivers are far better than modern receivers. These people can never have heard a good F.M. tuner, coupled to a high quality amplifier and speaker.

Most owners of these old receivers state how good the bass response is. This is due to the fact that all they hear is bass and no top response, as the bandwidth of the receiver will not cover higher audo frequencies, plus the fact that 4·5kc/s is the higher, audio frequencies are not transmitted on L.W./M.W. A.M. transmissions.

On M.W. and L.W. many stations have other stations competing for the same frequency, therefore the listener hears the required station but with another station in the background.—D. G. RICHMOND (Whixley, Yorkshire).

SIR,—I must endorse the remarks made by Mr. T. G. Davies (March issue) concerning anomalies of F.M. reception.

About 18 months ago I substituted a pair of coils in a Philips turret-tuned TV receiver with a pair of home-made coils wound to cover Band II. Despite the obvious fact that the TV set used a conventional A.M. demodulator, the F.M. transmission came through loud and clear.* I would hesitate to say that quality was better than a ratio detector would provide, but to my ear it was certainly satisfactory.

About the same time I modified the ratio detector circuit of a home-built F.M. tuner to a simple diode A.M. demodulator and much to my surprise the tuner worked admirably with a greatly increased sensitivity and no appreciable loss of quality. It certainly would appear from my experience that the use of conventional forms of F.M. demodulation are unnecessary in view of the additional complication involved.

I have also noticed the weak repetition of F.M transmissions at points on the dial other than the

* *Slope detection*!—ED.

correct one. As in Mr Davies's case the nearest station was Wenvoe, but I put this down to freak reception of Wrotham and other distant stations, but as I had no other means of checking frequencies at the time, this theory remains unconfirmed. —D. G. B. ARTHUR (London, S.W.9.).

CORRESPONDENTS WANTED

SIR,—I am sixteen and would like to correspond with any other radio enthusiasts of my own age, and anyone who has any information on, or has had any experience with, a six-valve "Metro-Stentor" radio.

This radio was purchased for ten shillings, with a rather pathetic 78 rev/min only record player in a magnificent cabinet. The circuit includes two 6V6's in push-pull, driven by a transformer from the anode of the double-diode triode. Also a two-position pre-selector control is fitted as standard (how many modern radios have this incorporated?)

The output, after a few modifications, is in excess of 11W, and with full long, medium, and short coverage and twin speakers; it is as good a radio as I have encountered in a long time. —P. FORBES (55 Shackleton Road, Tilgate, Crawley, Sussex).

SIR,—I am very interested in radio constructing and theory, and hope to take the R.A.E. shortly. I would like to correspond with someone of my own age (16). All letters received will be answered.—K. BAKER ("Bonaccord," 87 Batley Road, Alverthorpe, Wakefield, Yorkshire).

CALLING ALL CARS

SIR,—Thermion recently spoke about an interference generator to cut out noise from small radio portables. When is someone going to produce a small transmitter receiver to be fitted to all cars and work on a standard frequency? I have in mind a small R/T set behind the drivers right ear which would have a range of 30 yards and enable the driver of one car to speak to the other, such as in the case of overtaking. For city use there would be a jumble of speech but this could be overcome by the police who could use a high power transmitter in the control of traffic.—W. MACKENZIE (Kingussie).

A DIRECT-READING FREQUENCY-METER

(Continued from page 47)

Response-Pulse Duration

Whereas D1 removes the negative spikes of the differentiated square wave at Sk3 output, they are still present at pin 7 of V5, because there simply C11 and VR2 are used for differentiating. It is necessary that the response-pulse from V5 should have ended of its own accord before the negative spike arrives at C11, as this could otherwise terminate the response-pulse in V5 prematurely, giving erratic readings. This condition is obviously satisfied if R28 is made no larger than the value giving response-pulses on each range no longer than one-third of the time of one cycle of the input frequency giving full-scale deflection.

If this maximum size of response-pulse (to be checked on an oscilloscope) does not allow sufficient meter deflection to be obtained, then a more sensitive meter must be used. A 500μA movement should then be used, and D2 must be replaced by a 6V zener diode. Although the prototype worked well ultimately with the cheaper 1mA meter arrangement, adjustment was tricky and near the limit of what was possible, so that, if available, the 500μA meter might be used right from the start.

Alternatively, the constructor might try raising R27 to 56k or even 100k, and placing C11 between Sk3 and pin 7 of V5. This causes negative spikes to be absent at grid pin 7 too, and thus removes the necessity for the restriction of response-pulse time-length. Two disadvantages of this method are then the lower voltage level, which may lead to difficult triggering of V5, and the interference to triggering of V5 possible when apparatus is fed from Sk3. The issue must be decided by experiment. It is also possible to duplicate the arrangement feeding Sk3, but making the counterpart of R27 then about 56k, for triggering V5.

Input Waveforms Acceptable

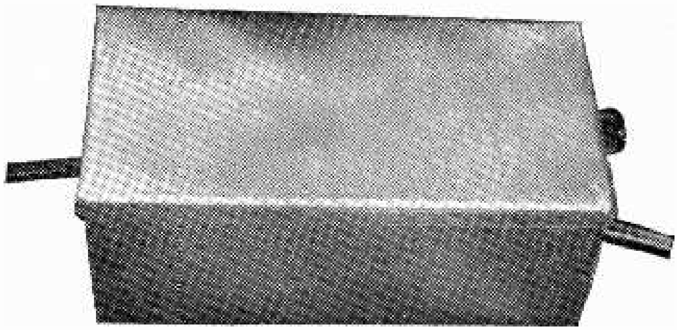
It is the positive-going transition of each cycle of any input waveform to V1 which will ultimately lead to a trigger to V5. Thus the only restriction placed on an input waveform is that such positive transitions of sufficient steepness must be present.

The steepness on a sine wave is certainly sufficient, and a sine wave is the simplest wave form possible. Consequently it is reasonable to suppose that for any other waveform, if positive transitions are weak, the negative ones are likely to be all the more distinct, e.g., a positive sawtooth. In such cases it is merely necessary to reverse the polarity of the input voltage. The input polarity should be such that the steepest transitions are from negative to positive. If of incorrect polarity, a single amplifier stage will reverse a signal. If from an anode circuit, it may be possible to tap off from a cathode resistor, or vice-versa, or from elsewhere in the circuit supplying the waveform, where polarity is reversed.

But this point is not so very critical. The prototype is remarkably easy going regarding waveforms it will accept. Fed from the extension speaker terminals of a radio set, the behaviour is exactly as expected. Relatively low readings on medium-wave music, higher but strongly fluctuating readings on speech, considerably higher readings on everything on an F.M. transmission, and very great readings of many kilocycles greater than anything else as soon as the carrier is detuned, with hiss, noise and sideband-splash of high frequency, or if any heterodyne whistles appear. The prototype will sort out and indicate the frequency of a heterodyne whistle considerably weaker than the actual programme on which the whistle is located, which is rather remarkable. Better proof of its generosity in type of waveform acceptable is hardly needed. ■

Transistor Receiver Mains Unit

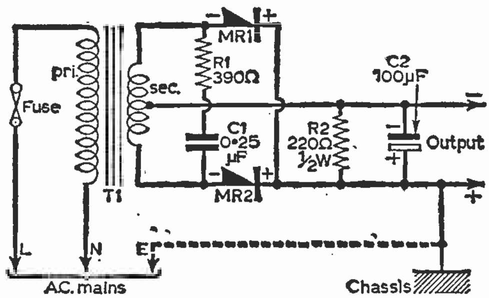
By F. G. Rayer



The complete unit.

THIS UNIT ENABLES A TRANSISTOR RADIO WHICH NORMALLY USES A 9V BATTERY TO RUN FROM THE MAINS

THIS eliminator allows mains operation of any transistor receiver or amplifier which is designed to run from a 9V or similar battery. Working costs are negligible, and the unit is, of



The circuit.

course, very useful indeed when testing receivers or experimenting with them. It can be disconnected in a few moments, so that the battery can be replaced when the receiver is to be taken elsewhere. No circuit changes whatever are needed in the receiver.

The circuit is shown in Fig. 1. The transformer isolates the secondary circuit and receiver from the mains. Two rectifiers are used in a full-wave circuit, with centre-tapped secondary. The 220Ω resistor draws a current of about 45mA, and as a result the output voltage is largely stabilised against fluctuations which would otherwise arise with changes in current drawn by the receiver. The 100μF condenser is for smoothing.

Constructional Details

Fig. 2 shows the layout of parts, and all wiring. A box approximately 4in. x 2in. x 1¼in. deep will easily hold the components. An aluminium plate is cut to fit in this box, with a little clearance, and the parts are assembled on this.

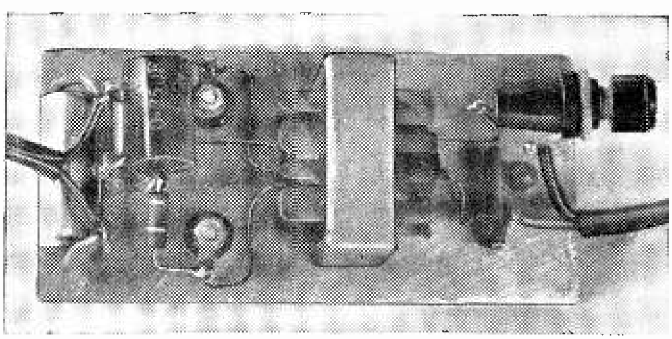
The transformer is held in place by passing its securing tags through holes. The primary leads go to the fuse holder, and an insulated tag, these items forming anchor points for the mains flex.

Both rectifiers are bolted to the chassis plate by their positive terminals, and the plate is also common to the mounting tag of the 3-tag strip, and the positive lead of the output circuit. It is essential that the secondary centre tap (blue) goes

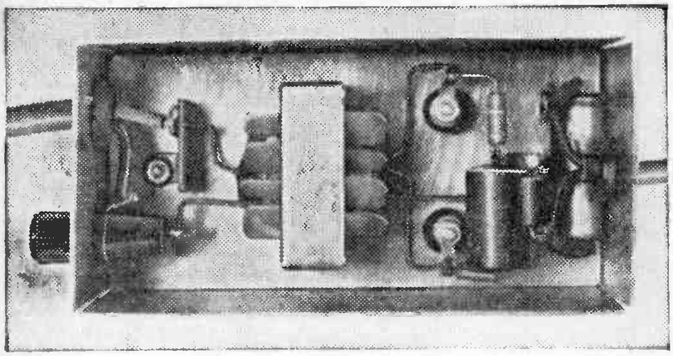
COMPONENTS LIST

Resistors:
- *R1 390Ω½W*
- *R2 220Ω½W*

Capacitors:
- *C1 0·25μF 150VW*
- *C2 100μF 12VW elec.*
- *MR1, MR2 GJ7-M rectifiers*
- *T1 9/0/9V transformer (Osmor)*
- *Two tag strips, 100mA fuse, fuseholder, etc.*



A top view of the unit.



The unit assembled in its ease.

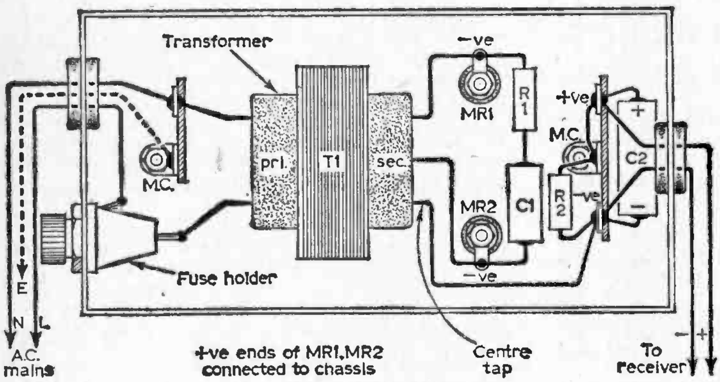


Fig. 2—The wiring diagram.

to the negative side of the circuit, as shown. The 100μF condenser should have an insulated sleeve, or should be covered with some type of insulation, to avoid contact between the can (negative) and chassis.

Twin flexible leads of convenient length pass through a grommet, to supply the receiver. If the receiver uses any of the popular kinds of 9V battery, a pair of battery clips can be soldered to these leads. The receiver battery leads can then be clipped to the eliminator output leads with a minimum of trouble. If the receiver uses a battery with sockets, a suitable socket strip can be purchased, or obtained from an old battery. The receiver can then be plugged into the eliminator output, or battery, at will.

For the mains circuit, use good quality flex. A 100mA fuse is inserted in the fuse holder, and it is preferable that this fuse be wired in the "live" mains lead, as in Fig. 1, so if a non-reversible (3-pin) plug is used, employ red for this lead, and take it to the "L" pin of the plug. Black is then used for "N" (neutral). When a 3-pin plug is available, the chassis and secondary circuit can be earthed at the earth pin, as shown by the dotted line in Fig. 1.

The chassis plate can be held in the box by the same bolts which secure the tag-strips, extra nuts being used underneath to obtain clearance for the rectifier terminals.

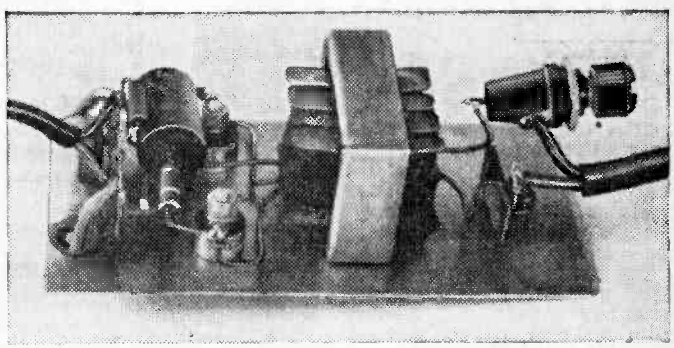
Testing

If a meter is available, connect it to the output leads, and insert the mains plug. The meter should show about 9V, the exact figure depending on the mains voltage, etc. The voltage on the prototype was found to read just over 9, with no load, and slightly under 9 with a receiver drawing 16mA. This compares favourably with a battery, and is suitable for any set of usual type.

Polarity

The meter will confirm that polarity is correct—it is essential that this is so. If the clips or sockets have been soldered to the correct leads, it will be impossible to connect the receiver incorrectly.

The eliminator leads or clips must not be allowed to come into contact with each other. ■



Another view of the unit.

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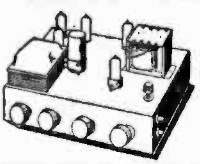

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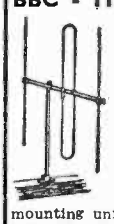

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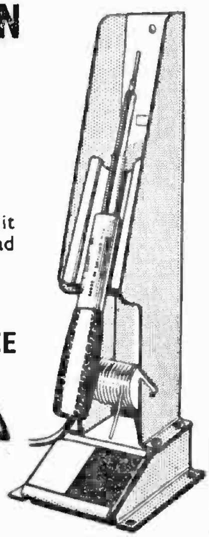

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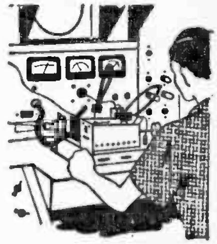

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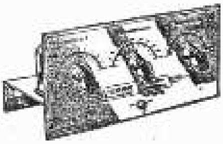

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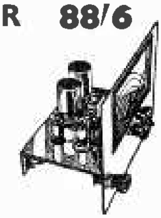

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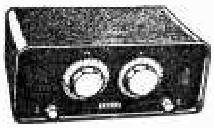

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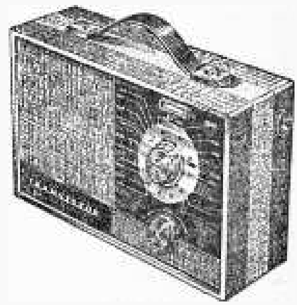

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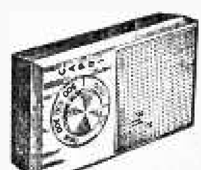

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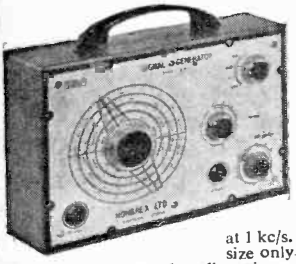

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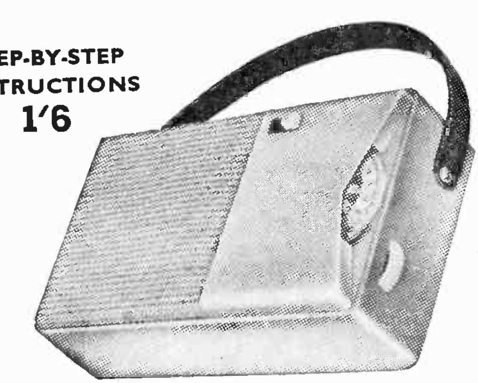

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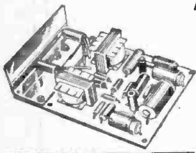

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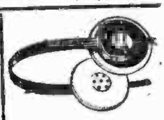

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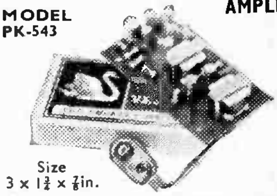
4 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER

MODEL PK-543



Size 3 x 1¾ x ⅞in.

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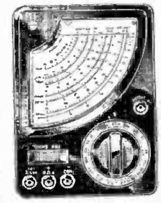
MODEL 200H



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2 Range resistance to 6 meg. Capacity and db ranges.

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Practical Wireless

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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.

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Dual-wave Crystal Diode	PW95	2/6
STRAIGHT SETS		
Battery Operated		
Modern One-valver	PW96	2/6
All-dry Three	PW97	3/6
Modern Two-valver	PW98	3/6
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	—	8/-
(No constructional details are available with this blueprint)		
The PW Roadfarer	—	5/-
(No constructional details are available with this blueprint)		
TELEVISION		
The PT Band III converter ..	—	1/6

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*
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/-
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Simple S.W. One-valver	PW88	2/6
Pyramid One-valver	PW93	2/6
BBC Special One-valver	AW387	2/6
A One-Valver for America ..	AW429	2/6
Short-Wave World Beater ..	AW436	3/6
Standard Four Valve S.W. ..	WM383	3/6
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Standard Four Valve	WM391	3/6
Listener's 5-Watt Amplifier ..	WM392	3/6

QUERY COUPON

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PRACTICAL WIRELESS, MAY, 1962

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A new design 6-Transistor Printed Circuit Superhet for Medium and Long Waves. Uses all sub-miniature parts. Sub-min. Mullard Transistors. Quality speaker output, fitted earphone/record Sockets. Cabinets Red/White or Blue/White with Gold fittings.

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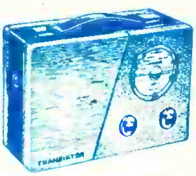

Medium and Long Wave Portable

8½ x 6½ x 3½in.

£6.19.6

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2,000 ohms per volt AC/DC. Size 5" x 3½" x 1½".

79/6

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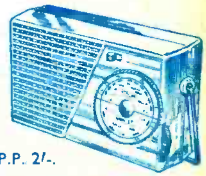

Size 5¼ x 3 x 1¾in.

Red or Blue and Gold trim

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Performance will amaze you.

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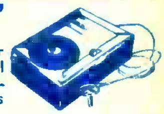

A Two Transistor Two Diode Personal Pocket Radio. Covering medium waves and top band.

Supplied with battery and quality Personal 'Phone. No aerial or earth.

Size 4¾ x 3 x 1¼in.

59/6 P.P. 1/6.

"PW-6" SUPERHET RADIO

Medium and Long Wave Radio

Size 5¾ x 3⅜ x 2in.

£8.10.0 P.P. 2/-.

Modified version of previously advertised "PW" Superhet. Now with new style Two Tone Cabinet. 1st grade components and transistors. Printed circuit.

TRANSISTOR PORTABLE TAPE RECORDER

BUILT AND TESTED

● Play/record up to 30 mins.
● Built-in speaker volume control batteries and play/record/rewind.
● Quality reproduction.
● Sturdy case 6 x 8¼ x 2¾in.

£11.19.6
Post free
Fully Guaranteed

Supplied complete with microphone, tape, batteries and personal phone.