RADIO & ELECTRONICS CONSTRUCTOR

DECEMBER 1974

25p

PULSE

COUNTING F.M. TUNER

I.C. AMPLIFIER

ALSO FEATURED

OSCILLOSCOPE AMPLITUDE CALIBRATOR

COMPONENTS

HOBBYIST - AMATEUR - DOMESTIC - SURPLUS - INDUSTRIAL - JUST A FEW OF OUR BARGAINS ARE LISTED BELOW - SEND STAMPED ADDRESSED ENVELOPE FOR A QUOTE ON OTHER REQUIREMENTS. THESE OFFERS APPLY ONLY TO MAIL ORDER AND NOT SHOP SALES.

GOODS SENT AT CUSTOMER'S RISK, UNLESS SUFFICIENT PAYMENT FOR INSURANCE INCLUDED (2p per £1 min 5p)

VALVE BASES

Printed circuit B9A – B7G 4p
Chassis B7 – B9G – B7G 4p
Shrouded chassis B7G – B9A .. 6p
B8A – B9A chassis – B12A tube .. 6p

TAG STRIP

6 way **4p** Single **1p**

WRIST COMPASS

30p with Needle Lock

TO3 Mica Washer **2p**
18 volt 4 amp charger, bridge rectifies **60p**
GC10/4B Cold Cathode **£5.00**
Brand New Boxed 6K7G **25p**

$1\frac{1}{4}$ glass fuses— 250 m/a or 3 amp (box of 12) **18p**
3" tape spools .. **8p**
10K+10K Log Switched Pot .. **55p**
PVC or metal clip on M.E.S. bulb holder .. **5p**
All metal equipment Phono plug .. **2p**
Bulgin, 5mm Jack plug and switched socket (pair) .. **30p**
12 volt solenoid and plunger .. **40p**
250 RPM 50 c/s locked frequency miniature mains motor .. **50p**
200 OHM coil, $2\frac{1}{4}$" long, hollow centre .. **10p**
Belling Lee white plastic surface coax outlet Box .. **30p**
R.S. 12 way standard plug and shell .. **50p**

SWITCHES

Pole	*Way*	*Type*	
4	2	Sub. Min. Slide	18p
6	2	Slide	20p
4	2	Lever Slide	15p
6	4	Wafer Rotary	30p each
4	3	Wafer Rotary	30p each
3	7	Wafer Rotary	30p each
2	5	Wafer Rotary	30p each
1	3	+ off Sub. min. edge	10p
1	3	13 amp small rotary	12p
2	2	Locking with 2 to 3 keys	£1.50
2	1	2 Amp 250V A.C. rotary	20p
1	2	Toggle	10p

COMPUTER AND AUDIO BOARDS

CONTAINING A SELECTION OF REASONABLE LEAD TRANSISTORS, SOME POWER, SILICON, GERMANIUM, ZENER DIODES, POT CORES HI-STAB RESISTORS, SOME WIREWOUND, CONDENSERS, CHOKES, TRIMPOTS, ELECTROLYTICS, ETC.
3lb. for **75p** + **30p** post and packing
7lb. for **£1.50** + **60p** post and packing

SKELETON PRESETS

SLIDER, HORIZONTAL OR VERTICAL STANDARD OR SUBMIN. **6p**

KNOBS

SILVER METAL PUSH ON WITH POINTER, OR WHITE PLASTIC, GRUB SCREW WITH POINTER AND SILVER CENTRE **10p** EACH.

ZM1162A INDICATOR TUBE

0-9 Inline End View. Rectangular Envelope 170V 2.5M/A **£3.60**

RESETTABLE COUNTER

English Numbering Machines LTD.
MODEL 4436-159-989
6–14 volt, 6 digit, illuminated, fully enclosed. **£2.50**

RESISTORS

$\frac{1}{8}$–$\frac{1}{4}$–$\frac{1}{2}$ watt .. **1p**
1 watt .. **2p**
Up to 5 watt wire **10p**
10 watt wire wound .. **12p**
15 watt .. **14p**

GEARED KNOB

Inner to Outer Ratio 8:1 .. **60p**

500k Dual Concentric Potentiometer **40p**

WIREWOUND POTS

250, 300 OHM, 1K, 4 watt, 5K, 10K, 11K, 20K, 50K, all at **20p each**

Philips transformer, safety fused. In 200-220-240v. Out 240v 60ma+6.3v 1a approx 2" x $2\frac{1}{4}$" x $2\frac{1}{2}$" **£1.50**
5K, 20K, Log Pot **15p**
1meg Tandem Pot **25p**
2M, 5M, Log Switched pot **25p**

THERMISTORS

VA1008, VA1034, VA1040, VA1055, VA1066, VA1100 VA1077, **15p**
VA1005, VA1026 **25p**

PARMEKO P480

6000/55, 20 Henry ·12A, potted choke **£1**

RELAYS

12 volt S.P.C.O. octal mercury wetted high speed **75p**
P.O. 3000 type, 1,000 OHM coil, 4 pole c/o **60p**

ELECTROLYTICS MFD/VOLT. Many others in stock

5p. 1/75.2/75, 2.5/64, 4/60, 5/50, 6/3, 6/25, 8/6, 8/40, 8/50, 8/150, 12/50, 15/35, 16/40, 16/50, 20/12, 25/3, 25/6, 25/12, 25/25, 25/30, 50/10, 50/12, 50/25, 50/50, 64/10, 100/6, 100/12, 100/15, 100/18, 100/25, 125/10, 150/12, 150/25, 200/3, 250/6, 200/12, 500/6.
6p. 1/350, 2/350, 150/40, 250/18, 250/30, 260/12. 330/10
9p. 400/16, 550/12.
20p. 8/500, 16/450, 100/200, 100/250–275, 16–32/275, 32–32/275, 100–100/150, 100–100/275. 50-50/300: **Solid Tantalum**, 8/20, 10/20, 12/20.
50p. 8/800, 2000/50, 12,000/12, 32–32–50/300.
£1.100–100–100–150–150/320.

INDICATORS

Arcolectric green, takes M.E.S. bulb **20p**
Bulgin D676 red, takes M.E.S. bulb **20p**
12 volt red, small pushfit **20p**
Mains neon, red. pushfit **20p**

CAPACITORS

Mixed type PFDS, 2p. 1, 3.3, 4.7, 5.6, 10, 12. 15, 16, 18, 20, 22, 24, 25, 27, 30, 33, 37, 39, 47, 50, 56, 68, 88, 100, 110, 120, 150, 200, 220, 250, 300, 330, 470, 500, 600, 680, 800, 1000, 2200, 3000, 3300, 5000.
Poly, met., film, paper, etc. MFD/Volt, 3p. .001/1250, .005/250, .03/350, .03/12, .03/200 .033/100, .0068/70, .056/350, .061/035, .069/350, .075/350, .08/350, .1/350, .1/500, .13/350, .25/150.
4p. 1500, 1800, 2200, 3000, 3300, 6800, 8200 PFD. .01/350, .013/350, .05/125, .05/250, .068/200 .25/350.
5p. .033/100, .1/250, .5/350.
6p. .1/600, .1/1500, .22/250. .5/250
10p. .01/1000, 1/350, 8/20, .1/900, .22/900, 4/16. .25/250 AC (600vDC)
40p. 5/150, 9/275AC, 10/150, 15/150, 40/150.

TRIMMERS, 20p each

100PF Ceramic, 30PF Beehive, 12PF PTFE 2500PF 750 volt, 33PF MIN. AIR SPACED 5PF, MIN. AIR SPACED, 50PF CERAMIC.

CONNECTOR STRIP

Belling Lee L1469, 4 way polythene. **3p each**

CAN CLIPS

1" or $1\frac{3}{8}$" or $\frac{3}{4}$" .. **2p**

LABGEAR MAINS DROPPER

36 ohm 25 watt + 79 ohm 9 watt **25p**

TUNING CONDENSERS 50PF, **50p**

2 Amp Suppression Choke .. **5p**

PAXOLINE

$3 \times 2\frac{1}{2} \times \frac{1}{16}$" .. **2p**
$4\frac{5}{8} \times \frac{1}{2} \times \frac{1}{8}$", .. **2 for 1p**
220K 3 watt resistors .. **2p**
100 ohm 3 watt resistor .. **4p**
VALVE RETAINER CLIP, adjustable **2p**

OUTPUT TRANSFORMERS

Sub-miniature Transistor Type .. **25p**
Valve type, centre tapped or straight **40p**

THE RADIO SHACK

161 ST. JOHNS HILL, BATTERSEA, LONDON S.W.11
Open 10 a.m. till 7 p.m. Monday to Saturday also most Sundays.
Phone 01-223 5016

3 pin din to open end, $1\frac{1}{2}$yd twin screened lead **35p**

Whiteley Stentorian 3 ohm constant impedance volume control way below trade at **£1**

SEMICONDUCTORS

Full spec. marked by Mullard, etc. Many other types in stock

AC107	15p	BC148A/B, 9B/C	12p	BF115	20p
AC127/8	12p	BC157/8/9	9p	BF167/173	25p
AC188	12p	BC158A/B	15p	BF178/9	30p
ACY28	18½p	BC159C, 157A	15p	BF180/1	25p
AD149	40p	BC178A/B	16p	BF182/3	40p
AD162	33p	BC179B	22p	BF184	17p
AF116/7	13p	BC186/7	25p	BF185	22p
AF124/6/7	20p	BC213L	11p	BF194/5	10p
AF139	30p	BC337/8	19p	BF194A	14p
AF178	30p	BC547	12p	BF196/7	13p
AF180/1	45p	BC558A	12p	BF200	25p
AF239	38p	BCY40	87p	BF262/3	23p
ASY27	30p	BCY70/1/2	12p	BF336	28p
ASY73	26p	BD112/3	52p	BFX29/30	27p
BC107A or B	13p	BD115/6	55p	BFX84/88	22p
BC107/8/9	9p	BD131/2	35p	BFY50/1/2	16p
BC108A/B	13p	BD135	37p	BFY90	60p
BC109B	18p	BD203	£1.41	BR101	35p
BC147/8/9	7p	BD232	75p	BSV64	50p
BC147A/B	13p	BD234/5	75p	BSX21	20p

BU105/01	£1.75	2N706	8p
CA3001	£2.50	2N987	42p
CV7042 (OC41 OC44,		2N1091	55p
ASY63)	12p	2N1302	15p
GET111	72p	2N2219	20p
MA393	50p	2N2401 (ASY26-27)	25p
OC35	40p	2N2904/5	18p
TAA570	£1.39	2N2906	13p
TAD100	£1.42	2N2907	20p
2G302	19p	2N3053	14p
2N393	50p	2N3055 (992)	39p

THYRISTORS

Amp	Volt		
1	240	BTX18-200	75p
1	400	BTX18-300	85p
1	240	BTX30-200	40p
6.5	500	BT102-500R	£1.12
10	700	BT106	99p
15	500	BT107	£1.20
6.5	500	BT101-500R	£1.15
6.5	500	BT109-500R	90p
20	600	BTW92-600RM	£3.90
15	800	BTX95-800R Pulse Modulated	£18.00

BRIDGE RECTIFIERS

Amp	Volt RMS		
½	1,600	BYX10	30p
1	140	OSH01-200	38p
1.4	42	BY164	50p

Plastic types

Amp	Volt RMS		
2	30	LT120	30p
0.6	6-110	EC433	

Encapsulated with built-in heat sink .. 15p

OTHER DIODES

IN916	6p	BA182	24p
IN4148	4p	OA5/7/10	20p
BA145	14p	BZY88 Up to 15 volt	7p
Centercel	10p	BZX61 11 volt	17p
BZY61	10p	BR100 Diac.	23p

1 AMP RECTIFIERS

IN4003	200 volt	5p
IN4004	400 volt	6p
IN4005	600 volt	7p
IN4006	800 volt	8p
IN4007	1,000 volt	8p

OPTO ELECTRONICS

ORP12	44p
BPX40	65p
BPX42	£2.48
BPY10	£1.50
(VOLTIAC)	
BPY68	£1.60
BPY69	£2.60
BPY77	£2.60

Diodes

Photo transistor

BPX29	£1.40
OCP71	35p

BIG L.E.D. 4½mm 2v 50m/A max.

RED	18p
ORANGE	31p
GREEN	31p
YELLOW	33p

TRIACS

Amp	Volt		
6	400	Plastic	90p
25	900	BTX94-900	£7.50
25	1200	BTX94-1200	£10.20

CQY11B L.E.D. Infra red transmitter £1 One fifth of trade

WESTINGHOUSE 28TIO 30 AMP 1000 VOLT THYRISTER WITHOUT NUT £5

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp .. £1.50

HIGH POWER RECTIFIERS

	Amp	Volt	
SR100	1.5	100	7p
SR400	1.5	400	8p
LT102	2	30	10p
BYX38-600	2.5	600	48p
BYX38-300R	2.5	300	42p
BYX38-900	2.5	900	54p
BYX38-1200	2.5	1,200	62p
BYX49-600	2.5	600	34p
BYX49-300	2.5	300	26p
BYX49-900	2.5	900	40p
BYX49-1200	2.5	1,200	52p
BYX48-300	6	300	40p
BYX48-600	6	600	50p
BYX48-900	6	900	60p
BYX48-1200	6	1,200	80p
BYX72-150R	10	150	35p
BYX72-300R	10	300	45p
BYX72-500R	10	500	55p
BYX42-300	10	300	45p
BYX42-600	10	600	65p
BYX42-900	10	900	80p
BYX42-1200	10	1,200	95p
BYX46-300*	15	300	£2.90
BYX46-400*	15	400	£3.20
BYX46-500*	15	500	£3.60
BYX46-600*	15	600	£3.90
BYX20-200	25	200	60p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£3.00

**Avalanche type*

RG4-1250 Mercury vapour rectifier £8.00

1″ Terryclips chrome finish .. 4p

Cinch 10-way terminal block 15p

Pair of LA2407 Ferrox cores with adjuster .. 25p

Chrome Car Radio facia .. 15p

Rubber Car Radio gasket .. 10p

DLI Pal Delayline .. £1.40

Relay socket .. 12p
Take miniature 2PCO relay

B7G or B9A valve can .. 2p

0-30, or 0-15, black pvc, 360° dial, silver digits, self adhesive, 4½″ dia. .. 15p

PNPN PROGRAMMABLE UNIJUNCTION BRY39 23p

F.E.T's

BFW10	55p
BSV79	£1.30
BSV80	£1.10

N. Channel

BSV81 M.O.S.T. .. £1.56

BFS28 Dual M.O.S.T. 92p

Plastic, Transistor or Diode Holder 1p

Transistor or Diode Pad 1p

Holders or pads 50p per 100

PAPER BLOCK CONDENSER

0.25MFD	800 volt	30p
1MFD	250 volt	15p
2MFD	250 volt	20p
2MFD	1.5 kv	50p
4MFD	250 volt	20p
15MFD	150 volt	50p

METAL CHASSIS SOCKETS

Car Aerial	7p
Coax	7p
5 or 6 pin 240° din	7p
Speaker din switched	7p
3.5mm Switched Socket	7p

ZN 414 AM RADIO IC £1.00

TAA300 T0-74 1 Watt A.F. AMPLIFIER I.C. 4·5 to 9v £1.46

5lb New Mixed Components **£2 plus 50p p & p**

HANDLES

Rigid light blue nylon 6¼″ with secret fitting screws 5p

Rotor with neon indicator, as used in Seafarer, Pacific, Fairway depth finders 20p each

Miniature Axial Lead Ferrite Choke formers 2p

DEE PLUG

McMurdo DA15P 15 way chassis plug 20p

Fairway 18009 Coax. socket .. 5p

TIE CLIPS

Nylon self locking 7″ 2p

CINCH 150

12 way edge socket 10p

1lb Mixed nuts, bolts, washers etc. 35p

Philips Iron Thermostat ... 15p

Bulgin 2-pin flat plug and socket 10p

McMurdo PP108 8 way edge plug 15p

TO3 HEATSINK

Europlec HP1 TO3B individual 'curly' power transistor type. Ready drilled 20p

Tested unmarked or marked ample lead ex new equipment

ACY17-20	8p	OC71/2	6p
ASZ20	8p	OC200-5	15p
ASZ21	15p	TIC44	24p
BC186	11p	2G240	2-50
BCY30-34	10p	2G302	6p
BCY70/1/2	8p	2G401	10p
BF115	10p	2N711	25p
BY127	8p	2N2926	7p
BZY88 series	5p	2N598/9	6p
HG1005	4p	2N1091	8p
HG5009	4p	2N1302	8p
HG5079	4p	2N1907	2-50
L78/9	4p	Germ. diode	2p
M3	10p	GET120 (AC128 in 1″ sq. heat sink)	20p
OA81	4p		
OA47	4p		
OA200-2	4p	GET872	12p
OC23	20p		

8 way Cinch standard 0.15 pitch edge socket 20p

U.E.C.L. 10 way pin connector 2B6000 OA1P10 .. 20p

U.E.C.L. 20 way pin connector 2A60000A1P20 30p

U.E.C.L. 10 way pin socket 2B606001R10 20p

U.E.C.L. 20 way pin socket B260800A1R20 30p

BELLING LEE L1354 TV Aerial diplexer 10p

Philips electronic engineer kits add on series A20, E1004, E1005 £1.00 each (parts worth more)

SMALL ORDERS, ENCLOSE SUITABLE STAMPED ADDRESSED ENVELOPE
LARGE ORDERS, ADD SUFFICIENT FOR POSTAGE, INSURANCE, ETC.
TOTAL GOODS PLUS CARRIAGE, ADD 8% V.A.T.

THE RADIO SHACK

161 ST. JOHNS HILL, BATTERSEA, LONDON S.W.11
Open 10 a.m. till 7 p.m. Monday to Saturday also most Sundays
Phone 01-223 5016

The largest selection

EX COMPUTER BOARDS
Packed with transistors, diodes, capacitors and resistors—COMPONENT VALUE £1·50. 3 for ONLY 55p + P. & P. 30p.
SPECIAL one as above PLUS Power Transistors ONLY 55p each + P. & P. 15p.
PAXOLINE BOARDS 7½ × 9" approx. 4 for 30p + P. & P. 20p.

FIBRE-GLASS PRINTED CIRCUIT BOARDS
16½ × 4" approx. 2 for 55p

DECON-DALO 33PC Marker
Etch resistant printed circuit marker pen 99p each.

VEROBOARDS
Packs containing approx., 50sq. in. various sizes, all 0·1 matrix 55p

REPANCO CHOKES & COILS
RF Chokes
CH1. 2·5mH 29p CH2. 5·0mH 30p
CH3. 7·5mH 31p CH4. 10mH 33p
CH5. 105mH 28p
COILS
DRX1 Crystal set 31p DR R2 Dual range 45p

COIL FORMERS & CORES
NORMAN ¼" Cores & Formers 8p
⅜" Cores & Formers 10p

SWITCHES
DP/DT Toggle 36p SP/ST Toggle 30p

FUSES
1¼" and 20mm. 100mA, 200mA, 250mA, 500mA, 1A, 1·5A, 2A.
QUICK-BLOW 5p each.

EARPHONES
Crystal 2·5mm plug 42p
Crystal 3·5mm plug 42p
8 ohms 2·5mm plug 22p
8 ohms 3·5mm plug 22p

DYNAMIC MICROPHONES
B1223. 200 ohms plus on/off switch and 2·5mm and 3·5mm plugs £1·85

3-WAY STEREO HEADPHONE JUNCTION BOX
H1012 £1·87

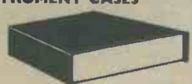
2-WAY CROSSOVER NETWORK
K4007 .80 ohms Imp. Insertion loss 3dB £1·21

CAR STEREO SPEAKERS
(Angled) £3·85 per pair.

BI-PAK

CATALOGUE AND LISTS
Send S.A.E. and 10p.

INSTRUMENT CASES



(Black Vinyl covered)

No.	Length		Width		Height	Price
BV1	8"	×	5¼"	×	2"	£1·10
BV2	11"	×	6"	×	3"	£1·45

ALUMINIUM BOXES

BA1	5¼"	×	2¼"	×	1½"	42p
BA2	4"	×	4"	×	1½"	42p
BA3	4"	×	2¼"	×	1½"	42p
BA4	5¼"	×	4"	×	1½"	50p
BA5	4"	×	2½"	×	2"	42p
BA6	3"	×	2"	×	1"	34p
BA7	7"	×	5"	×	2½"	70p
BA8	8"	×	6"	×	3"	90p
BA9	6"	×	4"	×	2"	58p

P. & P. 10p on each box

BIB HI-FI ACCESSORIES

De Luxe Groov-Kleen
Model 42 £1.95
Chrome Finish
Model 60 £1.50

Ref. 36A. Record/Stylus Cleaning Kit 33p
Ref. 43. Record Care Kit £2·42
Ref. 31. Cassette Head Cleaner 58p
Ref. 32. Tape editing Kit £1·68
Model 9. Wire Stripper/Cutter 83p
Ref. 46. Spirit Level 62p
Ref. B. Stylus and Turntable Cleaning Kit 34p
Ref. P. Hi-Fi Cleaner 31p
Ref. 32A. Stylus Balance £1·37
Ref. J. Tape Head Cleaning Kit 62p
Ref. 56. Hi-Fi Stereo Hints and Tips 42p
Ref. 45. Auto Changer Groove Cleaner £1·08

ANTEX SOLDERING IRONS
X25. 25 watt £2·05
CCN 240. 15 watt £2·48
Model G. 18 watt £2·26
SK2. Soldering Kit £3·25
STANDS: ST3, suitable for all models £1
SOLDER: 18SWG Multicore 7oz £1·61
22SWG 7oz £1·61. 18SWG 22ft 51p
22SWG Tube 33p

ANTEX BITS and ELEMENTS
Bits No.

102	For model CN240 3/32"	42p
104	For model CN240 3/16"	42p
1100	For model CCN240 3/32"	42p
1101	For model CCN240 ⅛"	42p
1102	For model CCN240 ¼"	42p
1020	For model G240 3/32"	42p
1021	For model G240 ⅛"	42p
1022	For model G240 3/16"	42p
50	For model X25 3/32"	48p
51	For model X25 ⅛"	48p
52	For model X25 3/16"	48p

ELEMENTS
ECN 240 £1·30 ECCN 240 £1·32
EG 240 £1·07 EX 25 £1·16

ANTEX HEAT SINKS 10p

VAT included in all prices. Please add 10p P. & P. (U.K. only). Overseas orders—please add extra for postage.

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C1	200	Resistors mixed values approx. count by weight	0·55
C2	150	Capacitors mixed values approx. count by weight	0·55
C3	50	Precision Resistors 0·1%, 0·01% mixed values	0·55
C4	75	⅛th W Resistors mixed preferred values	0·55
C5	5	Pieces assorted Ferrite Rods	0·55
C6	2	Tuning Gangs, MW/LW VHF	0·55
C7	1	Pack Wire 50 metres assorted colours	0·55
C8	10	Reed Switches	0·55
C9	3	Micro Switches	0·55
C10	15	Assorted Pots & Pre-Sets	0·55
C11	5	Jack Sockets 3 × 3·5m 2 × Standard Switch Type	0·55
C12	30	Paper Condensers preferred types mixed values	0·55
C13	20	Electrolytics Trans. types	0·55
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets, etc.	0·55
C15	5	Mains Slide Switches	0·55
C16	20	Assorted Tag Strips & Panels	0·55
C17	10	Assorted Control Knobs	0·55
C18	4	Rotary Wave Change Switches	0·55
C19	2	Relays 6—24V Operating	0·55
C20	1	Pack Sheets of Copper Laminate approx. 20 sq. ins.	0·55

PLUGS AND SOCKETS

PLUGS

PS 1	D.I.N. 2 Pin (Speaker)	0·11
PS 2	D.I.N. 3 Pin	0·12
PS 3	D.I.N. 4 Pin	0·15
PS 4	D.I.N. 5 Pin 180°	0·16
PS 5	D.I.N. 5 Pin 240°	0·16
PS 6	D.I.N. 6 Pin	0·17
PS 7	D.I.N. 7 Pin	0·18
PS 8	Jack 2·5mm Screened	0·18
PS 9	Jack 3·5mm Plastic	0·12
PS 10	Jack 3·5mm Screened	0·18
PS 11	Jack ¼" Plastic	0·15
PS 12	Jack ¼" Screened	0·22
PS 13	Jack Stereo Screened	0·36
PS 14	Phono	0·10
PS 15	Car Aerial	0·22
PS 16	Co-Axial	0·15

INLINE SOCKETS

PS 21	D.I.N. 2 Pin (Speaker)	0·14
PS 22	D.I.N. 3 Pin	0·20
PS 23	D.I.N. 5 Pin 180°	0·20
PS 24	D.I.N. 5 Pin 240°	0·20
PS 25	Jack 2·5mm Plastic	0·16
PS 26	Jack 3·5mm Plastic	0·16
PS 27	Jack ¼" Plastic	0·30
PS 28	Jack ¼" Screened	0·35
PS 29	Jack Stereo Plastic	0·30
PS 30	Jack Stereo Screened	0·38
PS 31	Phono Screened	0·18
PS 32	Car Aerial	0·22
PS 33	Co-Axial	0·22

SOCKETS

PS 35	D.I.N. 2 Pin (Speaker)	0·08
PS 36	D.I.N. 3 Pin	0·11
PS 37	D.I.N. 5 Pin 180°	0·11
PS 38	D.I.N. 5 Pin 240°	0·11
PS 39	Jack 2·5mm Switched	0·12
PS 40	Jack 3·5mm Switched	0·12
PS 41	Jack ¼" Switched	0·20
PS 42	Jack Stereo Switched	0·30
PS 43	Phono Single	0·08
PS 44	Phono Double	0·10
PS 46	Co-Axial Surface	0·10
PS 47	Co-Axial Flush	0·20

LEADS

LS 1	Speaker Lead 2 pin D.I.N. plug to open ends approx 3 metres long (coded)	0·20

CABLES

CP 1	Single Lapped Screen	0·07
CP 2	Twin Common Screen	0·11
CP 3	Stereo Screened	0·12
CP 4	Four Core Common Screen	0·23
CP 5	Four Core Individually Screened	0·30
CP 6	Microphone Fully Braided Cable	0·10
CP 7	Three Core Mains Cable	0·09
CP 8	Twin Oval Mains Cable	0·07
CP 9	Speaker Cable	0·05
CP 10	Low Loss Co-Axial	0·18

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VC 2	Single D.P. Switch	0·28
VC 3	Tandem Less Switch	0·46
VC 4	1K Lin Less Switch	0·15
VC 5	100 K anti-Log	0·46

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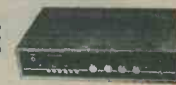

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Type	Amps	Price	P. & P.
MT50/½	½	£1·93	30p
MT50/1	1	£2·42	35p
MT50/2	2	£3·30	40p

CARTRIDGES
ACOS
GP91-1SC 200mV at 1·2cm/sec £1·35
GP93-1 280mV at 1cm/sec £1·85
GP96-1 100mV at 1cm/sec £2·80
J-2005 Crystal/Hi Output £1·05
J-2010C Crystal/Hi Output Compatible £1·20
J-2006S Stereo/Hi Output £1·75
J-2105 Ceramic/Med Output £1·95
J-2203 Magnetic 5mV/5cm/sec, including stylus £4·95
J-2203S Replacement stylus for above £3·00
AT-55 Audio-technica magnetic cartridge 4mV/5cm/sec £3·30

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R2 50 Mixed 1k Ω–8·2k Ω 50p
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AL10 AL20 AL30 AUDIO AMPLIFIER MODULES

The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po 3 WATTS f 1KHz	0·25%
LOAD IMPEDANCE	—	8-16 Ω
INPUT IMPEDANCE	f = 1KHz	100 k Ω
FREQUENCY RESPONSE —3dB	Po 2 WATTS	50 Hz-25KHz
SENSITIVITY for RATED O/P	Vs = 25V. R1 8Ω f = 1KHz	75mV. RMS
DIMENSIONS	—	3" × 2½" = 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power out for 2% T.H.D. (RL = 8Ω f = 1KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL 10. 3 watts	£2.50
AL 20. 5 watts	£2.85
AL 30. 10 watts	£3.20

POWER SUPPLIES

PS 12. (Use with AL10, AL20, AL30)	88p
SPM 80. (Use with AL60)	£3·25
FRONT PANELS PA 12 with Knobs	£1·00

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20)	£4·35
PA 100. (Use with AL30 & AL60)	£13·15

TRANSFORMERS

T461 (Use with AL10)	£1·38 P. & P. 15p
T538 (Use with AL20, AL30)	£1·93 P. & P. 15p
BMT80 (Use with AL60)	£2·15 P. & P. 25p

PA12 PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 84mm × 35mm.

Frequency response—
20Hz-50KHz (—3dD)
Bass control—
± 12dB at 60Hz
Treble control—
± 14dB at 14KHz
*Input 1. Impedance
1 Meg. ohm
Sensitivity 300mV
†Input 2. Impedance
30 K ohms
Sensitivity 4mV

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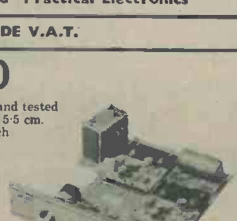
The STEREO 20



The "Stereo 20" amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls, Transformer, Power supply and Power amps. Attactively printed front panel and matching control knobs. The "Stereo 20" has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ± 12dB at 60Hz typically 0·25% at 1 watt. Treble con. ± 14dB at 14kHz.

£14·45

TC20 TEAK VENEERED CABINET
For Stereo 20 (front board undrilled) Size 10½" × 8¾" × 3", £3·95 plus 30p postage.

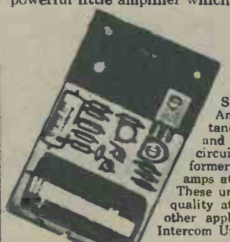
SHP80 STEREO HEADPHONES
4–16 ohms impedance. Frequency response 20 to 20,000Hz. Stereo/mono switch and volume controls, £4·95

NOW WE GIVE YOU 50w PEAK (25w R.M.S.) *PLUS* THERMAL PROTECTION! The *NEW* AL60 Hi-Fi Audio Amplifier FOR ONLY £3·95

- Max Heat Sink temp 90°C.
- Frequency Response 20Hz to 100KHz
- Distortion better than 0·1% at 1KHz
- Supply voltage 15-50 volts
- Thermal Feedback
- Latest Design Improvements
- Load — 3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm × 105mm × 13mm

Especially designed to a strict specification. Only the finest components have been used and the latest solid state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

STABILISED POWER MODULE SPM80

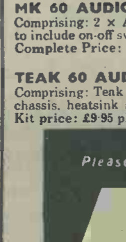


SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer BMT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available 10p **PRICE £3·25**

TRANSFORMER BMT80 £2·15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL60 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.



SPECIFICATIONS

Frequency Response	20Hz—20KHz ± 1dB
Harmonic Distortion	better than 0·1%
Inputs: 1. Tape Head	3·25 mV into 50KΩ
2. Radio, Tuner	75 mV into 50KΩ
3. Magnetic P.U.	3 mV into 50KΩ

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.

Base Control	± 15dB at 20Hz
Treble Control	± 15dB at 20KHz
Filters: Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than —65dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm × 82mm × 35mm

ONLY £13·15

MK 60 AUDIO KIT
Comprising: 2 × AL60, 1 × SPM80, 1 × BTM80, 1 × PA 100, 1 front panel, 1 kit of parts to include on-off switch, neon indicator, stereo headphone sockets plus instruction booklets. Complete Price: £28·75 plus 30p postage.

TEAK 60 AUDIO KIT
Comprising: Teak veneered cabinet size 16¾" × 11½" × 3¾", other parts include aluminium chassis, heatsink and front panel bracket, plus back panel and appropriate sockets, etc. Kit price: £9·95 plus 30p postage.

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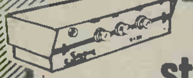

12 Watt stereo amp

Only **£10** 45p P. & P. SPECIAL OFFER LIMITED QUANTITY

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B79	4	IN4007 Sil. Rec. diodes. 1,000 PIV lamp plastic	50p
B81	10	Reed Switches, 1" long, ⅛" dia. High speed P.O. type	50p
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H63	4	2N3055 Type NPN Sil. power transistors. Below spec. devices	50p
H64	4	3819 N Channel F.E.T.'s ZN3819 in plastic case	50p
H65	4	40361 Type NPN Sil. transistors TO-5 can comp. to H66	50p
H66	4	40362 Type PNP Sil. transistors TO-5 can comp. to H65	50p
H69	8	Integrated Circuits DTL data supplied. Mixed Types, Flip Flops, Gates, Hex Invertors etc.	50p

Unmarked Untested Paks

B1	50	Germanium Transistors PNP, AF and RF	50p
B66	150	Germanium Diodes Min. glass type	50p
B83	200	Transistors, manufacturers rejects, AF, RF, Silicon and Germanium	50p
B86	100	Sil. Diodes sub. min. IN914 and IN916 types	50p
H34	15	Power Transistors, PNP, Germ NPN Silicon TO-3 Can.	50p
H67	10	3819 N Channel F.E.T.'s plastic case type	50p
H68	10	Experimenters Pak of Integrated Circuits. Data supplied DTL & TTL, some marked	50p

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Type No.	Gain	VCE	Polarity	Price
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40P1	15	15	PNP	20p
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90 WATT SILICON

Type No.	Gain	VCE	Polarity	Price
90N1	15	15	NPN	25p
90N2	40	40	NPN	35p
90P1	15	15	PNP	25p
90P2	40	40	PNP	35p

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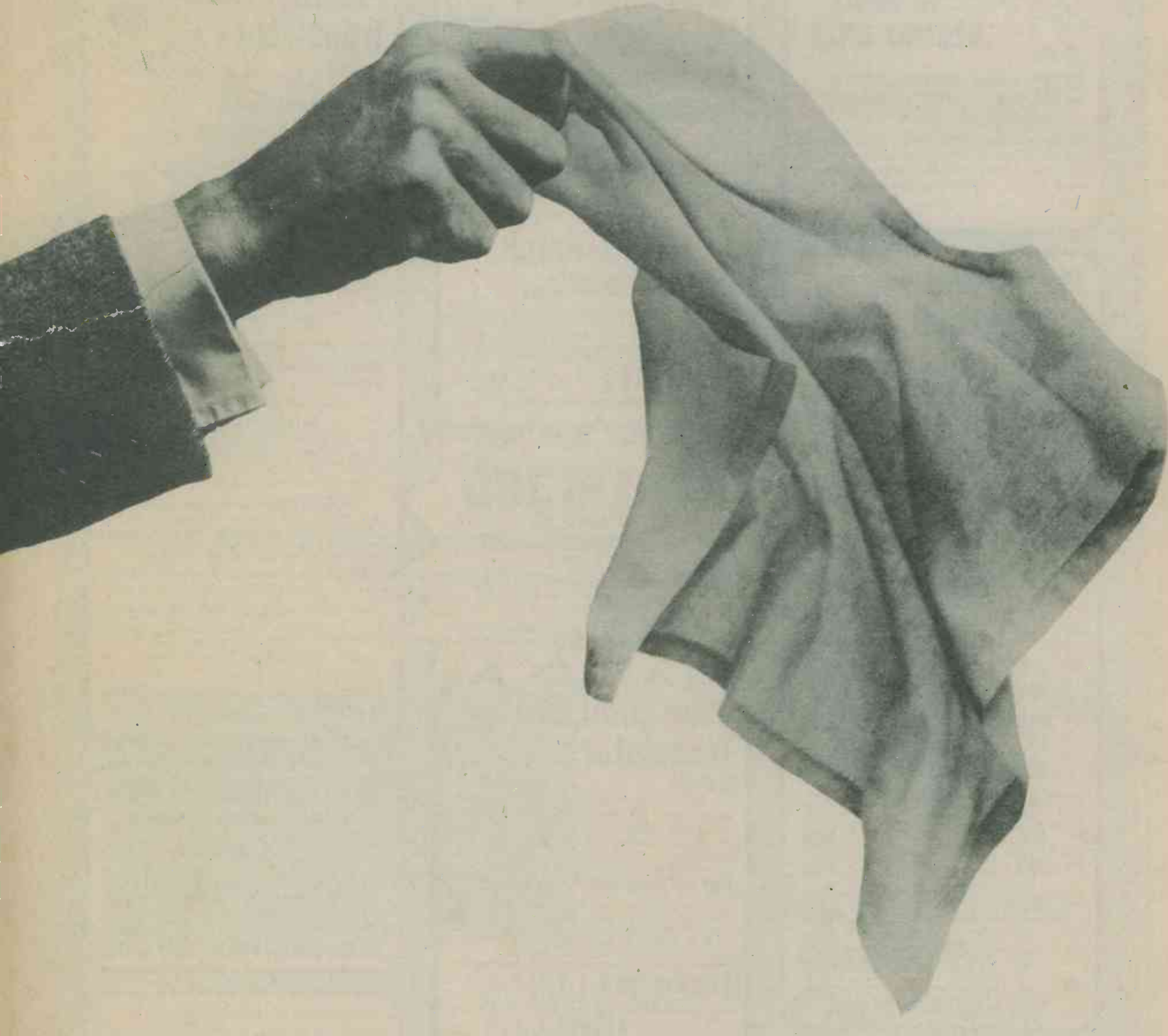


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Baker Major Module 3, 8 or 15 ohm	each	£10.75
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CONTENTS

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HALF WATT

A simple a.f. amplifier which can be assembled around an 8 pin d.i.l. integrated circuit

THIS LITTLE AMPLIFIER CAN BE BUILT ON A SMALL PIECE of 0.1 in. Veroboard having 22 by 9 holes, and it is capable of giving an output of 500mW r.m.s. into an 8Ω load when powered by a 9 volt supply. The amplifier is based on the Motorola MC1306P integrated circuit. This has a built-in pre-amplifier, enabling a variety of gain and input impedance options to be obtained.

The circuit is capable of superior results when compared with many discrete component amplifiers having a similar output power. The typical total harmonic distortion with an output power of 250mW at 1kHz is 0.5% At 500mW it is typically 5%.

A Class B output stage is used, and the quiescent current drain of the amplifier is only about 4mA. The i.c. contains the equivalent of 14 transistors, 5 diodes and 8 resistors. It is housed in a standard 8 pin d.i.l. package.

I.C. CIRCUITRY

The internal circuit of the MC1306P i.c. is shown in Fig. 1. The input to the pre-amplifier is taken to pin 6. TR1 and TR2 are connected as a common emitter Darlington pair, and offer a high voltage gain.

It is not yet possible to fabricate large value capacitors as part of an i.c., and this has led to the development of unusual techniques in i.c. circuitry to enable supply decoupling and interstage coupling to be obtained without such capacitors.

D1, R3, TR5, D2, R4, D3 and R5 provide a number of stabilized voltages across the main supply, and one of these voltages is fed to the base of TR3. The emitter voltage of TR3 is approximately 0.65 volt positive of its base voltage, and the voltage across R1 is in consequence also stabilized. A constant current must therefore flow in R1, and TR3 operates as a constant current source forming the collector load for TR1 and TR2. Supply decoupling is thus provided.

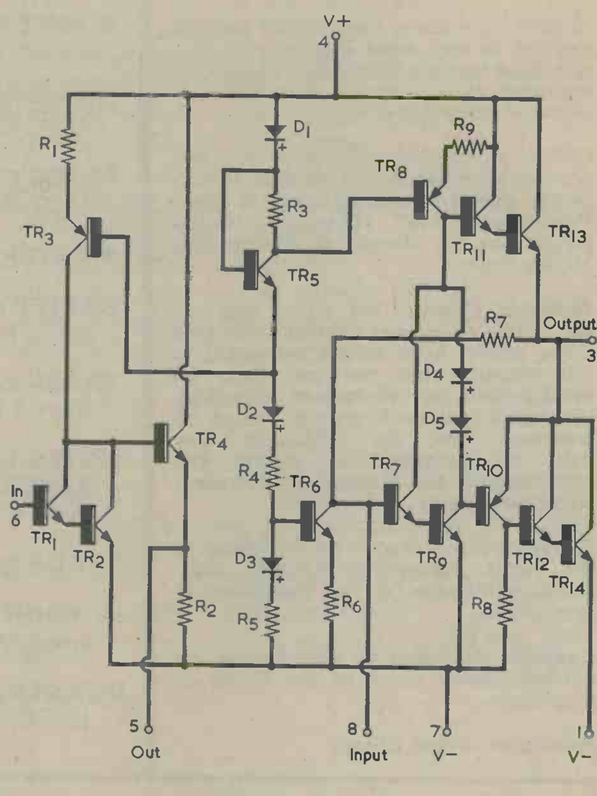


Fig. 1. The internal circuit of the Motorola i.c. type MC1306P. Pin layout is given in the assembly diagram of Fig 3

I.C. AMPLIFIER

By A. P. ROBERTS

TR4 is used as an emitter follower at the output of the pre-amplifier, and it provides an output impedance which is sufficiently low to fully drive the power amplifier section.

TR7 and TR9 are connected as a modified Darlington pair, and are the driver transistors. Their collector load consists of a constant current generator formed by TR8 and R9. D4 and D5 provide a small forward bias to the output transistors, so as to reduce crossover distortion to an unnoticeable level.

The output stage is a fairly conventional complementary configuration using TR11 and TR13 in an emitter follower Darlington pair for the amplification of positive-going output half-cycles, and TR10, TR12 and TR14 in a compound common emitter configuration for the amplification of negative-going half-cycles. R7, coupling back to the base of TR7, allows the output terminal to be at half supply voltage. The input impedance at pin 8 is such that the output of the pre-amplifier can be coupled direct to the input of the power amplifier.

The MC1306P is available from Jermyn Home Electronics, 112 Vestry Estate, Sevenoaks, Kent. It should be mentioned that there is a 50p charge for post and packing.

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)

R1	10kΩ
R2	220kΩ
R3	1kΩ
R4	2.2Ω
VR1	5kΩ potentiometer, log, with switch S1

Capacitors

C1	0.1µF, type C280 (Mullard)
C2	50µF electrolytic, 10 V. Wkg.
C3	82pF, disc ceramic or silvered mica with side wires
C4	0.047µF, type C280 (Mullard)
C5	200µF electrolytic, 10 V. Wkg.

Semiconductor

IC1	Integrated circuit type MC1306P (Motorola)

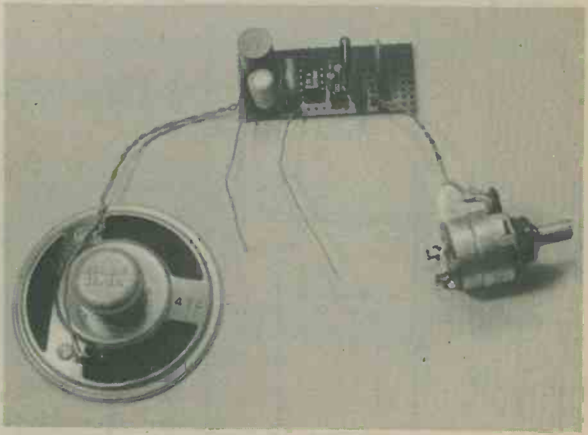
Switch

S1	s.p.s.t., part of VR1

Speaker

LS1	8 to 75Ω speaker (see text)

Miscellaneous
9 volt battery (see text)
Battery connectors
Veroboard panel, 0.1 in. matrix



The prototype amplifier coupled to the volume control and speaker. The positive 9 volt lead from the board to switch S1 was not connected when this photograph was taken

PRACTICAL CIRCUIT

A circuit diagram of a practical audio amplifier using an MC1306P i.c. is shown in Fig. 2. This has been designed for use as the audio stages of a small portable radio, and can be fed from any normal a.m. superhet detector circuit.

The input signal is fed via volume control VR1, C1 and R1 to the input of the pre-amplifier section of the integrated circuit. The pre-amplifier is biased by R2. The values given to R1 and R2 determine the voltage gain and input impedance of the pre-amplifier. The input impedance is approximately equal to the value given to R1. The method of setting the gain at the required level is similar to that used with operational amplifiers, and the voltage gain is approximately equal to R2 divided by R1. This is 22 with the values used here, and assuming that VR1 is at a low volume setting. The gain reduces at higher volume settings in VR1 because of the additional resistance inserted in series with R1 by the control. The impedance of the circuit feeding the volume control can also have a small effect on voltage gain. (These comments do not mean that the volume control does not carry out its normal function of controlling signal amplitude. Adjusting it so that it inserts increasing resistance in series with R1 has the secondary effect of slightly reducing pre-amplifier gain.)

Obviously there is some limitation to the maximum gain and input impedance that can be obtained. The maximum voltage gain is 270, which is the open loop gain of the circuit (i.e. the gain with no negative feedback). The maximum input impedance at any gain setting is limited by the fact that R2 should not be raised above a value of 1MΩ or poor d.c. stability may result. However, it is obvious that a large variety of gain and input impedance figures can be obtained by giving R1 and T2 the appropriate values.

Selecting the values of R1 and R2 for the required gain and input impedance is simple. R1 is given the value of the required input impedance, and R2 is then equal to R1 multiplied by the required pre-amplifier voltage gain.

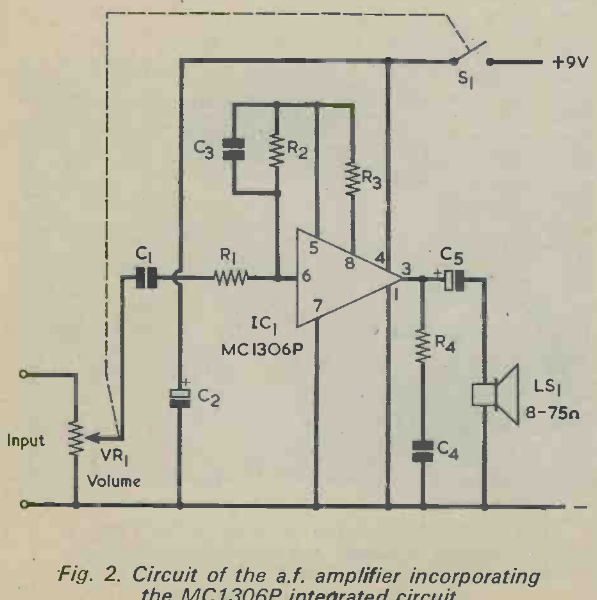


Fig. 2. Circuit of the a.f. amplifier incorporating the MC1306P integrated circuit

For more precise results when calculating the value of R2, the impedance of the source feeding R1 should also be taken into account.

In order to obtain good stability, the circuit is given a certain amount of high frequency attenuation by the inclusion of C3. This gives a –3dB point where the reactance of C3 is equal to the resistance of R1 (and is at about 10kHz with the values employed here).

R3 couples the output of the pre-amplifier to the input of the power amplifier. The value of R3 sets the voltage gain of the power amplifier section in the same way that the value of R1 sets the gain of the pre-amplifier. The biasing resistor for the power amplifier is included in the i.c. (R7 in Fig. 1) and has a value of 10kΩ.

The manufacturer's data sheet recommends a value of between 500Ω and 3.3kΩ for R3. With the value of 1kΩ specified in the present circuit the power amplifier voltage gain is approximately 10 (i.e. 10kΩ divided by 1kΩ).

C5 couples the output signal to the speaker. Since the impedance of the speaker is largely inductive it rises with frequency, and this can contribute to high frequency instability. R4 and C4 are therefore required to reduce the impedance across the output at the higher frequencies, and so maintain stable operation.

Only a single supply decoupling component is required, and this is C2. S1 is the on-off switch, and in the prototype amplifier is ganged with the volume control.

The unit gives an output of approximately 2 volts r.m.s. for 500mW into an 8Ω load, and with the values shown has a total voltage gain of 220. Neglecting the effect of the volume control resistance, an input of less than 10mV is theoretically required to produce the full rated output. The measured sensitivity of the prototype amplifier was somewhat less than this due to the presence of the volume control. In many cases the voltage gain of the unit will be higher than is required, and R2 can be reduced to a value between some 56kΩ and 100kΩ to produce a lower gain. With the values given in the Components List, the unit works well in conjunction with the popular ZN414 i.c., as well as with a.m. superhet circuits.

CONSTRUCTION

Despite its small size the amplifier is very easy to construct, as so few components are required. It is built on a Veroboard panel of 0.1 in. matrix, and details of this are shown in Fig. 3.

Start by cutting out a panel of the required size (22 by 9 holes with the copper strips running lengthwise) and then drill the two 6BA clear mounting holes. Next, cut the strips at the points indicated. The cuts at S2 and S8 isolate the strips at the mounting holes. Connect the two insulated link wires, then the capacitors and resistors, and lastly the integrated circuit. Be careful not to overheat the i.c. when soldering it into the circuit. The author used Mullard type C280 capacitors having side wires for C1 and C4.

The two electrolytic capacitors used had lead-outs at one end, but it will be equally in order to employ the more common type having lead-outs at opposite ends of the body. One lead-out can then pass through one of the requisite Veroboard holes and the other lead-out, passing down the side of the capacitor body, through the other Veroboard hole.

Finally, the external connections to VR1, S1, the

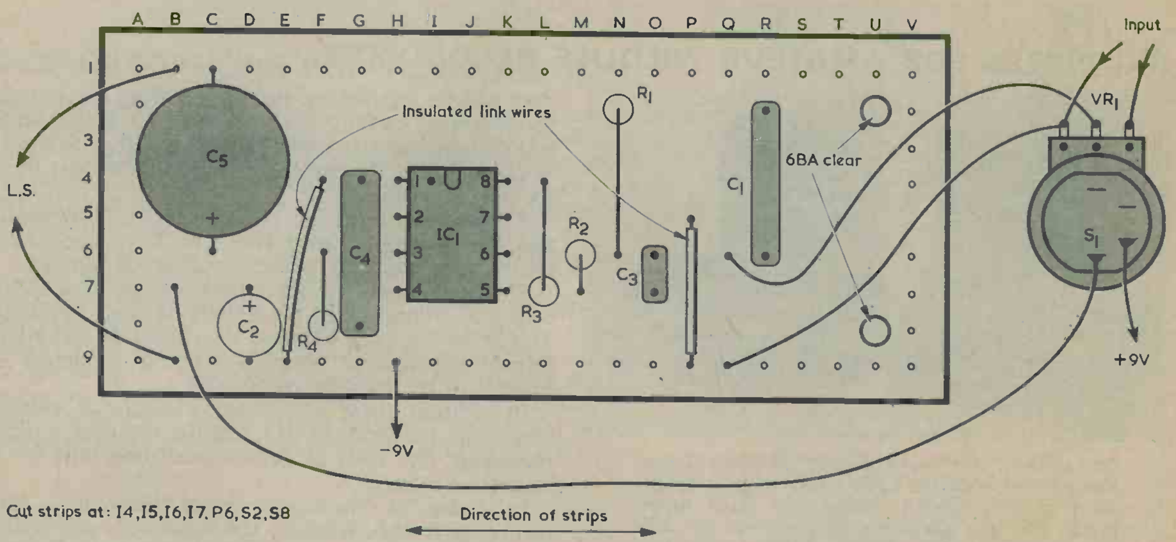


Fig. 3. Component layout on the Veroboard panel. As can be seen, few parts are required in addition to the integrated circuit.

speaker and the battery are made.

If the full rated output of 500mW is not required (and many small speakers are rated at only about 200mW or even less) a speaker with an impedance greater than 8Ω can be used. A maximum power of approximately 250mW is available with a 16Ω speaker, 160mW with a 25Ω speaker, and 53mW with a 75Ω speaker.

The circuit must not be used with a speaker having an impedance lower than 8Ω, nor with a supply of more than 12 volts.

When using the amplifier with a speaker of 16Ω or more a PP3 or PP4 battery is adequate to power the unit, but when using an 8Ω speaker a larger battery, such as a PP7 or PP9, should be used. ■

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received for to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

Taylor 94A TV Waveform and Alignment Generator – J. F. O'Hara, Ardagh, Rocheston Road, Douglas, Cork. To borrow or purchase manual or circuit.

Sanyo MR939 (Reel to Reel) and Akai CS30 (Stereo Cassette) – E. B. Davies, 103 Melbourne Road, Blacon, Chester. Circuits required.

Hammerstein Radiogram with Tape Recorder, Mercuty 5? – J. N. Shaw, 5 Yew Tree Road, Slough, Bucks. SL1 2AA. Circuit required for this South African made model.

NEWS . . . AND .

BIG PRIZES FOR AMATEUR WILDLIFE RECORDISTS

Top prize in this year's 'Scotch' Wildlife Sound Recording Contest is £250 worth of hi-fi equipment of the winner's choice from Rank Audio Visual. Pictured are two examples Akai CS-30D cassette deck, Akai 5200 amplifier and two Rank Domus 175 speakers
Other prizes include original watercolours featuring the subjects of the winning recordings, Grampian recording accessories and Scotch Hi-Fi tape

Top prize in this year's 'Scotch' Wildlife Sound Recording Contest, organised by 3M United Kingdom Limited, is £250 worth of Rank Audio hi-fi equipment. This will be selected by the winner from the comprehensive range of units from Akai, Rotel, Rank Audio, Rank Domus and Empire. This prize will go to the 3M Wildlife Sound Recordist of the year, the best of the six class winners.

As last year, there are two categories – for novices and for experienced recordists who have won first or second awards during the six preceding 3M contests.

There are classes for birds, mammals and insects and outdoor 'atmosphere' recordings in each category. Top prize for each of these six classes is an original framed watercolour specially painted to depict the subjects of the winners' recordings.

In addition, there is a special prize of £20 worth of Grampian recording accessories for the most original recording, and reels of Scotch recording tape for all successful entrants.

In order to encourage better techniques when recording British Wildlife, the organisers are inviting not only the winners, but every entrant, to the London prize-giving in the spring of 1975, when the judging panel will give an appraisal of the entries. There is no entry fee, but all entries must be submitted on Scotch reel-to-reel tape or Scotch cassettes. Closing date is January 31st, 1975, and entry forms are available from W. R. Bowles, Public Relations Executive, 3M United Kingdom Limited, 3M House, Wigmore Street, London W1A 1ET.

MODULAR PROTOTYPE HARDWARE FROM LEKTROKIT

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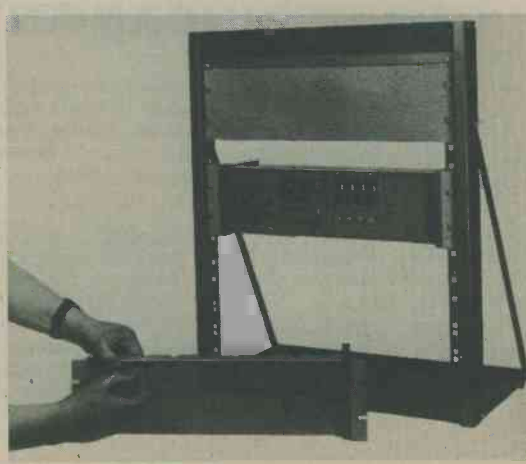
Its modular design approach permits the interchangeability of many parts, which means the chassis area can be extended as required, and enables individual assemblies to be stacked together to form more complex systems.

Further details from Lektrokit Ltd., 3 Trafford Road, Reading, RG1 8JR, Berkshire.



. . . COMMENT

NEW HEADPHONE FOR POPULAR HI-FI

Beyer Dynamic, the West Germany based manufacturer of microphones, headsets and audio equipment, have produced a new headphone, primarily intended for the popular hi-fi audio market. However, the quality of reproduction is still very high and the Beyer engineers claim that it will satisfy even the most discerning listeners.

This headset, coded DT 302, was featured prominently for the first time in the U.K. at the time of the Audio Fair.

The Beyer Dynamic DT 302 is a very lightweight headset. This is achieved by the design of the headband, which allows simple adjustment of the ear pieces up or down. These are protected by foam plastic pads eliminating any interference from 'local noise', at the same time being exceptionally comfortable to the wearer. Three metres of lightweight cable complete the DT 302 which will be retailed at £7.83 plus V.A.T.

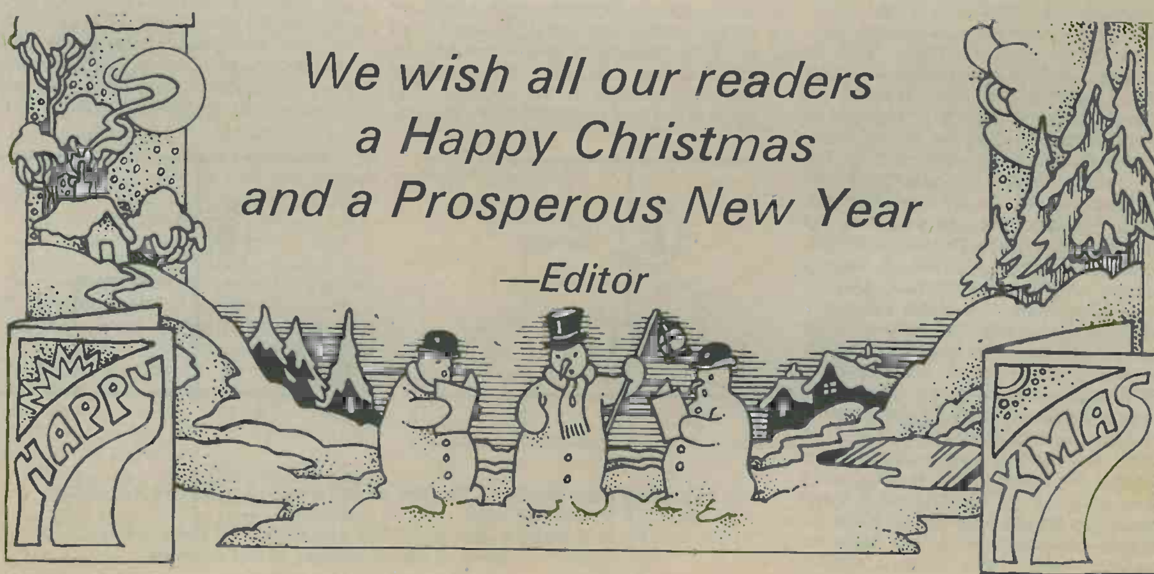
A unique high velocity open aire stereophone, ultra light: 66 g (2.3 oz), with a wide range frequency response of exceptional fidelity due to complete obviation of resonance and inhibition of transient response experienced with conventional stereophones

HELPING HANDS

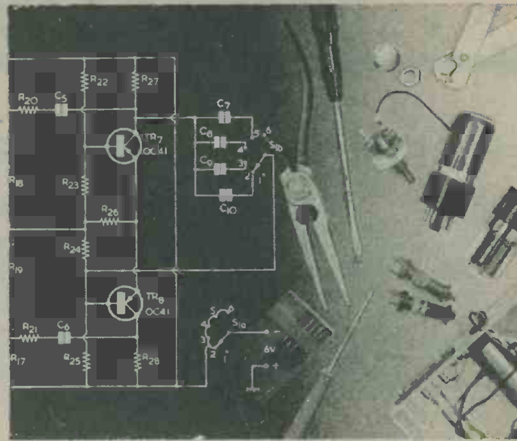
We have recently learned that the annual exhibition of *The British Amateur Electronics Club* has enabled the club to make a record donation of £457 to the Cancer Research Campaign; our congratulations to the club on such a splendid result.

Among the services members of the B.A.E.C. receive is an excellent Newsletter edited by their chairman, C. Bogod. Readers who may be interested in membership should write to the Honorary Secretary, J. G. Margetts, 11 Peartree Avenue, Maidstone, Kent.

It is one of the delights of our hobby that so many are prepared to give their time and energy to assist others in its pursuit, whether as individuals or as officers of a club or society. It is an additional pleasure when groups help others who may be outside the sphere of the hobby's interest – a case of goodwill always being in season.



'CONSTANT CURRENT' CLASS A AMPLIFIER



by G. A. FRENCH

Some of us who bit our teeth on valves tend occasionally to conjure up nostalgic memories of the very simple Class A a.f. output stages which were the order of the day in those earlier times. A typical output circuit merely consisted of a valve anode coupled to the primary of a speaker transformer, the secondary of which then coupled to the speaker itself. The resultant reproduction was not in the high fidelity category, but it was quite adequate for low cost domestic entertainment equipment.

The advent of the transistor has resulted in the introduction of the Class B push-pull output stage. This has the considerable advantage of high efficiency, thereby allowing small transistors to produce relatively high audio output powers. Some level of crossover distortion is liable to occur when a very high efficiency is required, although this can usually be reduced to an acceptable level by the use of negative feedback. High efficiency in the a.f. output stages of battery driven equipment is obviously desirable because it results in a low drain on the battery supply. With mains-driven equipment the question of supply current is much less important, and the main advantage of a high efficiency output stage is that this allows large a.f. output powers to be obtained with reasonably small output transistors.

The author decided to investigate the possibilities of making up a mains driven a.f. amplifier having a true Class A output, and incidentally offering an output power inevitably lower than that which the output stage transistors would provide in Class B. He was pleased to find that such an amplifier could have quite a simple circuit and that it gave good quality reproduction for normal domestic listening. The amplifier forms the basis of this month's 'Suggested Circuit' article, and it incorporates a constant current drive technique which the writer has not previously seen employed in this field.

CLASS A DRIVE

A simple method of providing a Class A drive to a speaker consists of using the output transistor as an emitter follower with its emitter current flowing directly through the speaker, as in Fig. 1(a). Signal voltage is applied to the base of the transistor, and this acts as a current amplifier with a voltage gain of unity. The circuit is capable of working reasonably well but it has the disadvantage that there is a continual standing current in the speaker. The speaker current increases when the output transistor base goes positive and decreases when the output transistor base goes negative. At zero signal input the standing current causes the speaker voice coil to be displaced from its mechanical position of rest, and inward and outward displacements of the voice coil in the presence of signal may not then be symmetrical about the zero signal position.

A possible alternative method of driving the speaker is shown in Fig. 1(b). Here, the direct emitter current flows through a resistor, across which the speaker is connected by way of a high value electrolytic capacitor. In consequence, there is no standing direct current in the speaker, and voice coil displacements on either side of the mechanical rest position are symmetrical, with the speaker functioning under its designed conditions. Unfortunately, the resistor requires a low value, comparable with speaker impedance, if the

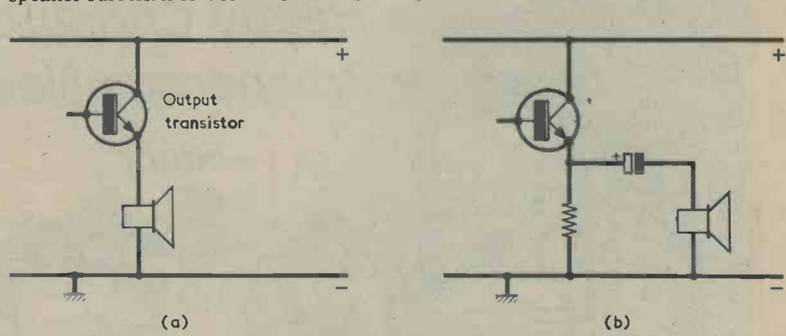


Fig. 1(a). One possible method of obtaining a Class A a.f. output stage
(b). If a resistor and capacitor are added, as here, there is no flow of direct current in the speaker

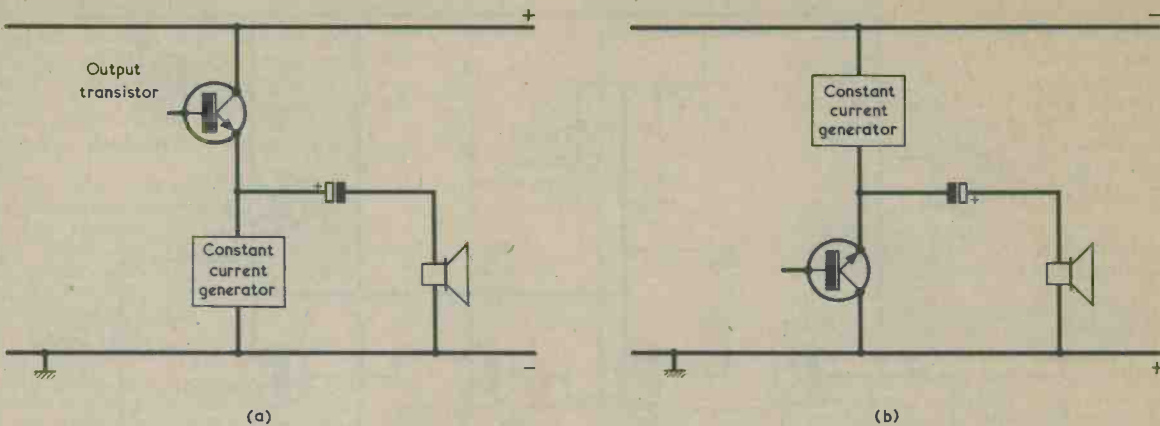


Fig. 2(a). An improvement is effected by allowing the standing direct current to flow through a constant current device (b). Slightly altering the circuit configuration produces several further advantages

transistor is to be brought onto proper operating conditions, whereupon a high proportion of the a.f. output power is wasted in the resistor.

Fig. 2(a) illustrates a new approach. Here, the resistor of Fig. 1(b) is replaced by a constant current generator, this being a device which allows the same pre-determined current to flow in it regardless of the voltage which appears (within limits) across its terminals. If the voltage at the base of the output transistor is varied the emitter voltage changes in sympathy, but the current flowing in the constant current generator remains unaltered. Thus, the constant current generator acts as an infinite resistance to alternating current. In Fig. 2(a) we have the situation where all the direct standing current from the output transistor emitter flows in the constant current generator, whilst all the alternating current is routed via the series capacitor to the speaker.

An even better configuration is shown in Fig. 2(b). The only change here is that the upper supply rail has been made negative instead of positive and we have now placed the speaker and its series capacitor across the output transistor instead of across the constant current generator. This arrangement forms a very effective Class A output coupling circuit provided that the constant current is greater than the highest peak signal current that will be passed to the speaker. In order that both negative and positive excursions of the signal can be handled equally, the output transistor will (at a first approximation) be biased so that its emitter is at half supply voltage in the absence of signal.

Having the constant current generator above the output transistor, as in Fig. 2(b), confers two advantages. The first of these is that it prevents any hum ripple voltages on the upper supply rail reaching the speaker or the output transistor. The ripple voltages appear at the upper terminal of the constant current generator but, since this passes the constant current only, are not applied to the speaker or transistor. The second advantage is that all the supply current to the output transistor stage passes through the constant current generator, with the result that the current drawn from the supply remains continually at the same value both under zero signal and under full signal conditions. There are, in consequence, no problems with respect to power supply voltage regulation or bypassing, and the output stage will work just as well with a poorly regulated and bypassed supply as it will with a high performance supply.

The concept of constant current drain from the supply may be more readily understood with the aid of Fig. 3. In this diagram the battery is an accumulator and it has a voltage equal to half the supply voltage. The transistor is biased so that, at zero signal, its emitter is also at half supply voltage. Under the circumstances, no current flows through the speaker. A positive-going signal half-cycle at the base of the transistor will cause its emitter to go positive also. There will then be two currents flowing in the emitter circuit: the constant current from the constant current generator plus a discharge current from the battery by way of the speaker. A negative-going signal half-cycle at the transistor base will cause the emitter to go negative of half supply voltage. This time the current from the constant current generator will become divided. Part of it will flow in the transistor emitter and the remainder will flow through the speaker into the battery, acting as a charging current for the latter. It will be seen that the transistor passes increased current with positive signal half-cycles and decreased current with negative signal half-cycles, the difference with the constant current passing, in both instances, through the speaker. Under normal conditions the *average* current in the transistor will be the constant current from the constant current generator. Also the overall discharge and charge currents in the battery will be equal and opposite giving an *average* battery current of zero. So far as the power supply is concerned, the only current which has been drawn from it is the continual constant current.

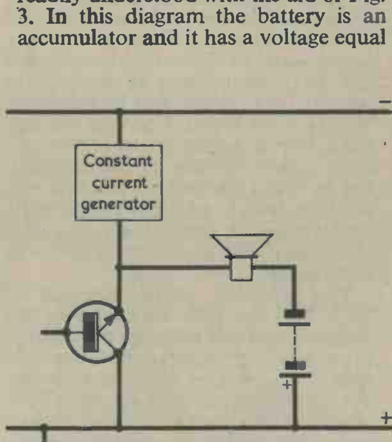


Fig. 3. The operation of the arrangement of Fig. 2(b) can be explained with the aid of this circuit

If we replace the battery of Fig. 3 with a large value capacitor the same effect will take place. Once the capacitor has become charged to half supply voltage after switching on the supply, it will behave in the same manner as the battery, undergoing discharge and charge currents on successive signal half-cycles. With the Fig. 3 arrange-

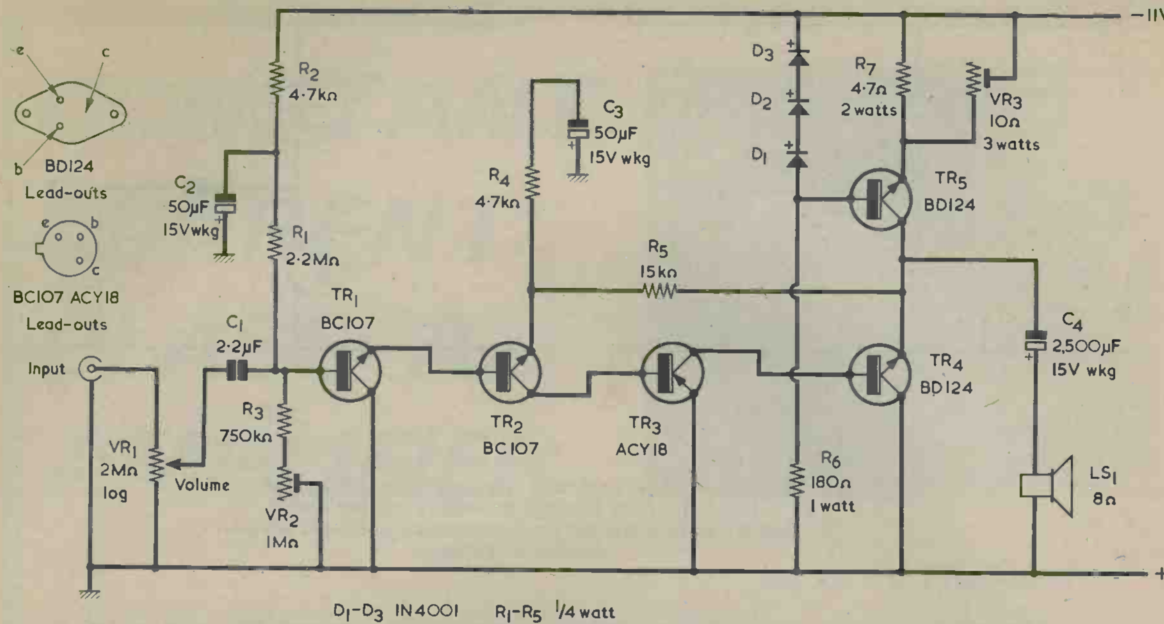


Fig. 4. A practical amplifier circuit incorporating a constant current output stage. This may be fully loaded by a crystal or ceramic pick-up

ment the large value capacitor would be between the speaker and chassis. It may just as usefully be between the transistor emitter and the speaker, as in Fig. 2(b).

Returning to Fig. 2(b), both the constant current generator and the output transistor pass an average current that is greater than peak signal current, and each has half the supply voltage across it. The overall power dissipation in the two devices is therefore well in excess of the maximum audio power which can be fed to the speaker. This low level of efficiency is accepted and it does not incur a serious cost hazard if the amplifier is mains driven.

PROVISIONAL DESIGN

It was decided to make up a small amplifier employing the principle shown in Fig. 2(b) to check results in practice. An arbitrary output power of 1 watt into an 8Ω loudspeaker was chosen as the design target.

A dissipation of 1 watt in 8Ω corresponds to an r.m.s. voltage of approximately 2.8 volts. (The square of 2.8 volts divided by 8Ω equals 1 watt.) The corresponding peak voltage is 3.9 volts. Thus, the overall voltage swing needed at the output transistor emitter is twice 3.9 volts or, roughly, 8 volts. A peak voltage of 3.9 volts across 8Ω corresponds, very nearly, to a current of 0.5 amp. It was decided in consequence to set up an output stage with a voltage swing of 8 volts and to provide a constant current of 0.55 amp, this being 50mA in excess of the possible maximum signal peak current. The simplified design treatment which was then instituted did not take into account possible base-emitter voltage drops in the amplifier transistors, but in practice it was found that the final output voltage swing was still retained at around 8 volts.

The practical amplifier circuit is shown in Fig. 4, and here TR4 is the output transistor and TR5 is the constant current generator. The negative supply voltage is 11 volts. If it is assumed that 3 volts can be allowed to be lost across the constant current generator then 8 volts is available for output voltage swing.

The constant current generator configuration will be familiar to most readers. The base of TR5 is held firmly at a fixed reference voltage level with respect to its emitter supply point by the three forward biased silicon diodes D1, D2 and D3, whereupon emitter current can be pre-set by means of R7 and VR3. The collector current is very nearly equal to the emitter current and can be looked upon as a constant current. The current will be less likely to vary if the forward current through the diodes is well in excess of the constant current divided by the transistor h_{FE}. In Fig. 4 the diode forward current is about 48mA, which is comfortably higher than the current required with the lowest gain transistor likely to be encountered.

The amplifier proper consists of TR2, TR3 and TR4. TR1 is an emitter follower, and it is added at the input to provide a high input impedance suitable for crystal or ceramic pick-ups. TR3 is a voltage amplifier driving TR4, and here we arrive at another advantage conferred by the constant current approach. In a conventional Class B circuit it is usual to have the voltage amplifier feed into a resistive collector load which is bootstrapped to the output. In consequence the voltage amplifier collector feeds a steady current into its load whilst collector current changes due to signal are fed to the output transistors. With the present circuit there is a reasonably steady base current in TR4 resulting from the constant current in its emitter circuit. As a result, TR3 collector feeds this steady current to TR4 base and also passes to it the changing currents due to signal. It then becomes possible for TR3 collector to couple directly into TR4 base, effective 'bootstrapping' being given without the necessity for actual bootstrapping components. A circuit simplification is thus achieved.

TR2 couples directly into TR3 in a manner given in many direct coupled Class B amplifiers. D.C. negative feedback is applied via R5 from the emitter of TR4 to the emitter of TR2, and it causes the emitter of TR4 to be held at the half supply voltage. If, for any reason, TR4 emitter should attempt to go negative so also do the emitter and collector of TR2, and the base of TR3. Phase reversal in TR3 then causes TR4 base to go positive, counteracting the initial tendency of TR4 emitter to go negative. A similar self-correcting chain of events takes place if TR4 emitter attempts to go positive.

The a.c. feedback loop takes in R4 and C3, whereupon the amplifier voltage gain becomes R5 plus R4 divided by R4, or 4 times. This is adequate to load the amplifier with the output from a crystal or ceramic pick-up. The voltage gain can be increased, if desired, by reducing the value of R4.

As already mentioned, TR1 is merely an emitter follower which enables a high input impedance to be given. Its emitter can be conveniently coupled directly to the base of TR1. The potential on TR1 base governs the potential on TR2 base, and this in turn governs the potential of the output emitter. The output emitter potential is set up to half-supply voltage by adjusting the pre-set potentiometer VR2.

TR2, TR3, TR4 and TR1 collector are all supplied from the voltage given by the constant current generator, TR5. The base of TR1 is supplied via the potentiometer consisting of R2, R1, R3 and VR2. Additional smoothing is given here by C2.

PRACTICAL OUTPUT SWING

In practice, it is impossible for the emitter of TR4 to be taken fully down to the positive supply rail because of base-emitter voltage drops in TR1, TR2 and TR4 itself. When, in the prototype, the base of TR1 was taken to chassis the emitter of TR4 fell to 1.6 volts above chassis potential. So the furthermost positive excursion of TR4 emitter is limited to 1.6 volts above chassis potential. However, the 3 volts allowed for the constant current generator proved to be generous, and it was found that the collector of TR5 could, in practice, rise to about 9.5 volts above chassis. Thus, the 8 volt output swing required at the output emitter is very nearly achieved, and the target 1 watt output is just obtained. To ensure symmetrical working VR2 is adjusted so that the emitter of TR4 is mid-way between the two limiting voltages; i.e. at about 5.5 to 5.6 volts above chassis potential.

When the amplifier is running TR4 dissipates a steady 3 watts whilst TR5 dissipates a steady 3.6 watts. Both these transistors require heat sinks and the author employed flat metal sheets measuring 3½ by 5½ ins. in the prototype amplifier. Smaller heat sinks of the ribbed type would probably also be suitable. It is of course a simple matter to check transistor temperature by touching each transistor case with the back of the finger, and this is quite safe as there are no high voltages in the

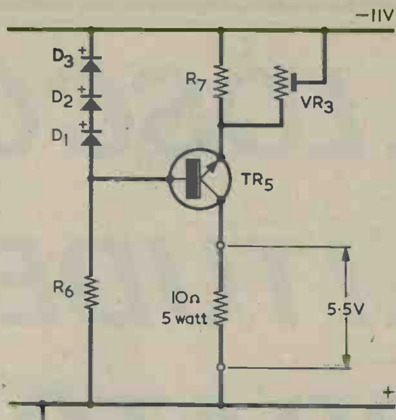


Fig. 6. Test circuit for setting up the constant current

amplifier. The transistors must have a tight thermal coupling to their heat sinks, and the heat sink for TR5 must be insulated from chassis. If a reasonably large chassis is used, TR4 could be bolted to it directly, the chassis then acting as its heat sink.

The power supply used by the author is shown in Fig. 5. The 12.6 volt transformer secondary was provided by two 6.3 volt windings of a heater transformer connected in series. Many valve h.t. mains transformers could be used here, the h.t. secondary being ignored. So far as new components are concerned there is an R.S. Components 'Hygrade' Filament Transformer offering two 6.3 volt 1.8 amp secondaries and this would be satisfactory for the power supply. The 3.9Ω current limiting resistor, R8, allows the requisite 11 volts to be produced across C5 when the supply is loaded by the amplifier. Supply voltages in excess of 11 volts should not be used.

In the constant current generator section of the amplifier, a voltage of about 2.1 volts appears across diodes D1 to D3, and R7 and VR3 are called upon to drop some 1.4 volts at the constant current of 0.55 amps. This corresponds to a resistance of about 2.5Ω. VR3 was a Bulgin 3 watt wirewound potentiometer whose maximum track current rating is, coincidentally, 550mA, and this is listed by Home Radio. R7 is connected in parallel with it to pass some of the emitter current and keep the current in VR3 below its maximum rating.

The amplifier and power supply should be assembled with, initially, no connection to TR5 collector. This collector is then temporarily connected to chassis via a 10Ω resistor, as in Fig. 6. A voltmeter is connected across the 10Ω resistor and VR3 is set to insert maximum resistance into circuit. The power supply is switched on and the resistance inserted by VR3 slowly reduced until the voltmeter indicates 5.5 volts. VR3 is then set up for the constant current of 0.55 amp, whereupon the amplifier is switched off, the voltmeter and 10Ω resistor removed, and the collector of TR5 connected into the amplifier circuit. This method of setting up VR3 does not incur excessive dissipation in TR5.

When VR3 has been set up, it is next necessary to set up VR2. The voltmeter is now connected between chassis and the emitter of TR4 and VR2 is adjusted for a voltage reading of 5.5 to 5.6 volts. Since this setting is to some extent dependent on the gain of TR2 and TR3 there is a slight chance that the desired voltage may, with some amplifiers built up to the circuit, be outside the range of VR2. If the lowest voltage obtained is greater than that desired, the value of R3 should be reduced slightly. If the highest voltage obtained is below that required, the value of R3 may be increased or that of R1 reduced. The amplifier must always be switched off when changing fixed resistor values in the input circuit.

All the components are readily obtainable with the possible exception of the two high wattage resistors R7 and R8. The precise value of R7 is not very important and it can in practice lie between 4.7Ω and 6.8Ω. In any event a 4.7Ω resistor in 2½ watt rating is available from Home Radio. Similarly, Henry's Radio list a 4.7Ω 4 watt resistor which would also be satisfactory. If R8 cannot be obtained as a single resistor it could consist of four 1Ω 2½ watt resistors in series (Home Radio) or two 8Ω 9 watt resistors in parallel (Henry's Radio). Other series or parallel combinations are also feasible, and a slight discrepancy from the nominal value of 3.9Ω is permissible.

The completed amplifier gave a very satisfactory performance, and there was no evidence of instability despite the extended chain of direct transistor couplings. It may be used with speaker impedances greater than 8Ω at the expense of reduced output power. Speakers with impedances lower than 8Ω must not be used. ■

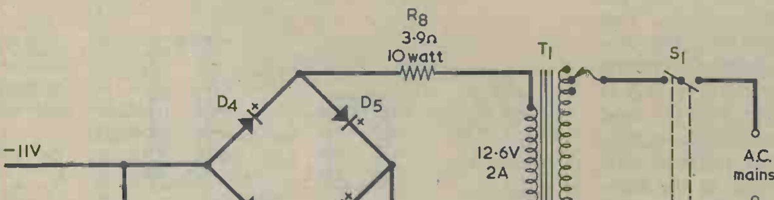


Fig. 5. The amplifier power supply

OSCILLOSCOPE AMPLITUDE CALIBRATOR

By A. Foord

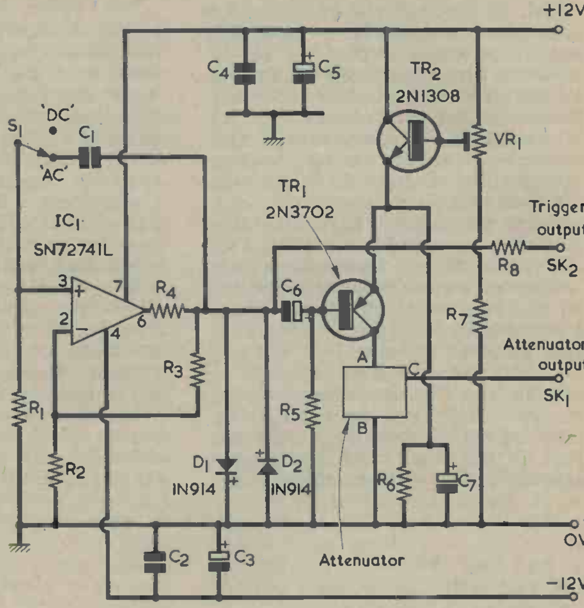
This unit provides a.c. or d.c. voltages from 10mV to 10 volts for calibration or test purposes, and consists of a multivibrator followed by an accurate attenuator

THE CIRCUIT DIAGRAM FOR THE AMPLITUDE CALIBRATOR itself is shown in Fig. 1, with details of the attenuator and switch in Fig. 2. A relaxation multivibrator is formed by IC1 and associated components. With S1 in the 'DC' position the non-inverting input pin 3 is referred to earth via R1 and negative feedback (from the output pin 6 via R3 to the inverting input pin 2) holds the output close to earth potential. This stage is then isolated from TR1 because C6 is effectively open-circuit at d.c.

MULTIVIBRATOR OPERATION

When S1 is in the 'AC' position the circuit will oscillate at approximately 1kHz in a relaxation mode. The negative feedback loop from the output to input via R3 is still in operation but there is also a positive feedback loop via C1 to the non-inverting input. The circuit changes state regeneratively each time the two inputs are at the same potential. The voltage movement at the output point (across the diodes D1 and D2) is fully transmitted to the non-inverting input by C1, and the voltage at this input then begins to recover exponentially towards earth potential. When part of this movement has been completed the voltage at the non-inverting input reaches the same voltage as the inverting input (depending on the ratio of R3 and R2) and regeneration occurs again.

Then the output voltage, the non-inverting input voltage and the inverting input voltage levels all swing to the opposite side of earth potential and the recovery process takes place again. The waveforms are shown in Fig. 3, which is not drawn to scale. Two of the accom-



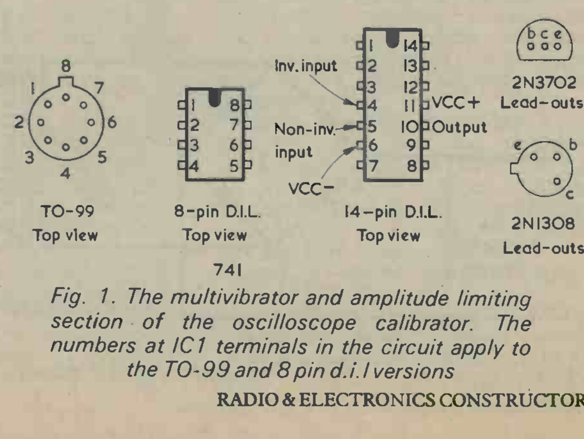


Fig. 1. The multivibrator and amplitude limiting section of the oscilloscope calibrator. The numbers at IC1 terminals in the circuit apply to the TO-99 and 8 pin d.i.l versions

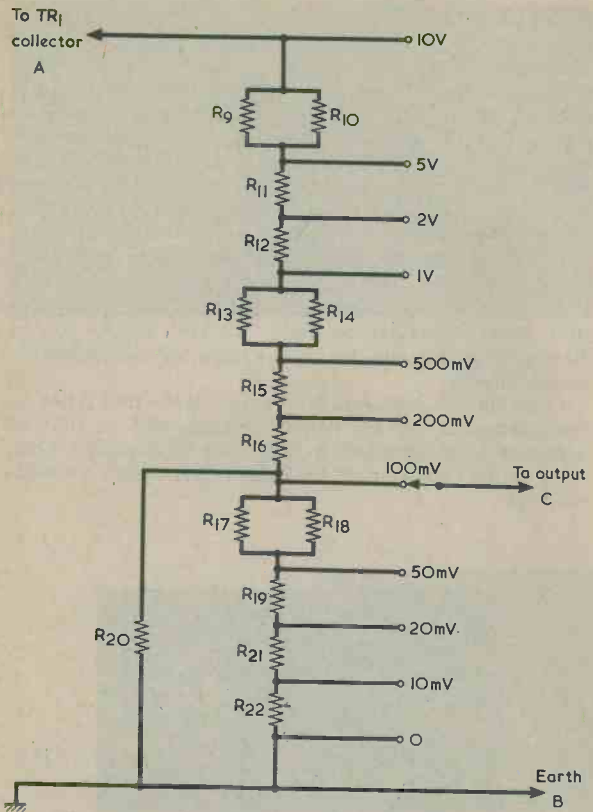


Fig. 2. The circuit of the attenuator. This gives output voltages ranging from 10mV to 10 volts

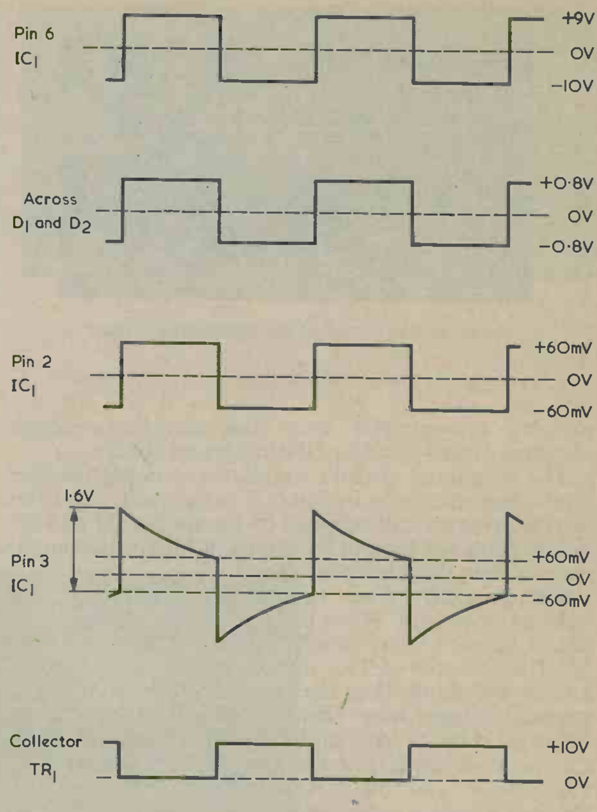


Fig. 3. Waveforms appearing at various points in the circuit. These are not drawn to scale

COMPONENTS

Resistors
(All fixed values ¼ watt)

R1	3.3kΩ 5%
R2	2.2kΩ 5%
R3	27kΩ 5%
R4	680Ω 5%
R5	33kΩ 5%
R6	2.2kΩ 5%
R7	2.7kΩ 5%
R8	6.8kΩ 5%
R9	1kΩ 2%
R10	1kΩ 2%
R11	300Ω 2%
R12	100Ω 2%
R13	100Ω 2%
R14	100Ω 2%
R15	30Ω 2%
R16	10Ω 2%
R17	100Ω 2%
R18	100Ω 2%
R19	30Ω 2%
R20	11Ω 2%
R21	10Ω 2%
R22	10Ω 2%
VR1	1kΩ pre-set potentiometer, linear

Capacitors

C1	0.047µF 10%
C2	0.047µF ceramic
C3	10µF electrolytic, 16 V. Wkg.
C4	0.047µF ceramic
C5	10µF electrolytic, 16 V. Wkg.
C6	10µF electrolytic, 16 V. Wkg.
C7	10µF electrolytic, 16 V. Wkg.

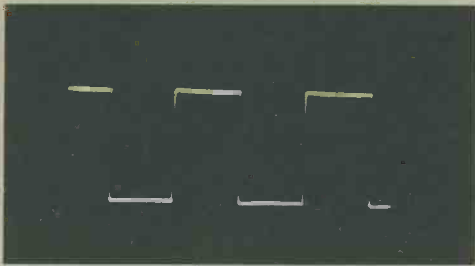
Semiconductors

IC1	SN72741L or equivalent (see text)
TR1	2N3702
TR2	2N1308
D1	1N914
D2	1N914

Switches

S1	s.p.s.t. toggle
S2	single pole 11 way rotary

Miscellaneous
SK1, SK2 sockets.



Waveform at pin 6 of the integrated circuit

panying photographs show the actual waveforms obtained at pins 3 and 6 of the integrated circuit.

The integrated circuit's amplitude switches between limits determined by its internal components, and this level is symmetrically clipped by the diodes D1 and D2 before being fed back to the inputs. R4 limits the output current from the integrated circuit.

TR2 provides a direct voltage slightly in excess of 10 volts at its emitter. When S1 is in the 'DC' position the circuit before C6 has no effect, and R5 turns TR1 hard on. The collector of TR1 therefore remains at 10 volts, and by switching S2 in the attenuator circuit of Fig. 2 stepped voltages from 10mV to 10 volts are available. When S1 is in the 'AC' position a 1.6 volt peak-to-peak square wave appears at the base of TR1 so that TR1 switches on and off. TR1's collector will therefore produce a square wave between zero and 10 volts, and again any peak-to-peak amplitude between 10mV and 10 volts may be switched to the output.

The integrated circuit used in the prototype and specified in the Components List is in the 8 lead TO-99 can. Other '741' i.c.'s such as the LM741CH, etc., can be employed, as also may the LM201H and LM301AH. Fig. 1 shows the appropriate pin assignments in 8 pin d.i.l. and 14 pin d.i.l. All pin references given in the text apply to the TO-99 or 8 pin d.i.l. encapsulation.

The performance of the unit is detailed in the Table.

CONSTRUCTION

Construction is not critical and may follow normal circuit practice. There is an output via R8 to SK2 which may be used as an oscilloscope trigger. C2 and C4 should be kept close to the integrated circuit to ensure that there is no danger of high frequency instability.

TABLE

OSCILLOSCOPE CALIBRATOR PERFORMANCE

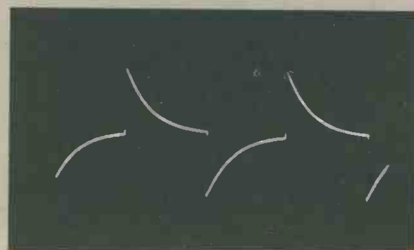
Output	A.C. or d.c., 10mV to 10V in 10 steps.
Frequency	Approximately 1kHz.
Accuracy	±2%.
Power supplies	+12V at 21mA, –12V at 8mA.
Trigger output	1.6V peak-to-peak.

SETTING UP

With S1 in the 'DC' position check that pin 6 of the integrated circuit is approximately at earth potential and that the output can be varied by S2 over the required range. Output voltages will only be approximately correct at this stage. With S2 in the 'AC' position check that a square wave of about 1.6 volts peak-to-peak appears at the trigger output socket and that an output at SK1 is available.

If all is well, set S1 to 'DC' and S2 to '10V' and measure the d.c. output voltage at SK1. Adjust VR1 until this is at the correct value of 10 volts. Since the unit relies indirectly on the +12 volt supply for its 10 volt reference, the +12 volt supply should preferably be stabilized.

Once the d.c. level has been adjusted the unit relies on the attenuator for the other voltages, and so that its accuracy is maintained it must not be loaded. When used as an oscilloscope calibrator this is not a disadvantage.

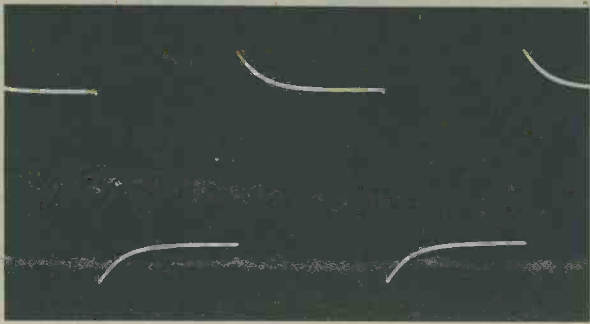


The waveform appearing at pin 3 of the i.c.

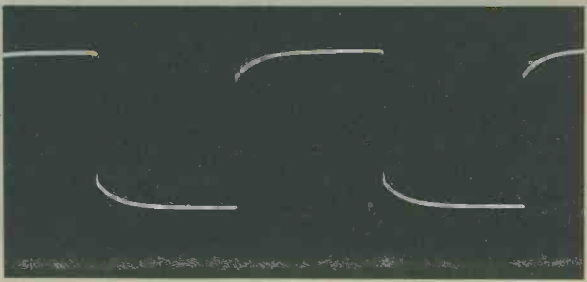
OSCILLOSCOPE GAIN CALIBRATION

The input stage of an oscilloscope has a similar arrangement to our amplitude calibrator, and signals greater than the most sensitive range of the oscilloscope are attenuated down to a common level before being applied to the amplifier. In setting the oscilloscope gain it is usual to switch to the most sensitive position (which may be 10mV or 50mV per centimetre of screen deflection), apply a known signal, and adjust the oscilloscope pre-set gain control until a correct reading is observed on the screen. The amplitude calibrator is ideal for this application because it can provide known signals, from 10mV peak-to-peak, which progress upwards in steps suitable for most oscilloscope calibration purposes.

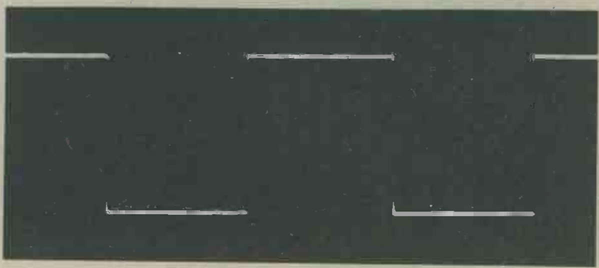
For a direct coupled oscilloscope this gain setting could in theory be carried out at d.c. by measuring the shift in spot position as the calibrator is connected and disconnected; but in practice the gain setting should be obtained at 1kHz with the oscilloscope input set to 'a.c. coupled'. There are two reasons for this procedure. Firstly a nominally direct coupled oscilloscope may suffer a small gain reduction at d.c.; and secondly, because of non-linearity in the oscilloscope amplifier, a



The effect of over-compensating an oscilloscope attenuator



Under-compensation gives the effect shown here



Trace given by a correctly compensated oscilloscope attenuator

d.c. voltage from zero volts at the bottom of the screen to (say) 10 volts at the top of the screen may not appear equal in amplitude to an a.c. coupled waveform of plus-and-minus 5 volts about the centre of the screen.

These points can easily be checked with the calibrator and it is normally only in home constructed oscilloscopes where non-linearity or low d.c. gain is experienced. Commercial instruments with their more complex circuits usually have a good performance.

Once the most sensitive range of the oscilloscope has been calibrated its built-in attenuator provides the other ranges with an accuracy which depends on the resistors used in its construction. If 1% resistors are used then the overall accuracy to be expected will depend quite a lot on the initial setting up and the care taken in reading off the oscilloscope screen. A typical accuracy would be 5% or better, and this is normally good enough for measurements taken with an oscilloscope.

OSCILLOSCOPE WAVEFORM CALIBRATION

For waveform adjustment each resistor in the oscilloscope attenuator has a parallel capacitor which is adjusted until the square wave visible on the screen has a flat top. The results of under- and over-compensation are shown in the photographs. These capacitors should be adjusted starting with the most sensitive range and working towards the least sensitive range, since they are interdependent.

When the basic oscilloscope has been calibrated any attenuating probes ('X10' or 'X100', etc.) can be similarly compensated.

SIGNAL SOURCE

The calibrator may be used as a signal source subject to the limitations imposed on accuracy if it is loaded. For many purposes this is unimportant; for example, in circuit testing or fault-finding on feedback amplifiers the circuit either works with a well defined gain or it fails to work at all. If 100mV is fed into an amplifier with a gain of 10 then a quick check to determine that the output is approximately 1 volt is often all that is needed.

Alternatively, if accurate measurements are required then the output of the calibrator should be measured under the loaded working conditions.

The calibrator is useful for square wave testing of audio or feedback amplifiers since any imperfections like ringing, poor rise time, l.f. droop, etc., are quickly shown up. ■

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT

Frequencies = kHz

Shortwave listening as a hobby is, by its very nature, a somewhat lonely affair. Enthusiasts sit, often night after night and sometimes even into the small hours, operating their respective listening station whilst listening for those elusive Dx signals they have read about in journals such as this. Being a loner, it is apparent that without some form of regular communication, much that could be heard would be missed through lack of information.

News of current activities on the broadcast bands, which is a necessity for all actively engaged seriously in the hobby, is to be found in the publications of various short wave listener clubs. Two such clubs which provide a useful inflow of information are the International Short Wave League and the World DX Club; for further information see the Small Advertisement section in this issue.

An overseas source that can be thoroughly recommended is the Danish monthly 'Shortwave News' published by the Danish Shortwave Clubs International. Entirely in English, the issue for October, for instance, was of thirty-two pages plus cover and of this total, ten pages were of members reports (broadcast band tips) and the remainder on news and information. The journal is extremely well produced and contains many illustrations, the page size is $8\frac{1}{4}$ x $11\frac{3}{4}$ in. (approx.) and is duplicated. The annual fee is £3.40 and the address (U.K. representative) is N. R. Green, 14 Marsden Road, Blackpool, Lancs. FY4 3BZ, to whom payments should be made.

CURRENT SCHEDULES

● PAKISTAN

Radio Pakistan, Karachi, currently (at the time of writing) has an External Service in English as follows – from 0230 to 0245 news at slow-speed to the Far East on **17830** and on **21730**; from 0430 to 0445 news at slow-speed to East Africa on **15325, 17830** and on **21590**; from 1100 to 1115 news at slow-speed to West Europe on **15115** and on **17910**; from 1530 to 1545 news at slow-speed to the Middle East on **11672** and on **15520**; from 1745 to 1800 news at slow-speed to Eastern Europe and Western USSR on **9690** and on **11672** and from 2000 to 2045 to the U.K. on **7085** and on **9465**. Note that frequencies are subject to some variation, that of the listed **15325** being actually measured by us on **15322.5** kHz.

● FINLAND

The Finnish Broadcasting Company, Helsinki, presents an External Service in English to Europe, North and South America from 1400 to 1430, from 1600 to 1630 and from 1800 to 1830 on **9550, 11755, 15185** and on **21605**; to Europe and South America from 2030 to 2100 on **9550, 11755** and on **15185** and to North America from 0300 to 0330 on **9585**.

● PORTUGAL

Radio Portugal, Lisbon, radiates an External Service in English to Eastern U.S.A. from 0200 to 0230 on **6025** and on **11935**; to Canada from 0300 to 0345 on **11840**; to Western U.S.A. from 0345 to 0430 on **6025** and on **11935**; to the Far East from 0730 to 0900 on **17880** and on **21495**; to India from 1345 to 1430 on **17895** and on **21495**; to East and West Africa from 1745 to 1830 on **11875** and on **21495**; to Europe from 2045 to 2130 on **6025**.

● NIGERIA

The 'Voice of Nigeria', Lagos, daily offers an External Service in English to Africa, the Middle East and Europe, from 0555 to 0735 on **7275, 11770** and on **15185**; to Africa, the Middle East and Europe, from 1530 to 1700 on **7275, 15120** and on **15185**; to Africa, Middle East and Europe, from 1800 to 1930 on **7275, 11770** and on **15120**.

● TURKEY

Radio Ankara listed a broadcast in English to Europe, the U.K., North Africa and North America from 2200 to 2230 on **11880**, this has now been extended till 0115.

● CHINA

For Dxer's, the Ikechao regional relay station of the Inner Mongolia People's Broadcasting Service at Tunsheng operates on **4525** in Standard Chinese with relays of Peking's First Programme and the Inner Mongolia Regional Service from Huhehot from 2125 to 0101 and from 0945 to 1401, according to the BBC Monitoring Service.

● LEBANON

Broadcasts from Radio Beirut to Europe and Africa in English, Arabic and French, from 1830 to 2030 are now on **11795** and those to Central and North America in French, Arabic, English and Spanish, from 0130 to 0330 are now on **9675**.

● EGYPT

The Radio Cairo 'Voice of Africa' Service now opens with a broadcast in English to East Africa from 1430 to 1515 on **17725**.

● CLANDESTINE

The 'Voice of Iraqi Kurdistan' currently operates as follows – from 1600 to 1730 (to 1800 on Fridays) in Kurdish; from 1730 to 1800 (Sundays, Tuesdays and Thursdays) in Assyrian; from 1730 to 1800 (Mondays, Wednesdays, Saturdays) in Turkmen; from 1800 to 1900 in Arabic and from 1900 to 1925 in English. All transmissions from this pro-Barzani transmitter are on **6940** (but see Around the Dial) and on **10055**.

● NORTH KOREA

Radio Pyongyang may be logged at 1800 when commencing their programme in English with station identification on **9977** and in parallel on **6338**.

● **LIBERIA**
Monrovia (Voice of America) can be heard at 0730 on **7280**, where we heard them presenting a talk on current world economics.

● **CZECHOSLAVAKIA**
Radio Prague at 0745 on **9505** with news of local affairs after the station identification, all in English.

● **MONACO**
Trans World Radio at 0720 on **7105** when presenting an evangelical programme in English.

● **CONGO**
R. TV Congolaise, Brazzaville, at 2014 on **15190** with primitively stirring African drums, chants and cries, the basis of all pop music!

● **CLANDESTINE**
The 'Voice of Iraqi Kurdistan' at 1810 on a measured **6941** with OM in Arabic, local music at 1815 then into Arabic harangue with both OM and YL speakers; lost under deliberate jamming at 1825. (See under Current Schedules).

● **AFGHANISTAN**
Radio Afghanistan at 1130 on **15195** with identification by OM and YL announcers in English, repeated twice, then news, commentary and 'Letter Box' programme, all directed to Europe.

● **PAKISTAN**
Radio Pakistan can be heard on many differing channels at various times throughout the day, here are some of those recently logged by us. On **4835** at 1603, OM with local news in English, sign-off at 1617 after talk by YL in English; on **7085** at 2035, identification by YL as 'World Service' then a newscast in English; on **15322.5** at 0917, programme of local music and songs; on **17770** at 1055, talk on India/Pakistan relations in English; on **17797** at 1059 interval signal (rather appealing and synonymous with the East), identification at 1100 in English then into Asian dialect and on **17910** at 1105, YL with news of Pakistan affairs at slow speed.

● **INDIA**
All India Radio can also be heard on many channels, both in the Overseas Service and the local Regional Services. On **3205**, Lucknow at 1656 with local music and song programme; on **3295**, Delhi at 1722 with local music and songs; on **3355**, Kerseong at 1650 with OM and YL in duet; on **4800**, Hyderabad with local music and Delhi on **11775** at 1005 with a newscast of Indian affairs in English.

● **KASHMIR**
Radio Srinigar at 1702 on **3277** when just fading in, local music and song programme.

● **MALAYSIA**
Penang on **4985** at 1510, announcements by OM in English, dance music Euro-style, songs in English, sign-off with National Anthem at 1630; Kuala Lumpur at 2220 on **4845**, Indian-type songs and music in the Tamil Service; Kuching (Sarawak) at 2212 on **5005**, OM with chants, YL announcer.

● **SRI LANKA**
Colombo on **4902** at 1622, local music and songs, Buddhist chants at 1703 after series of announcements; Colombo on **4870** at 1709, local music, OM with songs.

● **SINGAPORE**
Radio Singapore on **5010** at 1540 with programme of pop records (English), parallel on **5052**.

● **INDONESIA**
RRI Jambi on **4927** at 1559 when signing-off with Hawaiian guitar rendering of 'Love Ambon' – a regular daily ceremony.

● **CAMBODIA**
We should really list this as Kmere Republic but most people refer to the country as Cambodia, except the pro-communist clandestine VUNFC (see last issue) who use the name Kampuchea. Anyway, listen on **4907** from around 1600 when you will hear the capital Phnom-Penh. We heard a programme of local pops, complete with guitars etc., must they copy our bad habits?

● **NIGERIA**
Lagos on **4990** at 2209, African songs and chants, also on **15120** at 2022 with a similar type of programme.

● **SWITZERLAND**
Berne at 0920 on **11775** and also in parallel on **9590**, in English with 'Dateline', a programme about Swiss and European current affairs.

● **HOLLAND**
Hilversum at 0935 on **7210** with a current affairs programme in English.

● **CHINA**
Radio Peking at 1717 on **15095** with a talk in English on Chinese affairs.

● **GHANA**
Accra at 1730 on **3365**, six pips and then news in vernacular by OM.

● **DOMINICAN REPUBLIC**
HIJP Radio Commercial, Santo Domingo, on **4882** at 0620, OM with song in Spanish and typical local music.
HIBB La Voz del Papagayo, La Romana, on **5030** at 0622, Euro-type dance music records, identification at 0630 in Spanish.

● **VENEZUELA**
YVOI Radio Valera, on **4840** at 0400 with choral National Anthem at sign-off.
YVNM Radio Coro, on **4950** at 2247, songs in Spanish, Latin American style music.
YVNW Radio Bolivar, on **4770** at 0355, OM with song in Spanish, commercials with jingles, identification at 0356.

● **ECUADOR**
HCVP2 Sistema de Em. Atalaya, Guayaquil, on **4790** at 0417, LA music, two chimes then OM with identification.

● **HONDURAS**
HRVC Voz Evangelica, Tegucigalpa, on **4820** at 0422, a religious programme in English.

● **KASHMIR**
Azad Kashmir (Free Kashmir) on **3914** at 1812, local music, YL with songs, sign-off with (almost) endless choral anthem at 1835.

DIODE 'SORTER—OUTER'

By S. M. Peters

An inexpensive test circuit which is helpful when sorting out surplus diodes and rectifiers

A COLLEAGUE OF THE WRITER RECENTLY PURCHASED A batch of manufacturer's surplus silicon rectifiers by mail-order. On opening the pack he was a little surprised to find that the supplier had inserted a small note: 'Check polarity before use'. My colleague did this, to find that although all the rectifiers had the same shape, with the plastic housing curved at one end, the curved end was in some cases the rectifier anode and in other cases the rectifier cathode.

This is by no means an unusual state of affairs and it is, in any event, a wise course to check polarity with any unfamiliar or surplus diode, particularly if it is to be used as a rectifier in a power supply circuit. A rectifier connected wrong way round can cause havoc when the power supply is first switched on.

TEST UNIT

The test unit described in this short article requires few components and can be built in a relatively short time. The basic circuit approach is not new, but it may well be that the method of presentation of the results it gives is original.

The circuit of the 'Sorter-Outer' appears in Fig. 1, in which diagram T1 is a mains transformer having an 8 volt secondary. There are two test terminals, these being indicated in the diagram as 'A' and 'B'. The letters 'A' and 'B' are employed merely to identify the terminals for purposes of explanation in this article, and they do not appear as markings on the actual unit.

Let us now connect a diode to the terminals so that its cathode (the end marked with a plus sign in the diode symbol) connects to terminal 'B' and its anode to terminal 'A'. Thinking in terms of 'conventional current' (assumed to flow from positive to negative) the diode across the test terminals will then pass current during a.c. half-cycles in which the upper end of the 8 volt transformer secondary is positive. This current will then flow, to the lower end of the secondary, via D2, R1 and light-emitting diode LED1, causing LED1 to light up. Current cannot flow in the LED2 circuit because it is blocked by D3. Similarly, current cannot flow through any part of the circuit on half-cycles which cause the upper end of the 8 volt secondary to be negative, because the current is then blocked by the test diode itself.

If the diode is connected to the test terminals with its cathode to terminal 'A', it will prevent the flow of

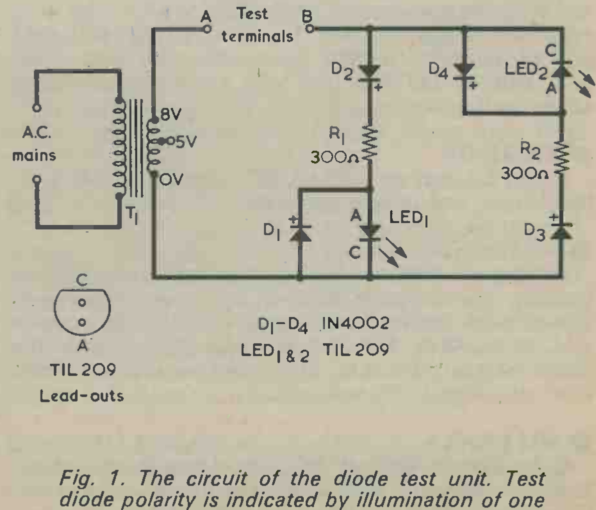


Fig. 1. The circuit of the diode test unit. Test diode polarity is indicated by illumination of one of the two light-emitting diodes

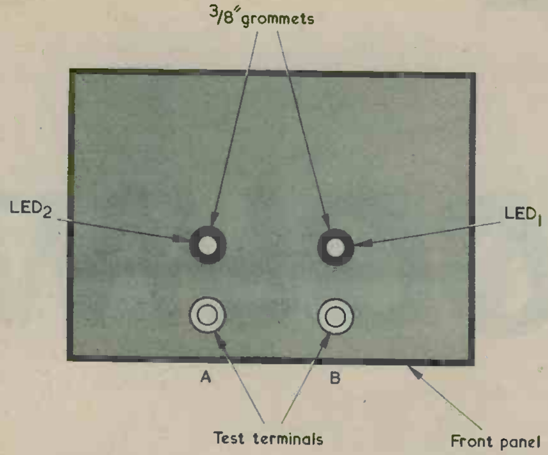


Fig. 2. A suitable front panel layout

current during half-cycles when the upper end of the 8 volt secondary is positive. It will, on the other hand, allow the passage of current when the upper end of the secondary is negative and the lower end is positive. This time the current flows from the lower end of the secondary through D3, R2, LED2 and the test diode to the upper end of the secondary. Light-emitting diode LED2 lights up.

Thus, LED1 lights up when the test diode cathode is at terminal 'B', and LED2 lights up when the test diode cathode is at terminal 'A'. When illuminated, the l.e.d.'s emit a bright red glow which one subconsciously associates with electrical positive or 'plus'. The front panel layout of the unit appears in Fig. 2, and it will be seen that LED1 is positioned alongside terminal 'B' and that LED2 is positioned alongside terminal 'A'. Connecting a diode to the test terminals results in a red (equals positive or 'plus') glow appearing at the terminal to which the diode cathode connects.

FURTHER POINTS

A few further points have to be dealt with before leaving the circuit of Fig. 1. It will be noted that diode D1 is connected across LED1 and diode D4 is connected across LED2. These two diodes are very probably not required but the author has included them to ensure that the reverse voltage across each l.e.d. cannot exceed 0.6 volt. Texas Instruments specify an absolute maximum reverse voltage of 3 volts for the TIL209 l.e.d. The reverse current which could flow through each l.e.d. via D2 or D3 is very low, but no reverse current figures for the TIL209 are available to the writer, and it was decided in consequence to follow an ultra-cautious policy and fit the two diodes D1 and D4. All the four diodes are silicon components type 1N4002.

Resistors R1 and R2 have a value of 300Ω and permit a current in each l.e.d. of about 30mA at half-cycle voltage peaks. Both resistors are $\frac{1}{4}$ watt 5% types.

Transformer T1 is a small bell transformer of the type available in Woolworth's stores. Its secondary has a 5 volt tap, which is unused. There is no mains on-off switch and the unit is simply plugged into the mains whenever it is required. If it is accidentally left plugged in after use no harm will result. Since T1 is a bell transformer it is intended to be continually connected to the mains supply, from which it draws negligible current when its secondary is unloaded.

As an added bonus the unit also indicates when a diode is short-circuited. Connecting a short-circuited diode across the test terminals causes both l.e.d.'s to light up. Neither diode will light up if the diode is open-circuited.

CONSTRUCTION

Component layout is unimportant apart from the fact that LED1 should be positioned alongside terminal 'B' and LED2 alongside terminal 'A'. The author used the front panel layout of Fig. 2, in which the l.e.d.'s have their bodies positioned in the centres of two $\frac{3}{8}$ in. p.v.c. grommets. The dimensions of this front panel are approximately $3\frac{1}{2}$ by $2\frac{1}{4}$ in., and it is fitted to a box, $2\frac{1}{4}$ in. deep, which has the transformer mounted at the bottom. This is a case which the author happened to have on hand. Any other box, metal or plastic, of about the same size can be pressed into service. If the case is metal, the mains lead must pass into it through a grommet. The two terminals were insulated types having what are effectively sockets at the top into which the leads of diodes with wire ends can be quickly inserted. Wander socket plugs would be equally suitable. At the low voltages involved, the diode can be safely held in the fingers whilst being checked.

With the author's method of construction, the components were fitted to two 5-way tagstrips having the centre tag common with the mounting lug. These are secured to the rear of the front panel, whereupon wiring is carried out as illustrated in Fig. 3. The leadouts of each l.e.d. are soldered to two of the tags, as shown.

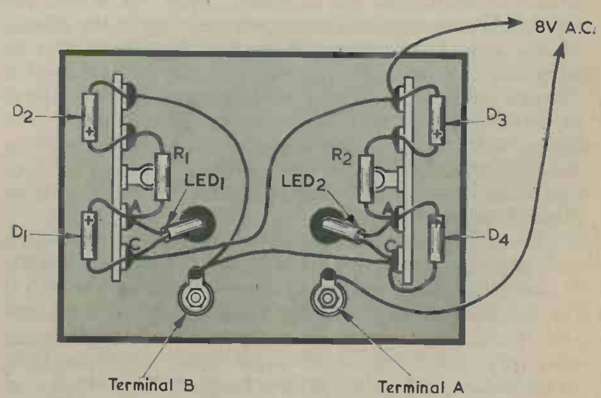


Fig. 3. All the components apart from the mains transformer can be mounted on the rear of the front panel

The author's unit has been in use for some months now, and has been successful in determining the polarity of a large number of silicon power rectifiers, as well as small silicon and germanium diodes. ■

PULSE COUNT

Pa

By R. A

By employing the pulse counting method of discrimination, this f.m. tuner performs as a superhet receiver having an i.f. amplifier which requires no tuned circuits at all. The tuner may be powered by a 9 volt battery or by a 9 volt power supply unit. Next month's concluding article will give details of construction and of setting up

ALTHOUGH THE PULSE COUNTING TYPE OF F.M. TUNER has been popular in the past amongst home constructors it does not nowadays seem to be encountered as frequently, this being possibly due to the advent of low cost f.m. integrated circuits. It has also to be admitted that the pulse counting tuner is suitable for the provision of mono signals only, and that it cannot be employed for stereo reception. Nevertheless, if a high quality mono signal is required the pulse counting method still represents the simplest method of f.m. reception, and it still has economic advantages over other systems.

This article, together with a concluding article which will appear in next month's issue, describes a simple 6 transistor pulse counting tuner covering the v.h.f. f.m. band of 88 to 108 MHz. Provided it has a reasonably strong aerial signal the tuner is capable of giving an extremely good signal to noise ratio. With a fully modulated signal the a.f. output is about 250mV r.m.s. at an impedance of 5kΩ, and the unit is therefore suitable to feed a signal to virtually any power amplifier or tape recorder. The tuner can be either mains or battery powered, and it is housed in a home-made cabinet measuring $9\frac{1}{2}$ by 7 by $4\frac{1}{2}$ in.

BASIC CIRCUIT CONFIGURATION

A block diagram of the tuner is given in Fig. 1. As may be seen, the aerial couples to an r.f. amplifier stage. This stage provides very little gain, but it is nevertheless absolutely essential because it prevents radiation from the aerial of the oscillation produced in the following mixer-oscillator stage. The latter is a self-oscillating

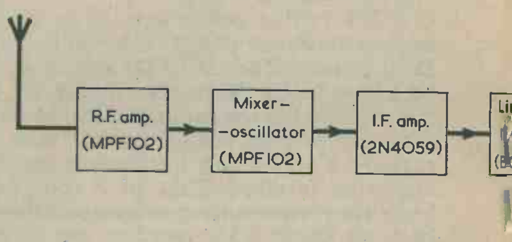


Fig. 1. Block diagram sh
simple f.m. tuner. This i
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ING F.M. TUNER

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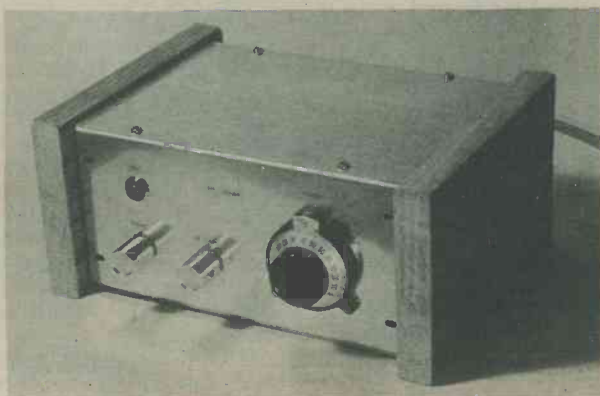
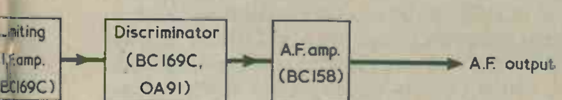


mixer and is tuned about 150kHz off the centre frequency of the received transmission. At the output of the mixer there are a number of v.h.f. signals together with the 150kHz difference frequency. The v.h.f. signals are filtered out, leaving the 150kHz signal, which is fed to the i.f. amplifier.

At the comparatively low frequencies involved here (about 225kHz maximum) ordinary RC coupled stages can be employed in the i.f. amplifier. Silicon transistors with reasonably low values of collector load resistor are used, and the voltage gain will not be significantly lower than the high figure which would be given at ordinary audio frequencies.

The first i.f. transistor gives normal amplification. So does the second i.f. transistor, but this also provides amplitude limiting as well. Amplitude limiting is very important since it greatly reduces the noise and distortion which would otherwise be present on the final signal. The limiting process is extremely simple, and it relies upon there being a sufficiently large signal at the limiter stage for the signal to be automatically clipped. The voltage gain of the tuner is very high and can be in the neighbourhood of 100dB, or 100,000 times, whereupon only a fairly modest signal amplitude is required to initiate the limiting action. For instance, if an aerial signal of only 100µV r.m.s. is subjected to 100dB of linear amplification the output would be 10 volts r.m.s. However, the limiter stage, powered only by a 9 volt supply, could not produce such an output, and it would clip the signal to about 3 volts r.m.s. maximum. Thus, automatic limiting is achieved without circuit complications.



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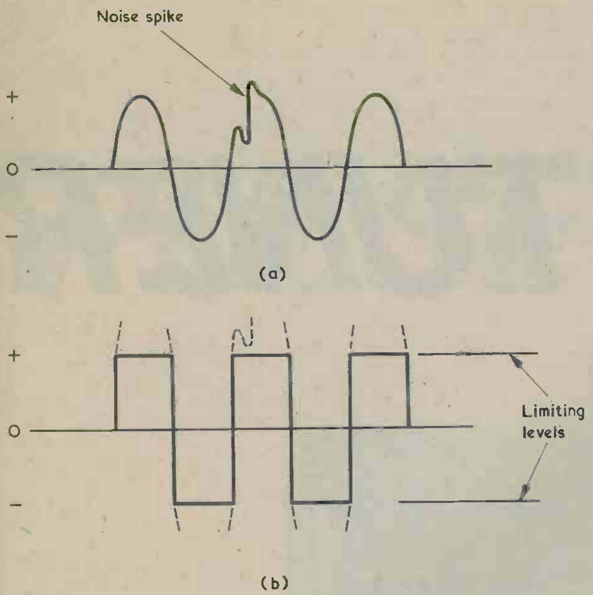


Fig. 2(a). A noise spike impressed on a signal waveform
(b). The spike disappears if the signal is amplified such that the spike is outside limiting level

Fig. 2 illustrates how this clipping effects an improvement in the signal to noise ratio. Fig. 2(a) shows a hypothetical i.f. signal before clipping, together with a noise spike on the carrier. Fig. 2(b) shows the output of the limiter, and demonstrates that the noise spike has been removed since it is in the clipped portion of the signal. Obviously, if the signal is only poorly limited or the noise spike is very large the limiting action will only be partially effective. For this reason the highest signal amplitude must always be sought. The limiting action will of course reduce any form of noise which is modulated on to the carrier.

Another function of the limiter is to provide an output which has a constant voltage for the discriminator stage. The purpose of the discriminator is to produce an audio output signal which rises and falls in amplitude as the carrier rises and falls in frequency. If the amplitude of the signal at the input of the discriminator should vary with frequency, this will obviously cause distortion. The frequency response of the i.f. amplifier is not flat and would cause such distortion. However if, say, the response of the i.f. amplifier varies by 6dB over the range of frequencies involved, the resultant potential distortion will be eliminated if more than that 6dB of limiting is provided as the output voltage amplitude from the limiter will then be constant.

The a.f. output from the discriminator is insufficient to drive many amplifiers, and it is in consequence followed by a low gain audio stage.

THE CIRCUIT

The circuit diagram for the tuner is given in Fig. 3. TR1 is the r.f. amplifier, and this consists of a Jugfet (i.e. a junction gate field effect transistor) in the grounded gate mode. The output from TR1 is coupled to TR2 by the coupling winding L2. TR2 is basically a grounded gate Colpitts oscillator, using a second Jugfet. The oscillator coil is L3 and oscillator tuning is carried out by VC2. L4 is an r.f. choke. The output from the mixer is developed across R3. C5 bypasses the v.h.f. frequencies, leaving the required lower frequency i.f. signal. TR2 is very stable in operation, and no a.f.c. is required.

TR3 and TR4 are the i.f. amplifiers, TR4 operating also as the limiter. Both transistors function as straightforward common emitter amplifiers, and they provide the majority of the gain in the tuner.

TR5, in conjunction with D1, provides discrimination. The clipped signal from TR4 is applied via C9, and a series of fixed short duration pulses are produced across the collector load resistor, R9, there being one pulse for each input cycle. Thus, if input frequency increases, the average current through R9 increases also, causing the average voltage at TR5 collector to reduce. Similarly, if the input frequency decreases so does the average current in R9, with a consequent increase in the average voltage at TR5 collector. As a result, the average voltage at TR5 collector corresponds with the modulating voltage on the input signal. The series of pulses are at too high a frequency to be audible, but the average voltage at TR5 collector varies at audio frequency and constitutes the audio output of the discriminator.

TR6 is a common emitter audio amplifier having a fairly low gain due to the negative feedback provided by its unbypassed emitter resistor, R12. F.M. broadcast transmissions are given a certain amount of treble boost (pre-emphasis) as a simple method of noise reduction. The receiver must therefore be given a small amount of treble cut (de-emphasis) and this is the purpose of C12. In addition to providing treble cut, C12 also causes the pulses from TR5 to be integrated, thereby producing a conventional audio output. The collector load for TR6 is the potentiometer VR1, which acts as an output a.f. volume control. Resistor R11 is inserted in series with the positive supply to TR5 and TR6. This resistor causes hum level to be reduced when a mains supply is employed, and also decouples the positive supply lead if the tuner is power by a battery.

The method of reception employed in the tuner results in a somewhat unusual effect so far as tuning is concerned. Since the i.f. is only 150kHz a transmission can be tuned in both with the receiver oscillator 150kHz above the signal frequency and with it 150kHz below the signal frequency. With this low i.f. it is not feasible to provide r.f. tuned circuits which would allow reception at only one oscillator setting, and the overall effect is that there are two closely spaced dial settings at which each station can be received. Either of the dial settings may be employed. Since local stations on the f.m. band are well spaced out in terms of frequency, the double tuning effect has no adverse effect on performance.

Only two pre-set adjustments are required in the completed tuner. VR2 controls the amplitude of oscillation in TR2, and is adjusted to give the best sensitivity consistent with stable operation. VC3 is used to align the r.f. stage. No test gear is needed for either adjustment, and there is of course no complicated

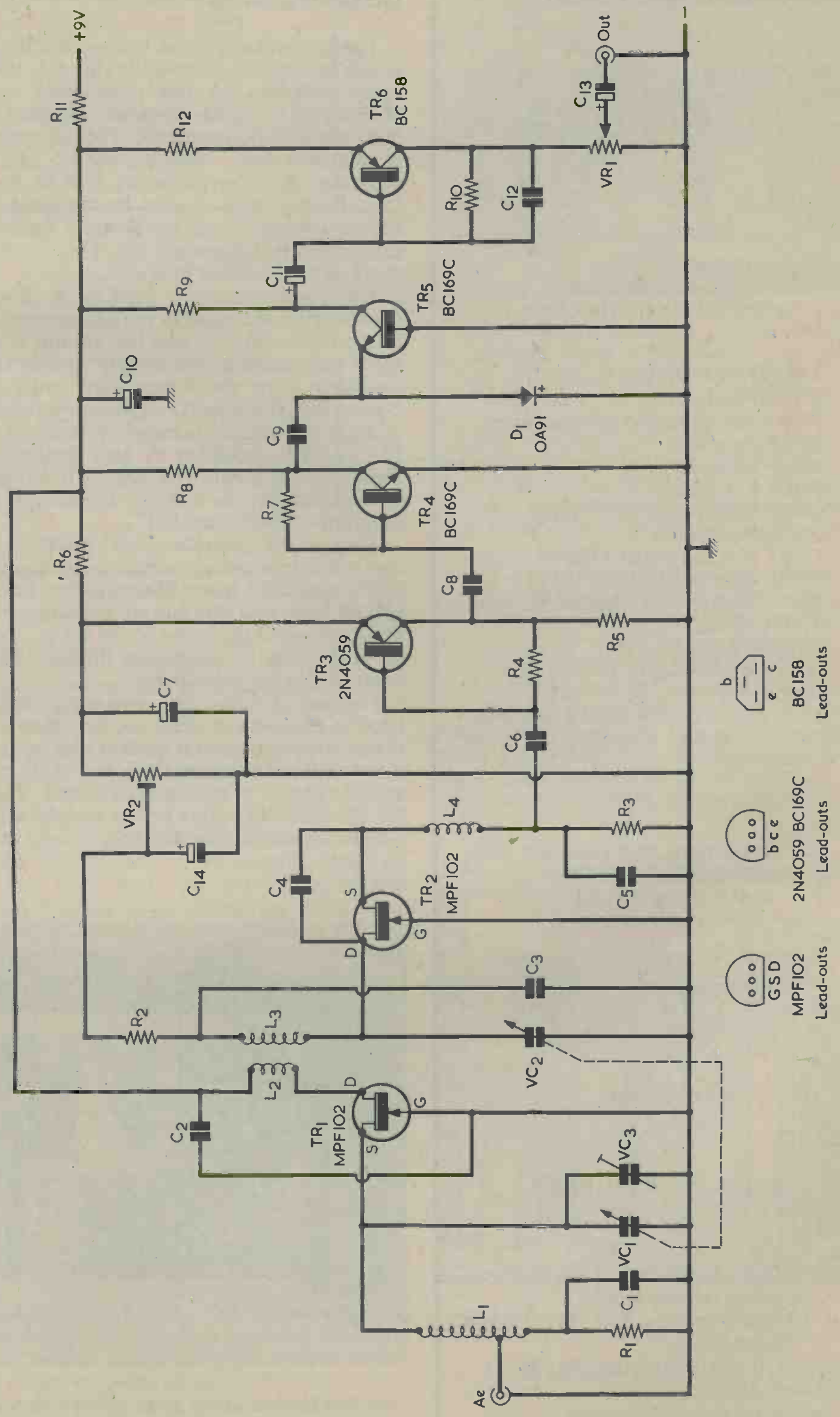


Fig. 3. The circuit of the f.m. tuner. This may be powered by a battery or by a mains supply unit

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)

R1	330Ω	R7	3.3MΩ
R2	1.5kΩ	R8	5.6kΩ
R3	10kΩ	R9	4.3kΩ
R4	820kΩ	R10	390kΩ
R5	6.8kΩ	R11	47Ω
R6	820Ω	R12	220Ω

VR1	5kΩ potentiometer, log
VR2	10kΩ pre-set potentiometer, horizontal skeleton (see text)

Capacitors

C1	5,000pF disc ceramic
C2	0.022μF polyester
C3	560pF polystyrene or silvered mica
C4	4.7pF ceramic
C5	100pF ceramic
C6	0.022μF polyester
C7	100μF electrolytic, 10 V. Wkg.
C8	0.022μF polyester
C9	150pF polystyrene or silvered mica
C10	100μF electrolytic, 10 V. Wkg.
C11	10μF electrolytic, tantalum bead, 16 V. Wkg.
C12	4,700pF disc ceramic
C13	10μF electrolytic, 10 V. Wkg.
C14	10μF electrolytic, 10 V. Wkg.
VC1, VC2	15 + 15pF variable 2-gang (see text)
VC3	5pF air spaced trimmer, miniature (see text)

Inductors
(Details in Part 2)

L1, 2, 3	Aerial, coupling and oscillator coils, home-wound
L4	R.F. choke, home-wound

Semiconductors

TR1	MPF102	TR5	BC169C
TR2	MPF102	TR6	BC158
TR3	2N4059	D1	OA91
TR4	BC169C		

Switch
S1(a)(b) D.P.S.T. rotary, toggle

Miscellaneous
2 Knobs
Vernier dial drive, 2 in., type T502 (Eagle)
2 tag strips (see Part 2)
Coaxial socket
Phono socket
2 'Universal' Chassis Sides, 8 by 4 in., Cat. No. CU56A (Home Radio)
6 4BA ½ in. threaded spacers, Cat. No. 7/Z56A (Home Radio)
Plain Veroboard, 0.1 in. matrix (see Part 2)
Aluminium sheet, 18 s.w.g.
Timber for cabinet ends (see text)
9-volt battery (optional – see text)
Battery connectors (optional – see text)

i.f. and discriminator alignment, as occurs with a conventional f.m. tuner or receiver.

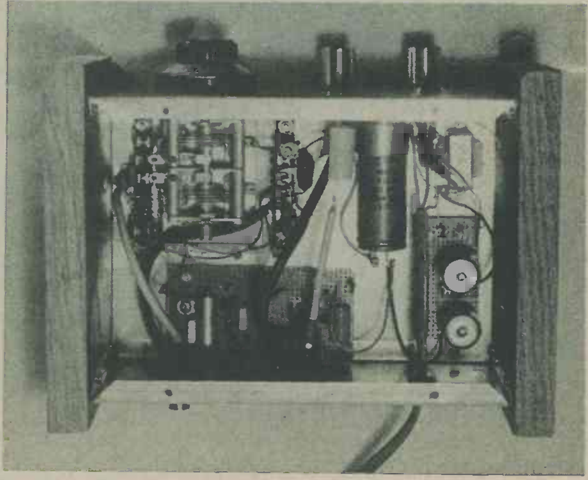
COMPONENTS

The components are in nearly all cases standard types which are readily obtainable through the normal mail-order suppliers. A few parts need some comment, however. C11 is, for instance, specified as a tantalum bead electrolytic capacitor. The capacitor needed here is available from Henry's Radio and a few other suppliers. VC3 is quoted as 5pF in the Components List. If this value cannot be obtained, the 10pF air-spaced trimmer listed by Henry's Radio as 'Type A1' can alternatively be employed. This component has been checked by the writer in practice.

The 2-gang capacitor used in the prototype has the construction indicated in the accompanying photograph of the tuner interior, and has a value of approximately 15pF each section. An exactly similar capacitor is not available from the larger mail order houses, but a 2-gang Jackson type 'O' capacitor having a capacitance of 16pF per section is listed by Home Radio. A 2-gang 25 + 25pF capacitor is also available from Home Radio, and this could be used as it stands, tuning being carried out over the first two-thirds of its travel from the minimum capacitance end.

The pre-set potentiometer specified for VR2 is a horizontal mounting skeleton component. The type 'PN', available from Electrovalue, Ltd., can be employed here, and this has tag spacing which allows it to fit directly into the holes of the 0.1 in. Veroboard panel on which the i.f. amplifier, limiter and discriminator components are mounted.

Further details on remaining components will become apparent as these are discussed in the constructional information, and readers who have queries on any other parts are advised to wait until the concluding article appears in next month's issue. The parts needed for the optional mains power supply will also be dealt with in the concluding article.



The interior of the tuner when it is fitted with a mains power supply unit. Modular construction permits a clean and uncluttered layout

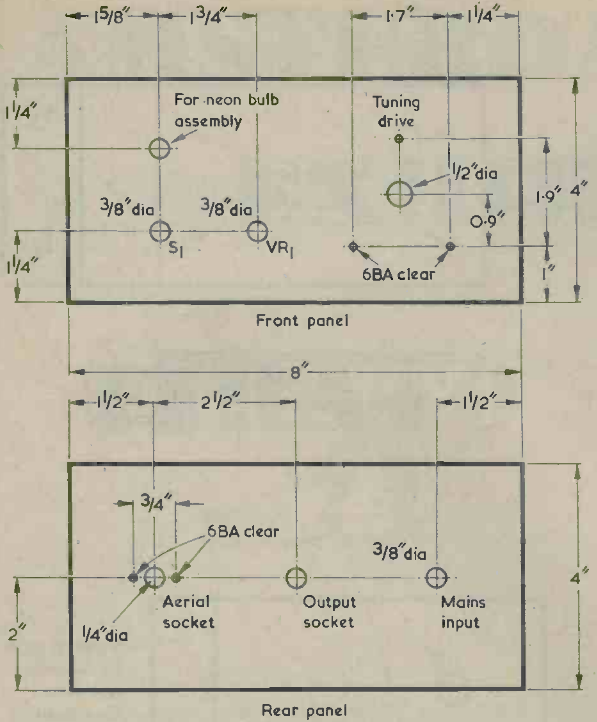
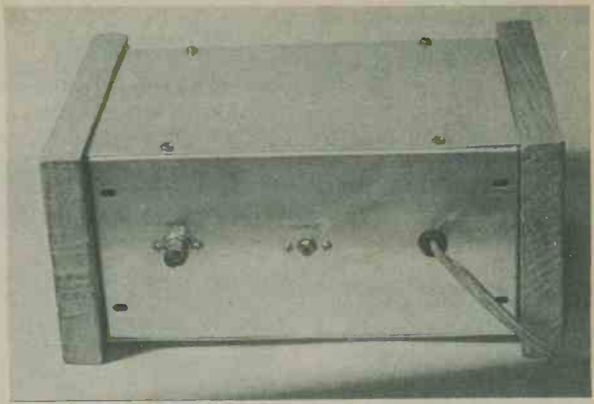


Fig. 4. Drilling details for the front and rear panels. The decimal dimensions apply to the tuning drive. Mounting holes at the output socket are drilled to suit the particular socket employed



The rear of the receiver. On this are mounted the coaxial aerial input socket and the phono output socket

CABINET

The cabinet is home-built and, as may be seen from the photographs, incorporates a 'book-end' mode of construction. The front and rear panels are Home Radio 'Universal Chassis' sides measuring 8 by 4 in. Fig. 4 gives drilling details for these. The hole for the neon bulb assembly is only required when the tuner is supplied by a mains power unit. The type of neon assembly employed is that which has its own integral series resistor and which may be connected directly across the mains supply. Switch S1 is a rotary double pole component and switches the mains when the mains power supply is employed, or the battery if the tuner is to be battery powered. It does not appear in the circuit of Fig. 3.

The tuning drive is secured to the front panel by three screws. The top screw is supplied with the drive, and it passes through the panel from the rear into a tapped hole in the drive. The lower two are $\frac{1}{2}$ in. 6BA screws (and nuts) and are obtained separately.

The aerial socket is an ordinary panel mounting coaxial socket. It is secured to the rear panel with two $\frac{1}{4}$ in. 6BA bolts, a solder tag being secured on the inside under one of the nuts. The output socket is a phono socket. The hole for the mains leads, if required, must be fitted with a rubber or p.v.c. grommet.

When panel drilling has been completed, the front and rear panels are secured to the wooden end cheeks. These measure 7 by $4\frac{1}{2}$ by $\frac{3}{4}$ in. thick, and are cut from $\frac{3}{4}$ in. timber. The panels are positioned $\frac{1}{4}$ in. in from the top and bottom, and $\frac{1}{2}$ in. in from the front and back of the end cheeks. Two holes are already drilled in each end flange of the panels, and it is through these holes that the fixing wood-screws pass. The cheeks are oak in the prototype.

The case is completed by two plates, top and base, cut from 18 s.w.g. aluminium sheet, each plate measuring 8 by $5\frac{7}{8}$ in. The base plate is secured to the lower set of flanges on the panels by six 6BA $\frac{1}{4}$ in. bolts, three to each flange. The requisite 6BA clear holes have, of course, to be drilled where required for these bolts. The top plate is made removable to allow access to the interior of the cabinet. It is secured to the upper set of panel flanges by four self-tapping screws capable of tapping into the existing flange holes.

A modular method of assembly is used, and Fig. 5

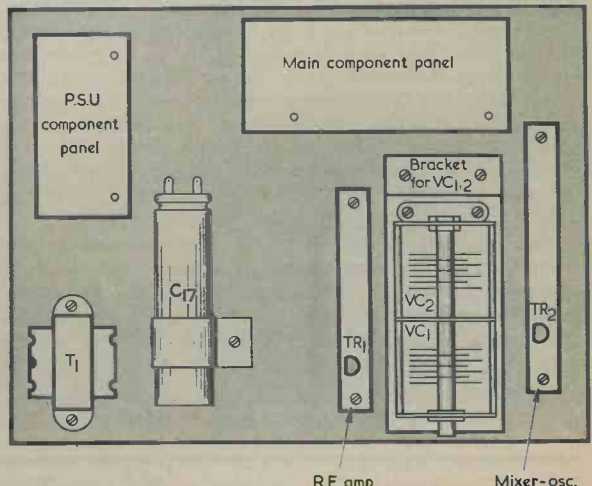
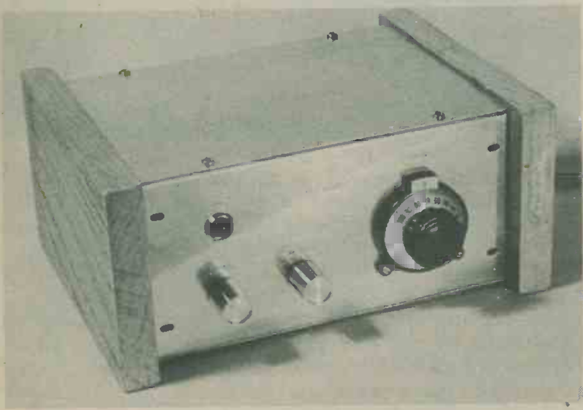


Fig. 5. General layout of the component modules on the tuner base plate. The positions of TR1 and TR2 are indicated so that the r.f. amplifier and mixer-oscillator sections (to be described in Part 2) can be correctly oriented

shows the positioning of the major components and the circuit modules. T1, C17 and the power supply unit component panel are not fitted if it is decided to have the tuner battery operated. The precise positioning of most of these parts is not critical, with the exception of the 2-gang tuning capacitor which must, of course, be positioned directly behind the tuning drive. Also, the r.f. and mixer modules should be positioned so that the two leads to the tuning capacitor fixed vane tags are reasonably short, and are not more than 1 in. long.



Another view of the front of the tuner. Legends cut from 'Panel Signs' Set No. 4 enhance the appearance

TUNING CAPACITOR MOUNTING

A mounting bracket is required for the 2-gang tuning capacitor VC1, VC2, and Fig. 6 shows two methods of providing this. The capacitor used in the prototype has its mounting holes on the underside of its frame and a bracket of the type shown in Fig. 6(a) is required. If the tuning capacitor has its mounting holes on its front plate (as has the Jackson type 'O' capacitor) the bracket should have the shape shown in Fig. 6(b). In both cases the purpose of the bracket is to raise the capacitor above the level of the tuner base plate and to align its spindle accurately with the tuning drive. No dimensions are given as these will depend on the particular capacitor employed. It is necessary for the capacitor and tuning drive to be aligned with reasonable precision as, otherwise, a smooth control of tuning will not be given.

The brackets in Figs. 6(a) and (b) are intended to be bolted to the base plate by means of 4BA bolts and nuts, and may be made from 18 s.w.g. aluminium. If possible, a thicker gauge of aluminium can be employed, should this be available, as it is desirable for the tuning capacitor to be mounted as rigidly as is reasonably possible.

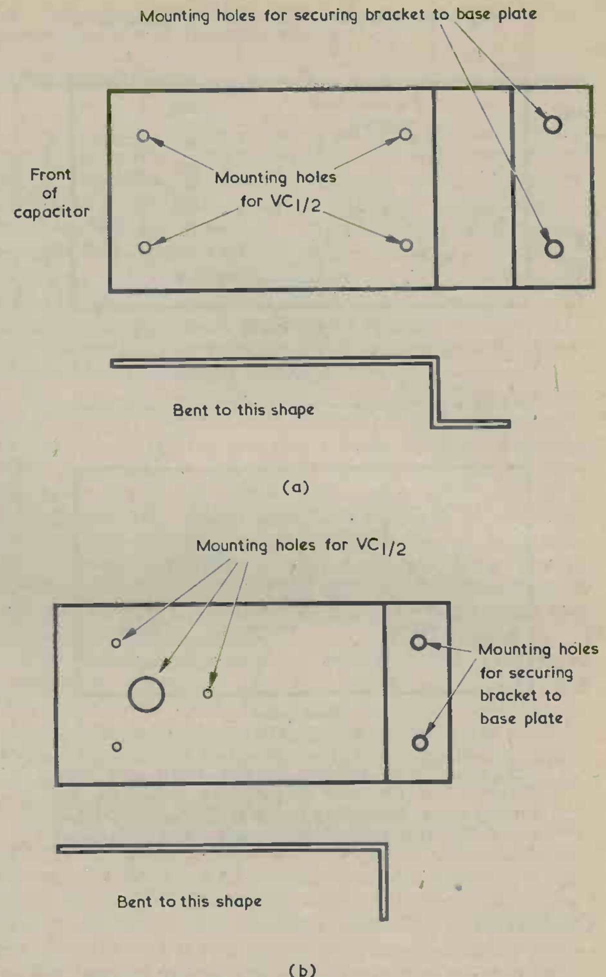


Fig. 6. The 2-gang tuning capacitor needs a mounting bracket to enable it to be mechanically aligned with the tuning drive. The bracket in (a) is suitable for capacitors having mounting feet, and that in (b) for capacitors with mounting holes in the front plate. Dimensions depend upon the capacitor employed

NEXT MONTH

The construction and setting up of the tuner will be described in next month's article. Details will also be given of the mains power supply unit.

(*To be concluded*)

DOUBLE REFLEX S.W. PERSONAL RECEIVER

In this receiver, described in the last October issue, D1 should be 1SJ50 and D2 1S44, and not as specified. The references to D2 at the end of the third line on page 153 and about two-thirds down the left column on page 154 now apply to D1.

AMSTERDAM RADIO EXHIBITION

FIRATO – 74

FIRATO – 74, HOLLAND'S RADIO AND T.V. Exhibition, was held recently. It is the 18th such exhibition and was thoroughly international in character, and was a good index of 'things-to-come' in the world of electronic entertainment; 24 countries exhibited.

Altogether there were 130 exhibitors; their exhibits covering radio and T.V., recording and playback equipment, video recorders, hifi audio equipment, aerial installations, electronic musical instruments, gramophone records, magnetic tapes, cassettes, etc., etc.

It was held in the Europa Hall, Amsterdam, and was jointly organised by RAI Gebouw B.V. and 'Stichting Firato Radiotentoonstelling' (Foundation Firato Radio Exhibition).

We visited the exhibition on the first day, and from the crowds present, no one could doubt the popularity of this type of exhibition and the interest shown in what's new in this field.

The coming popularity of video tape recording of T.V. was apparent from equipment to be seen on a number of Stands. Video tape recorders of very reasonable size were to be seen and complete 'set-ups' of portable video recorder, T.V. camera of a size comparable to an 8 mm cine camera, and interface ancillary equipment, were available. The price is of course high, when compared to current home movie equipment prices, but for schools, etc., it is well within the sort of price they would be happy to pay, and without doubt, as production of this type of equipment increases, so prices will come down. We came across some interesting facts and figures on this question of cost.

'A study of the price development of radio, T.V. and sound reproduction equipment in recent years reveals that these products are far less sensitive to inflation than consumer goods in other trades. Price increases are indeed inevitable, as soon as the general percentage of inflation exceeds the percentage of the savings achieved by large production series and improved efficiency'.

There was a wonderful range of portable transistor radios on view – many quite sophisticated covering the full shortwave range of frequencies. Small portable mono cassette recorders of many varieties indicated the present popularity of this type of entertainment unit and some very elaborate stereo tape recorders provided the more serious recording enthusiast with ideas for future developments in his particular field of interest. Stereo radio reception was well covered by numerous makes of tuner, and the HiFi enthusiast continues to be well catered for by high quality record players.

An interesting feature of the Exhibition was the inclusion of musical instruments of the more conventional type, as well as the electronic variety. There were for instance, several stands showing band and orchestral wind instruments, as well as a good variety of electronic organs.

One or two interesting novelties caught our eye. One was a 'black box', called a 'Rhythm Maker'. It appeared to be an electronic oscillator making 'noise'. The unit appeared to feed into the aerial socket of a portable transistor radio, from the loudspeaker of which then issued much amplifier noise! The pitch and rhythm of this could be changed by controls on the 'black box'. The numbers of enthusiastic pop fans surrounding this exhibit prevented us from getting more details.

It is customary on the Continent, to take one's TV programmes from a variety of transmitters, located in different directions and as often as not in countries adjacent to one's own. At one time, most elaborate aerial arrays were to be seen, with antennae pointing to half a dozen or so TV stations located in different directions. The appearance was truly reminiscent of the proverbial 'christmas tree'! All this is giving way to rotators, so that one good directive aerial array can be swung round from one direction to another as required. The design of many of these arrays was interesting, and we were intrigued to see at least one making use of a small dish antenna – real Space Age Stuff!

We naturally were particularly interested in the exhibits by firms dealing in Constructional Kits. These we thought covered the field of Home Construction of radio and electronic projects very fully, and the kits appeared to be complete and well presented with a good deal of thought having gone into the instructions. The home construction of electronic equipment is obviously a quite well patronised hobby on the Continent.

As with most Exhibitions, one would have had to spend several days there to thoroughly cover all the exhibits shown. One short visit left us in no doubt however, that the European Electronics Industry has lots of 'goodies' up its sleeve for catching the eye of future customers.

■

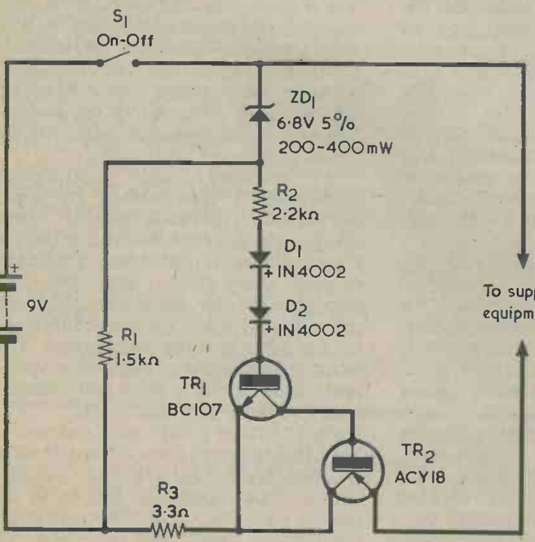
Battery Voltage Monitor

By G. B. Brown

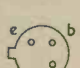
An ancillary circuit which prevents battery driven equipment operating at too low a supply voltage

QUITE A LOT OF TEST EQUIPMENT THESE DAYS IS BATTERY operated. A common practice here consists of incorporating a simple zener diode voltage regulator circuit to ensure that a stabilized supply voltage is available for the test equipment circuits. This is all very well in theory but, in practice, the voltage regulating circuit cannot normally cope with the situation where the battery voltage falls below the minimum at which the zener diode exerts control. What happens then is that the supply voltage in the equipment has a lower value than it should properly have, and the equipment is liable to give false readings or an otherwise incorrect performance. It is possible to guard against this state of affairs by periodically measuring the battery voltage or by fitting the equipment with a voltmeter. But the first of these approaches is tiresome and is liable to be forgotten, whilst the second incurs the expense of a permanently installed meter movement.

Circuit of the battery voltage monitor. This ensures that the supply voltage passed to the subsequent equipment falls to a very low value for battery voltages below 8 volts



R1–R3 1/4 watt 10%



ACY18 BC107
Lead-outs

MONITOR CIRCUIT

The battery monitor circuit described in this short article allows the test equipment circuits to function as their own voltmeter. Above a predetermined level the supply voltage applied to the equipment is the same as the battery voltage (minus a small voltage dropped across a turned on transistor). This situation continues down to the predetermined battery level; but below this level the supply voltage to the equipment falls very rapidly with only a small further decrease in battery voltage.

With the author's circuit, the nominal supply voltage is 9 volts and the predetermined level approximately 8 volts. Below the predetermined level the supply voltage to the equipment falls to 5 volts for a decrease in battery voltage of only 0.1 volt, to 3 volts for a battery voltage decrease of 0.2 volt and to 1 volt for a battery voltage decrease of 0.3 volt. The test equipment will give an obvious indication of low supply potential at these rapidly falling voltages, and will thereby indicate that a new battery is required.

In the circuit the zener diode gives a reference voltage of 6.8 volts, this being maintained at battery voltages below 8 volts by means of R1. TR1 and TR2 form a compound amplifier having a total current gain, typically, of some 15,000 times. Thus, a very small current in TR1 base is capable of turning TR2 hard on. As battery voltage decreases the voltage at the upper end of R2 falls at the same rate, whereupon there is a rapid transition from the conducting to the non-conducting state in the transistors as the two silicon diodes, D1 and D2, cease to pass forward current.

The voltage at which the transistors turn off is dependent upon the actual zener voltage, within tolerance, of ZD1 and the forward voltage-current characteristics of D1 and D2. If turn-off occurs at too high a voltage, one of the diodes may be removed from circuit. Lower turn-off voltages may also be achieved by using a 6.2 or a 5.6 volt zener diode in the ZD1 position.

Resistor R3 is a current limiting resistor and its function is to prevent excessive charging currents passing through TR1 when a high value electrolytic capacitor is connected across the equipment supply rails immediately after the monitor circuit. If such a capacitor is not fitted, R3 may be omitted.

The authr's unit gave a satisfactory serformance for load currents from 5.5 to 60mA. With a 60mA load current there was an 0.5 volt drop across R3 and TS2, of which nearly 0.2 volt was due to R3. The monitor circuit incurs a drain on the battery of 1.5mA at 9 volts. ■

THREE WAVEBAND TRANSISTOR PORTABLE

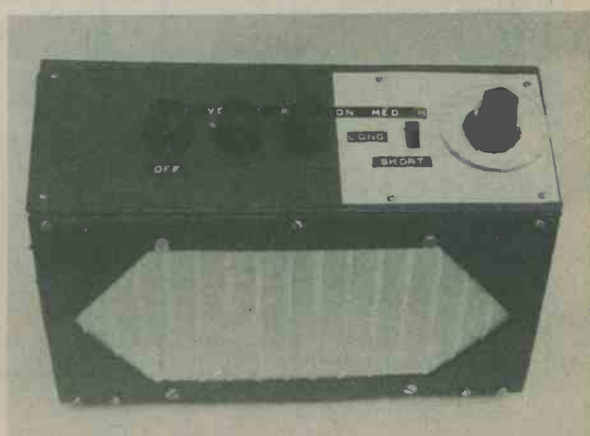
Part 1.

By
Sir Douglas Hall, K.C.M.G., M.A.(Oxon)

Covering long waves, medium waves and a short wave band from 19 to 60 metres, this receiver incorporates a 2-transistor reflex circuit which offers considerable amplification after its single aerial tuned circuit. Circuit operation and construction are described here, and next month's concluding article will give details of setting up and the assembly of a suitable case

THIS IS A THIRD ARTICLE DESCRIBING THE CONSTRUCTION of a receiver incorporating a new double reflex circuit which has been introduced by the author to readers of this magazine. The first article appeared in the May 1974 issue, and dealt with the 'Biflexette', a small 2-transistor portable covering medium and long waves and giving speaker reception of the more powerful stations. A double reflex short wave personal receiver was described in the second article (published in the October issue) and this consisted of an earphone receiver which required no external aerial or earth connection and which covered the short wave bands from approximately 19 to 50 metres.

The present article is devoted to the construction of a quite powerful three waveband portable working on long and medium waves and a short wave band extending from about 19 to 60 metres. Good loudspeaker reception is provided from a large number of stations on all three bands.



The completed receiver. This covers long, medium and short waves, and incorporates a sensitive reflex amplifying circuit

THE CIRCUIT

The circuit of the present receiver is shown in Fig. 1, in which TR1 and TR2 appear in the double reflex circuit. The operation of this configuration was discussed in detail in the article which dealt with the 'Biflexette', but a brief description will now be given as some readers may not have seen the earlier article or have it available. TR1 functions, at r.f., as a voltage amplifying f.e.t., feeding into TR2 which acts as an emitter follower. The r.f. signal is built up across L5, and diodes D1 and D2 provide detection. D1 offers a barrier to the passage of radio frequency current for purposes of reaction unless a small forward direct current is made to pass through it. This current is provided by the network comprising R2, VR1, R3 and R1, and its level is controlled by VR1. Since it varies the forward current in D1 and, hence, the impedance this diode presents to r.f. current, VR1 functions as a reaction control. A larger direct current is required on the short wave band, and this is obtained by short-circuiting R2 when short waves are selected.

Regeneration is in the Colpitts mode and C1 provides the tap into the tuned circuit on short waves. This capacitance is augmented on medium waves by C2, whilst on long waves C4 comes into use in parallel with C1. This is by way of choke L4, which offers a relatively low impedance at long waves and a considerably higher impedance at medium and short waves. Using a choke in this manner saves the extra switching which would otherwise be required, and it becomes possible to employ a simple 2 pole 3 way switch for wavechange purposes. The author used a double pole slide switch having a central off position.

The a.f. signal which appears after detection is passed, via the ferrite rod aerial coils, to the gate of TR1, which once more functions as a volage amplifier coupling to the base of TR2. This time TR2 operates as a common emitter amplifier, and the a.f. signal at its collector appears across volume control VR3. The signal at VR3 slider is then passed to the 'sliding bias' a.f. amplifier incorporating TR3 and TR4. Under no-signal conditions, base bias for TR3 is provided by way of VR4, D3 and R6. The collector current of TR3 is the base current for TR4, and VR4 is adjusted so that a small quiescent current flows in the two transistors. When an a.f. signal is applied to the amplifier it is rectified by D3 to produce an increased base bias current

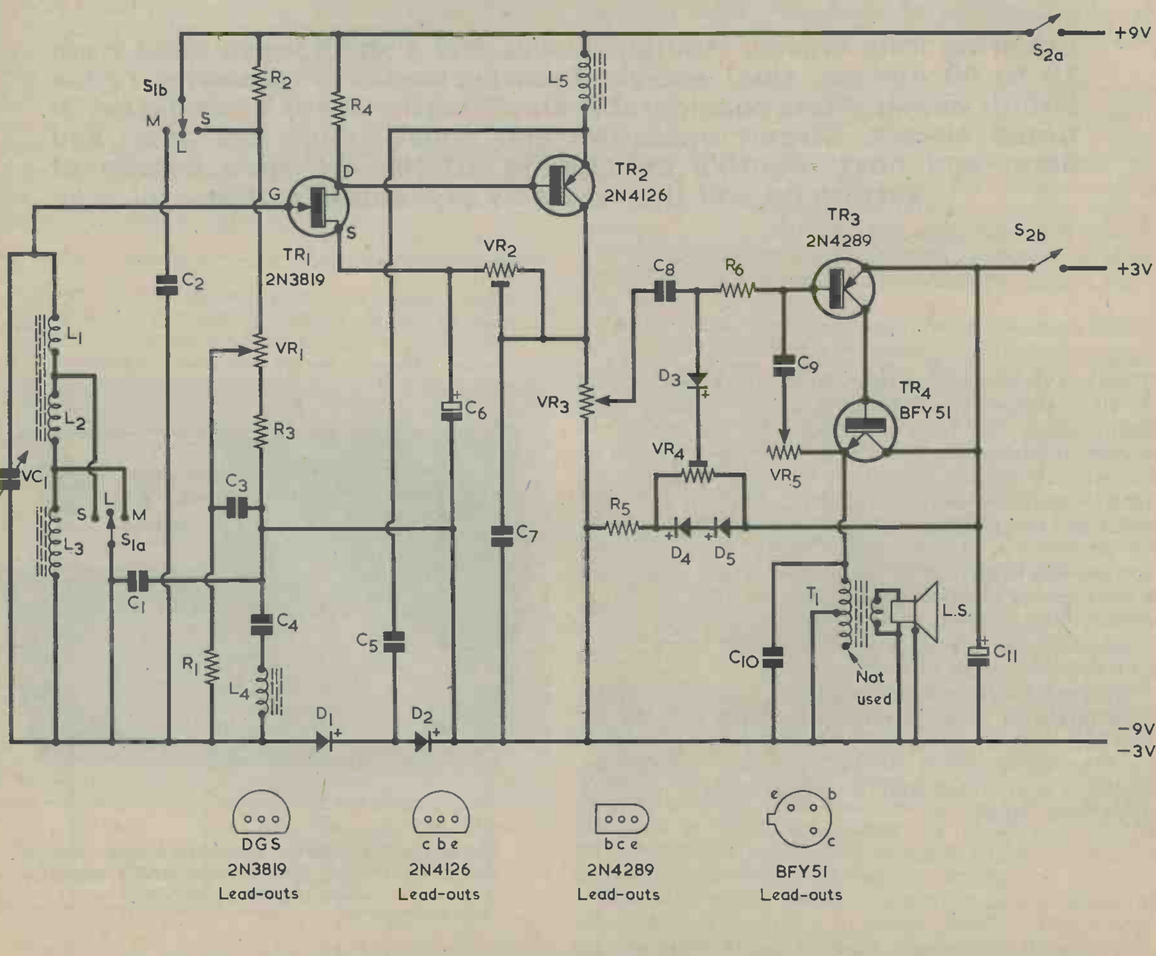


Fig. 1. The circuit of the three waveband transistor portable. TR1 and TR2 appear in a reflex circuit which offers amplification both at r.f. and at a.f.

COMPONENTS

Resistors
(All fixed values $\frac{1}{4}$ watt 10%)

R1	470kΩ
R2	1.5MΩ
R3	100kΩ
R4	3.9kΩ
R5	1kΩ
R6	10kΩ
VR1	500 or 470kΩ potentiometer, linear
VR2	27kΩ pre-set potentiometer, miniature slide
VR3	1kΩ potentiometer, log
VR4	1kΩ pre-set potentiometer, miniature skeleton
VR5	250 or 220kΩ potentiometer, log, with switch S2(a)(b)

Capacitors

C1	27pF silvered mica or ceramic
C2	68pF silvered mica or ceramic
C3	0.1μF polyester
C4	180pF silvered mica or ceramic
C5	1,000pF silvered mica or ceramic
C6	100μF electrolytic, 6.4 V. Wkg.
C7	0.1μF polyester
C8	0.1μF polyester
C9	0.01μF polyester
C10	0.1μF polyester
C11	800μF electrolytic, 4 V. Wkg.
VC1	150pF variable (see text)

Inductors

L1, L2, L3	see text
L4	1.5mH r.f. choke, type CH5 (Repanco)
L5	1.5mH r.f. choke, type CH5 (Repanco)
T1	Output transformer type TT56 (Repanco)

Semiconductors

TR1	2N3819
TR2	2N4126
TR3	2N4289
TR4	BFY51
D1	1SJ50 (R.S. Components)
D2	1S44
D3	1S44
D4	1S44
D5	1S44

Switch

S1(a)(b)	double pole switch, centre off, slide or toggle (see text)
S2(a)(b)	d.p.s.t. switch, part of VR5

Speaker
3Ω speaker, 8 by 5 in.

Batteries
9 volt battery type PP3 (Ever Ready)
3 volt battery No. 800 (Ever Ready)

Miscellaneous
Ferrite rod, 7 by $\frac{3}{8}$ in.
Ferrite rod, 3 by $\frac{3}{8}$ in.
Ball drive type 4511/F (Jackson Bros.)
Spindle coupler type EH16 (Bulgin)
18-way group board (see text)
PP3 battery connector
4 knobs
4 small rubber feet
2 small brass hinges
$\frac{1}{4}$ in. plywood
S.R.B.P. ('Paxolin') sheet
Fablon or Contact
Packet 1 in. spring clips No. LK2761 (Lektrokit)
Packet $\frac{3}{8}$ in. spring clips No. LK2721 (Lektrokit)
Speaker fabric
Bolts, nuts, washers, etc.

for TR3. The circuit functions such that, up to the overload point, the base bias available for TR3 is always greater than that needed to amplify the signal. This circumstance is achieved due to the negative feedback given by VR5 and C9, which reduces the gain of TR3 and TR4, together with the standing quiescent current which is initially present. Thus, TR3 and TR4 offer Class A amplification of the a.f. signal, drawing a current from the 3 volt supply which increases as signal strength increases. VR5 is made variable so that it may also function as a tone control.

D4 and D5 are included in circuit to stabilize the voltage across VR4, and thereby maintain the standing bias for TR3 as the battery voltage falls. These are silicon diodes and each gives a forward voltage drop of around 0.6 volt.

Transformer T1 couples TR4 to a 3Ω loudspeaker. The transformer ratio employed is a little over 4:1, and presents a load of approximately 50Ω to the emitter of TR4. A 35Ω speaker could have been used instead, thereby dispensing with the need for a transformer. However, such a speaker offers a relatively high resistance, causing much of the available battery voltage to be lost and the audible volume at maximum output to be considerably reduced. Transformer T1 has a low primary resistance and allows a higher output to be obtained. The need for a low resistance load for TR4 is of particular importance when a 3 volt supply is used. A 3 volt supply is attractive because it can be provided by an Ever Ready No. 800 (or equivalent) twin cell cycle lamp battery and this, at the time of writing, offers more power per penny than any other dry battery available.

COMPONENTS

Some points concerning the components required need to be dealt with next.

VR1, VR3 and VR5 should be small components. Those used by the author were type P20, available from Electrovalue Ltd., and having a body diameter of 0.79 in. Any other potentiometers of similar or smaller size may be employed. If difficulty is experienced in obtaining the 1kΩ log component required for VR3, a 5kΩ potentiometer may be employed instead with a 1.2kΩ resistor connected across its outside tags. The pre-set miniature slide potentiometer, VR2, is listed by Home Radio under Cat. No. VR101A. In the prototype, VC1 is an old but excellent Eddystone short wave air-spaced component. A suitable alternative is the Jackson

The parts which are visible inside the receiver when the hinged case is opened up

type C804 variable capacitor of the same value. Do not use a variable capacitor having metal end plates. Apart from D1 the semiconductors are generally available. It is essential to employ properly marked transistors. So-called equivalents may well be found not to work in this circuit. D1 is an R.S. Components diode type 1SJ50.

An 18 way group board is required. This is an R.S. Components 'Standard' group panel.

Two ferrite rods are employed, one being 7 in. by ⅜ in. and the other 3 in. by ⅜ in. Both of these will have to be obtained from a longer length of rod. The rod is marked with a file at the appropriate point and the excess then snapped off. The rods can be any grade other than blue grade, the latter being distinguished by a blue coding at one end. Blue grade ferrite is a low permeability type which is not suitable for the present receiver. It was handled by R.S. Components until a few years ago, and has since been discontinued. However, small stocks may still be held by some retailers.

As was mentioned earlier, the wavechange switch used by the author was a double pole slide switch having a centre off position. This type of switch is not advertised by the large mail order houses but readers who are fortunate enough to live near component retailers may be able to obtain one. Failing this, a double pole toggle switch with a centre off position can be employed. In the appropriate constructional diagrams which follow, the slide switch is assumed.

A flexible spindle coupler is required for VC1 and this should be an insulated type. The Bulgin type EH16 coupler can be employed here. In the hardware category are two small brass hinges, two 4BA bolts 2 in. long, two 4BA bolts 1¾ in. long and two 4BA bolts 1½ in. long. The 9 volt PP3 battery is held by a 1 in. spring clip (Lektrokit LK2761) and the 7 in. ferrite rod by two ⅜ in. spring clips (Lektrokit LK2721). These clips are available, in packets of ten, from Home Radio.

The speaker employed should have dimensions which do not exceed 8 in. by 5 in. by 3 in. If a speaker having any of its dimensions larger than these figures is used it will be necessary to amend the corresponding dimensions of the plywood and s.r.b.p. ('Paxolin') panels on which the parts are assembled.

CONSTRUCTION

Construction starts by taking the group board and cutting off three and a half pairs of tags (seven tags in all) so that it has the appearance shown in Fig. 2. Drill three ⅜ in. holes to take the bushes of VR1, VR3 and VR5. Then fit these three components and wire up these and the other parts in the manner illustrated in Fig. 2. For ease of presentation, some components are shown outside the group board in the diagram, but in practice they should all be within the group board outline. All component wiring should be as short as is reasonably possible. Transformer T1 is fitted by soldering its mounting lugs to the two tags shown.

Next turn to Fig. 3, which shows three items, all of which are cut from s.r.b.p. sheet. The item in Fig. 3(a) is merely a bracket, and its large hole takes a grommet in which is fitted the 3 in. ferrite aerial rod. The piece in Fig. 3(b) is a platform on which are mounted the PP3 battery and the No. 800 battery. The No. 800 battery is fitted between two 4BA 1½ in. bolts at holes E and C, with its positive terminal strip pressing against the bolt at hole C. A solder tag is fitted below at hole C, and the bolt provides the positive connection to the battery. A 4BA ¼ in. bolt at hole D, with a solder tag below, picks up the negative connection from the battery. When the battery is later fitted, its negative terminal strip is downwards, in contact with the ¼ in. bolt. The battery is then held down by means of the item shown in Fig. 3(c), this passing over the 1½ in. bolts and being secured by 4BA nuts on the top. The positions of holes A and B in Fig. 3(b) depend upon the speaker mounting holes, as also does the small hole in Fig. 3(a), and these three holes are marked out and drilled later.

Cut out a piece of Fablon 2 in. by 3 in. and leave all the backing paper on except for a ½ in. strip along one of the 2 in. sides. Wind the Fablon on to the 7 in. ferrite rod to form a loose-fitting sleeve 2 in. long. The ½ in. strip of exposed adhesive is last to be wound on and it thereby secures the end of the Fablon to itself. Wind 11 turns of 26 s.w.g. enamelled wire on this sleeve with the turns spaced out so that the coil length is 1½ in. Leave a few inches of wire at each end for later connections, securing the coil ends with a suitable adhesive tape. This is L1. Cut out a piece of Fablon 2½ in. by 3 in. and make a similar sleeve, 2½ in. long, for the 7 in. ferrite rod. Wind on 80 turns of 26 s.w.g. enamelled wire in a single layer with each turn touching the next. This coil is L2. Fit the two windings to the 7 in. rod so that they occupy the appropriate positions shown in Fig. 4(b). Both windings are in the same direction so that, when their inner ends are connected together, they are series-aiding. Make up a third Fablon sleeve 2½ in. long in the same manner as the two previous sleeves. This is fitted to the 3 in. ferrite rod. Wind on four pies of 90 turns each (360 turns continuous in all) of 38 s.w.g. enamelled wire. The pies may be about ⅜ in. wide and each separated from the next by about ⅛ in. This last coil is L3 and the winding of the ferrite aerial coils is now completed.

A ¼ in. plywood panel measuring 8½ by 3 in. is next cut out. This is the lower panel shown in Fig. 4(b) and the 7 in. ferrite rod is, later, fitted to this so that the rod and its mounting clips are just inside the adjacent long edge of the panel. A free margin of at least ¼ in. should be maintained inside the two 3 in. edges to take the edges of the receiver cabinet. Stick a piece of Fablon onto the panel over the area where the group board will

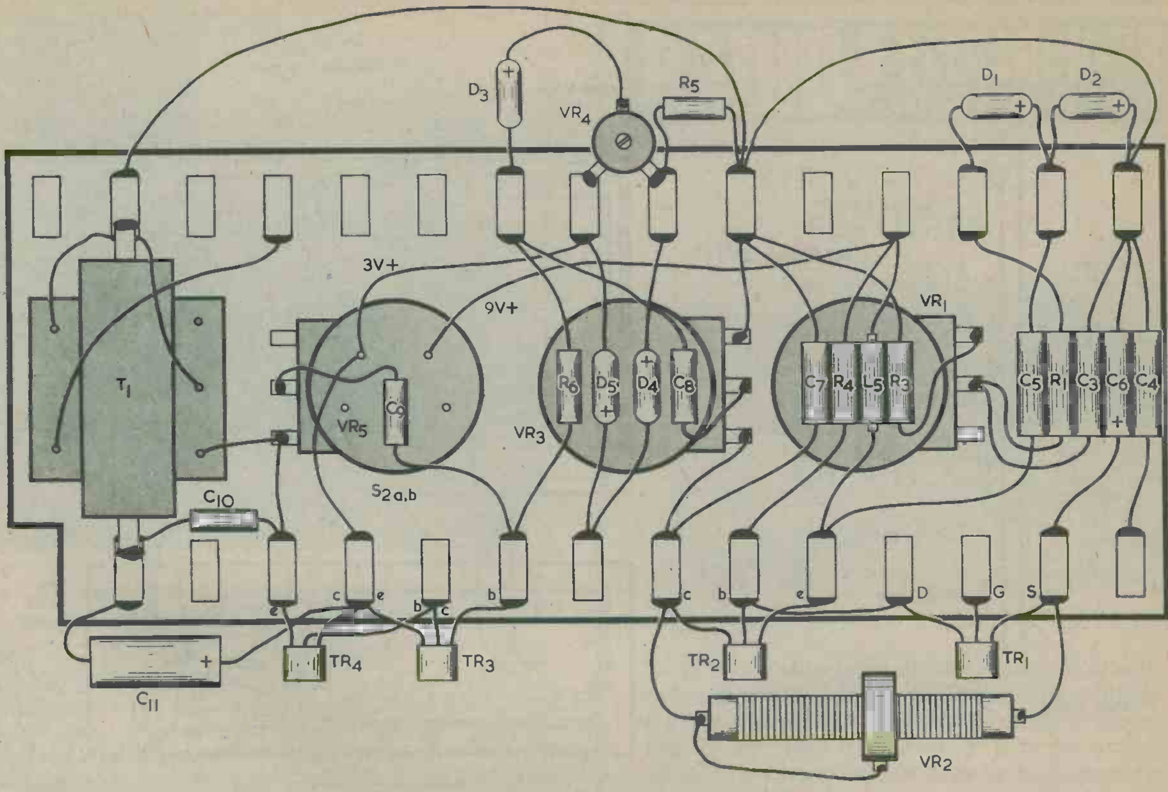


Fig. 2. Wiring on the group board. The 3 volt and 9 volt positive leads connect to separate poles of S2(a)(b)

be mounted, and make three holes to accept the bush mounting nuts of VR1, VR3 and VR5. The potentiometer spindles should be along the horizontal centre line of the panel, and this should allow just sufficient space on the panel for the 7 in. ferrite rod and its clips. Make a rectangular hole and two mounting holes for the slide switch S1(a)(b), or a single hole if a toggle switch is used here. The switch is just to the right of the group board, as seen in Fig. 4(b).

Also to be mounted are the tuning drive and flexible coupler for VC1, of which details are given in Fig. 4(a). A $\frac{7}{8}$ in. hole is required for the flange of the tuning drive, and its centre is on the horizontal centre line of the panel and 1 in. in from the adjacent 3 in. edge. The capacitor

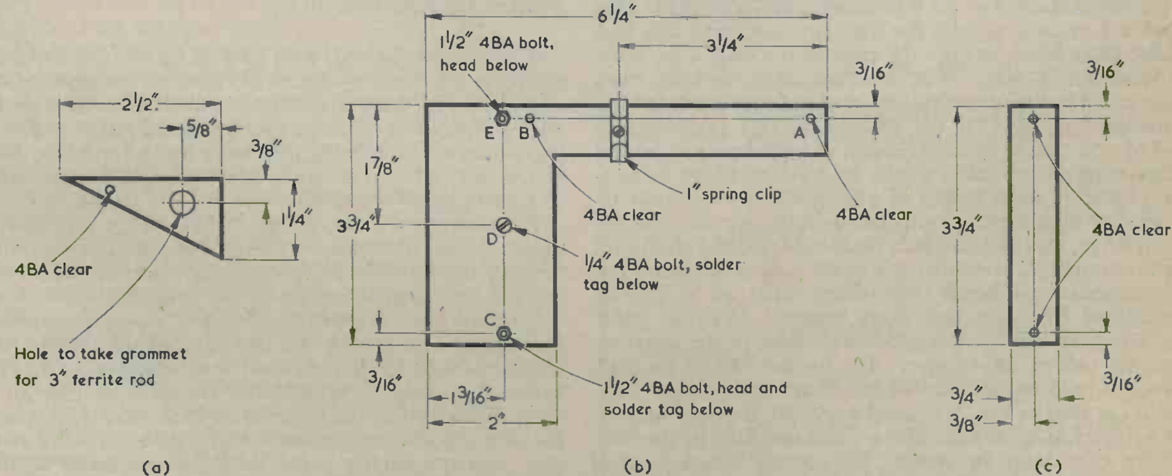
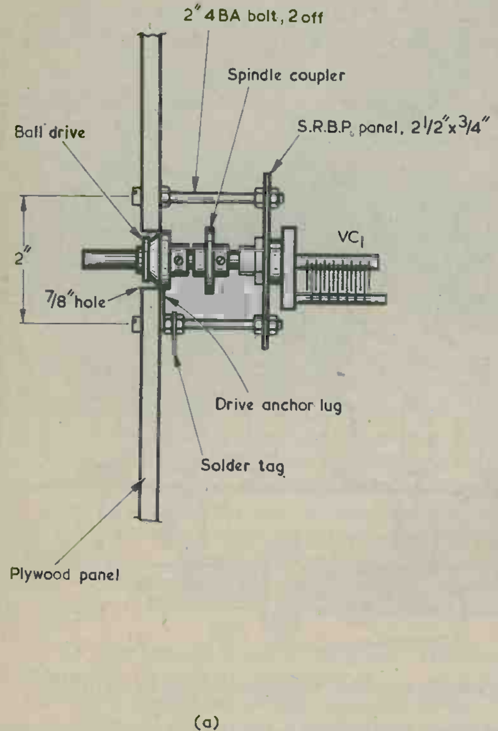


Fig. 3(a). The s.r.b.p. bracket on which the 3in. ferrite rod is mounted. The 4BA clear hole passes over one of the speaker mounting bolts

(b). Dimensions of the battery platform. The 4BA clear holes, A and B, pass over two of the speaker mounting bolts, and their positions depend upon the positioning of the corresponding mounting holes in the speaker frame

(c). The strip which secures the 3 volt battery



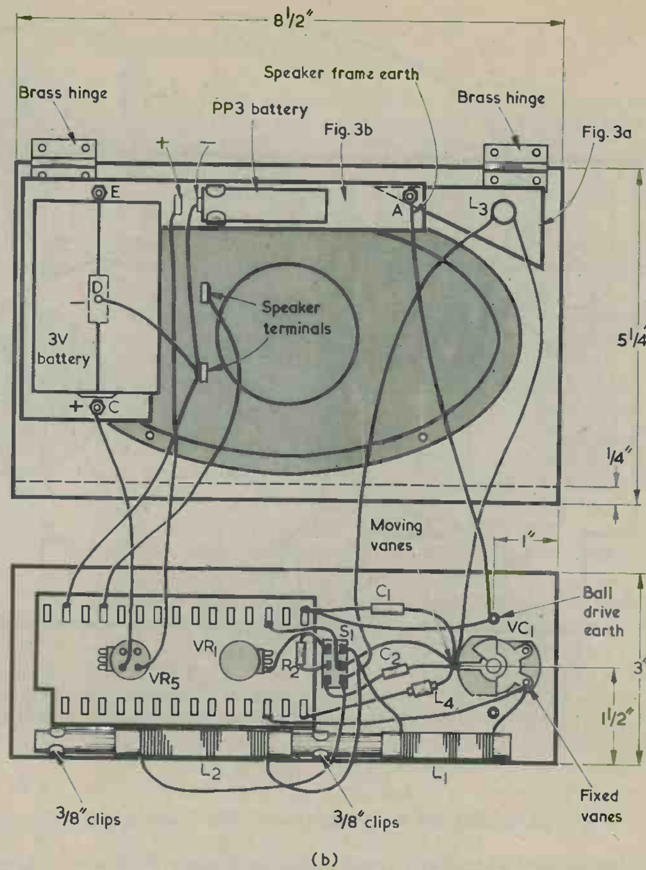


Fig. 4(a). Illustrating the manner in which VC1 is coupled to the ball tuning drive
(b). Final wiring steps on the plywood and speaker panels. Ensure that the two connections to S2(a)(b) on the group board correspond with the 3 volt and 9 volt switch poles shown in Fig. 2

is fitted to a strip of s.r.b.p. measuring 2½ by ¾ in. This has a ⅜ in. central hole for the capacitor bush and two 4BA clear holes to take the ends of the 4BA 2 in. bolts shown in Fig. 4(a). These space the capacitor back from the panel in the manner illustrated, leaving space for the insulated coupler. If the spindle of VC1 projects forward too much it may be cut, as appropriate, or the capacitor spaced back a little by washers on its mounting bush. A short length of ¼ in. spindle, which may be metal or insulated, appears between the coupler and the ball drive, and this can be a piece cut from the shaft of a potentiometer, or similar component. It is necessary for the spindle, and hence the moving vanes, of VC1 to be insulated from the ball drive because, to avoid hand capacitance effects, the latter is earthed to the negative supply rail of the receiver. The anchor lug of the ball drive is held under the 4BA nut securing the upper 2 in. bolt (as seen in Fig. 4(b)) and a second 4BA nut secures a solder tag to which the earth connection to the ball drive may later be made. The group board is now affixed to the plywood panel with short wood screws or countersunk bolts and nuts, after which S1(a)(b) and the VC1 mounting assembly are also fitted. It may be necessary to cut a small piece from a corner of the 2½ by ¾ in. s.r.b.p. strip to give clearance for the speaker frame.

FERRITE AERIAL

The 7 in. ferrite rod, with L1 and L2 on it, is fitted to the plywood panel by means of two ⅜ in. spring clips, as shown in Fig. 4(b). The clips are positioned as shown, with L2 between the clips and L1 to the right of them, this latter winding being free to be moved over the end of the rod. When it is finally adjusted, one or two turns of L1 will be off the rod.

Next cut out a piece of s.r.b.p. 8½ by 5¼ in. This is the upper panel illustrated in Fig. 4(b), and it has the speaker mounted on it. The speaker is fitted such that there is ¼ in. clear below its bottom edge, as seen in Fig. 4(b). If the speaker width is exactly 5 in., its upper edge will then be flush with the top edge of the panel. The surface of the s.r.b.p. panel below the speaker is screwed to the edge of the plywood panel when the two are, later, secured together. Mark out and drill four 4BA clear mounting holes for the speaker and then cut out a suitable aperture in the panel. Drill several holes at the bottom of the panel for the screws which will pass into the edge of the plywood panel. Four holes for the two hinges are also required, but it is better to leave these until later, when the case is being made up.

Bolt the speaker in place over a piece of speaker fabric. The two lower speaker mounting bolts in Fig.

The internal components, as seen from one side of the receiver

4(b) are $\frac{1}{2}$ in. long. The two upper bolts are $1\frac{3}{4}$ in. long and the first to be fitted is that at the left in the diagram. Before fitting the upper right-hand bolt scrape away the enamel at the speaker frame so that an earth connection may be made to this frame. Solder a piece of flexible wire to a 4BA solder tag, then fit the right hand bolt, securing the tag under the nut. Take up the s.r.b.p. piece of Fig. 3(a), and mark out and drill the 4BA clear hole in this such that, when it is passed over the upper right-hand speaker bolt, the piece will take up the position shown in Fig. 4(b). The right hand edge of the s.r.b.p. piece should be at least $\frac{1}{4}$ in. in from the adjacent $5\frac{1}{4}$ in. edge of the speaker panel. Fit the grommet and the 3 in. ferrite rod with L3 to the s.r.b.p. piece, pass the latter over the 4BA speaker bolt and secure it with a second 4BA nut. The 3 in. ferrite rod projects upward, perpendicular to the speaker panel.

Take the s.r.b.p. battery panel of Fig. 3(b) and mark out and drill the 4BA clear holes, A and B, on this such that, when the panel is passed over the two $1\frac{3}{4}$ in. speaker bolts, it takes up the position illustrated in Fig. 4(b). The left-hand edge of the platform should be at least $\frac{1}{4}$ in. in from the adjacent $5\frac{1}{4}$ in. edge of the speaker panel, and the upper edge (as seen in Fig. 4(b)) should be inside the top edge of the speaker panel. Solder a flexible lead to the solder tag at hole C of the platform and another lead to the tag at hole D. Fit a further nut over each of the $1\frac{3}{4}$ in. speaker bolts, pass the battery platform over these bolts, and fit two final nuts on top of the platform. Adjust these last four nuts so that the platform is held in a level position and just touches the frame of the speaker.

Complete the wiring shown in Fig. 4(b), this including C1, C2, R2 and L4. The wiring is carried out with the two panels disassembled.

The major part of construction is now complete. Next month's concluding article will deal with the procedure of setting up and the assembly of a case. The two panels of Fig. 4(b) are not secured together until the setting up has been completed.

(*To be concluded*)

ZENER CLIPPING CIRCUITS

By K. V. Logan

When current flows through a zener diode in the forward direction it acts just like any other silicon diode

WE ARE ALL FAMILIAR WITH THE SIMPLE ZENER DIODE voltage stabilizing circuit which is shown in Fig. 1(a). The voltage across the zener diode is equal to its zener voltage, within tolerance, and the circuit provides voltage stabilization when the series resistor passes a current which is greater than that drawn by the circuit which the stabilized voltage supplies. The remaining current then flows through the zener diode.

What happens if, as in Fig. 1(b), we reverse the zener diode? We will now find that the current which flows through the zener diode is the forward current which flows through any conducting diode. The semiconductor material in a zener diode is silicon, and in Fig. 1(b) the diode acts just like any other silicon diode. The voltage dropped across it is then of the order of 0.6 volt.

TWO VOLTAGE LIMITS

Thus, a zener diode can limit voltage excursion in both directions. For one polarity the voltage is limited at the zener voltage of the diode, and for the other polarity it is limited at 0.6 volt. This fact can be of advantage if we want to clip an alternating voltage.

Fig. 2(a) shows an alternating voltage having a value of 20 volts peak. We apply this voltage via a series resistor to a 10 volt zener diode in Fig. 2(b). Fig. 2(c) shows, in solid line, the voltage which appears at the upper terminal of the zener diode with respect to the lower earth line. During positive half-cycles the device functions as a zener diode, and the half-cycles are clipped at 10 volts. On negative half-cycles the device

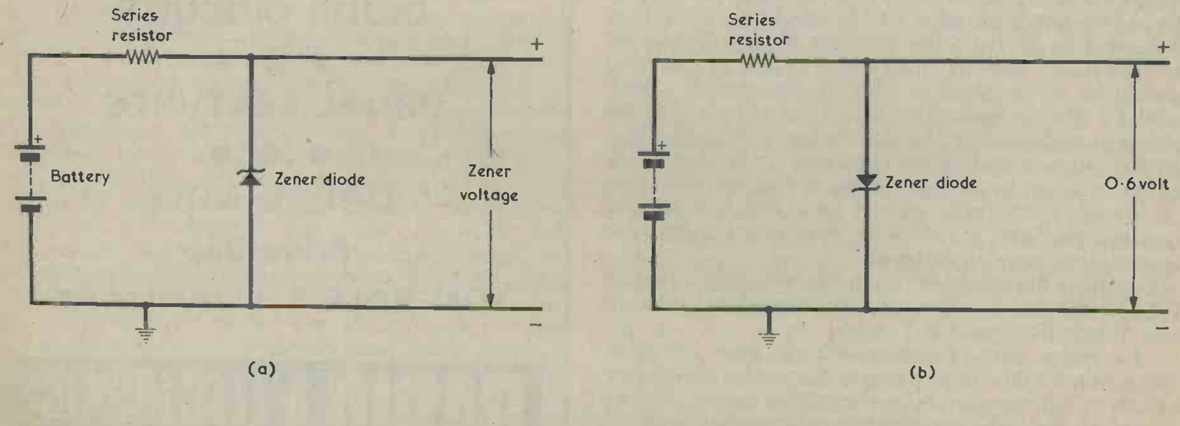


Fig. 1(a). A standard zener diode voltage stabilizing circuit
(b). In this circuit the zener diode is reversed, and it passes forward current

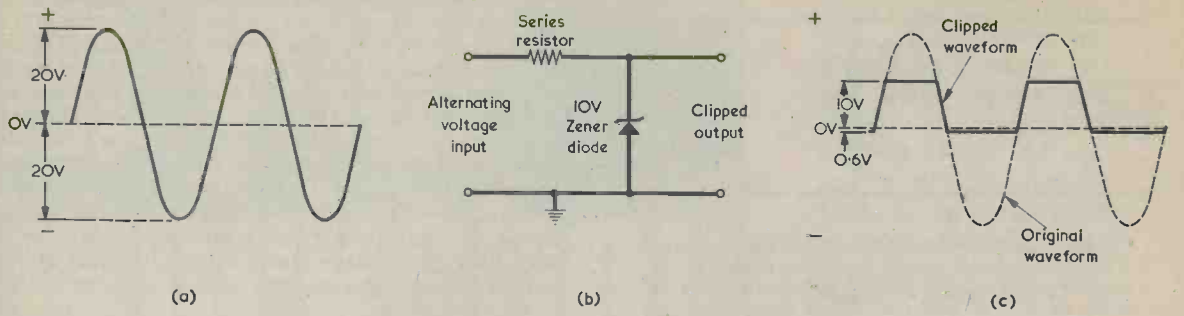


Fig. 2(a). A sine wave alternating voltage with an amplitude of 20 volts peak
(b). Applying the alternating voltage to a 10 volt zener diode
(c). The clipped waveform appearing at the upper terminal of the zener diode with respect to the earth line

functions as an ordinary silicon diode and it clips the half-cycles at 0.6 volt. In consequence, the diode has changed the original waveform to one having an amplitude of 10.6 volts peak-to-peak.

SPEECH CLIPPING

Speech clipping is often used in amateur transmitters to prevent over-modulation. A single zener diode can provide the clipping, but not in the circuit of Fig. 2(b) because the clipped waveform this gives is asymmetric and distortion would set in at the 0.6 volt clipping level. If, however, we feed the alternating voltage to the zener diode via a capacitor and take off an output via a second capacitor, as shown in Fig. 3(a), we would get symmetrical clipping at the output. Both capacitors need to have a low reactance at the frequency to be clipped. The first capacitor takes up a charge which allows successive half-cycles to be clipped at the same level along the half-cycle. These then appear, at the upper terminal of the diode and with respect to the earth line, in the form shown in Fig. 3(b). We now have symmetrical clipping of the alternating voltage. However, the horizontal centre line of the clipped waveform (which represents its average voltage) is mid-way between the positive and negative clipping levels and is positive of earth potential. This is the same as having a symmetric alternating voltage plus a direct voltage, and we remove the direct voltage by means of the second capacitor. The output waveform is then that shown in Fig. 3(c).

The circuit of Fig. 3(a) can be used to clip the output of a communications receiver driving high resistance 2,000Ω or 4,000Ω headphones. The two capacitors may be 0.2μF for this application and the limiting resistor can be of the order of 1.2kΩ. A low zener voltage is preferable and a useful value would be 3.6 volts. The diode can be a 400mW component. The output from the receiver is then limited to a peak-to-peak level of 3.6 plus 0.6, or 4.2 volts. This could protect the receiver operator's ears from that nerve-shattering sound which is given when accidentally tuning through a powerful transmission with the volume turned too high.

Two zener diodes connected back to back as in Fig. 4

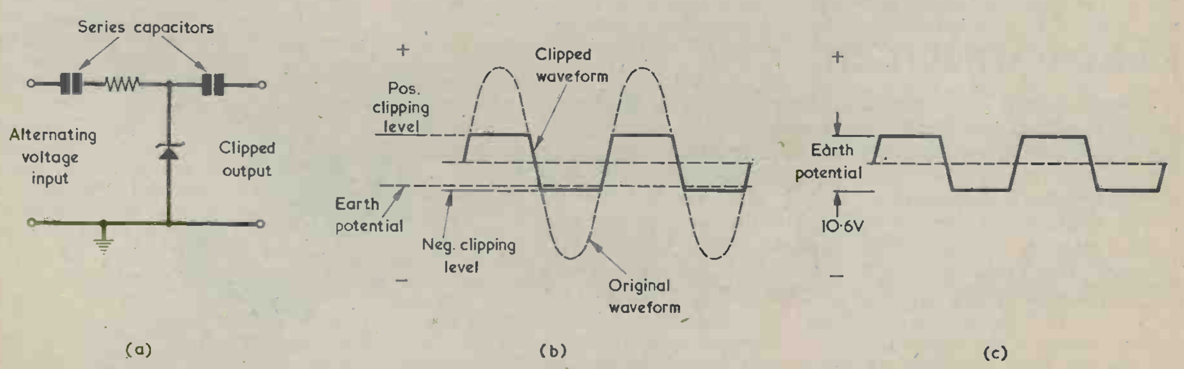


Fig. 3(a). Inserting capacitors in series with the input and output
(b). The clipped waveform is now symmetric, but its average voltage is positive of the earth line
(c). The second capacitor allows the average voltage of the waveform to become coincident with earth potential

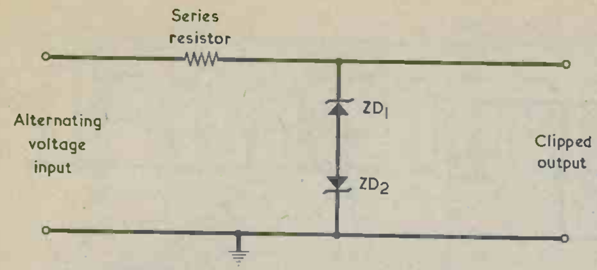
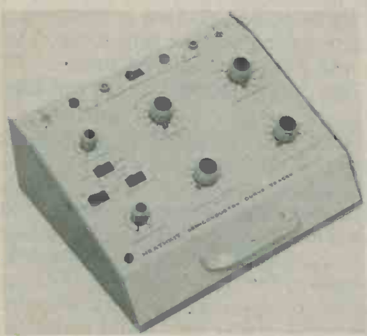


Fig. 4. Two zener diodes connected back to back provide symmetric limiting without the need for series capacitors, but limiting voltages cannot be made as low as with the single zener diode of Fig. 3(a).

give symmetrical clipping without the necessity for series capacitors, provided both diodes have the same zener voltage rating. When the upper input terminal in Fig. 4 is positive with respect to the earth line, ZD1 acts as a zener diode and ZD2 as an ordinary silicon diode. When the upper input terminal is negative, ZD1 acts as an ordinary diode and ZD2 as a zener diode. The peak level of the clipped signal is then the zener voltage of each diode plus 0.6 volt. This circuit does not offer clipping limit voltages that are as low as can be given by Fig. 3(a). With Fig. 4 the clipped peak-to-peak voltage (double the peak voltage with a symmetric waveform) is twice the zener voltage plus 1.2 volts, whereas in Fig. 3(a) the clipped peak-to-peak voltage is zener voltage plus 0.6 volt. ■

Trade News . . .

SEMI-CONDUCTOR CURVE TRACER



Anyone who works with solid-state circuits will appreciate the Heathkit IT-1121 Semi-Conductor Curve Tracer. Just connect it to any oscilloscope with horizontal sensitivity of 0.5V/div. and vertical sensitivity of 1V/div. and get an accurate display of operating parameters for virtually any discrete semiconductor.

Connecting the IT-1121 to a scope is easy with the plug-in cables supplied. A calibration switch permits fast, accurate scope calibration. You can display fundamental parameters such as gain (beta), leakage, breakdown voltage, saturation, forward conduction voltage, output admittance, linearity, capacitance effects, temperature effects and others. The extensive manual included in each kit tells how to interpret each display, making the IT-1121 a valuable educational aid.

Kit K/IT-1121, £52.95. Assembled A/IT-1121, £127.45 (including 8% VAT and delivery within United Kingdom.) FREE catalogue available from: Heath (Gloucester) Ltd., Gloucester, GL2 6EE.

PRINTED CIRCUIT KIT

A printed circuit kit from Eagle International of Wembley, Middlesex contains all the items necessary to reproduce a printed circuit to exact individual requirements. Designated the PK3 it is supplied in a durable case complete with comprehensive instructions.

The contents of the kit include: polishing powder, etch resist, etching liquid, resist remover, flux, copper clad phenolic circuit boards, stencil knife, spatula and etching tray. Recommended retail price of the PK3 is £2.86 excluding VAT.

In your workshop

This month Smithy the Serviceman, aided as always by his able assistant Dick, is engulfed in the flood of repairs which never fails to appear just before Christmas. The pair are eventually left with a simple stereo record player, but this offers a few unexpected effects before it is finally repaired

IT WAS THE MORNING OF CHRISTMAS EVE.

As always occurred just before Christmas, the Workshop presented a scene of frenzied activity as Dick and Smithy wrestled with the recalcitrant radios, record players and TV receivers which had chosen this, of all times, to go on the blink.

Outside, the unheeding crowds scurried about their Yuletide business, engrossed with the last-minute preoccupations of purchasing presents for suddenly remembered aunts, of calculating oven times against turkey weights from at least three different formulae in three separate cookery books, of dreading the arrival of mothers-in-law, and of parcelling up toy drums as gifts for the children of hated enemies.

The Festive Season had also left its imprint inside the bustling Workshop, and this gave evidence of Dick's dedicated labours during the previous week. All the window panes bore little circles of cotton-wool in neat parallel rows, apparently representing an arrested instant during a precise, geometrically controlled snow-storm. Two gaily coloured paper chains stretched from corner to corner, crossing each other at the lamp in the centre, to the flex of which they had been securely fastened. Stuck incongruously to the wall above Smithy's bench was a huge plastic Santa Claus, and stuck to the wall above Dick's bench was an enormous and equally improbable rubber reindeer. Both of these, seemingly poised without support in mid-air, gave the impression that the slightest tremor would bring them tumbling to the floor. But Dick, who was no slouch when it came to adhesives, had taken the precaution of fixing the figures in place with liberal applications of Araldite. The rest of the Araldite had come in useful too, and he had used it for sticking the mimic cotton-wool snow to the Workshop windows.

STEREO PLAYER

At the moment we join them, however, Dick and Smithy had no thoughts to spare concerning decorations or any other attribute of Christmas as they struggled with the sets they were servicing. Gradually the stock of receivers in the 'For Repair' rack diminished, whilst those which had been triumphantly carried over to the 'Repaired' rack increased in quantity. The morning passed on and, as Dick made his way yet again to the 'For Repair' rack, his first hurried impression was that there were still three units left on its shelves. The frown he had been exhibiting up to now suddenly changed to an expression of delighted surprise when he realised that the three units consisted of an inexpensive stereo record player and its two separate loudspeakers in their small cabinets.

"Hey, Smithy," he called out. "We're nearly at an end. I've just come to the last job!"

"Good show," grunted Smithy, from his bench. "I don't think I'll be long getting the TV I've got here finished, either."

Cheerfully, Dick carried the record player to his bench, after which he returned for the two speakers. He plugged these in at the rear of the record player unit then connected the latter to one of the row of mains sockets at the back of his bench. He switched on and listened expectantly. The record changer motor whirred just audibly into life but there was no evidence of any background noise or hum from the speakers. He selected a record from a battered collection on the shelf above his bench and placed it on the changer. Unfastening the transit clip which held the pick-up in position on its rest, he then set the changer in operation. The record clattered down onto the turntable. The pick-up arm rose, moved to the edge of the record and then gently descended. There was a thin reedy sound from the stylus in the record groove, but no corresponding output from the two loudspeakers. Dick adjusted the volume, tone and balance controls, but the speakers maintained their silence.

Leaning over towards the back of the record player he rocked each speaker plug gently in its socket, and then experimentally moved the speaker wires near the points where they entered their plugs. All this was to no avail and, as he gave the speaker plugs a last visual appraisal, he was mildly surprised to note that a jack plug had been inserted into another socket mounted on the rear panel. The jack plug served no obvious purpose, and it had no lead connected to it. Dick scratched his head, then reached forward and pulled the plug out of the socket.

At once the two speakers came to life and they reproduced the sound from the record at good volume and with quite acceptable quality. With a satisfied expression, Dick turned the volume down.

"How about that, Smithy?" he called out exultantly. "I've cleared this last job without even having to get inside the cabinet!"

"Hang on a jiff," replied Smithy over his shoulder. "Let me just get the back on this set of mine, and then I'll come and join you."

Smithy put the last screw into the back of the television receiver on his bench and gave it a final check.

Satisfied with its performance he switched it off, walked over to his assistant's bench and flopped down on his assistant's stool.

"Phew," he said, pulling out a handkerchief and mopping his brow. "What a morning!"

"Well, it's nearly over now," stated Dick consolingly. "This record player I've got here is the last thing we've got to do before Christmas. So far as I can tell, I've already got it working."

"What was the snag?"

"When I turned it on," said Dick, "there was no sound from the speakers. Then I found this jack plug stuck, all by itself, into a socket at the back. As soon as I pulled it out the speakers came on and since then the record player's been going like a bomb."

JACK PLUG

Dick handed the Serviceman the offending jack plug. Smithy looked at it critically.

"There's something queer here," he remarked, raising his eyebrows. "The socket this plug was in would be meant to give a stereo output. But this isn't even a stereo jack plug. It's just an ordinary quarter inch jack plug giving two connections at its tip and its sleeve."

"Does that matter?"

"Well," replied Smithy. "it certainly introduces an element of mystery. The stereo type of jack plug has three connections: one for chassis, one for the right-hand channel and one for the left-hand channel." (Fig. 1.)

"What's the socket for, anyway? For an extra pair of speakers, or something?"

"It's for stereo headphones, you twit. You don't seem to realise it, but there's a very wide range of stereo headphones available these days."

"Is there? What sort of impedances do they have?"

"Most of them," replied Smithy, "have impedances in the 8 to 16Ω range, but a few go up to 600Ω or so. They're all hi-fi jobs and many of them use moving-coil assemblies to reproduce the sound."

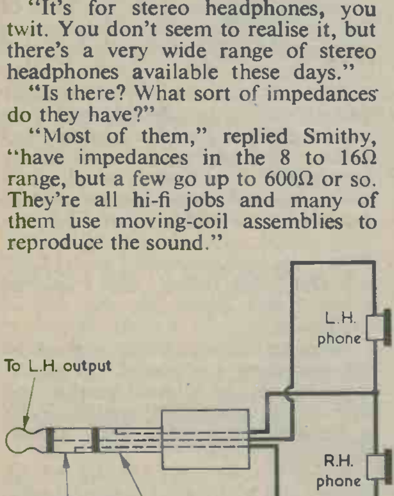


Fig. 1. Stereo headphones may be coupled to an amplifier by means of a 3-way jack plug. Typical connections are illustrated here

"Blimey," remarked Dick, impressed with this information. "I wonder what advantage there is in using hi-fi headphones? Why not just listen to the loudspeakers?"

"Apart from anything else," explained Smithy, "using stereo headphones means that you can listen to hi-fii without disturbing anyone else. Also, the phones help to keep out extraneous sounds."

Dick considered the situation.

"Stereo on headphones, eh?" he remarked eventually. "I suppose that if you turn your head to the right the whole orchestra moves round with you!"

"Let's not get involved in minor details," chuckled Smithy. "And let's concentrate on this record player instead. Now it's obvious that its jack socket is wired up so that the speakers are muted when a plug is inserted." (Fig. 2).

"Fair enough," said Dick, "but why was the plug put there in the first place?"

Smithy frowned, then shrugged his shoulders.

"Goodness alone knows," he remarked helplessly. "Some customers do very strange things with their equipment, as you know. Perhaps somebody found the plug lying around and thought it belonged to the record player because it fitted the socket. Or it may have been a kid larking around. At any event, I don't think we'd better assume that we've made the record player completely serviceable just by pulling that plug out. There may have been another snag, and someone then put the plug in before the player was picked up for repair."

"Well, I hope that's not the case," remarked Dick. "I've had enough of fault finding for now. I want to get off on my Christmas holiday."

"So do I," confessed Smithy. "Anyway, we'll give this record player a quick check."

By now the record on the turntable had played to its end. Smithy set up the changer and started to play the record once more. Experimentally, he adjusted the record player controls.

"The volume control," he remarked, "is working okay. Ah yes, and so are the tone controls. And there doesn't seem to be any noticeable distortion on either channel. All that's left is the balance control."

Smithy adjusted the balance control over its range to find that, whatever its setting, the volume level on both channels remained entirely unaltered. He checked again. But it was quite evident that the control was having no effect whatsoever on the output levels of the two channels.

"There *is* a snag," he sighed. "Still, it should be a pretty easy one to clear up. Pop over to the filing cabinet, Dick, and get out the service manual for this record player. If it's going to be our last job before the Christmas holiday, we might as well tackle it in the correct routine manner."

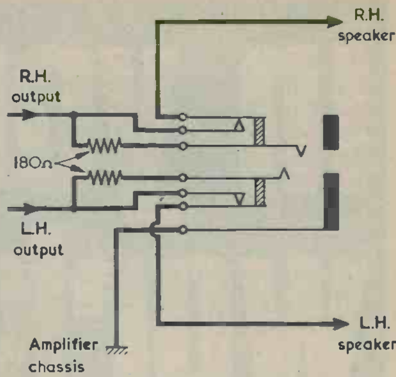


Fig. 2. A stereo headphone jack which automatically switches off the speakers when a jack plug is inserted. The outputs to the headphones are attenuated by series resistors, a representative value being shown

Whilst Dick went in search of the manual, Smithy cycled the changer to its stop. After the pick-up arm had descended on its rest and the turntable had become disengaged he switched off the record player. He next slipped the transit clip over the pick-up arm, turned the player on to one side and started to remove the screws which held its cover underneath.

"This balance circuit looks dead simple," remarked Dick, returning with the service manual. "Here is is."

He placed the record player manual on the bench and pointed his finger at the circuitry around the balance control. (Fig. 3).

Smithy glanced at the circuit briefly.

"Yes," he agreed shortly, "it's the elementary arrangement you frequently get in these record players. All it consists of is a pot whose slider goes to chassis, and whose outside ends couple into the left and right channels after the pre-amplifier stages."

"You couldn't have anything much easier," remarked Dick, continuing on the theme. "When the slider of the pot goes downwards it causes less resistance to appear across the left-hand pre-amplifier output and more resistance to appear across the output of the right-hand pre-amplifier. The result is that the left-hand channel offers lower gain and the right-hand channel gives greater gain. And the reverse happens if the slider of the pot goes upwards."

"Exactly," confirmed Smithy, still busy with the screws securing the bottom cover. "And the end result is that you can set the balance control so that both channels give the same level of gain. Ideally, you should be able to set the balance control for equal sound from each speaker whilst playing a mono record."

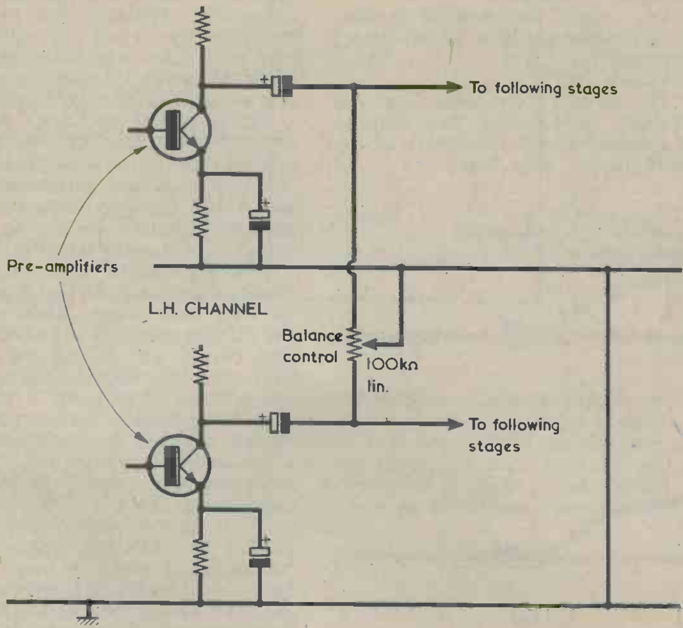


Fig 3 A simple balance control network

"This particular balance circuit," commented Dick, frowning, "seems to be pretty fierce in operation. Why, you can adjust the pot for zero output on either channel. When the pot slider is at the bottom of its track the left-hand channel is killed completely. The same thing happens with the right-hand channel when the slider is at the top of its track."

"True," agreed Smithy, "the amount of control *is* very high. Some record players have equal value resistors in series with the balance control track ends so that the range of control is reduced. But others use a circuit of the type we have here. I suppose the idea is that a balance control of this nature satisfies the more compulsive type of knob twiddler. If he finds that one or other of the channels is completely silenced when the control is at the ends of the range, then he will be quite convinced that there must be a setting in the middle which gives correct balance." (Fig. 4).

OPEN-CIRCUIT

Smithy put down his screwdriver and removed the cover.

"Now what," he queried, "do you think will be the most likely cause of the snag we've got here?"

Dick thought for a moment.

"Since," he suggested, "the balance control has no effect on either channel, I would guess that the fault is common to both sides. Most probably there's an open-circuit between chassis and

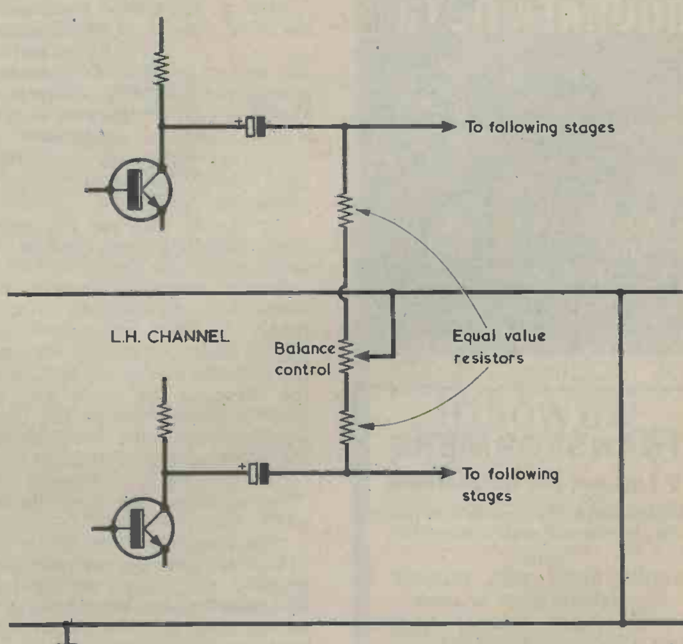


Fig. 4 In some stereo amplifiers the range of the balance control is reduced by inserting equal valve resistors in series with the track ends

the slider of the pot, or between the pot slider and its track."

"Very good," commended Smithy. "Let's next have a quick shufti inside. Oh dear!"

"What's up?"

"The chassis connection for the pot slider," said Smithy, "is to a solder tag eyeletted to the metalwork of the record player." (Fig. 5(a)).

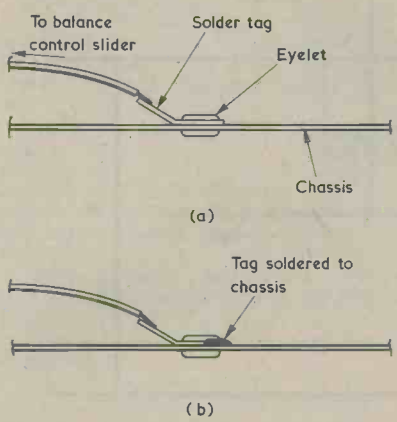


Fig. 5(a). The chassis connection for the balance control slider in the record player serviced by Smithy was made by way of a solder tag eyeletted to the chassis metalwork
(b). To obviate the risk of a future intermittent connection, Smithy soldered the tag over to the chassis

"Is that bad?"

"It can be. Anyway I'll just check for continuity between chassis and the centre tag of the pot."

Smithy pulled Dick's testmeter towards him and set it to a low ohms range. He next connected one test clip to chassis at a point remote from the eyeletted solder tag and connected the other to the centre tag of the balance potentiometer. The testmeter needle was deflected only slightly from the left-hand end of its scale.

"Blow me," remarked Dick. "You've found the open-circuit first go!"

"Now watch."

Smithy picked up a screwdriver and prodded the chassis tag lightly with its blade. At once the testmeter needle moved over to the right, to indicate zero ohms.

"See what I mean?" went on Smithy. "That eyelet probably wasn't thumped down hard enough at the factory, with the result that the contact between the solder tag and the metalwork had gone high resistance with time. Now that I've moved the tag the connection between the two will probably stay good for months or even years before it goes high resistance again. However, I'll make certain that *this* one doesn't go high resistance."

Smithy picked up Dick's soldering iron and a piece of solder, then applied them to the solder tag and the metalwork surface. After some moments the tag and metalwork were soldered together over most of the round section of the tag. (Fig. 5(b)).

The Serviceman next turned the record player over so that it stood on its base once more. After releasing the pick-up arm clip he switched it on and played the record once more. This time the balance control carried out its function correctly.

"Hooray," said Dick exuberantly, "that's the last job finished before Christmas."

He listened critically to the music from the speakers.

"That stereo player sounds jolly good," he remarked appreciatively. "I suppose it won't be long, though, before we'll be looking upon stereo as old hat and we'll be spending our time fixing up quadraphonic record players."

"It probably won't be long," agreed Smithy. "Four channel reproducing systems are a bit pricey at the time being but these are early days yet. Incidentally, it's possible to get a subjective 'all-round' sound effect with just the output of a stereo record player. Indeed, the scheme is used with some U.K. manufactured stereo amplifiers."

"Is it?" remarked Dick, surprised. "How does it work?"

"It works," replied Smithy, "by having two extra speakers which are positioned behind the listener. These are then fed with the channel difference signals at reduced level. Here's the idea."

Smithy scribbled out a circuit in the margin of the service manual (Fig. 6).

"What happens here," he went on, "is that the front right and front left speakers reproduce the right and left channels in normal manner. The two rear speakers are connected in series across the right and left outputs with a resistor between them to reduce their power level. When they're phased in the manner I've shown, the right-hand rear speaker reproduces an R-L signal and the left-hand rear speaker reproduces an L-R signal."

Dick looked at Smithy's circuit thoughtfully.

"Are those plus and minus signs alongside the speakers intended to indicate phase?"

"They are," confirmed Smithy. "They can, for instance, indicate the polarity across each speaker which is needed to make the cone move forwards, and this could be determined physically with the aid of a small dry battery applied to the speaker terminals."

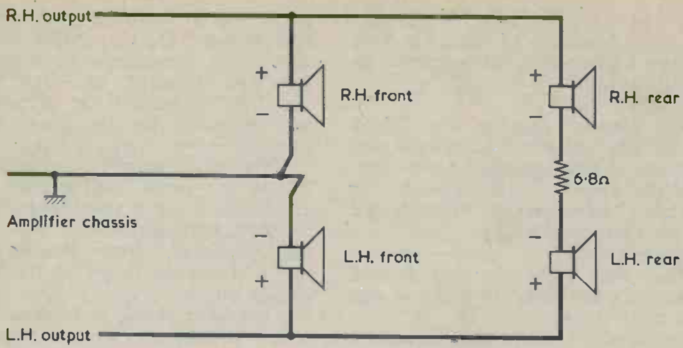


Fig. 6. A circuit which allows two loudspeakers behind the listener to reproduce the channel difference signals. The rear speakers should have the same impedance as the front speakers and the value shown for the resistor between them is representative .With high power amplifiers the resistor requires a rating of 3 watts. This circuit represents the '4D' mode of reproduction used in some Thorn stereo amplifiers

"How is it," asked Dick, "that the right-hand rear speaker reproduces an R-L signal whilst the left-hand rear speaker produces an L-R signal?"

"Simply because they're connected out of phase with each other," replied Smithy. "It's fairly obvious that the rear right-hand speaker is producing an R-L signal because the right-hand signal is applied to it in phase and the left-hand signal is applied to it out of phase. You can use the same sort of reasoning to see why the rear left-hand speaker produces an L-R signal. Don't forget that you indicate a reversal of phase by a minus sign. If you put R-L into brackets and put a minus sign in front, then the result when the brackets are removed is –L+R, or L — R!"

PILOT LAMP

"Well, that's a speaker system I didn't know about before," pronounced Dick. "Anyway, now that we *have* finished work let's start thinking about Christmassy things."

He leaned forward, opened a drawer in his bench and produced a small parcel wrapped in colourful paper. This sported a motif of robins and holly leaves intertwined against a background of snow.

"Here we are, Smithy," he announced, "here's my present for you."

"Ah, thank you, lad," intoned Smithy, taking the parcel from him. "Now let's see what we have here."

Carefully, the Serviceman removed the wrapping paper and placed it on one side. He looked doubtfully at Dick's present.

"Do you like it?" asked Dick eagerly.

"Why yes, of course," said Smithy uncertainly.

"I spent a lot of time choosing it."

"I'm certain you did."

"In fact it should just suit you."

"I have no doubt of it."

"The salesman said it was the most colourful tie he had in the shop."

"Oh, it's a *tie*," said Smithy. "Dear me, it's very wide, isn't it?"

"Not at all," responded Dick briskly. "Wide ties these days are all the rage, you know."

"I'm certain I'm most grateful," responded Smithy. "Now, let's see what I've got for you."

He walked over to his bench and returned with a package. Its wrapping paper had a pattern of robins and holly leaves intertwined against a snowy background.

"Why, that's a coincidence," remarked Dick. "Just the same paper that I used."

He removed the paper, then dubiously examined the contents of the package.

"Er – –," he remarked hesitantly, "they're very nice."

"I was sure you'd appreciate them," said Smithy cheerfully. "They should fit you just right."

"Fit me?" queried Dick suspiciously. "Whereabouts?"

"Why, on your shoes, you idiot. They're galoshes."

"Galoshes?"

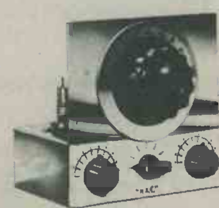
"Galoshes," repeated Smithy. "You slip them over your shoes."

"Sounds kooky to me," remarked Dick disapprovingly. "Do people actually go around with things like these over their shoes?"

"Of course they do," returned Smithy irritably. "They're to keep out the rain and the snow."

"Oh, I see," said Dick, relieved. "Well, they should be jolly useful to me. Thanks very much, Smithy."

"I'm glad you like them," said



Smithy in a mollified tone. "I must say it's very pleasant to have a nice mellow Christmassy atmosphere in the Workshop."

"Yes, isn't it?"

Dick glanced over at the record player. The record had finished and the pick-up had returned to its rest. Suddenly, Dick's eyes sharpened.

"Hello," he remarked, "There's still one little job outstanding."

"What's that?"

"The pilot light on that record player isn't working. Oh well, we can soon clear that!"

Impulsively, Dick turned the record player on its side and peered inside its cabinet. At once the pick-up arm left its rest and banged against the centre spindle of the changer.

"Trust you to knock things about," snorted Smithy irately. "Hadn't you better switch that player off before you start poking around inside?"

"There's no need," replied Dick airily, "it's only low voltage round the pilot lamp. Ah, here we are. The pilot lamp holder is one of those m.e.s. types that slide on and off. Wait a minute, it's a bit stiff."

Dick pulled at the refractory lamp holder. It suddenly came free, whereupon it shot out of Dick's grasp and, at the end of its two leads, rested on the case of one of the transistors on the printed circuit board. A frighteningly loud and raucous hum was reproduced by the left hand channel speaker, and Dick hastily flicked the bulb holder away from the transistor. The holder next came to rest on the chassis metalwork. The raucous hum from the loudspeaker ceased, to be succeeded by a quieter but far more unexpected and ominous hum emanating from the record player motor. After some moments there was a flash from one end of the circuit board and this last menacing hum stopped. Shaken, Dick switched off the record player.

"For the love of Pete," snarled Smithy furiously, "you'd wreck Fort Knox if they were dim enough to leave you in there on your own for five minutes. Do you realise that you may have completely destroyed the left-hand channel of that record player? I wouldn't be surprised if you've burnt out the gram motor, too."

"The gram motor?" spluttered Dick. "How on earth can a pilot lamp circuit burn out a gram motor?"

"Just take a look at the power supply section," grated Smithy, pointing a trembling finger at the record player circuit. (Fig. 7). "For a start the amplifier supply is obtained from a low voltage overwind on the gram motor. The voltage from the overwind then goes into a silicon bridge rectifier. When that lamp holder was resting on the chassis, one or other of its tags, or its metal body, was creating a short which was causing the overwind to feed direct into a single silicon rectifier. With an overload like that, it was no wonder the gram motor started humming." (Figs. 8(a) and (b)).

"What was the flash?"

"Hopefully," growled Smithy, "it was the fuse blowing."

"All right," continued Dick defensively. "Then why was there that loud hum from the speaker when the lamp holder was touching the transistor case?"

"Because," replied Smithy, "the transistor in question was a BC109 in the pre-amplifier stage. The BC109 is in a T0–18 metal can and, like many other T0–18 transistors, has it collector common with the can. You were injecting about 10 volts of raw a.c. into the output of the pre-amplifier stage."

"Stap me," said Dick contritely. "I hadn't realised it was possible for all these things to happen. Shall I put another pilot lamp in?"

"Blow the pilot lamp," said Smithy. "I'm more interested in seeing if the rest of the record player is still working. The safest thing you can do is get me a new fuse. The type I want is 800mA anti-surge."

Disconsolately, Dick walked over

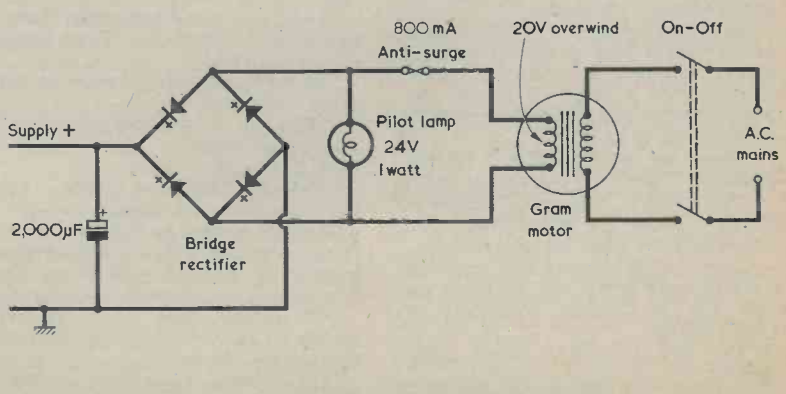


Fig. 7. Power supply circuit in which an overwind on the gram motor connects to a bridge rectifier

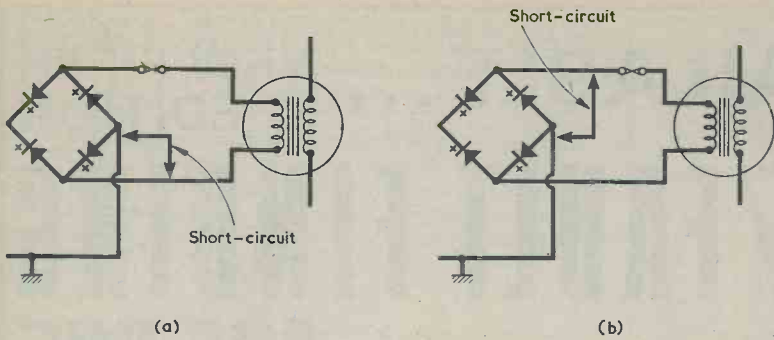


Fig. 8. If one of the terminals of the pilot lamp in Fig. 7 is short-circuited to chassis the resulting effect will be that shown in (a) or in (b). In either instance the gram motor overwind is effectively coupled to a single silicon rectifier

to the spares cupboard. Smithy temporarily wrapped a few turns of insulating tape round the lamp holder and its tags to ensure that it could not cause any more short-circuits. When Dick returned, Smithy quickly fitted the new fuse, set the record player upright and put the pick-up arm back on its rest. He switched on and started the changer cycle.

The pair listened with bated breath. The pick-up arm rose and descended on the revolving record. There was a slight hiss, and then the recording started. Dick and Smithy released their breath in a slow sigh of relief as the music was reproduced, just as before, from both channels.

CHRISTMAS SPIRIT

"Well, thank goodness for that," said Smithy with emphasis.

He went over to the spares cupboard, took out a spare pilot lamp and, after switching off the record player, fitted this to its holder. Steadfastly refusing all offers of help from his assistant he replaced the lamp holder in its correct place inside the record player, checked this out once more, then fitted the bottom cover.

"And that," he said with finality, "is that job done."

Dick handed him a record.

"Here," he said, "put this one on."

Carelessly, Smithy switched on the player again, put the record on the changer and set it in motion. Very soon, the Workshop was filled with the strains of "I'm Dreaming of a White Christmas" sung, as ever, by Bing Crosby.

"We couldn't," grinned Dick, his sturdy self-assurance once more returned, "let a Christmas go by without that record."

Now that the stresses of the day were over, Smithy allowed himself to gradually relax. With slowly increasing cheerfulness he gazed at the levitated Santa Claus above his bench and at the equally unsupported reindeer above Dick's. He glanced at the windows with their neat rows of pseudo-snow, giving the impression of an ordered cotton-wool-cushioned security at the heart of the maelstrom. He surrendered himself contentedly to a welcome period of tranquillity.

Dick coughed politely.

Smithy brought himself back to his surroundings. There was one more duty to be done.

Rising, he walked over to his bench, then returned accompanied by the pleasant clink of glass against bottle. Carefully, he charged Dick's glass, handed it to him, then filled his own.

"Well, Dick," he said, "a very Merry Christmas to you, lad."

"And," returned Dick warmly, "a very Merry Christmas *and* a Happy New Year to you, Smithy."

They rose, and held up their glasses.

"Most important of all," stated Smithy, "let us next wish a Merry Christmas and a truly Happy New Year to all the readers who've put up with our antics over the last year."

They drank deeply.

"And," concluded Dick, "let us once more finish, as on so many previous Christmasses, by saying 'God bless us, every one!" ■

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RECITALS OF RECORDED MUSIC. The second Saturday evening of each winter month. Next recital: December 14th, 1974, 8 p.m. at Woodford Green United Free Church Woodford Green, Essex. Bus routes 20, 20A, 179 and 275 – alight at "The Castle" stop. Programme includes works by Bach, Handel and Ravel.

FOR SALE: Enamelled copper wire 2½ oz. reels 30 s.w.g. only, 30p each. 250MΩ 1 in. pots, 5p each. Post and packing 10p. Daniel Collier, Sturtsbury Farm, Bumbles Green, Nazeing, Essex.

FOR SALE: Germanium point contact diodes, equivalent OA91. Branded. 5 for 25p inclusive. T.A.C., 59 Luckwell Road, Bristol, BS3 3ES.

(Continued on page 319)

SMALL ADVERTISEMENTS

(Continued from page 318)

FREQUENCY LIST TRANSFERS. We have a limited supply of sheets of Dial Frequency Transfers in black. Short Wave frequencies 1.8Mc/s to 32Mc/s and 144Mc/s and 146Mc/s. Includes amateur band marker frequencies at 100kc/s points and other short wave frequencies from 2 to 32Mc/s at every 500kc/s points. Each frequency is repeated. Two sheets for 5p. five sheets for 10p. postage 3p. Data Publications Ltd., 57 Maida Vale, London W9 1SN.

PERSONAL

JANE SCOTT FOR GENUINE FRIENDS. Introductions to opposite sex with sincerity and thoughtfulness. Details free. Stamp to: Jane Scott, 3/Con North St. Quadrant, Brighton, Sussex, BN1 3GJ.

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YOUNG MAN DISABLED needs work at home. Electronic/wire assembly. Would collect and deliver. Mr. B. Grimes, Llainwen, Glanrhyd, Cardigan, Wales, SA43 3PE.

IF YOU HAVE ENJOYED A HOLIDAY on the Norfolk Broads, why not help to preserve these beautiful waterways. Join the Broads Society and play your part in determining Broadlands future. Further details from:—The Hon. Membership Secretary, The Broads Society, "Icknield", Hilly Plantation, Thorpe St. Andrew, Norwich, NOR 85S.

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ENGINEER with sound electronics knowledge and experience required for our Wembley service dept. Good pay and prospects for suitable applicant aged 16 to 20. Close to trains, buses. Free lunches. Apply: Box No. G252.

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S.S.C. WIRE COIL LENGTHS

The Table lists lengths, in inches, of close-wound coils using s.s.c. (single silk covered) enamelled copper wire. Thus, a 50 turn coil of 24 s.w.g. wire has a length of 1.3in. Similar coil lengths will be given with s.r.c. (single rayon covered) enamelled wire.

Wire Gauge (s.w.g.)	10 Turns	20 Turns	30 Turns	40 Turns	50 Turns	60 Turns	70 Turns	80 Turns	90 Turns	100 Turns
16	0.70	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7.0
18	0.52	1.0	1.6	2.1	2.6	3.1	3.7	4.2	4.7	5.2
20	0.40	0.80	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0
22	0.32	0.64	0.96	1.3	1.6	1.9	2.2	2.6	2.9	3.2
24	0.25	0.51	0.76	1.0	1.3	1.5	1.8	2.0	2.3	2.5
26	0.21	0.41	0.63	0.84	1.0	1.3	1.5	1.7	1.9	2.1
28	0.17	0.34	0.52	0.70	0.87	1.0	1.2	1.4	1.6	1.7
30	0.15	0.29	0.44	0.59	0.73	0.88	1.0	1.2	1.3	1.5
32	0.13	0.26	0.39	0.52	0.65	0.78	0.91	1.0	1.2	1.3
34	0.11	0.22	0.33	0.45	0.56	0.67	0.78	0.89	1.0	1.1
36		0.19	0.29	0.39	0.48	0.58	0.68	0.77	0.87	0.96
38		0.15	0.23	0.31	0.39	0.46	0.54	0.62	0.70	0.77
40		0.13	0.20	0.27	0.33	0.40	0.47	0.53	0.60	0.67

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Features glass fibre PC board, Gardners low field transformer, 6–IC's, 10–transistors plus diodes etc. Designed by Texas Instruments engineers for Henry's and. P.W. 1972. Supplied with full chassis work, detailed construction handbook and all necessary parts. Full input & control facilities. Stabilised supply. Overall size 15½" x 2¾" x 6¾" mains operated. Free teak sleeve with every kit. **£31.00 (GB post paid)**

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Printed Circuit Panels 50p

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13 x 8 chassis speakers (carr/pack 30p each or 50p pair)
*150 TC 10 watts 8 ohm twin cone £2·20
*450 10 watts 4, 8, 15 ohm with twin tweeters and crossover £3·85 each
EW 15 watt 8 ohm with tweeter £5·25
350 20 watt 8, 15 ohm with tweeter £7·80 each
*Polished wood cabinet £4·80 carr. etc. 35p each or 50p pair

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Activity counter complete with power pack £9.97 post £1

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Sinclair Cambridge kit	£13.50
Sinclair Cambridge (built)	£17.50
Sinclair Memory	£22.50
Sinclair Scientific	£26.95

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0-50R	62p	
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GRAVINER INFRA RED DETECTOR

Designed for heat or light detector. Containing 931A photo multiplier & GK45 & network £3.50

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AMPLIFIERS (all single channel unless stated)

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2004	9 volt	250 MW O/P 3-8 OHM, 10–100MV I/P	£2·70
104	9 volt	1 watt O/P 8–16 OHM, 10 MV I/P	£3·10
304	9 volt	3 watt O/P 4–8 OHM, 10 MV I/P	£3·95
555	12 volt	3 watt O/P 8–16 OHM, 150 MV I/P	£4·10
555ST	12 volt	1½ + 1½ O/P 8 OHM, 150 MV I/P	£5·95
E1208	12 volt	5 watt O/P 4–16 OHM, 25–60 MV I/P	£5·10
608	24 volt	10 watt O/P 4–8 OHM, 30–50 MV I/P	£4·95
410	28 volt	10 watt O/P 8 OHM, 160 MV I/P	£4·95
620	45 volt	30 watt O/P 4–8 OHM, 150 MV I/P	£9·95
Z40	30/35 volt	15 watt O/P 4–8 OHM, 100 MV I/P	£5·45
Z60	45/50 volt	25 watt O/P 4–8 OHM, 100–250 MV I/P	£6·95
SA6817	24 volt	6 + 6 O/P 8 OHM, 100 MV I/P	£10·20

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(Post/Packing 15p per 1–6 items GB unless stated)

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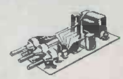

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Mullard LP 1185 10.7 MHZ IF unit with data	£4·50
Gorler Permability FM tuner (front end) 10.7 MHZ O/P	£4·20

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Marriot XRSP/17 ¼ Track High	£2.50
Marriot XRSP/18 ¼ Track Med	£3.50
Marriot XRSP/36 ¼ Track Med	£5.00
Marriot XRSP/63 ½ Track High	£1.75
Marriot Erase heads for XRSP 17/18/36 (XES 11)	75p
Marriot 13X1ZE 343 ½ Track Erase	75p
R/RPI Record/Play ½ Track	45p
H/RP Single Track Rec/Play	35p
Bogen Type UL290 Erase	£1.50
Miniature Stereo Cassette Rec/Play	£2.25

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FM5231 (tu 2) 6 volt FM tuner	£7·95
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SD4912. Stereo Decoder for Tu3. 12 volt	£7·95
SP62H 6 volt stereo FM tuner	£14·80
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Sinclair 12/45 volt FM tuner stereo recorder for above	£7·45
A1018 9 volt FM tuner in cabinet	£13·95
A1005M (S) 9–12 volt Stereo decoder FM for above	£7·50
1062 12 volt Stereo decoder General purpose	£6·50

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15 Watt	£5.20 post 30p
40 Watt	£6.80 post 40p

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Complete kit of parts including P/C boards £1.95 complete kit

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