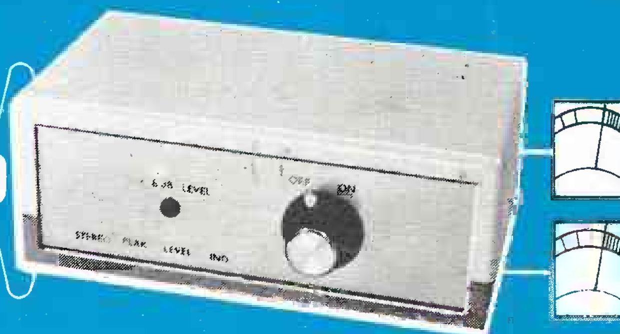
RADIO & ELECTRONICS CONSTRUCTOR

MARCH 1977

40p



STEREO PEAK LEVEL INDICATOR

MEDIUM AND LONG WAVE SUPERHET

PART ONE (2 Parts)

ALSO FEATURED

PRODUCING PRINTED CIRCUIT BOARDS

RADIO & ELECTRONICS CONSTRUCTOR

MARCH 1977
Volume 30 No. 8

Published Monthly (1st of Month)
First Published 1947

Incorporating The Radio Amateur

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9 1SN

Telephone 01-286 6141
Telegrams Databux, London

Annual Subscription: £5.50 (U.S.A. and Canada $11.00) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers please pay by cheque or International Money Order.

Technical Queries. **We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that such queries cannot be answered over the telephone; they must be submitted in writing and accompanied by a stamped addressed envelope for reply.**

Correspondence **should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers as appropriate.**

Opinions **expressed by contributors are not necessarily those of the Editor or proprietors.**

***Production.*—Web Offset.**

Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale, London W9 1SN

The *Radio & Electronics Constructor* is printed by Swale Press Ltd.

THE APRIL ISSUE WILL BE PUBLISHED ON 1st APRIL

TRADE COMPONENTS

JUST A FEW BARGAINS ARE LISTED - SEND STAMPED ADDRESSED ENVELOPE FOR A QUOTE ON OTHER REQUIREMENTS. PAY A VISIT. OVER 90% OF STOCK BELOW QUANTITY WHOLESALE PRICE. ALL PRICES INCLUDE THE ADDITIONAL DISCOUNT IN LIEU OF GUARANTEE

Goods sent at customer s risk, unless suficient payment for registration (1st class letter post) or compensation fee (parcel post) included.

VALVE BASES
Printed circuit B9A–B7G **3p**
Chassis B7–B7G **9p**
Shrouded chassis B7G–B9A–B8A **10p**
B12A tube **9p**

Speaker 6" x 4" 5 ohm ideal for car radio **70p**

TAG STRIP – 6 way **3p**, 9 way **5p**, Single **1p**

5 x 50pF or 2 x 220pF trimmers **20p**

Car type panel lock and key **40p**
18 volt 4 amp charger, bridge rectifier **79p**
GC10/4B **£3.00**

Telescopic aerial
Closed 9½", open 38½" Fitted right angle TV plug, **50p**

BOXES — Grey polystyrene 61 x 112 x 31mm, top secured by 4 self tapping screws **32½p**
Clear perspex sliding lid, 46 x 39 x 24mm **10p**
ABS, ribbed inside 5mm centres for P.C.B., brass corner inserts, screw down lid, 50 x 100 x 25mm orange **48p**; 80 x 150 x 50mm black **70p**; 109 x 185 x 60mm black **£1.10**

ALUMINIUM
3" x 2" x 1" **39p** 4" x 2½" x 2" **44p** 12" x 5" x 3 **£1.20**
2¾" x 5¼" x 1½" **45p** 4" x 5¼" x 1½" **54p** 10" x 7" x 3" **£1.22**
4" x 4" x 1½" **45p** 7" x 5" x 2½" **79p** 12" x 8" x 3" **£1.50**
4" x 2¾" x 1½" **45p** 8" x 6" x 3" **£1.02**

SWITCHES

Pole	*Way*	*Type*	
4	2	Sub. Min. Slide	**18p**
6	2	Slide	**20p**
1	3	13 amp rotary	**6p**
2	2	Locking with 2 to 3 keys	**£1.50**
2	1	2 Amp 250V A.C. rotary	**20p**

12 bank, multi-pole/way push-button (4 interlocking) **30p**
S.P.S.T. 10 amp 240v. white rocker switch with neon. 1" square flush panel fitting **20p**
S.P.S.T. dot 13 amp, oblong, push-fit, rocker **15p**

AUDIO LEADS
5 pin din plug 180° both ends 1½ Mtr., **80p**
3 pin din to open end, 1½ yd twin screened **35p**
Phono to Phono plug, 6ft. **35p**

COMPUTER AND AUDIO BOARDS
VARYING PANELS WITH ZENER, GOLD BOND, SILICON, GERMANIUM, LOW AND HIGH POWER TRANSISTORS AND DIODES, HI STAB RESISTORS, CAPACITORS, ELECTROLYTICS, TRIMPOTS, POT CORES, CHOKES ETC.
3lb for **85p** + **85p** post and packing
7lb for **£1.95** + **£1.20** post and packing

1k horizontal preset with knob **3p**

3" Tape Spools **3p**
1" Terry Clips **4p**
12 Volt Solenoid **30p**

TV KNOB
Dark grey plastic for recessed shaft (quarter inch) with free shaft extension **5p**

ENM Ltd. cased 7-digit counter 2¼ x 1¾ x 1¼" approx. 12V d.c. (48 a.c.) or mains **75p**

ZM1162A INDICATOR TUBE
0-9 Inline End View. Rectangular Envelope 170V 2·5M/A **£1**

REGULATED TAPE MOTOR
9v d.c. nominal approx 1½" diameter **60p**

12v 8 amp Transformer **£2.50 (p&p 85p)**

Ferric Chloride, Anhydrous mil. spec. 1lb bag **40p**

RESISTORS
⅛–¼–½ watt **1p**
1 watt **2p**
Up to 15 watt wire wound **6p**
1 or 2% five times price.

Cinch 8 way std 0.15 pitch edge connector **20p**

Semiconductor Data Book 171 pages. Covers Japanese types 25A12 through to 2SD335. Type/connection/parameter details **£1.50** No VAT

POTS
Log or Lin, single or dual, switched carbon or wire-wound, rotary or slider. All types **16p**
1.5m Edgetype **3p**

Skeleton Presets
Slider, horizontal or vertical standard or submin. **5p**

THERMISTORS
VA1008, VA1034, VA1039, VA1040, VA1055, VA1066, VA1082, VA1100 **10p**
VA1077, VA1005, **15p**

RELAYS
12 volt S.P.C.O octal mercury wetted high speed **40p**
P.O. 3000 type, 1,000 OHM coil, 4 pole c/o **40p**
Mains or 12v d.p.c.o heavy duty octal **50p**

3.5mm metal stereo plug **20p**

JAP 4 gang min. sealed tuning condensers **20p**

ELECTROLYTICS MFD/VOLT. Many others in stock

MFD	Up to 10V	25V	50V	70–75V	100V	200–250V	300–350V	450–500V
10	4p	5p	6p	8p	10p	12p	16p	20p
25	4p	5p	6p	8p	10p	15p	18p	20p
50	4p	5p	6p	9p	13p	18p	25p	—
100	5p	6p	10p	12p	19p	20p	—	—
250	9p	10p	11p	17p	28p	—	85p	£1
500	10p	11p	17p	24p	45p	—	—	—
1000	13p	22p	40p	75p	—	£1.50	—	—
2000	23p	37p	45p	—	—	—	—	—

As total values are too numerous to list, use this price guide to work out your actual requirements
8/20, 10/20, 12/20 **Tubular tantalum 20p each**
16-32/275V. 100-100/150V. 100-100/275V **30p**; 50-50/385V. 12.000/12V, 32-32-50/300V, 20-20-20/350V **60p**; 700 mfd/200V **£1.00**; 100-100-100-150-150/320V **£2.00**.

RS 100–0–100 micro amp null indicator Approx. 2" x ¾" x ¾" **£1.50**

INDICATORS
Bulgin D676 red, takes M.E.S. bulb **30p**
12 volt or Mains neon, red pushfit **18p**
R.S. Scale Print, pressure transfer sheet **10p**

CAPACITOR GUIDE – maximum 500V
Up to .01 ceramic **3p.** Up to .01 poly **4p.** .013 up to .1 poly etc. **5p.** .12 up to .68 poly etc. **6p.** Silver mica up to 360pF **8p,** then to 2,200pF **11p,** then to .01 mfd **18p.**
8p. .1/600: **12p.** .01/1000, 8/20, .1/900, .22/900, 4/16, .25/250 AC (600vDC) **40p.** 5/150, 9/275AC, 10/150, 40/150.
Many others and high voltage in stock.

FORDYCE DELAY UNIT
240 volt A.C./D.C. Will hold relay, etc., for approx. 15 secs after power off. Ideal for alarm circuits, etc. **£1**

CONNECTOR STRIP
Belling Lee L1469, 4 way polythene. **6p each**

1¼ glass fuses 250 m/a or 3 amp (box of 12) **6p**
Bulgin, 5mm Jack plug and switched socket (pair) **30p**

Reed Switch 28mm. body length **5p**

MAINS DROPPERS
36+79 ohm **5p**
66+66+158 ohm, 66+66+137 ohm
17+14+6 ohm, 266+14+193 ohm **5p**
50+40+1k5 ohm
285+575+148+35 ohm **5p**
25+35+97+59+30 ohm

5¼" x 2¾" Speaker, ex-equipment 3 ohm **30p**
2 Amp Suppression Choke **8p**
PAXOLINE 3 x 2½ x $\frac{1}{16}$" **4p**; 4⅞ x ½ x ⅛", **1p**
PCV or metal clip on MES bulb Holder **4p**
VALVE RETAINER CLIP, adjustable **2p**

OUTPUT TRANSFORMERS
Sub-miniature Transistor Type **25p**
Valve type. **40p**

Transformers 6 volt ½A **25p**
Whiteley Stentorian 3 ohm constant impedance volume control way below trade at **80p**
RS Yellow Wander Plug Box of 12 **25p**
18 SWG multicore solder **2½p foot**

THE RADIO SHACK
161 ST. JOHNS HILL, BATTERSEA, LONDON S.W.11
Open 10 a.m. till 7 p.m. Tuesday to Saturday. VAT receipts on request.
Terms: Payment with order Telephone: 01-223 5016

SEMICONDUCTORS

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

AC107	16p
AC128/176	8p
ACY28	19p
AD149	40p
AD161/2	33p
AF116	16½p
AF124/6/7	25p
AF139	20p
AF178/80/81	30p
AF239	30p
ASY27/73	30p
BC107/8/9 + A/B/C	6p
BC147/8/9 + A/B/C/S	6p
BC157/8/9 + A/B/C	6p
BC178A/B, 179B	12p
BC184C/LC	9p
BC186/7	20p
BC213L/214B	10p
BC261B	8p
BC327/8, 337/8	8p
BC547/8/8A/8C	10p
BC557/8/9	9p
BCX32, 36	12p
BCY40	60p
BCY70/1/2	12p
BD112/3	50p
BD115/6	31p
BD131/2/3	35p
BD135/7/9	30p
BD142	30p
BD201/2/3/4	80p
BD232/4/5	49p
BDX77	£1
BF115/167/173	15p
BF178/9	20p
BF180/1/2/3/4/5	15p
BF194/5/6/7	6p
BF194A, 195C	6p
BF200, 258, 324	20p
BF202/3	30p
BF336	27p
BFS28 Dual Mosfet	£1
BFW10/11 F.E.T.	40p
BFW30	£1
BFW57/58	17p
BFX12/29/30	20p
BFX84/88/89	17p
BFY50/51/52	13p
BFY90	50p
BR101	30p
BRY39/56	26p
BSV64	30p
BSV79/80 F.E.T.s	80p
BSV91 Mosfet	90p
BSX20/21	14p
BSY40	27p
BSY95A	12p
CV7042 (OC41/44 ASY63)	5p
GET111	40p
OC35	45p
ON222	20p
TIP30/3055	45p
TIS88A F.E.T.	23p
ZTX300/341	7p
2N393 (MA393)	30p
2N456A	50p
2N929	14p
2N987	40p
2N1507/2219	15p
2N2401	30p
2N2412	70p
2N2483	23p
2N2904/5/6/7/7A	15p
2N3053	14p
2N3055 R.C.A.	50p
2N3704	8p
2N3133	20p
2N4037	34p
2N5036 (Plastic 2N3055)	30p
2SA141/2/360	31p
2SB135/6/457	20p
40250 (2N3054)	30p

BRIDGE RECTIFIERS

Amp	Volt		
½	1,600	BYX10	30p
1	140	OSH01-200	26p
1.4	42	BY164	40p
0.6	110	EC433	6p
5	400	Texas	90p

NEW B.V.A. VALVES

6BW7	60p
EB91	34p
ECH81	34p
ECL80	36p
EF80	34p
EF183	34p
EY86/7	34p
PC86	53p
PC88	53p
PC97	36p
PCC84	34p
PCC89	45p
PCC189	45p
PCF80	34p
PCF82	34p
PCF801	46p
PCL82	34p
PL81	35p
PY500A	80p
PY81/800	38p
R20/U26	50p

OTHER DIODES

1N916	6p
1N4148	2p
BA145	14p
Centercel	24p
BZY61/BA148	10p
BB103/110 Varicap	15p
BB113 Triple Varicap	37p
BA182	13p
OA5/7/10	15p
BZY88 Up to 33 volt	7p
BZX61 11 volt	15p
BR100 Diac	15p

INTEGRATED CIRCUITS

TAA700	£2.00
723 reg (TO99)	45p
741 8 pin d.i.l. op. Amp	24p
TAD100 AMRF	£1
CA3001 R.F. Amp	60p
CD4013 CMOS	36p
TAA300 1wt Amp	£1
TAA550 Y or G	22p
TAA263 Amp	65p
7400	10p
7402/4/10/20/30	14p
7414	56p
7438/74/86	24p
7483	69p
LM300, 2-20 volt	£1
74154	90p

RECTIFIERS

	Amp	Volt	
IN4004/5/6	1	4/6/800	5p
IN4007/BYX94	1	1250	6p
BY103	1	1,500	18½p
SR100	1.5	100	7p
SR400	1.5	400	8p
REC53A	1.5	1,250	14p
LT102	2	30	10p
BYX38-300R	2.5	300	40p
BYX38-600	2.5	600	45p
BYX38-900	2.5	900	50p
BYX38-1200	2.5	1,200	55p
BYX48-300R	2.5	300	28p
BYX49-600	3	600	35p
BYX49-900	3	900	40p
BYX49-1200	3	1,200	52p
BYX48-300R	6	300	40p
BYX48-600	6	600	50p
BYX48-900	6	900	60p
BYX48-1200R	6	1,200	80p
BYX72-150R	10	150	35p
BYX72-300R	10	300	45p
BYX72-500R	10	500	55p
BYX42-300	10	300	30p
BYX42-600	10	600	65p
BYX42-900	10	900	80p
BYX42-1200	10	1,200	95p
BYX46-300R*	15	300	£1.00
BYX46-400R*	15	400	£1.50
BYX46-500R*	15	500	£1.75
BYX46-600*	15	600	£2.00
BYX20-200	25	200	60p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.50

*Avalanche type

TRIACS

Amp	Volt		
6	800	Plastic RCA	£1.20
25	900	BTX94-900	£4.00
25	1200	BTX94-1200	£6.00

Mullard Data Book 40p

RS 2mm Terminals Blue & Black ..... 5 for 40p

Chrome Car Radio facia 15p

Rubber Car Radio gasket 5p

DLI Pal Delayline 50p

Relay socket 10p
Take miniature 2PCO relay

B7G or B9A valve can 5p

0-30, or 0-15, black pvc, 360° dial, silver digits, self adhesive, 4½" dia. 10p

OPTO ELECTRONICS

Diodes

TIL209 Red	10p
BPX40	50p
BPX42	80p
BPY10 (VOLTIAC)	80p
BPY68, BPY69, BPY77	80p

Photo transistor

BPX29	80p
OCP71	34p

BIG L.E.D. 0.2" 2v 50m/A max.

ORANGE	14p
YELLOW	14p
CLIP	2p

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp £1.00

THYRISTORS

Amp	Volt		
1	240	BTX18-200	30p
1	400	BTX18-300	35p
1	240	BTX30-200	30p
15	500	BT107	£1
6.5	500	BT101-500R	90p
6.5	500	BT109-500R	£1.00
20	600	BTW92-600RM	£3.00
15	800	BTX95-800R Pulse Modulated	£8.00
30	1000	28T10 (Less Nut)	£3.00

.3" red 7 segment L.E.D. 14 D.I.L. 0-9+D.P. display 1.9v 10m/a segment, common anode 61p

DL747.6" £1.25

Minitron 3" 3015F filament £1.10

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

Plastic, Transistor or Diode Holder 1p

Transistor or Diode Pad 1p

Holdersorpads 50pper100

PAPER BLOCK CONDENSER

0.25MFD	800 volt	30p
1MFD	250 volt	15p
2MFD	250 volt	20p
4MFD	250 volt	20p

I.C. extraction and insertion tool 32p

CHASSIS SOCKETS

Car Aerial 9p, Coax 3p, 5 pin 180° 9p, 5 or 6 pin 240° din 6p, speaker din switched 5p, 3.5 mm switched 5p, stereo ¼" jack enclosed 10p.

Push-to-Break or Push-to-Make Panel Switch 24p

ENAM. COPPER WIRE

SWG.	PER YD.
20-24	3p
26-42	2.5p

GARRARD

GCS23T Crystal Stereo Cartridge 66p
Mono (Stereo compatible), Ceramic or crystal 60p

HANDLES

Rigid light blue nylon 6¼" with secret fitting screws .. 5p

Belling Lee white plastic surface coax outlet box 20p

Miniature Axial Lead Ferrite Choke formers 2p

RS 10 Turn Pot 1% 250, 500 Ω, 1K, 50K £1

Copper coated board 10" x 9" approx 25p

TIE CLIPS

Nylon self locking 7" or 3½" 2p

Geared Knob 8-1 ratio 1⅞" diam, black 70p

R.S. 2½" 35 ohm loud speaker 60p

Philips Iron Thermostat ... 15p

McMurdo PP108 8 way edge plug 10p

TO3 HEATSINK

Europlec HP1 TO3B individual 'curly' power transistor type. Ready drilled 12p

Tested unmarked, or marked ample lead ex new equipment

ACY17-20	8p
ASZ20	8p
ASZ21	30p
BC186	11p
BCY30-34	8p
BCY70/1/2	8p
BF115	10p
BY126/7	4p
HG1005	10p
HG5009	3p
HG5079	3p
L78/9	3p
M3	10p
OA81	3p
OA47	3p
OA200-2	3p
OC23	20p
OC71/2	5p
OC200-5	8p
TIC44	24p
2G240	£1
2G302	5p
2G401	5p
2N711	25p
2N2926	4p
2N598/9	6p
2N1091	8p
2N1302	8p
2N1907	£1
Germ. diode	1p
GET120 (AC128 in 1" sq. heat sink	15p
GET872	12p
2S3230	30p

CRAZY OFFERS

4700 mfd.	40v	35p
2500 mfd.	40v	30p
8 mfd.	500v	5p
400 mfd.	16v	4p
.1 mfd.	500v	1½p
.1 mfd.	1500v	2p
2200 mfd.	25v	30p
2200 mfd.	64v	40p
10000 mfd.	15v	12p
1250 mfd.	35v	10p
6800 mfd.	10v	6p
32+32 mfd.	275v	8p
16+32 mfd.	350v	12p
8+8 mfd.	350v	8p
150 mfd.	35v	4½p
100 mfd.	70v	4½p
1 mfd. non-polar	35v	3p
680 mfd.	100v	10p
15 mfd.	160v	3p
4700 pf. sub min	500v	1½p

Philips electronic engineer kits add on series E1004 75p each

G.E.C. 5% Hi-stab capacitors .013, .056, .061, .066, .069, .075, .08, .089, .095, .1 2p each

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

MAIL ORDER CUSTOMERS ONLY ADD 8% VAT-I PAY BALANCE ON 12½% ITEMS
ALL ENQUIRIES, ETC., MUST BE ACCOMPANIED BY A STAMPED ADDRESSED ENVELOPE

WILMSLOW AUDIO

THE Firm for speakers!

SPEAKERS

Baker Group 25, 3, 8 or 15 ohms	£13.00
Baker Group 35, 3, 8 or 15 ohms	£14.50
Baker Group 50/12 8 or 15 ohms	£21.00
Baker Group 50/15 8 or 15 ohms	£25.75
Baker Deluxe 12" 8 or 15 ohms	£17.50
Baker Major 3, 8 or 15 ohms	£15.00
Baker Superb 8 or 15 ohms	£22.50
Baker Regent 12" 8 or 15 ohms	£12.50
Baker Auditorium 12" 8 or 15 ohms	£21.00
Baker Auditorium 15" 8 or 15 ohms	£25.75
Castle BRS/DD 4/8 ohms	£9.95
Celestion G12M 8 or 15 ohms	£12.95
Celestion G12H 8 or 15 ohms	£15.95
Celestion G12/50 8 or 15 ohms	£18.00
Celestion G12/50TC 8 or 15 ohms	£20.00
Celestion G15C 8 or 15 ohms	£26.95
Celestion G18C 8 or 15 ohms	£39.95
Celestion HF1300 8 or 15 ohms	£7.50
Celestion HF2000 8 ohms	£8.55
Celestion MH1000 8 or 15 ohms	£13.50
Coles 4001 G&K	£5.90
Decca London ribbon horn	£31.50
Decca London CO/1000/8 Xover	£6.95
Decca DK30 ribbon horn	£20.50
Decca CO/1/8 Xover (DK30)	£4.75
EMI 14 x 9 Bass 8 ohms 14A770	£12.50
EMI 8 x 5, 10 watt, d/cone, roll surr.	£3.95
EMI 6½" d/cone, roll surr. 8 ohms	£3.95
Elac 59RM109 (15) 59RM114 (8)	£3.95
Elac 6½" d/cone, roll surr. 8 ohms	£3.95
Elac 10" 10RM239 8 ohms	£3.95
Eagle FR4	£6.75
Eagle FR65	£11.95
Eagle FR8	£14.95
Eagle FR10	£18.50
Eagle HT15	£4.50
Eagle HT21	£5.50
Eagle MHT10	£5.25
Eagle FF28 multicell. horn	£7.50
Fane Pop 15, 8 or 16 ohms	£5.75
Fane Pop 33T, 8 or 16 ohms	£9.95
Fane Pop 50, 8 or 16 ohms	£12.50
Fane Pop 55, 8 or 16 ohms	£16.75
Fane Pop 60, 8 or 16 ohms	£19.95
Fane Pop 70, 8 or 16 ohms	£21.75
Fane Pop 100, 8 or 16 ohms	£33.95
Fane Crescendo 12A, 8 or 16 ohms	£42.95
Fane Crescendo 12BL, 8 or 16 ohms	£44.95
Fane Crescendo 15/100A, 8 or 16 ohms	£54.95
Fane Crescendo 15/125, 8 or 16 ohms	£64.95

SPEAKERS

Fane Crescendo 18, 8 or 16 ohms	£75.95
Fane 910 Mk.II horn	£15.75
Fane 920 Mk.II horn	£45.95
Fane HPX1 crossover 200 watt	£2.50
Fane 13 x 8, 15 watt dual cone	£5.50
Fane 801T 8" d/c, roll surr.	£9.50
Goodmans Axent 100	£8.50
Goodmans Audiom 200 8 ohms	£14.95
Goodmans Axiom 402 8 or 15 ohms	£22.00
Goodmans Twinaxiom 8, 8 or 15 ohms	£10.60
Goodmans 8P 8 or 15 ohms	£6.50
Goodmans 10P 8 or 15 ohms	£6.95
Goodmans 12P 8 or 15 ohms	£16.50
Goodmans 12PG 8 or 15 ohms	£17.75
Goodmans 12PD 8 or 15 ohms	£18.75
Goodmans 12AX 8 or 15 ohms	£44.00
Goodmans 15AX 8 or 15 ohms	£49.00
Goodmans 15P 8 or 15 ohms	£24.00
Goodmans 18P 8 or 15 ohms	£39.95
Goodmans Hifax 750P	£16.95
Goodmans 5" midrange 8 ohms	£4.25
Gauss 12"	£132.00
Gauss 15"	£139.00
Gauss 18"	£140.00
Jordan Watts Module, 4, 8 or 15 ohms	£16.25
Kef T27	£8.50
Kef T15	£10.75
Kef B110	£10.95
Kef B200	£11.95
Kef B139	£24.95
Kef DN8	£2.75
Kef DN12	£7.25
Kef DN13 SP1015 or SP1017	£4.95
Lowther PM6	£32.00
Lowther PM6 Mk.I	£35.00
Lowther PM7	£48.00
Peerless KO10DT 4 or 8 ohms	£8.25
Peerless DT10HFC 8 ohms	£9.50
Peerless KO40MRF 8 ohms	£10.50
Peerless MT225HFC 8 ohms	£3.75
Richard Allan CA12 12" bass	£19.80
Richard Allan HP8B	£12.50
Richard Allan LP8B	£8.50
Richard Allan DT20	£6.25
Richard Allan CN8280	£16.95
Richard Allan CN820	£3.15
Richard Allan Super Disco 60W 12"	£17.95
Coles 4001 G&K	£5.90
Tannoy 10" Monitor HPD	£79.25
Tannoy 12" Monitor HPD	£87.00
Tannoy 15" Monitor HPD	£103.25

SPEAKER KITS

Baker Major Module 3, 8 or 15 ohms	each	£18.00
Goodmans DIN 20 4 or 8 ohms	each	£15.75
Goodmans Mezzo Twin kit	pair	£51.95
Helme XLK 20	pair	£17.50
Helme XLK 30	pair	£21.95
Helme XLK 35	pair	£26.75
Helme XLK 40	pair	£38.50
KEFkit 1	pair	£59.50
KEFkit III	each	£56.00
Peerless 1060	pair	£61.50
Peerless 1070	each	£54.95
Peerless 1120	each	£61.00
Peerless 2050	pair	£43.95
Peerless 2060	pair	£58.50
Richard Allan Twin assembly	each	£13.95
Richard Allan Triple 8	each	£20.75
Richard Allan Triple 12	each	£25.95
Richard Allan Super Triple	each	£29.50
Richard Allan RA8 Kit	pair	£37.80
Richard Allan RA82 Kit	pair	£59.40
Richard Allan RA82L Kit	pair	65 70
Denton 2XP Kit	pair	£23.25
Wharfedale Linton 3XP Kit	pair	£34.25
Wharfedale Glendale 3XP Kit	pair	£49.50

HI-FI
ON DEMONSTRATION
in our showrooms:

Akai, Armstrong, Bowers & Wilkins, Castle, Celestion, Dual, Goodmans, Kef, Leak, Pioneer, Radford, Richard Allan, Rotel, Tandberg, Trio, Videotone, Wharfedale, etc.

—Ask for our HiFi price list—

THIS MONTH'S SPECIALS (Carr. £2.50)

SANSUI 331	£114.00
PIONEER 7070	£199.00
TRIO KR 2600	£109.00
SUGDEN A21	£130.00
SANSUI SC 2000/2002	£160.00
MINIMAX Mk II	£46.95

We stock the complete Radford range of amplifiers, preamplifiers, power amplifiers, tuners etc., and also Radford Audio Laboratory equipment, low distortion oscillator, distortion measuring set, audio noise meter etc.

ALL PRICES INCLUDE VAT

(Prices correct at 17/2/77)

Send stamp for free 38-page booklet "Choosing a Speaker"

All units guaranteed new and perfect

Carriage and insurance
Speakers up to 12" **60p**; 12" **£1.00**; 15" **£1.75**; 18" **£2.50**; Kits **£1.00** each (**£2.00** per pair); Tweeters & Crossovers **33p** each.

COMPLETE KITS IN STOCK FOR

RADFORD STUDIO 90, RADFORD MONITOR 180, RADFORD STUDIO 270, RADFORD STUDIO 360, HIFI ANSWERS MONITOR (Rogers), HIFI NEWS NO COMPROMISE (Frisby), HI FI NEWS STATE OF THE ART, WIRELESS WORLD TRANSMISSION LINE (Bailey), PRACTICAL HIFI & AUDIO MONITOR (Giles), PRACTICAL HIFI & AUDIO TRIANGLE (Giles), POPULAR HIFI (Colloms) ETC.

On Dem. Answers Monitor, State of Art, etc.

Construction leaflets for Radford, Kef, Jordan Watts, Tannoy, HIFI Answers Monitor, Free on request

PA Amplifiers, microphones etc. by Linear, Shure, Eagle, Beyer, AKG etc.

FREE with orders over £10

"Hi-Fi Loudspeaker Enclosures" Book

WILMSLOW AUDIO

DEPT REC

LOUDSPEAKERS, MAIL ORDER AND EXPORT: SWAN WORKS, BANK SQUARE, WILMSLOW
HIFI, RADIO & TV: SWIFT OF WILMSLOW, 5 SWAN STREET, WILMSLOW CHESHIRE
PA, HIFI & ACCESSORIES: WILMSLOW AUDIO, 10 SWAN STREET, WILMSLOW CHESHIRE
TELEPHONE: LOUDSPEAKERS, MAIL ORDER AND EXPORT WILMSLOW 29599
HIFI, RADIO ETC., WILMSLOW 26213

Access & Barclaycard Orders accepted by phone

BI-PAK

High quality audio eq

NEW PUSH-BUTTON STEREO FM TUNER

Fitted with Phase Lock-loop Decoder

- ☆ FET Input Stage
- ☆ VARI-CAP diode tuning
- ☆ Switched AFC
- ☆ Multi turn pre-sets
- ☆ LED Stereo Indicator

Typical Specification:
Sensitivity 3μ volts
Stereo separation 30db
Supply required 20-30v at 90 Ma max.

OUR PRICE

£20.45

The 450 Tuner provides instant program selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.
Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T461**.
The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

STEREO PRE-AMPLIFIER PA 100

A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

Frequency response + 1dB 20Hz-20KHz
Sensitivity of inputs:
1. Tape input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms
P.U. input equalises to R1AA curve within 1dB from 20Hz to 20KHz. Supply - 20 - 35V at 20mA.
Dimensions:
299mm x 89mm x 35mm

£13.75

P.&P. 45p

MK60 AUDIO KIT: Comprising: 2 x AL60. 1 x SPM80. 1 x PA100. 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £29.55** plus 62p postage.

TEAK 60 AUDIO KIT: Comprising: Teak veneered cabinet size 16¾" x 11½" x 3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £10.70** plus 82p postage.

AL 60

VAT ADD 12½%

25 Watts (RMS)

● Max Heat Sink temp 90C. ● Frequency response 20Hz to 100kHz ● Distortion better than 0.1 at 1kHz ● Supply voltage 15-50v. ● Thermal Feedback ● Latest Design Improvements ● Load – 3, 4, 8 or 16ohms. ● 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.

£4.35

STEREO 30 COMPLETE AUDIO CHASSIS

7+7 WATTS R.M.S.

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck, etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 minutes).

TRANSFORMER £2.45 plus 62p p&p

TEAK CASE £5.25 plus 62p p&p

£16.25

p. & p. 45p

Stabilised Power Supply Type SPM80

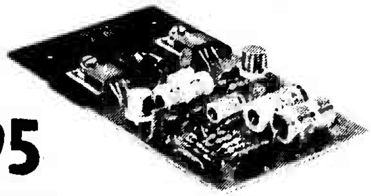
SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (r.m.s.) per channel simultaneously. With the addition of the Mains Transformer **BMT80**, the unit will provide outputs of up to 1.5A at 35V. Size: 63mm. 105mm. 30mm. Incorporating short circuit protection.

Input Voltage: 33-40 V.A.C.
Output Voltage: 33V D.C. Nominal
Output Current: 10mA-1.5 amps
Overload Current: 1.7 amps approx.
Dimensions:
105mm x 63mm x 30mm
Transformer BMT80:
£2.60 + 62p postage

£3.75

uipment mono and other modules for Stereo

NOW BI-PAK BRINGS YOU— The AL80 35 $^{RMS}_{W}$ power Amp!

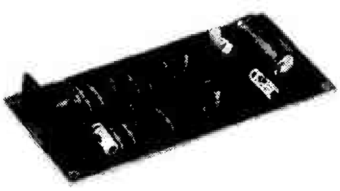


ONLY £6.95 + 8% VAT

A High Fidelity Power Amplifier with a maximum Power Output of 35 watt R.M.S., which has a maximum operating voltage of 60v. A MUST for all HI-FI users.

Maximum supply voltage	15-60v
Power output for 2% THD	35 watts R.M.S.
Harmonic distortion	0·1%
Load impedance	3-8-16 ohm
Input impedance	50K ohm
Frequency response +3dB	20Hz–40KHz
Sensitivity for 25 watts O/P	280mV R.M.S.
Max. Heat sink temperature	90°C
Dimensions	102mm x 64mm x 15mm
Mounting	2, 4BA fixing holes in heat sink
Fuse requirements	1·5A

MPA 30



Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new BI-PAK M.P.A. 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only. Used in conjunction are 4 low noise high gain silicon transistors. It is provided with a standard DIN input socket for ease of connection. Supplied with full, easy-to-follow instructions.

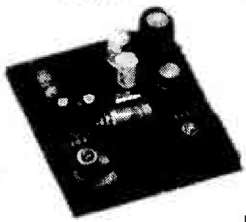
£2.85

VAT ADD 12½%

POSTAGE & PACKING

Postage & Packing add 25p unless otherwise shown. Add extra for airmail. Min. £1·00

AL 20-30
AUDIO AMPLIFIER MODULES



The 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 5 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 home. Harmonic Distortion Po = 3 watts f = 0·25% Load Impedance 8-16 ohm

Frequency response ± 3dB Po = 2 watts 50Hz-25KHz. Sensitivity for Rated O/P—Vs = 25v. RL = 80 ohm. f=1KHz 75mV. RMS. Size: 75mm x 63mm x 25mm.

AL20 5w R.M.S. **£2.95** AL30 10w R.M.S. **£3.25**

AND for those who need more P-O-W-E-R

AL250 **125 $^{RMS}_{W}$**

POWER AMP

Specially designed for use in— Disco Units, P.A. Systems, high power Hi-Fi, Sound reinforcement systems

SPECIFICATION:

Output Power: 125 watt RMS Continuous
Operating voltage: 50–80
Loads: 4–16 ohms
Frequency response: 25Hz–20kHz *Measured at 100 watts*
Sensitivity for 100 watts output at 1kHz: 450mV
Input impedance: 33K ohms
Total harmonic distortion
50 watts into 4 ohms: 0·1%
50 watts into 8 ohms: 0·06%
S/N ratio: better than 80dBs
Damping factor, 8 ohms: 65
Semiconductor complement: 13 transistors 5 diodes
Overall size: Heatsink width 190mm, length 205mm, height 40mm

ONLY £15.95 +8% VAT

NEW PA12

£6.70

NEW PA12 Stereo Pre-Amplifier completely redesigned for use with AL20-30 Amplifier Modules. Features include on/off volume. Balance, Bass and Treble controls. Complete with tape output.
Frequency Response 20Hz-20KHz (−3dB)
Bass and Treble range ±12dB
Input Impedance 1 meg ohm
Input Sensitivity 300mV
Supply requirements 24V. 5mA
Size 152mm x 84mm x 33mm

PS12

Power supply for AL20-30, PA12, S450 etc. Input voltage 15-20v A.C. Output voltage 22-30v D.C. Output Current 800 mA Max. Size 60mm x 43mm x 26mm. **£1.30**

Transformer T538 £2.30

BI-PAK

P.O. BOX 6 WARE HERTS
COMPONENT SHOP: 18 BALDOCK STREET, WARE. TEL: 61593

Stirling Sound

Q.V. MODULES FOR COST CONSCIOUS CONSTRUCTORS

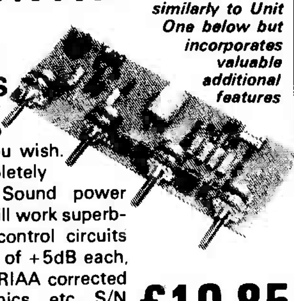
MADE IN OUR OWN U.K. FACTORY

NEW THIS MONTH!

UNIT TWO

FOR LOW AND HIGH OUTPUT CARTRIDGES

Unit Two is styled similarly to Unit One below but incorporates valuable additional features



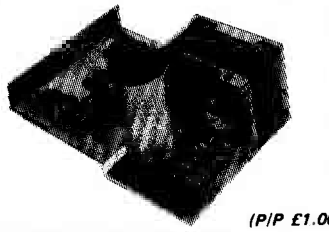
Here's another real money saver from Stirling Sound! Wire it into your system and style it how you wish. Full instructions make this completely straight-forward. Use Stirling Sound power amps for choice, but Unit Two will work superbly in any system. Active tone control circuits give bass and treble rise and cut of +5dB each, accepts inputs from 1 to 5 mV; RIAA corrected plus a 50mV input for ceramics, etc. S/N ratio — 60dB; channel separation typically 56dB; frequency range — 30-20,00 Hz ±1dB. Tested before despatch (ready built) and guaranteed. For 10-20 V. operation.

£10.85

100 watt R.M.S. POWER AMP and MATCHING 70 V. POWER SUPPLY

Your chance to save £1.95

Today's best 100 watt value now made even greater by including the Stirling Sound SS.370 power supply together at the sensational price of £21.00*. A ruggedly built and guaranteed assembly, ideal for disco, P.A., guitar use etc. Normal selling price for items bought separately is £22.95* — already superb value — so don't delay — order NOW!



SS.1100 100 watt R.M.S. power amp with heatsink type mounting flange **£9.45***

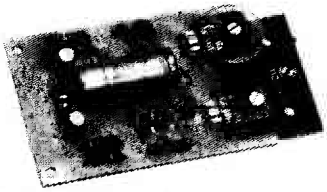
Full size heat sink **£1.00**

SS.370 70V/2A power supply with low volt take-off **£12.50***

SS.1100H (with large heat sink) and **SS.370** **£21.00***

(P/P £1.00 where SS.370 is ordered)

MORE STIRLING SOUND Q.V. MODULES TO SAVE YOU MONEY



POWER AMPLIFIERS

3-40 Watts R.M.S.

SS.103 3 watt r.m.s. mono. Short-circuit protected. Uses one I.C. **£1.75**

SS.103-3 Stereo version of above using two I.C.s **£3.25**

SS.105 5 watts r.m.s. into 4 ohms, using 12V **£2.25**

SS.110 10 watts r.m.s. using 24V and 4 ohms load **£2.75**

SS.120 20 watts r.m.s. into 4 ohms, using 34V **£3.25**

SS.140 Delivers 40 watts r.m.s. into 4 ohms using 45 volts supply unit such as **SS.345**. Ideal for small disco. P.A. etc. **£3.95***

If ordering Stirling Sound power supply units with Modules **SS.103** to **SS.120**, V.A.T. becomes 12½%.

TONE CONTROLS/PRE-AMPS

SS.100 Active toned control, stereo. 15dB on bass and on treble **£1.60**

SS.101 Pre-amp for ceramic cartridges, etc. Stereo. Passive tone control details supplied. **£1.60**

SS.102 Stereo pre-amp for low output magnetic P.Us. R.I.A.A. corrected **£2.65**

UNIT ONE TONE CONTROL/PRE-AMP

A real money saver this. Compatible with all relevant Stirling Sound modules as well as other makes.

Combined pre-amp with active tone-control circuits. ±15dB at 10KHz treble and 30Hz bass. Stereo, Vol./balance/treble/bass. 200mV out for 50mV in. Operates from 10 to 16V supply. **£7.80**

UNIT TWO — See above

F.M. TUNING MODULES

SS.201 Front end tuner, slow geared drive, two gang, A.F.C. facility. Tunes 88-108 MHz. **£5.00**

SS.202 I.F. amplifier. Metering and A.F.C. facilities **£2.65**

SS.203 Phase Lock Loop Stereo Decoder for use with the above or other FM mono tuners. A LED may be fitted. **£3.85**

SS.203-1 COIL-TYPE STEREO DECODER for use with SS.201 and SS.202, recommended where economy is called for. Available in two forms:-

with I.C. for neg. earth **£2.50**

Transistor type for pos. earth **£2.00**

WHAT QV MEANS TO YOU

It means Stirling Sound QUALITY and VALUE from modules made in our own Essex factory. They are all tested and guaranteed and offer unbeatable value. Designed by highly specialist electronic engineers with wide experience of constructors' and experimenters' needs. WATCH HOW THE STIRLING SOUND RANGE GROWS!

POWER SUPPLY UNITS WITH 13-15V TAKE-OFF POINTS

Except SS.312

NOW 8 TO CHOOSE FROM

Complete with mains transformers and low volt take-off points (not SS.300). All at 8% V.A.T. rate.

			P/P
SS.312	12V/1A	£3.75*	50p
SS.318	18V/1A	£4.15*	50p
SS.324	24V/1A	£4.60*	50p
SS.334	34V/2A	£5.20*	50p
SS.345	45V/2A	£6.25*	50p
SS.350	50V/2A	£6.75*	50p
SS.370	70V/2A	£12.50*	£1

SS.300 Power stabilising unit 10-50V adjustable for adding to unstabilised supplies. Built in protection against shorting (p/p 50p) **£11.95***

SS.310/50 Stabilised power supply with variable output from 10V to 50V/2A. Built-in protection against shorting **£11.95***

LARGE 12p S.A.E. BRINGS LATEST STIRLING SOUND 16 LARGE PAGE EQUIPMENT AND COMPONENTS PRICE LIST

WHEN ORDERING add 35p for p/p unless stated otherwise. V.A.T. add 12½% to total value of order unless price shows * when V.A.T. is 8%. Make cheques, etc. payable to Bi-Pre-Pak Ltd. Every effort is made to ensure correctness of information at time of going to press. Prices subject to alteration without notice.

Stirling Sound

A member company of the Bi-Pre-Pak group established 1959

Dept. RC.3, 220-224 WEST ROAD, WESTCLIFF-ON-SEA, ESSEX SS0 9DF

Telephone Southend (0702) 46344

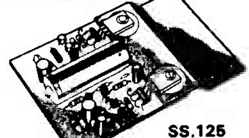
Personal callers welcome

SPECIAL DE-LUXE 25 WATT HI-FI AMP BARGAIN

Made to sell at £7.25

LIMITED NUMBER AVAILABLE AT £5.20

This is the Bi-Pre-Pak SS.125, designed and made for the connoisseur market of hi-fi and technical specialists. Gives 25 w.r.m.s. into 8 ohms using 50V, 22 w.r.m.s. into 4 ohms from 33V. input sensitivity — 150 mV for full output; distortion less than 0.05% at all powers. With full instructions. **TESTED & GUARANTEED. LIMITED NUMBER ONLY AVAILABLE.** Ideal for test and lab. work, super hi-fi etc.



SS.125 Power Amp

RETURN OF POST MAIL ORDER SERVICE

NEW BSR HI-FI AUTOCHANGER
STEREO AND MONO

Plays 12", 10" or 7" records Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200/250v. Size 13½ x 11¼in. Above motor board 3¼in. Below motor board 2½in.

With STEREO/MONO CARTRIDGE **£11.95** Post 75p

Single player version with cueing device **£13.50**

ELAC 10in HI-FI UNIT

10 watt, 15 ohm full range unit, 35 to 16,000 c.p.s. Base resonance 40 c.p.s.

BARGAIN PRICE **£4.50** post 45p

HEAVY METAL PLINTHS

With P.V.C. Cover. Cut out for most B.S.R. or Garrard decks. Silver grey finish. Size 12¼ x 14¼ x 7¼in. **£6.50**
Size 16 x 13¾ x 7in. £7.50 Post £1.25

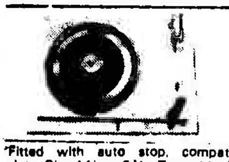
EXTRA LARGE PLINTH & COVER

Size: 20in. x 19½in. x 9in. TEAK FINISH
CALLERS ONLY **£18.50**

TINTED PLASTIC COVERS

Post £1

Sizes: 'A' 14¼in. x 12½in x 4¼in. £2.50. 'B' - 20¼in. x 12¾in. x 4¼in. £3. 'C' - 17¾in. x 13¾in. x 3¼in. £3.25. 19in. x 14¾in. x 4½in. £3.50; 16½in. x 14in. x 4in. £3.50
Ideal for record decks, tape decks, etc.



R.C.S. DISCO DECK SINGLE RECORD PLAYER

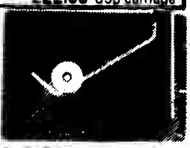
Fitted with auto stop, compatible cartridge. Baseplate. Size 11in. x 8¼in. Turntable. Size 7in. diameter. A/C mains. 220/250V motor has a separate winding 14 volt to power a small amplifier.
3 speeds plays all size records.
Two for £13. **£6.95** Post 45p

COMPLETE STEREO SYSTEM

Two full size loudspeakers 13¾ x 10 x 3¾in. Player unit clips to loudspeakers making it extremely compact. Overall size only 13¾ x 10 x 8¼in 3 watts per channel, plays all records 33 rpm 45 rpm. Separate volume & tone controls 240v AC mains

Attractive Teak finish Weight 13lbs.
Bargain Price **£22.50** 85p carriage

GARRARD MINICHANGER



Plays all size records, 3 speed. Size 12 x 8½in. Complete with stereo/mono cartridge.

£9.95 Post 75p.

CASSETTE RECORDER MOTOR ONLY. 6 Volt. Will replace many types. Ideal for models. **£1.25**

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in. sides 6 x 4in. **70p**; 8 x 6in. **90p**; 10 x 7in. **£1.15**; 14 x 9in. **£1.50**; 16 x 6in. **£1.45**; 12 x 3in. **87p**; 16 x 10in. **£1.70**. All boxes, many sizes in stock.

ALUMINIUM PANELS 18s.w.g. 6 x 4in. **15p**; 8 x 6in. **25p**; 10 x 7in **30p**; 12 x 5in. **30p**; 12 x 8in. **40p**; 16 x 6in. **45p**; 14 x 9 in. **50p**; 12 x 12in. **55p**; 16 x 10in. **75p**.
ALUMINIUM ANGLE BRACKET 6in long x ½ x ½ **15p**.

1½inch DIAMETER WAVECHANGE SWITCHES **45p**. EA: 2 p. 2-way. or 2 p. 6-way. or 3 p. 4-way.
1 p.1 2 way. or 4 p. 2-way. or 4 p. 3-way.
TOGGLE SWITCHES. sp. 20p dp. 25p dp. dt. 30p.
D.P.D.T. CENTRE OFF 65p. S.P.D.T. CENTRE OFF 45p.
Many types TOGGLE SWITCHES in stock

R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER BRITISH MADE

Ideal for Mike, Tape P.U., Guitar, etc. Can be used with Battery 9-12v. or H.T. line 200-300V. D.C. operation. Size 1¾" x 1¼" x ¾". Response 25 c.p.s. to 25 Kc/s, 26 db gain.
For use with valve or transistor equipment. Post
Full instructions supplied. Details S.A.E. £1.45 30p

NEW ELECTROLYTICS CONDENSERS

2/350V	20p	250/25V	18p	16+16+16/275v	45p
4/350V	20p	500/25V	20p	50+50/300V	50p
8/350V	22p	100+100/275v	65p	32+32/450V	75p
16/350V	30p	150+200/275v	70p	100+50+50/350V	85p
32/500V	50p	8+8/450V	50p	32+32+32/350	75p
25/25V	10p	8+16/450V	50p	30,000/25V	95p
50/50V	10p	16+16/450V	50p	4700/63V	95p
100/25V	10p	32+32/350V	50p	420/600V	£1.50

LOW VOLTAGE ELECTROLYTICS CONDENSERS
22, 25, 50, 88, 150, 470, 500, 680, 1500, 2200, 3300, mfd all 6 volt 10p ea.
22, 25, 68, 100, 150, 200, 220, 330, 470, 680, 1000, 1500, 2200, mfd all 10 volt 10p ea.
220, 330, 1000, 4700, mfd all 4v. 10p ea.
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 10p.
500mF 12V. 15p ; 25V 20p ; 50V 30p.
1000mF 12V 20p ; 25V 35p ; 50V 47p ; 100V 70p.
2000mF 6V 25p ; 25V 42p ; 50V 57p ; 4700/63V 95p.
2500mF 50V 62p ; 3000mF 25V 47p ; 50V 65p.
5000mF 6V 25p; 12V 42p; 35V 85p; 50V 95p.
500V 0.001 to 0.1 10p; 0.25 12p; 0.47 25p
CERAMIC 1pF to 0.01mF. 5p. Silver Mica 2 to 5000pF. 5p.
PAPER 350V 0.1 7p. 0.5 18p. 1mF or 2mF 150V 15p.
MICRO SWITCH single pole changeover 20p.
MICRO SWITCH sub min 25p.
TWIN GANG. "0-0" 208pF + 176pF £2. TWIN 365pF 50p.
Slow motion drive 365pF + 365pF with 25pF + 25pF 65p.
500pF standard twin gang 75p 120 PF twin gang 50p.

ELAC 9 x 5in. HI-FI SPEAKER, TYPE 59RM.
THIS FAMOUS AND WIDELY USED UNIT NOW AVAILABLE AT BARGAIN PRICE
10 WATT, 8 OHM. CERAMIC MAGNET. **£3.45**

NEON PANEL INDICATORS, 250V Red or Amber, 30p
RESISTORS. ¼w., ½w., 1w 20%, 2p; 2w 8p. 10 to 10M.
HIGH STABILITY, ½ w. 2% 10 ohms to 10 meg., 12p.
Ditto 5%. Preferred values. 10 ohms to 10 meg., 5p.
WIRE-WOUND RESISTORS. 5 watt. 10 watt. 15 watt. 10 ohms to 100K. 12p each. 2 w 0.5 ohm to 8.2 ohms 15p.
TAPE OSCILLATOR COIL. Valve type 35p.
FERRITE ROD 8" x ⅜" 30p; 6" x ⅜" 20p; 3" x ⅜" 10p.
TAG STRIP 28 way 14p.

MAINS TRANSFORMERS

ALL POST 50p each

250-0-250V 80mA. 6.3, 2A £2.95
250-0-250 80mA. 6.3v 3.5a. 6.3v 1a or 5v 2a £4.60
350-0-350 80mA. 6.3v 3.5a. 6.3v 1a or 5v 2a. £5.80
300-0-300 120mA. 6.3v 4a C.T.; 6.3v 2a £7.00
220v 45mA. 6.3v 2a. £1.75
HEATER TRANS. 6.3v 3 amps. £1.45 ½amp. 95p
GENERAL PURPOSE LOW VOLTAGE. Tapped outputs 2 amp 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24, 30v £4.60
1 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60, £4.60
2a. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £7.00
3a. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £8.70
5a. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £11.25
5, 8, 10, 16v ½a £2. 6-0-6v 500mA £1. 9v 1a £1
12v 300mA £1. 12v 500mA £1. 12v 750mA £1.
40v 2a tapped 10v or 30v £2.95. 20v 3a £2.
40v 2a £2.75 30v 5A and 34v 2A ct. £3.50
20-0-20v 1a £2. 30v 1½a £1.75. 20v ½a £1.75, 1a £2
1 amp Transformer, mounted on panel with input and output fuses supplies 0, 20v, 40v, 60v or 20-0-20v £3.50
AUTO TRANSFORMERS. 115v to 230v or 230v to 115v 150w £5; 250w £6, 400w £7; 500w £8
CHARGER TRANSFORMERS. Input 200/250v for 6 or 12v 1½a £2.75 4a £4.60.
FULL WAVE BRIDGE CHARGER RECTIFIERS.
6 or 12v outputs 1½a 40p; 2a 55p; 4a 85p.

R.C.S. STABILISED POWER PACK KIT

All parts including printed circuit and instructions to build this unit. Voltages available: 6v, 7.5v, 9v, 12v. Up to 100mA output.
Please state voltage required **£2.95** Post 45p

STEREO FM/AM TUNER AMPLIFIER CHASSIS BY KUBA

This all transistor chassis has push button selection for long, medium short and V.H.F. wave bands. Features A.F.C. on V.H.F. band with automatic stereo beacon light. Volume tone and Balance controls with push button mains on/off switch. Amplifier inputs for a cartridge or [illegible] record play back socket fitted. Four watts per channel output.
Chassis size 17 x 4 x 5in **£33.50** POST £1.50

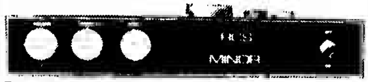
E.M.I. 13½ x 8 in. SPEAKER SALE!

With tweeter
And crossover. 10 watt **£5.95**
State 3 or 8 ohm Post 45p
15 watt version
8 or 15 ohm **£8.50**
20 watt version
8 or 15 ohm **£9.50**
as illustrated
Bass units only 20W **£7.50**
Bass units only 15W **£6.50**
Bass units only 10W **£4.95**
Post 65p

Bookshelf Cabinet **£7.50**

Teak Veneer. For above units Post £1.50

R.C.S. 10 WATT AMPLIFIER KIT



This kit is suitable for record players, tape play back, guitars, electronic instruments or small P.A. systems. Two versions are available. A mono kit or a stereo kit. The mono kit uses 13 semiconductors. The stereo kit uses 22 semiconductors with printed front panel and volume, bass and treble controls. Spec. 10 watts output into 8 ohm, 7 watts into 15 ohms. Response 20 cps to 30K/cs. Input from 20mV high imp. Size 9½in x 3in x 2in.

Mono kit **£11.25** Stereo kit **£17.50** post 45p

LOUDSPEAKERS P.M. 3 ohms. 7 x 4in. £1.25, 6½in. £1.50; 8 x 5in. £1.60; 8in. £1.75 10 x 6in. £1.90, 10in £2.50.
SPECIAL OFFER LOUDSPEAKERS! All Brand New. 3 ohm, 2½in, 2½in, 3½in, 5in 8 ohm, 2½in; 2½in; 5 x 3in, 5in. 15 ohm, 3½in; 5in, 6 x 4in; 5 x 3in; 7 x 4in; 25 ohm, 2½in, 3in, 5 x 3in, 7 x 4 in, 35 ohm, 3in, 5in. 80 ohm, 2½in, 2½in, 120 ohm, 3in.
£1.25 EACH

TWEETER VOLUME CONTROL 15 ohm 10 watt with 1in. long threaded bush for wood panel mounting. Will suit all tweeters 75p

RICHARD ALLAN TWIN CONE LOUDSPEAKERS 8in. diameter 4W £2.50, 10in. diameter 5W £2.95, Post 25p 12in diameter, 6W £3.50, 3 or 8 or 15 ohm models.
SPEAKER COVERING MATERIALS. Samples Large S.A.E.
Horn Tweeters 2-16Kc/s. 10W 8 ohm or 16 ohm £3.60.
De Luxe Horn Tweeters 2-18 Kc/s, 15W, 8 ohm £6.80
TWO-WAY 3,000 cps CROSS OVERS 3, 8 or 15 ohm £1.90
3-WAY CROSSOVER 850 cps and 3000 cps (25 watt) £2.20
100 WATT HORN TWEETER £10.95

GOODMANS CONE TWEETER £3.25

18,000 cps. 25 watts. 8 ohm.
5½in. Woofer 10 watt. Price £4.95.

ELECTRO MAGNETIC PENDULUM MECHANISM

1.5v d.c. operation over 250 hrs continuous on SP2 battery, fully adjustable swing and speed. Ideal displays teaching electro magnetism or for metronome, strobe etc. 95p. Post 20p

WEYRAD TYPE COILS

P50/1AC	60p	RA2W	£1.20	Twin Gang	£2
P50/2CC	40p	OPT1	85p	Printed Circuit	85p
P50/3CC	40p	LFDT4	85p		

COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18p. OUTLET BOXES, SURFACE MOUNTING 40p
BALANCED TWIN RIBBON FEEDER 300 ohms. 5p yd
JACK SOCKET Std. open-circuit 20p, closed circuit 25p; Chrome Lead Socket 45p. Phono Plugs 10p. Phono Socket 8p
JACK PLUGS Std Chrome 30p, 3.5mm Chrome 15p. DIN SOCKETS Chassis 3-pin 10p, 5 pin 10p, DIN SOCKETS Lead 3-pin 18p; 5-pin 25p: DIN PLUGS 3-pin 18p; 5-pin 25p VALVE HOLDERS 5p. CERAMIC 10p. CANS 5p.

R.C.S. 100 WATT VALVE AMPLIFIER CHASSIS

Professional model. Four inputs, Treble, Bass, Master Volume Controls. Ideal disco, P.A. or groups. 5 speaker outputs, very robust job
S.A.E. for details **£85** plus £2.50 carr.

NEW MIXER/AMP 150 WATT

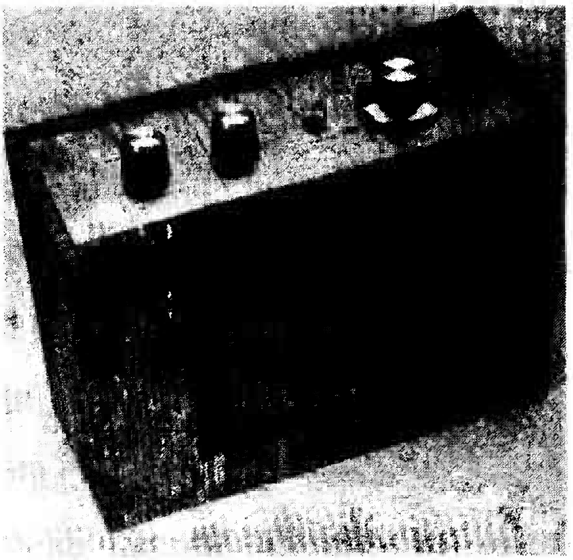
PROFESSIONAL TRANSISTOR AMPLIFIER **£68**
4 inputs 3 outputs, separate volume treble Carr. £1.50 and bass controls. Ideal disco or group P.A. amplifier
Send for leaflets on Disco Gear, Cabinets, etc.

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, CROYDON, SURREY.

Minimum post 30p. Access and Barclaycard welcome Phone your Order Open 9-6 Wed. 9-1 Sat. 9-5 (Closed for lunch 1.15-2.30)
Components Lists 10p. Cash price includes VAT Rail Selhurst. Tel. 01-684 1665

MEDIUM AND LONG WAVE SUPERHET



by A. P. Roberts **Part 1**

This is a basic design for a superhet receiver covering the medium and long wave bands. As with all conventional superhets, alignment of the mixer-oscillator and i.f. stages is required, but this can be carried out either with the aid of a multimeter or simply by working to the audible strength of received signals. Initial constructional steps are dealt with this month, and the completion of the project will be described in next month's concluding article.

This two-part article describes a very straightforward design for a medium and long wave broadcast receiver. It is not a miniature pocket-size set, and the outside dimensions of the prototype are 8¼ by 6 by 3½in. excluding control knobs. On the other hand, it is fully portable and uses an internal ferrite aerial and battery supply.

A superhet circuit is employed, and this provides excellent selectivity and sensitivity. A modern integrated circuit is incorporated in the audio stages of the receiver, giving plenty of volume at a negligible level of distortion from a 6 by 4in. elliptical speaker.

Construction of the receiver is quite simple. Although superhet designs need to be accurately aligned if they are to function well, the alignment procedure in this case is not particularly difficult and test equipment is not essential.

THE CIRCUIT

The complete circuit diagram of the receiver appears in Fig. 1. Taking an overall look at this, TR1 is the combined mixer-oscillator transistor, TR2 and TR3 are the i.f. amplifiers, D1 is the detector and IC1 is the audio amplifier.

Considering the circuit in greater detail, L1 is the medium wave tuned winding of the ferrite rod aerial, and L2 is the long wave tuned winding. S2 is the wavechange switch and it short-circuits L2 when it is in the medium wave position. Efficient coupling into the low input impedance of TR1 is achieved by using a coupling winding (L3) over L1, and by tapping into L2. C2 provides d.c. blocking. VC1(a) is the tuning capacitor for the aerial tuned circuit.

TR1 is employed as a conventional self-oscillating mixer. As an oscillator it functions in the common base mode with positive feedback being provided between its collector and emitter by way of the oscillator coil assembly, L4 to L6. The resonant frequency of the tuned winding (L5) determines the frequency of oscillation. C5 is a padder capacitor and VC1(b) is the tuning capacitor for the oscillator. VC1(b) and VC1(a) are ganged. TC1 and TC2 are alignment trimmers, and are an integral part of the 2-gang tuning capacitor.

When S2 is in the long wave position the frequency range of the oscillator is lowered by the addition of extra tuning capacitance across L5 in the form of TC3 and C4.

As a mixer, TR1 operates in the common emitter mode. The gain of TR1 alters with the changes in collector current which occur at oscillation frequency, and this effect provides the necessary mixing action. The resultant 470kHz difference signal is applied to the primary winding of IFT1. This rejects the other signals present at the output of the mixer, and only passes the 470kHz i.f. signal on to the subsequent stages of the receiver.

Conventionally, both the i.f. transformers would be connected the other way round, with TR1 and TR3 collectors connecting to the primary taps. Transposing the primary connections does not affect performance, and this has been done merely because it is more convenient so far as the physical layout of the receiver is concerned.

The i.f. stages are a little unusual in that an untuned coupling is employed between the two i.f. amplifier transistors. C7 provides a capacitive coupling here, whereas normally a ceramic filter or an i.f. transformer would be used.

This method of coupling does not cause any significant loss of sensitivity, but the fact that there are only two tuned circuits in the i.f. stages does result in the receiver having a slightly wider bandwidth than is usual with this type of set. Nevertheless, the level of selectivity is far higher than is obtained with a t.r.f. receiver, and is quite adequate. Also, due to stray circuit capacitances there is a certain amount of positive feedback in the i.f. stages, and this tends to improve selectivity.

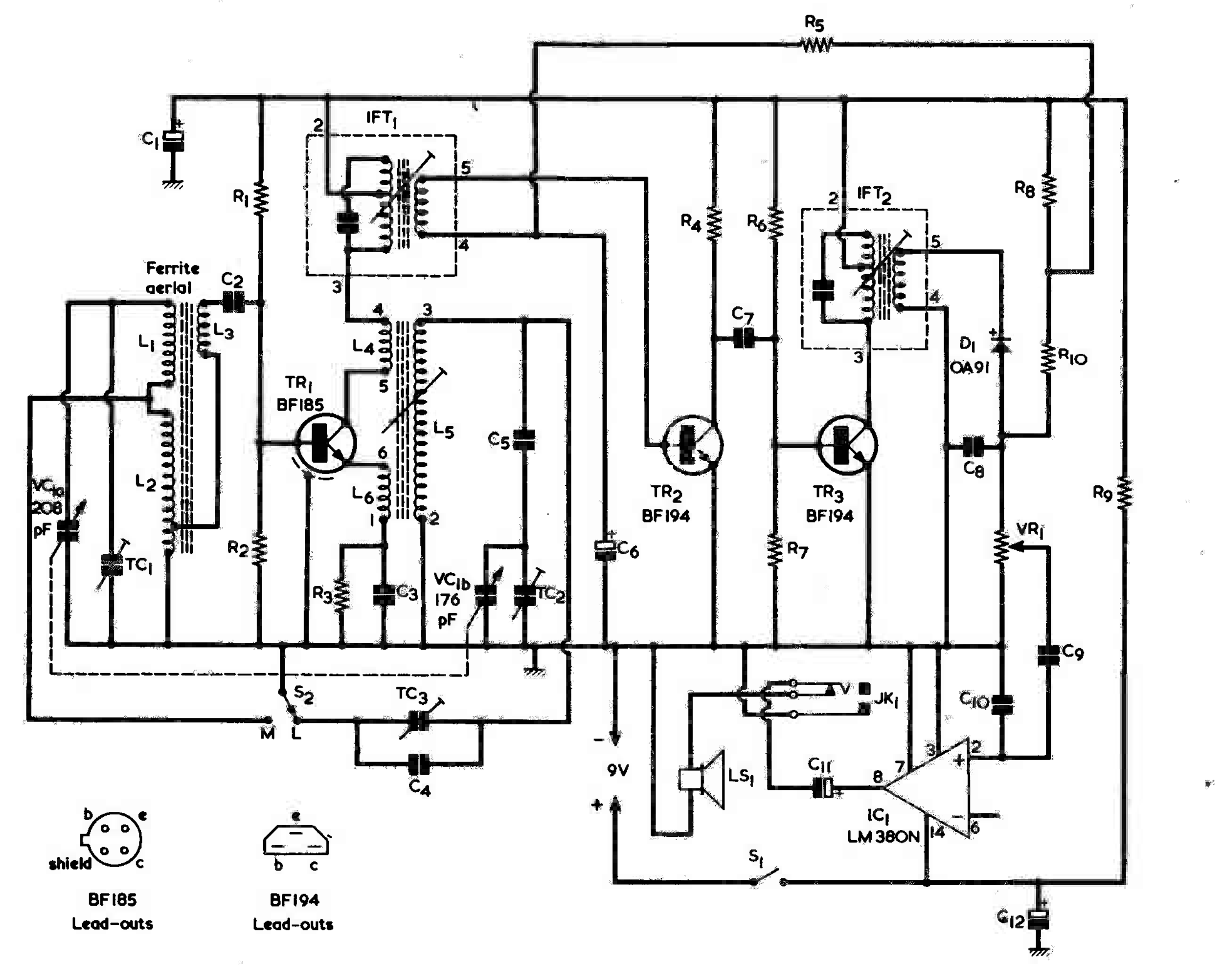
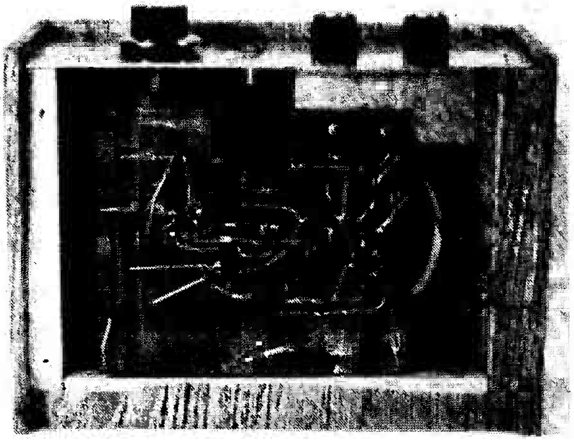


Fig. 1. The circuit of the medium and long wave superhet receiver



Looking inside the case with the rear cover removed. Visible here is the wiring side of the component panel and the bracket which secures it to the front panel

Both the i.f. amplifier transistors use the common emitter mode of operation, and it is these two transistors which provide most of the gain of the receiver.

The output of IFT2 feeds diode detector D1. This has the volume control, VR1, as its load resistor and C8 as the i.f. filter capacitor.

R8, R10 and VR1 form a potential divider which provides the bias voltage for TR2. The bias voltage is fed to TR2 base through R5 and IFT1 secondary. On strong signals the negative bias produced across VR1 due to the detected signal is relatively high and it reduces the base bias fed to TR2. This reduces its collector current and, in consequence, its gain.

The reduction in gain with strong signals constitutes a simple a.g.c. action, and it gives a fairly constant volume as the set is tuned from station to station, even though the strengths of the received signals may vary considerably. It also minimises the

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
R1 18kΩ
R2 15kΩ
R3 3.3kΩ
R4 2.7kΩ
R5 68kΩ
R6 560kΩ
R7 68kΩ
R8 100kΩ
R9 680Ω
R10 10kΩ
VR1 25kΩ potentiometer, log, with switch S1

Capacitors
C1 100μF electrolytic, 10 V. Wkg.
C2 0.01μF disc ceramic or type C280 (Mullard)
C3 0.01μF disc ceramic or type C280 (Mullard)
C4 47pF silvered mica or polystyrene
C5 220pF silvered mica or polystyrene
C6 10μF electrolytic, 10 V. Wkg.
C7 0.0022μF disc ceramic or plastic foil
C8 0.01μF disc ceramic or type C280 (Mullard)
C9 0.047μF type C280 (Mullard)
C10 470pF silvered mica or polystyrene
C11 220μF electrolytic, 10 V. Wkg.
C12 100μF electrolytic, 10 V. Wkg.
VC1(a)(b) 208+176pF 2-gang variable, Jackson type 00 with trimmers (Home Radio)
TC1, 2 part of VC1(a)(b)
TC3 140pF trimmer, mica (see text)

Inductors
L1, 2, 3 ferrite rod aerial type MW/LW.5FR (Denco)
L4, 5, 6 oscillator coil type TOC.1 (Denco)
IFT1 i.f. transformer type IFT13/470 (Denco)
IFT2 i.f. transformer type IFT14/470 (Denco)

Semiconductors
TR1 BF185
TR2 BF194
TR3 BF194
D1 OA91
IC1 LM380N

Loudspeaker
25Ω loudspeaker, 6 x 4in. elliptical (see text)

Switches
S1 s.p.s.t. toggle, part of VR1
S2 s.p.d.t. rotary (see text)

Socket
JK1 3.5mm. jack socket with break contact (see text)

Miscellaneous
Large control knob
2 small control knobs
9 volt battery (see text)
Battery connectors
Plain s.r.b.p. panel
Materials for case (see text)
Nuts, bolts, wire, etc.

noticeable effects of fading with distant stations.

A.F. STAGE

The audio amplifier is based on an integrated circuit type LM380N. This device is housed in a standard 14 pin d.i.l. package, and has a fixed voltage gain of typically 50 times. It has output short-circuit protection and thermal overload protection circuitry. The device is capable of providing output powers up to about 2 watts r.m.s., but in this circuit it is called upon to supply only about 350mW into a 25 Ω speaker. The use of a lower impedance speaker would permit a greater output power to be obtained, but this would be at the expense of battery life and is not recommended. On the other hand, a 35Ω speaker could be employed, with a slight drop in power output to about 250mW.

The LM380N requires very few external discrete components, and here just three capacitors are used. C9 is required to block the d.c. potential at VR1 slider from the i.c. input. C11 is the output d.c. blocking capacitor. It is essential that no r.f. signal should reach the input of the i.c. as this would almost certainly lead to instability. The third capacitor, C10, provides r.f. filtering at the input to the device.

There are two inputs to the LM380N, an inverting one and a non-inverting one. Only the non-inverting input is used, and the other input is simply ignored. Pins 3, 4, 5, 10, 11 and 12 of the LM380N are usually connected to chassis in applications where the LM380N provides a high output, and give a measure of heatsinking. These pins are connected together internally, and only pin 3 need be connected to chassis in the present circuit.

With its convenient voltage gain, protection circuitry, lack of discrete components and extremely low noise and distortion figures, the LM380N is just about ideal for this application.

JK1 is the earphone jack socket, and it has a break contact which disconnects the speaker when an earphone (which should have an impedance of 25Ω or more) is plugged in. The socket should have an open (i.e. non-insulated) construction, as it carries a chassis connection via its mounting bush and nut to the panel to which it is fitted. The only supply decoupling components which are required are C1, R9 and C12. S1 is the on-off switch and is ganged with the volume control.

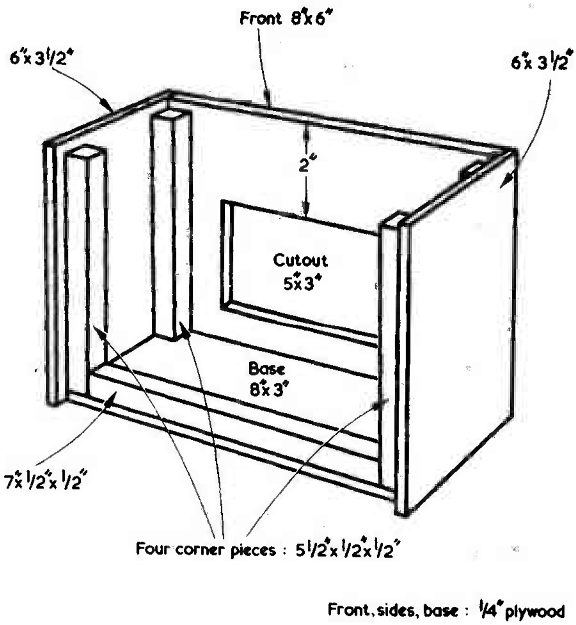
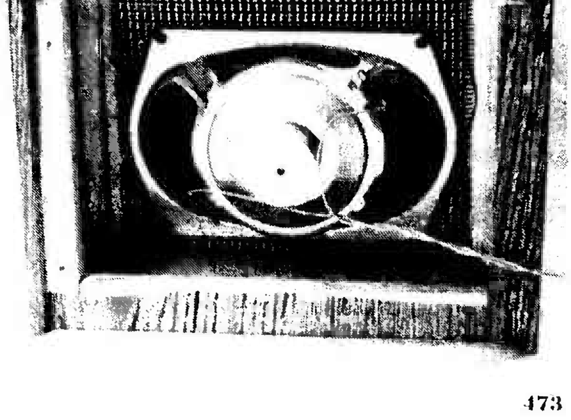


Fig. 2. The case is quite simple to prepare and assemble. As is explained in the text, it may be necessary to increase its depth to accommodate some loudspeakers

CASE CONSTRUCTION

A suitable case for the project can be constructed from ¼in. plywood with ½in. square wooden reinforcing pieces. An 18 s.w.g. aluminium front panel (which actually fits at the top) is used. Details of the case are illustrated in Fig. 2. As will become clear later, a component panel with the oscillator coil and the i.f. transformers mounted on it is positioned ver-



The shell of the case, with the loudspeaker mounted in position

The front panel and component panel assembly

tically behind the speaker, and there is a slight risk that, if the speaker has an exceptionally large magnet, there may not be sufficient space behind it for the panel. This point can be easily checked by finding, with the aid of the speaker and one of the i.f. transformers, the case depth needed to accommodate the speaker and the component panel, assuming that the panel, with its wiring, takes up $\frac{1}{4}$in. Should it be necessary, the $3\frac{1}{2}$in. dimension of the sides, and the 3in. dimension of the front panel and the base, may then be increased accordingly. It is doubtful whether such alterations will be required but it is still advisable to check first before cutting out any of the case sections.

The wooden parts are all cut out to size, after which the speaker aperture is cut out with the aid of a fretsaw. The four pieces of plywood and the corner pieces are then glued together, as shown.

The rear panel is an 8 by 6in. piece of $\frac{1}{4}$in. plywood, and it is secured to the case by four woodscrews which pass through it and into the corner pieces.

Dimensions and drilling details for the front panel are given in Fig. 3. As already stated, this is 18 s.w.g. aluminium. If, because of a speaker with an exceptionally large magnet, the 3in. dimension has to be increased, the holes for the controls and JK1 are still situated centrally between the two 8in. sides.

The drilling is quite straightforward apart from the three 4BA clear holes needed for mounting VC1(a)(b). They correspond with three 4BA tapped holes on the front plate of the capacitor frame and can be marked out with the aid of a small paper template. This has a $\frac{1}{4}$ in. hole cut in its centre and is passed over the spindle of the capacitor. The positions of the three tapped holes are then marked on it in pencil, after which the paper is transferred to the front panel and the holes are then marked out there. Several washers or spacers should be fitted on the bolts between the rear of the front panel and the capacitor frame. Also, the three mounting bolts must be short. If their ends pass more than marginally through the capacitor front plate they may damage the fixed or moving vanes.

The wooden parts of the case are covered with a self-adhesive plastic material such as Fablon, and this should provide a very attractive finish. With the front panel pushed into place, and then the back of the case screwed on, the front panel should be firmly held in position. If, however, a more positive form of mounting is required, four small holes may be drilled near the corners of the panel. Woodscrews can then pass through these holes into the tops of the corner reinforcing pieces.

A piece of speaker fabric is glued to the inside of the case behind the speaker cut-out, and then the speaker is mounted behind this. In the prototype the speaker was mounted by simply gluing it to the back of the speaker fabric. This provides quite an acceptable mounting in practice, provided that a good quality adhesive such as Bostik No. 1 is employed. Care must be taken to ensure that the glue is applied only to the front mounting surface of the speaker. If any adhesive gets on to the cone or surround of the speaker its quality of reproduction may be impaired.

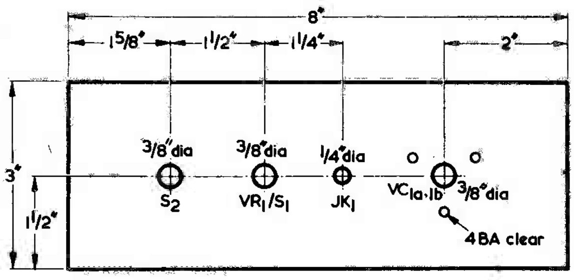


Fig. 3. Details of the front panel. This is made from 18 s.w.g. aluminium sheet

NEXT MONTH

In next month's concluding article details will be given of the component panel, final wiring and alignment. For completeness, the full Components List is printed this month, and any outstanding queries concerning components will be cleared up in the following article.

(To be concluded)

LIGHT OPERATED SWITCH

by N. R. Wilson

The switch described in this article can be made to operate either by a reduction or an increase in light intensity. An unusual optional circuit may be added to extend switching time after initial triggering.

Light operated switching circuits are always popular, either as novelty devices or for more serious applications. This article describes a simple circuit which is capable of being operated by small changes in light intensity, and which can be wired so that it is triggered either by a reduction in light or by an increase in light intensity.

THE CIRCUIT

The basic circuit of the light operated switch appears in Fig. 1 and it is quite conventional in operation. The sensing device is a light dependent resistor type ORP12, this presenting a resistance between its terminals which reduces when the light falling on it increases in strength. It is connected in series with R1 across the supply rails, and the junction of these two components is taken to the non-inverting input of an operational amplifier type 741. The pin numbering shown in the diagram is applicable to the 741 in its 14 pin d.i.l. package. The inverting input is connected to the pre-set potentiometer VR1.

The output of the 741 at pin 10 is in the low voltage state when the l.d.r. is illuminated, and goes to the high voltage state and energises the relay when the light intensity reduces. In consequence, the circuit is suitable for applications such as sensing the interruption of a light beam by a person or by a physical object.

When illuminated at its normal level the resistance of the l.d.r. is relatively low. VR1 is set up such that the inverting input is positive of the non-inverting input by a voltage whose value is dependent upon the

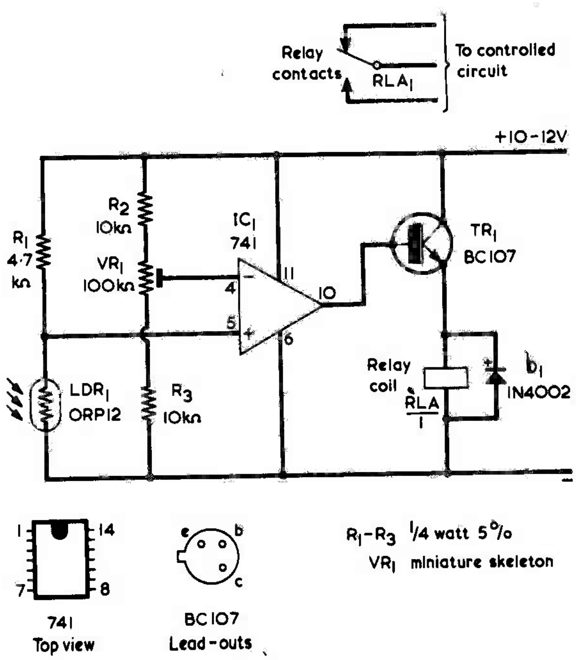


Fig. 1. The circuit of the light operated switch. This causes the relay to energise when the light falling on the l.d.r. reduces in intensity

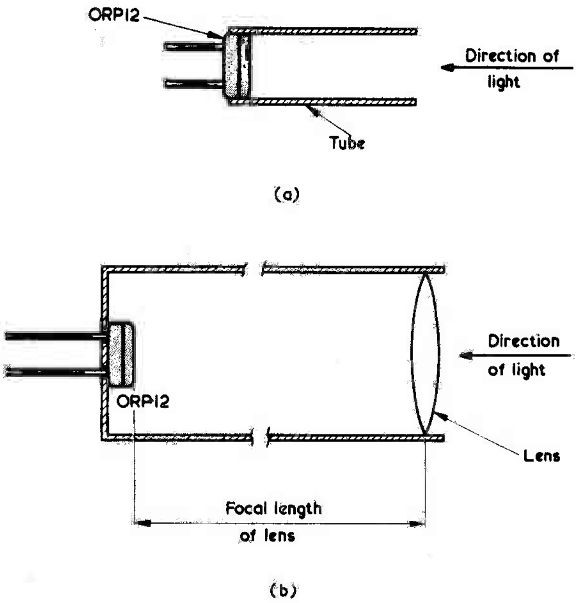


Fig. 2(a). The switch can be used to detect the breaking of a light beam. Here, the l.e.d. is mounted in a tube which is directed at the source of light

(b). A better performance is given if a simple lens system is incorporated

sensitivity required. In practice the slider of the potentiometer is advanced down its track until the 741 output goes high; the slider is then taken back past the point at which the 741 output returns to the low voltage state again.

If the incident light intensity reduces the resistance of the l.d.r. increases and the voltage at the junction of the l.d.r. and R1 goes positive. When this positive-going voltage passes that at the inverting input the output of the 741 goes very rapidly positive. The output of the 741 reverts to its low voltage negative state when the incident light intensity returns to its previous strength.

When the 741 output goes positive it causes relay RLA to energise, whereupon its contacts complete whatever external circuit is to be controlled by the light operated switch. It would be possible for the 741 to energise a relay directly, but it is preferable to interpose an inexpensive transistor in order that dissipation in the i.c. is kept at a low level. This transistor is TR1, and it functions as an emitter follower. The relay can be any type which is capable of energising at a voltage 2 volts lower than the supply voltage and which has a coil resistance of 250Ω or more. Connected across the coil is the usual diode which prevents the formation of a high back-e.m.f. on relay release.

Summing up the operation of the circuit in Fig. 1 it may be said that the l.d.r. is normally illuminated and that the relay is then de-energised; if the l.d.r. illumination is reduced the relay energises, subsequently releasing when the l.d.r. illumination returns to its previous level. Pre-set potentiometer VR1 is set up for the desired sensitivity.

If the circuit is to be used to detect the breaking of a light beam it is desirable to shield the l.d.r. from ambient light. One way of doing this is to mount the l.d.r. at the end of a tube whose internal diameter is the same as or slightly larger than the diameter of the l.d.r. See Fig. 2(a). The interior wall of the tube should be painted matt black and the tube is directed at the source of light. Better results are given by using a wider diameter tube with a convex lens at the open end, as in Fig. 2(b). The lens can be that in a cheap plastic magnifying glass and its focal length can be found by employing it to focus an image of an electric light bulb on a piece of paper; the focal length is then the distance between the lens and the paper. When employing a lens it should be possible to get good results with a 25 watt bulb positioned some 6 feet away from the l.d.r. assembly. Bulbs of lower power can also be tried.

EXTENDED SWITCHING TIME

The circuit can be modified such that, once the relay has been energised by a reduction in light intensity on the l.d.r., it stays energised for a predetermined period before releasing again. This modification requires that the relay has a spare set of changeover contacts in addition to those used for controlling the external circuit. The modification is shown in Fig. 3, in which diagram the relay contacts are depicted in the de-energised state. The additional components are the relay contact set, diode D2, R4 and electrolytic capacitor C1.

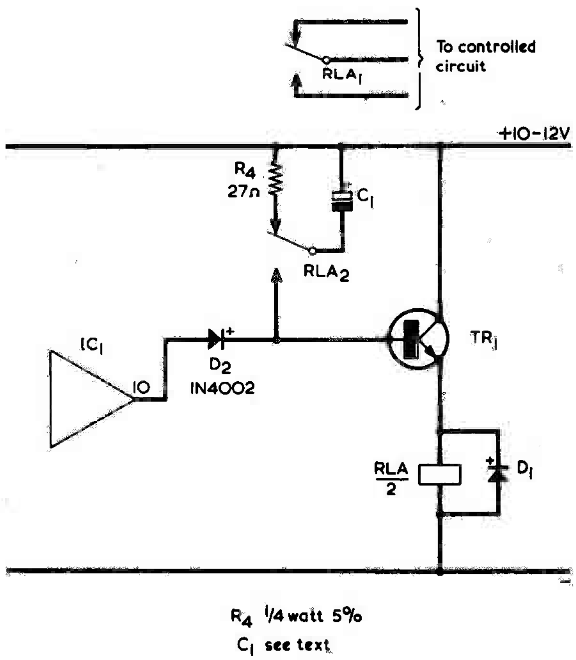


Fig. 3. A modification at the output of the 741 which causes the relay to remain energised after triggering for a pre-determined period

When the output of the 741 is low the relay is de-energised, as before. When the 741 output goes high so also, via the forward biased diode D2, does the base of TR1 and the relay energises. Relay contact set RLA2 changes over to the energised state, connecting the discharged electrolytic capacitor C1 between the positive rail and the base of the transistor. If the 741 output now goes low again it has no effect on relay operation as diode D2 merely becomes reverse biased. Instead, C1 starts to slowly charge, the charging current being the base-emitter current of the transistor. The voltage across the capacitor gradually increases, whereupon the voltage on the emitter of TR1 correspondingly decreases. After a period of voltage at TR1 emitter becomes too low to maintain the relay in the energised condition, and it releases. The circuit then reverts to its previous state and relay contact set RLA2 connects the low value resistor R4 across C1, causing the latter to rapidly discharge and become ready for the next delay period.

If, during the period, the output of the 741 goes high the negative terminal of C1 is taken nearly to the positive rail, and the delay starts once more after the 741 output has gone low again. It is in order to have the 741 change the voltage across an electrolytic capacitor in this manner since it has its own internal current limiting circuit.

The length of the delay period depends on the current gain of the transistor, the coil resistance of the relay and the voltage at which the relay de-energises. Since all these factors will vary between one unit made up to the circuit and another, the value of C1 has to be found experimentally. The length of time will be roughly proportional to the value of C1; if C1 is doubled in value so, approximately, will be the length of the period. The best approach here is to initially connect a 100μF capacitor in the C1 position and measure the length of the delay this gives. If it is, say, one-tenth of the desired delay, C1 can then be replaced by a 1,000μF capacitor. Due to the wide tolerance on eletrolytic capacitor values and other factors it may be necessary to try several final values if a fairly precise delay period is required. As a guide to what is to be expected, the author used a 500Ω relay type P.O.3000 in his circuit and found that 100μF in the C1 position gave a delay of about 20 seconds and that 2,200μF gave a delay of some 8 minutes. The capacitor employed should have a working voltage of 10 or more.

It will be found difficult to set up VR1 when the delay modification is incorporated because the relay does not respond, after triggering, directly to the state of the 741 output. In consequence, when setting up VR1 a voltmeter should be connected between the 741 output and the negative supply rail, this indicating when the output is in the high or the low state. In the low state, incidentally, there is a voltage of about 2 volts at pin 10 of the 741. An alternative approach consists of inserting a switch between the positive supply rail and the positive terminal of C1. The switch is opened when it is desired to set up VR1, and is subsequently closed to give the delay period facility.

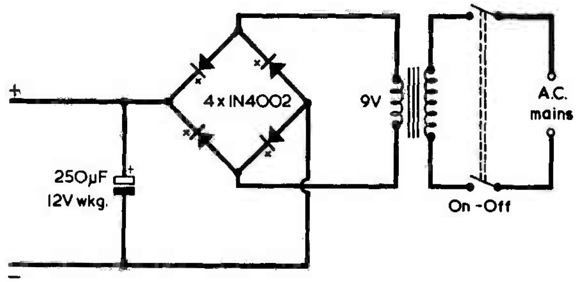


Fig. 5. A suitable mains power supply for the light operated switch

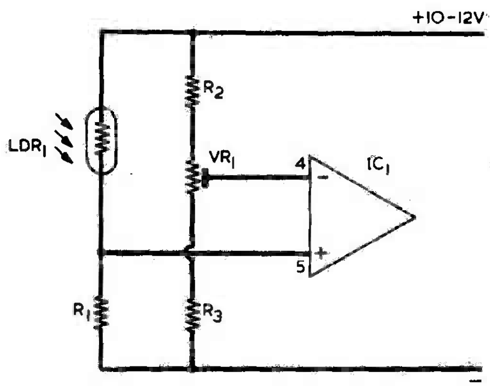


Fig. 4. If the l.d.r. and R1 are transposed the circuit responds to increases in light level

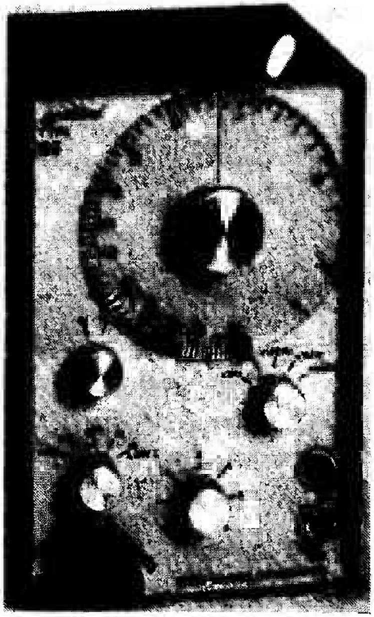
ALTERNATIVE OPERATION

Should it be desired to have the relay energise on an increase instead of a decrease in light intensity it is merely necessary to transpose the l.d.r. and R1, as shown in Fig. 4. As before, VR1 is adjusted for the desired sensitivity. The delay modification of Fig. 3 can be used with the circuit when it has this alternative mode of operation.

The circuit draws a current of several milliamps when the relay is de-energised, the current increasing by that required by the relay when the circuit is triggered. The supply does not have to be stabilized because the 741 compares similiar fractions of the supply voltage. A battery may be used but in most instances it will be more economical to employ a mains supply unit. This can be any type offering the voltage and current required, and an appropriate circuit is given in Fig. 5. A suitable mains transformer would be a 'Miniature 6VA' type available from Doram Electronics. The transformer required has two separate 4.5 volt secondaries which can be connected in series to provide a total of 9 volts. ■

NEWS . . . AND .

REDESIGNED SIGNAL GENERATOR



The Linstead G5 sine/square Signal Generator has been redesigned to produce an even better specification.

Although the price of £58.70 makes it one of the most inexpensive signal generators on the market, the distortion, range, accuracy and facilities make it one of the best.

The G5 is a high accuracy, solid state sine/square wave generator with a built-in 600 ohm switched attenuator. The output is fed from a power amplifier and can be either 600 ohm or a very low output impedance capable of delivering 3 watts into a 5 ohm load.

The frequency range of 10Hz to 1MHz is selected by a 5 position range switch and the large 10.5cm tuning scale (scale length 26cm).

With sine wave distortion less than ½% harmonic content and a frequency accuracy better than 2% ±1 Hz the G5 is suitable for "Hi-fi" work as well as general laboratory use.

Most oscillators suffer from "bounce" and unstable phase shifts when the frequency is changed. Linstead have resolved this problem by using a Wien bridge oscillator with FET inputs, enabling high tolerance resistors to be used and an accurate air space capacitor to change the frequency.

The output voltage of 6 volts r.m.s. can be reduced to less than 1mV by means of the continuously variable control and the switched attenuator.

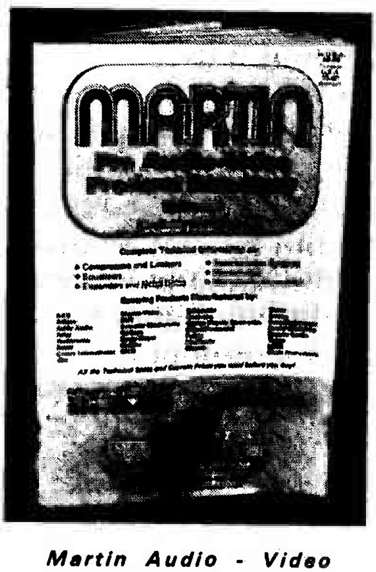
The G5 is designed to occupy the minimum amount of bench space (13cm x 13cm x 21cm high) and with its steel case is extremely rugged.

Manufactured by Linstead Electronic Instruments, Rosslyn Works, Roslyn Road, London N15 5JB.

PROFESSIONAL PRODUCTS DIRECTORY FOR U.S.A. READERS

Martin Audio-Video Corp. has just published its first major Product Directory, a 48-page compilation of more than 300 products from 30 manufacturers of professional equipment. Included are equalizers, expanders and noise gates, reverberation systems, microphones and microphone accessories. Compiled by John M. Woram, the Directory provides full technical information, detailed specifications and prices, and lists the significant parameters of each product. It is available from Martin Audio-Video Corp., 320 West 46 St., New York, N.Y. 10036. The cost is $5.00, which will be refunded on the first purchase of $50.00 or more.

This is the first volume in a series of Product Directories on Professional Audio-Video Equipment which will cover the entire spectrum of products available from Martin, America's largest supplier of professional equipment, parts and service. The company, founded in 1964, has a staff of some two dozen skilled employees occupying three floors at its New York City headquarters. It maintains an inventory that includes everything the professional requires, from a simple plug to a multi-track recording console.



Martin Audio - Video Corp.'s new Professional Products Directory, which lists more than 300 products from 30 manufacturers of professional equipment available from Martin. Compiled by John M. Woram

THE HIGH COST OF HOLES

Did you know that what may well be the greatest cost in a mass-produced printed circuit is the part the customer does not receive? It isn't the insulated backing or the copper foil or even the printing process itself. It's the holes!

If our source is correct, the most expensive factor in the production of boards is making the holes for component lead-outs. The holes have to be punched out or drilled and this can involve quite extensive tooling. The s.r.b.p. backing of printed boards is not the easiest of materials to pierce without fracturing or splitting. Indeed, if there are a number of closely spaced holes in a group it may be necessary to have two punching or drilling operations. Alternate holes in the group are made first, after which a second operation takes out the holes in between. Added to the initial tooling expense are the maintenance costs for the punches or drills, which do not have an everlasting life.

So, when you buy a ready-made copper-clad board with punched or drilled holes think of all those tiny fragments of copper-clad s.r.b.p. nestling under the punching or drilling machine. You won't receive them with the board but they are representative of much of its cost.

. . . COMMENT

AUTOMATIC AUDIO TEST EQUIPMENT

As a result of agreements recently signed between the Independent Broadcasting Authority and VG Electronics Ltd., a novel automatic audio testing equipment, developed by the IBA is to be marketed by VG Electronics Ltd. The company will be responsible for further engineering development and for the manufacture of the equipment.

An order for AATE, worth £30,000, has been placed by the IBA with VG Electronics Ltd.

AATE was developed to meet a requirement for a relatively low-cost automatic measuring instrument able to determine rapidly the amplitude/frequency response and noise levels of telecommunications circuits including "music channels". It thus measures the two performance parameters which normally present most problems to broadcast and telecommunications authorities and users. It is suitable for use on all audio transmission paths, including point-to-point links.

The equipment can be operated unattended, the receiver unit automatically providing a chart print-out of the parameters under test. The transmitter unit concerned is clearly identified by a coded pattern on the print-out.

RECORD DIVIDERS MAKE MUSIC CHOICE EASIER

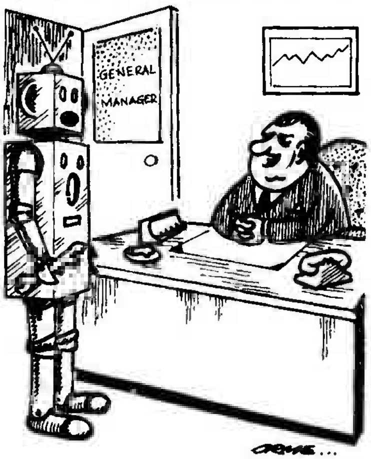
New hard-wearing record dividers designed by a London firm are becoming very popular.

Already, the Harlequin group has distributed 15,000 for use in its chain of shops throughout Britain. Other stores are also sending in their requests to the manufacturers, Signs Familiar Ltd., at 10 Queen's Road, Peckham, London, and considerable interest is being shown from overseas countries, in particular Australia, Norway, Sweden, Malta and Greece.

Made from heavy gauge black or white plastic, the dividers do not bend, tear or crease, and are designed to make any record display more attractive. They separate classics from rock 'n roll, soul from country and western, jazz from opera . . . The titles are limitless and are individually printed for a customer in a variety of colours and type styles.

The dividers are available in two sizes — for LPs (14in. x 12in.) at 45p each, and singles (8½in. x 7in.) at 32p and the cost includes individual titling.

Signs Familiar, who produce the dividers, can provide fast delivery, and for orders of 50 or more will print a company's name or logo on the dividers, in a different colour, free of charge.



"We're very pleased with your work so we're promoting you from Monday. You'll be on a higher voltage!"

GEOS LAUNCHING

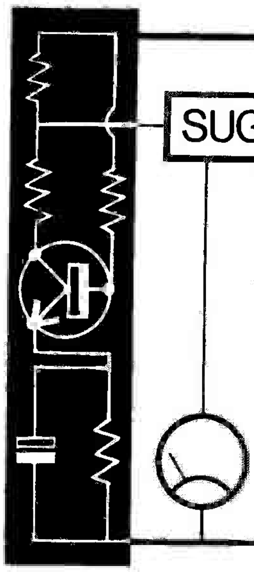
GEOS, Europe's first geostationary scientific satellite is due to be launched next month. GEOS has successfully completed tests, with excellent results at British Aircraft Corporation Electronics and Space Systems, Bristol.

GEOS will carry seven experiments devised by nine European scientific groups. These experiments will detect and measure the magnetic and electric fields surrounding the earth and the varying flow of particles (electrons and protons) emitted by the sun, enabling scientists to study the interaction of this so-called 'solar wind' with the earth's magnetic field and its consequent effects on the electrified layers of the atmosphere and the aurorae in polar regions.

The British tests have confirmed the compatibility of the scientific experiments with each other and the satellite's other equipment. Their electrical and magnetic fields have been shown to be acceptable and not to jeopardise the satellite's performance. The natural fields of the Magnetosphere which GEOS seeks to detect and measure are extremely weak and could be swamped in the vicinity of the satellite by self-generated fields.

GEOS is to be launched from the United States Eastern Test Range by Delta rocket and will have an operating life of two years.

The foregoing information was obtained from a BBC World Service progress report.



SUGGESTED CIRCUIT

PHASE SHIFT A.F. SIGNAL SOURCE

By G. A. French

For fault-finding and such applications as the checking and setting up of a.f. amplifiers and tape recorders it is desirable to have an a.f. signal source offering an output which is reasonably sinusoidal in character. If the signal source is required only occasionally the expense of a comprehensive a.f. signal generator is not justified, and a simple a.f. oscillator operating at a single frequency can be more than adequate.

Ironically, while it is a very easy matter to construct a square wave generator running at an audio frequency, the provision of a low cost sine wave a.f. generator raises a disproportionately large number of difficulties. It is possible to make up an LC oscillator incorporating an iron-cored a.f. transformer, but some care is needed in setting up feedback and transistor bias levels if the output is to at least approach the sinusoidal character desired. An RC oscillator is perhaps more attractive, but, even here, attention has to be paid to operating conditions to obtain a reasonably pure sine wave output. What is probably the simplest RC oscillator is the phase shift type, in which feedback is obtained by way of three CR sections which give a phase shift totalling 180 degrees. The a.f. signal source to be described in the present article is of this nature.

SIGNAL SOURCE CIRCUIT

The circuit of the signal source appears in the accompanying diagram, in which the oscillator consists of TR1 and its associated components. Feedback from the transistor collector to the base is achieved via the phase shift sections C2 and R2, C1 and R1, and C3 and the resistance at TR1 base. The oscillator signal appears at the collector of TR1 and is applied, via R7, to the base of a buffer amplifier, TR2. This transistor is connected in the common emitter mode and, in practice, gives greater isolation between the oscillator and output circuits than does an emitter follower coupled directly to TR1 collector. The signal at TR2 collector is passed via C5 to the attenuator, VR2, the slider of which couples to output jack JK1 via C6. It might be considered that VR2 could form the collector load for TR2 whereupon C5 could be omitted, but this method of connection would cause a direct voltage to appear across the potentiometer track and there would be a higher risk of noise when the slider is moved along the track. The full output voltage available is of the order of 200mV at an impedance given by the reactance of C6 plus 1kΩ or less, and this should be adequate for most applications for which the signal source will be required. VR2 is a linear rather than a log track component, with the result that output voltage is proportional to spindle rotation.

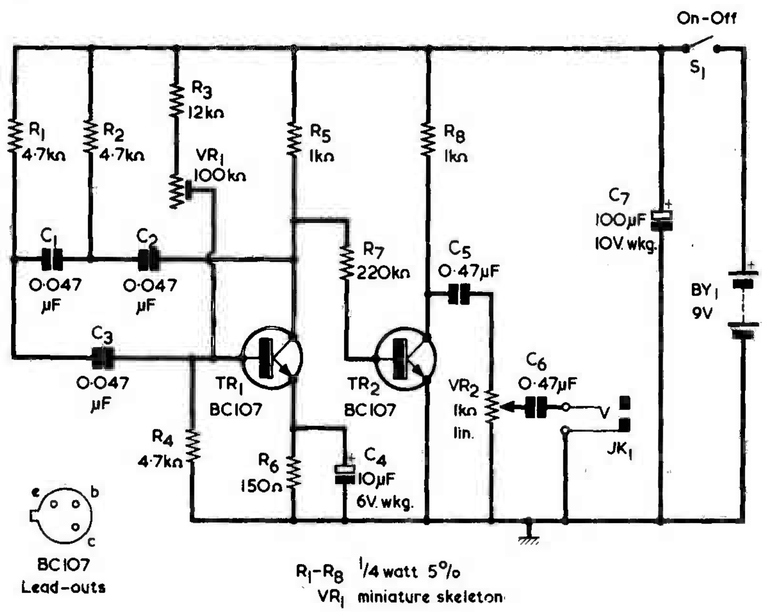
The test leads from the signal source consist of two flexible wires connected to a jack plug which is fitted into JK1. The wire connecting to the jack plug sleeve is terminated in a crocodile clip for connection to the chassis of the equipment with which the signal source is to be used. The second wire connects to the jack plug tip and may be terminated in another crocodile clip or in a test probe for signal injection.

An earphone or headphones having an impedance of 1kΩ or more can also be plugged into JK1 for checking the oscillator and for setting it up.

OSCILLATOR ADJUSTMENT

Phase shift oscillators incorporating a single transistor tend to be a little temperamental because of the low impedance presented at the base of the transistor. In consequence, pre-set potentiometer VR1 is included in the base bias circuit to allow the transistor to be brought to the correct operating condition.

To set up VR1, the output of the circuit is coupled to an a.f. amplifier or to an earphone or headphones of suitable impedance, and the unit is switched on. VR2 is set for maximum output. VR1 is then adjusted until TR1 commences to oscillate, and is finally left at a setting mid-way between those at which oscillation ceases. It should be noted that signal amplitude in the earphone or headphones will be at a comfortable but not very high level. The setting of VR1 obtained in this manner should be sufficient for oscillation to be maintained for battery voltages down to about 7 volts. There is a very slight risk that a few transistors of the type specified will not oscillate as readily as others. The author checked out four transistors in the TR1 position and experienced no difficulties on this score; and he mentions the point merely to ensure completeness of information. The oscillator frequency is around 500Hz. This changes slightly with the setting of VR1 and, also, with varying battery voltage.



The circuit of the phase shift a.f. signal source. This offers an output signal which is reasonably sinusoidal, and which will be found particularly suitable for the checking and setting up of a.f. amplifiers

COMPONENTS

All the components are standard parts. The fixed resistors and VR1 are as specified in the diagram. VR2 is a carbon track potentiometer. Apart from C4 and C7, the capacitors are all plastic foil types. C6 should have a working voltage which is higher than the voltages likely to be encountered in the equipment to which the signal source will be connected. C4 and C7 can, of course, have working voltages higher than those indicated. JK1 can be a 2.5mm., 3.5mm. or ¼in. jack socket, as preferred by the constructor. A PP6 battery will be adequate for BY1.

If the components are assembled in a metal case, this should be made common with the negative rail, as indicated by the chassis symbol in the diagram. Should a plastic case be employed, the chassis symbol can be ignored. Mounted on the front panel of the case are the on-off switch S1, the attenuator VR2 and the output socket JK1.

The current drawn from the battery when the oscillator is set up is approximately 5mA.

■

BACK NUMBERS

For the benefit of new readers we would draw attention to our back number service.

We retain past issues for a period of two years and we can, occasionally, supply copies more than two years old. The cost is 40p plus 11p postage.

Before undertaking any constructional project described in a back issue, it must be borne in mind that components readily available at the time of publication may no longer be so.

We regret that we are unable to supply photo copies of articles where an issue is not available. Libraries and members of local radio clubs can often be very helpful where an issue is not available for sale.

PRODUCING PRINTED CIRCUIT BOARDS

By P. R. Arthur

Many electronic constructional projects feature the use of printed circuit boards. This article reviews the production of printed boards at home, and offers much practical advice on board preparation and on the essential etching process.

Keen electronics enthusiasts can hardly have failed to notice the increasing use, these days, of printed circuit boards in published home constructor projects. One probable reason for the increase is the advent of integrated circuits, for which printed boards offer the most suitable method of connection. Also, many modern circuits are fairly complex, whereupon alternative forms of assembly can be excessively time-consuming and incur greater risks of wiring error.

Integrated circuits and sophisticated designs are almost certain to increase in popularity, and in consequence it becomes a virtual necessity for anyone who is seriously interested in electronic project construction to be able to etch his own printed boards. It is worth mentioning that, apart from giving a very neat and professional finish to equipment, printed circuit boards represent a relatively inexpensive form of construction.

MATERIALS REQUIRED

The materials required for etching printed circuit boards are quite readily available. The basic requirements are:

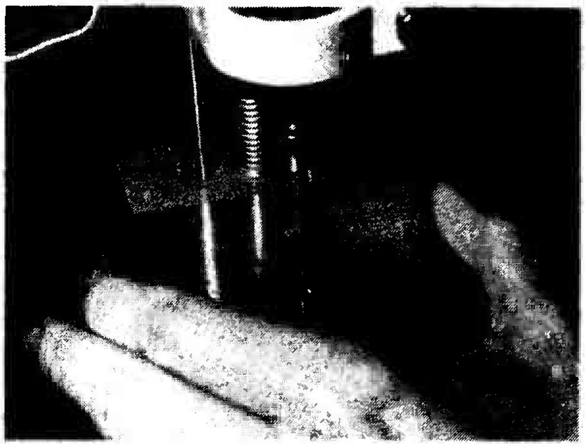
1. Copper clad board (either s.r.b.p. or fibreglass),
2. A printed circuit board marker pen, or etch resist and small paint brush,
3. Etchant,
4. Scouring pad or powder,
5. A small drill and bit.

Each of these will be discussed in more detail when its role in the process is reviewed.

After the copper clad board has been cut to size, hole positions are marked out with a pointed tool

COPPER CLAD BOARD

The copper clad board is, of course, the basis of the printed circuit board. It usually consists of a sheet of s.r.b.p. which is coated with a thin layer of copper on one side. (S.R.B.P., formerly frequently referred to in home constructor circles as "Paxolin", is the abbreviation for "synthetic resin bonded paper".) A superior grade of board is available which uses fibreglass rather than s.r.b.p. as the insulating material. For normal amateur requirements the s.r.b.p. variety is perfectly adequate, and fibreglass boards are only necessary when the board needs to be particularly strong for some reason (such as if a heavy mains transformer is to be mounted on it).



Drilling the holes in the board. A drill bit with a small diameter is essential here

It is perhaps worth mentioning that double sided copper clad board is also available. This is rarely encountered in amateur electronics, and is only employed in a few specialised designs. The etching process is much the same whether the board is single or double sided.

A board of the required size is unlikely to be available and it will be necessary to cut it out from a larger board. This can be done by means of a hacksaw with a fine toothed blade. A coarse blade must not be used as it will produce a very rough edge where the cut has been made and, since the insulating material is sometimes rather brittle, could even result in the board splitting.

ETCH RESIST

The etch resist is used to cover the areas of copper which are to remain after the board has been etched. Probably the best method of applying the etch resist is to employ one of the special resist pens that are widely advertised. These have a fine tip which enables intricate printed circuit board patterns to be easily marked out.

An alternative method is to use a fine artist's brush to apply the resist. The resist itself can then be any paint which will not dissolve in water, and it is obviously more convenient to employ a quick drying type. Automobile touch-up paint is often recommended for this reason, and the author's experience has been that matt finish paints are also very good.

The author has found it possible to apply the resist by means of an exhausted fibre-tipped pen, this being used rather as a cross between an ordinary etch resist pen and a paint brush. Provided too much resist is not taken up by the pen at one time, it gives a good means of marking out finely detailed patterns at very low cost.

Whatever means of applying the etch resist is used, always make quite sure it covers the appropriate areas properly and that it is fully dried out before the board is etched.

TRACING

Full size diagrams of the copper pattern of the printed circuit board are usually provided, and the traditional procedure consists of tracing this pattern onto a sheet of paper and then transferring it to the copper clad board. After this the resist is applied to conform with the pattern, the board is etched and it is finally drilled.

In the author's opinion this is not the best method, and so a slightly modified process will be described here.

A tracing is made from the printed circuit board diagram, but only the perimeter of the board and the drilling points are traced. Any excess paper is trimmed off the tracing and it is then fixed to the copper side of the copper clad board. Paper clips or double sided adhesive tape can be used to hold the tracing in position securely. A bradawl or similar pointed tool is then used to make small indentations in the copper at the points where the board is to be drilled. The indentations should be made with light pressure only as some copper clad boards have soft spots which can give way if heavy pressure is applied.

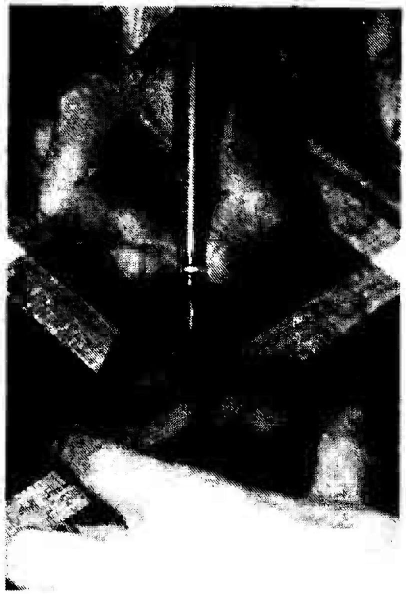
DRILLING

After making the indentations the tracing is removed from the board, which is then ready to be drilled. A very small diameter high speed steel drill bit must be employed here, and the author usually uses one with a diameter of either 3/64in. or 1/32in. except where a special component (such as an i.f. transformer) makes it necessary to provide a hole of larger diameter. A drill of 1/16in. should be regarded as the maximum size which is acceptable for drilling the holes for ordinary lead-out wires.

Ideally a miniature electric drill (such as that available from Precision Petite Ltd., 119a High Street, Teddington, Middlesex) should be used for drilling, but it is possible to employ a full size electric drill or a hand drill. One problem is that most full size drills will not take bits of less than 1/16in. diameter; however, it is usually possible to overcome this by tightly winding thin copper wire of about 40 s.w.g. around the shank of the small diameter bit so that it will be held firmly in the drill chuck.

It should be explained at this point that the larger the diameter of the drill bit the harder it will be to make sound soldered joints at the resulting holes. Another factor is that many designs use d.i.l. integrated circuits, and these have their pins spaced at

The copper clad board with holes drilled



Applying the resist. This covers all the copper areas which are to remain after etching

intervals of only 0.1in. Using a drill bit significantly greater than 1/16in. in diameter would obviously be impracticable for making holes with this spacing.

When the drilling has been completed the resist can be applied to the board. This is just a matter of referring to the printed circuit board diagram to see which holes are joined to which and then acting accordingly, maintaining the same layout as in the diagram. Where there are large copper areas as occur, for instance, with copper which is at earth potential, these are covered to conform with the diagram. When the resist has been applied and has dried the board is ready to be etched.

ETCHING

A solution of ferric chloride is used as the medium in which the board is etched. It may be possible to obtain ferric chloride crystals or a ready made solution from a local chemist. Ferric chloride crystals are also offered by some component mail-order houses. If crystals are obtained they should be dissolved in the smallest volume of water in which they will fully dissolve. Apply the crystals to the water and not the other way round. The crystals will dissolve more readily if the water is warmed slightly (but only slightly). No heat should be generated when ferric chloride in crystalline form is dissolved in water but it is advisable to check for this at first when using crystals from an unfamiliar source.

The saturated solution of ferric chloride just mentioned is somewhat stronger than is really necessary, and a weaker solution is sometimes recommended. The author's experience has been that anything from a 10% to a saturated solution will give a reasonably short etching time. However, the stronger the solution the quicker the etching process. Also, a stronger solution will have a longer life, and so less frequent making up of a solution will be necessary. The solution should be kept in a glass or similarly non-metallic container, and great care must be taken to prevent contact with the skin as it is highly corrosive. Any solution on the skin should be immediately washed off with liberal quantities of warm water. Skin contact should be avoided with the crystals also.

The ferric chloride advertised by some electronic component retailers is supplied in anhydrous form. It is rather difficult to use in this form since it contains no water and is a deliquescent substance. This simply means that it has an affinity for water, and will absorb it from the atmosphere or any other source of water with which it comes into contact.

In anhydrous form ferric chloride is a fine powder, and the utmost care must be taken when handling it because it can be released into the air as a cloud of fine particles. Anhydrous ferric chloride is more corrosive than the crystals or the solution and so even a small amount in the atmosphere is highly undesirable. To reiterate: if ferric chloride should get onto the skin or clothing it must be washed off at once, whatever form the chemical is in.

Making a solution from the anhydrous form of the chemical is not easy as it reacts rather violently when added to water and a considerable amount of heat is generated. The author has found two fairly successful ways of making a solution from this form of ferric chloride.

One method is to add only a small amount of the chemical to the container of water at one time. If the water becomes hot it should either be left to cool off before any more ferric chloride is added, or ice can be added to cool it down. It must not, however, be excessively cooled. On no account should water be poured on the ferric chloride.

The copper clad board complete with the resist pattern

The board is next immersed in the solution of ferric chloride which forms the etchant

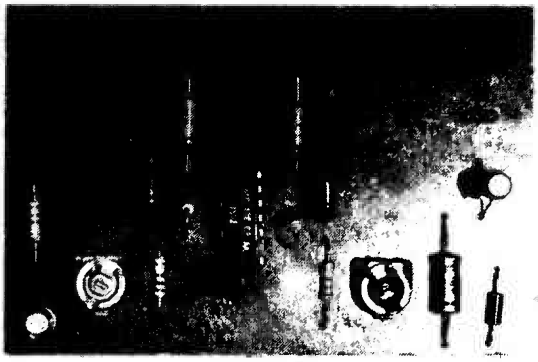
The second method is simply to spread a thin layer of ferric chloride over the bottom of a large shallow dish. Unless the atmosphere is excessively dry, the chemical will then slowly absorb moisture from the air. It is helpful to stir the chemical occasionally so that new upper surfaces are produced. When the chemical has become very moist to the point where all the contents of the dish are virtually a liquid, and not before, some water may be carefully added and the solution is then ready for use.

A brown precipitate will probably be produced in the solution whichever of these two methods is used. This can either be filtered off or it can be left to fall to the bottom of the container, the unpolluted solution then being poured off very slowly so that the sludge is left behind.

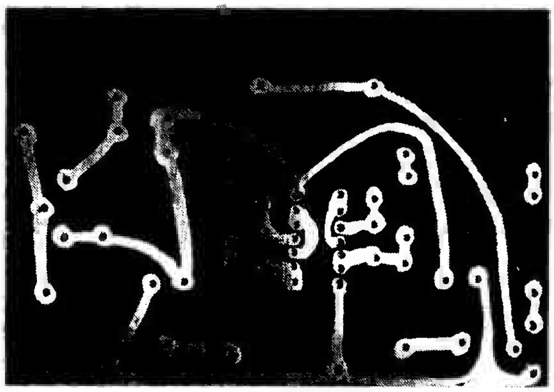
When it comes to the actual etching process the solution is poured into any non-metallic dish which is large enough to take the printed circuit board. Ferric chloride is corrosive to many metals and metal implements should not be used with it. The copper clad board is placed copper side up in the solution, and the dish is gently agitated as frequently as is reasonably possible. If the solution is not agitated an inactive layer will appear on the surface of the board and the etching action will be virtually halted. The process can be speeded up slightly by warming the solution.

Another method of decreasing the etching time is to employ a dish which tapers in towards the base, and into which the board will fit some way above the bottom. The board can then be placed in the dish copper side down, and gravity will largely remove the inactive surface coating. No agitation of the solution is then necessary, although occasional agitation will further hasten the process.

The time taken for all the exposed copper to be etched away is dependent upon several variable factors, but it usually takes between 15 minutes and 1 hour. The board should not be left in the solution any longer than is absolutely necessary as this could lead to the copper being removed from areas where the resist has not been completely effective.



The component side of the completed printed circuit board illustrates the neat and professional appearance which is imparted by this method of project construction



After etching and cleaning, the copper areas are clean, well defined and bright. The board is now ready to take the components

SCOURING PAD OR POWDER

Either wear rubber gloves or use plastic tweezers to remove the board from the etchant, and then rinse the board thoroughly in running tap water. Next, scouring powder as employed for cleaning sinks or a scouring pad, such as a Brillo pad, is used to remove the resist and clean the remaining copper to a bright finish. This process is carried out with the board still wet. After thorough drying the board is then ready for the components to be soldered into position.

Incidentally, copper clad board is rarely supplied with a clear bright finish and it is advisable also to thoroughly clean the copper side of the board in this way after it has been cut to size. Otherwise, surface dirt and corrosion could hinder the etching process and the adhesion of the resist to the board. For the same reason it is advisable to try not to touch the copper side of the board with the fingers once it has been cleaned prior to etching. ■

LOW CURRENT POWER SUPPLY

by
R. N. Soar

The main feature of this power supply design is the series current limiting circuit.

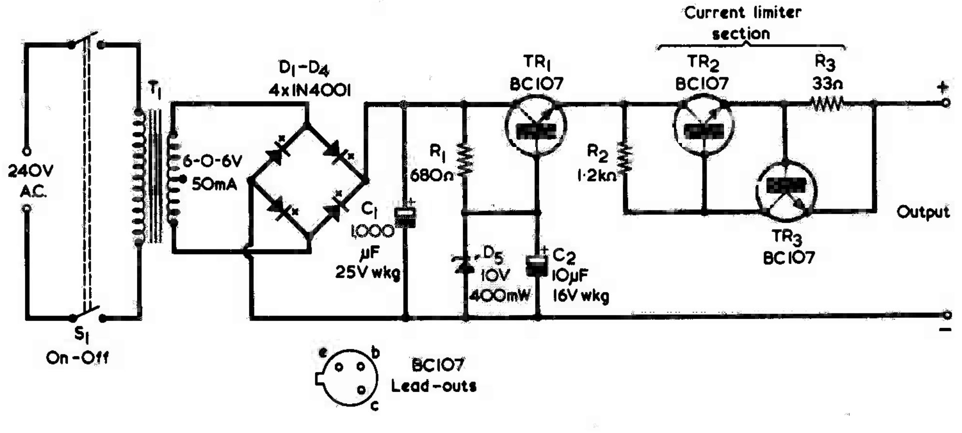
The supply to be described was intended for powering circuits which require only a low current. The rectifying and voltage regulating section of the supply is quite standard and this is followed by a series current limiting circuit which, with the prototype, limited the output current to a level of the order of 20 to 30mA.

THE CIRCUIT

The circuit of the power supply appears in the accompanying diagram. All the three transistors are silicon n.p.n. types. Mains transformer T1 offers a secondary voltage of 6-0-6 volts at 50mA. Here, the full 12 volt winding is applied via the bridge rectifier consisting of D1 to D4 to the reservoir capacitor, C1. A rectified voltage approaching the peak value of the secondary voltage appears across this capacitor.

This voltage is applied to the collector of TR1 and to R1. A regulated voltage of 10 volts nominal is given across zener diode D5, whereupon TR1 functions as an emitter follower and offers a voltage about 0.65 volt below zener diode voltage at its emitter.

The circuit as so far described is quite conventional. Any other circuit offering a reasonably well regulated d.c. output at around 9 volts may alternatively be employed.



The circuit of the power supply. The current limiting section incorporates TR2 and TR3

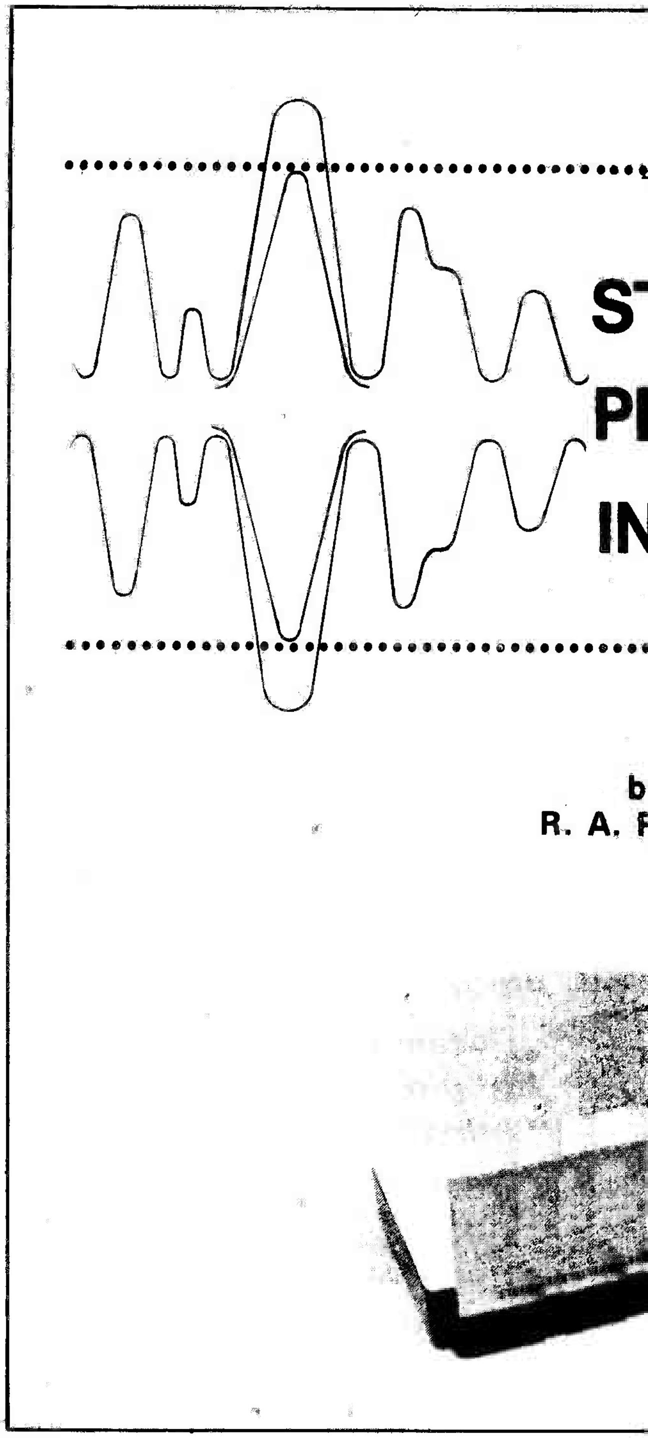
CURRENT LIMITER

The current limiting section is provided by TR2 and TR3. At currents below the limiting level TR2 is maintained conductive by the base current flowing via R2, and a voltage of the order of 9 volts is given at its emitter. The output current passes through R3, causing a voltage to be dropped across it. When this voltage is lower than about 0.65 volt TR3 does not conduct and has no effect on circuit operation.

If the current drawn rises to about 20mA the voltage across R3 becomes approximately 0.66 volt and TR3 commences to draw collector current via R2. A greater voltage is dropped across this resistor, whereupon the voltage at TR2 base, and in consequence at its emitter, falls. As a result, the power supply output voltage falls also. An increasing output current turns TR3 further on, giving a greater voltage drop across R2 and therefore a further reduction in output voltage. If the output terminals are short-circuited nearly the full regulated voltage from TR1 emitter is dropped across R2, and the output current is limited to a low level.

With the prototype the output voltage was 9.5 volts off load, dropping to 8.5 volts at 18mA and 7 volts at 20mA. When the output was short-circuited the output current was 34mA.

Different initial limiting currents (at which TR3 starts to conduct) of up to 30mA can be achieved by giving different values to R3. The series current limiting circuit given by TR2 and TR3 does not offer a high degree of output voltage regulation but it can be useful as a safety device in the supply of loads which draw a low current. ■



Peak signal level indicators have a very fast response time and are therefore capable of giving an indication of brief overloads which would be missed by conventional average-reading VU-meters. As they respond to peak rather than mean signal levels the input waveform is irrelevant, and a peak level indicator will not fail to respond properly to a spiky input signal, as would a normal VU-meter.

It is because of this that many cassette decks now have peak level indicators to supplement the VU recording level meters. Amplifiers are also occasionally fitted with a peak level indicator which is adjusted so that it will show up any clipping which should happen to occur at the output. Peak level indicators can, in fact, be usefully added to many types of audio equipment which do not already have this facility built in.

The subject of this article is a simple peak level indicator which uses only three active components, these being an inexpensive CMOS i.c. and two silicon transistors. It is presented as a self-contained unit, but in many cases it would probably be possible to build the indicator into the monitored equipment should this be preferred.

NOR GATE

The main part of the circuitry is based on a CD4001 quad 2-input NOR gate. The truth table for a 2-input NOR gate is shown in Fig. 1(a). This type of device is of course a logic circuit, and the inputs and output have two stable states. The two states are high (logic 1, approximately equal to the positive supply rail potential) and low (logic 0 or virtually zero volts). A truth table is simply a chart showing the output states produced by all the possible combinations of input state.

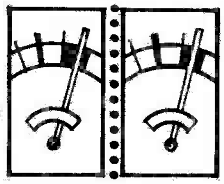
In the present circuit the NOR gates are used as inverters and this is accomplished simply by paralleling the two input terminals of each gate, as shown in Fig. 1(b). Reference to the truth table will prove that this arrangement does produce an inverter. When both inputs are low the output is high, and when both inputs are high the output is low.

SCHMITT TRIGGER

In a peak level indicating application it would be desirable for each inverting gate to have some form of triggering such that when the input rose above a certain pre-set level the output would go low, and if it then fell below a slightly lower level the output would go high again. Part of the monitored signal could then be fed to the input of a gate, and the output could be used to turn on an indicator light when the input

VU-meters are not able to
cause overloading in a recordin
in this article responds instantan
mined level, and can be connect
at the overload level of

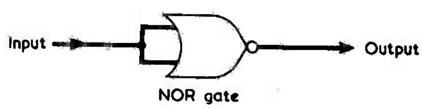
TEREO
EAK LEVEL
DICATOR



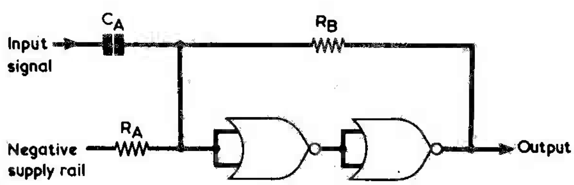
enfold

Input 1	Input 2	Output
Low	Low	High
Low	High	Low
High	Low	Low
High	High	Low

(a)



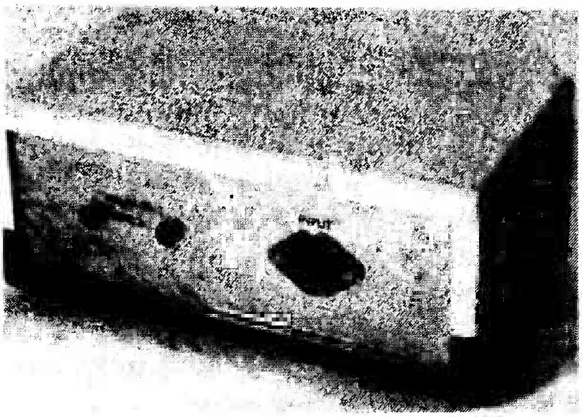
(b)



(c)

rning of brief peak signals which can
m. The peak Level indicator described
to signal amplitudes above a predeter-
any equipment offering signal voltages
than 500mV peak-to-peak.

Fig. 1(a). Truth table for a 2-input NOR gate (b). If the inputs of the NOR gate are connected together it functions as an inverter (c). Two NOR gates connected to form a Schmitt trigger. This can be triggered by an a.f. signal of sufficient amplitude applied via CA



Mounted on the rear panel are two insulated sockets for supply voltage checks and the a.f. input sockets. In the prototype the latter are provided by a 3-way DIN socket

signal exceeded the pre-set threshold level. In practice the circuit would be adjusted so that the threshold was reached with the input signal entering overload level.

Unfortunately, this type of triggering cannot be achieved with a single inverting gate on its own as this would tend to enter a linear amplifying mode when the input signal approached the threshold value, and there would be no precise level at which the output abruptly changed state. However, it is possible to obtain the desired triggering effect by connecting two inverters in cascade to give a Schmitt trigger, as shown in Fig. 1(c).

Since the two inverters are coupled in cascade, the input and output of the circuit are in phase. Under quiescent conditions the input is coupled to a negative voltage via RA, and so the output is in the low state.

If an input signal is now coupled to the circuit via CA it will have no effect until it reaches the input transfer level for the first inverter. The output of the circuit will then swing positive, taking the right hand end of resistor RB positive also. RB and RA form a potential divider for the output voltage and allow the input to go further positive as well. There is therefore a regenerative action which causes the output of the circuit to change rapidly to the high state. Since the inverters in the Schmitt trigger are CMOS devices, their input resistance is so high that it can be ignored and circuit operation is controlled entirely by RB, RA and the input signal passed by CA.

Should the input signal now drop towards zero a level will be reached at which the input voltage falls below the threshold voltage of the input inverter. This input signal voltage is somewhat lower than that which reached the threshold level when the signal was rising, because of the positive bias now being given to the input by way of RB and RA. As soon as the signal voltage falls below this threshold level the output of the second inverter starts to swing negative. There is, again, a regenerative action and it results in the output of the Schmitt trigger changing rapidly to the low state.

As has been noted the circuit has a degree of hysteresis, insofar that the input voltage needed to trigger the output to the high state is greater than that which causes the output to be triggered back to the low state. Hysteresis is a desirable property in a peak indicating circuit because it allows the overload indication to be present for a slightly longer period than the duration of the overload itself. Very slight or extremely brief overloads can then be more readily observed.

PRACTICAL CIRCUIT

The complete circuit diagram for the stereo peak level indicator is shown in Fig. 2. The four gates of the CD4001 i.c. are used in pairs, each pair being connected as a Schmitt trigger. The input of one trigger is fed with the left hand signal and the other trigger receives the right hand input.

Each Schmitt trigger has been slightly modified in order to provide variable sensitivity. If we consider the left hand circuit (the two trigger circuits are identical) this operates in exactly the same way as the basic circuit of Fig. 1(c) when the slider of R1 is at the bottom of its track. In this state the circuit is not very sensitive however, as an input signal of about 7 volts peak-to-peak is required in order to give triggering.

COMPONENTS

Resistors
(All fixed values ¼ watt 5% or 10%)
- R1 50kΩ or 47kΩ pre-set potentiometer, 0.1 watt skeleton, horizontal
- R2 1MΩ
- R3 10MΩ
- R4 27kΩ
- R5 680Ω
- R6 27kΩ
- R7 10MΩ
- R8 1MΩ
- R9 50kΩ or 47kΩ pre-set potentiometer, 0.1 watt skeleton, horizontal
- R10 3.3kΩ

Capacitors
- C1 0.1μF type C280 (Mullard)
- C2 0.1μF type C280 (Mullard)
- C3 15μF electrolytic, 10 V. Wkg.

Semiconductors
- IC1 CD4001AE
- TR1 BC109
- TR2 BC109
- LED1 TIL209 or similar l.e.d.
- ZD1 BZY88C7V5

Switch
- S1 s.p.s.t. rotary

Sockets
- SK1, SK2, input sockets, see text
- SK3 insulated socket
- SK4 insulated socket

Battery
- BY1 9 volt battery type PP3 (Ever Ready)

Miscellaneous
- Case, code no. 75-1238D (Vero Electronics)
- Control knob
- Battery connector
- Panel bush, for LED1
- Materials for printed board
- Wire, solder, etc.

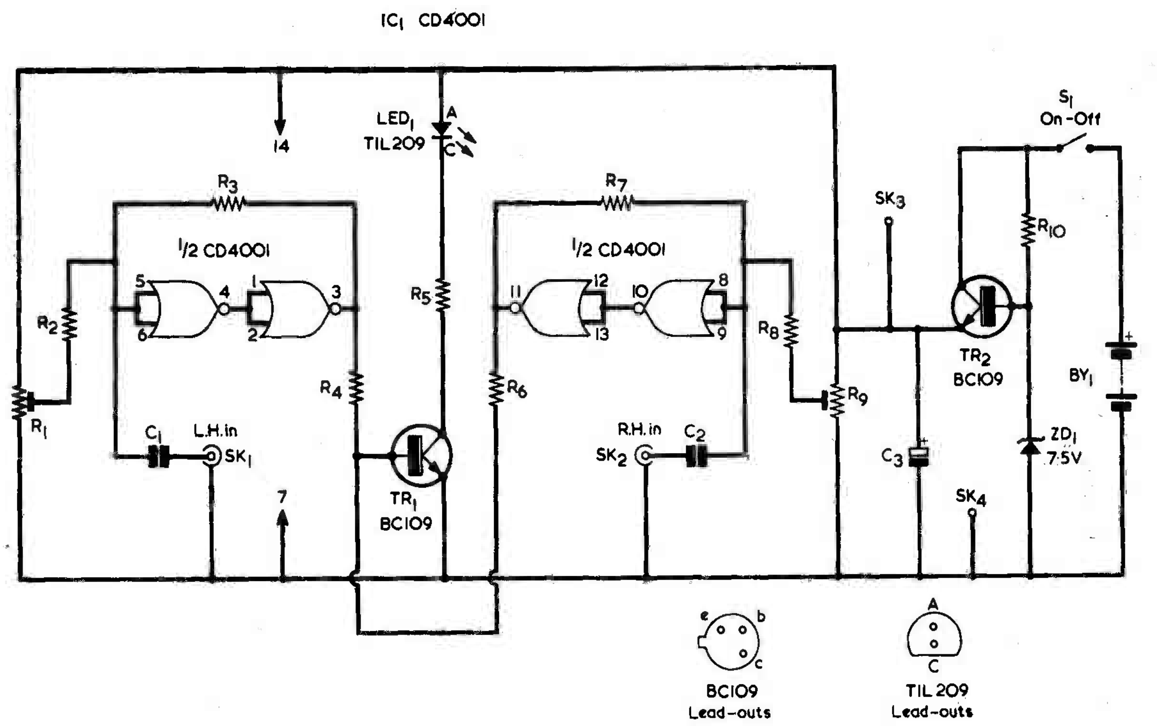


Fig. 2. Complete circuit diagram for the stereo peak level indicator

As the slider of R1 is advanced up its track it increases the quiescent voltage at the input of the trigger. If it sets, say, 2 volts at the input, then on positive input half-cycles the input signal will be added to this quiescent voltage. Therefore a positive input signal level of 2 volts less than before will be sufficient to trigger the circuit. In terms of peak-to-peak voltage, and assuming that an ordinary symmetrical input waveform is present, this results in a 4 volt reduction in the threshold voltage of the circuit.

There is a limit to the increase in sensitivity which can be provided, because the output will remain latched in the high state once the circuit has been triggered if R1 should be adjusted to offer too high a voltage. This is due to the hysteresis, and occurs when the quiescent input voltage is taken above the lower threshold voltage of the Schmitt trigger.

In practice, a minimum input sensitivity of approximately 500mV peak-to-peak can be attained.

OUTPUT GATE

It would be quite a simple matter to drive an indicator lamp from the output of each Schmitt trigger, but it is probably more convenient to have one indicator for both channels. This is the system which is currently employed with most cassette decks which are fitted with a peak level indicator, and it is the system which is used here.

It is undesirable to have the outputs of two separate CMOS gates connected together to drive an indicator as relatively heavy currents may flow when they are in opposite states. In consequence, the Schmitt trigger outputs are coupled to what is effectively a NOR gate incorporating R4, R6 and TR1. If either of the Schmitt trigger outputs is high, a base current will flow into TR1 via R4 or R6 as applicable. TR1 will then turn on and cause LED1 to be illuminated by way of current limiting resistor R5. TR1 will also turn on, and the l.e.d. will light up, if both trigger outputs are high.

Since the Schmitt trigger threshold voltages are proportional to supply voltage it is essential to employ a stabilized supply. This is given by the simple voltage regulating circuit consisting of R10, ZD1 and TR2, with C3 providing a low impedance bypass across the stabilized output. The stabilized voltage is a little lower than 7 volts, and sockets SK3 and SK4 are provided to enable this voltage to be checked, from time to time, with a multimeter. The current consumption of the complete circuit from the 9 volt battery is about 1.7mA when the l.e.d. is extinguished, rising to a little over 10mA when the l.e.d. indicates a large and continuous input overload.

The positive and negative supply rails connect to the CD4001 at pins 14 and 7 respectively. Some readers who have examined manufacturers' recommendations for the use of CMOS devices may feel that the input coupling capacitors, C1 and C2, should have resistors in series to ensure that possible currents in the internal input protective diodes are

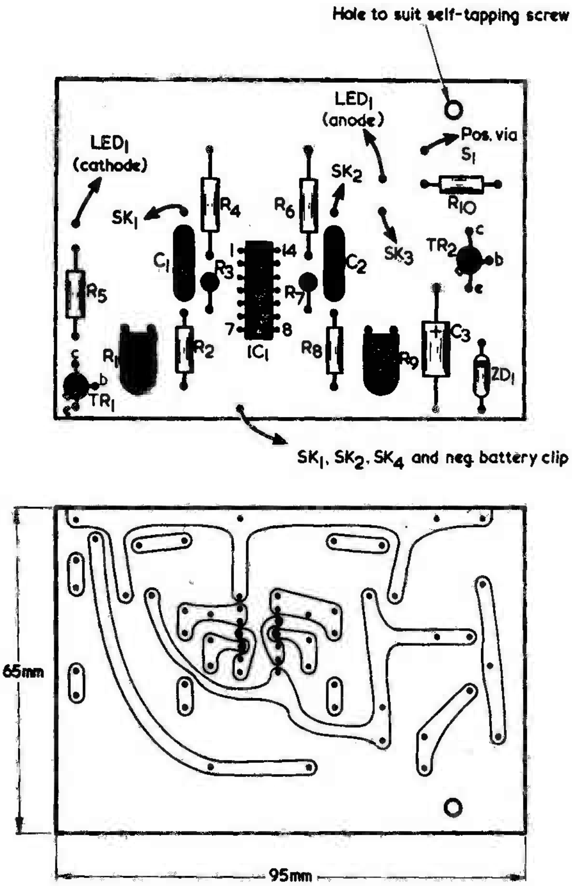


Fig. 3. Component and copper sides of the printed circuit board. The self-tapping screw employed for mounting is provided with the box specified

kept at a low level. In the writer's opinion, and judging from his own experience, such resistors are not required. Nevertheless, readers who wish to do so can fit a 10kΩ ¼ watt 5% resistor between C1 and SK1, and a similar resistor between C2 and SK2. The resistors may be mounted at SK1 and SK2. These resistors are not included in the Components List. Their insertion into the circuit does not alter its performance to any significant extent.

CONSTRUCTION

The prototype is housed in a Vero Electronics box, code no. 75-1238D, which has external dimensions of 154 by 85 by 60mm. This is a plastic box with anodised aluminium front and rear panels.

Two holes are required in the front panel for LED1 and S1, and these are mounted centrally between the top and bottom of the panel and symmetrically on either side of the vertical centre line, as illustrated in the photographs. A rotary switch, with knob, offers a better appearance than a toggle switch. The switch visible in the photograph of the interior of the case is a multi-pole component with only one pole used.

Mounted on the rear panel are two single insulated sockets, SK3 and SK4, and the input sockets SK1 and SK2. The latter may be any type favoured by the constructor, such as phono sockets, etc. The author employed a 3-way DIN socket.

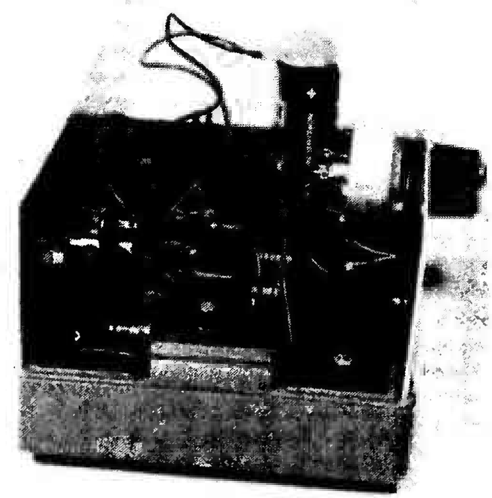
All the remaining small components are assembled on a printed board measuring 95 by 65mm., and this is reproduced in Fig. 3. The board is prepared in the usual way. Note that R1 and R9 are miniature 0.1 watt pre-set potentiometers having 0.2in. spacing between track tags and 0.4in. spacing between track and slider tags.

Although CMOS devices have a reputation for being easily damaged by static charges, the CMOS range of logic circuits have protective diodes at the input terminals and are not therefore readily damaged in this way. However, it is necessary to use a soldering iron with an earthed bit when soldering in the i.c., and to connect pins 7 and 14 into circuit first.

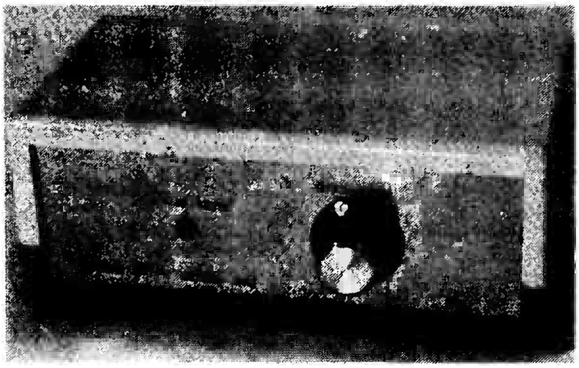
The completed printed board, with components, is wired up to the rest of the circuit by means of thin flexible p.v.c. covered wire and is then mounted in the case to the left hand side, as viewed from the front. The box specified has four plastic mounting pillars and the board is fitted to the one at the front left hand side by passing a self-tapping screw through the hole in the board. The screw is provided with the box, and the single hole mounting is quite adequate in practice.

Since the peak indicator is operating with signals at relatively high voltage level there is no necessity to screen any of the signal wiring inside the case. The rear panel can be earthed to the negative supply by way of the mounting nuts and bolts of SK1 and SK2. The front panel does not need to be earthed but, should an earth connection be desired, this can be provided by a wire soldered to the frame of S1 and the earthy input socket tag (or tags). The negative battery lead can also be soldered at the same point.

There is plenty of space for the PP3 battery to stand vertically on the right of the printed board. It can be held in position by a piece of foam rubber or plastic glued to the case lid at the appropriate position.



There is ample space inside the case for the printed board and the 9 volt battery



This alternative view of the front of the peak level indicator demonstrates the smart appearance resulting from the use of a manufactured case

ADJUSTMENT

The circuit points in the monitored equipment from which the indicator is to be driven will depend upon individual circumstances. In most instances the indicator can be fed from the signal circuitry at the VU-meter. VU-meters are normally fed via a rectifier or rectifiers (which can sometimes be an integral part of the meter itself) and a suitable signal take-off point is just before the rectifier circuit. A screened lead should be used to couple the monitored equipment and the indicator together, the outer braiding of the lead connecting to the equipment chassis at one end and to the negative supply rail of the indicator at the other end.

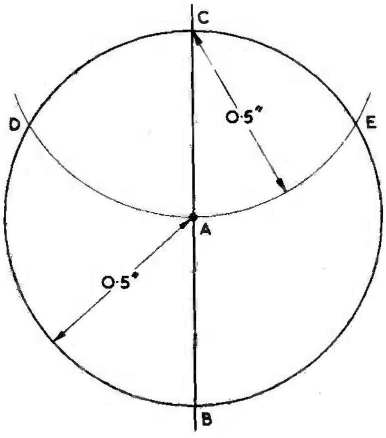
R1 and R9 are then adjusted for the required sensitivity on each channel. R1 is at its minimum sensitivity setting when its slider is fully clockwise, whilst R9 is at its minimum setting when its slider is fully anti-clockwise. A steady signal is then fed into the left hand channel of the equipment, this being preferably a sine wave signal from a signal generator or other source, and the equipment controls are adjusted so that the signal amplitude just reaches the level at which it is desired that the peak level indicator be triggered. R1 is then adjusted for the lowest sensitivity which causes LED1 to glow.

The same procedure is repeated for the right hand channel, with R9 being adjusted for the required sensitivity. ■

VARIABLE CAPACITOR MARKING-OUT

Another approach to the problem of marking out the 4BA clear mounting holes for variable capacitors.

By V. C. Tondelier



A simple means of marking out the three front plate mounting holes for a Jackson type "0" or "00" variable capacitor

Variable capacitors of the Jackson "0" and "00" type are mounted by means of three 4BA screws passed into tapped holes in the front plate of the capacitor. The holes are equi-spaced on a 1in. diameter circle concentric with the spindle, and the usual advice for marking out the corresponding holes on the panel to which the capacitor is to be mounted is to employ a paper template. This is marked up from the capacitor front plate itself.

In the October 1976 issue, the article "Mounting Variable Capacitors" by R. J. Caborn described an alternative method by means of which the holes could be marked out directly, the dimensions involved being derived from elementary trigonometry.

Here is an even simpler approach, for which no trig is needed, and which requires just a rule and a pair of compasses or dividers. The writer feels that it is also more accurate and certainly quicker.

In the accompanying diagram, A represents the centre of the capacitor spindle. A circle of 0.5in. radius is drawn with A as centre, after which a vertical line is drawn through A cutting the circle at B and C.

With C as centre, an arc of 0.5in. radius is drawn, cutting the circle at points D and E. The three mounting holes are then given at B, D and E. ■

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

The Amateur Bands continue to provide a change from operating over the various Broadcast Bands and it is often the case that resort here is made to the cw (Morse) sections of the former frequencies in order to ring the changes. Single-side-band transmissions and the 14MHz band section carrying such signals are rarely dealt with simply for the reason that the vast majority of Amateur Bands SWL's use this method of reception on this band and others and are therefore well aware of current events.

Dx being relative to the band in use, "Top Band" can often provide the spills and thrills — generally speaking stations over 200 miles distant from the reception point being indicative of Dx.

AMATEUR BANDS

● 1.8 – 2.0MHz

On cw — DJ6SI, DJ6TR, DK3DZ, DK5NK, DL3RK, DL7CY, EA8CR, EI8H, EI9J, GD4BEG, GI3JEX, GM3YOR, GM3ZSP, GM4AAF, GW3EOP, GW4ELI, HBØNL, HB9PF, HB9RM, KV4FZ, OH1NK, OK1ATP, OK1MKW/P, OK2BKP, OK3CWS, OK5TLG/P, OL5AUZ, OL9CEI, OL9CFE, OE2JG, OE5KE, PAØCRA, PAØHIP, W1BB/1, W1HGT, W8LRL, WA8IJI.

● 7.0 – 7.1MHz

On cw — CO2PY, FP8FU, HI8MOG, JA5PL, KP4CM, KP4WL, LU6KAL, OD5LX, PY7DDA, UL7BF, UW6CD, VE3HUL, VP1MPW, YV5BNR, ZL2AKW, ZL3CC, ZL4CU, 9J2WR.

● 21.0 – 21.45MHz

On cw — CO2CM, HK3AOY, HK3BUE, KP4DKX, LU9CV, PT6KZ, VP9IF, ZE2JH, ZS6SG, ZS6ME, 9Q5SW.

CURRENT SCHEDULES

Whilst correct at the time of writing, these schedules are sometimes subject to change at short notice.

● SWEDEN

"Radio Sweden", Stockholm, operates an External Service in English with the target areas to Europe and as shown. From 1100 to 1130 to Africa and the Pacific on **9630, 15305** and **21690**; from 1600 to 1630 to the Middle East on **6065, 9665** and **11735**; from 1830 to 1900 to Africa on **6065, 9720** and **11780**; from 2100 to 2130 to Africa and the Middle East on **6065, 9605** and **11845** and from 2300 to 2330 to North America on **6045, 6120** and on **9695.**

● CUBA

"Radio Havana" currently lists a programme directed to Europe in English from 2010 to 2140 on **17885.** A programme in English to the Americas is from 2050 to 2150 on **11865** and **17750.**

AROUND THE DIAL

● THAILAND

Radio Thailand, Bangkok, on a measured **9653.5** at 1335, OM in Malay with many mentions of "Radio Thailand", then a local pop programme on records.

● INDONESIA

RRI Jakarta on **11790** at 1410, local pops with English announcements by YL followed by station identification and a newscast in English by OM at 1415.

RRI Yogyakarta on a measured **5046.5** at 1445, with a programme of local music in traditional style.

RRI Jakarta on **4774** at 2204, OM with a newscast in vernacular followed by YL announcer, choir featuring local songs.

● INDIA

AIR Gahauti on **3375** at 1536, OM with a local newscast in English. The schedule of this one is from 0025 to 0145, 1145 to 1730 mostly in Assamese but with the English news at 1530. The power is 10kW.

AIR Kurseong on **3355** at 1534, in parallel with the above for the newscast. The schedule is from 1130 to 1700 and the power is 10kW.

AIR Gahauti on **3235** at 1525, OM with announcements in the East Regional Service, schedule 0100 to 0215, 1230 to 1800. The power is 10kW and, like other regional transmitters, it carries the 1530 English newscast relayed from Delhi.

AIR (All India Radio) Lucknow on **3205** at 1520, OM in vernacular in the North Regional Service. The schedule is from 0025 to 0215 and from 1130 to 1830, the power is 10kW.

AIR Delhi on **3295** at 1514, local music and songs in a programme directed to Bangladesh and Pakistan, in Urdu, scheduled from 1430 to 1830. This is part of the AIR Foreign Service, the power is 20kW.

AIR Delhi on **3905** at 1509, OM in Pushtu to Afghanistan then into a programme of Indian songs and music, scheduled from 1430 to 1545. The full schedule is — Home Service from 0130 to 0335, 1130 to 1445 (newscasts in English at 0130, 0240 and 1135); Foreign Service in Pushtu from 1430 to 1545, Persian 1615 to 1715, Arabic 1730 to 1830 and English from 2245 to 0115. The power is variable from 20 to 100kW.

AIR Aligarh on **11810** at 1330, YL with a newscast in English.

● **DENMARK**
Programmes from Copenhagen are in Danish but for those who wish to send a report, listen on **15165** from 1730 to 1815 (directed to Greenland) or from 1830 to 1915 on the same channel (directed to South America).

● **NORWAY**
"Radio Norway", Oslo, presents programmes in English intended for Europe and the target areas as shown as follows — Sundays from 1200 to 1230 to S.E. Asia and the Far East on **6015, 11850** and **15135**; from 1400 to 1430 to S. Asia, Africa and the Middle East on **9605, 17800** and **21655**; from 1600 to 1630 to North, Central and S. America on **15175, 15345** and **21655**; from 2000 to 2030 to Africa on **6130, 9645** and **11935.** On Saturdays from 1800 to 1830 to Middle East and N. America on **11860, 11895** and on **15345.** On Mondays from 0001 to 0030 to North and Central America on **6180, 9550** and on **9645.**

● **SUDAN**
"Radio Omdurman" has an External Service in which a newscast in Somali is broadcast every Thursday from 2100 to 2105. From then until 2200 a programme in Arabic for expatriates (news from 2145 to 2155) is to be heard on **5038** and **6150.**

The Domestic Service General Programme may be heard by listeners here in the U.K. from 1700 to 2200 sign-off on **7200** and **11835.**

● **ZAIRE**
"The Voice of Zaire", Kinshasha, offers a Domestic Service in French and vernaculars around the clock on **7255, 15245** and on **15350.** An opportune time to log one or more of these transmissions would be between 2100 and 2115 when a newscast in French is featured.

● **MALAYSIA**
The "Voice of Malaysia", Kuala Lumpur, radiates an External Service in which the English programme is listed from 0625 to 0855 on **6175, 9750** and on **15275.** The target area of this transmission is South East Asia.

● **QATAR**
The Domestic Service from Doha is transmitted on **9570,** in Arabic, from 0245 to 2100 sign-off.

● **ITALY**
"RAI — Italian Radio and Television", Caltanissetta, features a Domestic Service from 0600 to 1430 and from 1500 to 2215 on **6060** and **9515.** The power in each case is 25kW and all programmes are in Italian.

● **PAKISTAN**
Islamabad on **15110** at 1100, OM with news of local affairs in English, slow dictation.

Islamabad on **17665** at 1020, a programme of local music and songs for national overseas, identification then a newscast in English. Sign-off at 1115 without National Anthem.

Radio Pakistan has been logged again (see last issue) on **5010** at 0132, OM with news in Urdu, many mentions of Pakistan then into programme of local music and songs. This channel is unlisted in their schedule.

● **TURKEY**
Turkiye Polis Radyosu (Turkish Police Radio) on **6340** at 1752, when radiating a programme of local music and songs. The schedule of this one is from 0600 to 1100, 1200 to 1600 and from 1730 to 1900 from November to May. From June to October the transmission periods are one hour earlier. The power is 1kW.

Turkish State Meteorological Service on **6900** at 1805, with a programme of local music and songs. Local weather reports, in Turkish, are given on the hour, the schedule being from 0455 to 0700, 0800 to 0940, 1200 to 1615 and 1800 to 1930. The power is 2.5kW.

● **SYRIA**
Damascus apparently testing on **9300,** heard on several occasions (transmissions are irregular) with a programme in French followed by the interval signal on a guitar, identification in English by OM then a local newscast in English at 2030. Sign-on is sudden and without warning, usually around 2020 to 2028 in the middle of the French programme.

● **IRAQ**
Baghdad on **7230** at 1045, Arabic music and songs in the "Voice of the Masses" programme, scheduled on this channel from 0228 to 2320. The transmission is covered by Trans-World Radio, Monte Carlo sign-on at 1100.

● **KUWAIT**
Radio Kuwait on 7120 at 1338, OM with songs in Arabic in the Domestic Service which, incidentally, is also intended for listeners abroad. The schedule on this channel is from 0815 to 1000 and from 1130 to 1505.

Obituary

We regret to have to record the death, on the 15th January in his 70th year, of Mr. Austin Forsyth, O.B.E., G6FO, Editor of Short Wave Magazine since 1938.

During his editorship Austin Forsyth made a distinctive contribution to radio journalism and the cause of amateur radio, particularly when he felt it under attack.

As the editor of the only magazine specialising in short wave radio which can be purchased from the newstands, he used his unique position to popularise the hobby and his influence and personality will be greatly missed in the world of amateur radio.

We extend to his family our deep sympathy. **J.H.B.**

V.H.F. A.M. SUPERHET

Part 2

By D. F. W. Featherstone

In this concluding article the process of r.f. and oscillator alignment is described in detail. Also given is a table showing typical check voltages obtained with the prototype receiver.

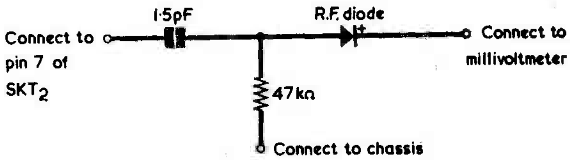


Fig. 11. The probe circuit employed for initial alignment of the r.f. coils. The diode may be an OA90 or OA91 and the millivoltmeter connects between its cathode and chassis

In last month's issue we examined the construction of this receiver and dealt with the alignment of the i.f. transformers. We now proceed to signal and oscillator alignment.

R.F. ALIGNMENT

Plug in one pair of coil packs, preferably those for the 85-105MHz range and connect the supplies, again initially checking for excessive current consumption. Adjust VR1 and VR2 to give the TR1 and TR3 emitter voltages shown in Table 2.

A simple method of aligning the r.f. and oscillator stages is to first set the r.f. stage approximately, then bring the oscillator in line with it; after which the oscillator is adjusted to give the required frequency range accurately and the r.f. stage finally adjusted for correct tracking.

Table 2

Check Voltages

(All voltages are with respect to chassis)

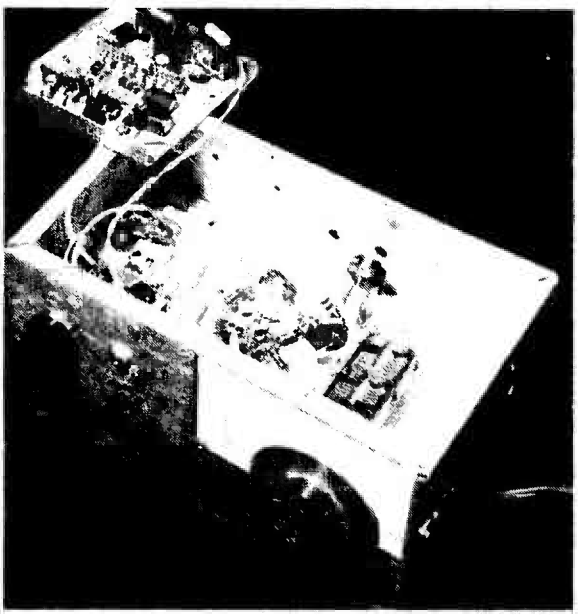
	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TR10
Collector	0	8.8	0	8.0	8.0	6.8	4.8	4.2	4.2	3.0
Base	−6.4	0.8	−5.6	1.0	1.0	1.2	0.8	0.8	0.8	0 to 0.25
Emitter	−7.0	0.2	−6.1	0.4	0.4	0.6	0.2	0.2	0.2	−0.4

The procedure for Range 2 will now be described. Start with only the r.f. coil pack plugged in and connect a valve or electronic millivoltmeter as shown in Fig. 11. Set VC1(a)(b) to maximum capacitance and the trimmer on the coil pack to minimum capacitance, and connect a signal generator to the aerial socket, SKT1. Vary the signal generator frequency around 85MHz until a reading appears in the millivoltmeter, reducing the signal generator output as necessary. Note the frequency at which the reading appears and adjust the core of the r.f. coil to bring this resonant frequency nearer to 85MHz, remembering that inserting a brass core lowers the inductance and raises the frequency. Re-set VC1(a)(b) to minimum capacitance, again find the resonant frequency and adjust the coil pack trimmer to bring it nearer to 105MHz. Continue this procedure until the full range of VC1(a)(b) gives the required coverage of 85 to 105MHz. If a v.h.f. signal generator is not available this whole process may be carried out by setting it to half the required frequency in each case, that is 42.5 and 52.5MHz, and tuning to the second harmonic.

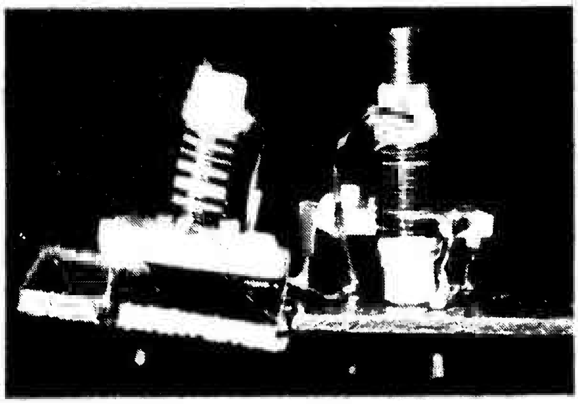
Having determined that the r.f. stage tunes over approximately the correct range plug in the oscillator coil pack, remove the r.f. probe circuit of Fig. 11 and carry out the next stage using an earphone plugged into the receiver output socket. Ensure that the signal generator output is modulated. Set VC1(a)(b) to minimum capacitance and the signal generator to 105MHz and adjust the trimmer of the oscillator coil pack until a signal is heard. At this stage it may be found that slight adjustment of VR1, VR2 and VR3 will give an improvement in the output volume, and such adjustments can be carried out. Set VC1(a)(b) to maximum capacitance, the signal generator to 85MHz, and adjust the core of the oscillator coil until the signal is heard again. Repeat this until the signal is heard at both ends of the range with no further adjustment, whereupon the oscillator range should be 74.3 to 94.3MHz.

As it is not usually possible to set a signal generator very precisely it is necessary, finally, to readjust the r.f. stage for really accurate tracking. Connect the meter set to the 0.5 volt or lower range across VR4 to measure detector output voltage, re-set VC1(a)(b) to maximum capacitance and adjust signal generator frequency to give maximum detector output. The frequency should be very close to 85MHz. Adjust the core of the r.f. coil as necessary for an increase of detector output. Set VC1(a)(b) to minimum capacitance, re-set the signal generator for maximum detector output, whereupon the frequency should be close to 105MHz, and adjust the r.f. coil pack trimmer for any increase in detector output. Repeat until no further improvement is possible. At this stage the encouraging sounds of Band II and other transmissions should be heard when an aerial is plugged into the receiver. The Band II signals will not be of hi-fi quality as the receiver is not designed for f.m. reception, but speech should be quite clear. Repeat the alignment for the other ranges, marking each coil pack for easy identification.

Finally, connect up TR10 and its associated components and check its collector, base and emitter voltages. With a signal generator set to produce about 0.2 volt detector output check that disconnecting the lead to TR10 base has no effect on detector output. Increase the output of the signal generator to obtain about 0.4 volt detector output and reconnect the lead to TR10 base. The detector output should fall to a value only slightly above 0.25 volt. This confirms that the a.g.c. system has no effect on weak signals and a significant effect on strong signals. The onset of a.g.c. action can be set to a higher delay voltage, if desired, by returning TR10 emitter to the junction of D2 and D3.



Looking into the top of the receiver with the a.f. amplifier sub-chassis removed from its position inside the case



Two of the coil packs used in the receiver

Any further alignment which may be found necessary, as for example when making new coil packs, should be carried out with the a.g.c. system disconnected.

The receiver should now require only a lid, battery holding clips if necessary and tuning scale calibration. Suitable scales which can be affixed direct to the front panel are given in 'Panel Signs' Set No. 5, available from the publishers of this journal. The frequencies of each range may be marked on the scale.

When completed, the receiver should give very satisfactory results. The prototype offers excellent reception using an aerial given by stripping off the last three feet of outer conductor from the coaxial feeder, leaving the inner conductor unscreened over this length.

FINAL NOTES

The constructor should not be discouraged if a coil seems difficult to tune to the required range; small departures from the dimensions given may cause considerable changes of inductance. If the inductance seems to be too low compress the coil slightly to reduce the length, and vice versa. The coil packs are not as fragile as they may appear to be and, provided the fingers touch only the s.r.b.p. base, they can be removed and inserted many times with no adverse effect on the alignment.

The values specified for C4 and C8 should allow good tracking at the frequencies involved. If tracking appears to be poor the value of C8 may be increased to around 22pF, the exact value being found by experiment. It will be recalled that in this receiver oscillator frequency is below signal frequency.

Test voltages obtained with the prototype are given in Table 2, these being taken with a 20,000Ω per volt meter switched to a 10 volt range. Due to component tolerances and spread in transistor characteristics, voltages in receivers built to the circuit will not be precisely the same as those in the table.

(Concluded)

BATTERY OPERATED TIMER

BY R. S. CARLMAN

This inexpensive timer is primarily designed for low current consumption from an unstabilized supply and is therefore particularly attractive for use with a battery. The timing period is continuously adjustable from about 3 to 60 seconds.

Mains operated electronic timers are commonly encountered devices, and their circuit design is eased by the fact that there is no necessity to restrict current consumption from the power supply. On the other hand, the occasion can arise when a portable battery operated timer is required, and in this instance current consumption from the supply assumes considerably enhanced importance.

In the timer to be described the load is switched by a relay, as is the normal practice with a timer. The timing sequence is, however, different from that usually encountered because the relay remains de-energised during the timing period and energises only when the period comes to an end. Thus, the relatively heavy relay current need only flow for a short time, as the unit can be turned off as soon as the timing period is completed. Switching off the timer also resets it for the next timing run.

SWITCHING CIRCUIT

The timer takes advantage of a switching circuit incorporating three silicon transistors in cascade. This circuit is shown in Fig. 1. Since the transistors are silicon types they do not conduct unless the base voltage is about 0.6 volt positive of the emitter voltage. When turned on, the collector voltage can fall to 0.2 volt, or less, positive of the emitter.

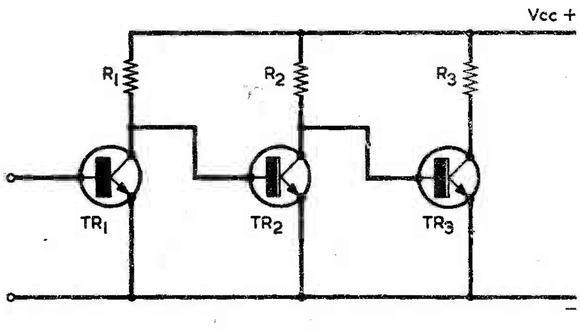


Fig. 1. A 3 transistor switching circuit having high input sensitivity

Let us assume that, initially, the base of TR1 is less than 0.6 volt positive of the emitter and that TR1 is in consequence turned off. No current flows into TR1 collector and all the current in R1 flows into TR2 base. As a result TR2 is turned fully on. Its collector voltage is at around 0.2 volt positive of the negative supply rail and TR3 is turned off.

We now take the base of TR1 gradually positive. As this base reaches 0.6 volt TR1 commences to draw collector current through R1. The collector current increases as TR1 base goes further positive until the voltage at the collector of TR1 falls below 0.6 volt. TR2 turns off, and all the current in R1 now flows into TR1 collector. Since TR2 draws no collector current through R2, this resistor provides base bias current for TR3, and TR3 turns on.

As will be seen, the circuit has two stable states. When TR1 is turned off, so is TR3. When TR1 is on, TR3 is turned on also. Due to the combined amplification in the three transistors, TR3 can be made to turn on by allowing a very small base current to flow into TR1. At an instant during the changeover of circuit states it is possible that all three transistors may be capable of linear amplification, and the circuit can then become unstable if an a.c. signal input (such as a mains hum voltage) is picked up at TR1 base. This risk can be eradicated by ensuring that TR1 base (or TR2 base) is bypassed to the negative rail by a suitable capacitor.

The collector load for TR3 is represented in Fig. 1 by R3. Because of the gain in TR3, R2 can have a much higher value than R3. In turn, R1 can have a much greater value than R2.

WORKING CIRCUIT

The full working circuit of the timer appears in Fig. 2. Here, R3 is replaced by the coil of relay RLA, across which is connected the usual reverse diode to prevent the formation of a high back-e.m.f. on relay release. The relay coil can have any resistance above 400Ω and should be capable of energising at a coil voltage of 6 volts. It has a single break contact set, RLA1, which is shown in the de-energised state elsewhere in the diagram. R1 and R2 of Fig. 1 are now replaced by R4 and R5 respectively. Connected between the base of TR1 and the negative rail is the

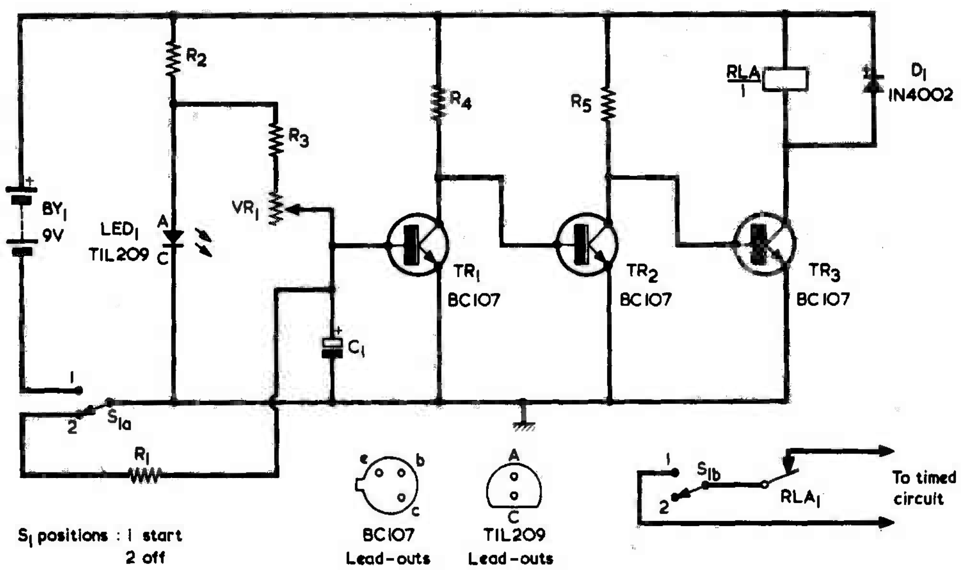


Fig. 2. The circuit of the battery operated timer. The length of the timing period is controlled by VR1

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
- R1 10Ω
- R2 3kΩ **(see text)**
- R3 22kΩ
- R4 100kΩ
- R5 22kΩ
- VR1 500kΩ potentiometer, linear

Capacitor
- C1 200μF electrolytic, 10 V. Wkg.

Semiconductors
- TR1 BC107
- TR2 BC107
- TR3 BC107
- D1 1N4002
- LED1 TIL209

Switch
- S1(a)(b) D.P.D.T., toggle (see text)

Relay
- RLA Relay with break contact set (see text)

Battery
- BY1 9 volt battery type PP9 (Ever Ready)

large value timing capacitor, C1. This capacitor prevents any a.c. signal voltage entering the transistor chain.

The light-emitting diode, LED1, is employed as a voltage stabilizing device and, when passing a forward current, allows a stabilized voltage of around 1.8 volts to appear across it. S1(a)(b) is a d.p.d.t. toggle switch and, in position 2, disconnects the battery and causes the timer to be switched off. In this position, S1(a) also ensures that the timing capacitor is discharged by way of the current limiting resistor, R1.

To start a timing period, S1(a)(b) is switched to position 1, thereby applying power to the three transistors and taking the short-circuit off C1. S1(b) completes the circuit path for the timed circuit via the relay contact set RLA1. Due to the presence of the discharged capacitor, C1, between its base and the negative rail, TR1 is turned off. So also is TR3 and the relay remains in the de-energised state. A forward current flows via R2 into the light-emitting diode and a stabilized voltage appears across it.

C1 now commences to charge by way of VR1 and R3. After a period, depending on the setting of VR1, the voltage across C1 rises to a level which allows current to flow into the base of TR1. TR1 turns on, and so does TR3, causing the relay to energise. Relay contact set RLA1 opens, breaking the circuit path for the timed circuit. The timing period has ceased and the drain on the battery now includes the relatively high current flowing in the relay coil. Battery life may be conserved by setting S1(a)(b) to position 2, thereby switching off the timer and rapidly discharging C1 so that the circuit is set up for the next timing run. This can be initiated at any time by putting S1(a)(b) to position 1.

During the timing period the current drawn from the 9 volt battery is about 2.5mA only. The current increases considerably at the end of the period when the relay energises, and its value depends upon the resistance of the relay coil.

With the prototype circuit the range offered by VR1 was 3 to 63 seconds. This will, of course, vary with other units built up to the circuit because of tolerances in the value of VR1 and, in particular, the value of C1. If C1 is a new component the timer requires about half a dozen runs to allow it to settle down to its final value and leakage resistance before starting any serious work with the timer.

Repeatability with the prototype was good and it is essential here that S1(a)(b) be a good quality component, as a small amount of resistance in S1(a) when it is in position 2 may prevent C1 from discharging fully, with the result that subsequent timing periods are too short. The author initially employed a cheap low voltage switch for S1(a)(b) which caused this trouble, but it was cleared by the use of a standard and more robust toggle switch.

Due to the high amplification provided by the three transistors the rise in relay energising current at the end of the timing period is rapid. Even at the end of a 63 second timing period the rise in current is faster than can be followed by a testmeter switched to a voltage range and connected across the relay coil. The author checked the circuit with a P.O.3000 relay having a 500Ω coil, and also with the 410Ω Miniature Open P.C. Relay retailed by Doram Electronics. Both relays performed satisfactorily.

BATTERY VOLTAGE

It was felt that the timer should give accurate results for battery voltages down to 7 volts and it was decided to design for a minimum battery voltage of 6 volts to leave a little leeway in hand. With a supply of 9 volts the current flowing in LED1 is about 2.3mA and at 6 volts it is about 1.3mA. An earlier article in this journal ('Light-Emitting Diodes' by R. J. Caborn in the January 1975 issue) described the result of some work on the use of the TIL209 as a voltage stabilizer, and showed that a shift of 1mA at currents of this order resulted in a voltage change, across the diode, of only 0.004 volt. The drop in voltage across the l.e.d. for a fall in battery voltage from 9 to 6 volts is, in consequence, of the order of 0.2%. It is possible that l.e.d.'s other than the TIL209 may offer a similar performance but this point has not been checked by the writer.

The timer was connected to a variable voltage supply set for an output of 9 volts and VR1 was adjusted to insert full resistance into circuit. The timing period was measured and found to be 63 seconds. The supply was then reduced to 7.5 volts and the period measured again. This time it was 62 seconds. At a supply of 6 volts the period was 61 seconds. Since a reduction in voltage across the l.e.d. should *lengthen* the timing period it is assumed that the lower supply voltages resulted in a compensatory reduction in the base current needed to turn on TR1. At any event, these results showed that the circuit should be adequate for battery voltages down to 7 volts. Since the timer is triggered at the end of a timing run by the onset of base current in TR1, it would be preferable to employ the unit in surroundings which are at normal room temperatures and not in excessively hot or cold environments.

The light-emitting diode may be fitted to the front panel of the timer to indicate that it is switched on. However, the glow it emits is rather low and may not be readily visible in bright surroundings.

All the components are standard parts. VR1 is a carbon track potentiometer and a good choice here would be a component having a moulded low-noise track. R2 has the rather 'awkward' value of 3kΩ. This is in the E24 series and is available in 5% from some suppliers but is offered only in 2% by others. Either tolerance will be satisfactory.

When the timer has been completed, VR1 is fitted with a pointer knob and scale and is calibrated by taking a number of timing runs at different settings, the lengths of the periods being measured by means of a clock or watch having a sweep second hand. ■

CATALOGUES

BI-PAK SEMICONDUCTORS

Currently available is the new 1977 Bi-Pak Catalogue, this covering an exceptionally large range of components and equipment for both the electronic hobbyist and the professional engineer. Included among the contents are aerials, hi-fi accessories, fixed and variable capacitors, resistors, potentiometers, plugs, sockets, speakers, microphones, transformers, testmeters, switches, Veroboards, equipment cases and many other items.

Also to be found is a wide listing of diodes, transistors, integrated circuits and other semiconductor devices. Six pages of the catalogue are devoted to transistor characteristics, including lead-out layouts. A similar helpful aid is a conversion table for Mullard equivalents of t.t.l. 7400 series i.c.'s.

The well known "Paks" take up four pages of the catalogue, these consisting of quantities of components offered at bargain prices. The catalogue has 127 pages, excluding the price list, and each item in it is identified by its own Order Number to eliminate errors and ambiguities. The new catalogue may be obtained from Bi-Pak Semiconductors, P.O. Box 6, Ware, Herts, price 50p, plus 15p postage and packing.

HOME RADIO COMPONENTS

The latest issue of the catalogue of Home Radio (Components) Ltd., has now become available. As with all the previous Home Radio catalogues, this is a bulky and excellently produced publication packed with items covering all aspects of radio and electronic home construction. Nearly all the products offered for sale are clearly illustrated and the catalogue also gives useful advice on colour codes and the selection of components for particular applications.

Measuring approximately 8 by 11in., the catalogue has 192 pages. The items listed appear in alphabetical order, thereby allowing a particular class of component to be quickly located. There is, further, a comprehensive index at the end which enables individual items within the broad alphabetical order to be found. Not encountered in other catalogues is a very extensive Lektrokit range of metalwork parts, and all products are identified by a Catalogue Number which eases the process of ordering and obviates ambiguities.

Further details on the catalogue can be found in the Home Radio advertisement which appears elsewhere in this issue. Price £1.40 including postage.

TRADE NOTE

CASSETTE STARTER PACK

Designed to appeal particularly to new cassette recorder owners, the Scotch cassette starter pack contains five C.90 Scotch High Energy cassettes, a head cleaning cassette, and a 48-page cassette recording guide.

The 'super ferric' cassettes are compatible with all machines, and give a total of 7½ hours recording time, with extended frequency response across the audible spectrum.

The booklet is packed with useful information for the recordist, with chapters on types of cassette tape; bias and equalisation; noise reduction systems; the recorder's controls and how to use them; making 'live' recordings and taping from discs and radio; and cassette manufacture. There is also advice on the care and handling of cassettes and machines, a quick reference trouble-shooting guide, and a glossary of hi-fi terms. The booklet — printed cassette size so that it can be handily kept alongside a cassette library — is written in simple-to-follow language and is illustrated with diagrams and cartoons.

Available from hi-fi dealers, the Scotch cassette starter pack costs around £6.50.

TEST PROBE CLIP

By H. Kennedy

An old ball-point pen can be converted to function as a test probe-clip which clips on to component wires.

It is convenient, when measuring voltages, to be able to leave an insulated probe clipped to the appropriate component lead. Crocodile clips are often pressed into service to enable this to be done, but they are clumsy in use. Also, if wrapped with insulating tape to prevent short-circuits they are difficult to attach. Professional probe-clips are no doubt the best answer for this problem, but a good substitute can be constructed from a discarded ball-point pen.

PREPARATION

The pen required is a "Bic" type having a transparent body. First, the empty ink tube and ball-point housing are pulled out from the case and put to one side. The ink tube is needed later. A series of 1/16in. diameter holes are drilled through one flat face of the hexagonal case to form the slot shown in Figs. 1(a) and (b); if the drill, while still turning, is pulled down from the top to the bottom hole a rough initial slot is readily formed. The sides of the slot can then be cleaned up with a small flat file.

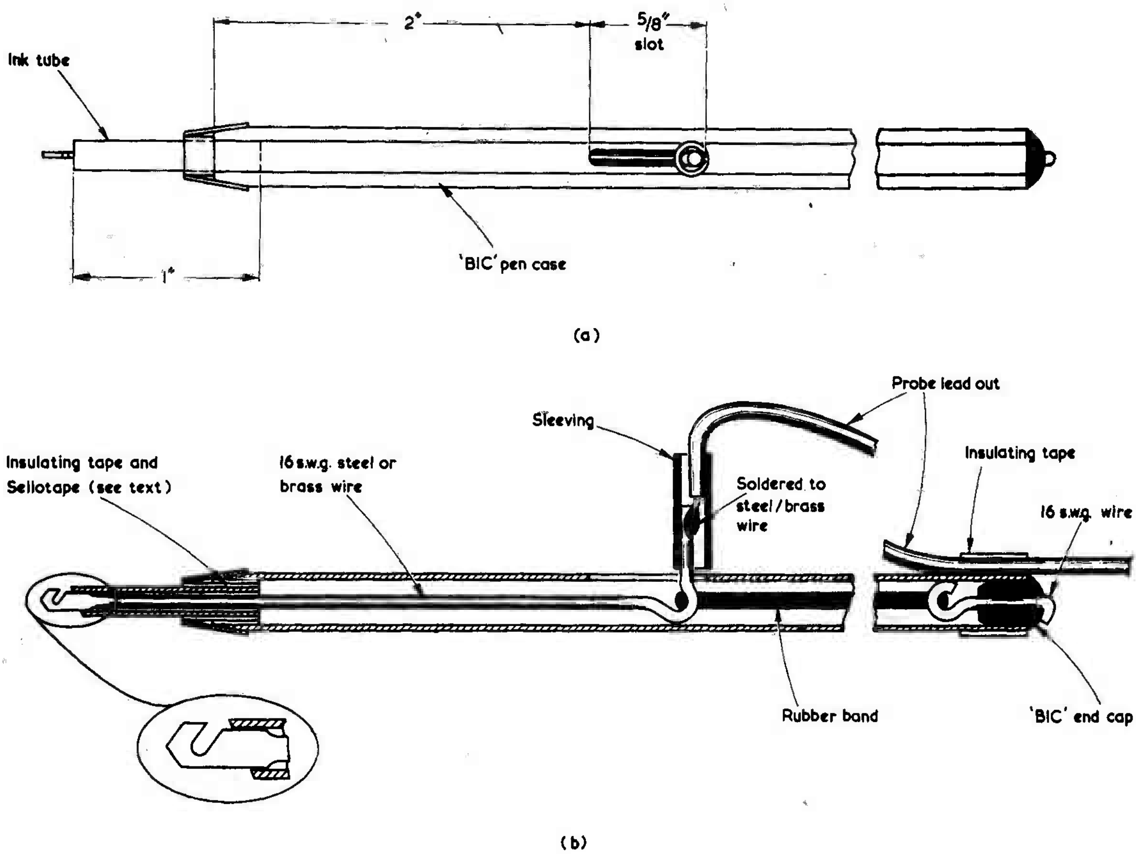


Fig. 1(a). Side view of the probe-clip. This is assembled in a discarded "Bic" ball-point pen (b). Internal structure of the probe-clip

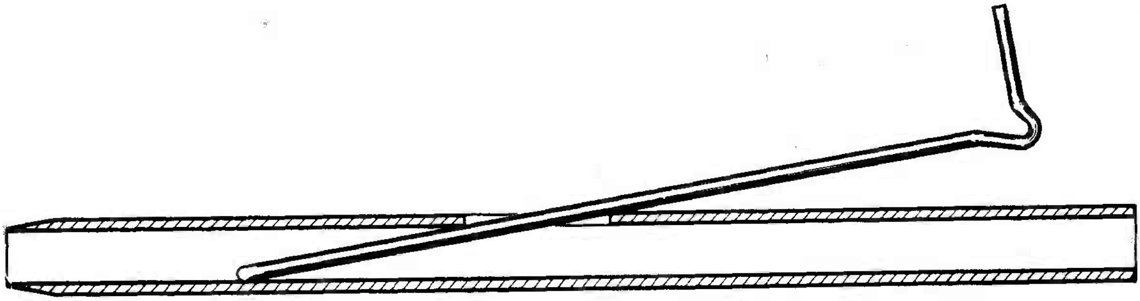


Fig. 2. Inserting the probe wire in the ball-point pen case

Next, take a 4in. length of 16 s.w.g. steel or brass wire and bend $\frac{1}{2}$in. at one end, as shown in Fig. 1(b). The other end of the wire should be filed smooth to remove any sharp edges or burrs which would scratch the inside of the case as it is passed through. Introduce the wire into the slot as in Fig. 2 and, with a little persuasion, force it along the case until it is sitting inside with the bent section at the slot. Check that the wire has not been permanently deformed by its insertion in the case and that it slides easily back and forth within the limits that the slot allows.

Take up the discarded ink tube, cut 1in. from it and clean it inside and out. A small piece of cotton wool wrapped around a length of wire will enable the inside to be cleaned fairly easily. Wrap $\frac{3}{8}$in. of one end with p.v.c. insulating tape and Sellotape so that it becomes a force fit in the mouth of the pen case, leaving a little less than $\frac{3}{4}$in. protruding. The author found that one layer of insulating tape and two layers of Sellotape were sufficient. Cut a slight chamfer at the end of the tube, as in Fig. 1(b).

pen, drill a 1/16in. hole through its centre and fit a piece of 16 s.w.g. brass or steel wire to it, bent to form a hook, as in Fig. 1(b). Fit a thin 3in. elastic band over the bent section of the probe wire, as shown in Fig. 3, the ends of the band being secured by a piece of thin wire. Feed the thin wire through the right hand end of the case. With care, the rubber band can be coaxed into the case, pulled through and have its ends hooked over the hook on the end cap, which is then refitted to the case. Since the rubber band is doubled, there are four strands of rubber between the hook and the probe wire.

Run the $\frac{3}{4}$in. length of sleeving along the lead-out wire so that it covers its joint to the probe wire. Tape the lead-out wire to the top of the pen case, leaving sufficient slack for the probe wire to move along the slot.

The probe-clip is now complete. If the bent section of the probe wire is pushed along the slot to the left (as shown in Figs. 1(a) and (b)) the flat section with the hook will emerge and the hook can be passed over the

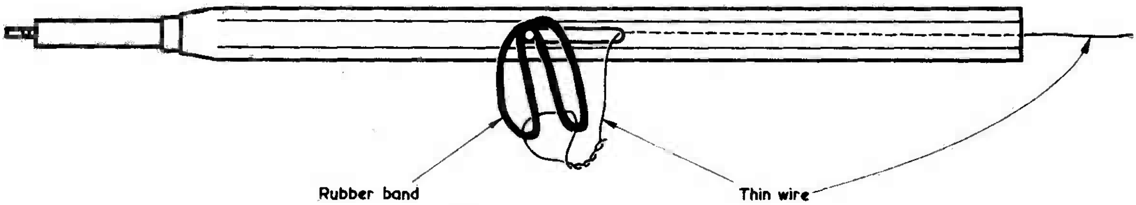


Fig. 3. Pulling the rubber band through the pen case. The band is used doubled

WIRE HOOK

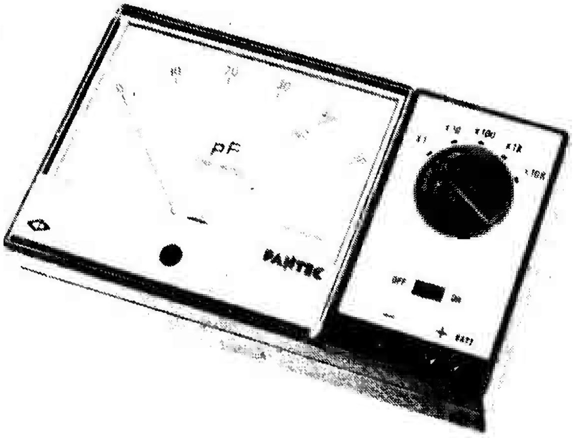
Move the wire fully to the left (as shown in Figs. 1(a) and (b)) and hammer the end $\frac{1}{2}$in. of the wire flat, taking care to keep the wire straight. The end can then be filed into the shape illustrated in Fig. 1(b), in which it has a hook which can be passed over a component lead. Note that the hook appears at the outermost edge of the chamfered ink tube, and that it must be positioned such that it retracts completely into the ink tube when the wire is moved, to the right, to the limit of the slot.

Pass a $\frac{3}{4}$in. length of sleeving over the flexible lead-out wire for the probe-clip and solder this wire to the 16 s.w.g. probe wire. Next, remove the end cap of the

lead to which connection is to be made. The rubber band will then maintain sufficient tension for the hook to remain clipped to the lead. The hook is released by pressing the bent section of the probe wire to the left again. If the probe-clip case is held like a pen, with the thumb behind the bent section of the probe wire, the probe-clip can be operated with one hand.

Finally, a word of warning. Since the insulating materials employed in the probe-clip are not of a type found in commercially produced items of this nature, the probe-clip must not be used with high voltages, such as those associated with the mains supply. On the other hand, it is eminently suitable for all measurements around low voltage transistor circuits. ■

New Products



CAPACITANCE METER

The PANTEC range of Multimeters and Test Instruments now includes the CP 570 Capacitance Meter. Five ranges can be selected by means of a rotary switch from 50pF to 0.5μF full scale. The meter movement is a class 1.5 3kΩ moving coil unit with sprung jewel bearings. Easy reading is ensured by a clear scale over 3in. long and a knife-edge pointer. Other features include overload protection and a battery test facility.

Further information from Carlo Gavazzi (UK) Ltd., North Crawley Road, Newport Pagnell, Bucks MK16 9HF.

DIGITAL CLOCK KIT FROM METAC

The latest digital clock kit from Metac International of 67 High Street, Daventry, Northants is a professional quality product which can be easily assembled by anyone in one hour or so.

Costing only £9.50 plus VAT, the kit combines established design techniques with the latest electronic components to provide a highly accurate, mains operated timepiece.

The kit contains everything except a mains lead and the only tools required for assembly are a small soldering iron, wire cutters and a screwdriver. The attractive white acrylic case which measures 10.5 x 5.7cms, is pre-drilled for easy assembly. The printed circuit board is also prepared ready for the clock components.

The heart of the clock is an integrated circuit manufactured by the General Instrument Corporation of America, one of the world's leaders in the field of microelectronics. In addition, it features a large green display which incorporates a 12/24 hour readout and a pulsating colon. Clock setting is by means of push buttons.

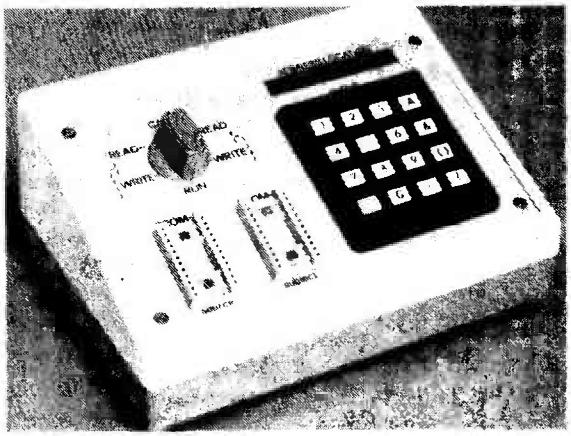
Metac International's clock kit is supplied as standard for 240V, 50Hz, 24 hour operation. A version is available, however, which will operate from 110V, 60Hz and 12 hour operation.

ADDITION TO RANGE OF PLASTIC VEROBOXES

Vero Electronics Limited have announced the introduction of an addition to their established range of plastic Veroboxes.

It is moulded in high impact ABS with the top section in white and the bottom section in light grey to match other boxes within this range. The sloping front design of the box incorporates an anodised aluminium panel to enable keyboards, switches, meters and other panel mounting components to be readily housed. Overall dimensions are approximately 4.5in. deep x 6.5in. deep x 1.5in. to 3in. high. The interior of the box provides a completely free space, but provision is made for a 100mm. x 160mm. Eurocard to be mounted in the base over the pillars through which the box is screwed together. Four plastic feet complete the unit as a free standing item.

The photograph illustrates the box together with a typical layout on the aluminium panel.



In your workshop

Take any number with two or more digits, rearrange the digits to form a new number then subtract the smaller from the larger. It would seem impossible that a simple electronic device could detect any error in this procedure, but then you haven't yet encountered Smithy's Magic Maths Monitor!

"Think," said Dick, "of any number lower than ten."

"All right," replied Smithy equably, "Nought."

Dick sighed.

"Trust you," he complained, "to be awkward. What I'm going to show you will work with nought, but it doesn't look so impressive. Give me another number."

"Okay," responded Smithy. "4 then."

"Right," said Dick quickly. "Start off by multiplying that number by 37."

Lazily, Smithy pulled out his ball-point pen, drew his note-pad towards him and wrote out the problem.

"The answer," he stated, "is 148."

"Fair enough," commented Dick. "Now multiply *that* number by 3. The result will give you a surprise."

Smithy carried out the further calculation.

"Well, I never did," he remarked calmly. "The answer comes to 444."

MATHS MONITOR

"There you are," crowed Dick triumphantly. "Didn't I say you'd get a surprise?"

"I distinctly heard you say that," replied Smithy mildly. "But where's the surprise?"

"Well," said Dick irritably, "you started off with one 4 and you ended up with three 4's."

"Humph," grunted Smithy. "I don't call that much of a surprise."

"Very well, then," snorted Dick. "Try it with another number. With 5, for instance."

"If I did that," stated Smithy, "the final answer would be 555. And if I started with 6 the final answer would be 666."

"Gosh," said Dick dejectedly. "You've twigged, then."

"Of course I twigged," retorted Smithy. "I twigged as soon as you told me to multiply by 3. 37 multiplied by 3 is 111, and so I was obviously multiplying my original number by 111. The answer was bound to come out as three figures which were the same as the original one."

Dick glanced up at the Workshop clock in disgust.

"It just beats me," he remarked despondently. "We've finished work early today and we've still got fifteen minutes to kill before we officially pack up, and so I thought I'd pass at least part of the time by trying out that little mathematical trick on you. And all you do is spot the secret behind it at the very first go."

Smithy looked at his assistant's woebegone expression, and a momentary grin passed over his face.

"I didn't know," he stated blandly, "that you were all that interested in maths. Usually it's as much as you can do to work out an Ohm's Law problem."

"I like," said Dick decisively, "playing around with *simple* maths problems."

"Like subtraction and addition?"

"That's right," responded Dick eagerly. "Something nice and easy where there are no decimals, no logs or anything complicated like that."

"What would you say," asked Smithy, "if I were to inform you that I had an electronic device in my bench cupboard which will tell you whether you are correct in a subtraction procedure involving any number you can think of which has two digits or more? And which will also check you on additions as well?"

"That sounds to me," responded Dick scornfully, "as though it's just an ordinary calculator."

"The device is much simpler than a calculator," stated Smithy. "In fact I made it up for a friend of mine who's a teacher at our local Tech. It's quite an amusing gadget for people who like playing around with maths problems. Come on over and have a look at it."

His interest aroused, Dick walked to Smithy's bench as that worthy reached down and opened his bench cupboard. Straightening up, Smithy placed an object on the surface of his bench. It consisted of a small plastic case with an aluminium front panel on which were mounted a number of miniature toggle switches, a push-button and two light-emitting diodes in panel-mounting bushes. (Fig. 1.)

"Blimey," commented Dick, intrigued. "I've never seen anything like this before. What are all the switches for?"

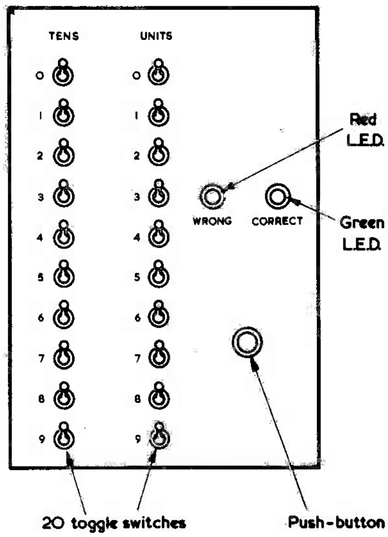


Fig. 1. The front panel layout of the Magic Maths Monitor. Numbers are entered into the Monitor by turning on the appropriately numbered switches

"In company with the green l.e.d. and the red l.e.d.," explained Smithy, "they're part of the set-up for checking whether the answer you get to a problem is correct. All the switches are off when they're up and they're turned on when they're down. Say that the problem answer you arrive at is 47. You feed the number 47 into the device by putting down the 4 switch in the 'Tens' column and the 7 switch in the 'Units' column. You then press the push-button whereupon, if your answer is correct, the green l.e.d. lights up. And if the answer is wrong the red l.e.d. comes on. I call the gadget my Magic Maths Monitor."

Dick cast a glance of utter disbelief at the Serviceman.

"Come on, Smithy," he said firmly, "you're having me on. A simple gubbins like this couldn't possibly show whether or not the answer to a maths problem is correct."

"Couldn't it?" responded Smithy. "Let's try it out then. You'd better use my pen and note-pad for what comes next, as you'll have a bit of subtracting to do."

"All right," said Dick, picking up the Serviceman's pen, "start me off."

"Write down," ordered Smithy, "any number having more than two digits in it. For starters, you could choose a number with four digits."

"*Any* number?"

"Any number you like," repeated Smithy. "Choose any number with four digits which catches your fancy."

"Okeydoke," replied Dick. "I'll write down — let me see now — 7,534."

Dick wrote the number on Smithy's note-pad.

"Now," said Smithy, "rearrange those digits to form another four-digit number."

"All right," stated Dick, busy with the pen. "I'll change the last three digits around to give the number 7,453."

"Good," commented Smithy. "The next thing you do is subtract 7,453 from 7,534."

His brow furrowed in concentration, Dick carried out the calculation. (Fig. 2(a).)

(a)	(b)	(c)
7534	71	71
7453	17	17
81	64	54

Fig. 2(a). The first subtraction attempted by Dick (b). An incorrect subtraction, immediately spotted by the Monitor (c). The correct version of the subtraction

"The answer," he announced, "is 81."

"Excellent," commended Smithy. "Enter it into the Monitor."

Dick leaned over, turned on switch 8 in the "Tens" column and switch 1 in the "Units" column. He then pressed the push-button.

The green l.e.d. glowed.

MORE NUMBERS

"Hey," said Dick, impressed. "This machine really *does* work."

Smithy grinned.

"Try it again," he chuckled. "To make things easy, try it with a two-digit number."

"All right," said Dick eagerly. "How about 17?"

He wrote down the number.

"The only way you can rearrange the two digits in that number," commented Smithy, "is to make the second number 71. 17 is is smaller than 71 so, this time, you subtract 17 from 71."

"I'm doing that right now," said Dick, as he worked out the subtraction. (Fig. 2(b).)

"What answer do you get?"

"64!"

"Right," said Smithy cheerfully. "Try that number for size."

Dick turned off the two switches he had previously set down on the Monitor, then turned on switch 6 and switch 4. Excitedly, he depressed the push-button.

The red l.e.d. lit up.

"There's something queer here," said Dick, surprised. "According to this my answer is wrong."

"And so it is," confirmed Smithy. "Do that subtraction again."

Dick turned to the note-pad.

"Well, blow me," he exclaimed, frowning. "My answer *was* wrong, too! It should have been 54, not 64." (Fig. 2(c).)

Dick turned off switch 6 in the "Tens" column and turned on switch 5. Expectantly, he placed his finger on the push-button.

This time, the green l.e.d. glowed.

"Ah," said Dick, turning off the two switches. "That's more like it."

"Why," suggested Smithy, "don't you try a really large number next?"

"If you like," said Dick obligingly. "Now let me think of some large random numbers. Ah yes, I'll write down 855,437, and I'll then rearrange this to give 345,578."

As he spoke, Dick wrote down the numbers. He then proceeded to subtract the smaller number from the larger. (Fig. 3(a).)

"Stap me," he remarked, scratching his head. "I picked some sticky figures here! Anyway, here's the answer I get: 509,859. That's much too large to go into your Maths Monitor, Smithy, so what do I do next?"

"You add up all the digits in the number and feed the answer into the Monitor," replied Smithy. "As I told you, this gadget can check for the ac-

	5	
	0	
855437	9	12000
345578	8	12
509859	5	11988
	9	
	36	
(a)	(b)	(c)

Fig. 3(a). A subtraction involving a large number
(b). The digits in the solution are added before being checked by the Monitor
(c). Another subtraction, in which the lower number has three noughts (not shown) at the left
(d). Again the digits of the solution are added
(e). Dick's unsuccessful attempt to foil the Monitor

1	
1	1451
9	1451
8	0000
8	
27	
(d)	(e)

curacy of addition as well as subtraction."

"Fair enough," stated Dick, putting the figures of the number in a column. "Now, let's see what these add up to."

Quickly, he ran Smithy's pen down the column of figures, then wrote down their sum. (Fig. 3(b).)

"There you are," he announced. "I make it 36."

He actuated switch 3 and switch 6 on the Maths Monitor, then pressed the push-button. At once the green l.e.d. lit up. As he flicked the switches back to their original settings an uneasy expression passed over his face.

"D'you know, Smithy," he said dubiously, "I'm beginning to find this Monitor a bit too spooky for my liking. I mean to say, I make up any old number I can think of, do a subtraction and an addition with it, and then this thing tells me whether or not my calculations are correct. What would have happened if I'd made the answer 37, say, instead of 36?"

"The monitor," said Smithy assuredly, "would show you that the answer was wrong."

Dick turned on switch 3 and switch 7, then actuated the push-button. The red l.e.d. became illuminated. Dick released the push-button as though it were red-hot, then turned off the two switches.

"I don't think I like this game," he remarked unhappily. "Just what *is* there inside that box?"

"Not very much," replied Smithy soothingly. "Just a few resistors and the odd transistor. Look, I'll tell you what to do next. Make up another large number with a few noughts in it, then rearrange the digits so that the lower number has the noughts at the left."

"Like, say, starting off with something like 12,000 then making the second number 00,012?"

"That," stated Smithy, "would be an excellent choice. What you're really doing then is subtracting 12 from 12,000."

Doubtfully, Dick carried out the subtraction. (Fig. 3(c).)

"I make the answer," he stated, "11,988."

"Right," said Smithy. "Again, that number's too large to enter into the Monitor, so add up its digits and try then."

Dutifully, Dick totted up the digits. (Fig. 3(d).)

"The result," he pronounced, "is 27. So I'll turn on the 2 switch and the 7 switch and see what happens."

He turned on the switches, then actuated the push-button. Once more the green l.e.d. glowed.

"Hell's teeth," he muttered apprehensively as he turned off the switches, "this is getting more like black magic all the time."

He glowered at the Maths Monitor then grinned malevolently as a thought suddenly occurred to him.

"I know something that will fox this darned machine," he said, picking up the pen. "Here's another number: 1,451. And I'm going to make the second number 1,451."

"But," protested Smithy, "they're both the same."

"No, they're not," retorted Dick quickly. "The second number is the first number with the 1's at the ends swapped over!"

Triumphantly, he wrote the numbers on the note-pad. (Fig. 3(e).)

"This," he gloated, "will deflate that device of yours. 1,451 minus 1,451 is obviously zero, so we'll enter

Fig. 4(a). *In this series, all the number digits add up to 9 or 18*
(b). Examining much larger multiples of 9

9	
18	1+8=9
27	2+7=9
36	3+6=9
90	9+0=9
99	9+9=18
108	1+0+8=9
117	1+1+7=9
126	1+2+6=9

(a)

9999	9+9+9+9=36
10008	1+0+0+0+8=9
10017	1+0+0+1+7=9
10026	1+0+0+2+6=9

(b)

zero into it by turning on both the zero switches."

Dick turned on switch 0 in the "Tens" column and switch 0 in the "Units" column. Exultantly, he pressed the push-button.

The green l.e.d. lit up.

ALL THE NINES

Stricken, Dick released the button then gazed at the Maths Monitor with fearful eyes.

"Could it be," asked Smithy solicitously, "that some little matter is vexing you?"

"Vexing me?" repeated Dick incredulously. "Here am I absolutely shattered and you're talking about me being vexed! What do you expect me to be when I've got this supernatural box of tricks in front of me? It's not a Monitor, it's a Monster!"

"This box of tricks, as you call it," remarked Smithy airily, "is nothing other than a simple device with a few switches and a couple of l.e.d.'s on it. Dash it all, you handle far more complicated things during your normal servicing work."

"Perhaps I do," spluttered Dick helplessly. "But the things I service don't tell me to take any number, do a simple subtraction and an addition with it and then tell me whether the answer is right or wrong. What I find most frightening is that I start off with any number; any number under the sun!"

"Take it easy," soothed Smithy, removing his pen from his assistant's nerveless fingers. "There's a perfectly sound mathematical reason why this device operates in the way it does, and I'll now put you out of your misery by explaining it to you. It all has to do with the rather eccentric behaviour of the figure 9 in the decimal system."

"'Eccentric'," commented Dick heavily, "is a very good word for me as well as for the figure 9. It means 'off-centre' and that fully describes my mental state at the moment."

"Now, the peculiarity with the figure 9," went on Smithy, ignoring his assistant's comments, "is that all the multiples of 9 have digits which add up to 9 or to another multiple of 9. An obvious multiple of 9 is 99, whose digits add up to 18. 18 is a multiple of 9, and its digits add up to 9."

"Hey, slow down a bit, Smithy. You're getting ahead of me here. How can you show that all multiples of 9 behave like that?"

"What is probably the easiest way of showing it is by inspection," said Smithy. "Let's start off with the figure 9, which is obviously a multiple of itself. The next multiple is 18 whose digits, as I said just now, add up to 9. Next comes 27, followed by 36. For each increase of 9, one digit increases by 1 and one reduces by 1. And so it goes on, with two digits, up to 90." (Fig. 4(a).)

"What happens after 90?"

"Well, we can't reduce the nought by 1 and so the next number becomes 99. After that we get 108, 117, 126 and so on. All these numbers are multiples of 9 and their digits all add up to 9 or to a multiple of 9."

Dick absorbed this information.

"That's easy to see with small numbers," he commented. "What happens when you get to higher numbers which are in the thousands, say?"

"You get pretty well the same sort of thing," replied Smithy. "Let's start off at 9,999, which is obviously a multiple of 9 and whose digits add up to 36. If we add 9 to 9,999 we get 10,008, the digits of which add up to 9. After this we get 10,017, 10,026, and so on. All are multiples of 9 and their digits add up to 9. So you have a blanket overall rule: whenever you get a number which is a multiple of 9, its digits add up to 9 or to a multiple of 9." (Fig. 4(b).)

"This means," said Dick slowly, "that if you want to check whether a number is divisible by 9 you just add up its digits."

"Correct," confirmed Smithy. "That can often be a useful mathematical short-cut, by the way."

"Well, I understand that bit now," said Dick. "But how does it explain the performance of this Maths Monitor?"

"Just concentrate," stated Smithy, "on what we've been doing, which has been to take any number, rearrange its digits and then subtract the smaller number from the larger. Let's say for a kick-off that the first number we choose is a multiple of 9. It could, for instance, be 7,542. This is a multiple of 9 because its digits add up to 18. We could then rearrange it to 5,472, and this new number must also be a multiple of 9, because its digits again add up to 18."

Smithy wrote down the numbers. (Fig.5(a).)

"I'll now subtract 5,472 from 7,542," he announced, "whereupon I get 2,070. This is once more a multiple of 9, because its digits add up to 9."

An agonised expression creased

(a)	(b)	(c)
7542	7543 (7542+1)	(multiple of 9)+n
5472	5473 (5472+1)	(multiple of 9)+n
2070	2070	multiple of 9

Fig. 5(a). Subtracting one multiple of 9 from another multiple of 9
(b). The same answer is given if both the multiples are increased by 1
(c). General rule covering all subtractions checked by the Monitor. It should be remembered that zero is a multiple of 9, which explains the result given in Fig. 2(c)

Dick's face. It was evident that he was in the process of conceiving a new idea.

"Just a minute, Smithy," he said slowly, "doesn't the result of the subtraction have to be a multiple of 9 in any case, without having to prove it by adding the digits?"

A warm avuncular glow entered Smithy's eye.

"Go on," he prompted gently.

"What I mean," continued Dick hesitantly, "is that if you subtract one multiple of 9 from another multiple of 9, the answer *must* be a multiple of 9. For example, if you take 18 away from 72 you get 54, or if you take 27 away from 63 you get 36."

PERSPICACITY

"My boy, my boy," beamed Smithy benevolently, "you couldn't be more right. You have grasped the essentials of the situation with an assurance which deserves the utmost credit."

"Have I? Does it? Gosh!"

"Your perspicacity has demonstrated an important basic truth: if you subtract one multiple of 9 from another multiple of 9 the answer must also be a multiple of 9. Now, we did just that when we subtracted 5,472 from 7,542. The answer was 2,070. Let's see what happens if we add 1 to both the first two numbers, so that they become 5,473 and 7,543. If I subtract 5,473 from 7,543, I once again get 2,070." (Fig. 5(b).)

"That's funny," remarked Dick. "It's the same as before."

"True," agreed Smithy. "What I was actually doing was subtracting a multiple of 9, plus 1, from another multiple of 9, plus 1. The 1's cancel out in the subtraction, so that the answer is the same."

Smithy wrote further on his notepad. (Fig.5(c).)

"This takes us," he announced, "to a general rule. If we subtract any multiple of 9, plus a number which I'll call 'n', from any other multiple of 9, plus the same number, the answer is always a multiple of 9."

"Stap me," exclaimed Dick. "At long last I'm beginning to get a glimmer of insight into this Maths Monitor."

"How it works is quite obvious when you think about it," stated Smithy. "Let's say that the first number you select has digits which add up to 14. This number will be a multiple of 9, plus 5. If you rearrange the digits they will still add up to 14, and the resultant number will once again be a multiple of 9, plus 5. When you subtract one number from the other the 5's cancel out and the result is always a multiple of 9."

"So," breathed Dick, "all that Monitor does is to have the green l.e.d. light up when the switches are set up to 9 or a multiple of 9."

"You've got it," confirmed Smithy. "The green l.e.d. also lights up for zero, to allow for characters who choose to subtract the same number from itself. The red l.e.d. lights up for all the remaining numbers, up to 98, which aren't multiples of 9."

"That must involve a lot of wiring to the switches, mustn't it?"

"Not necessarily," said Smithy, opening his bench cupboard once more and extracting a sheet of paper. "Here's the circuit. As you can see, all the switches are single-pole single-throw types. The switches in the 'Units' column are shown in the opposite direction to that in which they appear on the front panel of the Monitor, as this makes it easier to trace out the wiring in the diagram. You will note that a circuit from the left hand side to the right hand side of the switches is completed when the 0 switch and the 9 switch are closed, when the 1 switch and the 8 switch are closed, when the 2 switch and the 7 switch are closed, and so on." (Fig. 6).

"Dear, oh dear," chuckled Dick. "You can't have things much simpler than that. I see that the circuit is completed also for 0 and 0, and for 9 and 9."

"That's right," confirmed Smithy. "So far as lighting the l.e.d.'s is concerned, let's start by assuming that someone has selected, say, 29 by closing the 2 and the 9 switches. There is then no circuit across the switches. If the push-button, which I've shown as S21, is pressed, the positive side of the battery connects via R3 to LED2. This is the red l.e.d. and it then glows. If, on the other hand, the 2 and 7 switches are closed, pressing the push-button applies the positive side of the battery to all three resistors, R1, R2 and R3. The green l.e.d. glows and base current flows into the transistor via R2, turning the transistor hard on. LED2 cannot then light because it's effectively short-circuited by the collector and emitter of the transistor. Current will still pass through R3, and this now flows into the transistor collector. Okay?"

"I'll say it is," confirmed Dick warmly. "Gosh, Smithy, you certainly dream up some way-out ideas when you get going. What sort of battery do you need?"

"A 4.5 volt flat flashlamp battery would be quite adequate," said Smithy. "Or you could have three 1.5 volt HP11 cells in series. The circuit draws about 16mA when the red l.e.d. is lit, and about 45mA when the green l.e.d. is lit. You could, of course, reduce the current by increasing the values of R1 and R3, at the expense of decreasing the intensity of light from the l.e.d.'s. As the circuit stands, each l.e.d. passes about 16mA when it's lit."

GOING ON GREEN

"Well," stated Dick cheerfully, "you've certainly given me a few things to think about this afternoon."

"And," said Smithy a little sourly as he consulted his watch, "you've kept me nattering well after closing time yet again. Darn it, we should have left sixteen minutes ago."

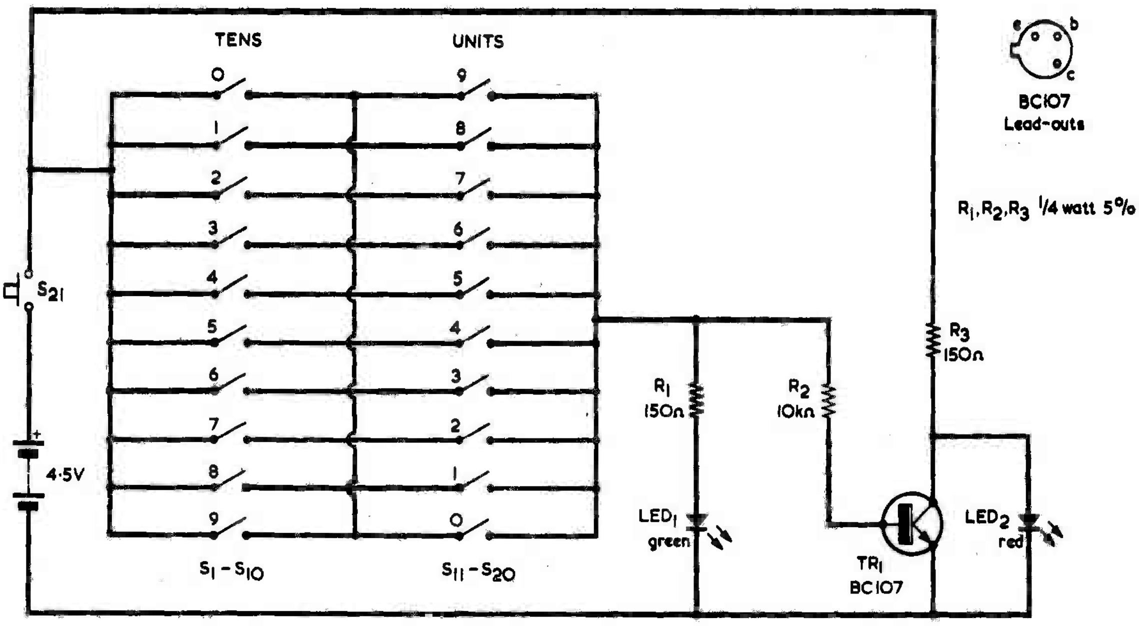


Fig. 6. The simple circuitry employed in the Maths Monitor. The direction of switches in the "Units" column is reversed to illustrate operation more clearly

"Sixteen minutes overdue, eh?" commented Dick.

He turned on switch 1 and switch 6 of the Magic Maths Monitor and pressed the push-button. The red l.e.d. lit up.

"Come on," snorted Smithy. "Stop messing around with that thing."

But Dick was not to be shifted until, after 17 minutes overdue (switches 1 and 7 turned on and another red indication) and 18 minutes overdue, when he closed the 1 and 8 switches and was finally awarded with the illumination of LED1, he pronounced that he had at last obtained the requisite green to go.

And thus the pair departed to enter their normal decimal lives, leaving the Magic Maths Monitor to occupy a world based on the number 9, in which all subtractions result in multiples of 9 and all additions eventually arrive at the mysterious number itself. ■

'ELECTRONICS + 5' LOOKS AHEAD

What will the face of electronics be by 1982? What changes will it make to our everyday lives? What new facilities will it bring in health care? Will it make communication easier? Will it help to economise energy and raw materials? Will it bring down traffic pollution?

It is not an easy matter to predict applied electronics prospects over the next five years. A careful balance must be struck between an over-simplified extrapolation of today's situation and the romantic long-term vision that is nearer to science fiction.

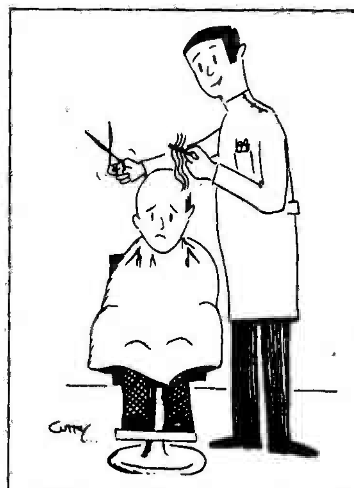
For the first time in France, SEE and GIEL** are attempting this feat with ELECTRONICS + 5, to be held from 28 March to 1st April, 1977, just before the Components Exhibition opens in Paris.*

Their aim will be to try, in the space of one week, to present a concrete realistic package of the development of electronics in key industries in five years' time, to reveal its impact on industry and society as a whole.

It will be an in-depth analysis integrating all the economic, technological, political and social aspects of the issue.

If ELECTRONICS + 5 is the success expected, SEE and GIEL intend to repeat the experiment and produce what in effect will be a constantly renewed picture of the development of electronics in all its varied applications in the five years after.

All enquiries should be addressed to Electronics + 5, 11 rue Hamelin, 75783 Paris Cedex 16. *Societe des Electriciens, des Electroniciens et des Radioelectriciens. **Groupement des Industries Electroniques.



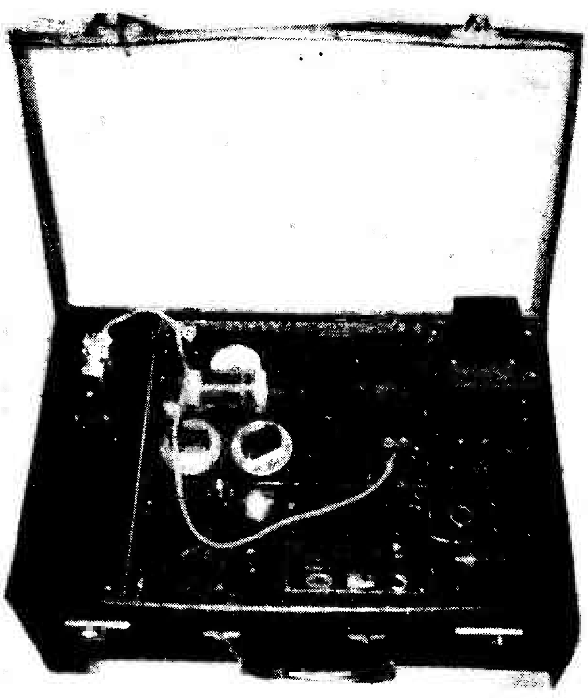
"How shall we tune the old micro-wave this week, professor?"

THE SET IN THE SUITCASE

By Ron Ham

Covert radio communications during World War 2 involved the use of equipment which, although beautifully made, would be considered fantastically bulky by present day standards.

Readers are familiar with the way in which modern agents, as presented on TV and at the cinema, take their portable radio equipment for granted. Hand-held transceivers with only a stumpy little aerial at the top have exceptionally long ranges, with no problems of screening by high buildings or motor car bodies. In practice, however, the make-believe performance of such equipment is not far removed from what is actually possible, thanks to the rapid advance of solid-state techniques during the past decade.



The "B2" portable transmitting and receiving set, employed by the Special Operations Executive for clandestine communications inside occupied Europe during World War 2

LOOKING BACK

But let us now forget about the present day and go back to the early 1940's when this country was at war and when portable radio communication was vitally essential to all branches of the armed forces. One particular branch was the S.O.E. (Special Operations Executive) whose agents, in occupied Europe, needed a reliable long range transmitter and a sensitive receiver to keep in touch with their headquarters in the U.K.

The Boffins of that time produced the famous "B2" set, this being housed in a suit-case measuring 18 by 12 by 5¼in. when closed. The suit-case provided a measure of concealment, and reduced the ever-present danger of the set being discovered.

The "B2" can be seen in the photograph and it has four main sections: an accessories box on the left, the transmitter at top centre, the receiver at bottom centre and the power unit at the right. The morse key, transmitter tank coils, crystals, earphones, aerial wire and mains and battery leads are all housed in the accessories box, whilst under the lid are the instructions for tuning and selection of the requisite transmitter tank coil. There is a mains voltage selector on top of the power unit which can be set up, by means of four small shorting links, to a number of mains voltages between 105 and 240. The power unit also incorporates a vibrator for operation from a car battery.

The "B2" covers 3 to 15MHz in three ranges, and the receiver has a supremely efficient slow-motion tuning drive which is a joy to handle. As the author has demonstrated many times, the receiver can easily resolve an s.s.b. signal on the 80 metre band by adjustment of the b.f.o. control.

The meter in the transmitter section functions both for tuning and testing, and just below it is a multi-way socket for the transmitter tank coils. The transmitter tuning controls are below the tank coil socket and, like all the other controls, are clearly marked and easy to adjust.

A small square box standing on the power supply section, at top right, contains a reel of flexible copper aerial wire. A short length of the wire is shown attached to the left hand latch on the case lid.

Like all the wartime sets the "B2" was well designed and beautifully made, although its glass valves made it fragile by modern standards. And, at 28lb., it was certainly no light weight to hump about. ■

Radio Topics

By Recorder

★ ★ ★ ★ ★ ★

Despite the fact that pocket electronic calculators are already very plentiful and cheap, I have still managed to resist the temptation to call in at the local Woolworths / Boots / Co-op / virtually any old cycle repair shop/and buy one for myself. One reason for my restraint is that calculators are bound to become cheaper still in the future, and so it's worth-while waiting for a little time. Another reason is that I don't want to get hooked on the darned thing.

People in engineering who employ pocket calculators tell me that they're extremely useful for long and involved calculations, but once you become accustomed to working with them you're liable to end up using them for simple sums such as 2 plus 2. It is almost certain that calculators will eventually change the whole approach towards mathematical training in the future.

FAREWELL, SLIDE RULE

One pocket device which is already outdated by the calculator is the slide rule. It takes a little time to get used to a slide rule but when it is mastered it is possible to sail almost effortlessly through quite involved calculations provided you can remember where the decimal point should be. But a slide rule doesn't even have the three significant figure accuracy of four figure logarithms, and it is necessary to have a 10 inch rule if reasonable resolution of its calibration is to be achieved. Who wants to tote a 10 inch slide rule around when a pocket electronic calculator can give much faster results and to a considerably higher degree of accuracy?

I hear that youngsters are now even beginning to question the necessity of learning how to calculate with logarithms. I must have been a little horror during my pre-war schooldays because I used to *enjoy* doing sums with logs. Logarithms, of course, replace a complicated multiplication or division by a simpler addition or substraction and, even these days, I feel quite happy to get out the old log tables when I have a tricky calculation to do.

Part of the fascination of calculators must be that they are not only mathematical devices but are also playthings. I bet that there are few readers who, on encountering a digital clock indicating 09.99 hours, haven't lingered a moment or two so that they can watch the display change to 10.00 hours. So it is with calculators and their little red l.e.d. numbers which jump magically into view as the appropriate button is pressed.

"TIMES TABLES"

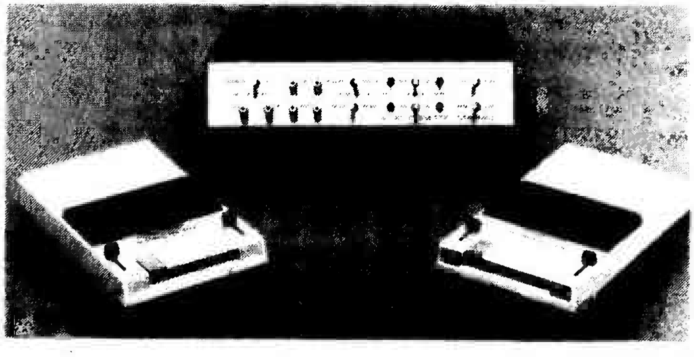
In those early schooldays of mine we used to learn our "times tables" by chanting them in unison at primary school. This is parrot-fashion learning, I know, and is a method which is frowned upon by many teachers these days. But I remain unyielding in my conviction that it is better to learn the tables by rote than make no attempt to learn them at all. You go to a shop nowadays and buy, say, nine items at 8p each from a young shop assistant. The chances are that there will be no end of anguish before the assistant finally arrives at the correct answer. (At this point I must confess that, at my local a few evenings ago, I bought a lager at 33p and a Scotch at 28p, and the young barmaid obligingly rang up 51p. But there it is; one has to ride with the system).

A further objection on my part to acquiring a pocket calculator is that I have a profound respect for Finagle's Law. If in any system it is possible for one section to fail then, inevitably, that section will fail. Nobody ever *doubts* the accuracy of a calculator. In the l.s.i. chips which form the heart of a calculator there must surely one day turn up the rogue chip which is the equivalent of a car produced on Christmas Eve. Perhaps when I do buy a calculator I'll get the one that slips the odd bit every now and again, but nobody will ever believe me because everyone is convinced that a calculator cannot make a mistake.

The dicey time will come when everybody uses and relies on calculators and all the chips are Christmas Eve ones.

DISPLAY TERMINAL

The first of the two accompanying photographs shows the CT 1024 Visual Display Terminal which is marketed by Computer Workshop, 174 Ifield Road, London SW10 9AG. The CT 1024 is designed to store 1,024 characters and display them on two pages of 512 characters, 16 lines of 32 characters on each page, or on one page of 16 lines of 64 characters. The characters can appear on a slightly modified TV set, on a video monitor or can be applied to the aerial socket of a domestic television receiver by means of a suitable modulator.



The AC-30 Audio Cassette Interface equipment, another Computer Workshop product. This employs tape cassettes for data storage

The Computer Workshop Visual Display Terminal type CT 1024. This can store 1,024 characters for display on a video monitor or television receiver

The Terminal is intended for use anywhere where data needs to be displayed. It has a great impact on advertising displays and is very useful as a teaching aid. It is claimed that the low cost of the Terminal makes a video display practical in many applications which have previously been precluded because of expense.

Also from Computer Workshop is the AC-30 Cassette Interface equipment illustrated in the second photograph. Cassette tape is now one of the most flexible and inexpensive means of mass data storage for computer systems. The AC-30 meets the Kansas City 1975 recording standard, which has been generally adopted to allow programmes and data to be freely interchanged between users of different computer systems.

The AC-30 will tolerate speed variations of approximately 30%. This represents an advantage in the case of speed variations due to changes in mains or battery voltage, wow and flutter and the worst case difference between recorders.

A further item available from Computer Workshop is the MP-68 Computer System. This is based on the Motorola 6800 microprocessor and can be used in conjunction with the CT 1024 Display Terminal.

PLAYING WITH PENDULUMS

Here is a simple, albeit rather fiddling, little experiment which can show the effects of coupling together resonant systems.

Take a piece of string about a yard to a yard and a half long and suspend it horizontally between two fixed points so that it is fairly taut. By means of another piece of string hang from it a large weight so that its centre of gravity is about 2ft. below the horizontal string. Next hang from the horizontal string a smaller weight so that its centre of gravity is about 2ft. 2in. below the horizontal string. Position the strings supporting the weight so that they are roughly equi-spaced along the horizontal string.

The large weight is the weight of one pendulum, which can be called the driver pendulum; whilst the small weight is the weight of a second pendulum, which can be referred to as the driven pendulum. Set the driver pendulum in motion along a line at right angles to the horizontal string. If the pendulums are close in resonant frequency the driven pendulum will then start to swing, its amplitude rising to a peak corresponding to minimum movement in the driver pendulum. The amplitude of the driven pendulum will then fall and that of the driver pendulum will in turn rise to a peak. The system will continue in this fashion with each pendulum reaching a peak in amplitude whilst the other passes through a null. By careful adjustment of vertical string lengths it is possible to make the spacing between peaks at least 10 seconds.

I used a PP9 battery for the large weight and a PP6 battery for the small weight. If the supporting vertical string is tied in a loop around the length of each battery, so that it passes around the bottom and between the two terminals at the top, the battery can be rotated inside this loop, thereby changing the height of its centre of gravity and offering a degree of "fine tuning". In practice, the horizontal string partly enters the suspension for each weight, which is why it is desirable to initially make the string holding the smaller weight a little longer than that on which the heavier weight depends.

The two pendulums could be looked upon as two tuned circuits of very high Q which are resonant at close frequencies and are tightly coupled together. It is readily possible to see the phase difference between the two pendulums as they gradually move in and out of phase and reach their peaks. An intriguing and certainly inexpensive little experiment.

THE VANISHING KIOSK

Telephone boxes, or "call offices" as the Post Office so quaintly calls them, are not as permanent as you may think. A friend of mine who is in the habit of taking an Autumn holiday at a seaside resort in South Wales, discovered this fact for himself in no uncertain manner.

During his holiday in 1975 he rang his home most evenings from one of two kiosks which were situated side by side outside the local telephone exchange. Then one evening he went to the phone boxes, to find that there was only one kiosk there. The second kiosk had completely disappeared.

Vandalism, he decided as he used the remaining phone box, was bad enough but this was ridiculous.

When, last year, he returned to the same holiday spot he found the two phone boxes in their familiar positions outside the exchange just as in the previous year. But this time he was able to solve the mystery. Half-way through his vacation he chanced to pass the telephone exchange one morning and spotted the nomadic phone box being loaded onto a Post Office lorry. A few enquiries elicited the information that it was Post Office policy to erect temporary kiosks at holiday resorts to handle the extra traffic during the season, and then take them away when it was assumed that only the local population would be requiring the service.

This raises almost incredible visions of a hitherto unsuspected activity on the part of the Post Office. There must be stores of temporary phone boxes at centres throughout the UK ready for use whenever an increase in traffic is liable to occur. When an extra kiosk is required out goes the lorry with the phone box and an accompanying engineer aboard. At the selected place, presumably always outside an exchange, the kiosk is unloaded and placed in position on the pavement. A local engineer throws out a 1-pair cable through the exchange window and the accompanying engineer takes up a similar cable from the box. The two pairs of wires are then ceremoniously twisted together, and off goes the lorry and its engineer to fill any other gaps in the telephone service which is provided for the community. ■

SMALL ADVERTISEMENTS

Use this form for your small advertisement

To: The Advertisement Manager, Data Publications Ltd., 57 Maida Vale, London W9 1SN

Please insert the following advertisement in the .... issue of RADIO & ELECTRONICS CONSTRUCTOR

15 words at 8p = £1.20

ALL WORDING IN BLOCK LETTERS PLEASE

I enclose remittance of.................being payment at 8p a word. MINIMUM £1.00
Box Number, if required, 20p extra

NAME..

ADDRESS..

....

Copy to be received four weeks prior to publication. Published on the 1st of every month.

SMALL ADVERTISEMENTS

Rate: 8p per word. Minimum charge £1.00
Box No. 20p extra

Advertisements must be prepaid and all copy must be received by the 4th of the month for insertion in the following month's issue. The Publishers cannot be held liable in any way for printing errors or omissions, nor can they accept responsibility for the ***bona fides*** of Advertisers. (Replies to Box Numbers should be addressed to: Box No. — ***Radio and Electronics Constructor,*** 57 Maida Vale, London, W9 1SN.

60kHz MSF RUGBY RECEIVERS BCD time-of-day output. High performance PLL 5V operation, pulsating LED. Kit or assembled instrument available. Prices £14.08-£23.47. Details: Toolex, Sherborne, Dorset.

WANTED: Large and small quantities of transistors, I.C.'s, displays, etc., etc., Call any Saturday to: 306 St. Paul's Road, London N.1. Telephone: 01-359 4224.

SERVICE SHEETS for Radios/TV's etc. 50p and s.a.e. Catalogue 20p and s.a.e. Hamilton Radio, 47 Bohemia Road, St. Leonards-on-Sea, Sussex.

GRIMSBY ELECTRONICS, LAMBERT ROAD, GRIMSBY: For components, cases, Veroboard, surplus, etc. by return. Lowest prices. Bargains list 9p. (Callers Saturdays only).

MULLARD COMPONENTS, Send s.a.e. for free list to P.M.S. Dept REC6, PO Box 6, Crawley, Sussex, RH10 6LH.

I SHALL BE PLEASED TO SUPPLY your components for projects in this magazine. State your requirements for a quotation. Barras Electronics, 11 North Street, Coventry, Warwickshire.

WANTED TO PURCHASE: All early books on radio, preferably before 1925. Box No. 282.

TREASURE HUNTERS! Construct 11-transistor metal detector giving £300 performance. 10 page illustrated plans, send £1. C. H. Lucas, 241 Upminster Road South, Rainham, Essex.

JOIN THE INTERNATIONAL S.W. LEAGUE. Free services to members including Q.S.L. Bureau, Amateur and Broadcast Translation, Technical and Identification Dept. — both Broadcast and Fixed Stations, DX Certificates, contests and activities for the SWL and transmitting members. Monthly magazine, *Monitor,* containing articles of general interest to Broadcast and Amateur SWLs, Transmitter Section and League affairs, etc. League supplies such as badges, headed notepaper and envelopes, QSL cards, etc., are available at reasonable cost. Send for League particulars. Membership including monthly magazines, etc., £3.75 per annum. (U.K. and British Commonwealth), overseas $10.00 or £4.00. Secretary ISWL, 1 Grove Road, Lydney, Glos., GL15 5JE.

THE JUNK BOX: Buy, sell, trade. Sample copy 70p, and goods list. 20 word small ad free with this ad. The Junk Box, PO Box 872, Peabody, Mass. 01960, U.S.A.

(Continued on page 517)

SMALL ADVERTISEMENTS

(Continued from page 515)

MANUFACTURERS NEEDED. Electronic-Security Devices — Millimetre Inch rules. 49% shares available. Ayres, Norton Fitzwarren, Taunton, Somerset.

ANTIQUE RADIO BOOKS. Newnes *"Television & Short Wave Handbook"* by F. J. Camm, 1935, £3.00. News Chronicle *"Wireless Constructor's Encyclopaedia"* by F. J. Camm, 3rd edition, circa 1930, £3.50. Prices include postage and packing. Box No. G318.

SIX 7-SEGMENT LED DISPLAYS £1. Ex-equipment but guaranteed in arrays of 6, with data. Mr. Bobker, 29 Chadderton Drive, Unsworth, Bury, Lancs.

TV REPAIRS SIMPLIFIED. Full repair instructions individual British sets £4.50; request free circuit diagram. Stamp brings details of unique TV publications. Auserec, 76 Churches, Larkhall, Lanarkshire.

FOR SALE: Telford Communications 2m. converter, G8AEV MKII. £10. G2UK, 21 Romany Road, Oulton Broad, Lowestoft, Suffolk.

COLLECTORS' ITEMS: Bound volumes of *The Wireless World* (which was then published weekly) for 1931, 1932, 1933, 1934, 1935, 1936, 1937, 1938 and 1939 (nine months only for this year due to outbreak of war). Two volumes per year, total of 18 volumes. All in very good condition. Offers invited. Box No. G319.

WANTED: Dual beam oscilloscope by keen amateur. Good S/H, fair priced scope please. Gibbons, 45 Peterborough Road, Castor, Nr. Peterborough, PE5 7AX.

T'HERS FIND MASSES MORE COINS/VALUABLES with latest auto-tuning 8 transistor variable acoustic professional detector. Save £100+ over comparable commercial machines. Complete easybuild plans/suppliers list £1.50. Detex Electronics, 20 Maldon Road, Acton, London W.3.

THE RADIO AMATEUR INVALID & BEDFAST CLUB is a well established Society providing facilities for the physically handicapped to enjoy the hobby of Amateur Radio. Please become a supporter of this worthy cause. Details from the Hon. Secretary, Mrs. Rita Shepherd, 59 Paintain Road, Loughborough, Leics., LE11 3LZ.

WANTED: *"Radio & Electronics Constructor"*, 1947-1969, preferably bound. State price. Dr. Cowan, 51 Wellington Street, Oxford, OX2 6BB.

POSTAL ADVERTISING? This is the Holborn Service. Mailing lists, addressing, enclosing, wrapping, facsimile letters, automatic typing, copy service, campaign planning, design and artwork, printing and stationery. Please ask for price list. – The Holborn Direct Mail Company Capacity House, 2-6 Rothsay Street, Tower Bridge Road, London, S.E.1. Telephone: 01-407 6444.

PRACTICAL ELECTRONICS PROJECTS. An exciting new construction book by G. C. Dobbs. 75p plus 10p postage. Calverton Publications, Redgates Court, Calverton, Nottingham.

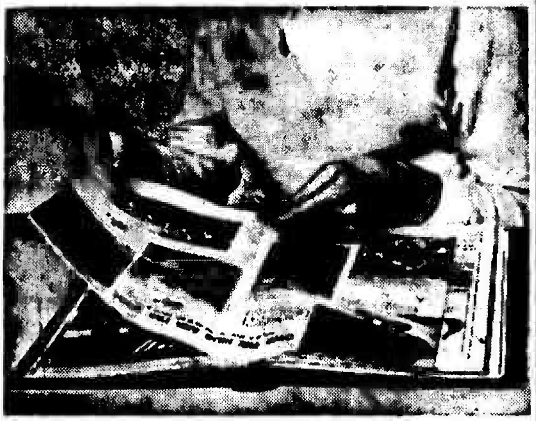
WANTED: Plug for the 6 volt d.c. socket on the Bush TP60 Cassette Tape Recorder. Box No. G326.

(Continued on page 518)

PLAIN-BACKED NEW STYLE SELF-BINDERS

for your other magazines

(max. format 7½" x 9½")



The "CORDEX" Patent Self-Binding Case will keep your copies in mint condition. Issues can be inserted or removed with the greatest of ease. Specially constructed Binding cords are made from Super Linen of great strength, very hard twisted and twice doubled. They are attached to strong RUSTLESS Springs under tension, and the method adopted ensures PERMANENT RESILIENCE of the Cords. Any slack that may develop is immediately compensated for, and the Cords will always remain taut and strong. It is impossible to overstretch the springs, as a safety check device is fitted to each.

COLOURS: MAROON OR GREEN

(If choice not stated, colour available will be sent)

PRICE £1.15 P. & P. 30p

Owing to heavy demand please allow 27 days for delivery

Available only from:—

Data Publications Ltd.
57 Maida Vale London W9 1SN

SMALL ADVERTISEMENTS

(Continued from page 517)

THE BRITISH AMATEUR ELECTRONICS CLUB for all interested in electronics. Four Newsletters a year, concessions for members and Major Projects sponsored by the B.A.E.C., currently the B.A.E.C. Computer. U.K. membership fee £2 a year from January 1st, overseas £3 surface, £4 airmail. S.A.E. for details to Hon. Sec., J. G. Margetts, 42 Old Vicarage Green, Keynsham, Bristol.

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 32 Mc/s at every 500Kc/s points. Each frequency is repeated. Two sheets for 5p., five sheets for 10p., postage 7p. Data Publications Ltd., 57 Maida Vale, London, W9 1SN.

HEATHKIT TEST GEAR, ETC. Most factory built. Generators: RF-1U £20. A.F. AG-9U £20. R/C bridge C-3U £15. Valve voltmeter with R/F probe V-7A £18. Oscilloscope 0-12-U £25. Electronic Switch S-3U £10. S.B.—101 case only £5. Collins mechanical filter 455-Z-5 with crystal £10. All items must be sold, i.e. o.n.o. Telephone: West Coker 2712.

FOR SALE: Merit Chemistry Set No. 2. Cat. No. 802. Offers? Box No. G327.

FAST SERVICE for resistors, capacitors, transistors, din plugs, jack plugs, audio leads. Special Offer: AC128 12p, post extra. S.A.E. list. Callers welcome. Torbay Electronic Components, 185 Higher Union Street, Torquay, Devon. Telephone: 211086.

RECITALS OF RECORDED MUSIC: The second Saturday evening of each winter month. Next recital: March 12th, 1977, 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 will include works by Delius, Vaughan Williams, Britten, etc.

PERSONAL

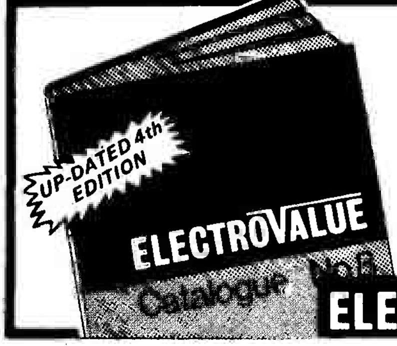
JANE SCOTT FOR GENUINE FRIENDS. Introductions to opposite sex with sincerity and thoughtfulness. Details free. Stamp to: Jane Scott, 3/Con North St. Quadrant, Brighton, Sussex, BN1 3GJ.

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.

ESSEX GARDENERS. Buy your Bedding and rock plants, shrubs, etc., also cacti from May's Nurseries, 608 Rayleigh Road, Hutton, Brentwood, Essex. Callers only. Monday to Saturday.

SPONSORS required for exciting scientific project. Norwich Astronomical Society are building a 30" telescope to be housed in a 20' dome of novel design. All labour being given by volunteers. Already supported by Industry and Commerce in Norfolk. Recreational. Educational. You can be involved. Write to: NAS Secretary, The Manse, Back Lane, Wymondham, Norfolk.

THE OPEN DOOR TO QUALITY



4th ISSUE INCLUDES NEW METERS AND SWITCHES as well as items from advanced opto-electronic components to humble (but essential) washers. Many things listed are very difficult to obtain elsewhere. The company's own computer is programmed to expedite delivery and maintain customer satisfaction. Attractive discounts continue on many purchases, Access and Barclaycard orders are accepted.

SEMI-CONDUCTORS ● COMPONENTS ● ACCESSORIES ● TOOLS

• **FREE POSTAGE** on all C.W.O. mail orders over £2 list value (excluding VAT) in U.K., add 15p handling charge.

144 pages
40p
Post paid
inc. refund voucher worth
40p

All communications to Head Office, Dept. RC 3, 28 ST. JUDES* ROAD, ENGLEFIELD GREEN, EGHAM, SURREY TW20 0HB.** Phone Egham 3603 Telex 284475. ***Hours 9-5.30 daily; 1 pm Sats.
NORTHERN BRANCH: 680 Burnage Lane, Burnage, Manchester M19 1NA. Phone 061-432 4945. ***Hours 9-5.30 pm, 1 pm Sats.***

ELECTROVALUE LTD

Please mention *'Radio & Electronics Constructor'* when replying to Advertisements

---

MULLARD FERRITE CORES — LA3 100 to 500 kHz, **75p**; LA5 30 to 100 kHz, **100p**; LA7 10 kHz, **100p** **LA13 for W.W. Oscilloscope, £2.00.**

SPECIAL OFFER – Metallised Polyester Capacitors by Erie, Mullard, etc. Values include: ·01/160V, ·01/250V, ·015/160V, ·022/160V, ·033/160V, ·047/160V, ·068/160V, ·1/160-250V, ·22/160V, etc. This is a bargain not to be missed. **100 for £3.00.**

1N4148 **SWITCHING DIODES**, 10 for **30p**; 50 for **£1.25**; 100 for **£1.50**; 1,000 for **£12.50.**

TRANSISTORS – All branded BC147, BC148, BC149, BC157, BC158, BC159, BF194, BF195, BF196, BF197, **10p each or 100 for £8.50.**

Please note all prices include UK Postage and appropriate VAT @ 8% or 12½%

XEROZA RADIO
306 ST. PAUL'S ROAD, HIGHBURY CORNER, LONDON N1
Tel: 01-226 1489

INTERNATIONAL SHORT WAVE LEAGUE

WE SPAN THE GLOBE

Membership £3.75 per annum (U.S.A. $10.00) including 12 monthly issues of *Monitor* — the League journal. Including free use of all Services, QSL Bureau etc.

THE LARGEST S.W.L. ORGANISATION IN THE WORLD

For full details write to:

The Secretary,
I.S.W.L.,
1, GROVE ROAD, LYDNEY,
GLOS. GL15 5JE.

'Management Information Systems'

An instruction Manual for Business Students
Deals with the underlying principles of systems and is a companion volume to "Data Processing" by Oliver & Chapman.

45 pages. Price 75p including postage

From:
D. P. PUBLICATIONS, 4 AMPORT CLOSE
WINCHESTER, HANTS.

H.M. ELECTRONICS
275a Fulwood Road, Broomhill
SHEFFIELD S10 3BD Tel: 0742-669676

BEC CABINETS (Book End Chassis)

Standard Cabinet		GB2	14" x 7" x 3"
GB1	14" x 6" x 2"	GB3	14" x 9" x 4"
GB1A	9" x 6" x 2"	GB4	14" x 9" x 6"

Send 15p for wallet of leaflets.

A beautifully designed modern cabinet with simulated black leatherette top (PVC bonded to metal) solid wooden end cheeks, with room at the back for Output Sockets etc. felt pads are fitted on bottom of cheeks for non-scratch.

GOING DOWN?

LISTEN to EXCITING 100-600KHz band with an L.F. CONVERTER. Includes 20dB gain antenna tuner and feeds 3.5-4MHz receiver. EASY to make, all parts, coils, printed circuit, case, etc., instructions, money back assurance. **ONLY £8.80 inc. post.**

CAMBRIDGE KITS **45 (EN) Old School Lane, Milton, Cambridge**

PLEASE MENTION THIS MAGAZINE WHEN WRITING TO ADVERTISERS

FOR THE BEGINNER

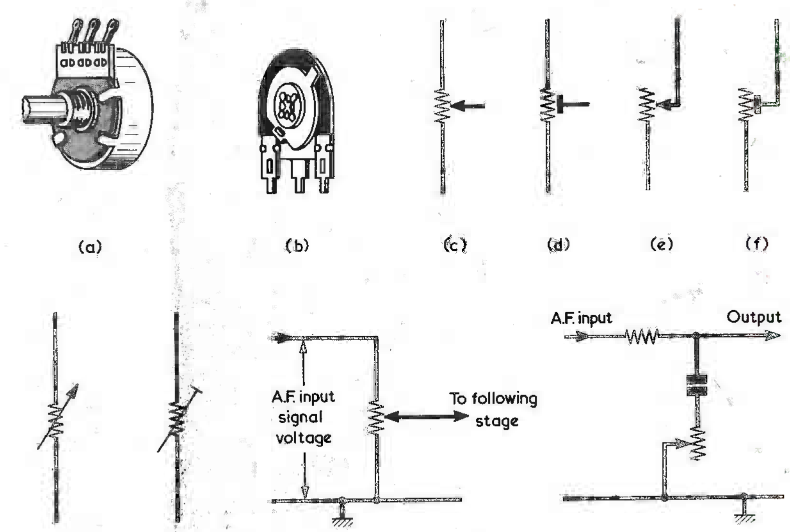
POTENTIOMETERS

Potentiometers consist of a continuous track of resistive material along which a slider or wiper can travel. Commonly encountered examples are the panel-mounting type, as in (a), and the small "skeleton" pre-set potentiometer of (b). The circuit symbol for a normally operated potentiometer is given in (c), and that for the pre-set version in (d). In most potentiometer applications a voltage is applied across the track of the component and the slider then taps off a portion of this voltage relative to one end of the track.

The same component may also provide a variable amount of resistance, whereupon connection is made to the slider and one track tag only. Symbols for the normally operated and pre-set versions are in (e) and (f) respectively, with frequently met variants in (g) and (h) respectively.

Potentiometers are available with linear or log tracks. With a linear track the change of resistance is directly proportional to slider movement whilst with a log track the amount of resistance between the starting end of the track and the slider varies approximately as the logarithm of slider movement. Small skeleton pre-set potentiometers normally have linear tracks only.

In (i) a potentiometer functions as a volume control. This potentiometer will have a log track because the response of the ear to varying sound amplitudes is of a logarithmic nature. In (j) the component is employed as a variable resistor in series with a capacitor having a low reactance at the higher audio frequencies. This combination functions as a simple "top-cut" tone control, attenuation of the higher audio frequencies increasing as the slider moves towards the upper end of the track.



(a) (b) (c) (d) (e) (f)

(g) (h) (i) (j)

The new Maplin Catalogue is no ordinary catalogue...

Hundreds of fascinating new lines.

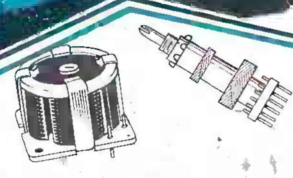
Several major new projects to build.

The new tools section includes a range of soldering irons and equipment whilst the test gear section includes a selection of multimeters from 1,000Ω/V to 100,000Ω/V to suit your requirements.

Find out about our major electronics' projects you can build. Our catalogue will help you choose one of our many leaflets and booklets giving full constructional details of such exciting projects as a stereo graphic equaliser, or an electronic piano, a sophisticated electronic organ, our advanced synthesisers — and many more.

Super Discount Voucher Scheme – saves you pounds!

Hundreds of photographs and illustrations.



Component section includes a wide range of coils, pot cores, ready-wound coils and chokes from microHenries to Henries, plus ranges of Denco coils and i.f. transformers etc.

Catalogue includes a very wide range of components: hundreds of different capacitors; resistors; transistors; I.C.'s; diodes; wires and cables; discotheque equipment; organ components; musical effects units; microphones; turntables; cartridges; styli; test equipment; boxes and instrument cases; knobs, plugs and sockets; audio leads; switches; loudspeakers; books; tools – AND MANY MANY MORE.

SEND THIS COUPON FOR **YOUR** COPY OF OUR CATALOGUE ON APPROVAL! Price 50p – SEND NO MONEY NOW.

Please rush me a copy of your brand new 1977/78 catalogue by return of post. Only if I am completely satisfied that it is worth every penny, will I send 50p within 14 days of receipt. If I am not satisfied, I may return the catalogue to you within 14 days without obligation. I understand that I need not purchase anything from your catalogue should I choose to keep it.

NAME ______________________

ADDRESS ______________________

______________________ REC3

Maplin Electronic Supplies P.O. Box 3, Rayleigh, Essex, SS6 8LR

**DON'T DELAY
POST COUPON NOW
IT COULD BE THE
BEST 50p YOU'VE EVER SPENT**

✱ **Our bi-monthly newsletter keeps you up to date with latest guaranteed prices – our latest special offers (they save you pounds) – details of new projects and new lines. Send 30p for the next six issues (5p discount voucher with each copy).**

MAPLIN
ELECTRONIC SUPPLIES
P.O. BOX 3, RAYLEIGH, ESSEX SS6 8LR
Telephone: Southend (0702) 715155
Call at our shop: 284 London Road, Westcliff-on-Sea, Essex
(Closed all day Monday) Telephone: Southend (0702) 47379