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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.

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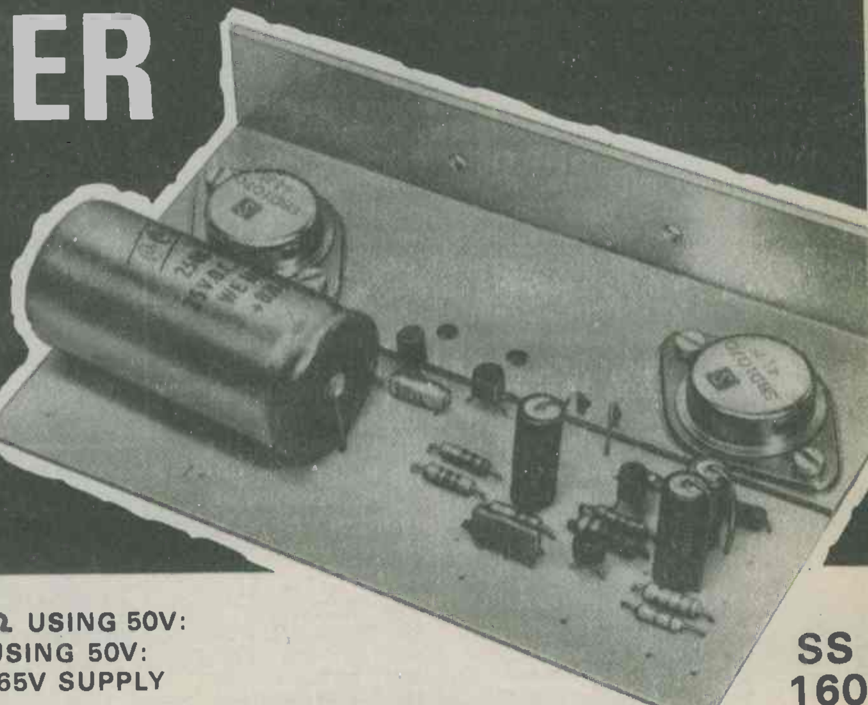
THE DECEMBER ISSUE WILL BE PUBLISHED ON 2nd NOVEMBER

A NEW 60 WATT R.M.S AMPLIFIER FROM Stirling Sound



- A COMPLETELY NEW DESIGN
- 60 WATTS R.M.S. (±1dB) INTO 4Ω USING 50V: 35 W.R.M.S. (±1dB) INTO 8Ω USING 50V:
- WILL OPERATE BETWEEN 20 & 65V SUPPLY (Output varies accordingly)
- T.H. DISTORTION BETTER THAN 0.3% (Typically 0.1%)
- FREQUENCY RANGE 10 TO 50,000Hz. —3dB AT 10Hz: —3dB at 50kHz
- INPUT 350mV FOR FULL OUTPUT

SS 160

It's another winner! from Stirling Sound

Coming between SS.140 and SS.1100 the new SS.160 fills a gap in power amplifier modules (3 to 100 watts r.m.s.) that will particularly please those wanting a not-so-big disco or P.A. system as well as those with speakers needing plenty of power to drive them. With circuitry developed around a self-centering mid-rail, excellent results will come also from using as little as 20 volts supply. (Power output will vary acordingly). Because we use heavy duty components able to operate beyond our claimed specifications; you can buy and build with confidence. YOUR SS.160 IS READY NOW AND WE HAVE EVEN MADE A NEW POWER SUPPLY UNIT (SS.360) SPECIALLY FOR IT.

£8.50 POST FREE INCL VAT — Large finned heatsink Post free inc VAT **75p**

Special Stirling Sound Offer

Bought separately SS. 160 costs £8.50, SS. 360 £12.75, *heatsink* 75p *(total — £22.00). Buying all three together (post free and inc VAT) it costs you only* **£21**

And the SS.1100 money saver

SS.1100 — £10.50; SS.370 — £14.75; Large finned heatsink — £1.50 (total — £26.75). Buying all three together (post free and inc VAT) saves you £2.00 — at **£24.75**

USE COUPON TO AVOID DELAY

TO STIRLING SOUND, 37 Vanguard Way, Shoeburyness, Essex.

Please Supply ....

....

....

For which I enclose £ .... (or by Access or Barclaycard)

Name ....

Address ....

....

REC 11

MORE STIRLING SOUND MODULES

POWER AMPS

All outputs rated in watts, R.M.S. ±1dB.

SS. 103 3W./one I.C./mono	£2.85
SS. 103-3 Stereo of above/2 I.C.s	£5.00
SS. 105 5W/3/13.5V	£3.95
SS. 110 10W/4/24V	£4.65
SS. 120 20W/4/34V	£5.15
SS. 140 40W/4/45V	£6.50
SS. 160 60W/4/50V	£8.50
SS. 1100 100W/4/70V	£10.50

TONE CONTROL/PRE-AMPS

SS. 100 Active st./bass/treble	£3.00
SS. 101 St. Pre-Amp for ceramic P.U.	£2.75
SS. 102 St. P.A. for mag. P.U.	£4.45
UNIT ONE St. P.A./tr./Bass/Vol./Bal.	£9.00
UNIT TWO as Unit One but for mag. P.U.s	£12.50

FM. STEREO DECODER

SS. 203 Phase lock loop with LED	£5.25

THE POWER SUPPLY UNIT YOU WANT IS HERE

All except SS.312 and SS.300 are fitted with low volt (13-15V) take off points for pre-amps, tuners etc.

SS.312	12V/1A	£6.60
SS.318	18V/1A	£6.95
SS.324	24V/1A	£7.65
SS.334	34V/2A	£8.75
SS.345	45V/2A	£9.98
SS.350	50V/2A	£11.75
SS.360	60V/2A	£12.75
SS.370	70V/2A	£14.75

Output stated when unloaded

SS.310/50 Stabilised unit, variable 10V to 50V/2A £16.69

SS.300 Add-on Stabilising unit 10-50V adjustable £5.02

PAY ONLY THE PRICE YOU READ AND NO MORE

All prices quoted include V.A.T. and goods are sent post free in U.K. Owing to the time between sending our advertisement to this journal and its appearing to the public, prices may be subject to alteration without notice. *E.&.O.E.*

Stirling Sound

37 VANGUARD WAY, SHOEBURYNESS, ESSEX

Telephone: Shoeburyness (03708) 5543

SHOP: (open all day Saturdays) 220-224 West Road, Westcliff-on-Sea, Essex SS0 9DF. (0702 351048)

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. MINIMUM ORDER GOODS VALUE £1.00.

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 **5p**
Chassis B7–B7G **9p**
Shrouded chassis B7G–B8A **10p**
B12A tube **10p**

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**

Aluminium Knobs for $\frac{1}{4}$" shaft. Approx. $\frac{5}{8}$" x $\frac{7}{8}$" with indicator Pack of 5. **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
$2\frac{3}{4}$" x $5\frac{1}{4}$" x $1\frac{1}{2}$" **45p** 10" x $4\frac{1}{2}$" x 3" **£1.02**
4" x 4" x $1\frac{1}{2}$" **45p** 12" x 5" x 3" **£1.20**

SWITCHES

Pole	Way	Type	
1	2	Sub. Min. Slide	12p
6	2	Slide	20p
2	1	Rotary Mains	20p
2	1 (or 1p 2W)	Micro with roller	20p
2	3	Miniature Slide	16p

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**

Sidleen/AFA Very High Security barrel Key Switch. 2 tubular keys **£1.50**

AUDIO LEADS
3 pin din to open end, 1½ yd twin screened **35p**
Twin phono—open end, 4ft., twin screened **35p**

COMPUTER & AUDIO BOARDS/ASSEMBLIES
VARYING CONTENTS INCLUDE 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** + **£1.00** post and packing
7lb for **£1.95** + **£1.40** 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 $2\frac{1}{4}$ x $1\frac{3}{4}$ x $1\frac{1}{4}$" 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 $1\frac{1}{2}$" diameter **60p**

3.5mm metal stereo plug **20p**

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

RESISTORS
$\frac{1}{8}$–$\frac{1}{4}$–$\frac{1}{2}$ 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**

Diode Equivalent Book, 172 pages, AA111 to ZY200, 1N34 to 1S3200, also outline and connection data.
£1.50 NO VAT

POTS
Log or Lin, single or dual, switched carbon or wirewound, 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**
700 ohm 11-31 volt miniature seled d.p.d.t. **80p**

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 $\frac{3}{4}$" x $\frac{3}{4}$" **£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, 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**

$1\frac{1}{4}$ 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**

Aluminium circuit tape, $\frac{1}{8}$" x 36 yards—self adhesive. For window alarms, circuits, etc. **60p**

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

$5\frac{1}{4}$" x $2\frac{3}{4}$" Speaker, ex-equipment 3 ohm **30p**
2 Amp Suppression Choke **8p**
3 x $2\frac{1}{2}$ x $\frac{1}{16}$" **PAXOLINE** **4p**
$4\frac{5}{8}$ x $\frac{1}{2}$ x $\frac{1}{8}$" **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**

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

STYLII 15p

ER5SB/5MX/HC1/HC2/ER2. Compact X2/X/C/SX. Garrard GCM21T/22T/GKM24T/GKS25/GP59. B.S.R. C1/FX1M/ST3/CS80/TC8/OP and T, and many other sapphire types.
Send sample required with payment and s.a.e if in doubt.

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

KEY EDIT and display boards with up to 132* 12V bulbs, 38 d.t.l. and t.t.l. i.c.'s and other components. (*A few bulbs may be broken). **£2.00 plus 75p p&p**

Crouzet 30-minute timer-programmer, multi-variable contacts **£6.00 plus £1.00 p&p**

ACOS DUST JOCKEY Automatic record cleaner **£1.00**

Wood cased 8-12V buzzer **£1.50 plus 80p p&p**

McMurdo 8 or 12 or 18-way plug and socket, ex-equipment **36p**

SEMICONDUCTORS

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

AC128/176	8p
ACY28	19p
AD149	40p
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
BC555/6/7/8/9	9p
BCX32 36	12p
BCY40	50p
BCY70/1/2	12p
BD113	50p
BD115/6	31p
BD131/2/3	35p
BD135/6/7/9	30p
BD140/142	30p
BD201/2/3/4	80p
BD232/4/5/8	49p
BDX77	£1
BD437	50p
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
BSV81 Mosfet	90p
BSX20/21	14p
BSY40	27p
BSY95A	12p
CV7042 (OC41/44 ASY63)	5p
GET111	40p
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
2N3553	50p
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

RECTIFIERS

	Amp	Volt	
IN4004/5/6	1	4/6/800	5p
IN4007/BYX94	1	1250	5p
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	26p
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
RAS310AF*	1.25	1,250	40p

Avalanche type

TRIACS

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

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

B9A valve can .. 5p

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

OPTO ELECTRONICS

Diodes		Photo transistor	
TIL209 Red	12p	BPX29	80p
BPX40	50p	OCP71	34p
BPX42	80p		
BPY10	80p		

(VOLTIAC)

BIG L.E.D. 0.2" 2v 50m/A max.
YELLOW 14p
RED 14p

BPY68, BPY69, BPY77 80p

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp £1.00

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

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

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
BY126/7	4p
HG1005	10p
HG5009	3p
HG5079	3p
L/8/9	3p
M3	10p
OA81	3p
OA47	3p
OA200-2	3p
OC23	20p
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

KLAXON 12-24v 2-tone transistorized Alarm Sounder. Note, pitch and duration variable. Weatherproof alloy case. £10.00 p&p £1.30

NEW B.V.A. VALVES

EB91	34p
ECL80	34p
PCC84	34p
6SN7	50p
6AT6	50p
EZ81	40p

TRANSFORMER

Ferromag C core. Screen-95-105-115-125-200-220-240v input: output 17v ¾A x 2 + 24-0-24v 1.04A + 20v 1mA. These current ratings can be safely exceeded by 50%. £3.50 + £1.00 p&p.

WOODS 240V A.C. Approx. 2,500 r.p.m. continuous rated 5 or 6in. FAN (ex-computer) **£3.60 plus £1 p&p**

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

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.

CRAZY OFFERS

2000 mfd.	50v	16p
2500 mfd.	40v	30p
8 mfd.	500v	6p
400 mfd.	16v	4p
.1 mfd.	350/500v	1½p
.1 mfd.	1500v	2p
2200 mfd.	25v	30p
1000 mfd.	200v	25p
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	350v	3p
680 mfd.	100v	10p
15 mfd.	160v	3p
4700 pf.sub min	500v	1½p
4700 mfd.	63v	70p
250 mfd.	300v	16p
4700 mfd.	40v	35p
25000 mfd.	25v	20p
1000 mfd.	63v	30p
1500 mfd.	70v	16p
500 mfd.	150v	16p
250 mfd.	50v	5p
12000 mfd.	12v	12p

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

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
TBA800	£1.00
741 8 pin d.i.l. op.	24p
SN76013N	£1.20
TAD100 AMRF	£1
CA3001 R.F. Amp	50p
CD4013 CMOS	36p
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TAA263 Amp	65p
7400	10p
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7414	56p
7438/74/86	24p
7483	69p
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AC128	£0·18	BC148	*£0·10	BC557	*£0·13	BIP20	£0·38	TIS90	*£0·22	2N3709	*£0·07
AC128K	£0·26	BC149	*£0·10	BC558	*£0·12	BIP19/		UT46	*£0·22	2N3710	*£0·07
AC132	£0·20	BC157	*£0·10	BC559	*£0·14	20MP	£0·80	ZTX107	*£0·10	2N3711	*£0·07
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AC137	£0·20	BC159	*£0·10	BD116	£0·80	BU105	£1·70	ZTX109	*£0·10	2N3820	£0·40
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AC142	£0·20	BC169	*£0·12	BD124	£0·70	BU205	£1·70	2N1613	£0·20	2N4058	*£0·12
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AC188	£0·18	BC182L	*£0·10	BD140	£0·60	MPSA05	*£0·30	2N2217	£0·22	2N4290	*£0·18
AC188K	£0·20	BC183	*£0·10	BD139/		MPSA06	*£0·30	2N2218	£0·22	2N4291	*£0·18
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AF116	£0·21	BC214	*£0·12	BD204	£0·80	OC36	£0·90	2N2907A	£0·22	2N5296	£0·56
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AF124	£0·30	BC238	*£0·16	BDY20	£0·80	TIC44	*£0·29	2N2926O	*£0·08	2N5459	£0·38
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AF180	£0·40	BC303	£0·28	BF594	*£0·30	TIP30A	£0·50	2N3055	£0·40	40311	£0·38
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AU113	£1·00	BC460	£0·38	BFX84	£0·23	TIP32C	£0·53	2N3646	*£0·09	40348	£0·80
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BC107B	£0·08	BC477	£0·20	BFX86	£0·25	TIP41B	£0·51	2N3703	*£0·08	40361	£0·36
BC107C	£0·08	BC478	£0·20	BFX87	£0·22	TIP41C	£0·53	2N3704	*£0·07	40362	£0·38
BC108A	£0·08	BC479	£0·20	BFX88	£0·22	TIP42A	£0·53	2N3705	*£0·07	40406	£0·45
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7402	0.15	7411	0.23	7445	0.90	7484	0.98	7495	0.75	74141	0.80
7403	0.15	7412	0.23	7446	0.90	7485	1.20	7496	0.80	74154	1.30
7404	0.15	7413	0.27	7447	0.78	7486	0.30	74100	1.00	74180	1.10
7405	0.15	7414	0.58	7448	0.80	7489	2.90	74110	0.50	74181	2.00
7406	0.30	7416	0.28	7475	0.48	7490	0.42	74118	0.90	74190	1.50
7407	0.30	7417	0.28	7480	0.50	7491	0.75	74119	1.85	74198	2.00
7408	0.15	7440	0.15	7481	0.95	7492	0.45	74121	0.30	74199	1.90

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Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
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CD4002	0·20	CD4015	0·98	CD4024	0·80	CD4037	0·95	CD4049	0·55	CD4081	0·22
CD4006	0·98	CD4016	0·52	CD4025	0·20	CD4040	0·95	CD4050	0·55	CD4082	0·23
CD4007	0·20	CD4017	0·98	CD4026	1·95	CD4041	0·82	CD4054	1·20	CD4510	1·30
CD4008	0·98	CD4018	1·00	CD4027	0·60	CD4042	0·82	CD4055	1·85	CD4511	1·60
CD4009	0·58	CD4019	0·55	CD4028	0·98	CD4043	0·98	CD4056	1·35	CD4516	1·40
CD4010	0·58	CD4020	1·10	CD4029	1·15	CD4044	0·94	CD4069	0·40	CD4518	1·25
CD4011	0·20	CD4021	0·98	CD4030	0·55	CD4045	1·40	CD4070	0·40	CD4520	1·25

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CA3014*	£1·70	LM320-24v	£1·85	MC1466L	£4·50	72710*	£0·36	SN76023N*	£1·40	TAD100*	£1·30
CA2018*	£0·75	LM380-14P	£0·98	MC1469R	£2·95	uA711C*	£0·32	SN76110*	£1·50	TBA540Q*	£2·20
CA3020*	£1·70	LM381*	£1·55	MC1496G*	£0·98	72711*	£0·32	SN76115*	£1·90	TBA641B*	£2·25
CA3028*	£1·02	LM3900N*	£0·65	NE536*	£3·50	uA723C	£0·50	SN76660*	£0·75	TBA800*	£0·80
CA3035*	£1·70	MC724P	£1·50	NE515A*	£3·50	72723	£0·50	SL414A*	£1·95	TBA810S*	£1·05
CA3036*	£1·35	MC1303L*	£1·48	NE540*	£1·50	uA741C*	£0·24	TAA550B	£0·35	TBA820*	£0·90
CA3042*	£1·50	MC1304P*	£2·95	NE550*	£0·95	72741*	£0·24	TAA621A*	£2 00	TBA920Q*	£3·40
CA3043*	£1·85	MC1310P*	£1·80	NE550D*	NLA	741P*	£0·24			TCA270S*	£3 90
CA3046*	£0·80	MC1312PQ*	£1·90	NE555	£0·40	uA747C*	£0·70				
CA3052*	£1·60	MC1330P*	£1·20	NE556	£0·82	72747*	£0·79				
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LM308*	£1·40			uA709C*	£0·28						
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600	THY3A/600	£0.60
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200	THY5A/200	£0.50
400	THY5A/400	£0.57
600	THY5A600	£0.59
800	THY5A/800	£0.81

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Volts	No.	Price
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600	THY5A/600P	£0.69
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200	THY7A/200	£0.57
400	THY7A/400	£0.62
600	THY7A/600	£0.78
800	THY7A/800	£0.92

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Volts	No.	Price
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100	THY10A/100	£0.57
200	THY10A/200	£0.62
400	THY10A/400	£0.71
600	THY10A/600	£0.96
800	THY10A/800	£1.22

16 AMP TO48 CASE

Volts	No.	Price
50	THY16A/50	£0.54
100	THY16A/100	£0.58
200	THY16A/200	£0.62
400	THY16A/400	£0.77
600	THY16A/600	£0.90
800	THY16A/800	£1.36

30 AMP TO94 CASE

Volts	No.	Price
50	THY30A/50	£1.18
100	THY30A/100	£1.43
200	THY30A/200	£1.63
400	THY30A/400	£1.78
600	THY30A/600	£3.60

No.	Price
BT101/500R	£0.80
BT102/500R	£0.80
BT106	£1.26
BT107	£0.93
BT108	£0.98
2N3228	£0.70
2N3525	£0.77
BTX30/50L	£0.33
BTX30/400L	£0.46
C106/4	£0.60

SUPER UNTESTED PAKS

Pak No.	Qty.		Order No.	Price
U50	100	Germ. gold bonded OA47 diode	16130	£0.60
U51	150	Germ. OA70/81 diode	16131	£0.60
U52	100	Silicon diodes 200mA OA200	16132	£0.60
U53	150	Diodes 75mA 1N4148	16133	£0.60
U54	50	Sil rect top hat 750mA	16134	£0.60
U55	20	Sil rect stud type 3 amp	16135	£0.60
U56	50	400mW zeners DO7 case	16136	£0.60
U57	30	NPN trans BC107/8 plastic	16137	*£0.60
U58	30	PNP trans BC177/178 plastic	16138	*£0.60
U59	25	NPN TO39 2N697/2N1711 silicon	16139	£0.60
U60	25	PNP TO59 2N2905 silicon	16140	£0.60
U61	30	NPN TO18 2N706 silicon	16141	£0.60
U62	25	NPN BFY50/51	16142	£0.60
U63	30	NPN plastic 2N3906 silicon	16143	*£0.60
U64	30	PNP plastic 2N3905 silicon	16144	*£0.60
U65	30	Germ. 0071 PNP.	16145	£0.60
U66	15	Plastic power 2N3055 NPN	16146	£1.20
U67	10	TO3 metal 2N3055 NPN	16147	£1.20
U68	20	Unijunction trans IIS43	16148	£0.60
U69	10	1 amp SCR TO39	16149	£1.20
U70	8	3 amp SCR TO66 case	16150	£1.20

■ Code Nos. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

COMPONENT PAKS

Pak No.	Qty.		Order No.	Price
C1	200	Resistor mixed value approx (count by weight)	16164	*£0.60
C2	150	Capacitors mixed value approx. (count by weight)	16165	*£0.60
C3	50	Precision resistors. Mixed values	16166	£0.60
C4	80	⅛W resistors mixed preferred values	16167	*£0.60
C5	5	Pieces assorted ferrite rods	16168	*£0.60
C6	2	Tuning gangs. MW/LW VHF	16169	*£0.60
C7	1	Pack wire 50 m tere assorted colours single strand	16170	£0.60
C8	10	Reed switches	16171	*£0.60
C9	3	Micro switches	16172	*£0.60
C10	15	Assorted pots	16173	*£0.60
C11	5	Metal jack sockets 3 x 3.5mm 2 x standard switch types	16174	*£0.60
C12	30	Paper condensers preferred types mixed values	16175	*£0.60
C13	20	Electolytics trans. types	16176	£0.60
14	1	Pak assorted hardware — nuts/bolts, gromets, etc.	16177	£0.60
C15	5	Mains slide switches assorted	16178	*£0.60
C16	20	Assorted tag strips and panels	16179	£0.60
C17	15	Assorted control knobs	16180	*£0.60
C18	4	Rotary wave change switches	16181	*£0.60
19	2	Relays 6-24V operating	16182	*£0.60
C20	1	Pak. copper laminate approx 200 sq. in.	16183	£0.60
C21	15	Assorted fuses 100mA-5 amp	16184	£0.60
C22	50	Metres PVC sleeving assorted size AND COLOUR	16185	£0.60
c23	60	½ watt resistors mixed preferred values	16188	*£0.60
C24	25	Presets assorted type and value	16186	*£0.60
C25	30	Metres stranded wire assorted colours	16187	£0.60

SLIDER PAKS

Pak No.	Qty.		Order No.	Price
S1	6	Slider potentiometers, mixed values	16190	*£0.60
S2	6	Slider potentiometers, all 470 ohms	16191	*£0.60
S3	6	Slider potentiometers, all 10k lin	16192	*£0.60
S4	6	Slider potentiometers, all 22k lin	16193	*£0.60
S5	6	Slider potentiometers, all 47k lin	16194	*£0.60
S6	6	Slider potentiometers, all 47k log	16195	*£0.60

CERAMIC PAKS

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Pak No.	Qty.		Order No.	Price
MC1	24	miniature ceramic capacitors, 3 of each value – 22pF, 27pF, 33pF, 39pF, 47pF, 68pF, and 82pF	16160	*£0.60
MC2	24	miniature ceramic capacitors, 3 of each value – 100pF, 120pF, 150pF, 180pF, 220pF, 270pF, 330pF and 390F	16161	*£0.60
MC3	24	miniature ceramic capacitors, 3 3 of each value — 470pF, 560pF, 680pF, 820pF, 1,000pF, 1,500pF, 2,200pF and 3,300pF	16162	*£0·60
MCA	21	miniature ceramic capacitors, 3 of each value — 4,700pF, 6,800pF 0.01µF 0·015µF, 0·022µF 0·033µF, 0·047µF	16163	*£0.60

LINEAR PAKS

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U721–30 Assorted Linear Types, 709, 741, 747, 748, 710, 588, etc.
ORDER No. 16227 *£1.60

U765D PM STEREO DECODER
5 ICs 76110 equivalent to MC1310P-MA767. Data supplied with pak.
ORDER No. 16229 *£1.60

U76A AUDIO POWER OUTPUT AMPLIFIERS
8 assorted types, SL403 76013, 76003, etc. Data supplied with pak.
ORDER No. 16228 *£1.00

74 SERIES PAKS

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74F–50 Flip-Flops assorted 7470-72-73-74-76-104-109, etc.
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74M–30 MSI. Assorted Types. 7441-47-90-154, etc.
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ORDER No. 16202 *60p

EC3–Values from 100uF to 680uF.
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75 Mullard C280 capacitors, mixed values ranging from 0.01uF to 2.2uF complete with identification sheet.
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These paks contain a range of Carbon Resistors, assorted into the following groups!

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ORDER No. 16214 *60p

R3–60 mixed ⅛W 10-82k
ORDER No. 16215 *60p

R4–60 mixed ⅛W 100-820k
ORDER No. 16216 *60p

R5–40 mixed ½W 100-820
ORDER No. 16217 *60p

R6–40 mixed ½W 1-8.2k
ORDER No. 16218 *60p

R7–40 mixed ½W 10-82k
ORDER No. 16219 *60p

R8–40 mixed ½W 100-820k
ORDER No. 16220 *60p

R9–60 mixed ⅛W 1-10M
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R10–40 mixed ½W 1-10M
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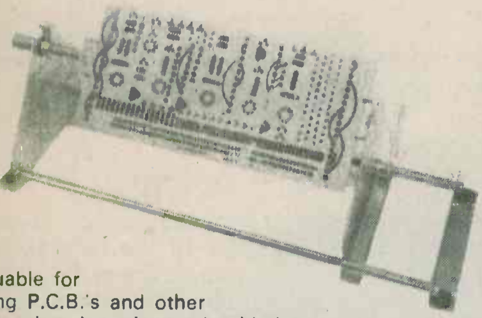

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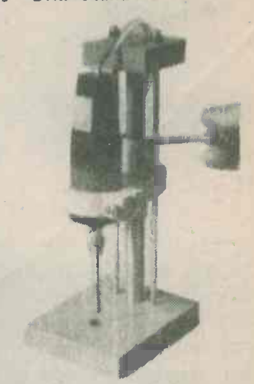

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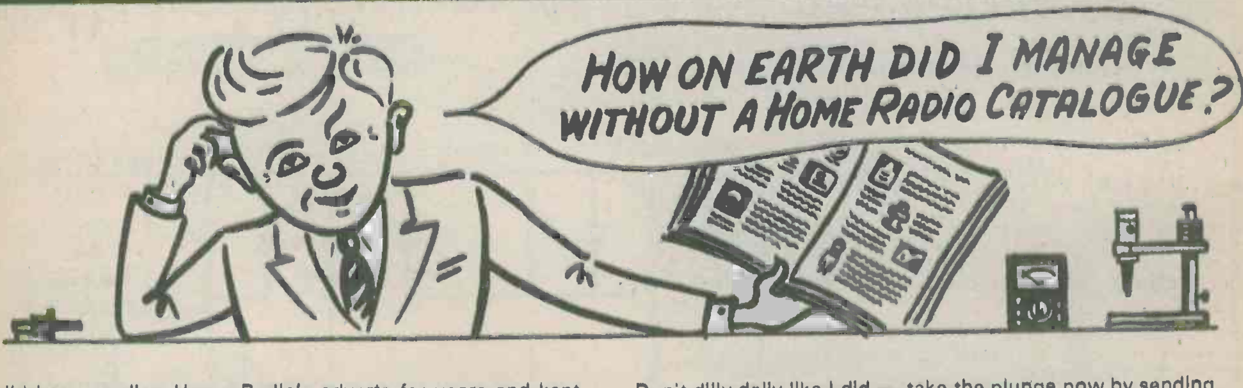

I'd been reading Home Radio's adverts for years and kept telling myself I must send off for a copy of their famous catalogue. But being an expert procrastinator I kept putting it off. I muddled along, picking up bits here and there, often calling at several shops before locating a particular component I needed.

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3-band T.R.F. Sh

by P. R. Arthur

This simple receiver is primarily intended to provide a good constructional project for the newcomer to short wave reception. The circuit is a t.r.f. type incorporating a regenerative detector. Using a t.r.f. design avoids the complication of alignment which arises if the more sophisticated superhet type of receiver is constructed. However, the price that has to be paid for this is a lower level of performance, although the set will provide good results if it is used skilfully.

T.R.F. designs tend to have a reputation for being rather inconsistent, but in the author's experience this is not the case provided ready-made coils are employed. The coils used in the present receiver are Denco Miniature Dual Purpose types and they provide coverage of the entire short wave spectrum in three ranges. The approximate coverage of each range is: range 3, 1.5 to 5MHz; range 4, 5 to 17MHz; range 5, 10 to 36MHz. The range numbers 3, 4 and 5 are those employed by the coil manufacturer. The coils are of a type initially intended for use with valves rather than transistors; however, the present circuit incorporates a field-effect transistor in the first stage, and this presents an impedance of the same order as that offered by a valve. The coils are plug-in components and the desired range is selected by simply plugging in the appropriate coil. This makes construction very much easier than it would be if range switching were used.

The field-effect transistor is the detector and there are two bipolar transistors which give a.f. amplification. Power is obtained from an internal PP3 battery, and running costs are low since the current consumption (including that of the preamplifier which is described later) is only about 3mA. The set has been designed for use with high impedance magnetic headphones, although in practice acceptable results will be given with medium or even low impedance headphones.

CIRCUIT DETAILS

The circuit diagram of the receiver is given in Fig. 1. The term t.r.f. (Tuned Radio Frequency) in-

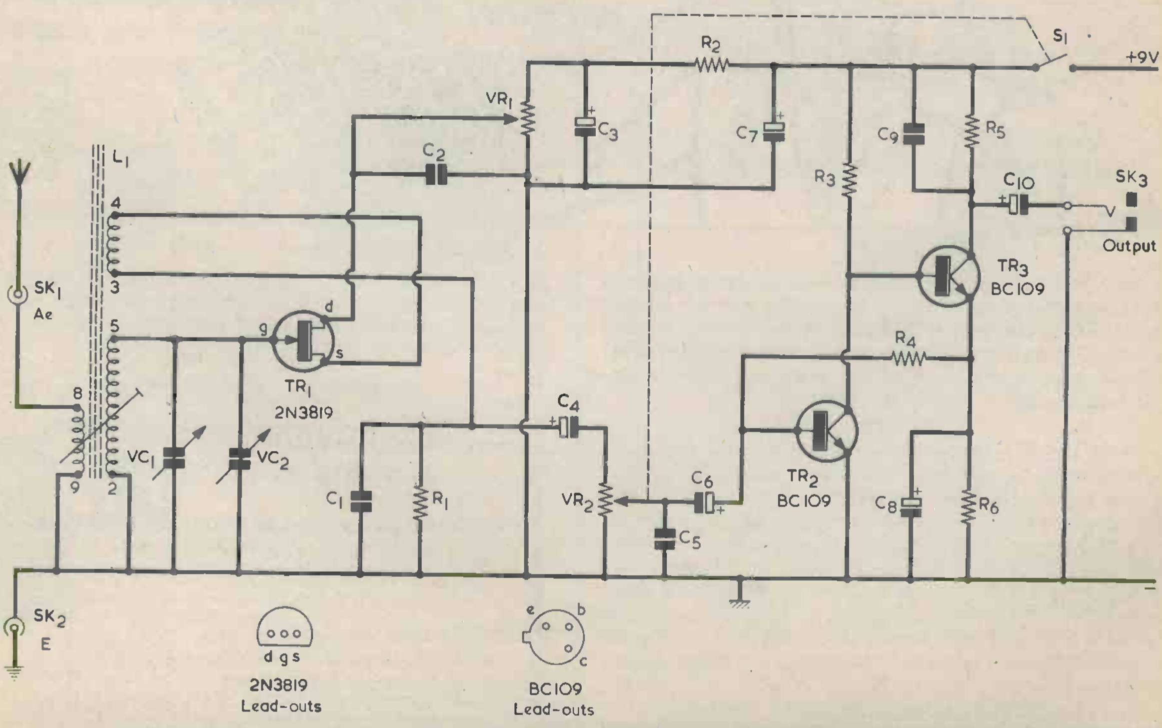


Fig. 1. The circuit of the 3-band shortwave radio. The bands are selected by plugging the appropriate coil in the L1 position

ort Wave Receiver

SIMPLE TO CONSTRUCT **COVERS 1.5 to 36MHz**

The 3 band short wave receiver is housed in a ready-made Verobox. The controls are well spaced out for ease of operation

COMPONENTS

Resistors
(All fixed values ¼ watt 5%. R7 and R8 are in the optional pre-amplifier.)

- R1 1kΩ
- R2 390Ω
- R3 5.6kΩ
- R4 2.2MΩ
- R5 4.7kΩ
- R6 5.6kΩ
- R7 180Ω
- R8 2.2kΩ
- VR1 10kΩ potentiometer, linear
- VR2 5kΩ potentiometer, log, with switch S1

Capacitors
(C11 is in the optional pre-amplifier.)

- C1 0.015μF polyester
- C2 0.015μF polyester
- C3 100μF electrolytic, 10 V. Wkg.
- C4 0.47μF electrolytic, 10 V. Wkg.
- C5 0.015μF polyester
- C6 0.47μF electrolytic, 10 V. Wkg.
- C7 100μF electrolytic, 10 V. Wkg.
- C8 10μF electrolytic, 10 V. Wkg.
- C9 0.0068μF ceramic plate or polyester
- C10 1μF electrolytic, 10 V. Wkg.
- C11 0.01μF polyester
- VC1 365pF variable, type "01" (Jackson)
- VC2 25pF variable, type C804 (Jackson)

Inductors
L1 Miniature Dual Purpose coils, Green, Ranges 3, 4 and 5 (Denco)

Transistors
(TR4 is in the optional pre-amplifier)

- TR1 2N3819
- TR2 BC109
- TR3 BC109
- TR4 2N 3820

Switch

- S1 s.p.s.t. toggle (part of VR2)

Sockets

- SK1 insulated socket
- SK2 insulated socket
- SK3 3.5mm. jack socket

Miscellaneous

- Verobox type 75-1412K
- 9 volt battery type PP3
- Battery connector
- High Impedance (2kΩ or 4kΩ) magnetic headphones fitted with 3.5mm jack plug
- 1 large control knob
- 3 small control knobs
- B9A valveholder
- Veroboard, 0.15in. matrix
- 18 s.w.g. aluminium sheet
- 4-way tagstrip (for optional pre-amplifier)
- Grommet
- Nuts, bolts, wire etc.

dicates that the received signal is detected at its transmitted frequency, with no intermediate frequency stage being used as occurs in a superhet. The aerial is coupled via socket SK1 to the coupling winding of coil L1, the tuned winding of which couples directly to the gate of the f.e.t. TR1. This last winding is tuned by the main tuning, or bandset, capacitor, VC1, and the fine tuning, or bandspread, capacitor, VC2. The manner in which these two capacitors are operated is explained later.

TR1 is connected in the common drain, or source follower, mode, the output from the source being applied to the feedback winding of L1. In consequence, part of the output is coupled back to the input, providing regeneration, or reaction as it is often called. The regeneration considerably increases not only the sensitivity but also the selectivity of the detector stage, and this is an important factor with short wave listening. The short wave bands are very crowded these days, and good selectivity is just as necessary as good sensitivity.

If the level of regeneration is too high the detector stage breaks into oscillation and proper detection of a.m. signals becomes impossible. For optimum results with a.m. signals the regeneration should be just below the level at which oscillation commences. In this circuit the amount of r.f. signal fed back is fixed, and regeneration is controlled by VR1, which varies the drain voltage and hence the gain of TR1. This rather indirect control of regeneration works very well in practice.

The audio output of the detector is developed across R1, with C1 providing an r.f. path to chassis for the feedback winding of L1 and also functioning as an r.f. filter component for the audio signal. C2 provides an r.f. bypass for the drain of TR1.

C4 couples the detector audio output to the volume control, VR2, from the slider of which the signal is applied to the 2-stage common emitter a.f. amplifier incorporating TR2 and TR3. These two stages provide an extremely high level of amplification, and in fact they account for most of the receiver's gain. It is important to ensure that no significant r.f. signal is allowed to leak through into the a.f. stages, as this could result in instability. Additional r.f. filtering is therefore provided by C5 and C9. These also slightly roll off the higher audio frequencies with a consequent small improvement in the signal-to-noise ratio.

The output signal is taken from the collector of TR3 and is coupled to the output socket, SK3, by way of d.c. blocking capacitor C10. C3, R2 and C7 provide supply decoupling. S1 is the on-off switch and is ganged with the volume control VR2.

All the components are standard parts but it should be noted that the electrolytic capacitors are specified as 10 volts working. It will be found difficult to obtain the lower value capacitors C4, C6 and C10 with this working voltage, and it will be perfectly in order to use capacitors having a higher working voltage, extending to some 100 volts working or so. The other electrolytic capacitors could have working voltages of 12 or 16 volts. The two BC109 transistors are frequently sold as gain-selected items, with the suffix letter A, B or C. Either the BC109B or BC109C will be satisfactory here.

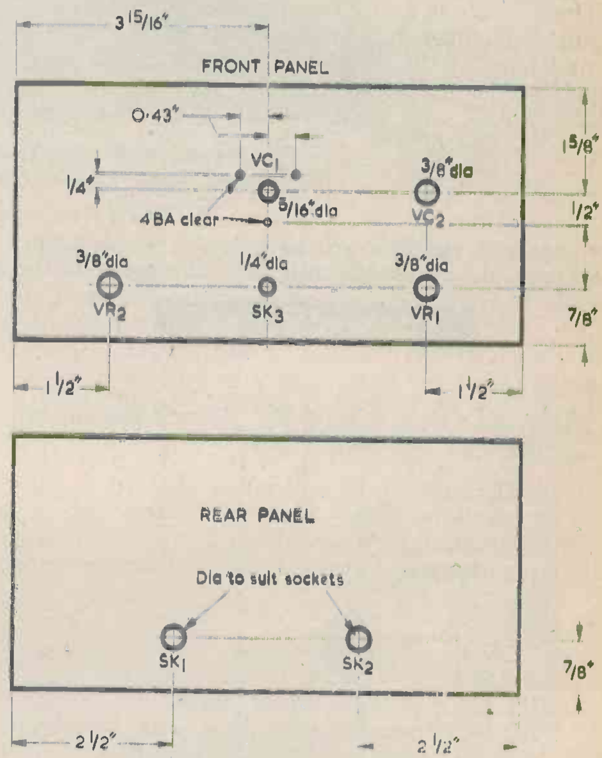
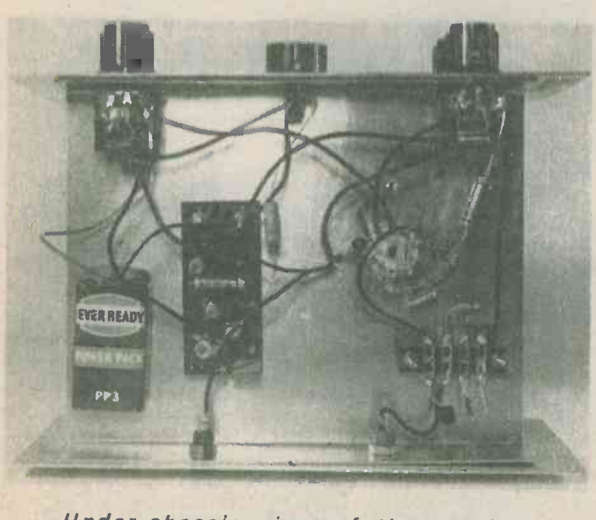


Fig. 2. Drilling details for the front and rear panels. The somewhat unusual 0.43in. dimensions define the positions of two of the bolts which secure VC1

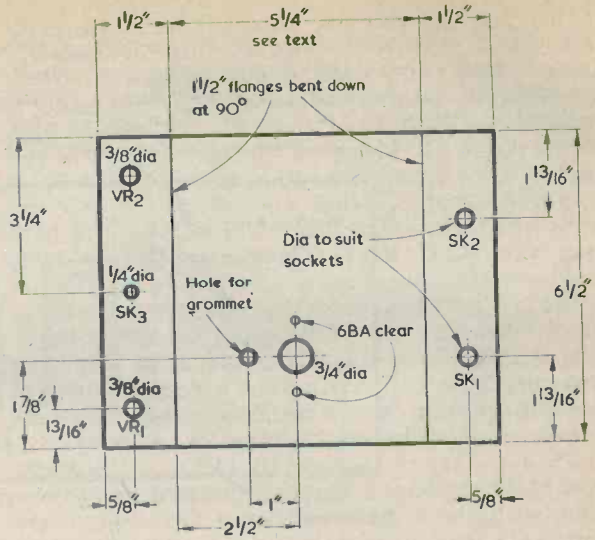


Under-chassis view of the receiver. The two a.f. stages are assembled on a Veroboard panel whilst the detector stage uses point-to-point wiring. The optional untuned pre-amplifier is wired up on a 4-way tagstrip

CASE AND CHASSIS

A ready-made case is used, this being a Verobox type 75-1412K which has outside dimensions of 205 by 140 by 110mm. This consists of a 2-part plastic outer casing with anodised aluminium panels front and rear. Drilling details for the two panels are given in Fig. 2. The three 4BA clear mounting holes for VC1 allow 4BA bolts to pass into tapped holes on the front plate of the capacitor.

Fig. 3. The dimensions of the chassis. The holes should be marked out as described in the text



These holes must be positioned very accurately.

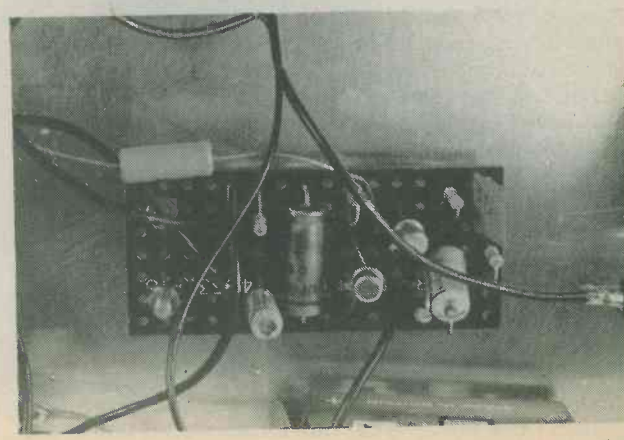
The chassis is home constructed from 18 s.w.g. aluminium sheet and is illustrated in Fig. 3. The front flange of the chassis is secured to the front panel by the mounting bushes and nuts of VR1, VR2 and SK3, and the rear flange to the rear panel by the bushes of SK1 and SK2.

To ensure good registration it is a good plan to use the panels as templates for marking out the corresponding holes in the chassis. The depth of the chassis from front to rear, should be such that the assembly of chassis and two panels allows the panels to fit correctly into the plastic case. This depth is shown as $5\frac{1}{4}$ in. in Fig. 3 but best results will be given by working to the actual physical dimensions of the case. The holes for the two controls and the three sockets are marked off and cut out after the chassis flanges have been bent down.

The $\frac{3}{4}$ in. hole on the chassis is for a B9A valveholder into which coil L1 is plugged. It may be cut out with a chassis punch or by drilling a number of small holes inside its periphery, taking out the centre piece and cleaning up with a small half-round or round file. The valveholder may then be used as a template for marking out its two 6BA clear mounting holes. A hole is drilled between the $\frac{3}{4}$ in. hole and the front flange of the chassis. This hole takes a small grommet, through which will pass a lead through the deck of the chassis.

The chassis and panels may next be secured together, after which the valveholder is mounted with the orientation shown in Fig. 5. A solder tag is secured, below the chassis, under each of the mounting nuts. VC1 and VC2 are next fitted in position. It is important to ensure that the ends of the three 4BA bolts which secure VC1 in place do not pass more than fractionally beyond the front plate of the capacitor frame as they may then damage the fixed or moving vanes of this component. Short bolts are therefore required. Spacing washers may be passed over each bolt between the front panel and the capacitor. It should be noted that there is no necessity to make any wired connection to the moving vanes of VC1 and VC2; these are automatically connected into circuit via their front panel mountings.

A close-up view of the Veroboard panel



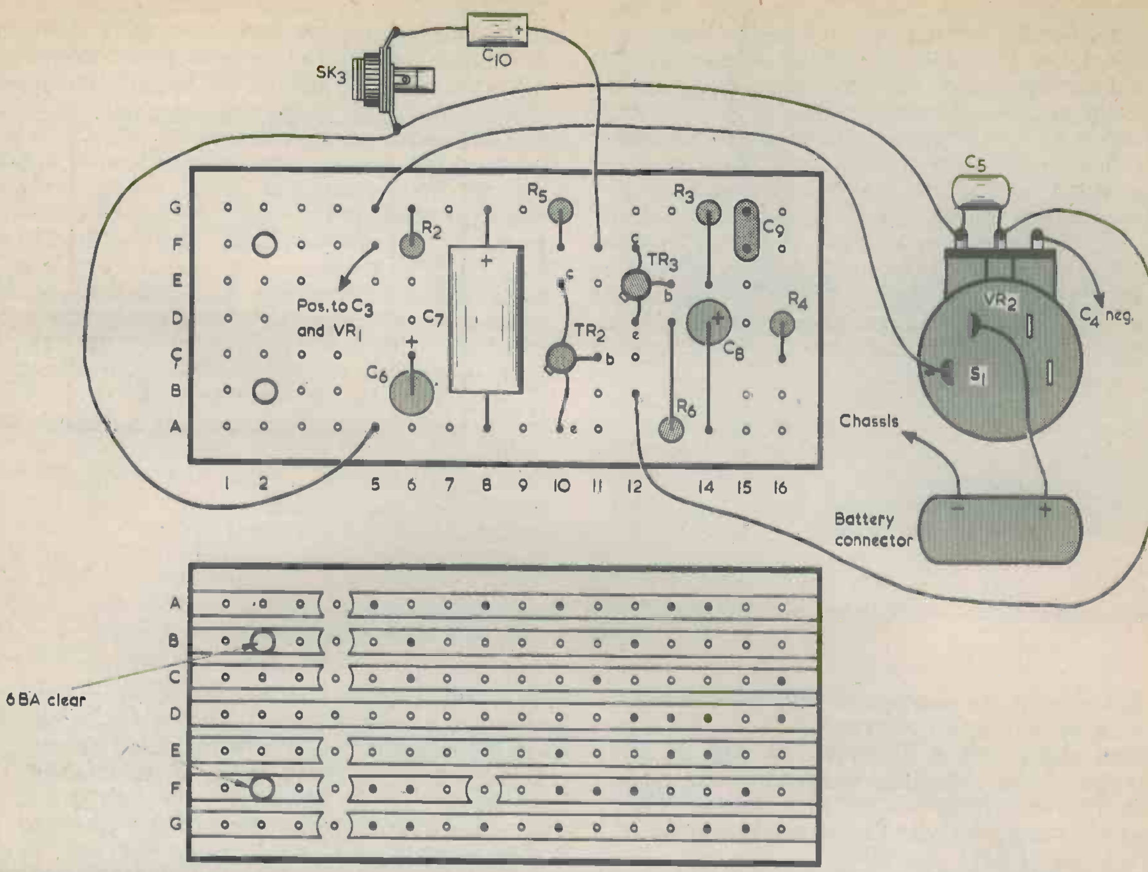


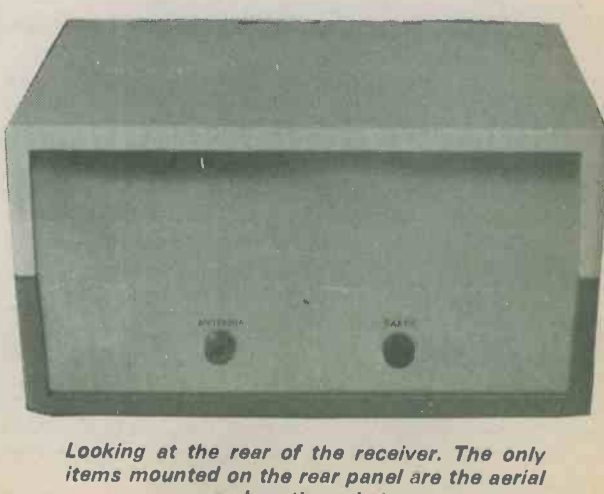
Fig. 4. The a.f. stages are assembled on a Veroboard panel, as shown here. C10 is positioned between the panel and the output jack socket

COMPONENT PANEL

The audio stages are wired up on a Veroboard panel of 0.15 in. matrix having 16 holes by 7 copper strips. Details are given in Fig. 4.

Start by cutting out a panel of the required size, and then drill the two 6BA clear mounting holes. Next make the 7 breaks in the copper strips, after which the various components are soldered in position. The panel is mounted on the underside of the chassis, with the mounting holes nearer the front, midway between SK2 and the space between VR2 and SK3. Its precise positioning is not critical. The panel can be used as a template for marking out the 6BA clear mounting holes in the chassis. Spacers about $\frac{3}{8}$ in. long are fitted to the bolts between the chassis and the panel, causing the connectors on the underside of the panel to be held well clear of the metal chassis. All the wiring in Fig. 4. should be completed before the component panel is finally mounted.

The panel picks up its negative supply connection via the mounting bush of SK3. In consequence, the lead from hole A5 should connect to the socket tag which is common with its mounting bush. If the jack socket has an insulated construction, the wire from hole A5 connects to the tag corresponding to the jack plug sleeve; a further wire from this tag then runs to the nearer chassis solder tag at the B9A valveholder.



Looking at the rear of the receiver. The only items mounted on the rear panel are the aerial and earth sockets

DETECTOR WIRING

Point-to-point wiring, as shown in Fig. 5, is employed for the detector stage. Some of the valveholder tags, to which there are no coil connections, are used as dummy anchor tags. The lead from the gate of TR1 passes through the grommet to the fixed vanes tag of VC1 above the chassis. A further wire, also above the chassis, connects the fixed vanes tag of VC1 to the fixed vanes tag of VC2. All the wiring associated with the detector stage should be kept reasonably short and direct.

There is plenty of room for the battery to the rear of VR2. A simple aluminium bracket can be devised to hold it in place.

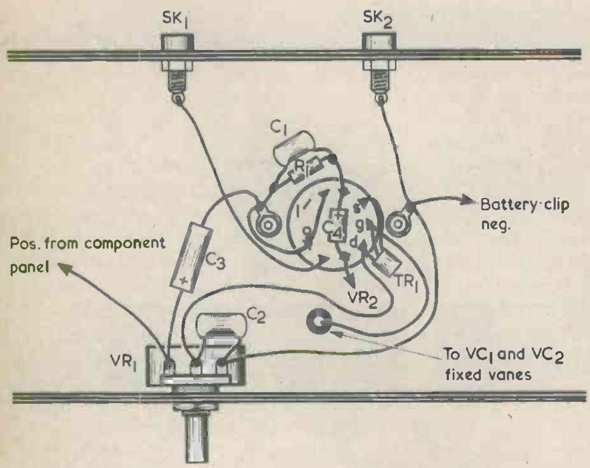


Fig. 5. Components and wiring in the detector stage

USING THE SET

In order to obtain good results it is important that VR1 be adjusted correctly. This is not a volume control, and it is not used in the same way as a volume control. It is not even used in the same manner as an r.f. gain control. With VR1 adjusted fully anticlockwise it will probably not be possible to receive any stations, and if any are picked up they will only be weak and it will be impossible to pick out just one signal using the bandset control. As VR1 is advanced there should be a steady increase in both selectivity and sensitivity until the point where the detector breaks into oscillation is reached. It is obvious when the detector is oscillating since a whistle of varying pitch is produced in the headphones as the set is tuned across an a.m. station, and proper reception becomes impossible.

For optimum results with a.m. signals the detector should always be adjusted to a point just below the threshold of oscillation. VR1 will need slight readjustment each time the tuning is altered significantly. VR2 is an ordinary combined volume and on-off control. Although VR1 can control the volume to a large extent, it should not be used as the volume control. In order to obtain best results VR1 should be adjusted in the manner just described, after which VR2 is used to set the required volume level from the phones.

Tuning is rather difficult with the bandset control as this covers a wide range of frequencies, particularly on ranges 4 and 5. It is much easier if the bandset control is adjusted to the centre of the band of interest, with fine tuning being carried out by means of the bandspread control. The bandspread capacitor has a much lower value than the bandset capacitor and it covers only a small part of each tuning range; in consequence tuning is much more spread out than is given with the bandset control.

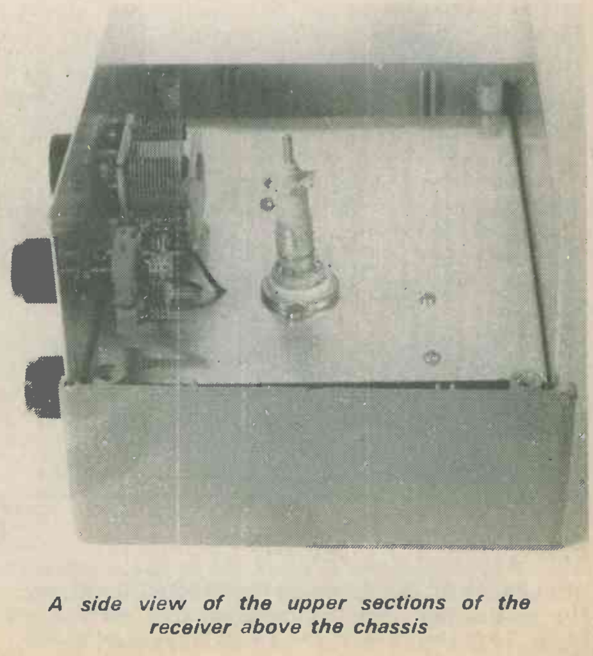
The coils are supplied with the threaded brass stems of the dust cores fully screwed in. Each core should be unscrewed so that about $\frac{1}{4}$in. of the brass stem protrudes above the former.

AERIAL AND EARTH

It is possible to receive a number of stations with a short indoor aerial, but for long distance (Dx) reception it is really necessary to employ a proper outdoor antenna. This is the case even when using a sophisticated communications receiver.

A length of 16 s.w.g. enamelled copper wire or multi-strand aerial wire set as high as possible, and preferably well clear of buildings and other large obstructions, should provide good results. The precise length is not important, and something in the region of 10 to 40 metres will be satisfactory. As one would expect, an aerial 40 metres long will provide a signal better than one 10 metres long. This is particularly so for reception on the low frequency bands covered by the range 3 coil.

It is also on the l.f. bands that the addition of an earth connection provides the most noticeable increase in signal strength. An earth can consist of a length of metal pipe to which a wire is connected. The pipe is pushed into moist earth at some convenient spot.



A side view of the upper sections of the receiver above the chassis

Another look at the completed receiver. The Verobox outer casing has a 2-tone finish

PRE-AMPLIFIER

The receiver, as so far described is satisfactory for reception of a.m. signals. It is also possible to receive c.w. (morse) and s.s.b. (single sideband) signals by taking the regeneration beyond the threshold of oscillation. With s.s.b. signals, sensitivity is higher when VR1 is adjusted well beyond the oscillation threshold.

Unfortunately, when the detector is oscillating the oscillatory signal is coupled to the aerial via L1, with resultant radiation which can interfere with other receivers. If it is intended to use the receiver for the reception of c.w. and s.s.b. it is necessary to fit a pre-amplifier between the aerial and L1 to prevent the radiation. The pre-amplifier can be untuned and it needs only a simple circuit.

A suitable circuit is given in Fig. 6. In this a p-channel f.e.t. is connected in the common source mode. R8 is the source bias resistor and C11 its bypass capacitor. R7 is the gate bias resistor and the drain load is the winding of L1 to which the aerial previously connected. The gain of the pre-amplifier is negligible but it is not its purpose to increase sensitivity, it is intended instead to provide isolation between the detector and the aerial.

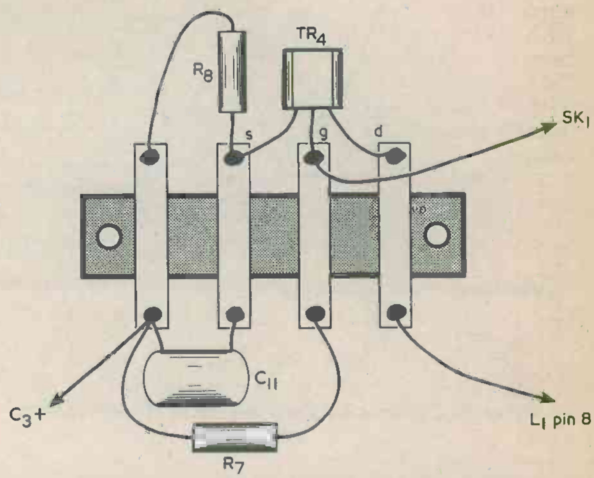


Fig. 7: The few components required for the pre-amplifier are assembled on a 4-way tagstrip

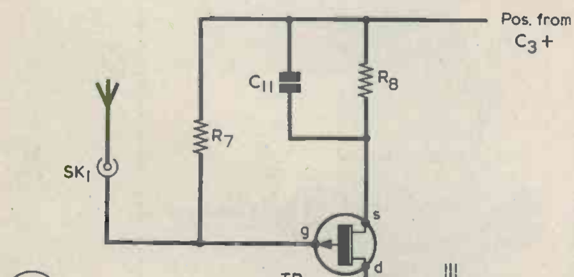
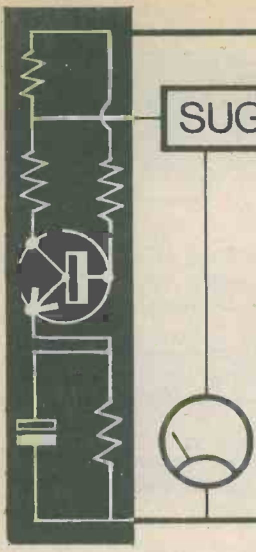


Fig. 6. The circuit of the untuned signal pre-amplifier. This is fitted when it is intended to use the receiver for c.w. and s.s.b. reception

Wiring details for the pre-amplifier are given in Fig. 7. The tagstrip is a piece cut from a 28-way tagstrip type B, available from Doram Electronics, but of course any other similar small 4-way tagstrip would be equally suitable.

The completed tagstrip assembly is mounted below the chassis between SK1 and the B9A valveholder in the position shown in the photograph of the chassis underside. It is mounted by means of two 6BA bolts and nuts, spacers being passed over the bolts to keep it clear of the chassis surface. It is then wired to SK1, C3 and the valveholder as indicated in the diagram.

The original wiring of the receiver remains unaltered except for the lead between SK1 and pin 8 of the valveholder. This lead is omitted when the pre-amplifier is included in the set. ■



SUGGESTED CIRCUIT

ZENER VOLTAGE CHECKER

By G. A. French

Although a fairly high proportion of present day zener diodes employed for home constructor applications are of the BZY88, BZX85 and BZX61 types, there has been an exceptionally wide range of diodes manufactured in the past with very many different type numbers. Because of this a large quantity of zener diodes are available in constructors' spares boxes and in retailers' stocks which are difficult to classify reliably in terms of zener voltage or, in many cases, in terms of lead-out polarity.

The very simple zener voltage checker which forms this month's "Suggested Circuit" is capable of quickly finding both the zener voltage and the polarity of any zener diode having a zener voltage of 25 volts or less. With a simple modification the range of zener voltages which can be checked may be extended to 34 volts. Zener voltage is checked at a current of 5mA, which is that recommended by Mullard for acceptance tests on diodes in the BZY88 series. The checker may also be employed to find the polarity of rectifier diodes. It is used in conjunction with any multi-testmeter having a sensitivity of 10kΩ per volt or better on its voltage ranges.

CHECKER CIRCUIT

The circuit of the zener diode checker appears in Fig. 1. In this, transistor TR1 functions as a constant current generator offering a current of 5mA in its collector circuit. Its base is held at a regulated voltage with respect to the lower negative rail by the light-emitting diode LED1, across which appears a voltage of the order of 1.5 volts. The current flowing through the l.e.d. via R2 is approximately 3mA. Pre-set potentiometer VR1 is set up such that when a zener diode is connected to the zener test terminals, a current of 5mA flows in the emitter and, hence, the collector circuit. (Emitter current is equal to collector current plus the relatively small base current needed to maintain the collector current). Since the voltage across LED1 is constant and the resistance inserted into circuit by R1 and VR1 (after setting up) is similarly constant, the emitter and collector currents must also be constant. This holds true for all collector loads, including short-circuits, connected across the zener test terminals, provided the loads are able to cause the 5mA collector current to flow.

The l.e.d. serves two functions. Its first task is to furnish the regulated voltage for TR1 base which has just been mentioned. When the collector of TR1 passes its constant current of 5mA the current flowing into its base via R2 is sufficiently small to be ignored in practice, and nearly all of the current in R2 passes through the l.e.d., causing it to glow. If the zener test terminals are open-circuit no collector current can flow and TR1 ceases to function as a transistor. Instead, its base-emitter junction acts as a forward biased silicon diode and all the current flowing in R2 passes via this diode into VR1 and R1. The resistance values are such that about 0.5 volt then appears across VR1 and R1, and about 1.1 volt between TR1 base and the negative rail. Under these circumstances the l.e.d. is extinguished. The l.e.d. remains extinguished if TR1 collector current rises to some 2.5mA, then com-

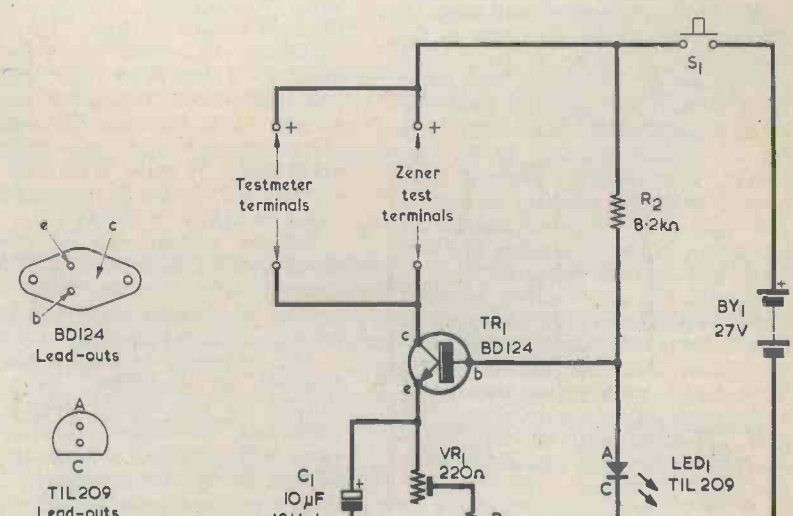


Fig. 1. The zener voltage checker has a very simple circuit and requires few components. The BD124 is a small power transistor, and it does not need to be mounted on a heat sink as it is considerably under-run

mences to glow dimly as collector current is increased above this level. Its brightness increases with increasing collector current and reaches full intensity when the collector current is at its constant current value of 5mA. Thus, the l.e.d. offers an auxiliary monitoring of collector current conditions, since it is extinguished if the collector current is lower than 2.5mA.

The intended collector load for TR1 is, of course, the zener diode being checked by the unit. This is connected to the two zener test terminals, across which are connected a second pair of terminals. A multi-testmeter switched to an appropriate voltage range is connected to this second pair of terminals and indicates the zener voltage of the device being checked.

To use the unit, the testmeter is set to a suitable voltage range, say 0-50 volts, and push-button S1 is pressed. With no zener diode connected the meter will read about 26 volts and the l.e.d. will be extinguished.

A zener diode is next connected with correct polarity to the test terminals, as in Fig. 2(a). If S1 is now pressed the zener voltage of the diode at 5mA will appear across the test terminals and this will be indicated directly by the testmeter. If necessary the testmeter can be switched to a lower volts range to resolve the zener voltage reading more readily.

When the zener voltage is lower than about 25 volts the l.e.d. will glow and the meter will show the appropriate voltage. Zener voltages above 25 volts will result in a reduced glow in the l.e.d. or in its extinction. Another method of working here is to press S1 without the zener diode being connected and then to connect the diode. If there is no reduction or only a fractional reduction in voltmeter reading, then it can be assumed that the zener voltage of the diode is too high for a reliable reading to be obtained. If a rectifier diode is connected with the polarity shown in Fig. 2(a) there will simply be no reduction in meter reading and the l.e.d. will remain extinguished.

Should the zener diode be connected with incorrect polarity, as in Fig. 2(b), it will function as a normal forward biased silicon diode. The l.e.d. will glow and the voltmeter will indicate about 0.6 volt. The same result will be given if a rectifier diode is connected with the same polarity.

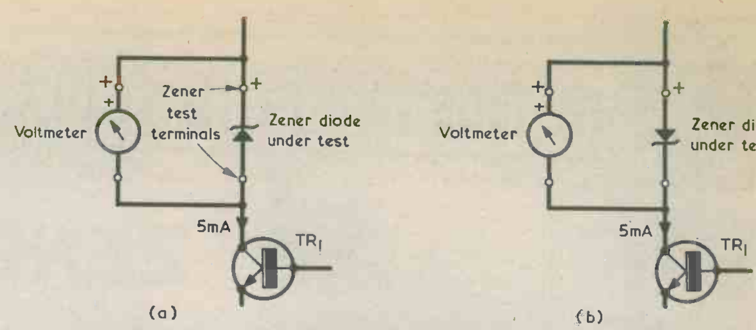


Fig. 2(a). When a zener diode is connected with correct polarity to the zener test terminals the voltmeter indicates its zener voltage. The voltmeter is an external testmeter connected to the testmeter terminals

Fig. 2(b). If a zener diode is connected with incorrect polarity it functions as a forward biased silicon diode and the voltmeter gives a reading of about 0.6 volt

CIRCUIT DETAILS

A few circuit details need to be discussed next. TR1 is a small silicon power transistor in an SO-55 housing, and is considerably underrun even at maximum dissipation when the zener test terminals are short-circuited. It does not need to be mounted on a heat sink. Maximum dissipation in TR1 is about 120mW and originally the circuit was checked out with a small signal transistor rated at 300mW in the TR1 position. This worked quite well apart from the fact that the constant current drifted noticeably upwards when the transistor was maintained at maximum dissipation for protracted periods. Such drift is completely absent with the much larger BD124 transistor.

VR1 can be a standard sized skeleton pre-set potentiometer, as opposed to a miniature 0.1 watt skeleton type. The latter could, in practice, carry the 5mA emitter current for TR1 but more reliable long term results can be expected with the larger component.

The battery voltage of 27 volts is rather high, but, as the current requirement of the circuit is 8mA and this small current is only drawn when S1 is pressed, a suitable supply could consist of three PP3 9 volt batteries connected in series. If desired, a fourth 9 volt battery could be added, taking the supply voltage up to 36 volts. This would allow the checking of zener voltages up to about 34 volts. With a 36 volt supply, R2 should be increased in value to $11k\Omega$ or $12k\Omega$.

Battery voltage can be readily monitored by the testmeter. If S1 is pressed with no zener diode connected the testmeter will read battery voltage less about 1 volt.

The testmeter terminals may in practice be insulated screw terminals or insulated sockets, as preferred. The same applies to the zener test terminals. If it is intended that fairly large batches of zener diodes are to be checked it will be found helpful to use insulated sockets spaced apart from each other by slightly more than 1in. The zener diode lead-outs can then simply be pushed into the sockets and the diode held in position whilst S1 is pressed.

A component which has not as yet been mentioned is capacitor C1. This is included merely to ensure that there is no risk of instability in the amplifying stage from TR1 emitter to its collector. These two electrodes are in phase to alternating voltages and unwanted feedback can happen if the components are housed in a plastic case, as is preferable, and long leads are used to make connection to a zener diode under test. C1 may have a working voltage higher than that indicated in Fig. 1. The connection to TR1 collector is made, incidentally, to its metal case by way of a solder tag held under one of its securing screws.

When the circuit has been assembled it is necessary to set up VR1 for a constant current of 5mA. First, VR1 is adjusted to insert maximum resistance into circuit. The testmeter is then connected to the testmeter terminals and, since it will be measuring current in a circuit which has just been assembled, is initially set to a high current range. S1 is pressed after which, if the first meter reading indicates that it is safe to do so, the testmeter is switched to a current range which allows a clear reading of 5mA. S1 is pressed again and VR1 carefully adjusted for this reading. No further setting up is required.

The unit may be assembled in a plastic case, on the front panel of which are mounted S1, the l.e.d., and the two pairs of terminals. A plastic case has the advantage, when compared with a metal case, that no problems arise if one of the lead-outs of a zener diode being checked should happen to touch the front panel.

If this article had been appearing several years ago the circuit would have included its own panel mounted meter for zener voltage readings. The present high cost of panel mounting meters now, however, makes it more attractive financially to merely fit a pair of terminals to which an external testmeter can be temporarily connected when a zener diode, or diodes, is being checked. ■

RECENT PUBLICATIONS

RADIO, TV & AUDIO TECHNICAL REFERENCE BOOK. Edited by S. W. Amos, B.Sc (Hons), C.Eng., M.I.E.E. 1,167 pages, 215 x 135mm. (8½ x 5¼in). Published by Newnes-Butterworths. Price £24.00.

One of the reviewer's favourite text books in the past for quick information retrieval has been the 1954 edition of Newnes' "Radio and Television Engineers' Reference Book." This has been subsequently brought up to date with a number of new editions, achieving its fourth edition in 1963. Since that date there have been wide-ranging developments in electronics, in its hardware and in its maintenance. To reflect these changes the publishers have now produced the new reference book which is under review, and this is intended mainly for the technician who operates and maintains electronic equipment. Included in this category are the technical assistant, the technical operator, the service engineer and the amateur radio or audio enthusiast.

The volume has 35 different Sections, each written by an expert in the subject covered. Certainly all of radio and television is here, from studio equipment and transmitters to the domestic receiver, and there is more besides. For example, the Section on basic electronic circuits deals with such matters as pulse-shaping and digital techniques. Audio is represented by Sections devoted to microphones, loudspeakers, disc and magnetic recording and reproduction, high fidelity amplifiers (including current-dumping amplifiers), sound studios and equipment, and sound transmitters. Other Sections are devoted to land-mobile radio telephone equipment, test equipment and even batteries. Mathematical presentation has been kept to the minimum and there are numerous clear photographs and line diagrams.

The book is a veritable treasury of information and it manifestly reflects great care on the part of its contributors and excellent compilation on the part of its editor.

AN INTRODUCTION TO OPERATIONAL AMPLIFIERS. By Lucas M. Faulkenberry. 269 pages, 235 x 190mm. (9¼ x 7½in). Published by John Wiley & Sons Ltd. Price £10.00.

This book, which is printed in U.S.A., is primarily intended to introduce the student of electronics to operational amplifier parameters, parameter measurement and basic operational amplifier circuitry. It may be employed for a single semester introductory course in op-am theory and application in junior colleges and technical institutes. The book is divided into ten instructional Units, each of which provides an introduction, objectives, test material and examples, a summary, self-test questions and a laboratory experiment. To take greatest advantage of the book the reader needs a basic understanding of transistor circuits, algebra and trigonometry together with, for the Unit covering integrators and differentiators, an elementary knowledge of calculus.

The author, of Texas State Technical Institute, presents his facts in an extremely clear and lucid manner and, apart from the student, the work will be of value to the enthusiast who has an amateur interest in operational amplifiers as well as to the technician who deals with these devices professionally. Each successive Unit in the book deals with a more advanced aspect of operational amplifier performance and, although these are intended to be read in order by the student, the more experienced reader can consult any section of the book to satisfy his requirements on a particular feature of operational amplifier behaviour. In general, practical examples are based on the 702, 709 and 741 op-amps.

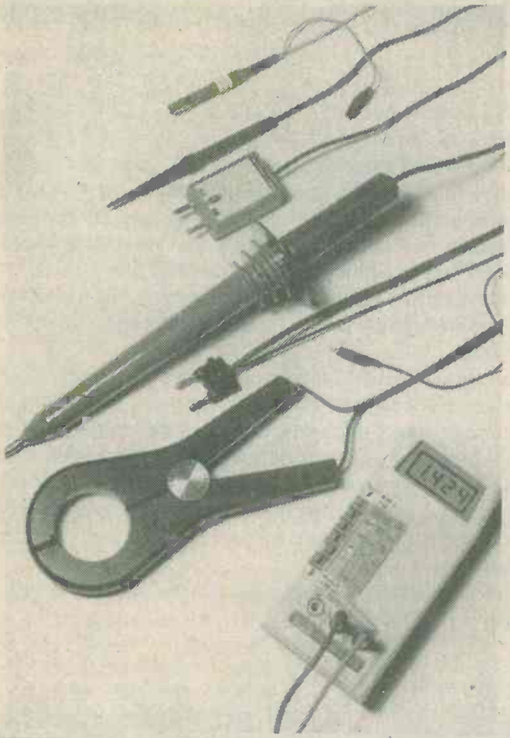
ELECTRONIC FUNDAMENTALS AND APPLICATIONS, Fifth Edition. By John D. Ryder. 555 pages, 230 x 145mm. (9 x 5¾in.) Published by Pitman Publishing Ltd. Price £4:95.

Intended for the more advanced reader, the fifth edition of this book has been almost totally rewritten to take in latest developments. Chapters on integrated circuits and the operational amplifier as a gain element have been added and the logic circuit chapters now reflect the ready availability of logic integrated circuits. Whilst the book deals with the physical fundamentals of solid-state devices, the approach is circuit-oriented with main emphasis on feedback, gain elements, modulation, frequency conversion, oscillation and logic as being relatively independent of active device characteristics.

The book commences with an examination of solid-state conduction, then proceeds to the diode, the bipolar transistor and the field-effect transistor. Further chapters deal with active networks incorporating transistors, feedback, transistor bias, linear amplifier frequency response, the operational amplifier and its applications, tuned and wide-band amplifiers and power amplifiers. The book then turns to oscillator principles, modulation and frequency conversion, digital circuits, digital switching with integrated circuits, and rectification and control. A final short chapter discusses the vacuum tube. There are three appendices dealing with Bessel functions, fundamental physical constants and definitions of symbols.

"Electronic Fundamentals and Applications" has become well established, and in its fifth edition offers valuable enlightenment on modern electronic devices and circuitry.

NEWS . . . AND .



ACCESSORIES EXTEND RANGE OF DMM APPLICATIONS

The range of accessories available with the newly announced Fluke 8020A miniature digital multimeter, extends its capabilities into the fields of temperature, r.f., high voltage and current measurement.

Two r.f. probes can be provided. Model 82RF enables the measurement of high frequency r.f. voltages from 100kHz to 500MHz, with an accuracy of 1dB up to 100MHz and 3dB from 200MHz to 500MHz. The model 81RF may be used for frequencies from 100kHz to 100MHz, and has an over-all accuracy of 1dB.

The high voltage probe, model 80K-40, is a general purpose accessory for measurements up to 40kV d.c. or 28kV r.m.s. a.c. With a guaranteed probe accuracy of 1% at 25,000V, the 80K-40 is invaluable in t.v. servicing applications in which the establishment of precise h.t. and e.h.t. values is essential.

To convert the 8020A into an accurate thermometer, the 80T-150 universal temperature probe can be used. The operational temperature range of the probe is –50°C to +150°C, and the instantaneous temperature is registered at 1mV d.c./degree.

THE B.A.E.C. 12th AMATEUR ELECTRONICS EXHIBITION

The organisers of this year's B.A.E.C. Exhibition state that it was the best one they have had since the event was first organised in 1966.

It was held from 16th to 23rd July and there were many electronic games and projects provided by members from all parts of the country. Many members travelled long distances to attend.

With the aid of the annual raffle a record £753 was handed to the Cancer Research Campaign, and again this year, we must congratulate all concerned.

Readers interested in learning more about the club should write to the Hon. Sec. J. G. Margetts, 42 Old Vicarage Green, Keynsham, Bristol.

SPECIAL R.A.E. COURSE — 1977-1978

Aspiring Radio Amateurs who live in North London, and have failed the Radio Amateur examination for a transmitting licence, are especially catered for in a special course for those who do not wish to start all over again.

The course is held at the De Beauvoir G.L.C. Evening Institute, Tottenham Road, Balls Pond Road, Islington, N1, Tuesdays and Thursdays, 7.30-9.30 p.m.

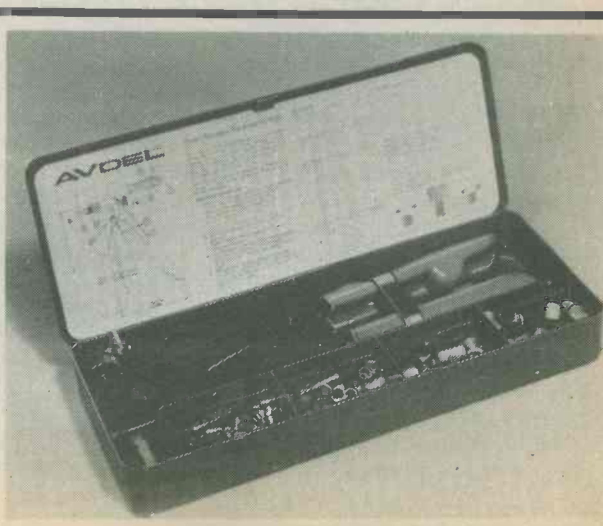
The course is also for those who have passed and want practical construction and operating experience. Senior Tutor: Fred Barns — G3AGP.

NUTSERT KIT FROM VEROSPEED

Verospeed, of Barton Park Industrial Estate, Eastleigh, Hants, now offers an invaluable production aid to those building metalwork enclosures for one-off applications, with the introduction of a Nutsert Kit.

The kit contains an easy-to-use hand tool, developed specifically to place the one-piece insert into thin sheet metal down to 0.5mm. (0.02in) thick. Accompanying this is a selection of M3, M4, M5 and M6 Nutserts, together with the appropriate nose bushes and mandrels.

When inserted, the Nutsert gives a strong, deep, vibration-proof steel thread, which can be placed after painting without damage to the surrounding surface. The operation requires access to only one side of the sheet, making it ideal for "square tubing" and "box frame" cabinets.



. . . COMMENT

MARCONI INTERNATIONAL FELLOWSHIP

Learned societies, academies, universities and individuals in industry and public life throughout the world are now being invited to propose candidates for the 1978 Marconi International Fellowship.

The Fellowship — a $25,000 grant — commemmorates Guglielmo Marconi's creative contributions to scientific discovery, engineering and technology. Established in 1974 on the centenary of the inventor's birth, the Fellowship commissions significant creative works that will add to the knowledge and understanding of how communications, science and technology can be applied to the improvement of human life.

The Fellowship is granted to an individual in recognition of outstanding contributions towards this goal with the clear understanding that the grant is made to commission work by the recipient or some other person or persons the recipient designates. If the recipient designates another to undertake the work in connection with the Fellowship, both parties will be explicitly identified and appropriately recognised when the Fellowship is presented.

It is customary to invite the Fellowship recipient to deliver a public lecture based on the commission at an appropriate occasion during the twelve months following the presentation of the Fellowship.

The first three Fellowships have been awarded in the fields of communications and electronics to Dr. James R. Killian Jr., Honorary Chairman of the Massachusetts Institute of Technology, in association with Lord Briggs, Worcester College, Oxford University; to Professor Horoshi Inoso, University of Tokyo; and to Professor Arthur L. Schawlow, Stanford University.

Nominations for the 1978 Marconi International Fellowship must be received by October 15th, 1977. All inquiries should be addressed to: The Marconi International Fellowship Council, Aspen Institute for Humanistic Studies, 1919 Fourteenth Street, No. 811 Boulder, Colorado, 80302, U.S.A.

Although we pride ourselves on being a practical and down to earth magazine we also give our readers news of scientific advances affecting the hobby.

In this issue, for example, is a report on GEOS, the first all-scientific geostationary satellite, news of a Russian amateur satellite programme and a description of the world's largest integrated circuit.

In the next issue, in our practical role, we are featuring that very popular piece of equipment — a metal locator. The Simple Metal Locator, by our well known contributor R. A. Penfold, is a low cost design offering adequate sensitivity for general purpose metal and pipe detection. There are only two active devices in the circuit, these being a field-effect transistor and a CMOS operational amplifier.

LOCAL RADIO — BBC STATEMENT

BBC Local Radio station managers recently met Mr. Ian Trethowan, Director General Designate, and Mr. Howard Newby, Managing Director Radio, to discuss the future development of BBC Local Radio.

Mr. Trethowan reaffirmed the BBC's commitment to the completion of the Corporation's network of community stations throughout the United Kingdom, but pointed out that development could take place only if the expected White Paper on the future of broadcasting gave the go-ahead, and within the context of the BBC's financial situation.

Mr. Trethowan and the managers agreed that they oppose the Annan Committee's recommendation for a new Local Broadcasting Authority. The BBC believes in the valuable public service provided by its existing 20 station, but they serve only two thirds of English listeners.

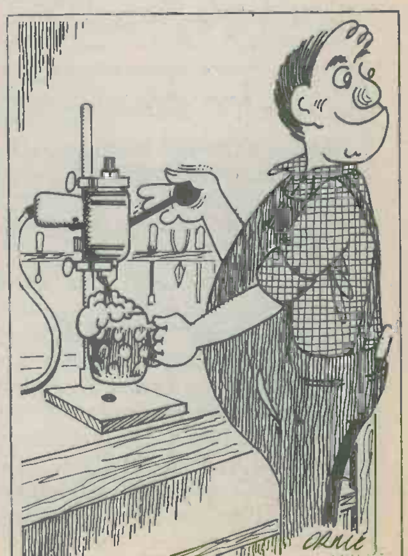
As a matter of urgency, a working party is to be set up by Mr. Michael Barton, the General Manager of Local Radio, to prepare more detailed plans for the first batch of stations.

This would enable the BBC to advise the government of its priorities as soon as their agreement to more stations is given.

From the list of proposed new stations already published, the working party will determine the priorities, and recommend where the first stations should be, and how they can be readily established.

LASCAR MODULES NOW AVAILABLE IN KIT FORM

Lascar Electronics, the Essex-based manufacturers and distributors of electronic modules, have recently announced that their range of modules is now available in kit form. The modules involved include power supplies, amplifiers, timers, comparators, count/displays, digital frequency meters, digital panel meters and many other popular modules. Accessories such as soldering irons, side-cutters etc., are also available. A range of components including I.C.s, L.E.D.s and bezels, p.c. mounting transformers and various other semiconductors are also introduced. All Lascar products feature competitive prices and same-day delivery by first class letter post. A folder containing their catalogue, new product up-date and details of their kits and components is available from Lascar for 50p. Lascar are at Module House, PO Box 12, Second Avenue, Billericay, Essex.



SPECIAL SERIES

Blob-a-job

No. 5 SECONDS FLASHER

A USEFUL TIMING DEVICE

by I. R. Sinclair

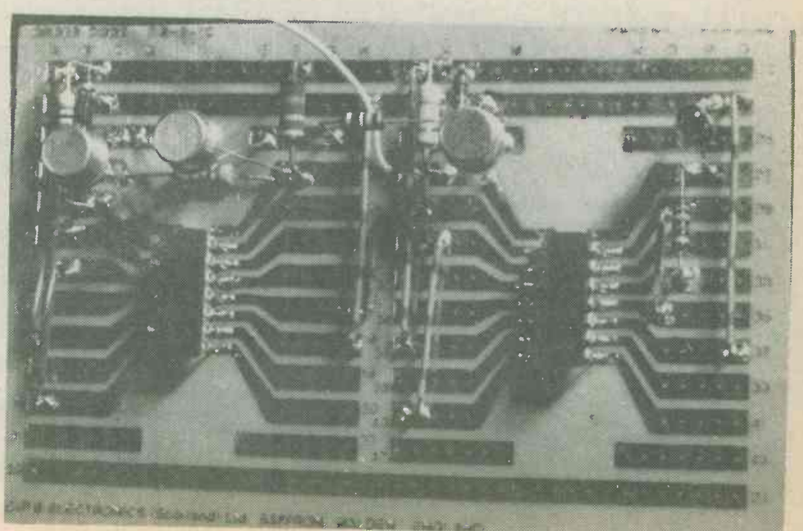
This article describes a timing device which causes an l.e.d. to flash once per second. Despite the fact that flashing frequency is controlled by the mains, there is no direct connection to the mains supply whatsoever.

This circuit can be very useful for timing, particularly in a photographic dark room, since its output is a flashing l.e.d. working at one cycle per second. Unlike the type of seconds flasher which is controlled by an oscillator, this circuit uses the mains waveform as the source of timing pulses, so that timing accuracy is excellent and is not affected by such things as changes in mains voltage or, more important, battery voltage.

MAINS SIGNAL

The principle is to pick up a signal from any mains wiring (a lamp flex, for example) without making a direct connection, and to amplify this signal in a transistor circuit. The output of the transistor circuit will be pulses at 50Hz, the mains frequency, and these pulses are counted by a frequency divider consisting of two SN7490 integrated circuits. The output of the frequency

The completed seconds flasher. The Blob Board permits a comfortable layout for the components and integrated circuits. Spare pads are available for series supply diodes should these be necessary



divider is a square wave of one second period, which can be used to operate the l.e.d. so that the light is on for ½ second and off for ½ second.

This type of circuit could be built more simply with CMOS devices, but it was decided to stick to the more rugged t.t.l. types despite the greater battery drain (although this is less serious if a 6 volt accumulator is used). Another price that has to be paid for using t.t.l. is the necessity for transistor amplification of the mains signal. Like all t.t.l. circuits, the flasher can be operated from a 5 volt supply, but a 4.5 volt battery can be used in practice and will last quite well provided that the flasher is not used for long periods continually. A 6 volt dry battery or accumulator may also be used if a silicon diode or diodes is wired in series to drop the voltage. One diode is required for a 6 volt dry battery and two for a 6 volt accumulator (which can give 6.6 volts when fully charged). The circuit must *never* be operated from a 6 volt accumulaqtor which is also being charged. The current drawn by the flasher is around 80mA. By its nature the flasher will not be used for long periods so that battery life should be reasonable.

The transistor circuit employed with the i.c.'s is designed to give a snap-over action to avoid false triggering of the counter, together with an input of sufficiently high sensitivity to pick up the 50 Hz mains hum. Three transistors are used and these could be any small-signal n.p.n. silicon transistors (not power types) of reasonably high gain. The prototype used 2N1711's.

BLOB BOARD ASSEMBLY

The circuit of the flasher is shown in Fig. 1, the circled numbers in this diagram indicating the pads or tracks on the Blob Board to which the corresponding components are connected. A type ZB-2-IC Blob Board is used for the project, this having mounting pads for two d.i.l. integrated circuits as well as separate pads for the transistors and the l.e.d.

Start construction by tinning the pins of the i.c.'s, using a hot iron and resin-cored solder. The i.c. can be held in a paper clamp in the manner shown in the photograph* if you are worried about heat shunting. However, tinning is such a quick operation that there is no danger to i.c.'s of the type used here. Set the board right way up on the bench then place IC1 on it as shown in Fig. 2, with pin 1 on pad 7. Blob on pin 1 using a blob of solder freshly melted on the iron then check that the positioning of IC1 on the pads is correct. If all is well, blob pin 8 to its pad, then check again. When satisfied that the pin positioning is correct, blob on all the other pins. This process of checking is necessary because the i.c. can be easily removed when only pins 1 and 8 are soldered to the board.

* *On page 156.*

COMPONENTS

Resistors
(All ¼ watt 5%)
R1 470kΩ
R2 6.8kΩ
R3 39kΩ
R4 10kΩ
R5 1kΩ
R6 1kΩ
R7 470Ω

Semiconductors
IC1 SN7490
IC2 SN7490
TR1 2N1711
TR2 2N1711
TR3 2N1711
D1 1N4001
LED1 TIL209

Blob Board
Blob Board type ZB-2-IC

Miscellaneous
Silicon diode or diodes (see text)
On-off toggle switch

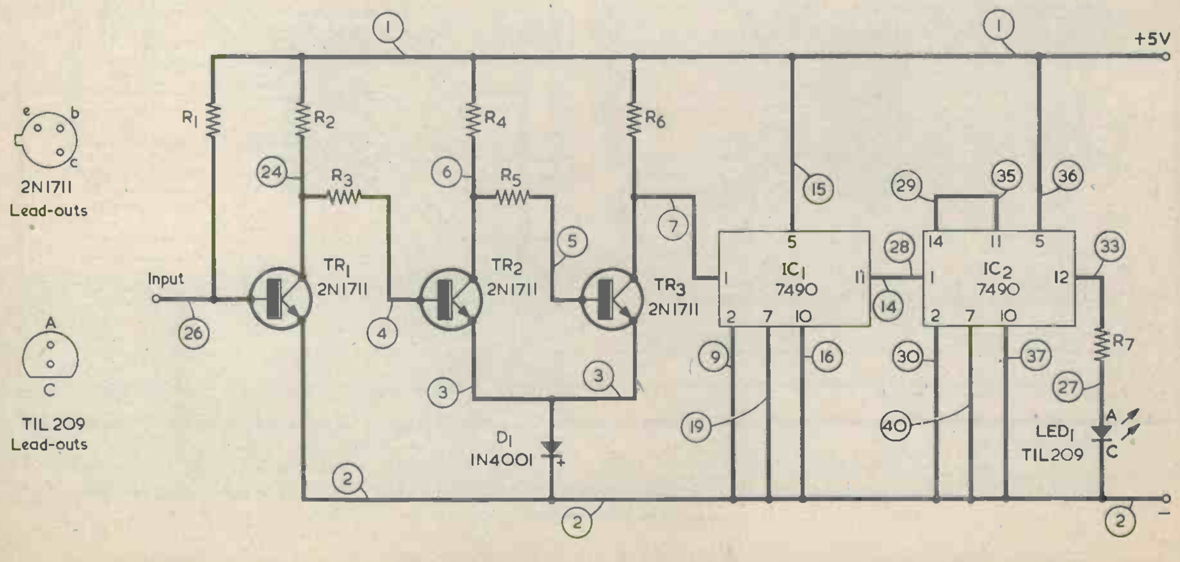


Fig. 1. The circuit of the seconds flasher. The circled numbers refer to the Blob Board pads to which connections are made.

When all the pins have been soldered the i.c. can only be removed with the aid of desoldering braid or a desoldering tool.

Next solder IC2 to the board in the same manner, by first blobbing pin 1 to pad 28, checking, then blobbing pin 8 and checking again before finally soldering all the remaining pins.

When the i.c.'s have been mounted start the circuit wiring by making the supply conections to track 1 (5 volts positive) and track 2 (supply negative). Using insulated wire links, connect pin 10 of each i.c. to track 2, and connect pin 5 to track 1. Connect R7 between pad 33 (pin 12 of IC2) and the spare pad 27, then connect the l.e.d. between this pad and supply negative at track 2. There is a flat on one side of the l.e.d. body, and this indicates the cathode lead-out which connects to track 2. Next connect pins 2 and 7 of each i.c. to supply negative. If these two pins are not connected to the negative rail no counting will take place, since these are the reset pins of the counters. Finish off the i.c. connections by connecting pin 11 of IC1 to pin 1 of IC2, and connecting pin 11 of IC2 to pin 14 of IC2. All the wiring as so far described is shown in Fig. 2.

TRANSISTOR CIRCUIT

The transistor circuit can be wired in now, and this is shown in Fig. 3. Resistor R6 is wired from pad 7 to track 1. Remember to tin the ends of the resistor leads before blobbing it to the board. The ends of transistor leads should be tinned, too. R5 is blobbed between pad 5 and pad 6. The base of TR3 connects to pad 5, the collector to pad 7 and the emitter to pad 3. D1 is wired from pad 3 to track 2, its cathode lead (indicated by a band on its body) connecting to track 2. TR2 is now connected in with its emitter on pad 3, its base on pad 4 and its collector on pad 6. Load resistor R4 is blobbed between pad 6 and pad 1, and R3 is blobbed between pads 4 and 24.

The remaining transistor, TR1, is now wired in. It has its emitter on pad 2, its collector on pad 24 and its base on pad 26. R2 is connected between pads 24 and 1, and R1 between pads 26 and 1. Pad 26 is the input point for the transistor circuit and a length of single insulated flexible wire about a metre long is soldered to this. An on-off switch can be added, this being inserted in series with the positive supply. It can be fitted at any convenient point.

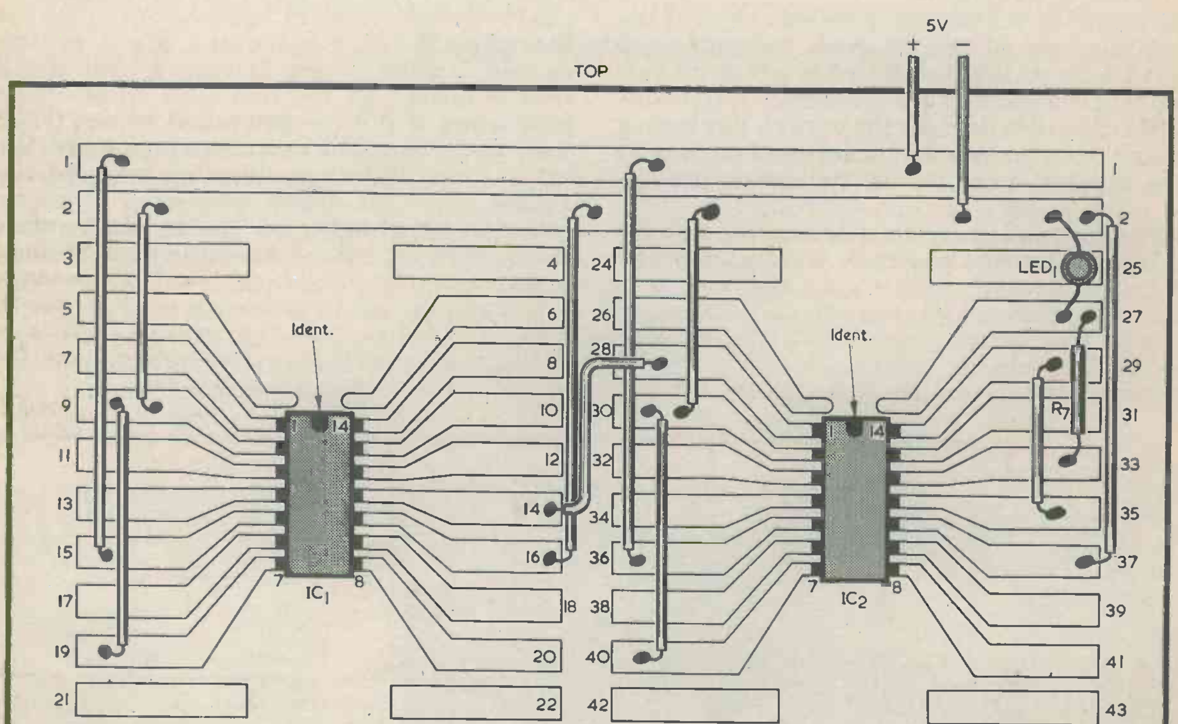


Fig. 2. First stage in construction. The i.c.'s are mounted as shown, then the wire links, LED1 and R7 are blobbed on

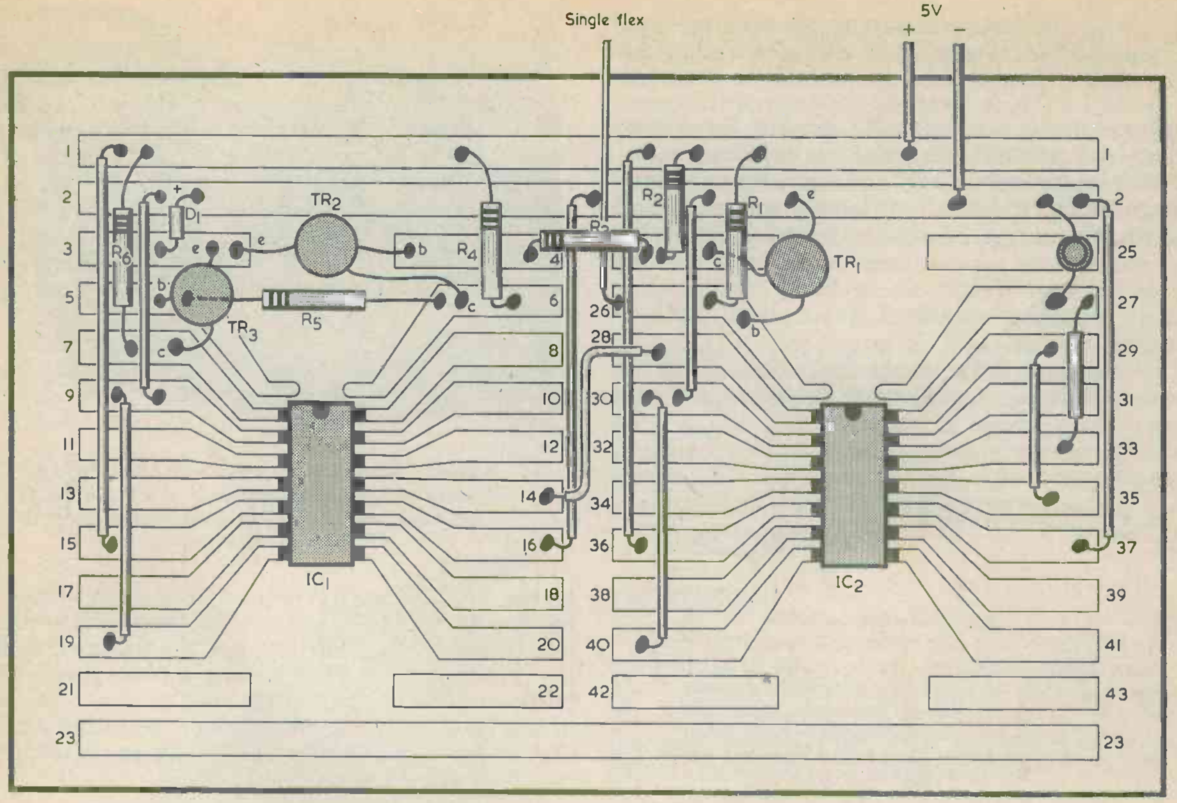


Fig. 3. Completing the assembly. Here, the transistors and resistors are wired to the Blob Board

TESTING AND OPERATING

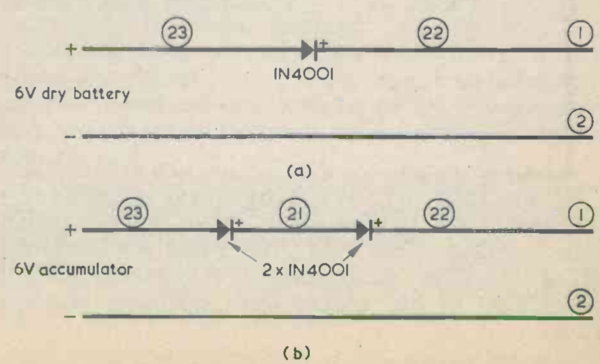
Check that all the wiring, including the connections to the i.c.'s, is correct. Several i.c. pins are left open-circuit deliberately. Make sure that the battery polarity will be correct, although if a series diode or diodes is used accidental reversed polarity will do no harm. The i.c.'s will be damaged if a battery is connected directly to them with wrong polarity, so it is better to use a battery connector when a dry battery is used.

As was mentioned earlier, a 6 volt dry battery can be used if a silicon diode is connected in series to drop the voltage. As shown in Fig. 4(a), the positive side of the battery connects to pad 23, the diode being blobbed between pad 23 and pad 22, with an insulated link wire connecting pad 22 to pad 1. The negative side of the battery connects to track 2.

With a 6 volt accumulator two diodes are required, as in Fig. 4(b). The positive input connects to pad 23, and the first diode is wired between pad 23 and pad 21. The second diode connects between pad 21 and pad 22, with an insulated link wire connecting pad 22 to track 1. The negative input from the accumulator is wired to pad 2.

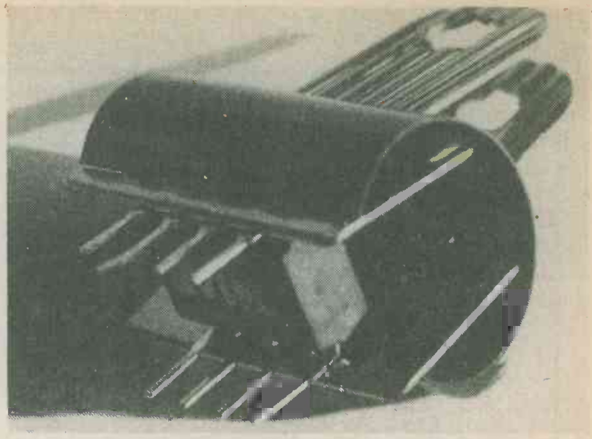
When a diode or diodes is used the on-off switch is connected between pad 23 and the positive terminal of the battery or accumulator.

Fig. 4. (a) The flasher can be supplied by a 6 volt dry battery if a silicon diode is inserted in series to drop the voltage
(b) Two silicon diodes are required when a 6 volt accumulator is employed



Switch on the flasher, keeping the pick-up lead from pad 26 well away from mains wiring. The counter will probably not operate. Now hold the pick-up wire in your hand. If the gain of the transistors is high the counter will probably start, and counting should definitely proceed when the pick-up wire is wound around an unscreened mains lead, as shown in Fig. 5. Note that there is no direct connection to the mains. Should no counting still take place, check your connections carefully; the other possible source of trouble is leaky transistors, possibly from unmarked job-lots or other "bargain" sources.

In use always time events from the l.e.d. and never the other way round, since the timing will not be correct for the first second or so after switching on. Switch on the timer, let the flash rate settle (a few flashes only) and then use the flasher for timing. For example, when timing a photographic exposure switch on the flasher and, on the third flash of the l.e.d., turn on the enlarger, counting ZERO. Count ONE on the next flash, and so on until the required exposure has been made. ■



A paper clamp affords a suitable heat shunt for tinning integrated circuit pins. An 8 pin i.c. is seen here, but the idea is equally applicable to 14 pin devices

Fig. 5. A 50Hz a.c. voltage is obtained by wrapping the insulated pick-up wire around any unscreened cable carrying the mains supply. Note that there is no direct connection between the two

WORLD'S LARGEST INTEGRATED CIRCUIT

by
Michael Lorant

What could well be the world's largest integrated circuit is Westinghouse's multi-cell electroluminescent display panel.

Scientists of Westinghouse Research Laboratories in America have successfully demonstrated novel real-time video performance on a thin-film transistorised electroluminescent panel that is no thicker than ordinary window glass.

The scientists are investigating the grey-scale capabilities of the 6 by 6 inch panel which has been made in 20 and 30 lines per inch versions. "Grey-scale" refers to the ability to generate a scale of brightness levels between dark and light. Acceptable television imagery with no visible smear, even for rapidly moving objects, has been obtained by the scientists.

DIGITAL DISPLAY

The one-eighth inch thick panel is primarily designed for digital and alphanumerical display applications such as are required for computer readouts, in radar displays and many other fields. These involve simple on-off operation of the display elements. However, since the microminiature thin-film transistors which control the brightness of the elements are also capable of grey-scale operation, a decision was made to attempt video inputs.

Westinghouse's new 6 by 6 inch electroluminescent display panel. The panel contains some 12,000 microminiature light emitting elements which light up when electricity passes through them. Although intended primarily for alphanumerical presentations the panel offers possibilities for TV display, and development is proceeding in the search for greater resolution and true grey-scale performance

According to Dr. Brody, head of the Westinghouse research group, "the picture on our current panel can be taken directly from any video-tape feed or commercial TV signal. It has high quality contrast and no problem with flicker, though we have a long way yet to go before achieving the line resolution and brightness of a present-day television receiver."

The new thin-film transistorised panel is actually *an enormous integrated circuit* — possibly, at 6 inches square, the largest in the world. The picture elements themselves are phosphor dots which light up when electricity passes through them, in a manner similar to the excitation of the phosphors on the inside face of a television picture tube.

The matrix of dots is produced by vacuum depositing thousands of tiny interlocked thin-film circuits onto a glass substrate, coating the circuits with a phosphor film and sealing the "sandwhich" with a glass cover plate.

Each individual element consists of two thin-film transistors, a storage capacitor and a phosphor overlay material. The transistorised matrix allows separate elements to be energised without activating others in the same row or column. Moving images are formed when a number of dots are triggered almost simultaneously across the entire screen, 30 times per second. The transistors also control the dots' brightness.

TV IMAGING

Westinghouse scientists are now working on a $3\frac{3}{4}$ by 5 inch display panel designed specifically for TV imaging. This panel, which will use a white phosphor instead of the green of the alphanumeric displays, will have 262 lines and will consist of over 80,000 elements. (A black and white screen with full TV resolution would require some 250,000 elements, and a colour screen would need three times as many). Work is also in progress to increase the line density further, to 100 and even to 128 lines per inch. The latter density is above the human eye's resolution limit at normal viewing distances and the image therefore appears continuous.

The major obstacle in developing a solid state screen to a performance level comparable with that of present day cathode ray tubes has been the problem of distributing the information to large numbers of picture points by some sort of wiring. There has been no practical way of physically wiring to 100,000 or more light emitting dots individually; nevertheless, through thin-film transistor technology, the wiring is integrated into the panel itself. Leads on two sides of the panel feed signals to the thin-film circuit matrix, which then energises the electroluminescent cells. The development of scanning and edge drive circuits, which can be simultaneously deposited onto the substrate along with the transistorised matrix, will further reduce the number of external leads from the present 220 to about 20. Continuous shading, rather than the eight levels of brightness presently used, can be achieved through a modification of the drive electronics. Substantially better TV-type performance is expected from panels designed specifically for video display.

Westinghouse already has phosphors in all necessary colours for a thin-film, transistorised, matrix-driven colour television panel, but it would take many more years of concentrated effort to achieve this.

However, the systematic development of thin-film transistor technology, even without any further technological breakthrough, could be the solution to the electronics industry's more than 20-year search for a solid state equivalent of the bulky, high-voltage cathode ray tube.

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

As a starter this month there is news of an established clandestine transmitter which, according to the BBC Monitoring Service, is on the air from 0030 to 0130 and from 1200 to 1300 on **5110**, also from 1030 to 1130 on **6304**. The latter transmission period is thought to change on a monthly basis — 1030 to 1130, 1330 to 1430 and from 1400 to 1500. The transmitter in question announces in English as "Voice of the People of Burma" (in Burmese "Myama-pye Pey-Thu Ah-than"; in Chinese "Mien-tien Jen-min Chih Sheng Kuang-po Tien-Tai"). The policy is pro-Peking and Burmese Communist Party, the transmitter itself being located on or near the Burma/Chinese border.

This month brings the commencement, in SWL terms, of the Far Eastern 'season', with the arrival of signals from those exciting and exotic-sounding place-names all situated many miles east of Suez. Looking at my log for October last year, I note such entries as Rangoon on **4725** at 1408; RRI Jakarta on **4805** at 1540; RRI Banda Aceh on **4954.5** at 1525; RRI Ujang Padang on **4719** at 1400; RRI Yogyarkarta on **5046.5** at 1445; RRI Palembang on **4855** at 1450; RRI Jakarta on **4774** at 2204; Hanoi on **4932** at 1454 and on **3999** at 1447; Bangkok on **4830** at 1540; Penang on **4985** at 1520; Phnom-Penh on **4908** at 1425; Sarawak on **5005** at 1440 and Lhasa on **4035** at 1533.

Perhaps this year may prove even better than the last, hope springs eternal I suppose. Being an incurable optimist, I am pinning back my ears in the hope of logging Viet Bac (on **4105** and **6917** from 1125 to 1430) and Hue regional radio service (on **4680** from 1030 to 1100 and from 2200 to 2400), both of these being in Vietnam.

Well — I did say I was an optimist!

CURRENT SCHEDULES

● ROMANIA

"Radio Bucharest" has an External Service in which programmes in English intended for listeners in Europe are from 1300 to 1330 on **9690**, **11940** and on **15250**; from 1930 to 2030 on **9510** and **11940** and from 2100 to 2130 on **9665** and on **11970**.

● CZECHOSLOVAKIA

"Radio Prague" radiates programmes in English for the U.K. and Eire from 1630 to 1700 on **5930** and **7345**; from 1900 to 1930 on **5930**, **7245** and on **7345**; from 2000 to 2030 on **5930** and **7345** and from 2130 to 2200 on **6055**.

● POLAND

"Radio Warsaw" offers programmes in English to Europe from 0630 to 0700 on **6135**, **7270** and on **9675**; from 1200 to 1230 on **6095** and on **7285**; from 1600 to 1630 on **6135** and **7270**; from 1830 to 1900 on **6095** and **7285**; from 2030 to 2100 on **6095** and **7285** and from 2230 to 2300 on **3955**, **5995**, **6135**, **7125** and on **7270**.

● ALBANIA

"Radio Tirana" broadcasts in English to Europe from 0630 to 0700 on **7065** and on **9500**; from 1630 to 1700 on **7065** and on **9480**; from 1830 to 1900 on **7065** and **9480**; from 2030 to 2100 on **7065** and **9480** and from 2200 to 2230 on **7065** and on **9480**.

● PAKISTAN

"Radio Pakistan", Karachi, beams programmes in English to Europe from 1100 to 1115 (a newcast at slow-speed) on **15115** and on **17665**; from 1815 to 1820 (newscast) on **9790** and on **11640**; from 2115 to 2145 on **9790** and on **11640**.

● ISRAEL

Programmes from Jerusalem, in English to Europe, may be heard from 1200 to 1230 on **11655**, **15100**, **15405**, **15485** and on **17815**; from 2000 to 2030 on **9009**, **9425**, **9815**, **11655**, **11960** and on **15512**; from 2230 to 2300 on **9435**, **9815**, **11655**, **11960** and on **15485**.

● CAMEROON

Radio Garouga on **5010** at 0428 when opening the proceedings with the National Anthem, identification and announcements in French by YL. The schedule is from 0430 to 0700 and from 1700 to 2200 daily, an English programme being radiated from 1830 to 1845. The power is 30kW.

● CHAD

Ndjamana on a measured **4904.5** at 0425, interval signal (Balafon), National Anthem, identification by OM in French. The schedule of this one is from 0430 to 0630, 1740 to 2200 (Saturdays until 2300) and the power is 100kW.

● CONGO

RTV Congolaise, Brazzaville, on **4765** at 1955, OM with announcements in French, African drums, YL with song in vernacular, Schedule is from 0430 to 0700, 1700 to 2300. A programme in both Portuguese and English ia radiated from 2115 to 2145 (Fridays 2150 to 2220, Saturdays 2100 to 2130, Sundays 2235 to 2305). The power is 50kW.

● KENYA
Nairobi on **4804** at 1945, announcements in English, Jim Reeves records in the Home Service which is entirely in English on this channel. Schedule is from 0255 (Sundays from 0330) to 0630 and from 1300 to 2010 (Saturdays until 2110). Not an easy one to log, the power is just 1kW.

● MAURITANIA
Nouakchott on **4845** at 1957, announcements in French, OM with local pops on records. Schedule is from 0630 to 0900 and from 1800 to 2230 (Fridays and Saturdays until 2400; Sunday 1700 to 2400). The power is 100kW.

● GHANA
Ejura on **4980** at 1940, a programme of recorded pops, OM announcer in English. The schedule is from 0530 to 0800 and from 1200 to 2305 (Saturday and Sunday from 0530 to 2305). The power is 20kW.

● GUINEA
Conakry on **4910** at 0308, OM in vernacular, local-style music. The schedule is from 1230 to 0830 and the power is 18kW.

● S. YEMEN
Aden on **5060** at 0315, YL with song in Arabic, local music in a programme intended for East Africa scheduled from 0300 to 0805 also from 1100 to 2200 (Friday from 0300 to 2200), during Ramadan until 2300. The power is 7.5kW.

● N. YEMEN
Sana'a on **4853** at 2020, OM with song in Arabic, local-style music. Also logged in parallel on **9780.** Schedule is from 0300 to 0700 and from 1100 to 2110 and the power is 25kW.

● BENIN
Cotonou on **4870** at 1943, OM's with a discussion in French on foreign policy matters. Schedule is from 0515 to 0830 and from 1615 to 2300 (Saturday from 1600, Sunday from 1630). The power is 30kW.

● EGYPT
Cairo on **17625** at 1032, Arabic songs and music in a "Voice of the Arabs" programme scheduled from 0800 to 1400 on this channel.

● ISRAEL
Jerusalem on **17630** at 1036, local pops, YL announcer in the Hebrew Domestic Service scheduled here from 1030 to 1400 and also in parallel on **12077.**

● PAKISTAN
Islamabad on **17665** at 1041, OM with song in Urdu, local music then a newscast at slow-speed in English after station identification at 1100.

● YUGOSLAVIA
Belgrade on **9620** at 1850, YL with the English programme to Europe, the Middle East and Africa scheduled here from 1830 to 1900, also logged in parallel on **6100** and **7240.**

● E. GERMANY
Berlin on **9730** at 1903, YL with the programme in English radiated to Europe daily from 1830 to 1915 on this channel and in parallel on **6080, 6115, 7185** and on **7300.**

● FINLAND
Helsinki on **11755** at 1916, YL with listeners in the English programme intended for Europe, the Middle East and W. Africa from 1900 to 1930 here and in parallel on **15265.**

● CHINA
Radio Peking on **6665** at 2020, YL in Chinese in the Domestic 1st Programme on this channel from 2000 to 1735.
Radio Peking on **7504** at 2015, YL in Chinese in the Domestic 1st Programme scheduled here from 2000 to 1735.

● INDIA
AIR Delhi on **11620** at 1925, YL and OM alternate with listeners letters in the English programme in the General Overseas Service directed to the U.K. from 1745 to 2230.

● RWANDA
Kigali on **15410** at 1214, programme announced as "African Service of the Voice of Germany" followed by news commentary in English. This is the Kigali Relay of Deutsche Welle, Cologne, the English programme being scheduled from 1200 to 1245 and intended for West Africa. Also in parallel (from Kigali Relay) on **17765** and from Cologne on **17875** and on **21600.**

● ECUADOR
Radio Splendit, Cuenca, on a measured **5025.5** at 0430, OM station indentification, announcements with added echo-effect, local-style music. Schedule is from 1100 to 0430 but the closing time can vary up to 0530. The power is 5kW.

● COLOMBIA
Ondas del Meta, Villavicencio, on **4885** at 0404, OM with identification, guitar music, OM with song in Spanish. The schedule is from 1000 to 0500 and the power is 1kW.
La Voz del Llano, Villavicencio, on **6115** at 0239, OM in Spanish, local-style music, heard under a Moscow transmission. The schedule is from 0900 to 0500 and the power is 1kW.

● BRAZIL
Radio Difusora de Amazonas, Manaus, on a measured **4806** at 2206, OM with announcements in Portuguese, local pops on records. Schedule is from 2200 to 0400 and the power is 5kW. This one tends to vary in frequency from **4805** to **4806.**
Radio Clube do Para, Belem, on **4855** at 0336, OM with announcements in Portuguese, local-style music. Schedule is from 0800 to 0500 and the power is 2kW.
Radio Jornal do Brasil, Rio de Janeiro, on **4875** at 0342, YL with songs in Portuguese, guitar music. The schedule is from 0900 to 0530 and the power is 10kW.
Radio Borborema, Campina, on a measured **5023.5** at 0310, OM announcer in Portuguese, Latin-American style dance music. The schedule is from 0830 to 0420 and this one can vary in frequency from 5020 to 5025 and, just to make life easier, it sometimes identifies as "A Princesa do Sul." The power is 1kW.

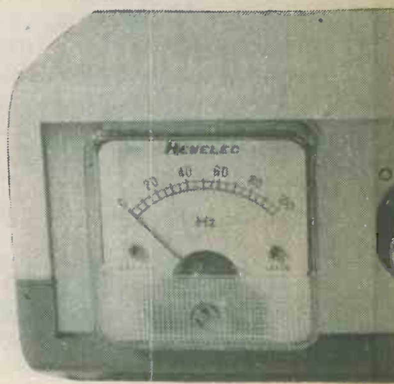
● NOW HEAR THIS
La Voz de los Caras, Bahia de Caraquez, Ecuador, on **4795** at 0432, OM with songs in Spanish after identification.

ANALOGUE FRE

● **Covers 0-100kHz in 4 switched ranges**

by R.

● **Direct indications of input signal frequency**



There are many methods of measuring the frequency of a signal which lies within the range of about 10Hz to 100kHz. Some methods require the use of an accurately calibrated signal generator to provide a reference signal; these include the Lissajous figure method, which also requires a suitable oscilloscope. Making frequency measurements using this or a similar method has the disadvantage that sophisticated items of test gear are normally required. Such methods also tend to be rather slow and tedious.

There can be little doubt that a digital frequency meter provides the best way of measuring the frequency of both a.f. and r.f. signals. Such instruments can provide the ultimate in accuracy and convenience, but unfortunately they tend to be rather complex and expensive. For the measurement of audio frequencies only, an analogue frequency meter is probably a much more practical proposition. An analogue meter can be quite simple and inexpensive, but will nevertheless provide an adequate degree of accuracy for most amateur requirements.

A unit of this nature forms the subject of the present article. The circuit is based on two CMOS i.c.'s, which are the only active devices employed. There are four measurement ranges, these being Range 1, 0-100Hz; Range 2, 0-1kHz; Range 3, 0-10kHz; Range 4, 0-100kHz. The unit is self-contained and is powered by its own internal 9 volt PP3 battery.

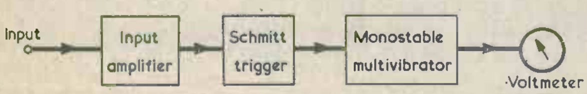


Fig. 1. Block diagram illustrating the stages which make up the analogue frequency meter

OPERATING PRINCIPLE

The block diagram of Fig. 1 shows the stages which make up the instrument. The input amplifier has to fulfil two functions, those being to provide a reasonably high sensitivity and to offer a high input impedance. This enables the unit to measure low level signals with a minimum of loading on the signal source. The Schmitt trigger is a circuit which can have only two stable output states: the output can either be low (virtually equal to the negative supply rail potential) or high (virtually equal to the positive supply rail potential). The output assumes the low state if the input voltage is below a certain threshold voltage, and the high state if it is above this voltage. The purpose of this stage is to produce an output waveform having a fast rise time, even if the input signal has only a slow leading edge (such as a sine wave has).

This fast rise time is needed in order to operate the next stage reliably. The third stage is a monostable multivibrator, and this type of circuit, once triggered, provides an output pulse of a fixed duration. The monostable circuit is triggered each time it receives a positive input pulse, and so in the presence of a suitable input signal a string of output pulses will be produced.

An important feature of the monostable is that it can only be triggered by a rising waveform. Therefore, if the input is still in the high state after the output pulse has ended, the circuit will not be retriggered at once. First it is necessary for the input to go low, and then high once again. Thus, one

QUENCY METER

● Employs 2 CMOS integrated circuits

Penfold

● Low current consumption of 4mA

output pulse is produced by each input cycle, and the length of the output pulses is constant and unaffected by the frequency of the input signal.

The output of the monostable feeds a simple voltmeter circuit which measures the average output voltage. For the sake of explanation let us assume that full-scale deflection of the voltmeter is given by the multivibrator output waveform shown in Fig. 2(a). Here, the output signal has a 1:1 mark-space ratio, whereupon the average output voltage will obviously be half the peak output voltage.

If the waveform of Fig. 2(a) were produced by, say, a 1kHz input signal to the multivibrator, then reducing the input frequency to 500Hz would produce only half the number of output pulses, as shown in Fig. 2(b). The average output voltage would then only be a quarter of the output peak voltage, or one half of its previous level. The voltmeter would therefore read half f.s.d. A further halving of the input frequency to 250Hz would produce the output waveform of Fig. 2(c) and the reading in the meter would be a quarter of full-scale deflection.

There is obviously a linear relationship between the frequency of the input signal and the meter reading, and so the meter can be calibrated directly in terms of frequency. In practice, f.s.d. in the meter does not have to correspond with a 1:1 mark-space output waveform for the desired relationship to be produced. It is only necessary for the length of each input cycle to be longer than the length of the monostable output pulse.

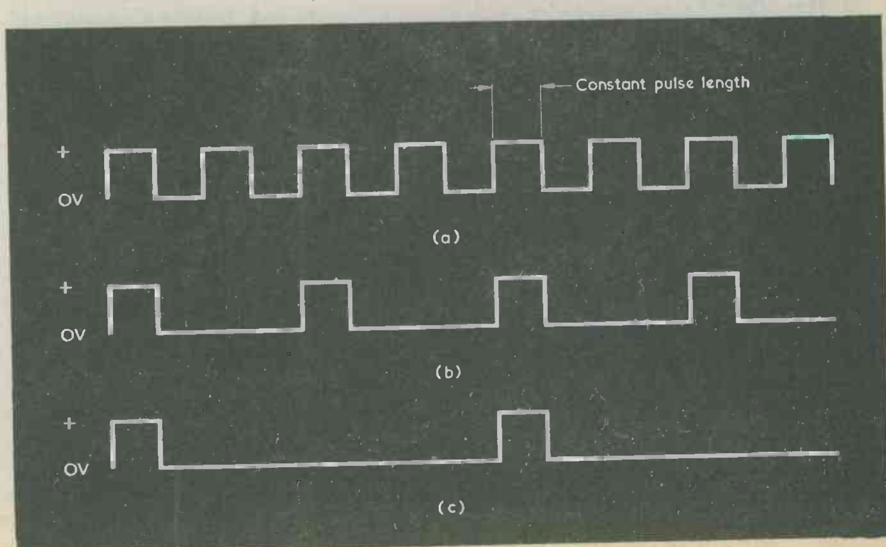


Fig. 2(a). Multivibrator output waveform given when the length of an input signal cycle is twice the length of the multivibrator pulse
(b). Halving the input signal frequency results in the number of output pulses being similarly halved
(c). Here, the input frequency is one quarter of that at (a)

THE CIRCUIT

The complete circuit diagram of the analogue frequency meter is given in Fig. 3. The input amplifier and Schmitt trigger circuits are built around IC1, which is a 4001 quad 2 input NOR gate. Here each of the gates has its two inputs connected in parallel, so that each of the gates acts as an inverter. It is possible to make such an inverter act as an amplifier by connecting a bias resistor between the output and input, and this is the purpose of R2. The input signal is coupled to the input of this inverter via d.c. blocking capacitor C1 and resistor R1. The values of R1 and R2 control the voltage gain and input impedance of the circuit by the virtual earth technique. The specified values produce an input impedance of about 270kΩ, and a voltage gain of just under 4 times.

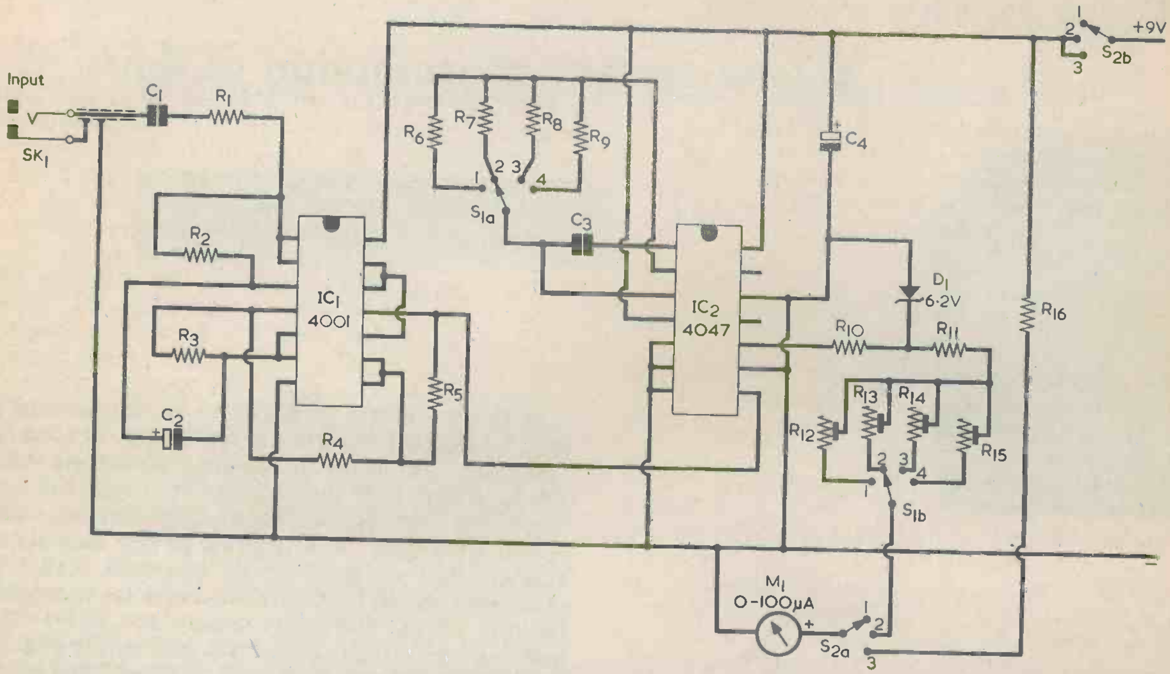


Fig. 3. The circuit of the analogue frequency meter. Current consumption from the 9 volt battery is only 4mA

COMPONENTS

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)
R1 270kΩ
R2 1MΩ
R3 1.5MΩ
R4 5.6kΩ
R5 18kΩ
R6 1MΩ
R7 100kΩ
R8 10kΩ
R9 1kΩ
R10 1.2kΩ
R11 5.6kΩ
R12 47kΩ pre-set potentiometer, skeleton, horizontal 0.1 watt
R13 47kΩ pre-set potentiometer, as R12
R14 47kΩ pre-set potentiometer, as R12
R15 47kΩ pre-set potentiometer, as R12
R16 100kΩ 2%

Capacitors
C1 0.1μF type C280 (Mullard)
C2 2.2μF electrolytic, 10 V. Wkg.
C3 0.001μF polystyrene
C4 100μF electrolytic, 10 V. Wkg.

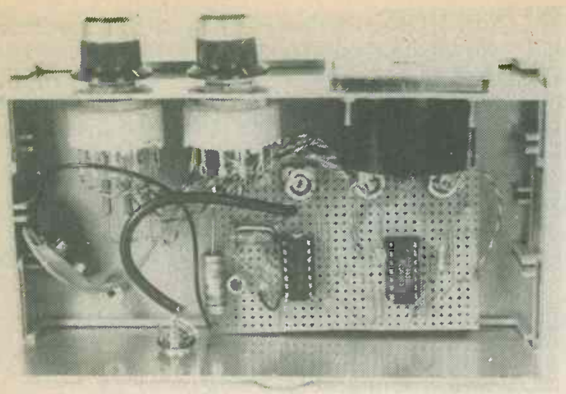
Semiconductors
IC1 CD4001AE or MC14001CP
IC2 CD4047AE or MC14047CP
D1 BZY88C6V2

Meter
M1 0-100μA moving-coil

Switches
S1(a)(b) 2-pole 6-way rotary with adjustable end stop
S2(a)(b) 2-pole 6-way, as S1(a)(b)

Socket
SK1 3.5mm. jack socket

Miscellaneous
Case (see text)
2 control knobs
9 volt battery type PP3 (Ever Ready)
Battery Connector
2 i.c. holders, 14 pin d.i.l.
Veroboard, 0.1in. matrix
Screened cable, connecting wire, etc.



The two integrated circuits and most of the other small components are assembled on a Veroboard panel. The four resistors R6 to R9 project backwards from the tags of the range switch

The output from this amplifier is fed to a second amplifier stage via C2. This second amplifier has R3 as its bias resistor and gives a voltage gain of about 50 times.

The remaining two inverters are used in a simple Schmitt trigger configuration. They are connected in cascade, and the input signal is applied to the input of the first inverter via R4. R5 is connected between the output of the second inverter and the input of the first inverter and provides the positive feedback needed for the Schmitt trigger action. The operation of this type of Schmitt trigger has been discussed in detail in an earlier article ("Stereo Peak Level Indicator", *Radio and Electronics Constructor,* March 1977).

IC2 is a 4047, and this is a very versatile device which can be used in several astable and monostable modes. It is connected to operate here as a non-retriggerable positive edge triggered monostable multivibrator. The timing capacitor is C3, and the timing resistor is whichever of the four resistors, R6 to R9, is switched into circuit by S1(a). Using four switched timing resistors enables the four frequency ranges to be covered.

The Q output of the i.c. is the one which is used here, and the not-Q output (pin 11) is simply ignored. The Q output is normally in the low state, and goes high when the monostable is triggered (the not-Q output is the inverse of this), and the output pulses are fed to the voltmeter circuit by a zener shunt regulator circuit which consists of R10 and D1. This regulator circuit is essential, as otherwise the peak output voltage, and hence also the meter reading, would be affected by changes in the supply voltage.

The voltmeter is given by the 0-100μA meter M1, whichever of the pre-set potentiometers R12 to R15 is switched in by S1(b), and R11. Using four pre-set potentiometers enables each range to be calibrated individually.

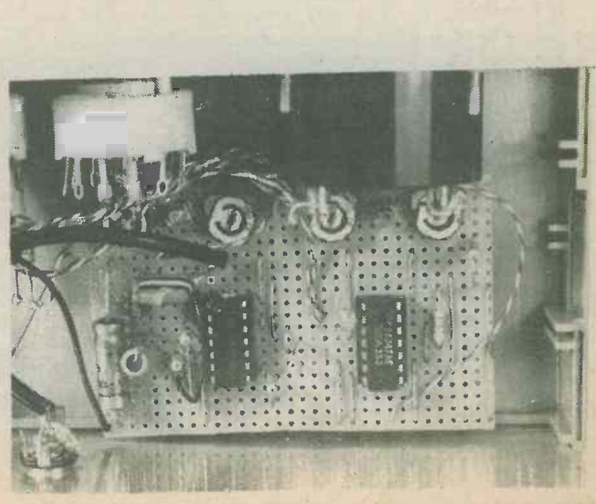
S2(a)(b) provides on-off and function switching. In position 2 the unit is switched on and S2(a) connects the meter to the arm of S1(b), thereby providing normal functioning. In position 3, S2(a) connects the meter to the positive rail via R16, whereupon the meter indicates battery voltage on load with f.s.d. at approximately 10 volts.

The current consumption of the unit is a little under 4mA, and so with normal usage the battery will have nearly its shelf life. At middle frequencies an input signal of only about 10mV r.m.s. is needed in order to activate the circuit, and signals of as much as a few volts r.m.s. will not damage the unit. The sensitivity falls off somewhat towards the upper and lower limits of the frequencies which can be handled.

It is possible that the input amplifier may show signs of instability, in which case the meter will not indicate zero when no output is applied. This can be cured by adding a low value capacitor across the input to reduce the input impedance at very high frequencies. The capacitor is not shown in Fig. 1 or in the Components List, and further details of it are given later.

The two switches, S1(a)(b) and S2(a)(b) are 6-way 2-pole rotary types with adjustable end stops. S1(a)(b) is set up for 4-way operation and S2(a)(b) for 3-way operation. Capacitor C2 is specified as 10 volt working but it will almost certainly be necessary to obtain this with a higher working voltage. Working voltages up to 63 volts will be quite in order here. The capacitor functions, in the present circuit, with virtually zero polarising voltage across it, but in practice this is quite a

The two integrated circuits are both CMOS types. They are fitted into i.c. holders after wiring has been completed



satisfactory state of affairs. Potentiometers R12 to R15 are miniature skeleton types having 0.2in. spacing between track tags, and 0.4in. spacing between the track and slider tags.

CONSTRUCTION

The dimensions of the case will depend upon the physical size of the meter which is employed for M1. The author employed an imported Japanese meter with front dimensions of 42mm. square which he happened to have on hand, whereupon the prototype was housed in a Verobox type 75-1238D which has a width of 154mm., a height of 60mm. and a depth of 85mm. However, a meter of this size may be difficult to obtain, although any other 0-100μA meter will be equally suitable electrically. Other 0-100μA meters will very probably be too large to fit into the 75-1238D case whereupon it may be possible to accommodate

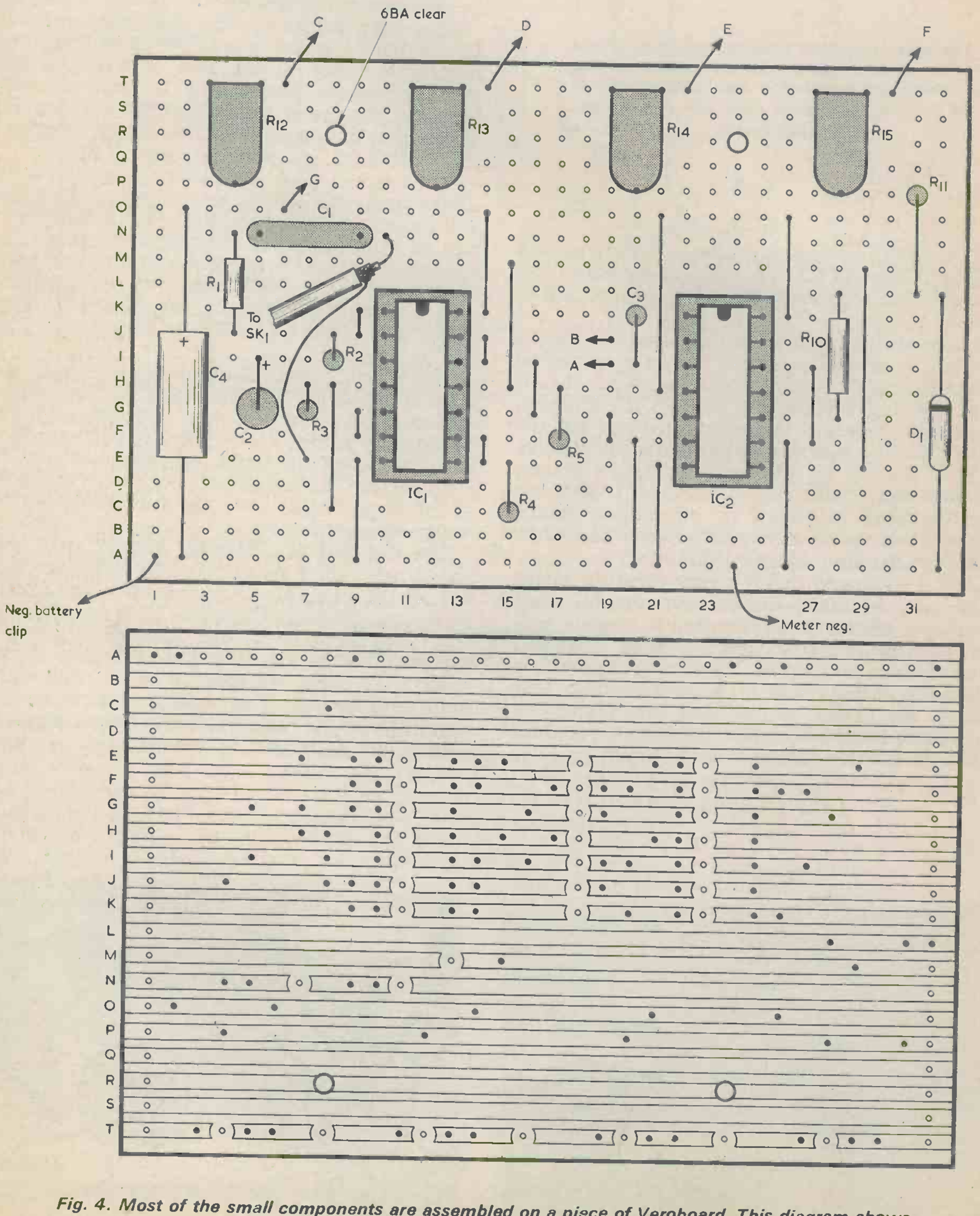
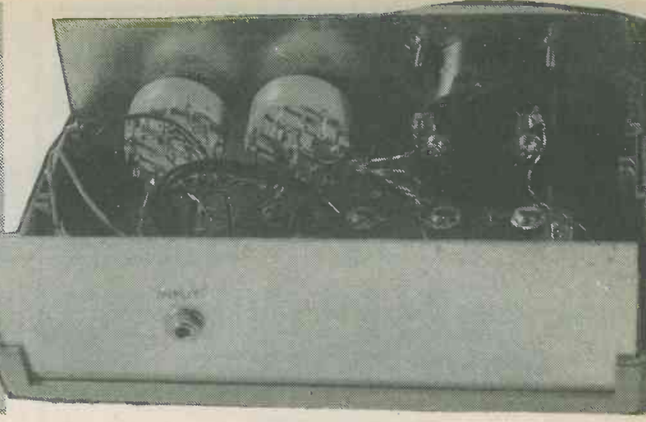


Fig. 4. Most of the small components are assembled on a piece of Veroboard. This diagram shows the two sides of the board



A view from the back of the frequency meter with the case top removed. The input jack socket is mounted on the rear panel and connects to the component panel by way of screened cable

them in the slightly taller Verobox type 75-1239K, which is similar to the 75-1238D case but has a height of 80mm. Any other box capable of taking the meter, the switches, the component panel and the battery may of course be used.

A very simple front panel layout is used, as can be seen from the photographs. The large cut-out for the meter, which for most types is 1.5in. in diameter, can be made with a fretsaw or a coping saw. The meter can then be used as a template by means of which its four mounting holes are marked out. These are then drilled a suitable clearance size. The mounting holes for S1(a)(b) and S2(a)(b) are $\frac{3}{8}$in. diameter. The input socket is mounted on the rear panel. This is a 3.5mm. jack socket which, with most types, requires a $\frac{1}{4}$in. diameter hole.

COMPONENT PANEL

Most of the circuitry is wired up on a Veroboard panel of 0.1in. matrix having 32 holes by 20 copper strips, and details of this are provided in Fig. 4. Inevitably a large number of link wires are used, and care should be taken not to omit any of these. Also, be careful not to leave out any of the numerous breaks in the copper strips. The two mounting holes are 6BA clearance, and it is advisable to drill these as soon as the panel has been cut to size, and before any of the components have been soldered into position.

The two CMOS i.c.'s can be damaged by high static voltages, and so they are usually packed in some form of protective material, such as conductive foam. It is recommended that i.c. sockets be used, and that the i.c.'s should be left in the protective packaging until all the wiring has been completed and checked. They may then be plugged into the sockets.

Some of the components are mounted on the switch tags, and details of this wiring are given in Fig. 5. The latters "A" to "G" in this diagram correspond to similarly identified points in Fig. 4. Before wiring to the switches check the outer tags which correspond to the inner tags. With some switches, their relative positioning may differ from that shown in Fig. 5. When all wiring is complete, the component panel may be secured in position by means of two 6BA bolts passed through holes in the bottom of the case, the four pre-set potentiometers being at the front. Spacers are used on the 6BA bolts to ensure that the Veroboard underside is clear of the case bottom and also, if a Verobox is used, one of the mounting pillars moulded into the case. There should be space for the battery behind S1(a)(b). It can be held in position by foam rubber or plastic above and below, or by means of a simple clamp fixed to the rear panel.

If it is found necessary to add the low value capacitor across the input to clear instability this may be connected directly across the input socket. The value required will typically be 100pF, but it is best to experiment here and find the lowest value which eliminates the instability and then fit that value.

CALIBRATION

In order to calibrate the unit it is necessary to have four signals of known frequency, one being used for the calibration of each range. With the unit turned on and switched to the appropriate range, the calibration signal is coupled to the input socket and the relevant pre-set potentiometer is adjusted to produce the appropriate meter reading. For ranges 1 to 4, the calibration pre-set potentiometers are R12, R13, R14 and R15 respectively.

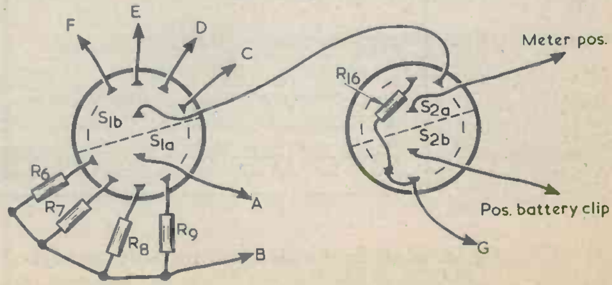
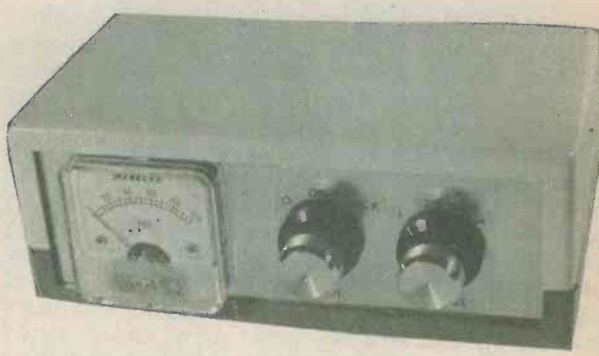


Fig. 5. The connections to the two switches. The points marked "A" to "G" are wired to the similarly identified points on the Veroboard component panel

There are many possible sources of calibration signals. Many modern crystal calibration oscillators have outputs at 100kHz and sometimes even 10kHz, and other low frequency outputs are provided. Some items of digital test equipment will provide outputs at 100kHz, 10kHz, 1kHz and 100Hz from a crystal oscillator and divider chain (or will provide sub-divisions from other known and accurate frequencies) and if access to such equipment is available this is obviously ideal.

A good quality commercially manufactured a.f. signal generator will provide suitable calibration signals, but unsophisticated types are less than perfect here as their accuracy may not be very high.



This angled view of the frequency meter emphasises its functional and professional presentation

The linearity of the analogue frequency meter is excellent, and so its accuracy is dependent upon the linearity of the meter used (which can be expected to be of a high order) and the accuracy with which the pre-set potentiometers are adjusted. Therefore, it is worthwhile taking the trouble to find accurate calibration signals and exercising due care when setting up the potentiometers.

In the absence of suitable test equipment it will be necessary to use one's initiative in order to find suitable calibration sources. For instance, the U.K. mains supply is maintained at a frequency of 50Hz with quite a high degree of accuracy. Thus, a low voltage mains transformer can be used to provide a 50Hz calibration signal. The output from the transformer can be reduced to a suitably low voltage level by means of a simple potential divider.

A piano can be used to find suitable known frequencies. For example the "A" above "Middle C" has a frequency of 440Hz, the "A" above this is 880Hz and the "A" below is 220Hz. It is possible by aural means to accurately tune an a.f. signal generator or oscillator to the same frequency as the piano, and then use the signal from the generator or oscillator as the calibration source.

HIGHER VOLTAGE SWITCH

By D. Snaith

How one set-maker overcame a small difficulty with supply voltages.

Here's a little problem.

In a mains-driven f.m. receiver you have an MC1310P stereo demodulator i.c. which splits the signal from the detector into left and right hand channels. Pin 6 of the MC1310P can operate a pilot lamp, causing this to light up when a stereo signal is present. The internal transistor in the i.c. which switches on the lamp handles currents up to 75mA and the maximum supply voltage which should be applied to pin 6 is specified as 14 volts.

Two supply voltages are available. One is a stabilized 13 volt supply and the other is an unstabilized 23 volt supply which is given immediately after the full-wave supply rectifier. The pilot lamp is rated at 14 volts 40mA.

How can the MC1310P and the pilot lamp be connected up?

SUPPLY DIFFICULTY

The obvious answer is to connect the lamp between pin 6 and the stabilized 13 volt supply, as in Fig. 1. When a stereo signal is present the internal transistor in the MC1310P turns on and causes the lamp to light up. But in some receivers this solution can cause difficulties. There is an abrupt demand on the stabilized supply and this demand could result in a small but undesirable variation in the stabilized voltage; sufficient, perhaps, to cause detuning when the varicap tuning potentiometers of the receiver are fed from the stabilized supply.

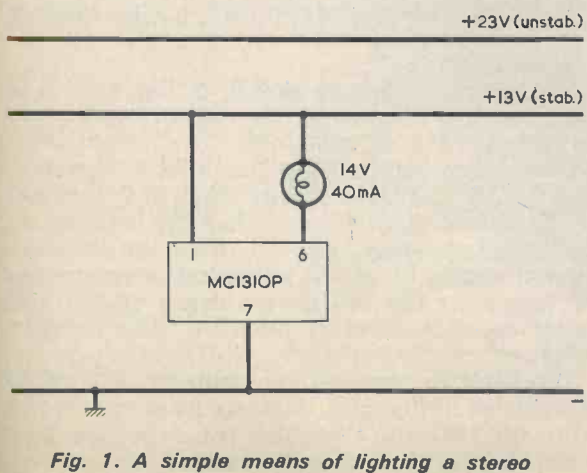


Fig. 1. A simple means of lighting a stereo beacon lamp from a 13 volt stabilized supply. A 23 volt unstabilized supply is also available

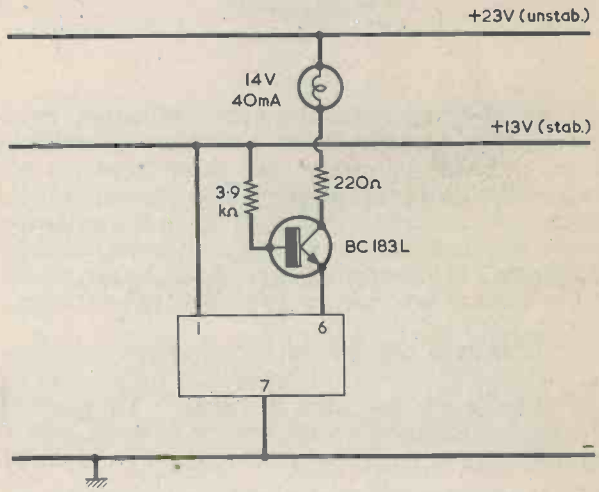


Fig. 2. An alternative circuit which takes advantage of the 23 volt supply. This arrangement reduces current demand on the stabilized supply to a much lower level

Fig. 2 shows a neat answer to the problem. An n.p.n. transistor is added to the circuit as also is a 3.9kΩ base bias resistor and a 220Ω resistor in series with the pilot lamp. The latter is now returned to the unstabilized 23 volt supply.

In the absence of a stereo signal, pin 6 of the MC1310P is high, no current flows through the base-emitter junction of the transistor and the pilot lamp is extinguished. At the same time, pin 6 of the i.c. cannot rise above the potential of the 13 volt stabilized rail.

When a stereo signal is received, pin 6 of the i.c. goes low and a bias current flows through the 3.9kΩ resistor, turning the transistor on. A current of 40mA now flows from the 23 volt supply through the lamp, the 220Ω resistor and the transistor into pin 6. 40mA in 220Ω gives a voltage drop of 8.8 volts, leaving a nice comfortable voltage of about 14 volts for the lamp.

The author spotted this circuit, incidentally, in the service sheet for the Ferguson 3476 stereo tuner-amplifier. ■

THE QUIZZOR QUIZ GAME PRECEDENCE

A number of sequence/quiz indicators have preceded the Quizzor. A few have been extendable to any number of inputs, but these have not all been particularly inexpensive. The Quizzor is both cheap and extendable and is, so far as the author is aware, the first integrated logic unit to be published. It uses t.t.l. integrated circuits, which are readily available at low cost and which interface directly with light-emitting diodes.

The object of the Quizzor is to indicate who has the right to answer a question in a quiz game or who wins in a game such as "snap". The person who pushes his button first has his l.e.d. lit, and it remains alight until the reset button is pressed.

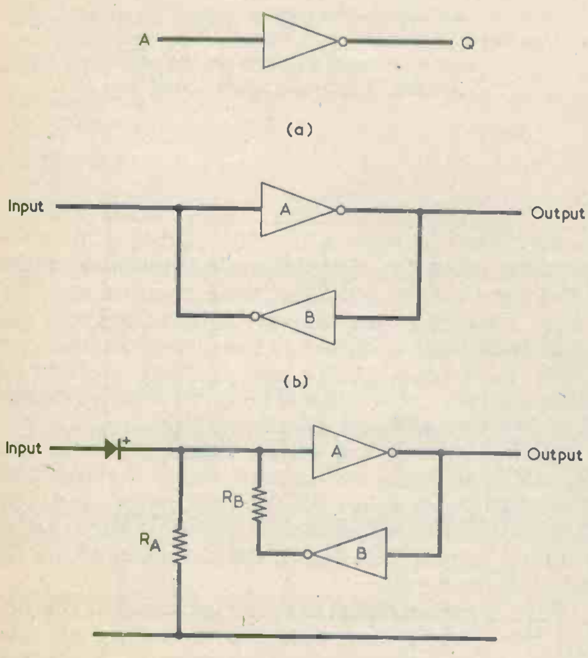


Fig. 1(a). The symbol for an inverter
(b). Two inverters connected to form a memory cell
(c). In practice, resistor RB has to be inserted in the memory cell circuit. RA biases the cell so that it always takes up the same state at switch-on

Once one l.e.d. has been lit up, no other l.e.d. can subsequently be turned on.

LOGIC

In t.t.l. digital systems it is customary to call a low output voltage O and a high output voltage 1. This notation is useful in explaining the logic circuits employed in the Quizzor. Fig. 1(a) shows the diagrammatic representation of an inverter; and there are six of these in a 7404 integrated circuit. If you put a logical O at the input (A) you get a logical 1 at the output (Q). In the same way a 1 at A gives a O at Q. Thus the device gives at its output an opposite, or inverted form of the signal at its input.

If two of these inverters are connected as in Fig. 1(b) they form a memory that can store either a O or a 1. If the input is a O then the output of inverter A is a 1. This 1, when put through inverter B, gives a O which reinforces the input and thus stores the information. As the circuit stands the input cannot, in practice, be changed from O to 1 because the output of inverter B remains at O until the output of inverter A falls to O. Attempting to force the input to 1 could damage inverter B.

A solution consists of inserting a current limiting resistor between the output of inverter B and the input of inverter A, the resistor having a value which prevents excessive current in inverter B at the instant when the input is taken to 1. The value of the resistor is, also, such that the input of A is still held at O before the application of a 1 to the input. With t.t.l. devices a suitable value for such resistor is 330Ω .

This resistor appears as RB, in Fig. 1(c). A second resistor, RA, biases the memory cell to give an output of 1 at switch-on. The value of this resistor is too high to draw the input of inverter A back to O if it is momentarily taken to 1. However, at the instant of switch-on, when the memory cell could take up either of its two states the small bias current drawn by RA is sufficient to ensure that the output of the cell always takes up a 1 after switch-on. A satisfactory practical value for RA is 4.7kΩ .

The Quizzor employs six memory cells of the type shown in Fig. 1(c). After application of power all six cells take up an output of 1. A positive pulse is applied via a diode to any one of the six inverters, whereupon its output drops to 0 and stays in this state.

By L. O. Green

INDICATOR

FULL CIRCUIT

Looking at the full circuit diagram for the Quizzor in Fig. 2 is now much easier. The six memory cells can readily be distinguished, with resistors R1 to R6 carrying out the RA function and R7 to R12 the RB function. More than six memory cells could be employed if desired, using the same basic circuit for each additional cell.

After switch-on all the outputs of the cells are at 1, with the result that no current flows through R13. There is no voltage across this resistor and hence no base bias for TR1, which remains cut off. With TR1 off there is no current in R15, whereupon TR2 is turned off as well. No current can flow in R17, so the voltage at point P will rapidly rise to that of the positive supply rail as C1 charges via R18. This point is thus a source of logical 1.

If any of the push-buttons, S1 to S6, is pressed, point P is connected to the input of the corresponding memory cell. The output of the cell at once drops to 0, causing the l.e.d. to which it is connected to light up and a current to flow through R13. The voltage dropped across this resistor turns on TR1, the collector of which takes up a voltage

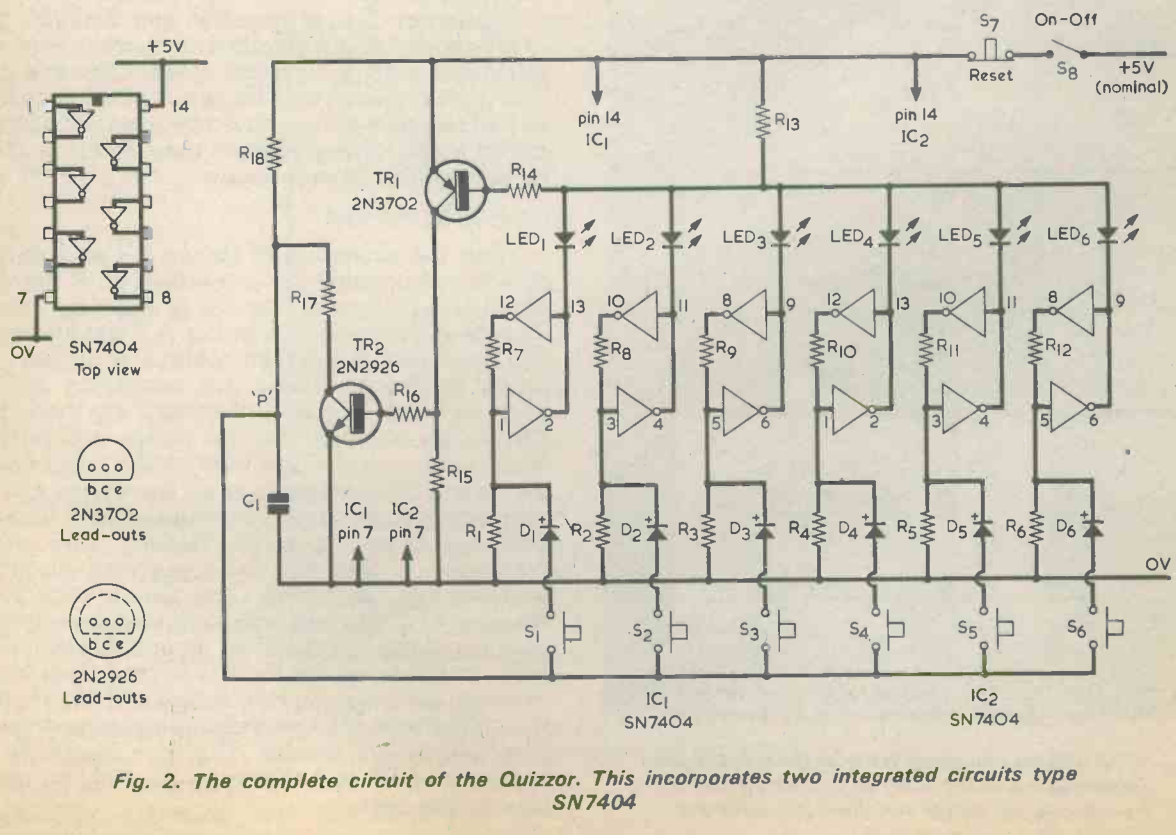
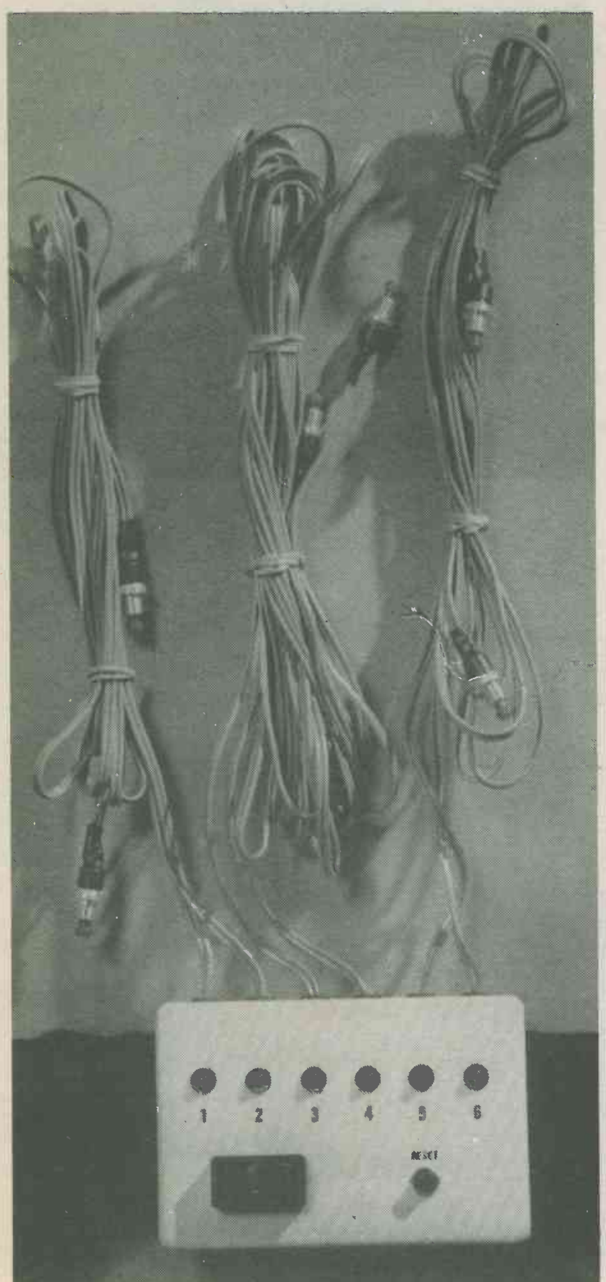


Fig. 2. The complete circuit of the Quizzor. This incorporates two integrated circuits type SN7404

nearly equal to that of the positive rail and causes TR2 to turn on also. The potential at point P then drops to logical 0 at a rate governed in the main by the values of R18, R17 and C1. The fall to logical 0 is, in any case, less than 0.001 second; there is more than ample time for the triggered memory cell to latch into its new state. At the same time the period is short enough to prevent another memory cell being triggered.

The circuit stays indefinitely in this state with the l.e.d. corresponding to the button which has been pressed remaining alight. If the Reset button, S7, is pressed and released, the power supply is momentarily disconnected and the circuit reverts to its previous state with all l.e.d.'s extinguished. Diodes D1 to D6 ensure that no other memory cells



The Quizzor unit complete with the leads to the contestant's press-buttons. The two black felt satchels on either side hold the batteries

COMPONENTS

Resistors
(All $\frac{1}{4}$ watt 5%)
R1-R6 4.7kΩ
R7-R12 330Ω
R13 270Ω
R14 47kΩ
R15 10kΩ
R16 47kΩ
R17 1kΩ
R18 82kΩ

Capacitors
C1 0.1μF type C280 (Mullard)

Semiconductors
IC1, IC2 SN7404
TR1 2N3702
TR2 2N2926 (see text)
D1-D6 1N914
LED1-LED6 red l.e.d., with mounting bush

Switches
S1-S6 press-button, push to make
S7 press-button, push to break
S8 s.p.s.t., rocker

Miscellaneous
Plastic case type PB1
2 batteries, No. 800 (Ever Ready)
Veroboard, 0.1in. matrix
Twin flexible wire
Material for battery satchels

can be triggered by the 1 at the input of the triggered cell.

Transistor TR2 is specified as a 2N2926, which is offered by many retailers in current gain group selections with a different colour for each group. The gain required in TR2 is not at all critical and any of the gain groups could be used. Readers who prefer a closer specification may obtain a 2N2926 in the middle Orange group.

CONSTRUCTION

With the exception of the l.e.d.'s and switches, all the components are assembled on a Veroboard panel of 0.1in. matrix having 22 holes by 24 strips. This panel is illustrated in Fig. 3. First drill out the two mounting holes then make the breaks in the strips as shown. These are numerous and care must be taken to ensure that they are made in the correct places and that the strips are fully cut. Next, solder on the link wire on the copper side of the board. This passes over all the strips, and each strip apart from strip D is soldered to it. The components may then be fitted. The author recommends that the two integrated circuits be soldered into place first. Once the i.c.'s are in position it is easier to locate the remaining components because of the symmetrical layout. Resistors R7 to R12 straddle over the i.c.'s. The lead from hole G6 provides the common connection to S1 to S6, whilst that from hole H18 provides the common connection to the l.e.d. anodes. The wire from hole W18 connects to S7 and thence to S8 and the positive side of the battery.

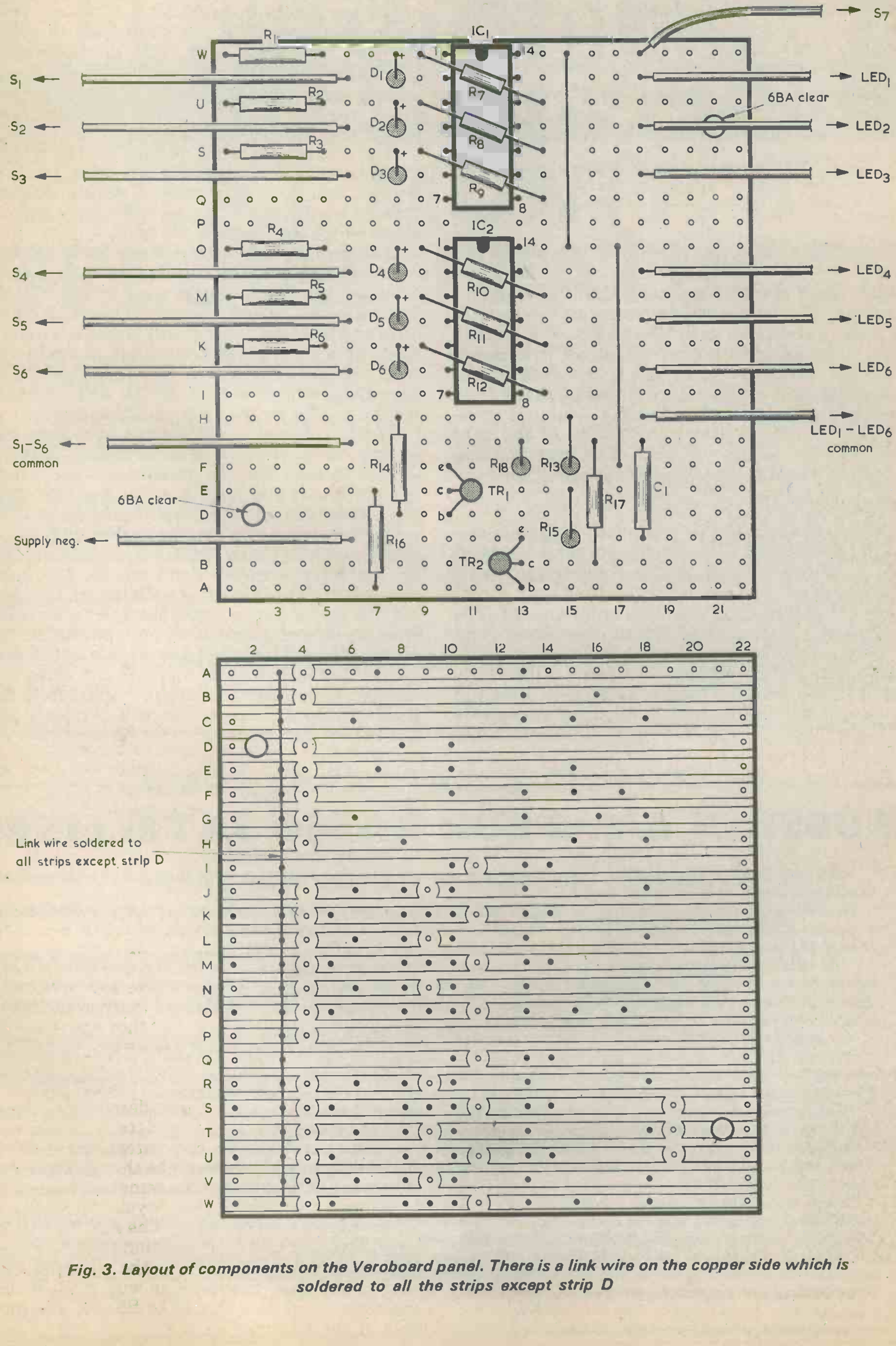


Fig. 3. Layout of components on the Veroboard panel. There is a link wire on the copper side which is soldered to all the strips except strip D

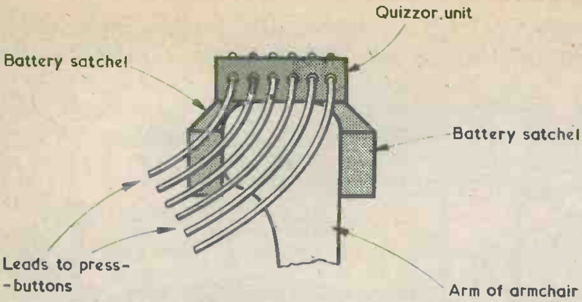


Fig. 4. The Quizzor unit is held in place on the arm of an armchair by allowing the two battery satchels to hang down on either side

The author's unit was assembled in a plastic box type PB1 which has dimensions of 114 by 76 by 38mm. This is available from Maplin Electronic Supplies. The l.e.d.'s are mounted on the front of the case in company with S7 and S8. S7 is a small press-to-break push-botton whilst S8 is a rocker action switch. The Veroboard is mounted on the detachable rear of the case, connecting to the front panel components by thin flexible insulated wires. Switches S1 to S6 are push-buttons of the type which can be held in the hand. The wires to these switches pass through holes in one side of the case.

MECHANICS

The author does not feel it is out of place to discuss the mechanics of the Quizzor to some length as they cost far more than the actual electronics used.

The Quizzor has been designed for quiz games and must therefore fit into this environment. The case is small because the electronics are small, and the small case greatly enhances the appearance of the l.e.d.'s. Since the batteries need to be fairly large to cope with the quiescent current, which in the case of the prototype is 25mA, they are outside the case. Two 3 volt twin-cell batteries, Ever Ready No. 800, are used. In order to allow simple access to the batteries and to hold the case on the arm of an armchair each battery is fitted in a felt satchel, the satchels being glued to either end of the case rear, as show in Fig. 4. The satchels hang down on either side of the chair arm. The author made his own satchels, but you may need to enlist the services of a girl-friend, wife or mother! Wires passing through the rear of the case connect to the batteries by means of solder joints at the battery terminations. A third wire connects the two batteries in series to give 6 volts.

The correct operating voltage for the integrated circuits used in the Quizzor is 5 volts, but a 6 volt battery with its normal internal resistance does not give an excessive voltage for the simple logic functions which are carried out here.

Switches S1 to S6 are on long leads so that the contenders do not have to huddle around the control box. The lead lengths used by the author are two each of 1, 2, and 3 metres. This is 12 metres of wire and does not come cheap. Although round section cable looks much better than the twin twisted and twin moulded types, sheer cost decrees that the cheapest wire is used. In the author's case this turned out to be the twin moulded type.

Finally, the value of R13 may need to be altered to suit the particular l.e.d.'s employed. Its value should be such that the maximum current through it is 14mA. If you have a meter you can measure the increase in supply current when an l.e.d. lights up, and this will give you the current in R13. In the prototype it is 12mA, and this is adequate. If you do not have a meter don't worry; the mode of operation of the Quizzor is such that the l.e.d.'s will only be on for a short time, and the i.c.'s are in any case capable of a safe maximum output current of 16mA. If you feel that the l.e.d.'s could be less bright it is advisable to increase the value of R13 slightly, say to 330Ω or 390Ω. Apart from reducing i.c. output current, this will certainly extend the life of the batteries. ■

RUSSIAN AMATEUR RADIO SATELLITES

There have been persistent rumours in amateur radio circles that the Russians were about to launch an amateur radio satellite, similar to the OSCAR 6 and 7 satellites.

At last a definite announcement of the USSR's intentions in this field have been made. AMSAT has received from the International Telecommunications Union's International Frequency Registration Board circular No. 1273 dated July 12th, 1977 which states:

"The USSR Administration wishes to inform countries, Members of the I.T.U., that the USSR is working on the establishment of an amateur satellite service system. This system 'RS' will be based on 3 to 4 satellites on a circular near-polar orbit. The amateur satellite stations are designed for multiple access with re-transmission and frequency translation without demodulation on a real time scale."

The proposed date for bringing the system into operation is given as 1977-1978. The satellites' orbit will be at an inclination of 82°, with an apogee and perigee of 950Km, i.e. the orbit will be circular. The orbital period will be 102 minutes. The uplink frequency will be 145.8 to 145.9MHz, i.e. 100KHz bandwidth, and the down link will be 29.3 to 29.4MHz, again 100KHz bandwidth. The maximum communications distance will be 6000Km, i.e. 3700 miles.

The satellites will have quarter wave circularly polarised receiving antennas, and a user uplink power of 10-15 watts into a 10-12dB antenna which is suggested as adequate for reliable communication.

The downlink transponder power will be 1.5 watts into a half-wave transmitting circularly polarised antenna.

It is thought that the "RS-OSCARS" will be launched piggyback with the Meteor meteorological satellites from the Plesetsk launch site.

Comparative data for OSCAR 6 and 7 is:

OSCAR 6. Period 115 minutes, inclination 102°, circular orbit of 1451Km. Transponder receive frequency 145.9 to 146.0MHz; transmit frequency 29.45 to 29.55MHz.

OSCAR 7. Period 115 minutes, inclination 102°, circular orbit of 1450Km. Two transponders, one with receiving facilities on 145.85 to 145.95MHz, transmitting on 29.4 to 29.5MHz. The second, receiving on 432.125 to 432.175MHz and transmitting on 145.925 to 145.975MHz.

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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.

In your workshop

Petty thieving is, unhappily, one of the norms of our present society, and it even intrudes into the sheltered world of Dick and Smithy. But Smithy, ingenious as ever, is able to produce an electronic device which guards objects on display from the attentions of the small-time criminal. The device is battery operated and the standing supply current when it is in the non-activated state is extremely low.

"It's Joe again."

Dick, slouched on his stool, gazed moodily at the floor.

"Joe?"

"Yes, Joe," repeated Dick dolefully.

Smithy took a prodigious draught of tea from his mug then laid it back on his bench, alongside the remains of his lunch-time sandwiches. The mug, a recent acquisition in the Workshop, bore on its side the pictures of the Queen and the Duke of Edinburgh together with the legend, "Silver Jubilee: 1953-1977."

"D'you mean Joe down at the Caff?"

"That's the one."

"Isn't he the bloke who's always changing the place round to suit current trends?"

"That's right. But for the moment he's just let it go back to being an ordinary Caff, with all the sauce bottle tops corroded and no mustard on the tables.

PROTECTION DEVICE

Dick brightened.

"Still," he continued more cheerfully, "he did do the place up for the Silver Jubilee Bank Holiday. He had flags and bunting everywhere. You've never seen anything like it."

His face fell again.

"And that," he concluded mournfully, "is when he got his Jubilee mugs in. He picked up a whacking great job-lot of them really cheap, and he reckoned he'd make a bomb with them. In the end he only flogged one and that was to me."

"That must be the one you flogged to me then," remarked Smithy. "The one I've got here now. You didn't half make a sales pitch with it, too, telling me how unpatriotic I would be if I didn't buy it. Why couldn't he sell the rest of the mugs?"

"Look at the dates on the side of your mug."

Smithy turned his mug round and examined the dates in question.

"Well, I'm dashed," he exclaimed. "I've been drinking out of this for the last three months or so and I hadn't even noticed anything wrong. It should have '1952' on it instead of '1953'."

"Exactly," confirmed Dick. "There must have been a mistake at the mug works and that's why Joe got them so cheap. He didn't spot the error either until he tried to sell them. In fact, he's still trying to sell them after all this time. He's got a dirty great display shelf full of them which he keeps replacing every now and again."

"If he doesn't sell any mugs why does he have to keep replacing them?"

"They get pinched," explained Dick. "And that's why I'm so cheesed off at the moment. Last night he talked me into dreaming up an electronic alarm which would prevent the mugs being lifted, and for the life of me I can't think of anything that would work."

"What about a simple insulated guard wire passing through the handles of the mugs, rather like the guard wires you see in shops where they sell clocks and things?" suggested Smithy. "If the wire is cut a relay causes an alarm bell to ring."

"That wouldn't beat the characters who go into Joe's Caff," stated Dick with conviction. "They'd stick pins through the wire on either side of the point where they were going to cut it, and then connect the pins together with another bit of wire!"

"Would they, indeed," said Smithy thoughtfully.

He sipped reflectively at his tea.

"What we want then," he resumed, "is something more sophisticated. This is starting to get interesting."

"Have you any ideas?" asked Dick eagerly.

"They're beginning to come through," responded Smithy. "Now, to start off with, an ordinary piece of wire is no good, and so we can use, say, a screened wire. If we pass a signal through this wire the signal will be cut off if the wire is broken, thereby operating a relay which sounds an alarm bell. That bit shouldn't be difficult. The next thing to think about is the power supply."

"The alarm gadget will have to be battery operated," put in Dick. "If it was mains operated and there was a power cut with the lights going out, the entire shelf of mugs would disappear in ten seconds flat!"

"Fair enough," said Smithy. "Then we have to make up a battery operated circuit which, when the guard wire is uncut, draws a very low current from the battery. Otherwise the cost of replacing batteries would make the whole thing uneconomic."

"I suppose," stated Dick, "we *could* knock up something which only drew a few milliamps from the battery."

"I'm not thinking in terms of milliamps," responded Smithy. "I'm thinking of a standing current which is measured in microamps. Let's say as a design aim that we'll try to keep the standby current when the guard wire circuit is unbroken down to less than twenty microamps."

"Less than twenty microamps?" repeated Dick incredulously. "Blimey, you'd need some sort of CMOS integrated circuit to do that wouldn't you?"

"Not really," replied Smithy. "We could do it quite easily with a few low-cost silicon transistors. Now, where's my note-pad?"

MULTIVIBRATOR

Smithy turned round on his stool to face his bench, and retrieved his note-pad from a pile of service manuals. As he pulled out his pen and started to sketch out a circuit, Dick walked over towards him and peered down at the pad.

"There you are," said Smithy proudly, as he laid down his pen. "Here's the first part of the guard circuit and it's a straightforward multivibrator. This provides the signal which goes into the screened guard wire. I've even jotted down the formula which gives you the frequency." (Fig. 1.)

Dick looked uncertainly at the

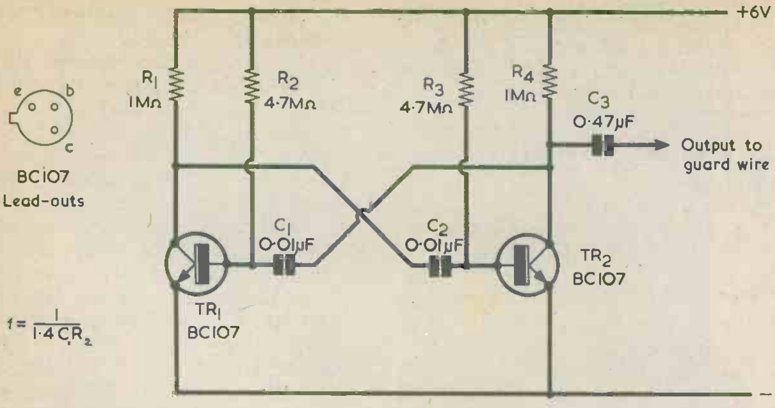


Fig. 1. The circuit of the multivibrator section of Smithy's guard circuit. In the equation the C and R terms apply to R2 and C1, or to R3 and C2

circuit.

"That doesn't look very straightforward to me. I've never ever seen a multivib having base and collector resistors with values as high as that."

"Well, you're seeing one now," retorted Smithy. "The collector resistors are 1MΩ and the base resistors are 4.7MΩ, and I chose these values to keep operating current low. Since this is a standard multivibrator, TR1 is on when TR2 is off, so that current flows first in R1 and then in R4. A resistance of 1MΩ at the supply voltage of 6 volts means a current of 6μA, and so the total collector current at a first guess is only 6μA, drawn for half the time by TR1 and for the other half by TR2. Actually, the current will be a bit higher than this because there is a small current in each collector resistor for a short while after the associated transistor has turned off. When TR2 turns off, for instance, current still flows in R4 until C1 becomes fully charged. There'll be a little extra current, too, in R2 and R3. I'd say that the total current drawn by the multivibrator would be, rough check, around 10μA."

"Gosh," said Dick, impressed, "that's *really* low. Just a minute, though. The two transistors you've used are silicon types. Isn't that likely to cause trouble because of the low reverse voltage ratings that silicon transistors have in their base-emitter junctions?"

"What happens in a multivibrator of this nature," said Smithy in reply, "is that when each transistor turns off its base is taken negative of the negative supply rail by approximately the supply voltage. If the base-emitter junction of a silicon transistor is taken to its breakdown level the junction then acts as a zener diode. But that won't happen here because the transistors I've selected are BC107's and these have a reverse base-emitter rating of 6 volts. Which is the same as the supply voltage."

"Blimey, Smithy," said Dick aggrievedly. "You have answers ready before I even ask the questions! How do we know this multivibrator circuit will work?"

"By the simple process of trying it out in practice," stated Smithy. "Find yourself an odd piece of tagboard and wire it up. It's a very simple circuit and it shouldn't take you more than five minutes or so to put it together."

Dick needed no second bidding, and he rushed eagerly to his bench to start work on the multivibrator. Smithy rummaged around on his own bench and found a battery holder into which he inserted four HP7 cells. He checked the voltage at the battery holder terminals and noted that this was a satisfactory 6.1 volts. He then quaffed deeply from his colourful mug of dubious dating, after which he scribbled some figures on his pad and then thoughtfully drew a further circuit diagram.

"I've nearly finished," called out Dick from his bench. "I'll bring this multivib over to you in a few more ticks."

Quickly, Smithy's assistant applied his soldering iron to several final joints, after which he laid it back on its rest. This done, he examined his handiwork carefully, then carried the small tagboard on which he had wired up the multivibrator to Smithy's bench.

"Right," said Smithy. "We'll see how it works. Whilst you were making it up I worked out its frequency. This is approximately 15Hz."

"How will you check that it works?"

"The obvious method," replied Smithy, "would be to connect the output to an a.f. amplifier or an oscilloscope. But there are a couple of very quick dodges that can also be used to check whether a multivibrator is running. One is to use an ordinary medium and long wave transistor radio. There's one here on my bench and I'll show you."

Smithy leaned over and picked up a small transistor receiver which he had finished repairing just before lunch-break. He switched it on, selected long waves, then tuned it to a section of the dial where there were no signals. He connected the multivibrator to the 6 volt battery holder and positioned the radio so that its internal ferrite rod aerial was close to the multivibrator wiring. A faint 15Hz buzz became audible from its speaker. He disconnected the 6 volt supply and the buzz ceased.

"That multivib is working all right," he remarked confidently, as he switched off the radio and returned it to the back of his bench. "Even with the very high values of collector resistor it has, that multivibrator is generating a sufficiently strong square wave for its harmonics to come through on the long wave band."

HEADPHONE DODGE

"What's the other dodge for checking multivibrators?"

"It's to use a pair of reasonably sensitive high resistance magnetic headphones," replied Smithy. "You know, the types which are 2,000 Ω per headphone. If you just connect one lead to the collector of a multivibrator transistor you'll usually hear the multivibrator tone. You don't have to connect the other headphone lead to anything, and the great advantage of this dodge is that there's virtually no loading on the multivibrator. Now, I have to say that both of these ideas are one-way in character. If you hear the tone in the headphones or via the receiver speaker you know that the multivibrator is running. If you don't hear the tone it's still possible that the multivibrator is working, but it's then necessary to check this by more conventional means." (Fig. 2.)

"Well," said Dick, looking down at Smithy's note-pad, "those are two little ideas which I'll have to to remember for the future. What's this new circuit you've drawn up?"

"It's the section of the alarm unit which detects the presence of the multivibrator signal passed via the guard wire," explained Smithy. "The signal from C3 in the multivibrator circuit passes through the guard wire and then goes through a second capacitor, C4, before being applied to the base of transistor TR3." (Fig. 3.)

"What does TR3 do? Does it amplify the signal?"

"It acts as a switching transistor," replied Smithy. "If you look at its collector circuit you'll see that there's a 1M Ω resistor, R6, going up to the positive supply, and a

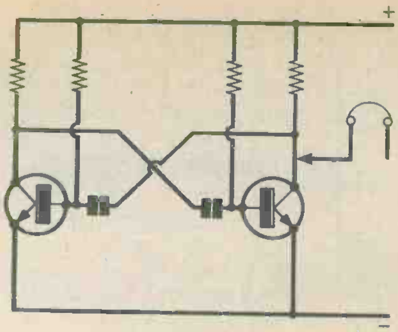


Fig. 2. It is frequently possible to hear the tone of an a.f. multivibrator in a pair of high resistance magnetic headphones with only one of the headphone leads connected to the multivibrator

0.22μF capacitor, C5, coupling the collector to the negative rail."

Dick studied the circuit for a few moments.

"You've got the multivibrator output coupling directly to the base of TR3," he said eventually, "and there'll be a low impedance between that base and the negative rail. Won't this low impedance load the multivibrator output very heavily?"

"It will put a fair load on the multivibrator," agreed Smithy, "but only for the first few cycles of oscillation after switching on. After that, C3 and C4 will have acquired a charge which causes the base of TR3 to be taken positive by about 0.6 volt during the most positive part of each multivibrator cycle. Like this."

Smithy sketched out the waveform appearing at TR3 base. (Fig. 4(a).)

"Oh, I see," commented Dick. "The base-emitter junction of TR3 is acting like a silicon diode."

"That's right."

"Why," asked Dick, "have you drawn the multivibrator output waveform so that the positive-going edge is curved instead of straight? Surely, that multivibrator should be giving a square wave output."

"It doesn't," stated Smithy. "That positive-going edge is what is given when TR2 in the multivibrator turns off. As I mentioned just now, its collector doesn't go fully positive immediately; instead, it goes positive at a fairly slow rate as C1 charges via R4. You get that effect in any multivibrator of the type we're using here. The important point is that the base of TR3 is taken up to about 0.6 volt positive for quite a sizeable part of each multivibrator cycle."

"And what does that do?"

"It causes TR3 to turn on during the period when the base is positive," replied Smithy. "In consequence, C5 is maintained discharged by the transistor. What happens here is that the voltage across the capacitor is held at about 0.2 volt when TR3 is on. When TR3 turns off, C5 commences to charge via R6 but, due to the high value of this resistor, it can only charge up to a little less than a volt before TR3 turns on again and takes the voltage back to about 0.2 volt. The voltage across the capacitor has a waveform something like this."

Smithy drew a further waveform. (Fig. 4(b).)

"I'm beginning to see the idea behind all this," said Dick thoughtfully. "When there's an input signal

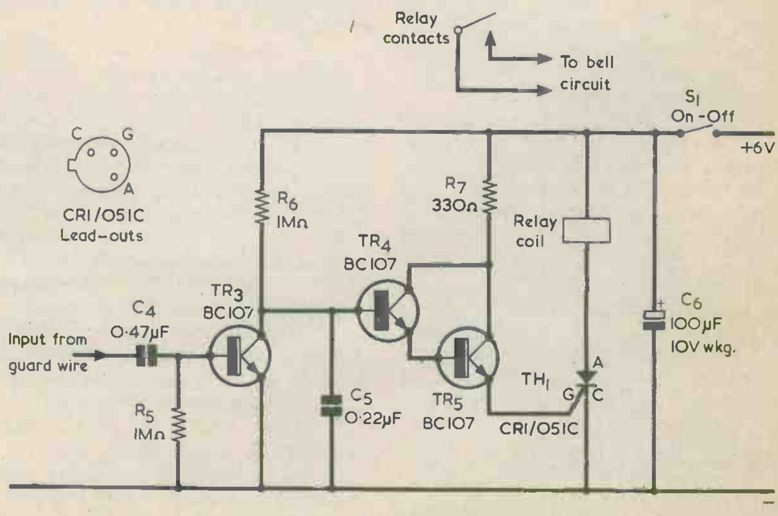


Fig. 3. The sensing and relay section of the guard circuit. The relay contacts close when the relay energises

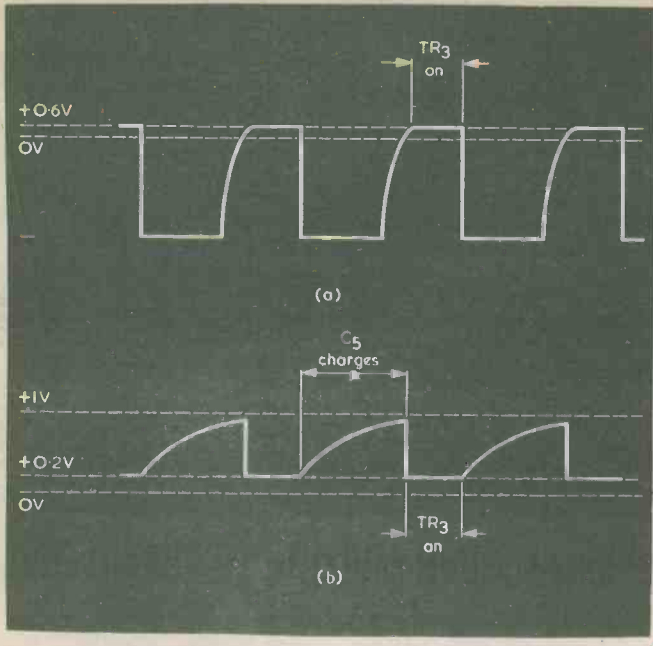


Fig. 4(a). The voltage on the base of TR3. This causes the transistor to turn on for a relatively large fraction of each multivibrator cycle (b). C5 charges when TR3 is off and is rapidly discharged when TR3 turns on. This waveform shows the voltage at TR3 collector

from the multivibrator getting through the guard wire to the base of TR3, that transistor keeps C5 discharged so that the voltage across it never rises more than a little under 1 volt."

"That's the idea," confirmed Smithy. "Also, the only current drawn from the 6 volt supply is that passing through R6. Since this resistor has a value of 1MΩ, the current passing through it is a little less than 6μA."

"Right," stated Dick. "I suppose that if the signal is interrupted by, say, a break in the guard wire, TR3 is not turned on at all and C5 charges up via R6."

"You've got it," grinned Smithy. "If there's a break in the guard wire, TR3 base is taken to the negative rail via R5 and the transistor turns off completely. C5 at once charges up by way of R6."

DARLINGTON PAIR

"I wonder," mused Dick, "what the rate of charge will be."

"It's quite easy to make a rough guesstimate here," said Smithy. "If you can cast your mind back to the gen-session we had around the time of the Jubilee Bank Holiday you may recall that we found that a charging current of 1μA into 1μF gives a voltage increase across the capacitor of 1 volt per second. We're starting off here with a charging current of a little less than 6μA going into a capacitance of 0.22μF, and so the initial increase of voltage across C5 when TR3 turns off will be at around 30 volts per second, this slowing down as the voltage increases. Speaking in very approximate terms, the voltage across C5 will reach a target value of 1.8 volts about one-fifteenth of a second after TR3 turns off."

"Blimey," remarked Dick excitedly as a sudden thought struck him. "The frequency of the multivibrator is 15 cycles per second. You only need to miss one positive pulse from the multivibrator for the voltage across C5 to rise to that 1.8 volt level you're talking about. Gosh, you don't half hide some crafty deals in the circuits you dream up, Smithy!"

"I have my moments," remarked Smithy modestly. "In practice you'd need to lose more than one positive multivibrator pulse before the remainder of the circuit is actuated but, even so, you wouldn't need to lose more than a few."

He picked up his vividly red, white and blue mug, drained its contents with one Brobdingnagian swallow and handed it to his assistant. Wordlessly, the latter took it from the Serviceman and carried it over to the variegated assortment of cracked and battered utensils near the sink which constituted the Workshop's culinary effects. Dick returned with the mug, now charged with a fresh steaming quantity of the precious fluid. Smithy drank avidly, then wiped his mouth noisily with the back of his hand.

"I don't know why you bother to

just drink that stuff," Dick remarked dispassionately. "It would save you time if you simply mainlined it straight into your bloodstream."

Smithy frowned at his assistant.

"I don't think," he stated, a touch of ice in his voice, "that that comment was in the best of taste."

"It was a joke," explained Dick patiently. "It was a remark intended to be in jugular vein!"

Smithy groaned.

"Let's get back to this circuit," he said hastily. "As I was saying just now, when TR3 turns off completely the voltage across C5 rises to 1.8 volts in something like one-fifteenth of a second."

"There's something that's just occurred to me," remarked Dick. "We keep talking about 1.8 volts across C5. What's so important about 1.8 volts?"

"It's the voltage at which TR4 commences to pass base current," said Smithy. "There are three silicon junctions between the upper plate of C5 and the negative rail, these being the base-emitter junction of TR4, the base-emitter junction of TR5 and the gate-cathode junction of thyristor TH1. Each of these drops a forward voltage of about 0.6 volt, with the result that no current can flow into the base of TR4 until that base is 1.8 volts positive of the negative rail."

"Just a minute," interrupted Dick, looking more closely at the circuit. "Aren't TR4 and TR5 connected up as a Darlington pair?"

"They are," confirmed Smithy, "with the consequence that there is a very high degree of current gain from the base of TR4 to the emitter of TR5. Right now, let's get back again to C5 charging up. When the voltage across C5 reaches 1.8 volts, forward current flows via R6 into the base of TR4. C5 needs to charge up only a little higher after this for the forward current flowing into TR4 base to be sufficiently high to allow the emitter current from TR5 to trigger on the thyristor. That current is limited to about 15mA by R7, but the thyristor will in fact be triggered when its gate current is somewhat less than 10mA. The relay whose coil is in the thyristor anode circuit then energises, and its contacts cause an alarm bell to ring. Once the thyristor is triggered on it stays on, even if the gate current is removed again, and so the relay remains energised until the circuit is turned off by the on-off switch. The current drawn on the 6 volt supply is now the current drawn by the relay coil plus the gate current flowing into the thyristor, but this relatively high current doesn't matter because the alarm is now on and triggered. Previously, the current drawn by this part of the circuit was only the 6μA passed by R6, because TR4, TR5 and TH1 were all turned off."

"What about leakage current in the transistors and the thyristor? Won't these add to the standby current?"

"With modern silicon semiconductors," stated Smithy, "leakage currents will be negligibly low. Well now, you might as well assemble this part of the alarm circuit on another tagboard and we'll then check out the whole thing."

"What sort of relay will I want?"

"Oh, any relay with a coil resistance of 300Ω or more which will energise reliably at a coil voltage of 5 volts or less. An excellent choice would be the Doram Electronics Miniature Open P.C. Relay with a 410Ω coil. I think we've got one knocking around somewhere."

"And the on-off switch?"

"There's no need to mount that on anything at this stage. Just connect it into circuit with a pair of flexible leads."

COMPLETE CIRCUIT

Again Dick returned to his bench and again there was the sound of frenzied industry as he assembled the signal sensing and relay section of Smithy's circuit. Whilst Dick worked, Smithy sipped at his tea musingly. After some moments he pulled his note-pad towards him, tore off the top sheet and drew a new circuit. Eventually, Dick announced that he had completed his wiring of the circuit.

"Good show," commented Smithy. "Bring it over here and then find two co-ax sockets, two co-ax plugs and a length of screened cable. TV aerial plugs and sockets will do."

Dick soon found the items required and he then positioned

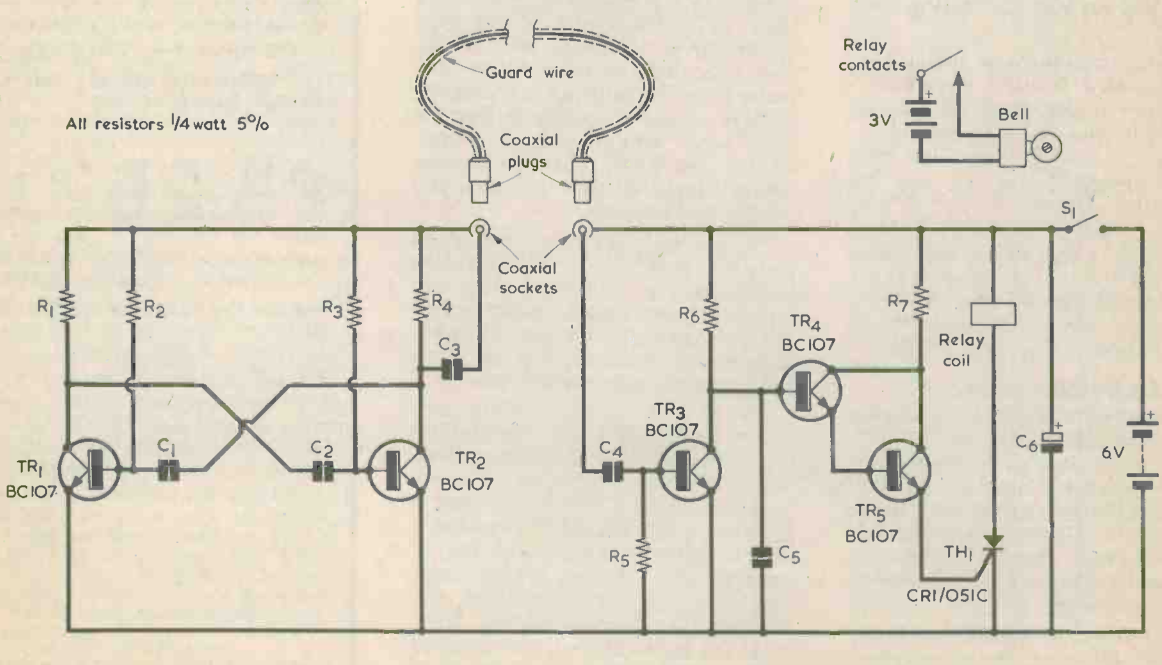


Fig. 5. The complete circuit of the guard device, illustrating how the two sections are coupled together by the screened guard wire. The bell sounds if either the inner or outer conductors of the guard wire are cut or if they are short-circuited together

himself alongside the Serviceman.

"I have now," stated that worthy, "drawn out the complete circuit of the electronic guard device. On the left is the multivibrator and on the right is the sensing and relay section. These are joined together by the guard wire which passes through the handles of the items being protected. The guard wire is, as I suggested at the beginning, a length of flexible screened wire. With this, the wire screening does three things. For a start, it screens the centre wire from picking up any static or noise which could upset the operation of the sensing section." (Fig. 5.)

"You've connected the screening to the positive rail. Why's that?"

"To give added protection. Let's suppose someone tries to beat the alarm and, in so doing, cuts the screening of the guard wire without cutting the centre lead. The positive supply to the multivibrator will then be interrupted, the multivibrator will stop and the alarm will sound. That's the second thing the guard wire screening does."

"What's the third thing?"

"It causes the alarm to sound if someone starts messing around with the guard wire and, in so doing, shorts the centre lead and the screening together. The output from the multivibrator to TR3 will then cease because it is short-circuited effectively to the negative rail."

"Gosh Smithy, you've thought of everything! The alarm sounds if the guard wire screening is cut, if the guard wire centre lead is cut or if the guard wire screening and centre lead are shorted together. Blimey, there's just no way of beating this circuit!"

"It would certainly be difficult to do so," stated Smithy cheerfully. "When you make up the circuit in final form you put all the electronics in a plastic or wooden box with the two coaxial sockets on the front panel. The guard wire has a coaxial plug at each end; this is threaded through the objects being protected and the ends are then plugged into the coaxial sockets. For the time being you can connect up the sockets with flexible wires and just have them lying on the bench. And we shan't bother about the bell circuit at this stage. We can tell if the gadget is operating by just looking at the relay armature. I've shown a separate battery for the bell, incidentally, because most electric bells draw quite heavy interrupted currents, and these could mess up the electronics if the same battery was used for both."

With the aid of Smithy's soldering iron Dick quickly coupled together the negative rails of the two sections of the guard circuit, then temporarily wired up the coaxial sockets. Finally, he connected the screened wire to the two coaxial plugs and fitted them into the sockets.

Ceremonially, Smithy connected the circuit to the 6 volt battery holder and switched on. The relay remained de-energised. He removed one of the coaxial plugs from its socket and quickly replaced it. The relay became energised, and stayed energised until Smithy switched the circuit off. Smithy switched on again then, with a screwdriver, short-circuited the screening and centre lead of the guard wire at one of the coaxial sockets. The relay energised, and remained energised once more until the circuit was switched off. Finally, Smithy unsoldered the wires at the inner and outer contacts of one of the coaxial sockets and held them in place with two crocodile clips. The relay was triggered on when the connection to the centre contact was broken. It was also triggered on when the connection to the outer contact was broken. Smithy re-soldered the leads at the socket.

CURRENT READING

"There you are," he said triumphantly. "Everything is working just as it should do."

"That's fantastic," breathed Dick, round-eyed. "Old Joe will go mad with delight when I bring this little lot in to him tonight."

"There's just one last thing to check," said Smithy. "And that's to measure the standby current drawn by the circuit when it's in the non-triggered condition."

Smithy drew his testmeter towards him and clipped its leads in series with the positive connection to the battery holder. He initially selected a high current range and switched on. The meter needle gave a slight kick as the $100\mu F$ bypass capacitor in the guard circuit charged, and then fell virtually to the zero mark. Smithy selected lower ranges until, on the most sensitive range of the meter, he obtained a significant forward deflection of the needle.

"And how," said Smithy exuberantly, pointing at the testmeter, "about that?"

The testmeter needle indicated $17\mu A$.

And so we end with a jubilant Dick and Smithy together with a Jubilee mug guard circuit indubitably drawing less than Smithy's design aim of $20\mu A$. Would Jubilee-ve it?

■

EDITOR'S NOTE:

The CR1/051C thyristor employed by Smithy is available from Arrow Electronics Ltd., Leader House, Coptfold Road, Brentwood, Essex.

GEOS — THE FIRST ALL — GEOSTATIONARY IN THE WORLD

By Arthur C. Gee

WHAT HAPPENS WHEN A SATELLITE DOES NOT GO INTO PLANNED ORBIT?

The European Space Agency planned to launch the world's first purely scientific geostationary satellite GEOS in April. A geostationary orbit is one in which the satellite *appears* to be stationary because it makes one circular equatorial orbit in exactly 24 hours. These orbits are usually associated with communications satellites which need to provide fixed continuous zones of coverage.

The satellite's geostationary orbit was to have been 36,000 km above the equator, when it would be in view of ESA's new ground station at Odenwald in Germany, for 24 hours a day. Also 36 hours after launch, a specially developed European apogee boost motor would transfer GEOS from its launch orbit into the geostationary orbit.

One of GEOS's main functions is to study the magnetosphere, which is the region of near-Earth space where the magnetic field of the earth still plays a dominating role. The magnetosphere prevents direct access of energetic solar particles to the earth and thus protects our planet from the harmful effects of space radiation.

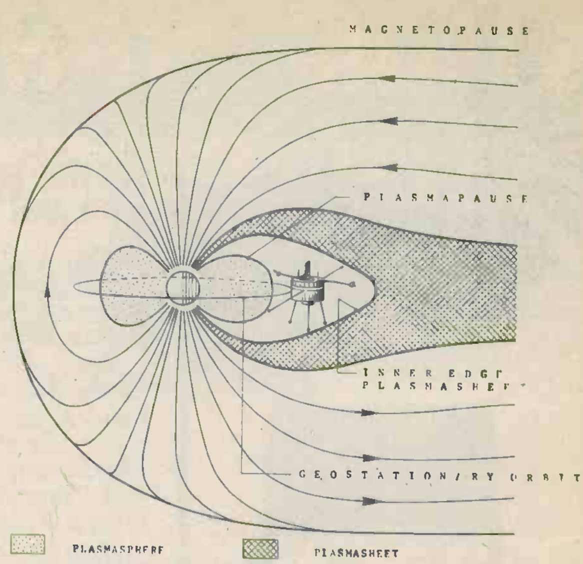
The fact that GEOS, which is ESA's ninth satellite, was to carry an exceptionally sensitive experimental payload, imposed severe constraints on the design of the spacecraft, especially in the fields of electromagnetic and chemical cleanliness. For example, a complex system of eight booms which deploy in orbit, including two radial booms 20 metres long, had to be designed to position sensitive experimental detectors as far as possible from satellite generated interference so that they could measure minute variations in the magnetosphere. In order to maximise the correlation of satellite data with ground station, balloon and sounding rocket measurements made on the same magnetic longitude. GEOS was to have been shifted on the same orbit between 0° and 35° E during the first year of operations by means of its altitude control hydrazine thrusters. In another difficult orbital manoeuvre, the satellite, with its booms deployed, was to be turned over every six months to avoid shadowing of the solar array by the radial booms.

The total weight of GEOS at launch was 573 kg.

Height 1.1 metres; diameter 1.62m. Two of its axial booms were 2.5 m. long; two more 1.0 m. long; two radial booms 3 m. long and the two more long radial booms 20 m. long. The "beginning of life" solar array power was 115 watts, with an "end of life" array power of 87 watts. The planned operational life is 2 years. Its geostationary was planned to be 36,000 km; its inclination less than 1.6°.

The spacecraft was built for ESA by industry in ten European countries. The prime contractor was the British Aircraft Corporation and the project was managed by

SCIENTIFIC SATELLITE



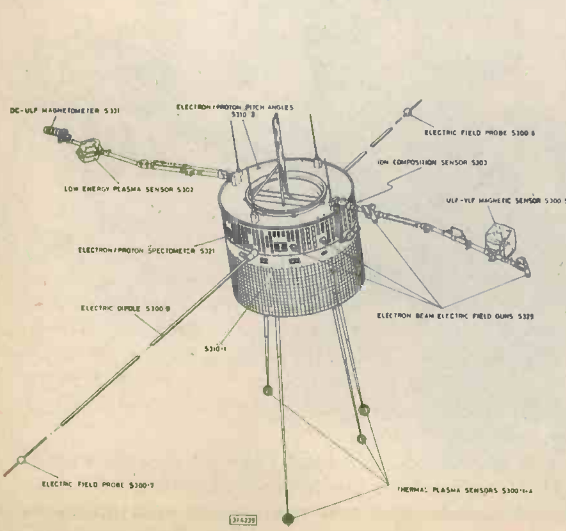
Diagrammatic view of earth's magnetosphere showing orbital environment of GEOS.

ESA's European space Research and Technology Centre at Noordwyk in Holland.

GEOS was launched on schedule at 10.15 GMT on Wednesday, April 20th, from the Eastern Test Range at Cape Canaveral, Florida. Whilst initial reports indicated that its orbital parameters were as expected and the spacecraft was operating satisfactorily, it soon became clear that the satellite had received no spin at separation from its Delta 2914 launcher and it was announced from the Eastern Test Range that a malfunctioning of the launch vehicle had occurred during second and third stage separation. As a result, the launcher failed to place the satellite into the transfer orbit required for subsequent injection into geostationary orbit.

Immediate and successful action was taken by ESA's space operations centre at Darmstadt in Germany to stabilise the satellite, and it was reported that it was safe, but in a too low transfer orbit, but was operating normally. This meant that GEOS would not now be able to be placed in its intended geostationary orbit as planned. A special meeting was called to which all those concerned with the experiments aboard GEOS were invited to discuss what could best be done with GEOS in its new orbit. This meeting took place on 26th April, and also an inquiry opened at the McDonnell Douglas HQ at Huntingdon Beach, California, into the malfunctioning of the Delta 2914 which launched GEOS.

As it was observed that the satellite's position in its incorrect transfer orbit was having an adverse effect on its solar cells and endangering the spacecraft's power supply, a decision had to be taken immediately on an alternative orbit. On April 25th at 07.38 hours GMT, the ESA's European Space Operations Centre at Darmstadt successfully fired the spacecraft's apogee boost motor and placed GEOs in a new orbit of 12.06 hours elliptical format, with an apogee of 28,498 km and perigee of 2,131 km and an inclination of 26.85 degrees. The operation was preceded by various altitude manoeuvres carried out over the weekend to reorientate the spin axis of the satellite to 70 degrees to enable the apogee boost motor to be fired in exactly the right direction.



At the meeting on April 26th it was decided to proceed with the first of GEOS's seven experiments, switching them on and testing for 30 minutes on April 29th. Prior to this a rotation of the satellite's orbit to move its apogee westwards from 90° E to 35° E at the rate of 4 to 5 degrees per day was carried out. This increased its visibility from Odenwald to about two to seven hours daily, disappointing when compared with the planned 24 hour visibility of the geostationary orbit, but better than nothing at all.

During subsequent days, boom deployment was proceeded with in easy stages, to see all was working properly. By the end of the first week in May, the experimental switching on and testing programme was completed and all seven experiments became operational. The UHF antennas were successfully deployed on April 27th, since when, telemetry at twelve KBS and 95 KBS has been received and processed successfully each day.

The seven GEOS experiments have, between them, detected electron and proton spectra, relatively heavy ions and have provided magnetic field data down to 3.5 earth radii. The electron beam experiment acquired its signal almost instantaneously. This is an indication that this novel experiment designed to measure the electric and magnetic fields will be able to carry out these measurements over the observable part of the satellites revised non-geostationary orbit.

So, what at first looked like being a disaster, was turned into something which after all will produce worthwhile scientific data.

■

Trade News . . .

SLIM AND RUGGED SUBMINIATURE LOUDSPEAKER

A new subminiature loudspeaker, the CB, combining a slim and rugged design with reliable performance, has been launched by Knowles Electronics of Victoria Road, Burgess Hill, Sussex.

The CB's exceptional slimness — its depth is only 9.65mm — makes it particularly suitable for use in talk-back pagers and walkie-talkies.

It is also suitable for inter-office communications equipment, dictating machines, sophisticated telephone systems and other communications equipment.

Its rugged and splash proof design makes it especially ideal for outdoor applications. The front can be exposed to splashing provided the rear cavity is sealed from the atmosphere.

Yet nothing has been sacrificed to performance. Although rated at 50 milliwatts, the new model has a level of intelligibility of equipments up to one watt.

The CB range contains six types, that is three impedances of 12, 24 and 48 ohms at 500 Hertz, with either face-fire or edge-fire sound outlet ports for manufacturing convenience. Its dimensions are 25.15 x 25.40 x 9.65mm.

WEIR INSTRUMENTATION RANGE AT LABORATORY EQUIPMENT EXHIBITION

Weir Instrumentation Limited will be showing their latest bench power supply units and card power supply modules at the Laboratory Equipment Exhibition, to be held at the Thames Polytechnic, Woolwich, 26th and 27th October.

They will be featuring the advanced Microlab 105, believed to be the first unit of its kind specially designed for use in development and test of microprocessor based systems. This unit not only delivers all the d.c. supplies required for a complete microcomputer system but also provides essential "start-up" and "shut-down" logic signals and delays for programme and memory protection.

Also on display will be the Weir Twinpack dual power supply, based on the very successful Mini 400, a pair of these units being mounted in a single case with a common mains supply inlet.

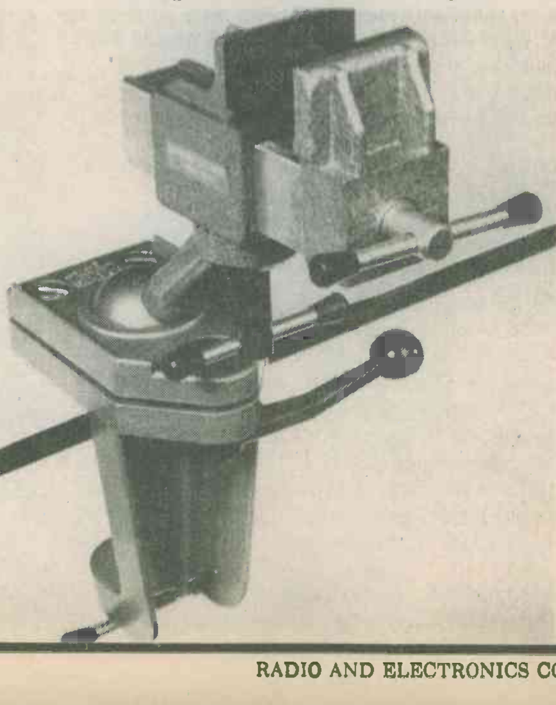
The Company will, in addition, be showing examples of Weir Electronics custom built power supply equipment, specially designed and manufactured on an o.e.m. basis to meet customers' exact requirements.

Equipment shown will include high voltage power units, such as the supply for the photo multiplier units in EMI's advanced Body Scanner computer controlled X-ray diagnostic system, and high-voltage multi-rail power supplies for use in photo copying machines.

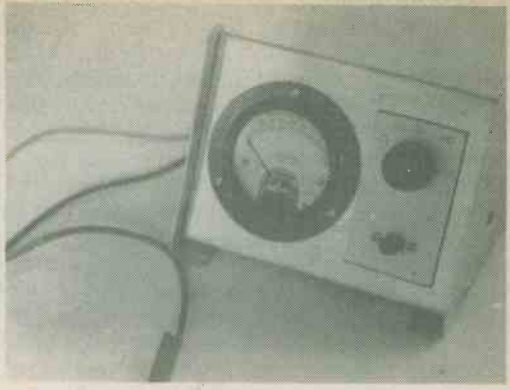
Also on show will be examples of high reliability low voltage composite power supplies specially tailored for computer systems.

PRECISION MADE BENCH VICE

A precision made bench vice which should interest many enthusiasts is now available from Greenwood Electronics of Portman Road, Reading, Berkshire, manufacturers of professional soldering irons and equipment. The Oryx Model 1B vice is a versatile tool with 3.5 inch jaws and is fully adjustable to rotate through 360° and can be locked in any position. The vice is equipped with nylon jaw linings giving a firm grip with no damage to the work piece. Jaw linings are replaceable. The main components of the vice are cast in high tensile strength lightweight alloy and finished in stove enamelled green. Cost of the Oryx bench vice is £19.95 plus VAT at 8%.



SIMPLE TO MAKE INSTRUMENT CASE



by J. Turner

Metalworking often raises problems for constructors, usually because of lack of facilities, space or suitable tools. Our contributor therefore describes a neat instrument case which is quite easy to make, and also passes on a number of very useful general tips.

This case is designed for construction using very simple technical skills in sheet metalwork which yet yield a satisfactory and even professional looking result.

Only the most basic tools are needed: a hand drill and a few drill bits, a hammer or mallet, some short squared off scraps of wood and a pair of good tinsnips. A bench vice is desirable but not essential.

The main purpose of this article is to demonstrate how easily the case may be constructed. Dimensions are given for the front and back, and these can be readily modified if a larger or smaller case is required.

Fig. 1. The case in its assembled form. There are four aluminium panels, a tie rod and four rubber feet

RAW MATERIAL

The raw material proposed is sheet aluminium in 18 s.w.g. (approximately 1mm. thick), or perhaps 16 s.w.g. (approximately 1.5mm. thick) for larger size cases.

The shape of the case is that of a triangular cross-section with flat ends. The ends are two separate pieces of metal and the triangular body itself is also made of two parts.

When deciding on the sizes of the parts it seems usually that the most important considerations are either the dimensions of the front panel if the instrument needs a large number of knobs and dials, or alternatively the enclosed volume if shoehorning many components in is the real problem.

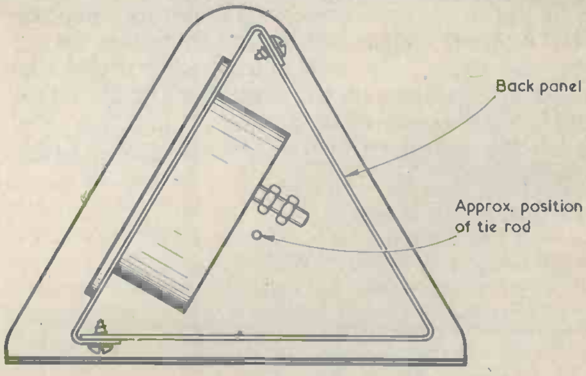


Fig. 2. A section through the middle of the case

The example chosen to illustrate the general method is a simple multimeter using a standard panel meter movement, a wafer switch and a potentiometer with a small selection of resistors and pre-set potentiometers. For economy of bench space the whole thing is made as small as possible so that the limiting factor becomes the size of the front panel.

Now if you look at the diagrams you will see that the one really important feature of the dimensions is that the front and back panels should be exactly the same width and should have parallel edges. This is just the sort of requirement that is difficult to meet with tools of home workshop type so we must adopt a sensible expedient. For most of us our material will almost certainly be obtained, directly or indirectly, as off-cuts from some factory scrap bin and usually the pieces are trimmings taken off the edges of large sheets with an accurate guillotine. These pieces are hence truly parallel and well suited to our needs. Because of this the choice of width of our case will tend to be influenced by the size of our available material. For the multimeter case the width adopted is 105mm. and naturally both front and back panels were cut from the same piece of metal.

Having chosen the best off-cut for our requirements we now need to mark out where we have to cut it and bend it. For neatness the cuts should be at right angles to the edges of the sheet but real precision in this is not absolutely vital. On the other hand it is very important that the *bends* should be as truly as possible at right angles to the edges or the finished case will end up with a skewed shape. If you have a good engineer's tri-square by all means use it but if not you need not rush out and buy one. All you need to make a very precise right angle is a straight edged piece of card, or even paper, which can be folded neatly in half so that its edge doubles back over itself. It can then be passed over the edge of our sheet metal to allow us to mark a true line across. A more permanent square can be improvised by substituting thin sheet metal for the card. For making the marks upon our aluminium sheet a ball-point pen is quite as good as a proper scriber and an ordinary pencil will serve almost as well.

When sheet metal is cut with ordinary tinsnips it will be found that the edges will inevitably become curled to some extent but, in the thickness we are using and especially with a malleable metal like aluminium, this can be corrected very easily either with judicious use of a mallet or hammer and wooden block or even just by reshaping with finger pressure alone.

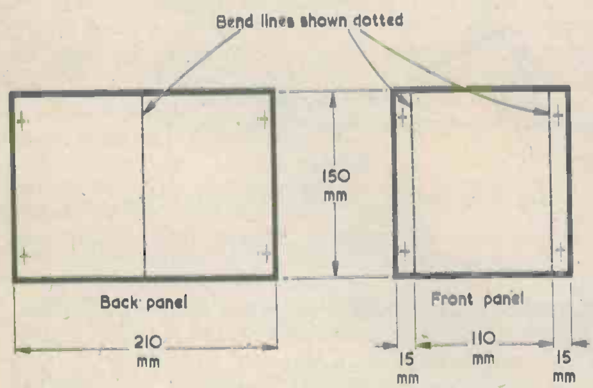


Fig. 3. Front and back panel blocks. These are shown in the flat before bending

BENDING

Now as has been said the most critical part of the construction lies in making good crisp bends in the front and back panels so, having marked their positions carefully as shown in the diagrams, we need to make quite sure that the actual bend lines come just where we want them. If we have a good bench mounted vice available this will simplify matters considerably. We can clamp the metal up against some well defined straight-edged former such as a piece of steel angle or strip (if the latter it should be at least 5mm. thick) or a piece of hardwood or perhaps even Formica-faced chip or blockboard, and them push the metal down with the hands, finally closing it up using a mallet or hammer with a block of wood to protect the metal from direct blows.

If no vice is available the sheet metal can be held between two pieces of wood with the edge of the lower one aligned with the line of the required bend and then turned down using a hammer and wooden block. The two pieces of wood can be held together by clamping to the bench or merely by placing them on the floor and standing on them.

Fig. 4. The tie rod. This consists of a bicycle wheel spoke cut to length with its end bent to form a hook

The two bends on the front panel and the single bend in the rear panel are all made to an included angle of about 60°. If this angle can be achieved over the wooden or metal former all well and good but if the available former can only yield 90° bends don't worry. Once the bend has been well started in the right place it can be finished by putting the panel flat upon the bench, or even on a plank on the floor, with the bent part uppermost and the metal restrained by hand (or foot) pressure, and then using a mallet or hammer and block to close it down as desired.

When this has been done it will be possible to fit the front and back panels together as a direct check that the angles are correct and match one another. To join these two together we shall use four self-tapping screws roughly in the positions indicated. Actual positions are largely immaterial provided only that the two panels align properly at the edges.

For fitting self-tapping screws we will need two drills, the first giving a hole of such a size that the screw cuts its thread and grips when screwed in and the second, larger, drill giving a hole, called the clearance size into which the screw fits loosely. To ensure that these two holes are in line first clamp the panels in position and drill through with the smaller size then separate them and enlarge the top hole only to clearance size. If the holes are drilled as described one at a time and screwed together as they are made there will be plenty of scope for

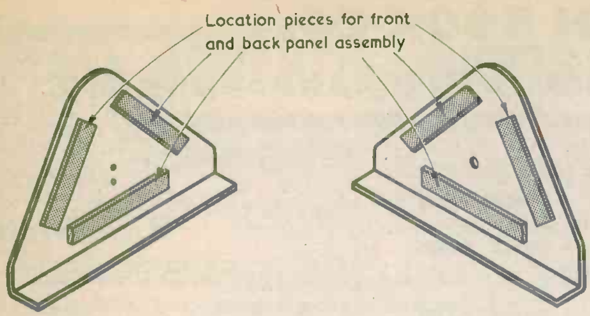


Fig. 5. The end panels. Also shown are four rubber pads which provide the feet

minor adjustments to the shape of the case as it is assembled. Some simple form of temporary fixing by small cheap G cramps or even a pair of Mole grips will be found very helpful at this stage.

edges but remember to avoid scratching the face of the metal.

To hold the ends in place we will use a single tie rod passing down the middle of the case parallel with the front panel. The actual position of this rod will probably be influenced by the components inside but it must be reasonably near the centre of the triangle which is the cross-section. The rod could conveniently be a length of studding (continously threaded metal rod) with nuts each end, but there is a simpler and perhaps more attractive alternative in the form of an ordinary bicycle wheel spoke. This can be cut to a suitable length and a flattened hook formed on the cut end, as shown, to fit into two adjacent holes drilled in one end piece. The hole in the other end piece should be large enough to take the nipple and preferably countersunk to match it.

It would seem sensible to insulate the tie rod with a plastic sleeve which, if reasonably tight, will also serve to simplify assembly by making the rod

Similar techniques can be employed for the construction of larger cases. The right hand case here houses an electric time switch

CASE ENDS

The ends of the case are made from identical flat blanks which are bent as before either in a vice or held between planks of wood. Notice that the edges of the end pieces are, unlike the front and back panels, fully exposed and so must be smoothed and rounded to remove any sharpness. This can be best accomplished by rubbing emery cloth along the

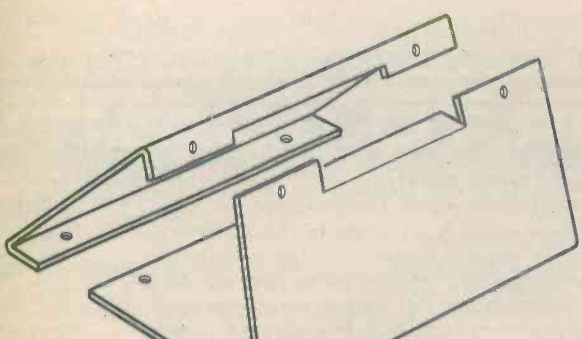


Fig. 6. The front and back panels ready for assembly. These have been modified to provide an integral handle

captive in the end cover in which it is hooked.

To prevent the ends sliding about we now stick on the inside surface of each, using Araldite, three scrap pieces of metal so placed that they locate against the inside of the triangle formed by the front and back panels. It is suggested that for many types of instruments it will be a good idea to arrange the positioning of the ends so that the protruding lip each side of the front panel is quite deep to give protection to knobs and lamps etc., in the event of the instrument being dropped on its face.

The lower edges of the ends, which are turned back under the case, can have strips of rubber glued on with Evostick to provide simple and very satisfactory feet.

An additional feature which can quite easily be worked into this design is an integral handle. The finger grip itself is provided by slitting the flange, at the top of the front panel, in two places about 90 or 100mm. apart and curling this part back inside. To allow clearance for the finger tips a similar pair of slits are cut into the upper edge of the back panel and the intervening section is bent inwards.

To obtain a rather different effect using the same basic method the end pieces may be made very satisfactorily out of chipboard either veneered or laminate faced. These are edged appropriately, after cutting, with a veneer or vinyl strip or even paint. ■

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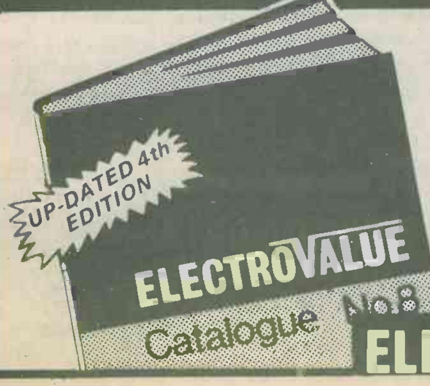

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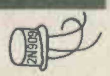

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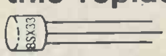

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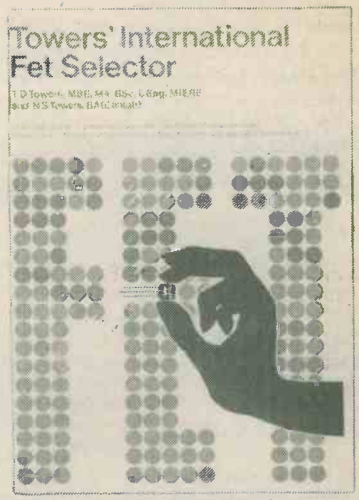

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(Continued from page 187)

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(Continued on page 190)

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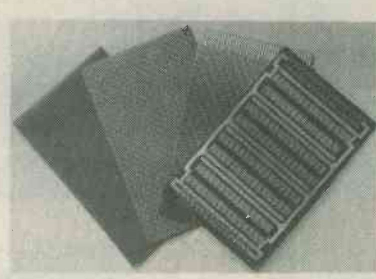

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(Continued on page 191)

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(Continued from page 190)

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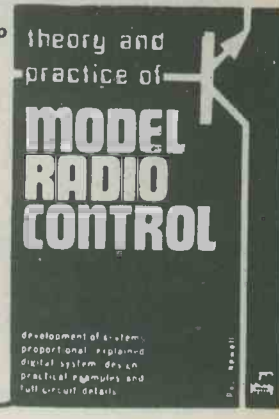

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