RADIO CONSTRUCTOR
& ELECTRONICS

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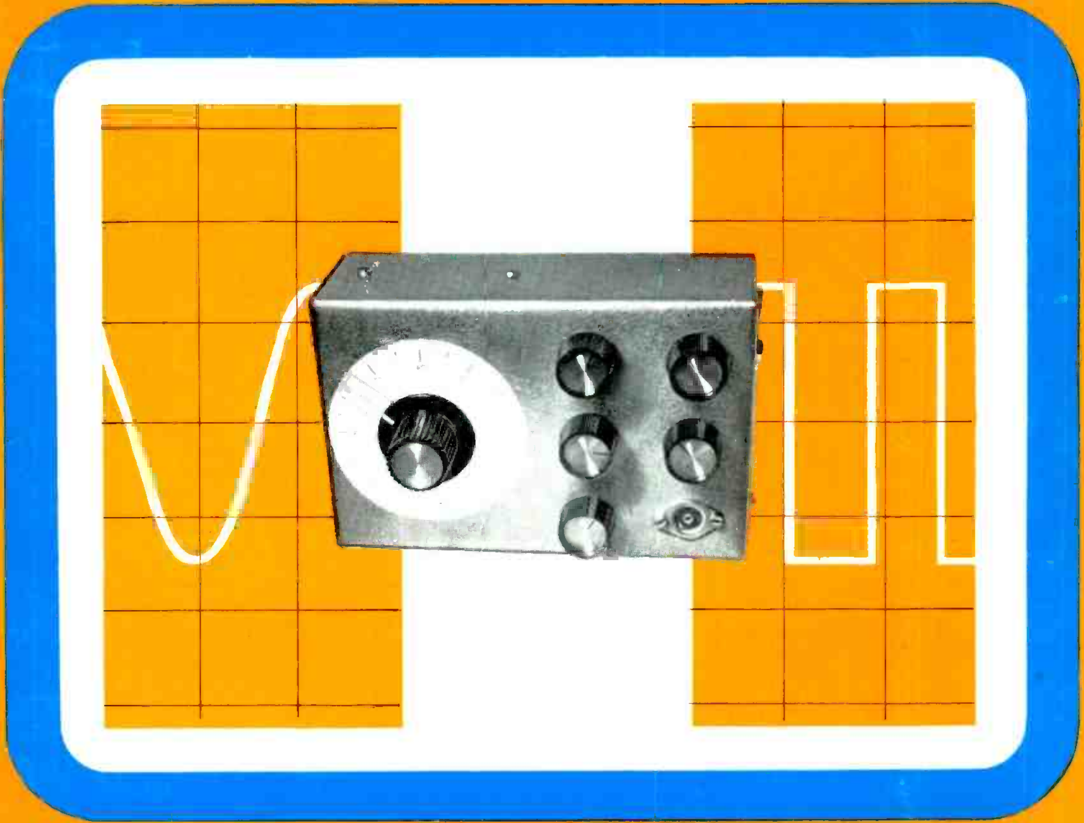


A.F. SIGNAL GENERATOR

This generator offers both sine and square wave outputs and it covers 15Hz to 150kHz in four ranges

Special
IN THIS ISSUE

ELECTRONIC METRONOME
SHORT WAVE CRYSTAL SETS


HOME
UNIT
INSURANCE
1 Household contents and personal possessions up to £600
2 All Risks cover on personal belongings up to £60
3 Personal accident insurance (road, rail and sea risks) – £3 per week
4 Loss of cash up to £20
5 Household removal cover up to £600
6 All Risks cover on sports equipment up to £30
7 Personal liability cover for the family up to £20,000
8 Cover on Radio, Television etc., for damage in the home up to £60
9 Holiday deposits cover up to £20
9 policies in ONE

COMPONENTS

HOBBYIST - AMATEUR - DOMESTIC SURPLUS
INDUSTRIAL - BULK OFFERS

JUST A FEW OF OUR BARGAINS ARE LISTED BELOW - PAY US A VISIT
OR SEND STAMPED ADDRESSED ENVELOPE FOR A QUOTE ON YOUR REQUIREMENTS

SEMICONDUCTORS

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

AF116	**15p**
AC188	**25p**
AD161	**30p**
AD162	**30p**
Matched pair	**50p**
BFY52	**16p**
ORP12	**43p**

2N3055	**45p**
2N2401	**15p**
Centercel Diodes	**5p**
6–110 volt, 0.6 amp. nominal bridge rect. encapsulated with built in Heat Sink	**15p**

T.O.3 Mica washers	**2p**

UNMARKED TESTED

BY127	**8p**
BC107–8–9	**5p**
2N2926	**5p**

$1\frac{1}{4}$ glass fuses— 250 m/a or 3 amp (box of 12)	**6p**
3" tape spools	**4p**
FX2236 Ferrox Cubes	**5p**
PVC or metal clip on M.E.S. bulb holder	**3p**
All metal equipment Phono plug	**2p**
Bulgin, 5mm Jack plug and switched socket (pair)	**20p**
12 volt solenoid and plunger	**25p**
250 RPM 50 c/s locked frequency miniature mains motor	**50p**
200 OHM coil, $1\frac{1}{4}$" long, hollow centre	**10p**
Relay, P.O. 3000 type, 1,000 OHM coil, 4 pole c/o	**60p**

SWITCHES

Pole	*Way*	*Type*	
4	2	Sub. Min. Slide	**10p**
6	4	Wafer Rotary	**12p each**
1	11		
4	3		
3	7		
2	5		
1	3	off Sub. min. edge	**10p**
1	3	13 amp small rotary	**12p**
2	2	Locking with 2 to 3 keys	**£1.50**

RESISTORS

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

SKELETON PRESETS

5K or 500K	**3p**

SAFETY PINS

Standard size, 10 for **4p**

VALVES – NEW AND BOXED

DY86	**44p**	EM87	**90p**	PL84	**46p**
EB91	**26p**	EL84	**36p**	PY81	**40p**
ECC82	**36p**	EY86	**46p**	PY82	**42p**
ECC83	**36p**	EZ80	**30p**	PY88	**52p**
ECH81	**44p**	PCC84	**50p**	UABC80	**58p**
EABC80	**46p**	PCC89	**62p**	UCL82	**50p**
EBF89	**44p**	PCF80	**38p**	UL84	**50p**
ECL82	**44p**	PCF82	**50p**	UY85	**42p**
ECL86	**56p**	PCL82	**38p**	UM84	**32p**
EF80	**36p**	PCL84	**50p**	UCH81	**44p**
EF85	**44p**	PCL85	**64p**	6BA6	**26p**
EF86	**44p**	PCL86	**56p**		
EF91	**52p**	PL36	**78p**	MANY OTHERS	
EF183	**40p**	PL81	**72p**		
EF184	**44p**	PL83	**56p**		

DIE CAST ALLY BOX

$4\frac{5}{8} \times 3\frac{5}{8} \times 2\frac{1}{8}$ with lid **50p**

5K switched volume control	**15p**
5K Log Pot	**10p**
1meg Tandem Pot	**15p**

BSR TD2 TAPE TRANSPORTER

With 4 track heads **£2.50**

STEEL BOX WITH LID

$10 \times 5\frac{1}{2} \times 3$" grey hammer finish **£1**

RESETTABLE COUNTER

6–14 volt, 6 digit, illuminated, fully enclosed. **£2.50**

RELAY

6 volt, 2 pole c/o heavy duty contacts **50p**

ELECTROLYTICS

Mullard C426, TCC, CRL, CCL, HUNTS, STC SUB MINIATURE, ETC.

MFD	*Volt*		*MFD*	*Volt*	
16	50	**5p each**	20	12	**4p each**
260	12		100	6	
50	50		100	25	
100	18		100	6	**2p each**
125	10		6	3	
8	50		8	6	
12	20		25	6.4	**3p**
10	20		250	18	**7p**
8.2	20		500	6	**6p each**
50	25		400	16	
2.5	64		8	500	**9p**
25	25		100	200	**10p**

CONDENSERS

MFD	*Volt*	
0.005	500	**2p each**
0.001	1,250	
3.3PF	500	
500 PF	500	
2,200PF	500	
3,300PF	500	
0.1	350	**3p each**
0.1	500	
0.25	150	
0.056	5% 350V	
0.061		
0.066		
0.069		
0.075		
0.08		
0.1	1,500	**4p each**
0.25	350	
0.5	350	**5p**
0.22	250	**5p**

Mullard Polyester

TUNING GANG

100PF, 50PF, 33PF
20p each

TRIMMERS

30 PF Beehive	**10p each**
12PF P.T.F.E.	
2,500PF 750V	

WIREWOUND SLIDER

150 OHM, 250 OHM
5K **4p each**

INDICATORS

12 volt red or mains neon amber, push fit round, chrome bezel
15p each

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

WIREWOUND POTS

250, 350 OHM, 1K, 4 watt, 10K, 20K, 50K, all at **10p each**

RECORD PLAYER CARTRIDGE

ER.5XME Mono, with turn over stylii, single hole fixing **35p**

GREEN INDICATOR

Takes M.E.S bulb **10p**

CONNECTOR STRIP

Belling Lee L1469, 12 way polythene. **5p each**

CAN CLIPS

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

T.O.5 HEATSINKS

Style 154 high conductivity **5p**

PAXOLINE

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

OUTPUT TRANSFORMERS

Sub-miniature **20p**

THE RADIO SHACK

161 ST. JOHNS HILL, BATTERSEA, LONDON S.W.11
Open 10 a.m. till 8 p.m. Monday to Saturday **Phone 01-223 5016**

SMALL ORDERS, ENCLOSE SUITABLE STAMPED ADDRESSED ENVELOPE

LARGE ORDERS, ADD SUFFICIENT FOR POSTAGE, INSURANCE, ETC.

The largest selection

NEW LOW PRICE TESTED S.C.R.'s

PIV	1A TO-5 £p	3A TO-66 £p	7A TO-66 £p	10A £p	16A TO-48 £p	30A TO-48 £p
50	0·23	0·25	0·47	0·50	0·53	1·15
100	0·25	0·33	0·53	0·58	0·63	1·40
200	0·35	0·37	0·57	0·61	0·75	1·60
400	0·43	0·47	0·67	0·75	0·93	1·75
600	0·53	0·57	0·77	0·97	1·25	—
800	0·63	0·70	0·90	1·20	1·50	4·00

SIL. RECTS. TESTED

PIV	300mA £p	750mA £p	1A £p	1·5A £p	3A £p	10A £p	30A £p
50	0·40	0·06	0·05	0·07	0·14	0·21	0·47
100	0·04	0·06	0·05	0·13	0·16	0·23	0·75
200	0·05	0·09	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·23	0·34	0·45	1·85
800	0·10	0·17	0·13	0·25	0·37	0·55	2·00
1000	0·11	0·25	0·15	0·30	0·46	0·63	2·50
1200	—	0·33	—	0·33	0·57	0·75	—

TRIACS

VBOM	2A TO-1 £p	6A TO-66 £p	10A TO-88 £p
100	30	50	75
200	50	60	90
400	70	75	1-10

DIACS

FOR USE WITH TRIACS BR100 (D32) 37p each

UNIJUNCTION

UT46. Eqvt. 2N2646, Eqvt. TI843. BEN3000 27p each, 25–99 25p 100 UP 20p.

NPN SILICON PLANAR

BC107/108 10p each; 50–99 9p; 100 up, 8p each; 1,000 off, 7p each. Fully-tested and coded TO-18 case.

FREE

One 50p Pak of your own choice free with orders valued £4 or over.

SPECIAL OFFER

2N2926 (Y) (O) 10 for 50p, 25 for £1 20,000 TO CLEAR

CADMIUM CELLS

ORP12 43p
ORP60, ORP61 40p each

GENERAL PURPOSE NPN SILICON SWITCHING TRANS. TO-18 SIM. TO 2N706/8, BSY27/28/95A. All usable devices no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

£p	
	100 For 1.75
20 For 0.50	500 For 7.50
50 For 1.00	1000 For 18.00

PHOTO TRANS.

OCP71 Type. 43p

SIL. G.P. DIODES £p

300mW	30	0·50
40PIV(Min.)	100	1·50
Sub-Min.	500	5·00
Full Tested	1,000	9·00

Ideal for Organ Builders.

D13D1 Silicon Unilateral switch 50p each.

A Silicon Planar, monolithic integrated circuit having thyristor electrical characteristics, but with an anode gate and a built-in "Zener" diode between gate and cathode. Full data and application circuits available on request.

FULL RANGE OF ZENER DIODES VOLTAGE RANGE 2-33V. 400mV (DO-7 Case) 13p ea. 1½W (Top-Hat) 18p ea. 10W (SO-10 Stud) 25p ea. All fully tested 5% tol. and marked. State voltage required.

10 amp POTTED BRIDGE RECTIFIER on heat sink. 100 PIV. 90p each.

JUMBO COMPONENT PAKS

MIXED ELECTRONIC COMPONENTS

Exceptionally good value

Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 3lbs in weight. Price incl. P. & P. £1.50 only

Plus our satisfaction or money back guarantee.

BRAND NEW TEXAS GERM. TRANSISTORS
Coded and Guaranteed

Pak No.			EQVT
T1	8	2G3713	OC71
T2	8	D1374	OC75
T3	8	D1216	OC81D
T4	8	2G381T	OC81
T5	8	2G382T	OC82
T6	8	2G344B	OC44
T7	8	2G345B	OC45
T8	8	2G378	OC78
T9	8	2G399A	2N1302
T10	8	2G417	AF117

All 50p each pak

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS. Our price 25p each.

120 VCB NIXIE DRIVER TRANSISTOR. Sim. BSX21 & C407, 2N1893 FULLY TESTED AND CODED ND 120. 1-24 17p each. TO.5 N.P.N. 25 up 15p each.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 5p each. Any Qty.

NEW LINE

Plastic encapsulated 2 amp Bridge Rects.

50 v RMS 32p each
100 v RMS 37p each
400 v RMS 46p each

Size 15 mm x 6 mm

KING OF THE PAKS Unequalled Value and Quality

SUPER PAKS

NEW BI-PAK UNTESTED SEMICONDUCTORS

Satisfaction GUARANTEED in Every Pak, or money back.

Pak No.		£p
U1	120 Glass sub-min. general purpose germanium diodes	0.50
U2	60 Mixed germanium transistors AF/RF	0.50
U3	75 Germanium gold bonded diodes sim. OA5, OA47	0.50
U4	40 Germanium transistors like OC81, AC128	0.50
U5	60 200mA sub-min. Sil. diodes	0.50
U6	30 Silicon planar transistors NPN sim. BSY95A, 2N706	0.50
U7	16 Silicon rectifiers Top-Hat 750mA up to 1,000V	0.50
U8	50 Sil. planar diodes 250mA, 0A/200/202	0.50
U9	20 Mixed volts 1 watt Zener diodes	0.50
U11	25 PNP silicon planar transistors TO-5 sim. 2N1132	0.50
U13	30 PNP-NPN sil. transistors OC200 & 2S104	0.50
U14	150 Mixed silicon and germanium diodes	0.50
U15	25 NPN Silicon planar transistors TO-5 sim. 2N697	0.50
U16	10 3-Amp silicon rectifiers stud type up to 1000 PIV	0.50
U17	30 Germanium PNP AF transistors TO-5 like ACY 17-22	0.50
U18	8 6-Amp silicon rectifiers BYZ13 type up to 600 PIV	0.50
U19	25 Silicon NPN transistors like BC108	0.50
U20	12 1.5-Amp silicon rectifiers Top Hat up to 1,000 PIV	0.50
U21	30 A.F. germanium alloy transistors 2G300 series & OC71	0.50
U23	30 Madt's like MAT series PNP transistors	0.50
U24	20 Germanium 1-Amp rectifiers GJM up to 300 PIV	0.50
U25	25 300Mc/s NPN silicon transistors 2N708, BSY27	0.50
U26	30 Fast switching silicon diodes like 1N914 micro-min	0.50
U29	10 1-Amp SCR's TO-5 can up to 600 PIV CRS1/25 600	1.00
U31	20 Sil. Planar NPN trans. low noise amp 2N3707	0.50
U32	25 Zener diodes 400 mW D07 case mixed volts, 3–18	0.50
U33	15 Plastic case 1 amp silicon rectifiers IN4000 series	0.50
U34	30 Sil. PNP alloy trans. TO 5 BCY26, 2S302/4	0.50
U35	25 Sil. planar trans. PNP TO-18 2N2906	0.50
U36	25 Sil. planar NPN trans. TO-5 BFY50/51/52	0.50
U37	30 Sil. alloy trans. SO-2 PNP, OC200 2S322	0.50
U38	20 Fast switching sil. trans. NPN, 400Mc/s 2N3011	0.50
U39	30 RF germ. PNP trans. 2N1303/5 TO-5	0.50
U40	10 Dual trans. 6 lead TO-5 2N2060	0.50
U41	25 RF germ. trans. TO-1 OC45 NKT72	0.50
U42	10 VHF germ. PNP trans. TO-1 NKT667 AF 117	0.50
U43	25 Sil. trans. plastic TO18 A.F. BC113/114	0.50
U44	20 Sil. trans. plastic TO-5 BC115/116	0.50
U45	7 3-Amp SCR's TO-66 case up to 600V	1.00

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

NEW QUALITY TESTED PACKS

Pack	Description	Price £p
Q1	20 Red spot trans. PNP	0.50
Q2	16 White spot R.F. trans. PNP	0.50
Q3	4 OC77 type trans.	0.50
Q4	6 Matched trans. OC44/45/81/81D	0.50
Q5	4 OC75 transistors	0.50
Q6	4 OC72 transistors	0.50
Q7	4 AC128 trans. PNP high gain	0.50
Q8	4 AC126 trans. PNP	0.50
Q9	7 OC81 type trans.	0.50
Q10	7 OC71 type trans.	0.50
Q11	2 AC127/128 comp. pairs PNP/NPN	0.50
Q12	3 AF116 type trans.	0.50
Q13	3 AF117 type trans.	0.50
Q14	3 OC171 H.F. type trans.	0.50
Q15	5 2N2926 sil. epoxy trans.	0.50
Q16	2 GET880 low noise germ. trans.	0.50
Q17	3 NPN 1 ST141 & 2 ST140	0.50
Q18	4 Madt's 2 MAT 100 & 2 MAT 120	0.50
Q19	3 Madt's 2 MAT 101 & 1 MAT 121	0.50
Q20	4 OC44 germ. trans. A.F.	0.50
Q21	3 AC127 NPN germ. trans.	0.50
Q22	20 NKT trans. A.F. R.F. coded	0.50
Q23	10 OA202 sil. diodes sub-min.	0.50
Q24	8 OA81 diodes	0.50
Q25	6 IN914 sil. diodes 75PIV 75mA	0.50
Q26	8 OA95 germ. diodes sub-min. IN69	0.50
Q27	2 10A 600PIV sil. rects. 1S45R	0.50
Q28	2 Sil. power rects. BYZ13	0.50
Q29	4 Sil. trans. 2 2N696, 1 2N697, 1 2N698	0.50
Q30	7 Sil. switch trans. 2N706 NPN	0.50
Q31	6 Sil. switch trans. 2N708 NPN	0.50
Q32	3 PNP sil. trans. 2 2N1131, 1 2N1132	0.50
Q33	3 Sil. NPN trans. 2N1711	0.50
Q34	7 Sil. NPN trans. 2N2369, 500MHZ	0.50
Q35	3 Sil. PNP TO-5 2 2N2904 & 1 2N2905	0.50
Q36	7 2N3646 TO-18 plastic 300MH2 NPN	0.50
Q37	3 2N3053 NPN sil. trans.	0.50
Q38	7 PNP trans. 4 2N3703, 3 2N3702	0.50
Q39	7 NPN trans. 4 2N3704, 3 2N3705	0.50
Q40	7 NPN amp. 4 2N3707, 2 3N3708	0.50
Q41	3 Plastic NPN TO-18 2N3904	0.50
Q42	6 NPN trans. 2N5172	0.50
Q43	7 BC107 NPN trans.	0.50
Q44	7 NPN trans. 4 BC108, 3 BC109	0.50
Q45	3 BC113 NPN TO-18 trans.	0.50
Q46	3 BC115 NPN TO-5 trans.	0.50
Q47	6 NPN high gain 3 BC167, 3 BC168	0.50
Q48	4 BCY70 NPN trans. TO-18	0.50
Q49	4 NPN trans. 2 BFY51, 2 BFY52	0.50
Q50	7 BSY28 NPN switch TO-18	0.50
Q51	7 BSY95A NPN trans. 300MH2	0.50
Q52	8 BY100 type sil. rect.	1.00
Q53	25 Sil. & germ. trans. mixed all marked new	1.50

PRINTED CIRCUITS—EX-COMPUTER

Packed with semiconductors and components. 10 boards give a guaranteed 30 trans and 30 diodes. Our price 10 boards. **50p.** Plus 10p P. & P. 100 Boards £3. P. & P. 30p.

POWER TRANSISTOR BONANZA!

GENERAL PURPOSE GERM. PNP

Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACE.:—OC25-26-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. TI3027-3028, 2N250A, 2N456A-457A-458A, 2N511 A & B. 2G220-222, ETC. VCBO 80V VCEO 50V IC 10A PT. 30 WATTS Hfe 30–170.

PRICE	1–24	25–99	100 up
	43p each	40p each	38p each

SILICON High Voltage 250V NPN TO-3 case. G.P. Switching & Amplifier Applications. Brand new Coded R 2400 VCBO 250/VCEO 100/IC 6A/30 Watts. HFE type 20/fT 5MHZ.

OUR PRICE EACH:

1–24	25–99	100 up
50p	45p	40p

2N3055

115 WATT SIL POWER NPN
50p EACH

EX-STOCK TYPE EACH AS PRICED

OC20 50p	OC28 40p	AD149 43p	BD131 70p	BD139 75p
OC22 30p	OC29 40p	AL102 85p	BD132 80p	BD140 85p
OC23 33p	OC35 33p	AL103 85p	BD135 70p	BD155 75p
OC24 45p	OC36 40p	BD121 60p	BD136 80p	BU105 £3
OC25 25p	AD140 40p	BD123 75p	BD137 70p	2N3054 45p
OC26 25p	AD142 40p	BD124 70p	BD138 80p	

AD161 *NPN*
AD162 *PNP*

M/P COMP GERM TRANS.
OUR LOWEST PRICE OF 55p *PER PAIR.*

SILICON 60 WATTS MATCHED NPN/PNP
BIP 19 NPN TO-3 Plastic.
BIP 20 PNP. Brand new.
VCBO 100/VCEO 50/IC 10A. HFE type 100/ft 3mHZ.
OUR PRICE PER PAIR:

1–24 prs.	25–99 prs.	100 prs.
60p	55p	50p

RTL Micrologic Circuits

Epoxy TO-5 case	Price each 1–24	25–99	100 up
uL900 Buffer	35p	33p	27p
uL914 Dual 2i/p gate	35p	33p	27p
uL923 J-K flip-flop	50p	47p	45p

Date and Circuits Booklet for IC's Price 7p.

DUAL IN LINE SOCKETS

14 & 16 Lead Sockets for use with DUAL-IN-LINE I.C.'s. TWO Ranges PROFESSIONAL and NEW LOW COST.

Prof. Type No.	1-24	25-99	100 up
TSO14 pin type	30p	27p	25p
TSO16 pin type	35p	32p	30p
Low Cost No.			
BPS 14	15p	13p	11p
BPS 16	16p	14p	12p

SILICON PHOTO TRANSISTOR. TO-18 Lens end NPN Sim. to BP 25 and P21. BRAND NEW. Full data available. Fully guaranteed.

Qty.	1·24	25·99	100 up
Price each	45p	40p	35p

F.E.T.'S

2N3819	35p
2N3820	60p
2N3821	35p
2N3823	30p
2N5458	40p
2N5459	40p
BFW 10	40p
MPF105	40p

NEW EDITION 1971

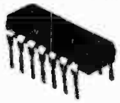
TRANSISTOR EQUIVALENTS BOOK. A complete cross reference and equivalents book for European, American and Japanese Transistors. Exclusive to BI-PAK 90p each. Red cover edition.

A LARGE RANGE OF TECHNICAL AND DATA BOOKS ARE NOW AVAILABLE EX. STOCK. SEND FOR FREE LIST

OUR STOCKS of individual devices are now too numerous to mention in this Advertisement. Send S.A.E. for our listing of over 1,000 Semiconductors. All available Ex-Stock at very competitive prices.

-the lowest prices!

74 Series T.T.L. I.C'S DOWN AGAIN IN PRICE



Check our 74 Series List before you buy any I.C's. Our prices are the lowest possible. All devices ex-stock. Full spec. guaranteed

BI-PAK Order No.	Price and qty. prices 1-24 £p	25-99 £p	100 up £p
BP00 = SN7400	0·15	0·14	0·12
BP01 = SN7401	0·15	0·14	0·12
BP02 = SN7402	0·15	0·14	0·12
BP03 = SN7403	0·15	0·14	0·12
BP04 = SN7404	0·15	0·14	0·12
BP05 = SN7405	0·15	0·14	0·12
BP07 = SN7407	0·18	0·17	0·16
BP08 = SN7408	0·18	0·17	0·16
BP09 = SN7409	0·18	0·17	0·16
BP10 = SN7410	0·15	0·14	0·12
BP13 = SN7413	0·29	0·26	0·24
BP16 = SN7416	0·43	0·40	0·38
BP17 = SN7417	0·43	0·40	0·38
BP20 = SN7420	0·15	0·14	0·12
BP30 = SN7430	0·15	0·14	0·12
BP40 = SN7440	0·15	0·14	0·12
BP41 = SN7441	0·67	0·64	0·58
BP42 = SN7442	0·67	0·64	0·58
BP43 = SN7443	1·95	1·85	1·75
BP44 = SN7444	1·95	1·85	1·75
BP45 = SN7445	1·95	1·85	1·75
BP46 = SN7446	0·97	0·94	0·88
BP47 = SN7447	0·97	0·94	0·88
BP48 = SN7448	0·97	0·94	0·88
BP50 = SN7450	0·15	0·14	0·12
BP51 = SN7451	0·15	0·14	0·12
BP53 = SN7453	0·15	0·14	0·12
BP54 = SN7454	0·15	0·14	0·12
BP60 = SN7460	0·15	0·14	0·12
BP70 = SN7470	0·29	0·26	0·24
BP72 = SN7472	0·29	0·26	0·24
BP73 = SN7473	0·37	0·35	0·32
BP74 = SN7474	0·37	0·35	0·32
BP75 = SN7475	0·47	0·45	0·42
BP76 = SN7476	0·43	0·40	0·38
BP80 = SN7480	0·67	0·64	0·58
BP81 = SN7481	0·97	0·94	0·88
BP82 = SN7482	0·97	0·94	0·88
BP83 = SN7483	1·10	1·05	0·95

BI-PAK Order No.	Price and qty. prices 1-24 £p	25-99 £p	100 up £p
BP86 = SN7486	0·82	0·80	0·88
BP90 = SN7490	0·67	0·64	0·58
BP91 = SN7491AN	0·87	0·84	0·78
BP92 = SN7492	0·67	0·64	0·58
BP93 = SN7493	0·67	0·64	0·58
BP94 = SN7494	0·77	0·74	0·68
BP95 = SN7495	0·77	0·74	0·68
BP96 = SN7496	0·77	0·74	0·68
BP100 = SN74100	1·75	1·65	1·55
BP104 = SN74104	0·97	0·94	0·88
BP105 = SN74105	0·97	0·94	0·88
BP107 = SN74107	0·40	0·38	0·38
BP110 = SN74110	0·55	0·53	0·50
BP118 = SN74118	1·00	0·95	0·90
BP111 = SN74111	1·25	1·15	1·00
BP119 = SN74119	1·35	1·25	1·10
BP121 = SN74121	0·67	0·64	0·58
BP141 = SN74141	0·67	0·64	0·58
BP145 = SN74145	1·50	1·40	1·30
BP150 = SN74150	1·80	1·70	1·60
BP151 = SN74151	1·00	0·95	0·90
BP153 = SN74153	1·20	1·10	0·95
BP154 = SN74154	1·80	1·70	1·60
BP155 = SN74155	1·40	1·30	1·20
BP156 = SN74156	1·40	1·30	1·20
BP160 = SN74160	1·80	1·70	1·60
BP161 = SN74161	1·80	1·70	1·60
BP164 = SN74164	2·00	1·90	1·80
BP165 = SN74165	2·00	1·90	1·80
BP181 = SN74181	2·75	2·60	2·40
BP182 = SN74182	0·97	0·94	0·88
BP190 = SN74190	3·50	3·25	3·00
BP191 = SN74191	3·50	3·25	3·00
BP192 = SN74192	2·10	1·95	1·75
BP193 = SN74193	2·10	1·95	1·75
BP195 = SN74195	1·10	1·05	0·95
BP196 = SN74196	1·80	1·70	1·60
BP197 = SN74197	1·80	1·70	1·60
BP198 = SN74198	5·50	5·00	4·00
BP199 = SN74199	5·50	5·00	4·00

PRICE-MIX. Devices may be mixed to qualify for quantity prices.
PRICES for quantities in excess of 500 pieces mixed, on application.
Owing to the ever increasing range of TTL 74 Series, please check with us for supplies of any devices not listed above, as it is probably now in stock. WARE 3442.

LINEAR I.C's— FULL SPEC.

Type No.	Price 1-24	25-99	100 up
BP 201C—SL201C	63p	55p	45p
BP 701C—SL701C	63p	50p	45p
BP 702C—SL702C	63p	50p	45p
BP 702—72702	53p	45p	40p
BP 709—72709	53p	45p	40p
BP 709P—µA709C	53p	45p	40p
BP 710—72710	53p	45p	40p
BP 711—µA711	60p	50p	45p
BP 741—72741	75p	60p	50p
µA 703C—µA703C	43p	35p	27p
TAA 263—	70p	60p	55p
TAA 293—	90p	75p	70p
TAA 350	170p	158p	150p

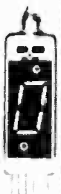
LOGIC DTL 930 SERIES I.C's

ROCK BOTTOM PRICES

Type No.	Price 1-24	25-99	100 up
BP930	12p	11p	10p
BP932	13p	12p	11p
BP933	13p	12p	11p
BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
BP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9093	40p	38p	35p
BP9094	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

Devices may be mixed to qualify for quantity price. Larger quantity prices on application. (DTL 930 Series only).

NUMERICAL INDICATOR TUBES



MODEL	CD66	GR 116	3015F
Anode voltage (Vdc)	170 min	175 min	5
Cathode cur'nt(mA)	2.3	14	
Numeral h'ght (mm)	16	13	9
Tube height (mm)	47	32	22
Tube diameter (mm)	19	13	12
I.C. driver rec.	BP41 or 141	BP41 or 141	BP47
PRICE EACH	£1.70	£1.55	£1.90

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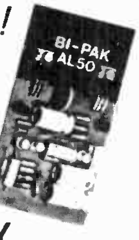

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UIC05 = 12 × 7405N	50p	UIC53 = 12 × 7453N	50p	UIC91 = 5 × 7491N	50p
UIC10 = 12 × 7410N	50p	UIC54 = 12 × 7454N	50p	UIC92 = 5 × 7492N	50p
UIC13 = 8 × 7413N	50p	UIC60 = 12 × 7460N	50p	UIC93 = 5 × 7493N	50p
UIC20 = 12 × 7420N	50p	UIC70 = 8 × 7470N	50p	UIC94 = 5 × 7494N	50p
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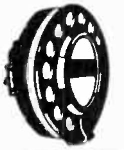

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BSY27	0·13	OC28	0·30
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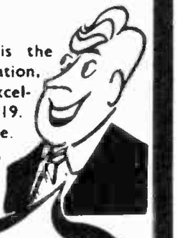

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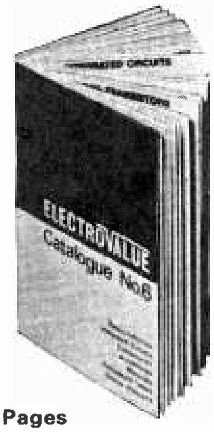

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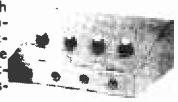

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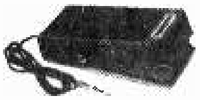

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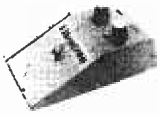

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1.0 µF:	±5% 40p;	±2% 50p;	±1% 60p;	Size 1" × $\frac{5}{8}$" × $\frac{1}{2}$"
2.2 µF:	±5% 50p;	±2% 60p;	±1% 75p;	Size 1" × $\frac{3}{4}$" × $\frac{5}{8}$"
4.7 µF:	±5% 70p;	±2% 90p;	±1% 115p;	Size 1$\frac{1}{4}$" × $\frac{3}{4}$" × $\frac{5}{8}$"
10.0 µF:	±5% 110p;	±2% 140p;	±1% 180p;	Size 1$\frac{3}{8}$" × $\frac{3}{4}$" × $\frac{5}{8}$"
15.0 µF:	±5% 160p;	±2% 210p;	±1% 270p;	Size 1$\frac{3}{8}$" × 1" × $\frac{7}{8}$"

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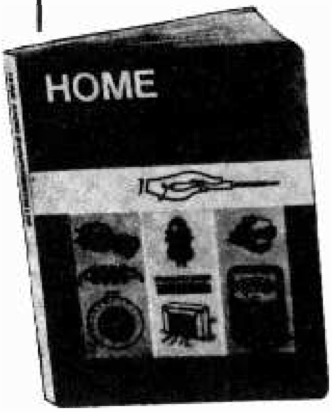

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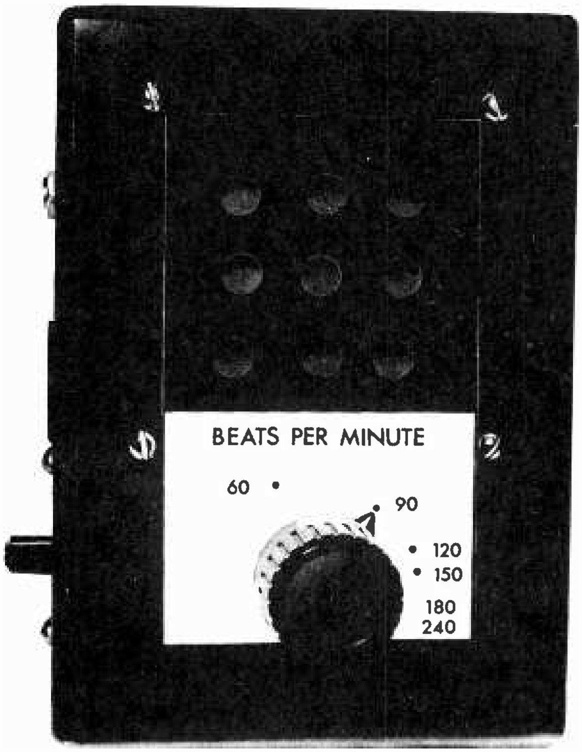


ELECTRONIC METRONOME

by

M. G. Argent

The unijunction relaxation oscillator and amplifier unit described here can be used as a metronome either on its own or coupled to a more powerful amplifier.

THIS IS AN EASY TO BUILD UNIT INCORPORATING inexpensive components, and it offers advantages over a conventional metronome which costs much more.

THE CIRCUIT

The circuit, shown in Fig. 1, consists basically of a unijunction transistor, TR1, which functions as a relaxation oscillator driving a current amplifying stage, TR2 and a loudspeaker.

The principle, briefly, of the unijunction transistor can be explained in the following manner. An equivalent circuit for the unijunction transistor is shown in Fig. 2. If a positive voltage rising in amplitude with respect to base 1 is applied to the emitter, a time will come when the emitter-base diode, shown as D1, becomes forward biased, whereupon current will flow via D1 and rB1. Referring back to Fig. 1, the rising voltage appears across C1 due to the fact that, as soon as the unit is switched on, C1 charges up via RV1 and R1. The speed at which C1 charges is determined by the values of C1, RV1 and R1. In this case RV1 is the frequency control of the unit.

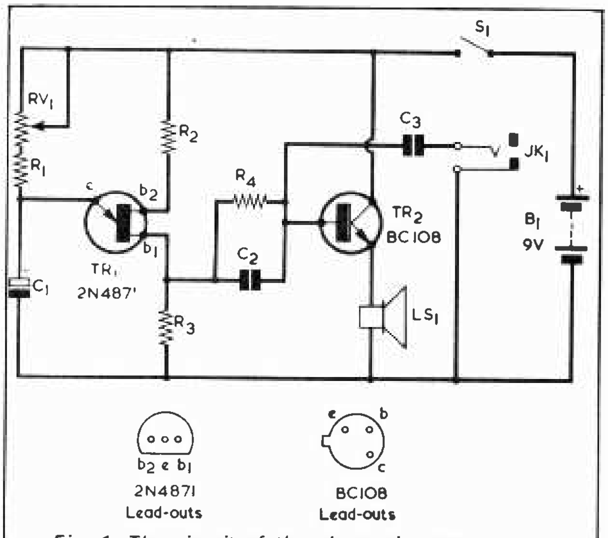


Fig. 1. The circuit of the electronic metronome

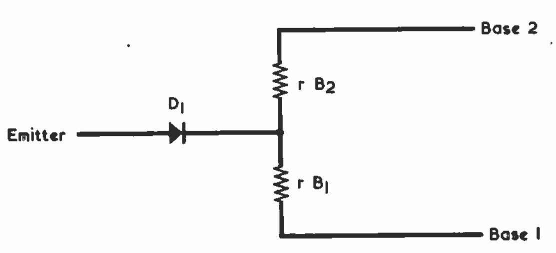


Fig. 2. An equivalent circuit for the unijunction transistor

When the voltage across C1 reaches the point where D1 becomes forward biased, C1 is rapidly discharged through the emitter, base 1 and R3. Because of this current through R3 a voltage appears across it. Capacitor C1 then commences to charge again and the process is repeated when the voltage across it is sufficiently high to forward bias diode D1 once more.

The resultant waveform across R3 is a series of voltage spikes or pulses. These are fed via R4 and C2 to the base of TR2, which drives the loudspeaker. The purpose of R4 and C2 is to reduce the lower frequency response of the circuit so as to give more of a click in the loudspeaker than a thud.

There is a facility also to connect the unit to an external amplifier, for use with groups where the unit alone would not be loud enough. This output is taken via C3 to jack socket JK1. C3 has a low value which further reduces the lower frequency response since, otherwise, damage may result to the speaker or speakers of the external amplifier. This facility is a great advantage over the conventional metronome.

COMPONENTS

Resistors
(All fixed values ⅛ watt 10%)

R1	10kΩ
R2	100Ω
R3	1kΩ
R4	56kΩ
RV1	100kΩ potentiometer, log

Capacitors

C1	10μF electrolytic, 10V. Wkg.
C2	0.01μF, Mullard miniature foil.
C3	2,200pF, paper or plastic foil.

Transistors

TR1	2N4871
TR2	BC108

Loudspeaker

LS1	35Ω loudspeaker, 2½in. (see text)

Switch

S1	Miniature slide switch.

Socket

JK1	2.5 or 3.5mm. jack socket

Battery

B1	9 volt battery, type PP4 (Ever Ready)

Miscellaneous
Battery connectors
Veroboard, 0.15in. matrix, 7 strips by 16 holes
Knob
Plastic case (see text)

CONSTRUCTION

The circuitry is assembled on a piece of 0.15in. matrix Veroboard measuring approximately 2½in. by 1⅛in., with the strips running lengthwise. There are 7 strips, each with 16 holes. The component and copper sides of the board are shown in Fig. 3. Only two 'cut-aways' are required, and these may be made with a small drill or spot face cutter. RV1 is connected such that the resistance it inserts into circuit decreases as it is rotated clockwise. The layout is by no means critical, and the unit could be built into an existing amplifier. The author used a small black plastic case with lid measuring 3⅛ by 4½ by 1⅜in. and this enabled the circuit to be made up as a neat self-contained unit. If a plastic case of this size cannot be obtained, a small plywood housing of around the same dimensions could be constructed instead. The board and battery were held in position with the aid of a polystyrene ceiling tile cut to size.

A view inside the metronome case. The on-off switch and jack socket are mounted on the side remote from the case hinge

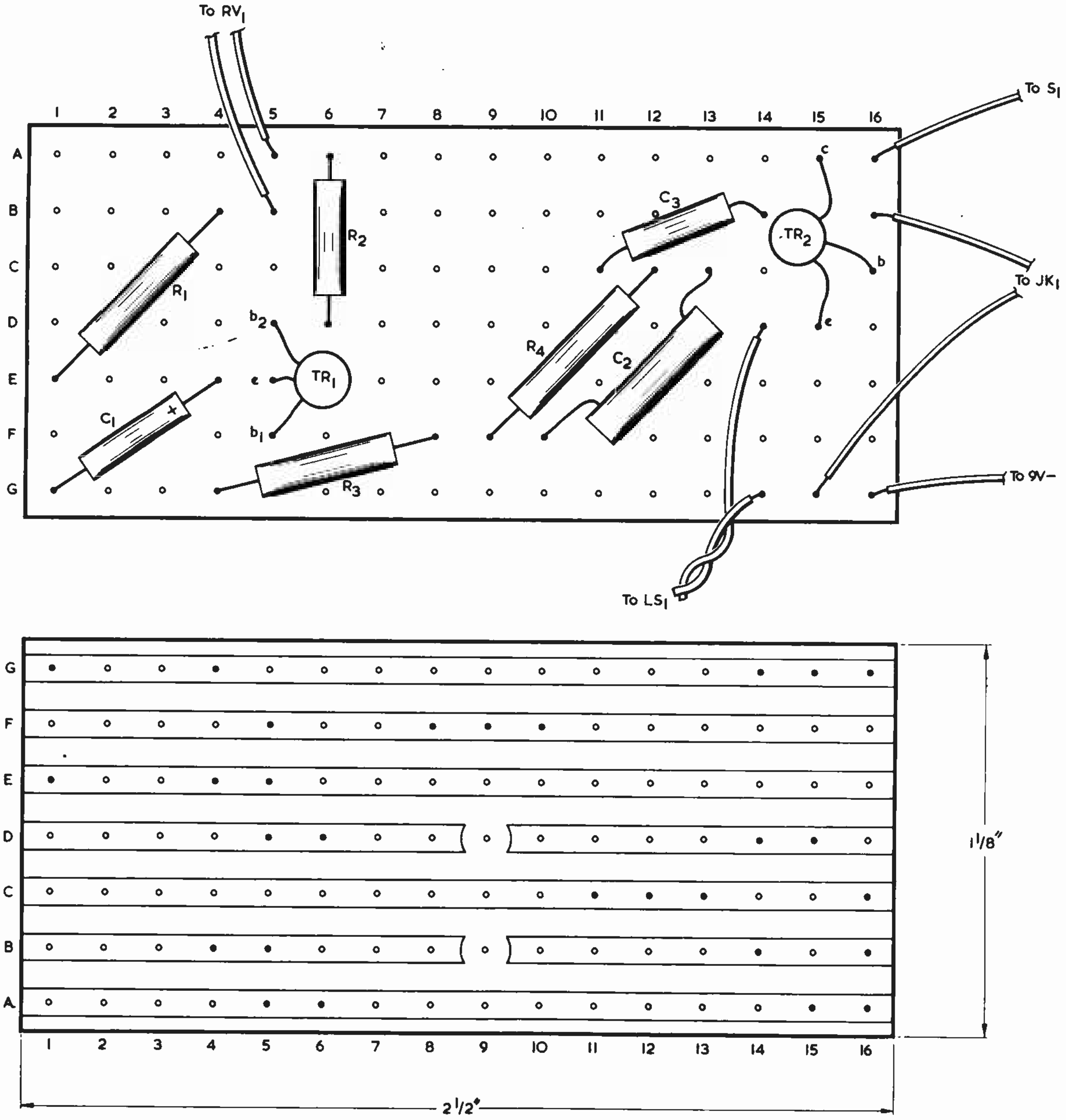


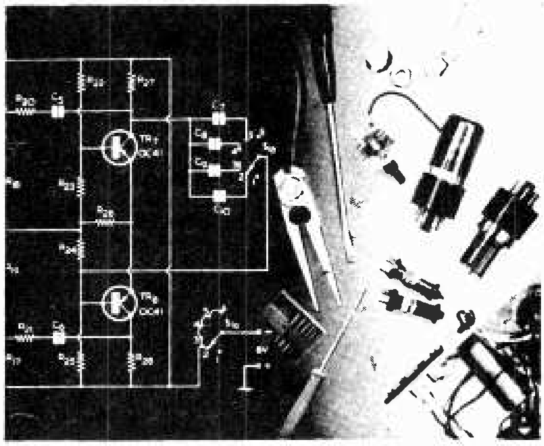
Fig. 3. The component and copper sides of the Veroboard

The 2N4871 unijunction transistor is available from LST Electronic Components Ltd., 7 Coptfold Road, Brentwood, Essex. The 35Ω speaker employed by the author is an R.S. Components type, obtainable from retailers of R.S. Components parts, including Celectron-E, P.O. Box No. 1, Llantwit Major, Glamorgan, CF6 9YN.

The easiest way of calibrating the unit is to check it against a stop-watch, but if the constructor has an oscilloscope with a calibrated slow timebase this would be more accurate. Once calibrated, the unit will be found extremely stable. Current consumption from the 9 volt battery is of the order of 2 to 4mA, rising to the higher value as frequency is increased. ■

AUTOMATIC BATTERY MONITOR

by G. A. FRENCH



SOME ITEMS OF BATTERY-OPERATED electronic equipment incorporating semiconductors, including in particular test gear, are intended to be used only when the battery voltage is above a certain specified level. If the battery voltage falls below the prescribed level the equipment may still function, but its performance becomes erratic or gives rise to incorrect measurements.

The user of such equipment may not, however, be aware that its battery voltage has fallen below the critical level. The only way in which the satisfactory operation of the equipment can be assured is to measure the voltage of its battery from time to time or, for complete certainty, on each occasion that the equipment is used. A requirement of this nature tends to be irritating and time consuming. A possible answer consists of providing the equipment with a built-in voltmeter which continually indicates battery voltage, but this can be a relatively expensive solution.

The voltage monitoring device to be described in this month's contribution to the 'Suggested Circuit' series offers an alternative approach. Inserted in series with one of the equipment battery leads are components which cause the supply to be applied only when the battery voltage is above a predetermined level. When the battery voltage falls below this level the equipment simply does not switch on. Thus, non-functioning of the equipment automatically indicates that a new battery is required; with the results that the equipment cannot be operated at a battery voltage that is too low, and that no voltage measurements are needed.

Before proceeding further it must be emphasised that the circuit to be discussed is in the experimental category and that it is primarily intended to function with equipment which draws, by way of resistive circuits, a current of the order of 10mA or more from the supply. In practice, successful operation with equipment which draws a lower current is perfectly feasible, but this point may only be determined by actual experiment with the equipment concerned. A further factor is that the monitoring circuit causes some 0.65 volt of battery voltage to be lost, and that it requires setting up to the operating voltage by an empirical approach which involves the insertion of silicon diodes. On the credit side are the facts that the circuit functions completely automatically and draws no extra current from the battery.

The monitoring circuit components will not be overloaded in terms of voltage and current if the equipment with which they are used is designed to operate from a dry battery whose voltage does not exceed 18 volts.

CIRCUIT OPERATION

The circuit of the automatic battery monitor appears in Fig. 1. Here, thyristor TH1 is inserted in series with the negative supply to the equipment in which the monitor is fitted. Connected across it are zener diode ZD1, limiter resistor R1, and as many forward biased silicon diodes as are required to provide the desired operating potential for the device.

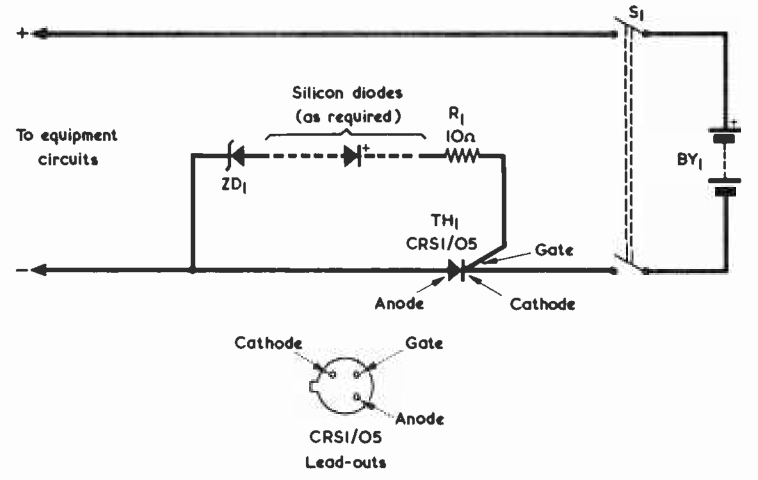


Fig. 1. The circuit of the automatic battery monitor. This ensures that the supplied equipment cannot be switched on if battery voltage is below a predetermined level

When switch S1 is closed the thyristor and the associated components are coupled to the battery via the supplied equipment. Assuming a resistive path between the equipment supply lines, a positive voltage is applied to the anode of the thyristor and to zener diode ZD1. If this voltage is sufficiently high, ZD1 (together with whatever silicon diodes are in series with it) allows sufficient gate current to flow in the thyristor to turn it on. The thyristor in its conductive state then allows the full battery current to flow to the equipment, offering in the process a voltage drop of about 0.65 volt between its anode and cathode. There is, now, no triggering current to the gate but this fact is unimportant since, once it has fired, the thyristor remains in the conductive state. It can only be returned to its non-conductive state by turning off S1.

If when S1 is closed the battery voltage is too low, either too small a triggering current or none at all is passed to the gate of the thyristor and it does not fire. In consequence, the supplied equipment cannot operate.

PRACTICAL TESTS

The writer checked out the circuit in practice, using a fixed resistor to represent the circuits of the supplied equipment. BY1 was replaced by a power supply having a variable voltage output. See Fig. 2(a). ZD1 was a 6.2 volt 5% 250mW zener diode and, initially, no silicon diodes were in circuit whereupon ZD1 connected directly to R1. It was found that the circuit operated reliably when the fixed resistor representing the equipment circuits had a value of about 1.3kΩ or less. With a 1kΩ resistor the thyristor became conductive when S1 was closed for all voltages from the power supply in excess of 7.6 volts. Below this voltage the thyristor did not fire.

Some equipment will have a large value electrolytic capacitor across its supply lines and so the experiment was repeated with a 1,000μF capacitor added, as in Fig. 2(b). This time the thyristor fired for all voltages from the power supply in excess of 6.5 volts, and did not become conductive at lower voltages. It is patent that, at the instant of closing S1, the capacitor was nearly equivalent to a short-circuit, and this explains why it caused the voltage at which triggering occurred to be lower. As before, the circuit did not operate when the resistor had a value in excess of about 1.3kΩ.

Both with and without the capacitor, the dividing line between voltages which fired the thyristor and those which did not was well-defined and sharp. If the battery voltage was very slightly lower than that needed to fire the thyristor, a small gate current flowed through the resistor representing the supplied equipment. Such a current would be insufficient to cause operation of any equipment connected in place of the resistor.

Next, a silicon diode was inserted between the zener diode and the 10Ω limiting resistor, being connected with the polarity shown in Fig. 1. This caused the voltage at which the thyristor fired to be raised by approximately 0.6 volt. Adding more silicon diodes in series increased the voltage by a further 0.6 volt per diode.

Summing up the results of the experiment it can be stated that the circuit worked reliably when the resistor representing the equipment circuits had a value which caused some 6mA or more to flow after the thyristor fired. Taking into account spread in thyristor characteristics, it would seem safe to say that the circuit should function correctly if the resistive paths in the supplied equipment circuits caused 10mA or more to flow after the thyristor fires, and that reliable operation is quite possible at lower currents but has to be proven by experiment. The resistive paths will normally be given by such things as base bias potentiometers and the like There is, however, another factor which needs to be taken into account, since it has to be remembered that the transistors in the supplied equipment circuits will themselves tend to draw current at quite a low voltage and that this current will add to that flowing through the resistive paths. Thus, it is possible for the monitoring circuit to function even when the current through the resistive paths of the equipment is, on its own, insufficient. But this point can, again, only be determined by practical experiment.

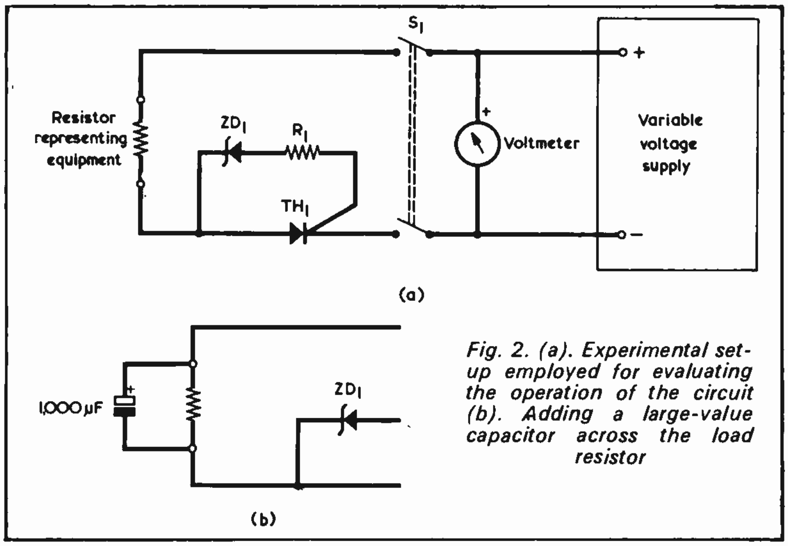


Fig. 2. (a). Experimental set-up employed for evaluating the operation of the circuit (b). Adding a large-value capacitor across the load resistor

A second finding is that the voltage at which the thyristor fires is, for a given zener diode and quantity of silicon diodes, reduced when a large value electrolytic capacitor happens to be connected across the equipment supply lines.

SETTING-UP

The setting-up of the monitoring circuit is considerably eased if a variable voltage power supply is to hand, since it is then merely necessary to increase the output voltage of the supply to the level where the thyristor fires. If such a power supply is not available it is necessary to use a battery having single cells from which tappings in 1.5 volt steps can be obtained.

First, select a 200 to 400mW zener diode whose nominal voltage is about 1 volt below that at which the circuit is desired to operate, and connect it directly between the anode of the thyristor and the 10Ω resistor. No silicon diodes are fitted at this stage. Connect the monitoring circuit to the equipment with which it is to be used and then switch S1 on and off, increasing the supply voltage between each closure of the switch. If the circuit is capable of operating with the particular equipment employed, the thyristor should fire at some voltage which is higher than the zener diode voltage. If this voltage is greater than the desired one, replace the zener diode with one having a lower voltage rating and repeat the process. Should the firing voltage be equal to that desired, then the monitoring circuit is finally set up and ready for use. If the firing voltage is lower than the desired one, insert one or more silicon diodes between the zener diode and the 10Ω resistor as required, or fit a higher voltage zener diode and start again. The silicon diodes, incidentally, can be of any type. Miniature silicon rectifiers such as the 1N4001 represent a good choice, particularly as they take up very little space.

In the diagrams it is assumed that the on-off switch is a double-pole type. Circuit operation remains unaltered if a single-pole on-off switch is used instead, and this may be inserted in either the positive or the negative line from the battery. ■

NOTES ON SEMICONDUCTORS

Further Notes—10

VIVE LA DIFFERENCE

by

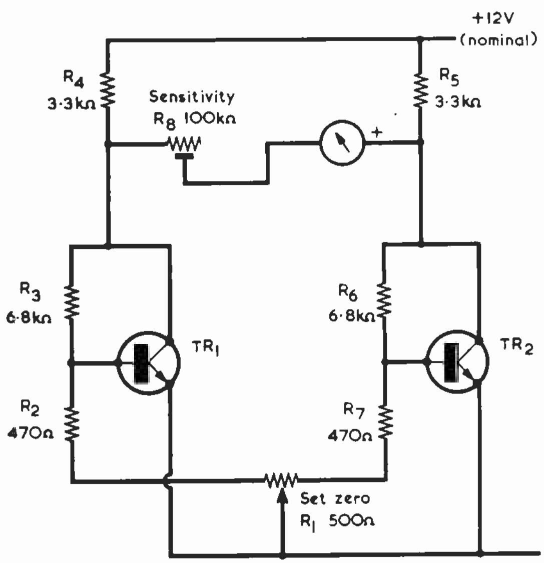
Peter Williams

Our contributor develops the electronic thermometer theme introduced last month, and describes a differential thermometer having higher sensitivity together with greater freedom from inaccuracies due to changes in supply voltage.

TO CARRY THE BRIDGE IDEA EMPLOYED IN LAST month's topic a stage further, consider the properties of the circuit shown in the diagram. If the transistors in this diagram are held at the same temperature then the bridge may be readily balanced by fine adjustment of R1. Then each transistor is almost equally affected by supply voltage changes and the zero drift is very small.

TEMPERATURE DIFFERENCE

However any difference in temperature between the transistors produces a proportional unbalance again of order 20mV/K (that is 20mV/°C by the old convention since the unit of temperature is now called the Kelvin) With a sensitive meter it is quite possible to distinguish an unbalance of this order and temperature differences of a few degrees can be measured with some accuracy provided that adequate calibration can be carried out first. This can be done by immersing the transistors in water at different temperatures determined by conventional thermometers (though care must be taken that the transistors are not immersed for too long). Distilled water is preferable since its low conductivity ensures that if the leads are immersed there is minimum disturbance to the circuit bias levels.



An electronic differential thermometer which is capable of a high degree of sensitivity. All fixed resistors are $\frac{1}{2}$ watt 5%. The two thermistors are high-gain silicon and should be of the same type with similar characteristics. In use, TR1 is held at the higher temperature

The procedure with the circuit in use is then to adjust the zero control (R1) with the transistors at the same temperature, and the sensitivity control (R8) to give a reading appropriate to the desired full-scale value when the transistors are at a known difference in temperature.

If desired, different values of R8 can be switched in to provide different temperature differential ranges. The zero setting will not remain perfect when the transistors are kept at an equal but much higher temperature than the original calibration point, but the error is small for well-matched transistors – they should be selected if possible for equal Vbe values at equal collector currents and temperature.

The higher sensitivity available with this form of circuit is allied to a further advantage when the thermal properties of power transistors are to be investigated. If one transistor is at ambient temperature, and the other in contact with the power transistor then the temperature rise due to internal heating is directly measureable. The effects of various heat-sinks can thus be readily investigated. It is useful to add a spot of silicone grease to the contact area to aid thermal contact, and care should be taken to minimize curvature of the surfaces in contact. Inevitably some error is introduced if the test procedure (immersion in water) is different from the experimental procedure (surface contact). However the simplicity of the circuit together with its tolerance of supply variation makes it well worth experimenting with. As before the meter sensitivity is not too critical but should be as high as possible with 0–50 μA the ideal. By increasing the current levels throughout, other meters can be catered for.

This for the time being concludes the look at d.c. applications of the transistor, and next time we shall look at a circuit that has some claims to being the world's simplest amplifier. ■

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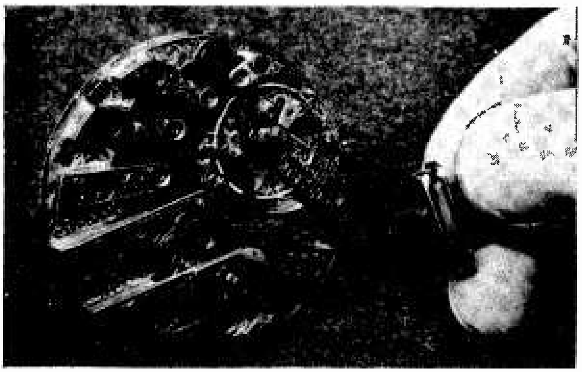

A Geneva lever watch movement contrasted with the smallest 32 kHz quartz watch crystal yet developed.

The Geneva lever movement, from the Science Museum, South Kensington, is approximately one hundred years old. Featuring a club-toothed escape wheel operating at 15,000 beats per hour, it represents the most accurate form of lever escapement, capable of keeping time to within 5 or 10 seconds a day.

The quartz crystal, mounted longitudinally in a cold-welded case measuring 15 x 5 mm, 3 mm high, and developed by ITT Components Group Europe, operates at 32,768 cycles per second. Largely unaffected by temperature changes at normal ambient levels, and resistant to repeated 100 g shocks that would undoubtedly destroy the older mechanism, it is capable of maintaining accuracy to within one minute a year.

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There will be included FREE in each copy a sample Veroboard of 0.15 in matrix having 7 strips by 16 holes. This Veroboard will be suitable for the construction of any of three very attractive projects, all especially designed by our Technical Editor – J. R. Davies.

The projects are – an I.C. AMPLIFIER, a SIGNAL INJECTOR and a RADIO 2 TUNER.

These projects form part of the "exciting plans for the future" mentioned in our July issue. We have not only added "Electronics" to our title, to bring it into line with our contents, but also extra pages – altogether a bumper issue.

There will obviously be a great demand for the SPECIAL OCTOBER issue, to be on sale 2nd October, and supplies will be limited. To make sure of a copy readers are advised to place an order with their newsagent NOW.

BRITISH ASSOCIATION OF RADIO CONTROL SOARERS

The object of the Association is to band together all those with radio control soaring as their prime hobby interest, to co-ordinate the activities of R/C Soarers for their mutual benefit, and to further and protect the interests of the R/C flier.

The Association hope to form a number of Project Groups for work and research on different aspects of the hobby.

Readers interested in Radio Control Flying should write to the Hon. Secretary, B.A.R.C.S., 64 Wellington Road, Hampton Hill, Middlesex, for further details.

LOW COST RADAR BEACON FOR MARINE NAVIGATIONAL BUOYS

Positive identification of marine buoys and markers on a ship's radar screen is made possible with a new pulse-coded radar beacon, or Racon, introduced by EMI. Fitted to a navigational buoy, this solid-state transponder transmits a coded signal which results in an enhanced echo on a ship's radar.

The coded transmission is triggered off by the scanning signals of a ship's radar – these signals being picked up in the Racon by an RF receiver via a slotted wave-guide aerial. Transmitted every 40 seconds, the RF output of the transponder is slowly swept over the marine frequency band with a fast amplitude-modulated waveform superimposed on it to broaden effectively the bandwidth of the ship's radar.

On the ship's PPI display, the beacon's signal pinpoints the position of the navigational marker by appearing as a line of 'dashes' commencing from the buoy's position. This line of radar echoes measures about 3,000 yards long on the PPI range scale and can be identified by the Racon's pre-set code.

Cylindrical in appearance, it weighs about 20 lb. and is 9″ high and has a diameter of 8″.

. . . COMMENT

SOME SEPTEMBER EVENTS

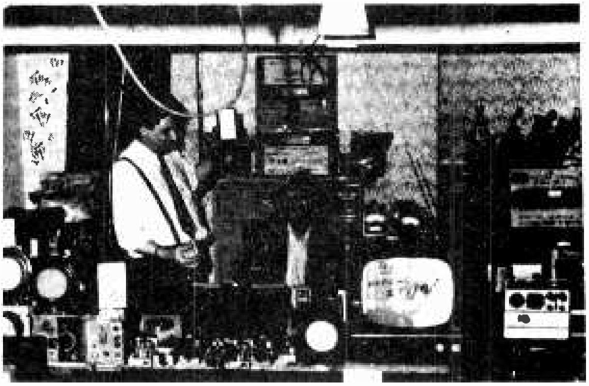
The Star Short Wave Club of Leeds is again holding a grand junk sale, on behalf of the Radio Amateur Invalid Bedfast Club.

The sale is being held in two parts on 6th September and 27th September at New Inn Hotel, Bramley Town Street, Leeds 13, commencing at 7.30 pm.

Donations of equipment from readers interested in helping this good cause would be gratefully received.

Details from T. Leeman, 115 Asket Drive, Seacroft, Leeds, LS14 1HX.

A scene at a recent sale is shown in the accompanying photograph.



- An International Broadcasting Convention is to be held at Grosvenor House, London, from 4th to 8th September.
- The British Amateur Television Club will hold its 1972 Amateur Television Convention on Saturday 16th September, commencing at 10.30 am and closing at 6.30 pm.

Once again, by kind permission of the I.B.A., the convention will be held at their headquarters – 70 Brompton Road, Knightsbridge, London.

IN BRIEF

- An associate company of L.S.T. Components Ltd., called Arrow Electronics Ltd., has recently been formed to provide a source of guaranteed "mail order" components for the electronics enthusiast. A catalogue with special order forms and pre-addressed envelopes, combined with an easy to use catalogue coding facilitate a rapid component supply service.

The address of the new company is Arrow Electronics Ltd., 7 Coptfold Road, Brentwood, Essex.

- A new side window photomultiplier tube for use in spectrometer applications where wide spectral coverage is necessary, has been introduced by the Electron Tube Division of EMI Electronics Ltd., at Hayes, Middlesex.
- Just published by Jermyn Distribution of Vestry Estate, Sevenoaks, Kent, is a 16 x 24 in. wall chart listing the full range of Raytheon's Linear Integrated Circuits that are available ex-stock.
- SDS Components Ltd., Gunstone Road, Hilsea Trading Estate, Portsmouth, Hants. now despatch all parcels via Securicor to provide a 48-hour delivery service to customers in England, Scotland and Wales.
- Following full stability tests, the Post Office has accepted the Ferranti microwave telecommunications equipment linking the Isles of Scilly with the mainland.
- The 1972/73 edition of its stock catalogue has been published by ITT Electronic Services. Copies may be obtained from them at Edinburgh Way, Harlow, Essex.

GIANT RADIO EAR TO PROBE DEEP SPACE

The present generation of mankind may be able to tune in on intelligent civilisations beyond Earth, if Congress appropriates the money to start building the VLA, America's proposed super-powerful radio observatory.

The National Science Foundation, under whose aegis the radiotelescope would be designed and constructed, said that an array of antennas resembling the giant "dishes" used to track spacecraft, would be set up in geometric patterns to pick up and focus signals emanating from the edge of the universe, 13,000 to 16,000 million light years away. The pattern would be an extension of the interferometer technique (placing antennas in a row or at right angles to one another) already widely used in radio-astronomy to enhance the strength of incoming radio signals.

A specific location has not yet been chosen for the new telescope, but it would be built in a pattern some 24 miles long at a high-altitude site in the south-western part of the United States, well away from earth-generated background noise.

It is likely that any new very large antenna would be used, at least part time, in "passive listening" for radio signals from other civilisations which many scientists believe must inhabit planetary systems around distant stars.

He likes to think of all those T.V. Sets flickering out "Normal Service will be resumed as soon as possible."

SHORT WAVE CRYSTAL SETS

by

J. Braunbeck

Our contributor describes a fascinating method of reception which borrows from the early days of radio to open up an entirely new field for the experimenter

BY TRADITION, THE CRYSTAL SET IS A RECEIVER FOR medium and long waves. But there is no technical reason for this limitation and it can only be explained historically.

The long range propagation of short waves had not been discovered until valve receivers were well established, so nobody cared about crystal sets when listening commenced on the short wave bands. The crystal set was considered to be dead, a thing of the past and suitable for the Kensington Science Museum only.

Nevertheless, the crystal set can still have its fascinating side for any amateur constructor who wants to achieve results by investing in a minimum number of components. And what can be more suitable for experiments than a crystal set which lets you listen to stations thousands of miles away? A type of crystal set, it may be added, which was never built in its appropriate period of history.

SHORT WAVE PROPAGATION

Short waves are known to bridge large distances with only moderate transmitter power, and a considerable part of amateur radio activity is based on this fact. But low power amateur transmitters are not the only short wave stations in operation. There also exist quite a number of high powered short wave broadcast stations, whose output may be compared with that of medium wave transmitters. These high power short wave transmitters sometimes produced high field strengths in faraway places. Such field strengths are comparable with those of a local medium or long wave transmitter and are therefore suitable for reception by a crystal set.

CONVENTIONAL CIRCUIT

A crystal set for short waves does not necessarily have to be very different from one intended for medium wave reception. Of course, the tuning coil has to have fewer turns and, in order to obtain optimum results, the aerial has to be matched as accurately as possible to the tuning circuit.

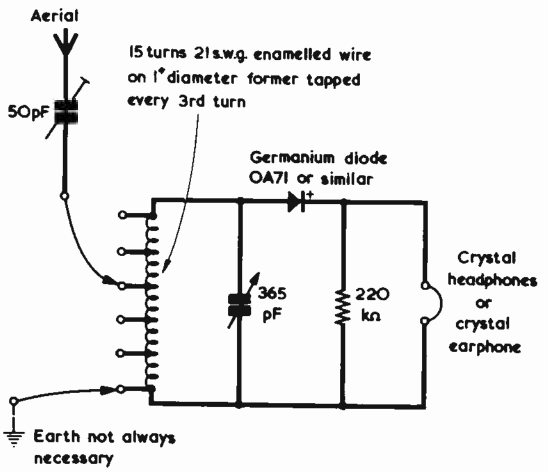


Fig. 1 A conventional circuit for short wave crystal reception. Aerial matching is achieved by taps in the resonant coil together with a trimmer capacitor in the aerial lead. As with the other two diagrams, a headphone jack socket is required in addition to the components shown in the circuit

Fig. 1 shows a working circuit and, here, there are a number of taps on the tuning coil together with a variable capacitor in series with the aerial. The optimum tap for the aerial connection has to be found by trial and error, as also does the best setting of the series aerial capacitor. Both the aerial matching adjustments and the tuning are interdependent since one affects the other, with the result that operating the set tends to become somewhat like a game of skill. One should not, however, complain too much about this. Our fathers or grandfathers had much more trouble in simply looking for a suitable spot on the crystal for the cat's whisker, whereas all we have to do is to merely solder into circuit a germanium diode. The germanium diode should, incidentally, be a high quality component. It is a good idea to try a few specimens in the circuit, after completion, to find which one gives best results.

The receiver uses either crystal headphones or a crystal earphone. As a crystal phone has almost infinite d.c. resistance, the 220kΩ resistor is included to complete the diode circuit. If this resistor is omitted, strong signals might build up an electric charge across the crystal phone and thereby block the germanium diode.

The aerial should not be too long. About 20 to 30ft. of aerial length will give best results. Though an outdoor aerial is almost always superior in performance, an indoor wire will frequently cope quite well. It is probable that only inhabitants of concrete and steel framed buildings, in which indoor radio reception is generally poor, will be compelled to resort to an outdoor aerial. An earth connection is not always necessary, as the capacitance to earth of the set and the operator may often be sufficient.

AVOIDING AERIAL TROUBLE

Obviously, the main problem in building a short wave crystal set consists of finding the best way of getting the short wave signal out of the aerial and into the tuning circuit. Though this problem can be solved by employing a matching circuit like that shown in Fig. 1, there is an even simpler solution. One gets all the energy from the aerial into the tuning circuit if the aerial is itself made part of the tuning circuit.

This can be done quite easily by making the resonant coil large enough to act as an aerial loop. For the short wave range a single loop of about 2 or 3ft. diameter will have the required inductance. Though it is advantageous to construct a suitable wood or cardboard framework to support the loop, it may also be simply 'laid out' in a makeshift manner. In neither case does it seem to be absolutely necessary for the loop to be circular, and it can even be given a square or rectangular shape.

A means should, however, be provided for rotating the loop, preferably around a vertical axis. If this is done it will be found that the crystal set receives different stations with different loop positions. In order to avoid mechanical construction problems it could be helpful to tape the loop to the surface of a wooden door. Opening and closing the door then effectively rotates the loop.

Fig. 2 shows a short wave set employing a loop and having no aerial matching problems. If the constructor is content to employ the loop laid out in a loose manner the actual set may be made quite small. This version could be particularly suitable for excursions and vacations. Usually, the loop will be indoors, and it should work well in nearly all buildings with the exception of those which are concrete and steel framed. In this latter case it is advisable to place the loop as near as possible to a window or balcony.

An earth connection will not be necessary. On the other hand, it may prove helpful if hand-capacitance effects to the set or to the loop prove troublesome.

RESONANT LINE CIRCUIT

There is yet another way to tune the crystal set and provide an aerial for it. Take two parallel wires and short-circuit one end. Across the other end will appear an r.f. voltage if the wires are subjected to an electromagnetic wave whose wavelength is four times their length. A quarter wavelength parallel wire system of this nature behaves like a resonant circuit, and is quite often employed as one in ultra high frequency circuits.

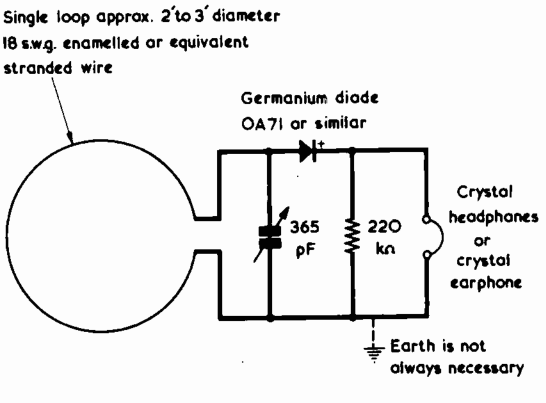


Fig. 2. Aerial matching problems are avoided by combining the functions of aerial and tuning coil in a single wire loop

Used in the short wave range a parallel wire system is not quite so convenient as it is with higher frequencies, but it can still be made up. The system can be tuned by varying its length mechanically, but a simpler method consists of connecting a variable capacitor across the open end. The circuit shown in Fig. 3 makes use of the latter approach.

The parallel wires can consist of 300Ω flat twin feeder (available from Home Radio under Cat. No. AF5). Though there should not be too many bends in the feeder it does not need to be completely straight. It can, for instance, be fixed on a wall around a few corners. For initial experiments the feeder may be laid out flat on the floor.

The prototype built by the author uses a feeder 16ft. long, which corresponds to a little less than 5 metres.

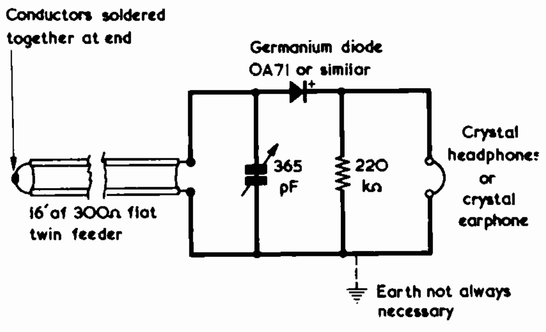
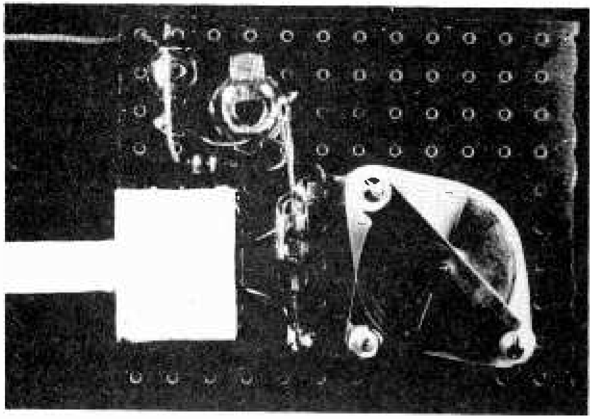


Fig. 3. A quarter wavelength parallel wire system provides both aerial and tuning element. A variable capacitor across the open end provides electrical 'stretching' of the quarter wavelength wires. It is not essential to employ 300Ω flat twin feeder for the parallel wires, but the feeder provides a good practical choice



This experimental short wave crystal set is provided with terminals which may be connected to a quarter wavelength wire pair. Though wiring is not critical, all high frequency connections should be as short as possible

Thus, the set is provided with a quarter wavelength parallel wire system for the 20 metre band. However, the variable capacitor electrically 'stretches' the parallel wires, so that wavelengths up to the 31 metre band can be received. Like the other circuits, this set does not need an earth connection, though in some situations such a connection may give an improvement in performance.

The accompanying photograph shows a receiver employing the twin feeder. This couples into the perforated board at the lower left hand side, connecting to a 2-way terminal block and thence to the tuning capacitor. (The exposure, which was made sufficiently long to bring out the darker aspects of the subject, results in both the feeder and terminal block being reproduced as fully white.)

RESULTS TO BE EXPECTED

The propagation of short waves is subject to a number of variable influences and one cannot, therefore, predict what station will produce a fieldstrength suitable for crystal sets at any given place or time. On the other hand there are many short wave stations all over the world, which makes it fairly probable that some stations should be heard at any time. The user of a crystal set is, of course, completely powerless to prevent fading. In spite of these limitations it is still fascinating to listen to voices and music from a few thousands of miles away without any amplifier or energy source.

There are no noticeable differences in sensitivity between the three circuits described here. At the author's home in Vienna, Austria, the 31 metre band transmission from the European Service of the B.B.C. comes in loud and clear nearly every evening. Among other stations received more or less regularly are Tirana (Albania), Ankara (Turkey), Tangier (Morocco), Moscow and Paris. ■

The 8-Watt

Part 2

IN LAST MONTH'S ISSUE WE EXAMINED THE CIRCUIT OF this 8 watt amplifier, then discussed the components. We finished by assembling the chassis and mounting the major parts on it. We now proceed to the wiring.

WIRING-UP

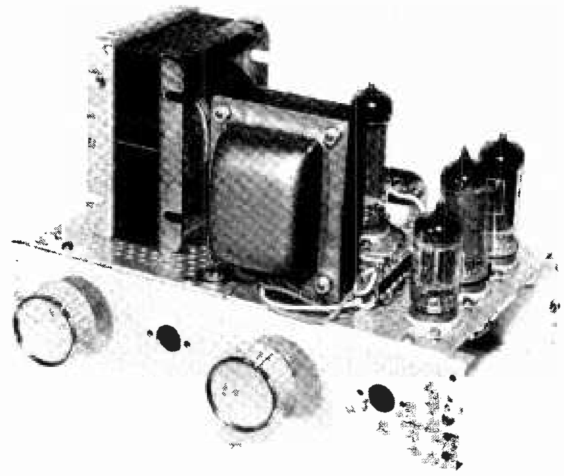
To ease working, the wiring-up steps are numbered. This not only ensures that all connections are made correctly, but it also enables the wiring to be stopped at any time and resumed later. It is merely necessary to complete the step in process, make a note of its number, then start again later at the next step. To ensure that a component lead-out or wire is not connected to a tag that has already been soldered, soldering should only be carried out when expressly stated. This means that, where more than one wire connects to a tag, all the wires are so connected before they are soldered to that tag.

It will have been noticed in last month's issue that the tags of the four 5-way tagstrips are numbered from 1 to 20. This numbering is repeated in the diagrams given this month. A further point is that the four non-earthy tags in each of the Lektrokit 5-way tagstrips have two connection holes, one 'upper' (i.e. further away from the chassis) and one 'lower'. This fact simplifies wiring since it ensures that an excessive number of wires need not be connected at a single tag hole. In the instructions which follow, reference is made to the upper and lower connection holes of these tags. It is assumed in the diagrams that the lower connection hole is on the same side of the tagstrip as the mounting lug and that the upper connection hole is on the opposite side. See the inset in Fig. 7. In practice the upper and lower connection holes are both on the same side of the strip.

Wiring should be carried out with the aid of a small well-tinned electric soldering iron, using radio-type resin-cored solder such as Multicore 'Ersin' or 'Savbit'. On no account should a paste or liquid flux be used.

A few of the component lead-outs require to have sleeving passed over them since they run close to other wires and tags. The instructions state where sleeving is necessary. There should be no need to sleeve the remaining component lead-outs if these are spaced out adequately. All resistor and capacitor lead-outs should be kept reasonably short, cutting off the excess wire as necessary.

'JUBILEE' Amplifier



by J. R. Davies

In this concluding article, full details of wiring-up are given, together with test voltages and final constructional information

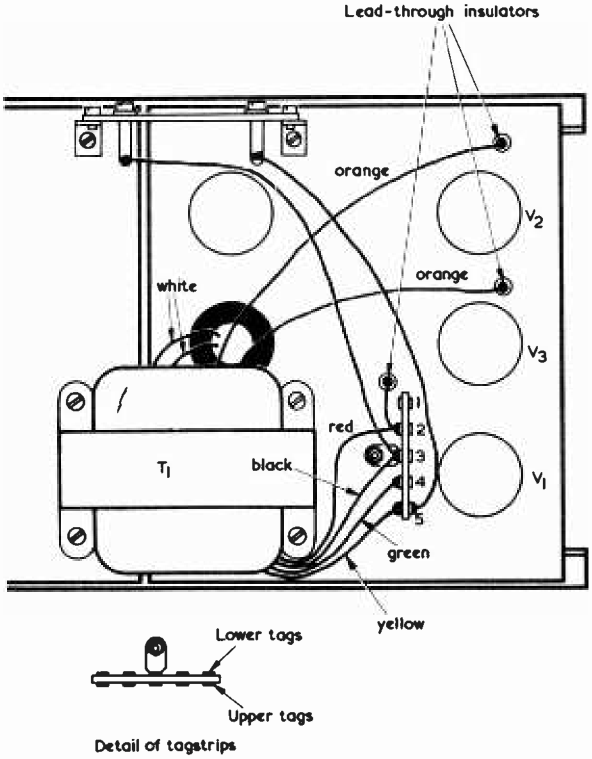


Fig. 7. The output transformer connections above the chassis

OUTPUT TRANSFORMER

We commence at the output transformer.

1. Refer to Fig. 7, which shows output transformer wiring above the chassis. Shortening as necessary, connect the yellow transformer lead to tag 5 (lower) and solder. Similarly shortening, connect the green lead to tag 4 (lower) and solder. Similarly shortening, connect the black lead to tag 3. Similarly shortening, connect the red lead to tag 2 (lower). Connect a wire between tag 2 (lower) and the adjacent lead-through insulator. Solder at the insulator and at tag 2 (lower).

2. Connect a wire between tag 3 and the left-hand tag (left-hand as shown in Fig. 7) of the 2-way terminal strip. Solder at that tag and at tag 3. Connect and solder a wire to the right-hand tag of the 2-way terminal strip. Connect and solder its other end to tag 2 (upper) if a 15Ω output is required, to tag 4 (upper) if an 8Ω output is required, or to tag 5 (upper) if a 2.5Ω output is required. (The 2.5Ω output is satisfactory for a 3Ω speaker). Fig. 7 shows this wire connected to tag 5 (upper).

3. Without shortening, connect the two orange leads to the two remaining lead-through insulators, as illustrated in Fig. 7. Solder at the insulators temporarily only. These two wires may need to be transposed later if it is found that the negative feedback circuit has incorrect phase.

4. The primary of T1 is wound, in practice, in two sections, each with a white lead which connects to h.t. positive. Pass the two white leads from T1 through the ¾ in. grommet.

MAINS TRANSFORMER

5. Fig. 6 was published last month to illustrate the correct method of mounting the mains transformer T2. This diagram also gave wiring details and we now return to it. Connect the 'SC' (short for 'screen') tag

of T2 to the adjacent chassis solder tag. Solder at the chassis tag. Connect a wire from the 'O' h.t. winding tag between the two '250' tags to the 'SC' tag. Solder at the 'O' h.t. winding tag.

6. Locate the 'O' and '6.3' heater winding tags at the bottom left of the transformer (bottom left as shown in Fig. 6). Connect R17 (220Ω) between the 'O' heater winding tag and the 'SC' tag. Connect R18 (220Ω) between the '6.3' tag and the 'SC' tag. Solder all the connections at the 'SC' tag.

7. The wires next to be added are all routed along the rear of the mains transformer and pass through the ¾ in. grommet to the chassis underside. Their route is visible in the photograph showing the upper view of the chassis. The wires should be laid along the chassis surface as neatly as possible and they will later be secured in position by a clip. Refer next to Figs. 6 and 8.

Connect a wire 2 ft. long to the 'O' heater winding tag at the transformer bottom left. Solder at the 'O' tag. Connect a second wire 2 ft. long to the adjacent '6.3' heater winding tag. Solder at the '6.3' tag. Run the two wires along the rear of the mains transformer and through the ¾ in. grommet. On the underside of the chassis the two wires are twisted together, (they need not be twisted above the chassis) and, following the route shown in Fig. 8, pass to V2 valveholder. Shortening as necessary, connect one wire (it does not matter which) to pin 4 of V2 and the other to pin 5 of V2. Connect two further wires to pins 4 and 5 of V2, and solder at pins 4 and 5.

8. Twist together the two wires from pins 4 and 5 of V2 and, shortening as necessary, connect one of these (it does not matter which) to pin 4 of V3 and the other to pin 5 of V3. Connect two further wires to pins 4 and 5 of V3, and solder at pins 4 and 5.

9. Twist together the two wires from pins 4 and 5 of V3 and, shortening as necessary, connect and solder one of these (it does not matter which) to pin 9 of V1. Shortening as necessary connect the other wire to pin 4 of V1. Join together pins 4 and 5 of V1 with a short length of bare wire. Solder at pins 4 and 5. This now completes the heater wiring for V1, V2 and V3.

10. Returning to Fig. 6, connect and solder two 18 in. lengths of wire to the two '250' h.t. winding tags of the mains transformer. Pass these round the rear of the transformer and through the ¾ in. grommet. Turn the chassis over and, shortening as necessary, connect and solder one wire (it does not matter which) to pin 1 of V4, and connect and solder the other wire to pin 7 of V4.

11. Turning again to Fig. 6, locate the 'O' and '6.3' heater winding tags at the top right of the mains transformer. Connect and solder two 18 in. wires to these two tags. Pass these wires round the rear of the transformer and through the ¾ in. grommet. Again turn the chassis over and, shortening as necessary, connect and solder one wire (it does not matter which) to pin 5 of V4. Connect the other wire to pin 4 of V4. Join together pins 3 and 4 of V4 with a short length of bare wire. Connect a wire between pin 3 of V4 and tag 10 (lower). Solder at pins 3 and 4 of V4 and at tag 10 (lower).

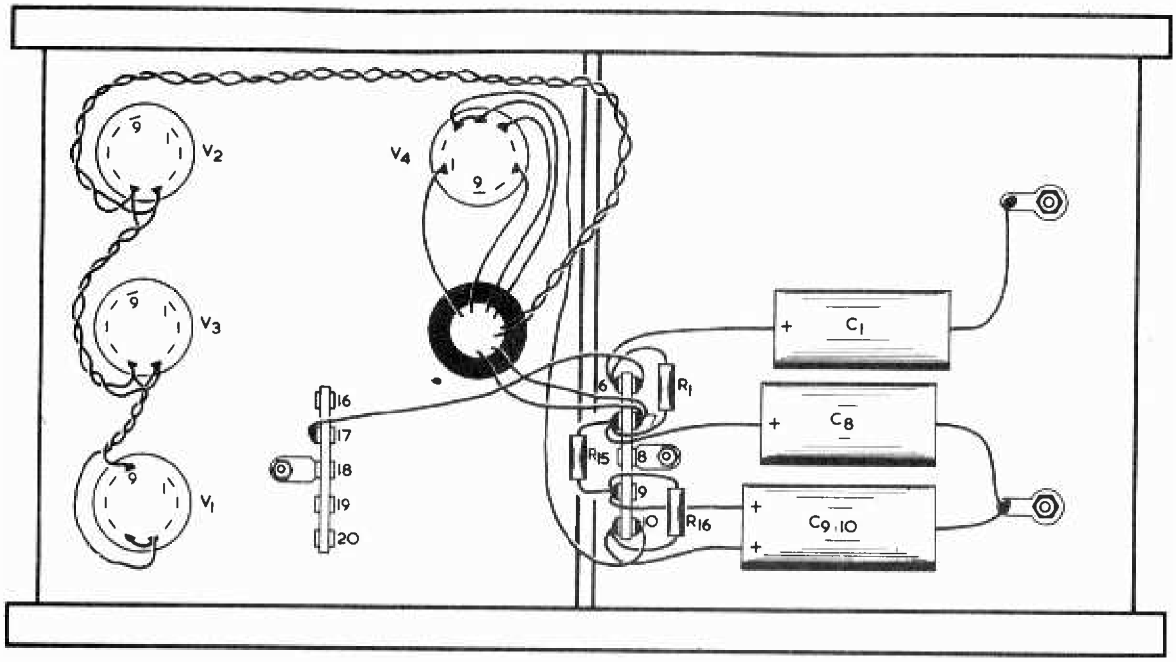


Fig. 8. Heater and power supply wiring

POWER SUPPLY COMPONENTS

12. The connections to T2 secondary are now completed and we proceed next with fitting the power supply components. These are also shown in Fig. 8. Take up the dual electrolytic capacitor C9, C10 (32+32μF) and examine its positive lead-outs. If one of these is coded red connect this lead-out to tag 10 (upper) and connect the other positive lead-out to tag 9 (upper). If no colour coding is provided on the capacitor either of the positive lead-outs may connect to tag 10 with the other lead-out connecting to tag 9. Connect R16 (470Ω 5 watts) between tag 10 (upper) and tag 9 (upper). Solder at tag 10 (upper). Connect the negative lead-out of C9, C10 to the adjacent chassis tag.

13. Shortening as necessary, connect and solder the two white leads from output transformer T1 to tag 7 (lower). (These wires were passed through the ¼ in. grommet in Step 4.)

14. Connect the positive lead-out of C8 (50μF) to tag 7 (upper). Connect the negative lead-out of C8 to the adjacent chassis tag, as shown in Fig. 8. Solder at the chassis tag. Connect R15 (270Ω 2 watts) between tag 9 (upper) and tag 7 (upper). Solder at tag 9 (upper).

15. Connect together tag 6 (lower) and tag 17 (lower). Solder at tag 6 (lower). Connect R1 (27kΩ 5%) between tag 7 (upper) and tag 6 (upper). Connect the positive lead-out of C1 (50μF) to tag 6 (upper) and its negative lead-out to the adjacent chassis tag, as illustrated in Fig. 8. Solder at tag 6 (upper) and the chassis tag.

SIGNAL WIRING

16. The wiring in Fig. 8 is now complete and we proceed next to the signal wiring shown in Fig. 9. Connect pin 9 of V2 to pin 3 of V2. Connect pin 9 of V3 to pin 3 of V3, soldering at pin 3 of V3. Connect the chassis tag alongside tag 13 to the centre spigot of V2. Connect this same chassis tag to the centre spigot of V3. Solder at the chassis tag. (Some B9A valveholders have a tag between pins 1 and 9 which is integral with the centre spigot and which can take the centre spigot connections. With other B9A valveholders it is necessary to connect directly to the spigot itself). All the wires fitted in this step should be pressed against the chassis underside so as to leave room for the components which follow.

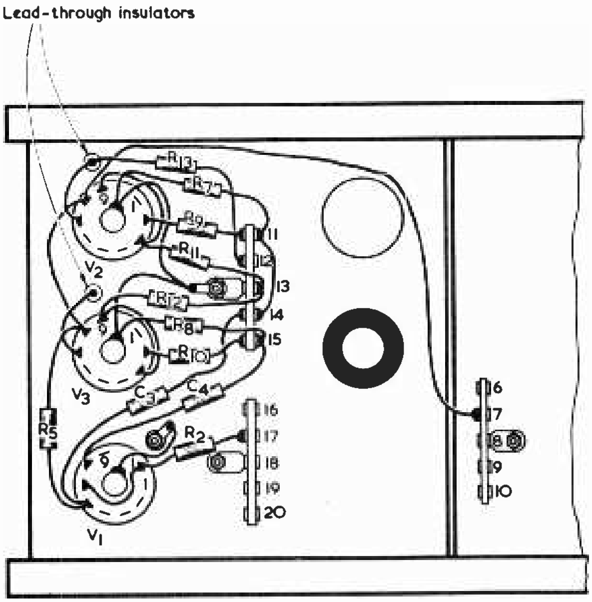
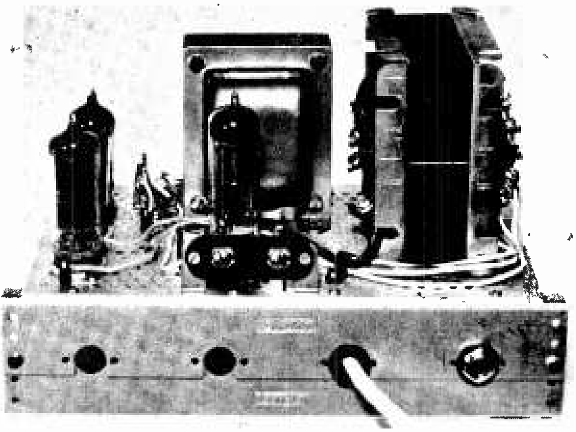


Fig. 9. Initial steps in the signal wiring



A view of the rear of the amplifier. The speaker terminal strip is in the centre with the rectifier immediately behind

17. With the wire following the route shown in Fig. 9, connect tag 7 (upper) to pin 8 of V2. Solder at tag 7 (upper). Connect pin 8 of V2 to pin 8 of V3. Solder at pin 8 of V2. Fitting sleeving over its lead-outs connect R5 (27kΩ 2%) between pin 8 of V3 and pin 6 of V1. Solder at pin 8 of V3.

18. Connect pin 7 of V3 to the adjacent lead-through insulator. Solder at pin 7 of V3. Connect pin 7 of V2 to the adjacent lead-through insulator. Solder at pin 7 of V2. Fitting sleeving over the lead-out which connects to tag 12, connect R13 (47kΩ) between the lead-through insulator last dealt with and tag 12 (lower). Solder at the lead-through insulator and at tag 12 (lower).

19. Fitting sleeving over the lead-out which connects to pin 6, connect C3 (0.022μF) between pin 6 of V1 and tag 14 (lower). Solder at pin 6 of V1 and tag 14 (lower). Connect R10 (4.7kΩ) between pin 2 of V3 and tag 15 (lower). Solder at pin 2 of V3 and tag 15 (lower).

20. Connect C4 (0.022μF) between pin 8 of V1 and tag 15 (upper). Connect R8 (470kΩ) between the centre spigot of V3 and tag 15 (upper). Solder at the centre spigot and at tag 15 (upper). Connect R12 (270Ω 1 watt) between pin 9 of V3 and tag 13.

21. Connect R9 (4.7kΩ) between pin 2 of V2 and tag 11 (lower). Solder at pin 2 of V2 and tag 11 (lower). Connect R7 (470kΩ) between the centre spigot of V2 and tag 11 (upper). Solder at the centre spigot of V2. Connect tag 11 (upper) to tag 14 (upper). Solder at tag 11 (upper) and tag 14 (upper). Connect R11 (270Ω 1 watt) between pin 3 of V2 and tag 13. Solder at pin 3 of V2.

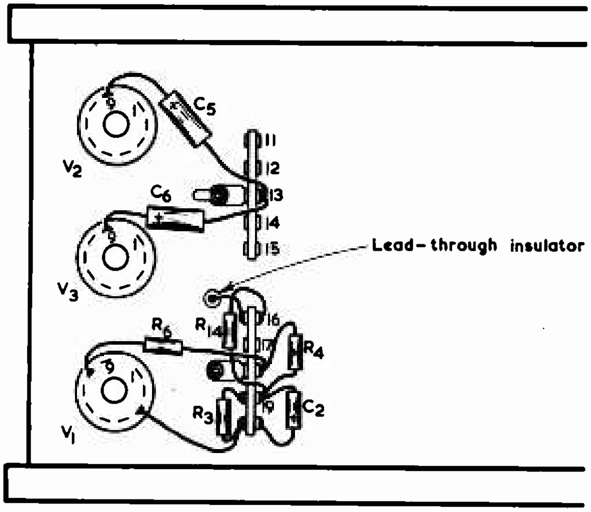


Fig. 10. The components which are fitted prior to the installation of VR2/S1

22. Connect the chassis tag adjacent to V1 to V1 centre spigot. Solder at the chassis tag. Connect pin 1 of V1 to pin 7 of V1. Solder at pin 7 of V1. Connect R2 (100kΩ) between pin 1 of V1 and tag 17 (lower). Solder at pin 1 of V1 and tag 17 (lower).

23. We next turn to Fig. 10. Connect the positive lead-out of C5 (80μF) to pin 9 of V2 and the negative lead-out of C5 to tag 13. Solder at pin 9 of V2. Connect the positive lead-out of C6 (80μF) to pin 9 of V3 and the negative lead-out of C6 to tag 13. Solder at pin 9 of V3 and at tag 13. Connect the lead-through insulator adjacent to tag 16 to tag 16 (lower). Solder at the insulator and at tag 16 (lower).

24. Connect pin 3 of V1 to tag 20 (lower). Solder at pin 3 of V1. Connect R3 (2.2kΩ) between tag 19 (lower) and tag 20 (lower). Solder at tag 19 (lower) and at tag 20 (lower). Connect R6 (27kΩ 2%) between pin 8 of V1 and tag 18. Solder at pin 8 of V1. Connect R4 (100Ω) between tag 18 and tag 19 (upper). Solder at tag 18.

25. Connect R14 (750Ω) between tag 16 (upper) and tag 19 (upper). Solder at tag 16 (upper). Connect the positive lead-out of C2 (25μF) to tag 20 (upper) and the negative lead-out of C2 to tag 19 (upper). Solder at tag 20 (upper). VR2/S1 is fitted in the next Step (see Fig. 11), and C2 should be so positioned that it will not foul this component.

TONE CONTROL CIRCUIT

26. The spindle of VR2/S1 is cut to the desired length and this control is fitted to the front chassis rail assembly at the second hole from the V1 end, as illustrated in Fig. 11. It should be orientated such that its right-hand potentiometer tag (right-hand as shown in Fig. 11) is furthest away from the chassis underside. If it has a locating lug this will need to be bent away or cut off.

27. Connect the lead-through insulator between V2 and V3 to the left-hand tag of VR2, running the wire under the tagstrip with tags 11 to 15, as shown in Fig. 11. Solder at the insulator and at the left-hand tag of VR2. Connect C7 (0.01μF) between tag 19 (upper) and the centre tag of VR2. Solder at tag 19 (upper) and the centre tag of VR2. Connect tag 12 (upper) to the right-hand tag of VR2. Solder at tag 12 (upper) and the right-hand tag of VR2.

28. Fit the ½ in. grommet to the rear chassis rail assembly at the third hole from the V2 end. Pass the 3-core mains lead through this and strip off its outer covering. Connect and solder the earth lead (green and yellow) to tag 8 (upper). Connect and solder the live lead (brown) to one of the tags of switch S1. Pass the neutral lead (blue) through the ½ in. grommet and connect it to the 'O' primary tag of mains transformer T2. Fit a plastic clip (Lektrokit Part No. LK2831) over the mains lead and clamp this to the chassis with a 6BA nut and bolt at any convenient

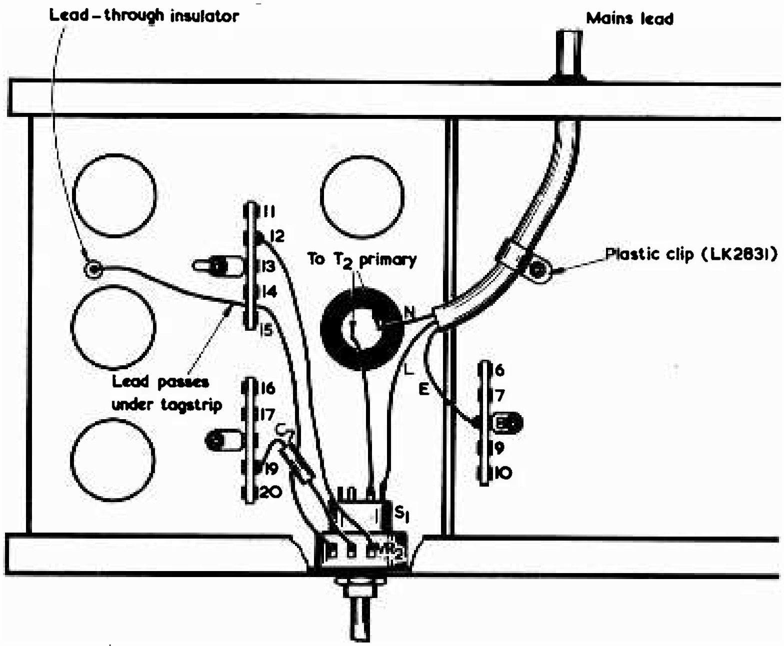


Fig. 11. Adding VR2/S1 and the mains input lead

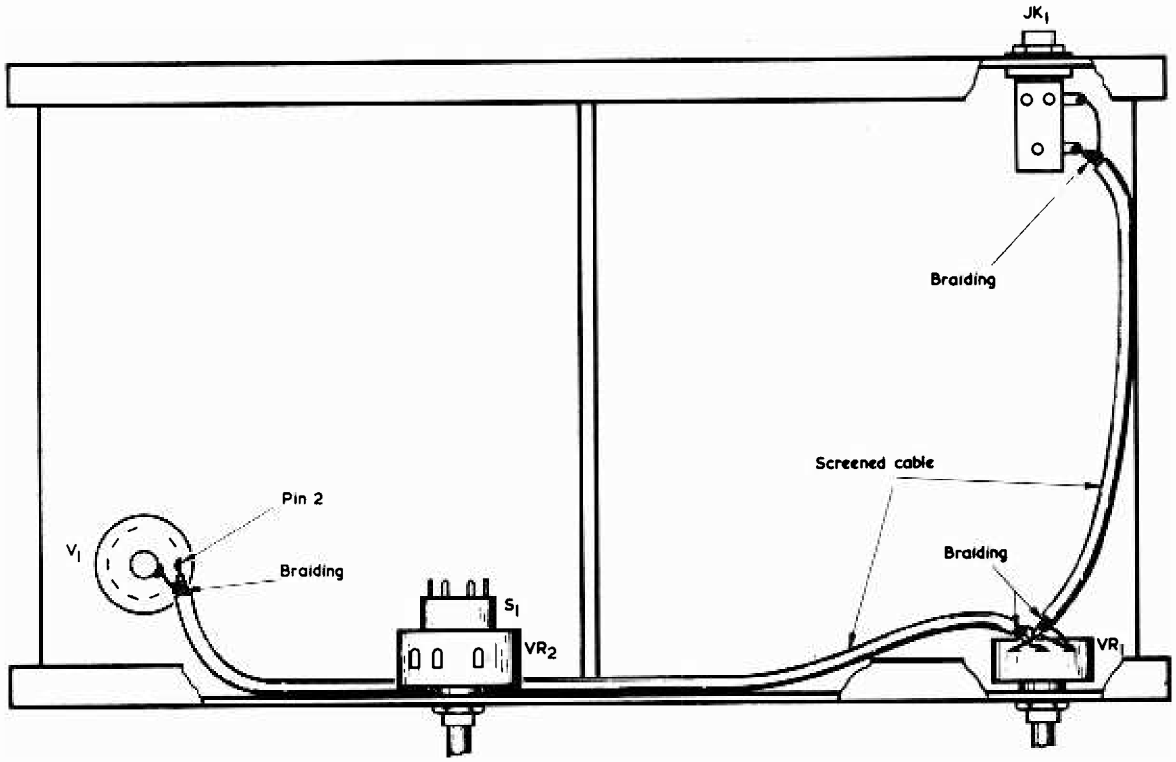


Fig. 12. The final wiring steps involve the fitting of VR1 and the input jack

point near the ½ in. grommet. Solder at the 'O' tag.

29. The positions of the tags on S1 may vary with different makes or models of switch. With the aid of a continuity tester (such as a test-meter switched to an ohms range or a battery and bulb in series) locate the switch tag which corresponds to that to which the live mains lead has just been connected. Connect this tag to either the '200', '230' or '250' primary tag of mains transformer T2, according to the local mains voltage. (For 240 volt mains connect to the '250' tag). Solder at the tag of S2 and the primary tag of T2. Fit a 3-way mains plug at the free end of the mains lead, making certain that the live lead (brown) connects to the live pin, the neutral lead (blue) connects to the neutral pin, and the earth lead (green and yellow) connects to the earth pin.

VOLUME CONTROL CIRCUIT

30. The next components to be fitted are volume control VR1 on the front chassis rail assembly and input jack JK1 on the rear chassis rail assembly. See Fig. 12. The spindle of VR1 should be cut to the desired length before it is mounted, and its tags project away from the chassis underside. Both components are mounted at the chassis rail assembly holes furthest from the V1 end of the chassis. Should it happen that the locating lug of VR1 coincides with the adjacent 6BA clear hole in the chassis rail assembly this factor may be taken advantage of when mounting this component. If not, the locating lug must be bent away or cut off. As was mentioned last month, should JK1 be the jack socket specified a ⅜ in. washer needs to be fitted under its securing nut to enable it to be properly mounted in the Lektrokit chassis rail hole.

31. Take up the screened cable and strip one end. Connect the braiding to the centre spigot of V1 and the inner conductor to pin 2 of V1. Solder at the centre spigot and at pin 2 of V1. (Soldering at the centre spigot also completes the connection from the adjacent solder tag which was made in Step 22).

32. Pass the screened lead along the chassis under VR2/S1 and, shortening as necessary, connect its inner conductor to the centre tag of VR1 and its braiding to the right-hand tag (right-hand as shown in Fig. 12) of VR1. Solder at the centre tag of VR1. Strip one end of the remaining screened cable and connect its inner conductor to the left-hand tag of VR1 and its braiding to the right-hand tag of VR1. If the potentiometer employed has a metal back which is not, by reason of its construction, common with its mounting bush (and thence with chassis) connect the metal back of VR1 to its right-hand tag. Solder at the left and right-hand tags of VR1 and, where applicable, at its metal back.

33. Run the screened cable just fitted along the chassis underside to input jack JK1. Shortening as necessary, connect its braiding to the tag of JK1 which is nearer the rear chassis rail assembly and connect its inner conductor to the remaining tag of JK1. Solder at both tags of JK1.

34. Fit knobs to VR1 and VR2/S1. Insert a 12AU7 into V1 valveholder, a 6BW6 into V2 valveholder, a 6BW6 into V3 valveholder and an EZ81 into V4

valveholder. Fit a Lektrokit plastic clip (Part No. LK2831) above the chassis over the leads from the ¾ in. grommet to T2 primary and secondary tags so that these are kept tidy. The position of the clip may be judged from the photograph showing the top of the chassis. If the 2-way terminal strip has been fitted correctly and its tags soldered neatly, the latter should not interfere with V4. Should this occur, however, the appropriate tag should be bent out of the way.

NEGATIVE FEEDBACK

35. The amplifier is now complete, with the exception of the checking of the negative feedback phasing. Visually examine the wiring that has been carried out and ensure that there is no risk of short-circuits due to stray pieces of wire or 'blobs' of solder. If an ohmmeter is available check for short-circuits between the h.t. positive line (at tag 7) and chassis. The ohmmeter needle will give an initial kick as its test prods are applied due to charging current in the h.t. electrolytic capacitors. Because of these capacitors the ohmmeter will probably give a lower resistance reading when applied with one polarity, than it does when applied with the opposite polarity.

36. Connect a loudspeaker to the amplifier at the terminal strip at the rear and, with VR2/S1 switched off, plug the supply lead into the mains. Switch on and listen carefully. If, after the valves warm up, the amplifier goes into oscillation, switch off *immediately*. The oscillation indicates that the feedback is positive instead of negative, whereupon the orange leads from transformer T1 to the lead-through insulators which were connected in Step 3 have to be changed over. Should these leads have to be changed over, do so with temporary connections and check again. When all is well, the orange leads may be shortened as necessary and soldered permanently to the lead-through insulators. The 'Jubilee' audio amplifier is now complete and ready for use.

FINAL DETAILS

A few final points need to be mentioned before concluding this article.

It will be found that, immediately after switching on the amplifier, a slight hum is audible from the speaker. This reduces to a negligible level when the valves warm up and the negative feedback loop becomes operative. This is the hum which was referred to in last month's issue.

The accompanying Table shows voltages obtained with the prototype, as measured with a 20,000 ohm per volt meter. These readings should be looked upon as offering a guide only. Tolerances in components and valve characteristics, together with other factors, cause the figures in the Table to be approximate only, and small discrepancies encountered in individual amplifiers do not necessarily imply a fault condition.

TABLE
Voltage Readings
All voltages are with respect to chassis

Circuit Location	Chassis Point	Voltage
Cathode V4	Tag 10	270V
Junction R16, R15	Tag 9	230V
Screen-grids V2, V3	Tag 7	210V
Anode V1 (b)	Pin 6, V1	137V
Cathode V1 (b)	Pin 8, V1	73V
Anode V1 (a)	Pin 1, V1	70V
Cathodes V2, V3	Pin 3, V2, V3	11V

No particular precautions need to be observed when employing the amplifier. If housed in a cabinet, holes in the bottom and the back of the latter should be provided for ventilation purposes. The amplifier should not be operated without a loudspeaker connected to it.

(Concluded)

RADIO AMATEUR EXAMINATION COURSES

A course to prepare students for the R.A.E. in May/June 1973 will again be held at the Gosforth Evening Institute, Gosforth Secondary School, Regent Avenue, Gosforth, Northumberland, commencing in September 1972.

Designed specifically for the R.A.E., the course is also ideal for anyone wanting to get an insight to radio theory having just taken up radio or electronics generally as a hobby or professionally.

Held on a Tuesday/Wednesday of each week from 7 pm to 9 pm, candidates may sit the R.A.E. at the school.

Enquiries to D. R. Loveday, G3FPE, 5 Carlton Road, Benton, Newcastle-upon-Tyne.

Theory classes for the Radio Amateurs' Examination will be held in the 1972/3 session at Beckenham and Penge Adult Education Centre, 28 Beckenham Road, Beckenham, Kent, commencing Tuesday 19th September at 7.00 pm.

Application for enrolment may be made by post to the Area Office, 244 Croydon Road, Beckenham, Kent, BR3 4DA from 29/8/72.

The lecturer is R. E. Piper, G3MEH.

It is anticipated that an R.A.E. course will be held again at the Birkenhead Technical College, Borough Road, Birkenhead. Classes will be held on Thursday evenings, the lecturer being L. Roberts G3 EGX.

Enquiries to A. Seed G3FOO, 31 Withert Avenue, Bebington, Wirral, Cheshire.

A Radio Amateurs' Examination Course is to be held at the Glasgow College of Nautical Studies, 21 Thistle Street, Glasgow C.5.

The Course will meet at the College on Tuesdays and Thursdays from 7 pm to 9.30 pm commencing Tuesday 12th September 1972. Enrolment will take place at the College at 7 pm on the opening evening, and the fee for the course is £3.00 payable on enrolment. Students under the age of 18 on 1st August, 1972, will not be required to pay a fee.

The Syllabus of the course embraces theory, licence conditions and morse instruction. No prior knowledge is assumed or required.

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MEASURING SMALL CAPACITORS

by

R. E. Stewart

Ambiguities and errors in the measurement of low-value capacitors can be eradicated by the use of the 'screened' lead technique.

THE MEASUREMENT OF LOW VALUE CAPACITORS, BELOW some 20pF or so, can raise quite a few practical problems. This is because there are stray capacitances between the individual sections of the capacitor and earth and between its two lead-outs. In a small ceramic capacitor having lead-outs spaced by about 8mm., as in Fig. 1, the stray capacitance between the two leads may well be of the order of 0.5pF or more.

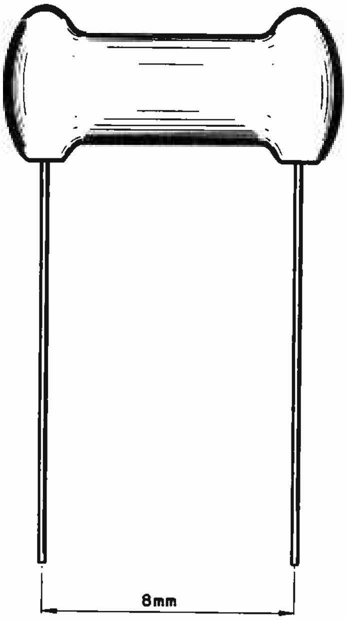


Fig. 1. A typical low value ceramic capacitor with side lead-outs

'SCREENED' LEADS

Difficulties due to stray capacitances are overcome in industry by measuring the capacitance of low value capacitors with the leads 'screened'.

An illustration of the technique is given in Fig. 2, in which a capacitor under test is inserted into a contact jig. Note that each capacitor lead passes down a metal channel and that a springy leaf contact bears against it. The jig is constructed such that the spacing between the entry points for the capacitor leads is equal to the lead-out spacing.

The jig is employed in the following manner. First of all the capacitance between the two sections of the jig is measured without a capacitor inserted. The capacitor to be measured is next inserted and the new capacitance measured. The *difference* between the two readings is then calculated and this is stated to be the value of the capacitor. Thus, if the capacitance in the jig before the capacitor is inserted is 3.6pF, and this increases to 7.4pF when the capacitor is inserted, the value of the capacitor is 7.4 minus 3.6pF, or 3.8pF.

This approach is employed at capacitor factories and it will be noted that it measures the capacitance within the body of the capacitor only. Whatever additional capacitance is added by the lead-outs and by stray capacitances to earth cannot then affect the capacitance figure given, and the method enables the capacitor manufacturer to produce low value capacitors without subsequent arguments with his customers about their values. If the manufacturer's customers choose to change the capacitance by connecting his wares into circuit with long leads positioned close together, or by mounting the capacitor bodies close to a metal chassis, he can hardly then be blamed for an apparent shift in value.

The technique shown in Fig. 2 is often referred to as capacitor measurement with the lead-outs 'screened'. The term is understandable since the jig screens the lead-outs from each other and also from earth.

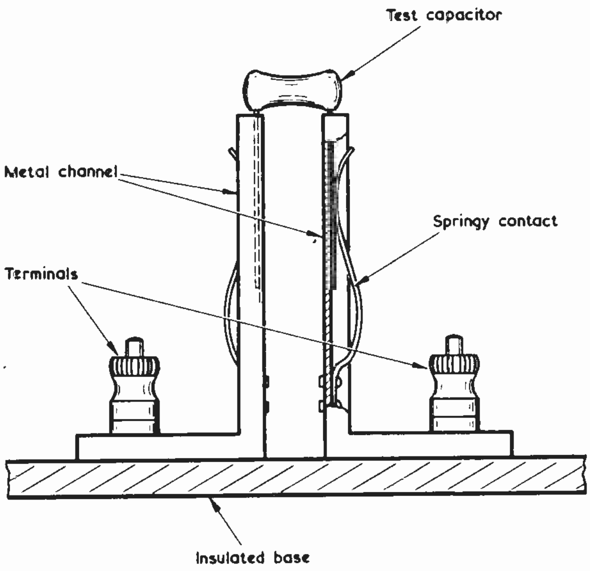


Fig. 2. An example of a capacitance measuring contact jig. Part of the right hand contact assembly is shown cut away to illustrate the construction

It is easy to make up a single 'screened' lead contact jig which will give results that are quite adequate for the amateur workshop or small laboratory, and a suitable method of construction is shown in Fig. 3(a). The jig consists of two hollow metal cylinders some 5cm. long mounted vertically on a small base made of insulating material such as Paxolin or Perspex. The cylinders are tapped centrally at their base and are secured with 6BA or 4BA screws, as convenient. Two leads soldered to tags mounted under the screw heads connect the cylinders to two large terminals for ease of connection to the capacitance meter. The dimensions given in Fig. 3(a) are tentative only and may be varied slightly to suit whatever material happens to be on hand. The capacitor leads are simply inserted down the central holes in the cylinders as in Fig. 3(b) whereupon, if the leads are sufficiently clean, adequate contact is given to the two cylinders to enable a capacitance measurement to be obtained.

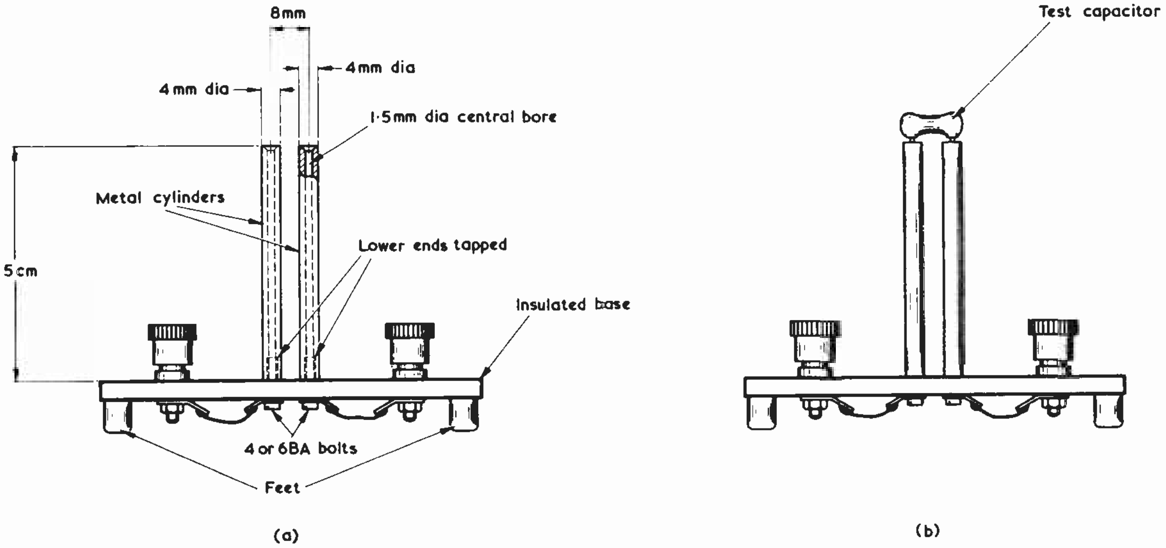
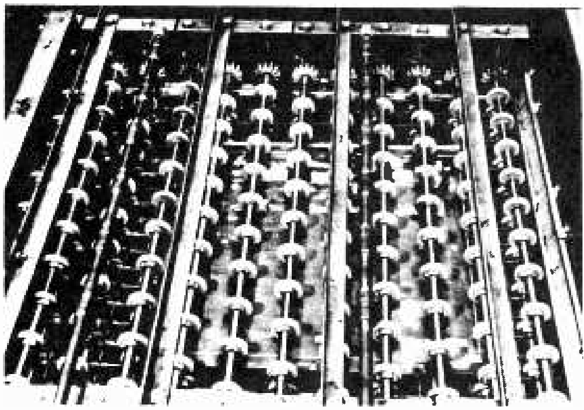


Fig. 3(a). A simple capacitance measurement jig with tentative dimensions
(b). The measurement jig in use. The value of the capacitor is the capacitance of the jig with the capacitor inserted minus the self-capacitance of the jig on its own

The two cylinders can consist of brass turned on a lathe. However, it is more than probable that a well-stocked junk-box will yield a source of metal tubing, or similar, which can be pressed into service without the necessity of extensive metal-work. The metal of which the cylinders are made is unimportant provided that it has a surface which does not tarnish or oxydise readily, since it would then offer poor contact to the capacitor leads. ■

Trade News . . .

'METHOKLONE' S A NEW SOLVENT FROM ICI



ICI Mond Division is marketing a new solvent – 'Methoklone' S – a specially formulated product designed for many cleaning applications, particularly in the manufacture of printed circuit boards, where there is need for a powerful solvent to remove resists. The use of photosensitive resists, especially the newer, dry film resists, demands a solvent capable of removing the polymerised product and 'Methoklone' S is ideal for this purpose.

The new solvent has a low boiling point, is nonflammable and has high solvent power.

'Methoklone' S will also remove decorative metal after etching; protective lacquer from electric motors and electric components; printing ink from printing machinery components; pitches and waxes from semi-conductors etc. For further information write to: Imperial Chemical Industries Ltd., Thames House North, Millbank, SW1.

AUSTEN SOLDERMASTER MK V

Charles Austen Pumps Limited who introduced their Soldermaster desoldering tool for removing faulty multi pin components from boards and for salvaging reuseable components from faulty assemblies at a time when multi pin components were first being introduced in electronic circuits, have developed a new unit, the Soldermaster Mk. V; this meets the requirements of Companies who favour the use of temperature controlled irons for use on the latest type of microminiature multi pin components and boards.

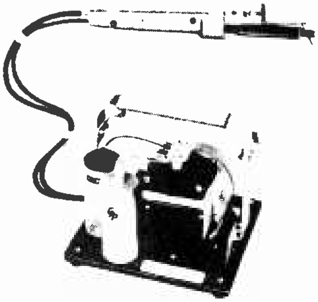
A Weller 100 watt temperature controlled iron has been adapted for use with the new unit. It is fitted with a solder catch pot and an interchangeable hollow bit through which the operator may apply a vacuum. An Austen Capex Mk. II diaphragm pump driven by a shaded pole motor provides the vacuum source, it is mounted on a bakelite base fitted with a carrying handle and an iron rest. The noise level of the pump has been reduced to a minimum by fitting a polypropylene expansion chamber. The pump is protected from resin fumes by a cleanable microfilter.

Six bits are supplied with the standard unit, the bit holder being designed to facilitate quick interchange. The Weller temperature controlled iron, while safeguarding components and boards by preventing excessive bit temperature rise, reduces bit erosion and gives much faster temperature recovery when used continually for desoldering.

The bit sizes range from 0.078" to 0.125" outside diameter and are suitable for component pins of 0.020" to 0.063" diameter.. A moulding which holds the complete range of bits is incorporated in the instrument.

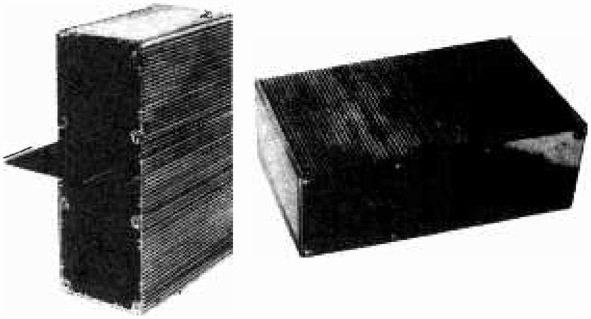
The Soldermaster Mk. V is a compact unit weighing only 6½ lbs. and measuring 7½" x 6" x 6" high.

Full details are available from Charles Austen Pumps Ltd., 100 Royston Road, Byfleet, Surrey.



VERO ELECTRONICS INTRODUCE VEROBOXES

Vero Electronics announce the introduction of a new range of extruded aluminium enclosures to be sold under the name of Veroboxes (R). These consist of a range of eight different stock sizes of extruded boxes. The boxes are made up of combinations of two types of extrusion 50 mm wide which slot together. The precision joints tighten under stress and are rigidly secured when the cover plate screws are fitted. Finned sides act as an effective heat radiating surface. Two .15 mm slots are provided on the inside face of each extrusion to accommodate either printed circuit cards or metal deck plates. They are supplied in kit form for ease of storage and despatch. Details from: Vero Electronics Ltd., Industrial Estate, Chandlers Ford, Hampshire. SO5 3ZR.



Q S X

by

Frank A. Baldwin

(All Times GMT)

In the opening paragraphs of this feature in the July issue, the subject of unidentified stations was briefly discussed and in particular, two such stations were mentioned, these being Kuwait on **4968** and Tananarive on **4985.** Neither of these however were positive identifications, it merely being suggested that the times quoted, the languages used and the programme contents, could possibly fit Kuwait and Tananarive. Since then other observations have been made by various operators with the results recounted below.

Dealing with the frequency, transmissions in Arabic were heard both by the writer and two other operators during early May but later in the same month, just 1kHz away – on **4967** – a transmission in Portuguese turned out to be CR6RE Radio Clube de Malange, Angola. Three enthusiasts, operating independently, logged the Angolan, in one case part of the station identification being heard.

What are we to make of all this? The ability of the operators is undoubted, their repute beyond question, all being seasoned SWL's of long standing. The answer is probably that they were all correct and that Kuwait did in fact briefly return to an old channel for some unknown (to the writer) purpose. The Arabic language is not used by Angolan stations but is one that is instantly recognisable by two of the operators who identified the language as such – each having lived in the Arabic world for a period of time. The Portuguese language is also easily recognisable to broadcast band enthusiasts of long-standing, undoubtedly therefore CR6RE was heard. Times and conditions could also however play a part in all this, as seasoned SWL's are well aware. It is quite possible to hear one station without any trace of the other.

What of the second channel, that of **4985?** Well, a similar situation exists. Since the tentative suggestion that Tananarive was the station heard, and that the unknown language used was Malgache following the news in French, other operators have identified the Portuguese language – this suggesting that the transmitter could be CR6RB Radio Ecclesia, Angola. Perhaps again all are right, varying conditions allowing each station to be heard at slightly differing times on separate days.

If you, the reader, care to join in the fun, keep an open mind and ear and tune to **4968** from around 1930 to 2130, remembering to vary to **4967** from time to time. Also tune to **4985** from around 1930 through to 2200, braving the late-summer static and the commercial QRM at the same time!

● UNUSUAL LOGGING

Turning to another matter, reader H. Green of Brixham, Devon, tells me that he has regularly logged VNG on **12000** at good signal strengths every morning over the past two years from 0600 to 0800, the station expressing appreciation of his reports and tape recordings, replying with a QSL card. Some interference is experienced to the signals of VNG from a USSR station at 0625. But HG does not end there, he goes on to inform me that the **7500** VNG signals are also regularly noted in the mornings but that the signals are very much weaker than those of **12000.** Even this however is not the end of H. Green and his sterling efforts. His definition of a 'realistic' unusual logging is VNG on **4500** from between 1900 and 2000, frequently in company with a transmission emanating from China. Additionally, he has also noted Sydney Airport Tower giving forecasts on weather and visibility for various Australian airfields on **10010.** Considering HG' uses "an ancient valve type receiver" which originally cost 50p, but which has since been 'put right', it says a lot for his ability as an operator. Let us hear from you again HG.

The only unusual logging we can offer this time is the reception of Phnom-Penh, Kmere Republic, at 0250 on a measured **4908.** Unusual in the fact that (a) signals were like those of a local station (SINPO 44444) and (b) we were awake! The programme consisted of the usual chants, local music and the clashing of gongs, drum beats and tinkling bells.

● LATIN AMERICA

A couple of early morning sessions on the 60m band produced the usual Venezualans and a few others but nothing spectacular – we must have chosen the wrong mornings! In any event, general observations point to the fact that the LA's have not been coming through so well this year coupled with the fact that the noise level has been higher than ever. However, we did log the following –

4760	**0310**	YVPP Radio Frontera, San Antonio, Venezuala, with the usual LA songs and music. Schedule 1000 to 0400, 2kW.
4830	**0305**	YVOA Radio Tachira, San Cristobal, announcements and identification in Spanish. Schedule 1000 to 0400, 1kW.
4860	**0303**	YVQE Radio Maracaibo, LA music and commercials. Schedule 0900 to 0400, 10kW.
4865	**0259**	PRC5 Radio Clube do Para, Belem, Brazil, LA music and closing at 0300. Schedule 0900 to 0300, 2kW.
4870	**0257**	YVKP Radio Tropical, Caracas, commercials in Spanish. Schedule 1000 to 0400, 5kW.
4900	**0243**	Radio Juventud, Barquisimeto, usual LA mx. Schedule 1000 to 0400, 10kW.
4940	**0252**	YVPA Radio Yaracay, San Felipe, LA mx and songs. Schedule 1000 to 0400, 10kW.
4945	**0255**	HJDH Radio Colosal, Neiva, Colombia, talk in Spanish. Schedule 24 hours, 2.5kW.
4960	**0240**	YVOA Radio Sucre, Cumana, LA music. Schedule 1000 to 0430 1kW.
4990	**0237**	Radio Barquisimeto, distinctive LA guitar music. Schedule 1000 to 0400, 15kW.
5030	**0235**	YVKM Radio Continente, Caracas, LA music. Schedule 0900 to 0400, 10kW.
5055	**2310**	ZYX24 Radio Cultural de Cuiaba, Brazil, announcements in Portuguese and LA music.
15115	**0220**	HCJB Quito, Ecuador, in English to USA and in parallel on **9605** and **11745.** ■

A. F. SIGNAI

Cover Feature

R. A.

THIS INSTRUMENT PROVIDES HIGH QUALITY SINE AND square waves from 15Hz to 150kHz over four switched ranges. These ranges are listed in the Table.

The instrument is completely self-contained, power being provided by an internal 9 volt battery. Current consumption from this battery is approximately 6mA for sine wave output, and 8mA for square wave output.

The maximum sine wave output is approximately 500 mV r.m.s., and the maximum square wave output is 5V peak-to-peak. The overall dimensions of the prototype are only 6 by 4 by 2¾in.

The generator is suitable for making nearly all types of test on audio equipment, such as checking for distortion with the sine wave output, and for transient response with the square wave output. Five silicon transistors are used in the circuit, which has been kept as simple as possible.

THE WIEN BRIDGE NETWORK

Fig. 1 shows the theoretical circuit of a Wien Bridge network. This is a frequency selective network which gives a valley-type response curve. When R1 is equal to R4 and C1 is equal to C2, as is usually the case in practical versions of the bridge, the frequency of operation can be found from the equation

$$fo = \frac{1}{2\pi R1.C1}$$

The circuit is really a phase shift network, having zero degrees phase shift at the frequency of operation.

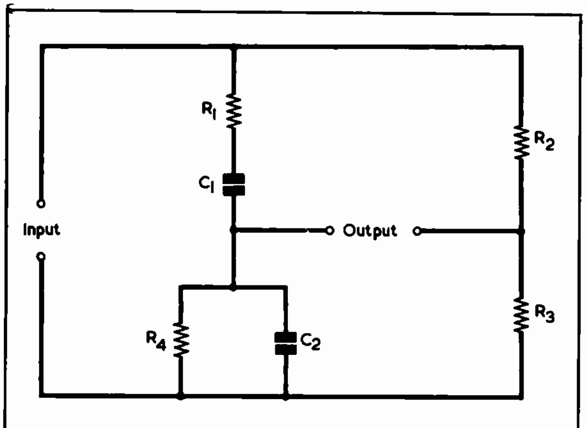
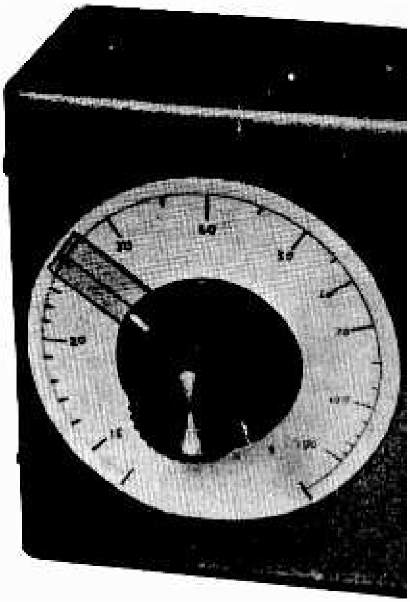


Fig. 1. The Wien Bridge circuit



TA

Range (S1 position)
1 2 3 4

This generator offers both sin
covers 15Hz to 15

GENERATOR

* *

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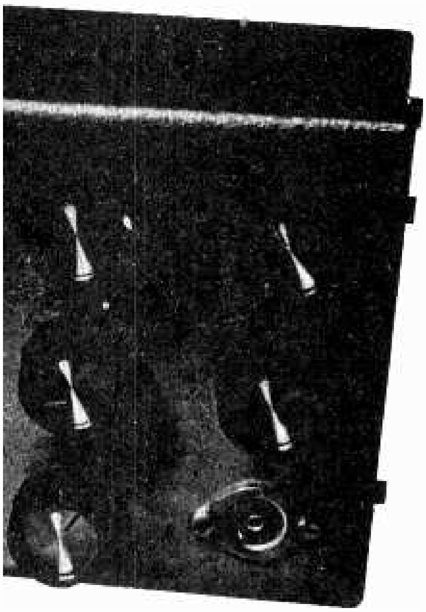


.E

equency coverage
Hz – 150Hz
0Hz – 1.5kHz
5kHz – 15kHz
kHz – 150kHz

and square wave outputs and it
kHz in four ranges

Therefore, if we connect this network between the input and the output of an amplifier which has its input and output signals in phase, and providing the gain of the overall circuit is at least unity, it will oscillate at the operating frequency of the Wien Bridge network. The amplifier need have a gain of only 3 to compensate for losses in the Wien Bridge network, and thus give an overall gain of unity.

The output of the oscillator will not be the required sine wave unless the gain of the overall circuit is maintained at exactly unity. There is then only sufficient gain for the circuit to oscillate at the frequency of the response peak, and at no other, and thus an almost pure sine wave is produced.

The skeleton circuit of a simple Wien Bridge oscillator is shown in Fig. 2. As the input to the amplifier is at a relatively high impedance, resistors R2 and R3 of Fig. 1 are not required in the circuit. The network output is taken from across R4 and C2.

Since the amplifier needs a gain of only 3, a considerable amount of negative feedback can be used to give the circuit a wide bandwidth and low distortion. The feedback is given by taking the collector load of TR2 to the emitter circuit of TR1. Direct coupling is used in order to obtain the best possible frequency response. Feedback is also applied via the variable resistor, this being adjusted to give exactly unity gain.

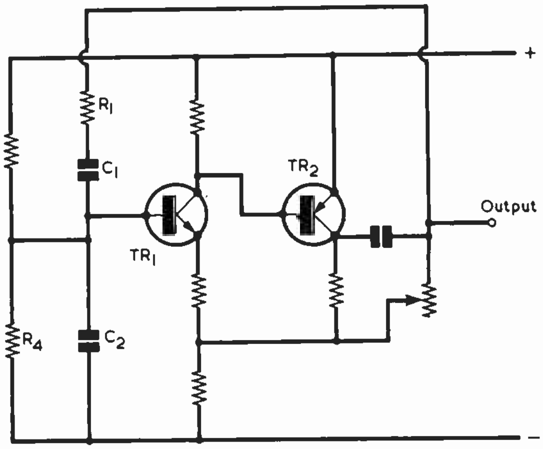


Fig. 2. Basic Wien Bridge oscillator. R4 is now also part of the potential divider which biases TR1

THE CIRCUIT

The circuit diagram of the complete signal generator is given in Fig. 3. Here, TR1, TR2 and TR3 form the Wien Bridge oscillator. This differs from the simplified version shown in Fig. 2 in three ways.

First, the two resistors of the Wien Bridge network have been replaced by a dual-gang variable resistor, VR1,2. This is capable of varying the operating frequency of the unit over the range selected. Second, the two capacitors in the network have been replaced by C1 to C8, any two of these being switched into circuit by the range switch, S1(a)(b). This gives the unit its four frequency ranges. Third, an emitter follower, TR3, has been added at the output of the circuit, to give a much lower output impedance. The variable resistor of Fig. 2 now appears as VR3 and couples to the emitter of TR3 and not, as occurred previously, to the collector of TR2.

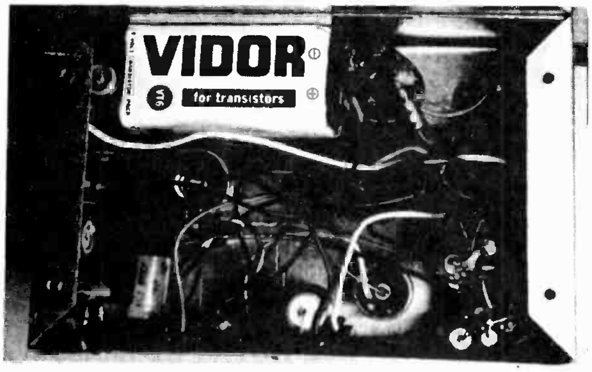
The emitter load for TR3 is the potentiometer VR4. This control gives a linear variation, enabling the output to be varied from zero to maximum.

The output from the Wien Bridge oscillator is next taken, via S2(c) in position 2, to the simple step attenuator given by R9, R10 and R11, and thence, by way of S3, to the output socket. Alternatively the ouput may be taken, by S2(d) in position 3, to the squaring circuit given by TR4 and TR5. In the first of these two instances, the sine wave outputs selected by S3, with VR4 at maximum, are approximately 500mV, 50mV and 5mV r.m.s.

For optimum accuracy in terms of frequency C1 to C8 inclusive should be close tolerance components. Non-electrolytic capacitors to the values required are available in 1% tolerance from Home Radio under Cat. Nos. 2FG25 (1,000pF), 2FG29 (0.01μF), 2FG33 (0.1μF) and 2FG37 (1μF). The 1μF value is also available, in tolerances of 5%, 2% and 1%, from V. Attwood, P.O. Box 8, Alresford, Hants. Capacitors having wider tolerances may be used at the expense of accuracy of frequency.

SQUARE WAVE

There are two basic methods of obtaining a square wave from a sine wave. One method is to generate a sine wave having a very high voltage amplitude and to feed this into a clipping circuit. The other approach consists of applying the sine wave to a Schmitt trigger, and that is the method used here.



A view inside the case of the generator

COMPONENTS

Resistors

(All fixed values ¼ watt 5%)

R1	3.3kΩ
R2	1kΩ
R3	680Ω
R4	4.7kΩ
R5	1.5kΩ
R6	150Ω
R7	5.6kΩ
R8	100Ω
R9	6.2kΩ
R10	620Ω
R11	68Ω
R12	8.2kΩ
R13	3.3kΩ
R14	18kΩ
R15	15kΩ
R16	1.2kΩ
R17	560Ω
VR1,2	10kΩ + 10kΩ dual gang potentiometer linear.
VR3	25kΩ potentiometer, linear
VR4	1kΩ potentiometer, linear.
VR5	50kΩ preset potentiometer, skeleton

Capacitors

(C1–C8 close tolerance – see text)

C1	1μF
C2	0.1μF
C3	0.01μF
C4	1,000pF
C5	1μF
C6	0.1μF
C7	0.01μF
C8	1,000pF
C9	100μF electrolytic, 10 V. Wkg.
C10	400μF electrolytic, 10 V. Wkg.
C11	100μF electrolytic, 6.4 V. Wkg.
C12	25μF electrolytic, 10 V. Wkg.
C13	150pF disc ceramic
C14	100μF electrolytic, 10 V. Wkg.

Transistors

TR1	BC171
TR2	2N3702
TR3	BC113
TR4	2N2926 Yellow
TR5	2N2926 Yellow

Switches

S1	3-pole 4-way, miniature rotary (see text)
S2	4-pole 3-way, miniature rotary.
S3	4-pole 3-way, miniature rotary (see text)

Battery

B1	9-volt battery type PP6 (Ever Ready)

Miscellaneous

1 large knob
5 small knobs
1 coaxial socket
Battery clips
Paxolin for component boards
Aluminium for case
Nuts, bolts, etc.

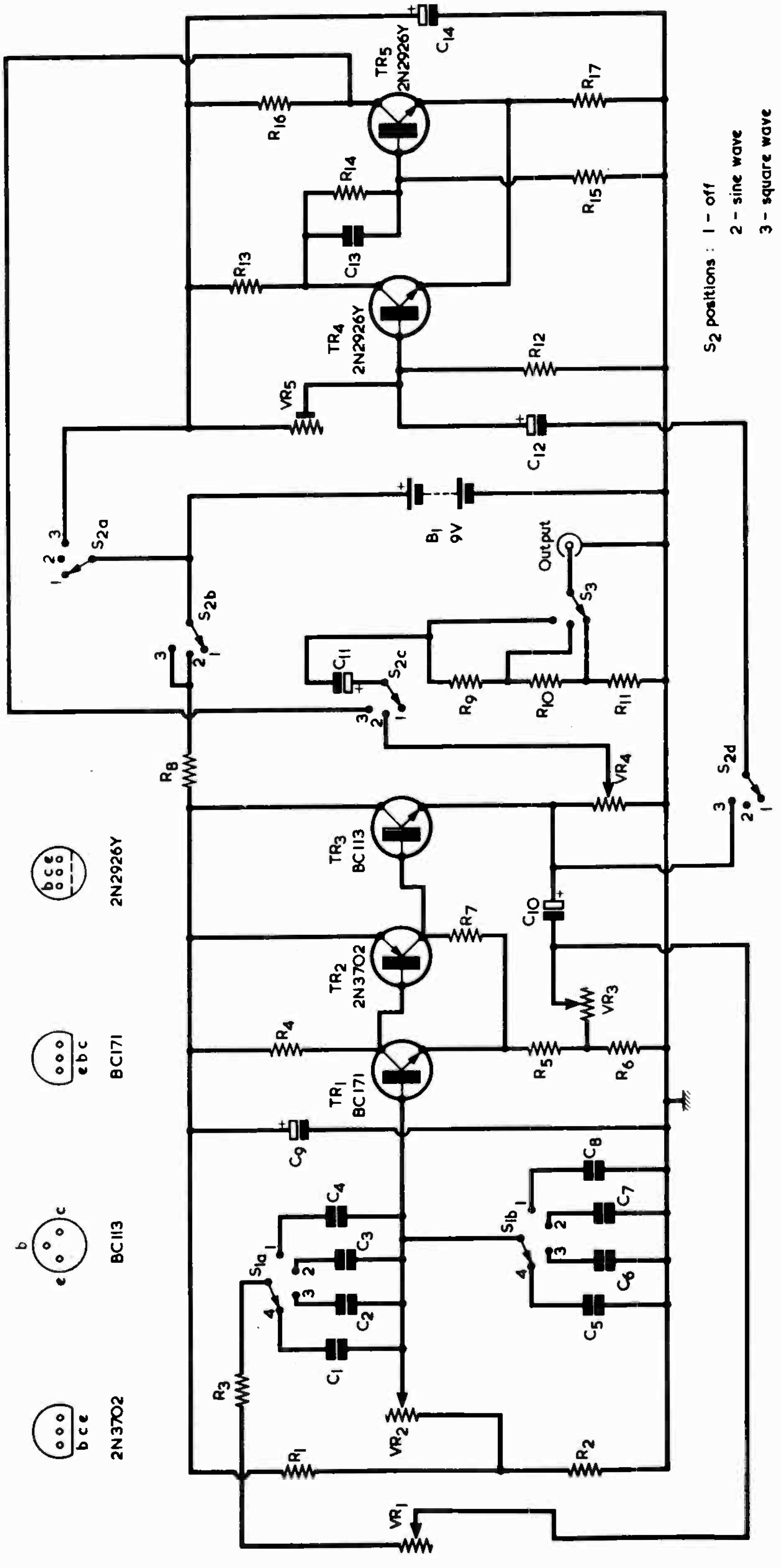


Fig. 3. Complete circuit diagram of the audio signal generator

TR4 and TR5 appear in the Schmitt trigger circuit. VR5 is adjusted such that TR4 is normally off and TR5 is normally on. When a negative-going half-cycle from the Wien Bridge oscillator is applied at the input, i.e. the base of TR4, there is no effect in the circuit since TR4 is already turned off. As soon as a positive-going half-cycle commences, however, TR4 begins to turn on and TR5 to turn off. A regenerative action then takes place, causing TR4 to turn hard on very quickly and TR5 to quickly turn off.

VR5 is adjusted to give a biasing current to TR4 which is just below the point at which, without an input, the regenerative action occurs. Thus, the positive-going half-cycle will have only just commenced when the circuit becomes triggered, causing the voltage at TR5 collector to suddenly swing much higher. TR5 collector will remain at this high level until the input voltage at TR4 base falls to nearly zero, whereupon the Schmitt trigger will return to its original condition and the voltage at TR5 collector will quickly return to its previous value.

An almost square wave is thus produced at TR5 collector. Capacitor C13 is included between TR4 and TR5 to improve the wave shape at high frequencies.

The output of the squaring circuit is taken from TR5 collector and is passed, when S2(c) is in position 3, to the attenuator given by R9, R10 and R11. There is no continuously variable output control for square waves, and S3 selects outputs of approximately 5V, 500mV and 50mV peak-to-peak.

THE CASE

The prototype signal generator is housed in a home-made aluminium case measuring 6 by 4 by 2in. This is constructed from 18 or 20 s.w.g. sheet aluminium and details are given in Fig. 4. Readers should not have difficulty in fitting the components in this housing but it must be stressed that they need to be small or miniature. Ensure that there will be room for the PP6 battery under VR1,2, and if necessary slightly reposition the hole for this component. The spacing between the mounting holes for S1 and S2 is only 1¼in., but this should just comfortably allow two miniature rotary switches to be mounted side by side. The single potentiometers, VR3 and VR4, should be small types with a body diameter of about ⅞in. or less. Capacitor C14 needs to be a reasonably small component also, as it will otherwise not be possible to fit the battery.

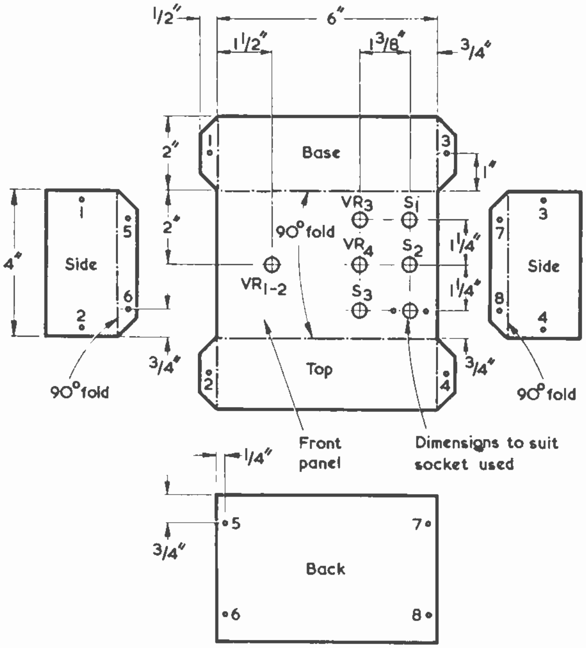
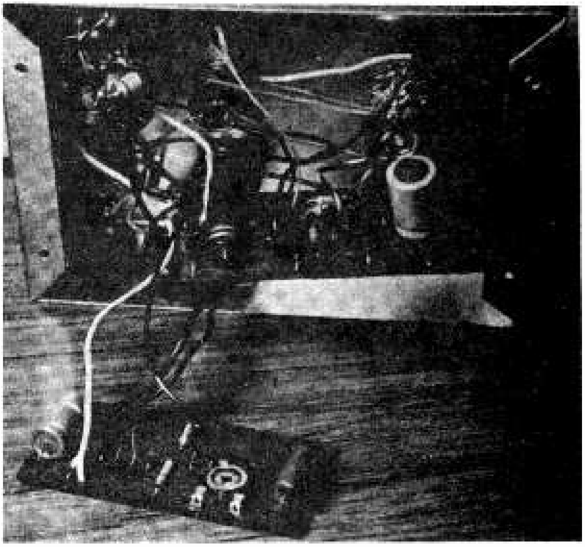


Fig. 4. Details of the aluminium case for the , instrument

Once the aluminium sections illustrated in Fig. 4 have been cut out, all the holes shown in this diagram should be drilled before any bending is carried out. The way in which the parts of the case fit together can be ascertained from Fig. 4, since the two holes marked '1' fit together, as do the two holes marked '2', those marked '3', and so on. Note that, in the diagram, what will eventually be the rear ends of the two sides are shown towards the front panel. All the flanges are ½in. wide and the positions of flange holes can be adjusted from the one which is shown dimensioned in the diagram. Thus, hole '6' is ¾in. from the side edge. Holes '5', '7' and '8' are similarly dimensioned. Holes '1' to '4' are 6BA clear and will take ¼in. 6BA bolts when the case is assembled. Holes '5' to '8' on the side flanges are for self-tapping screws, whilst holes '5' to '8' on the back are self-tapping screw clearance. The mounting holes for the controls are ⅜in. diameter.

The mounting holes for the two component boards can be marked out from the component boards themselves, using the latter, before the components are fitted, as templates. This process can be carried out after the case has been assembled. The four holes required are 6BA clearance and the mounting bolts are 1in. or more in length. The component boards are stood off from the case surface by insulated spacing washers, and their positions can be adjudged from Fig. 7 and the photographs.



Here, the two component boards are removed from their positions to enable their assembly to be seen more clearly

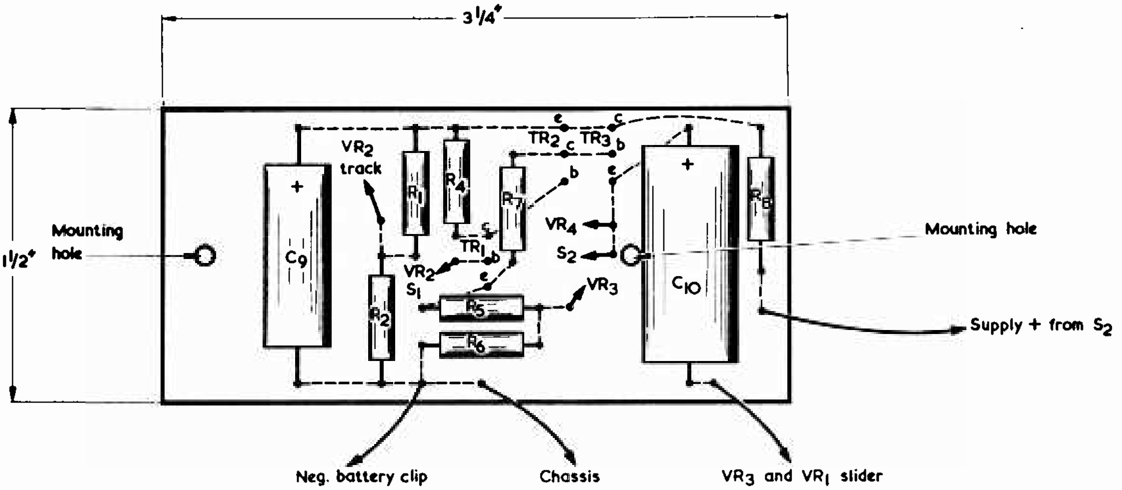


Fig. 5. The components and wiring on the Wien oscillator board

If the constructor does not wish to build his own case, there are several commercially produced aluminium cases of around the same dimensions and one of these could be employed instead.

When the case is completed, it may be left with a natural finish or it can be painted. (The painting will have to be carried out after the circuit boards have been cut out and drilled so as to enable their mounting holes to be made). The prototype was given a coat of hammer finish paint.

ELECTRICAL CONSTRUCTION

Most of the signal generator circuit is built up on two component boards, one for the Wien Bridge oscillator and the other for the Schmitt trigger. Details of the board on which the oscillator is assembled are given in Fig. 5, and details of the board for the Schmitt trigger in Fig. 6. These diagrams are reproduced full size.

The method for producing the completed boards is to cut pieces of Paxolin to the required size and trace, and then drill the holes, at the places indicated in the diagrams. Component leads are next passed through the appropriate holes and bent over at right angles. The leads are then soldered together as indicated by the dotted lines in the diagram. Bare tinned copper wire of around 22 s.w.g. can be used to bridge any gaps if component leads are too short to reach the other leads to which they are to be connected. The lead connecting R8 to the collector of TR3 (see Fig. 5) must be covered with insulated sleeving where it crosses the lead to C10.

Mounting holes in the boards are drilled 6BA clear, and smaller holes are drilled for the component leads. To prevent the wiring on the underside of each board short-circuiting to the case, insulated spacing washers are placed over each securing bolt, appearing between the

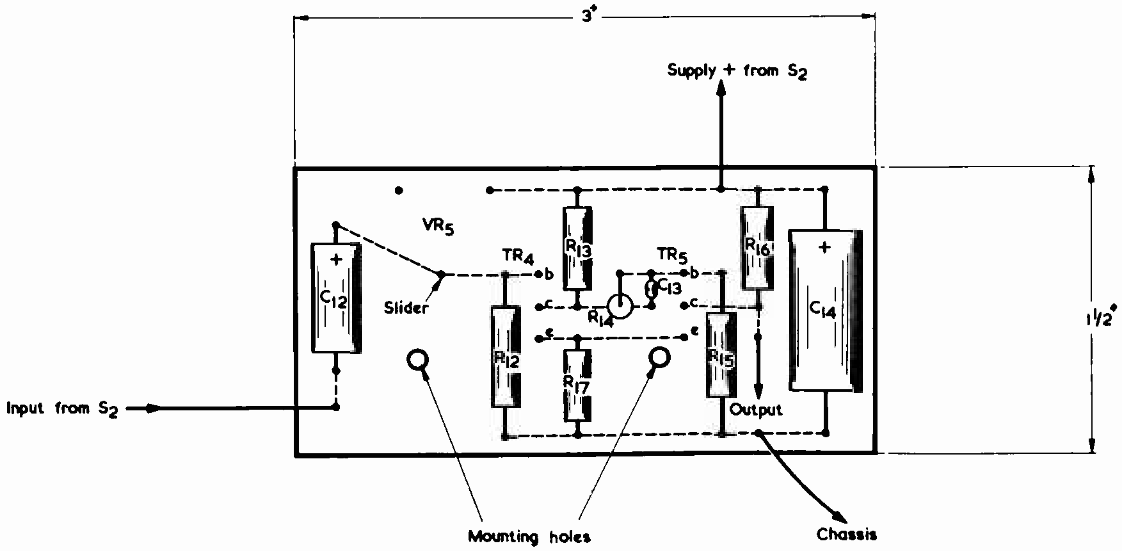


Fig. 6. The Schmitt trigger board. In company with Fig. 5 this is reproduced full size and may be traced

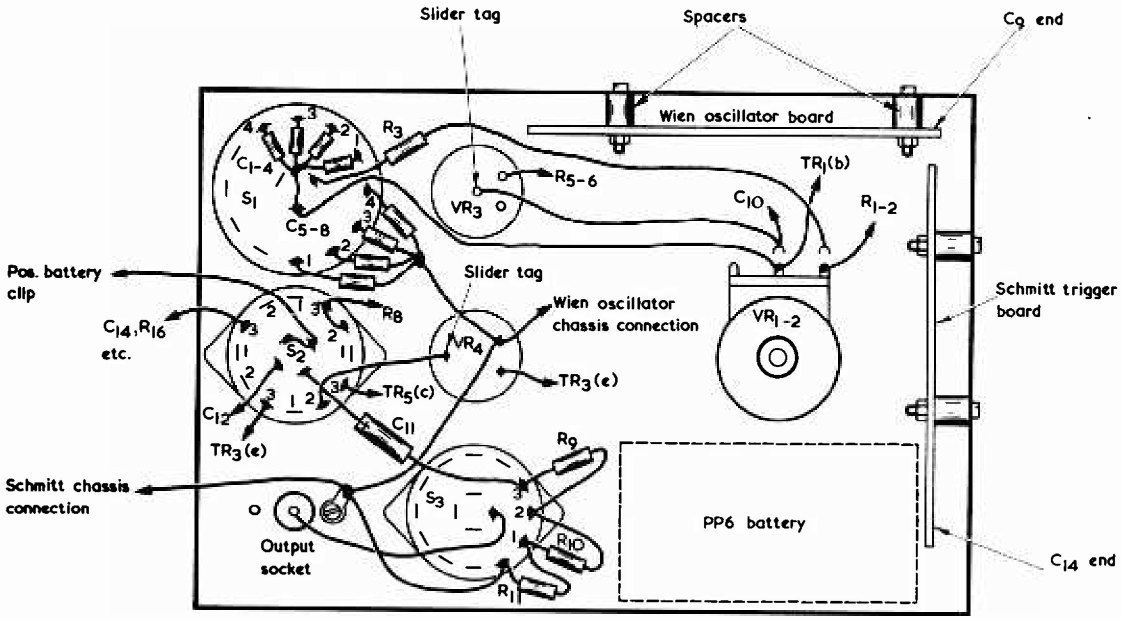


Fig. 7. The wiring inside the case. Note that one end of R11 is anchored to an unused switch tag

board and the case. These spacing washers are approximately ¼ to ⅜in. long and may be cut from a piece of narrow bore Paxolin tubing or, say, from the barrel of a discarded ball point pen.

A diagram illustrating the wiring to the controls is given in Fig. 7. The positions of the tags of S1, S2 and S3 are those encountered in the switches employed in the prototype any may vary for different switches. It is best to check the contacts which correspond to the switch arm tags with a continuity tester, and wire up accordingly. It will be noted that only two poles of S1 and one pole of S3 are used. Because of this, S1 could be 2-pole 4-way and S3 could be 1-pole 3-way, but it will probably be found easier to obtain the switches as specified. The battery is mounted in the space under VR1,2. It fits in fairly tightly. If it is found to be a little loose, foam rubber can be packed in as required.

CALIBRATION

Calibrating the generator can be a bit of a problem, as an accurate signal generator and an oscilloscope are required for this, and anyone building the generator is unlikely to already possess such equipment. Those who own the required equipment, or can gain access to it, can calibrate the generator using the Lissajous figure method. It can also be calibrated against an audio frequency meter, should one be available.

Another rear view of the generator

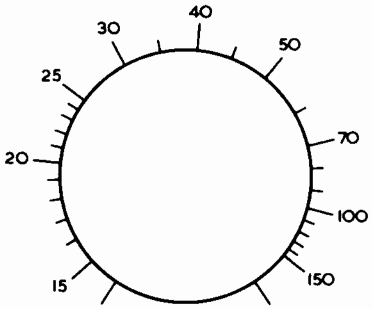


Fig. 8. A suitable scale (reproduced half-size) which may be used if no other means of calibration is available

For those who are unable to use either of these methods, the scale shown in Fig. 8 can be traced out and enlarged (it is reproduced half-size) and used on the instrument. Owing to variations between different potentiometers this scale will only give approximate indications of frequency, but it will nevertheless be helpful for virtually all of the applications in which the generator will be employed.

USING THE GENERATOR

The generator has six controls. The dual gang potentiometer, VR1,2, varies the frequency over the range selected by S1. S2 is the function switch and it causes the unit to be switched off on position 1, whilst positions 2 and 3 select sine and square wave outputs respectively.

VR4 provides a continuously variable control over the sine wave output. S3 is the 3-position attenuator switch, and it controls both sine and square wave outputs.

VR3 is the feedback control. When it is turned right back, so that it inserts minimum resistance into circuit, there should be no output from the unit. If the control is advanced, a point will be reached where the circuit begins to oscillate. For the highest quality sine wave output, VR3 should be advanced to a point where the oscillation is just sustained. For the square wave output VR3 should be advanced such that the circuit is oscillating strongly.

The preset potentiometer, VR5, is adjusted in the following manner. Connect a multitestmeter set to read 10 volts f.s.d. between TR5 collector and chassis. Turn VR5 fully clockwise, so that it inserts maximum resistance. Switch on the unit by setting S2 to position 3 and adjust VR3 so that the sine wave oscillator does not run. If VR5 is now adjusted for a much lower resistance the voltage read by the meter will, at some setting, suddenly swing to a much higher level, around 8 volts. The final setting required in VR5 is just before this point i.e. VR5 should insert the minimum possible resistance without the voltmeter reading rising to the higher level. ■

IMPROVED DIGITAL DISPLAY

by

D. A. Nicole, G8CYJ

Our contributor describes a digital display based on that which appeared in the January 1972 issue. The revised circuit saves four diodes for a single digit display and also enables a single set of gating diodes to be employed in a two-digit display.

THIS ARTICLE DESCRIBES TWO IMPROVEMENTS WHICH can be made to Suggested Circuit No. 254, 'Pilot Lamp Digital Display', published in *The Radio Constructor* for January, 1972.

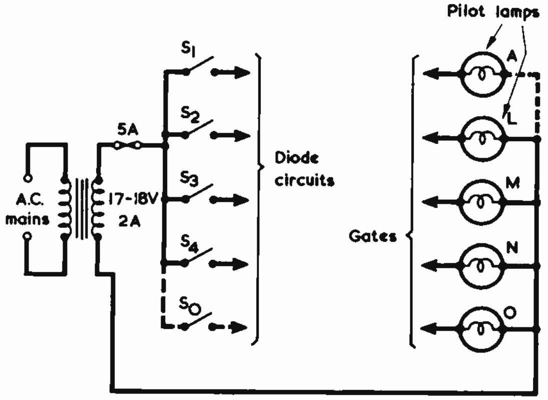
HALF-WAVE OPERATION

Since there is at least one diode in series with each lamp, the rectifier bridge, D1 to D4, can be omitted and the switching circuit run direct from a.c., as in Fig. 1. This will be half-wave rectified by the diodes and will not interfere with circuit operation. The energy content of the waveform, however, is now only half of its original value, and to compensate for this the transformer secondary voltage must be increased to

$$12.6 \times \sqrt{2} = 17.5\text{V}.$$

A 17V or 18V transformer would work well in practice. As the revised circuit uses only the same power as before, the secondary current rating can be reduced in proportion to the increase in voltage. Thus a 2A secondary should be satisfactory. The diodes are also subjected to a slightly higher inverse voltage (25V), but this is well within their rating.

Fig. 1. Revised digital display circuit, in which the bridge rectifier is omitted. This may be compared with Fig. 5 of 'Pilot Lamp Digital Display', which appeared on page 339 of the January 1972 issue



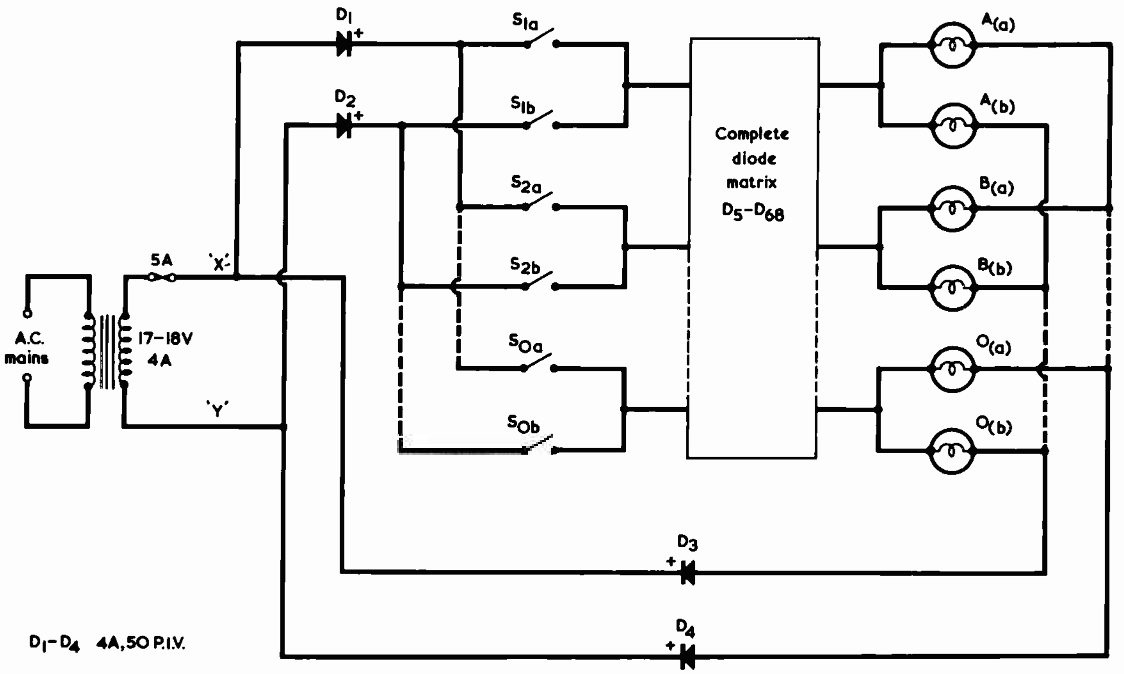


Fig. 2. This circuit enables two sets of pilot lamps to be controlled by way of a single diode matrix. The lamps and switches for the first digit have the suffix (a), and those for the second digit have the suffix (b)

TWO-DIGIT DISPLAY

In the first paragraph of the preceding article is was suggested that the circuit could be duplicated to drive two sets of lamps. However, it would in principle be possible to use the one matrix of coding diodes to drive as many sets of lamps as are desired, this being done by rapidly switching the lamps and switches for each digit into the matrix in turn. With more than two sets this becomes very complicated, requiring transistor switches, but it can be achieved very easily for two digits. The output from a 17–18V 4A transformer is half-wave rectified to give two separate outputs, 180° out of phase. See Fig. 2. These outputs are fed individually to the switches, combined through the diode matrix, which is identical to that in the original circuit, and then the current is then routed through the correct set of bulbs.

A more detailed explanation can be given by stating initially that, when point 'X' in Fig. 2 is positive of point 'Y', conventional current flows through D1, through whichever of switches S1(a) to S0(a) is closed, through the diode matrix, which includes the ABC gate, GHI gate, etc., and then through the required lamps of A(a) to O(a). The reverse biased diodes D2 and D3 prevent any current flowing through S1(b) to S0(b) or lamps A(b) to 0(b). Conversely, when 'Y' is positive of 'X', current flows through the 'b' group of lamps and switches, the 'a' group being isolated by D1 and D4. Thus, the overall effect is of independent control of the two lamp sets by the switch banks.

EDITOR'S NOTE

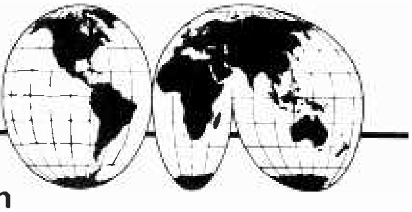
Full-wave rectification of the a.c. supply was incorporated in the original circuit to reduce the effect of flicker, which is evident in some bulbs when run from a half-wave rectified supply. However, the half-wave flicker with the bulbs employed in the circuit is, in practice, negligibly low, whereupon the improvements described in this article are particularly valuable. The circuits in the original article take up too much space to merit reproduction so soon after the article appeared. If desired, the January 1972 issue may be obtained direct from the publishers at 20p plus 6p postage. ■

Digital Frequency Monitor

In Fig. 6 of this article on page 743 of the last July issue, Preset 2 was shown as passing to the main counter. It should, instead, have been labelled as passing to the input gate and divider.

SHORT WAVE NEWS

FOR DX LISTENERS



By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

CLUB NEWS

We commence this month with news about various clubs which may interest some readers. There are many clubs, leagues or societies, which cater for the short wave listener interest, such organisations producing a news sheet or journal at regular intervals, usually monthly, and various other services together with a wealth of information necessary for the active pursuit of the hobby. The majority of these clubs are devoted to the interests of the broadcast bands enthusiast whilst a few also additionally provide for the amateur bands listener.

World Dx Club publishes a monthly bulletin 'Contact', this consisting of 24 duplicated quarto-sized pages plus the cover. This club covers both the broadcast and amateur interests, the annual subscription rate is £1.50 for U.K. and Eire residents. A sample copy of 'Contact' may be obtained for 10p from the Secretary, Clive Jenkins, 11 Wesley Grove, Portsmouth. PO3 5ER.

South African Dx Club is anxious to obtain new members and their bulletin 'Dx News' is often quoted in many Dx programmes around the world, the information contained therein being informative and authoritative. Further information with respect to sample copies and rates etc., may be obtained from Gerry Wood, P.O. Box 24, Plumstead, C.P., Republic of South Africa.

Union of Asian Dx-ers exists for those who are interested in Dx from the Asian point of view. Of interest to broadcast band listeners, the Union is headed by G. Victor Goonetillike who is probably the bext known Dx'er in all Asia. For further details write to G. V. Goonetillike, Galle Walauwa, Piliyandala, Republic of Sri Lanka and enclose one International Reply Coupon.

British Association of Dx'ers, often quoted in these columns, is devoted entirely to broadcast band interests and issues its journal 'Bandspread' on a fortnightly basis by first class post. The latest edition to hand, Number 40, was of sixteen foolscap-sized sheets packed with information for the s.w.l. Additionally, extra publications dealing with specific aspects of Dx-ing are often included for no extra charge. Only up to date news items are published and members must be actively engaged in broadcast band Dx-ing and report on a regular basis. The charge for this first class service is £3.00 per annum for U.K. residents and the address is – BADX, 16 Ena Avenue, Neath, Glam.

Next month we shall include more information on other clubs providing services specifically for the short wave listener.

NOW HEAR THESE

This month we commence with an item of news from the South American continent.

● **BRAZIL**

Radio Nacional Brasilia, listed on **15445**, has been logged on **15448** (19.42 metres) at 2327 with a commentary in English, station indentification and a request for reports. Also heard at 2221 with an English programme on **15448** and at 2154 on **11720** (25.60m), and from 2143 to 2206 on **15448** with music, programme in English and a request for reports, all according to BADX. The listed power is 10kW.

● **LEBANON**

Radio Beirut has replaced the **15355** channel with that of **15170** (19.78m) for the English, Arabic and French services for Europe from 1830 to 2030.

● **INDIA**

AIR Delhi is now operating on a new frequency for the service in French to South East Asia, being logged on **11725** (25.59m) 100kW at 1115, this probably replacing the **21660** channel.

● **ALGERIA**

The service in French from Radio Algiers for the Middle East may be heard on **11835** (23.55m) and on **15420** (19.45m) from 2100 to 2300.

● **SOUTH KOREA**

VOFK Seoul has been logged on **15335** (19.56m) by BADX operators at 0630 with sign-off in French and then into English with a newscast. The listed power is 50kW.

● **JORDAN**

Radio Amman was recently logged with the service in English at 1705 when a newscast was radiated on **9560** (31.38m). The programme in English is broadcast from 1630 to 1730 on this channel and also on **7155** (41.92m) from 1100 to 1300.

● **COSTA RICA**

TIFC San Jose, 'Faro del Caribe' ('Lighthouse of the Caribbean') has been heard daily ending the English programme at 0430 on the regular **9645** (31.10m) channel (2kW). The parallel **6037** (49.69m) channel was almost inaudible.

● **SOUTH AFRICA**

Radio RSA has been logged by a BADX operator on **15160** (19.79m) at 1000 with the service in English to Australia, a new frequency on the recommendation of the operator concerned (Bob Padula – an Australian Dx'er) which shows just how useful a 'top flight' short wave listener like BP can be on occasions.

● **BELGIUM**

ORU Brussels has been heard at 0630 signing-on with the news in French on a new frequency of **15110** (19.85m).

● **ARGENTINA**

LRA32 Buenos Aires has been logged on the regular **9690** (30.96m) channel at 0507 with Paraguayan songs and Spanish announcements with station identification at 0512.

TIME-CHECK

The stations mentioned in **NOW HEAR THESE** are listed here on a time-check basis for the convenience of readers.

GMT	Freq.	Stn.	Rcvd.
0415	9645	TIFC San Jose	
0507	9690	LRA32 B. Aires	
0630	15110	ORU Brussels	
1000	15160	Johannesburg	
1100	7155	Amman	
1115	11725	Delhi	
1630	9560	Amman	
1830	15170	Beirut	
2100	11835	Algiers	
2100	15420	Algiers	
2221	15448	R. N. Brasilia	

CURRENT SCHEDULES

● INDIA

Transmissions in English to the U.K. and Western Europe from All India Radio are now radiated as follows – from 1800 to 1910 on **7215** (41.58m), **9525** (31.50m) and on **11620** (25.82m). From 1945 to 2045 on **7215, 9525, 9912** (30.27m) and on **11620.** From 2045 to 2230 on **7215, 9525, 9912** and on **11620.**

● HOLLAND

The current schedule of Radio Nederland, in English to Europe, is from 1400 to 1520 on **6020** (49.83m) and from 1830 to 1950 on **6020, 6085** (49.30m) and on **21570** (13.91m) on weekdays. On Sundays, the 'Happy Station Sunday Programmes' are radiated from 0930 to 1050 on **6020, 6410** (46.82m) and on **7275** (41.24m). From 1400 to 1520 on **6020**; from 1830 to 1950 on **6020, 6085** and on **21570.** The address is – Radio Nederland, P.O. Box 222, Hilversum.

● GHANA

The external service from Accra, 'Voice of the Revolution', in English to Europe, is from 2045 to 2215 on **9545** (31.43m). To the U.S.A. from 2000 to 2100 on **9760** (30.74m) and on **11850** (25.32m).

● ISRAEL

The service in English from Jerusalem is now broadcast to Europe from 2035 to 2115 on **6170** (48.62m) and on **9625** (31.17m) and to Africa on **9009** (33.30m). (BADX).

● SOUTH KOREA

The English service schedule of VOFK Seoul is as follows – to North America from 0300 to 0330 on **15335** (19.56m); to South Asia and Australasia from 1200 to 1230 on **9640** (31.12m) and from 1400 to 1430 on **15335**; to Europe from 0630 to 0700 on **15335.** (BADX).

● CUBA

Radio Havana now has the English schedule as follows – to Northern Europe from 2010 to 2140 on **17815** (16.84m); to the U.S.A. from 2050 to 2150 on **15285** (19.63m), from 0100 to 0450 on **11930** (25.15m), from 0100 to 0600 on **11815** (25.39m), from 0330 to 0600 on **11760** (25.51m) and from 0630 to 0800 on **9525** (31.50m). (BADX).

● CHINA

Radio Peking currently broadcasts in English to Europe from 2030 to 2130 on **6610** (45.38m), **6825** (43.37m), **7590** (39.53m), **8490** (25.33m) and on **9030** (33.22m). From 2130 to 2230 on **6610, 6825, 7590, 8490, 9030** and on **11675** (25.70m).

AROUND THE DIAL

● BANGLADESH

Radio Bangladesh, still varying in frequency around **17930** (16.73m), was recently logged at 1235 with news and comment in English. It has also been heard on **9690** (30.96m) from 0230 to 0301 mixed with signals from the BBC to South Asia and in parallel, in the clear, on **15520** (19.33m) with the General Overseas Service of R. Bangladesh.

● HAITI

According to reports, 4VEJ Cap Haitien has raised power from the listed 2.5kW to 10kW on the usual **11835** (25.35m) channel and has an English programme from 2300 to 0200. (WDXC).

● IVORY COAST

Abidjan now radiates a service in English from 1820 to 1955 on the regular **11920** (25.17m) channel on weekdays, the power is 100kW.

● NORTH VIETNAM

Hanoi currently radiates the news in English at 1000 and at 1530 on **10040** (29.88m) and at 2000 on **15005** (19.99m).

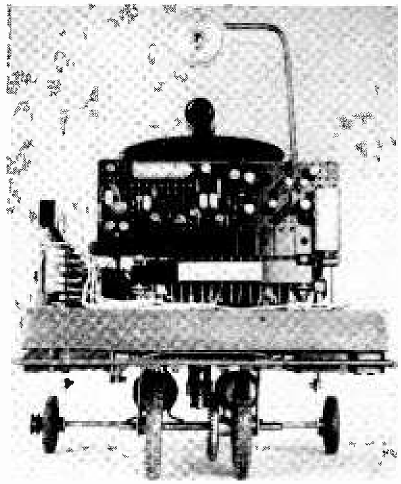
S.W.L. PUBLICATION

There are many such publications, both commercial and private, dealing with broadcast band interests but one that may possibly interest readers of these columns is 'Latin American Commercials'. This 24-page booklet is available direct from Nils Ingelstrom, Vavstolsvagen 1, 161 48 Bromma, Sweden, for either nine IRC's or 70p U.K. currency. Written by two Swedish Dx'ers, it provides a comprehensive list of the commercials used by Latin American stations and also contains information on the music of this part of the world (LA mx), programme formats and speech habits. Both of the authors recently visited Latin America and are therefore recognised authorities on all aspects of LA Dx'ing.

MIDDLE EAST DX'ERS

Middle East Dx Club, 5 Cologne 91, Remscheider Str. 97, West Germany, will provide a diploma to any Dx'er who has heard at least ten Middle East broadcast stations (Afghanistan, Yemen, S. Yemen, Iraq, Israel, Jordan, Iran, Kuwait, Lebanon, Muscat and Oman, Qatar, Dubai, Saudi-Arabia, Syria, Turkey, Egypt and Cyprus), seven IRC's should be sent with supporting QSL cards. The cards will be returned with the diploma, the address for applicants is – Gerhard Schreier, Diploma Manager, 6902 Sandhausen, Albert Schweitzer Str., 2, West Germany.

CYCLOPS



PART THREE

by
L. C. Galitz

This article is the third in a series dealing with robots and cybernetic devices, and it continues with the construction details of Cyclops. This month, a description of the basic reflex circuitry is given

In the first article in this series it was stated that Cyclops is positively tropic towards light of a moderate intensity, and negatively tropic towards light of a high intensity. He is also negatively tropic towards material objects, and the touch stimulus should override the effects that any particular light stimulus produce.

BASIC OPERATION

Reference to Fig. 13 will show how this is accomplished. The output from the photocell which forms Cyclops' eye is fed to a pre-amplifier, after which it passes to three Schmitt triggers. Following the Schmitt trigger with the highest threshold (i.e. lowest sensitivity) is an inverter, the output of which passes to one input of each of two two-input And-gates. The other input of each And-gate connects to one of the other Schmitt trigger outputs. The output of the upper And-gate in Fig. 13 operates a relay which inhibits the scan motor, and the output of the lower And-gate passes to another relay which inhibits both scan and drive. Under no-light conditions, therefore, there will be zero output from each of the three Schmitt triggers, and there will thus be a logic one from the inverter, resulting in each gate having a logic nought on one input, and a logic one on the other input.

Under these conditions, neither scan nor drive is inhibited, and Cyclops will explore the terrain randomly. If he then comes across a light some distance away, and if it is of sufficient brilliance to operate the Schmitt trigger with the lowest threshold, there will

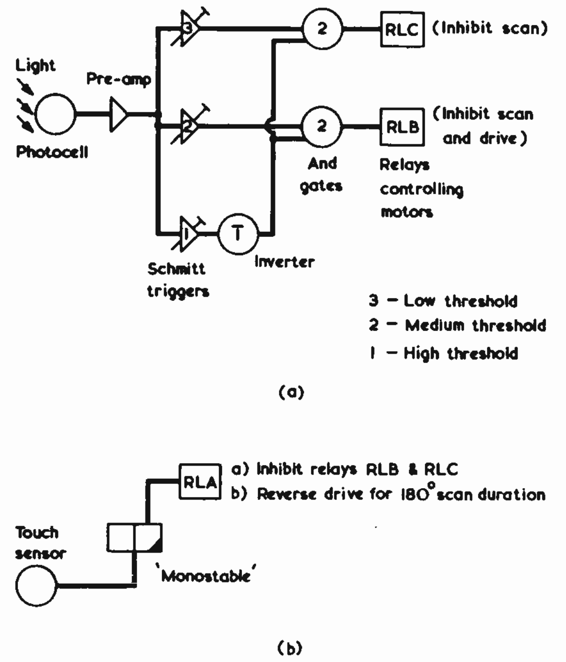


*Fig. 13 (a) Logic diagram for light sensing
(b) How the touch sensor operates relay RLA*

now be logic ones on both the inputs of the upper And-gate, this being the one whose output operates the relay which inhibits scan only. In consequence, Cyclops will stop exploration and commence homing into the light as detailed in the first article.

When he comes sufficiently close to the light source the medium threshold Schmitt trigger also fires, whereupon both And-gates have logic ones on each of their inputs. The lower And-gate operates the relay which inhibits drive as well as scan. Thus Cyclops will stop in front of the light to 'recharge his batteries'.

Should the light be so powerful as to 'dazzle' him, the high threshold Schmitt trigger will fire as well as the other two. However, the inverter inverts the output of the high level Schmitt trigger and thus, in this situation, the And-gates have logic ones on the inputs connected to the low and medium threshold Schmitt triggers, but logic noughts on the inputs connected to the inverter, Therefore the scan and drive inhibition is itself inhibited, causing Cyclops to ignore extremely bright lights.

The touch sensor consists of microswitches at the ends of each side of the chassis, making eight microswitches in all. Bars are fixed between the buttons of the two microswitches on each side of the chassis, so that when Cyclops bumps one of his sides on an object, either one or both microswitches operate. All the microswitches are wired in parallel and go to the input of the obstacle-avoiding circuitry which, on receiving an input, operates a relay via a monostable. This relay disconnects the coils of the other two relays, so that any inhibition of drive and/or scan is itself inhibited. The third relay also reverses the drive direction of the main drive motor, and therefore, on bumping into an obstacle, irrespective of whether Cyclops is scanning, homing into a light, or even recharging his batteries, he will reverse, execute a turn, and then move off in the direction opposite to the one in which he was moving when encountering the obstacle. The latter feature is accomplished by arranging the duration of the monostable to be equal to the time the scan motor takes to turn the main drive assembly through 180°.

THE CIRCUIT

It is necessary now to turn to the circuit diagram given in Fig. 14.

The 'monostable' operating the avoid mechanism consists of R1, C1, D1, TR1, relay coil RLA/4 and contact RLA1. When any of the touch sensor microswitches operates, R1 is connected to the negative rail via the microswitch contacts and the normally closed contacts RLA1. This connection causes C1 to charge up quickly and TR1 then operates the relay, being turned on by the voltage across C1. Contacts RLA1 open and C1 discharges through the base circuit of TR1, until TR1 eventually switches off and RLA/4 de-energises. By now, Cyclops will have managed to extricate himself from most objects, but in some tricky circumstances, e.g. the family cat, he may still be entangled. If a touch sensor closes once more he will move forward very briefly in the time it takes to charge C1 again. In some cases this will free him but otherwise he will go through the avoid cycle again until he does eventually free himself. This short jerk between cycles is due to contacts RLA1, and it often proves useful when negotiating difficult situations.

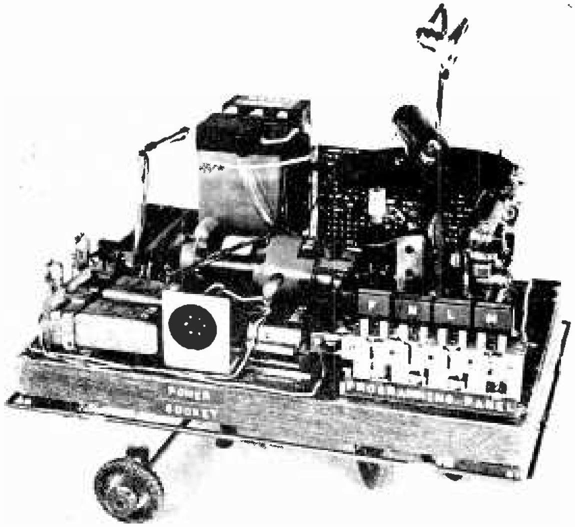
The photocell X1 and resistor R2 form a potential divider at the base of the pre-amplifier, TR2. This is in the common collector mode, offering high input impedance and high current gain. Wired in its emitter circuit are three preset potentiometers, the wipers of each passing to a Schmitt trigger. These potentiometers set the threshold values for the triggers. The first Schmitt trigger consists of TR3, TR4 and R4 to R8. Due to the fact that the inverted output of this trigger is required, the output is taken from the first collector rather than the second. The second Schmitt trigger consists of TR5, TR6 and R9 to R13, whilst the third Schmitt trigger consists of TR13, TR14 and R16 to R20. The outputs from these latter two Schmitt triggers are taken from the usual collectors, i.e. those of TR6 and TR13 respectively.

The two And-gates are formed by TR7, TR8, TR11, TR12, R14 and R15. These four transistors are n.p.n. types, and the gates operate by using the current sinking logic mode. In order for the output of each gate to be negative, i.e. at logic one, both transistors must be cut off, and as they are n.p.n. devices, both transistors require a negative bias on their bases for this to occur. In all other cases, the current through the emitter resistor is 'sunk' through either one or both transistors.

The output of each gate passes to a relay driver transistor working in the common collector mode, and there is the usual diode across the relay coil preventing transients from damaging the driving transistor.

The common coil connection of the relays is taken via a break contact, RLA2, of RLA/4; and thus, when the obstacle avoiding circuitry comes into action, both RLB/1 and RLC/1 cut out.

The rather elaborate on/off switching is due to the fact that two on/off switches are used in the prototype. One switch, S1, switches on the basic reflex circuitry only, whilst the other, S2, switches on the learn circuits



Side view of Cyclops. The Veroboard assembly in front of the eye support unit, and the horizontal device (actually a dry reed switch) behind the accumulator, are added after the circuitry described in this and next month's issue has been completed

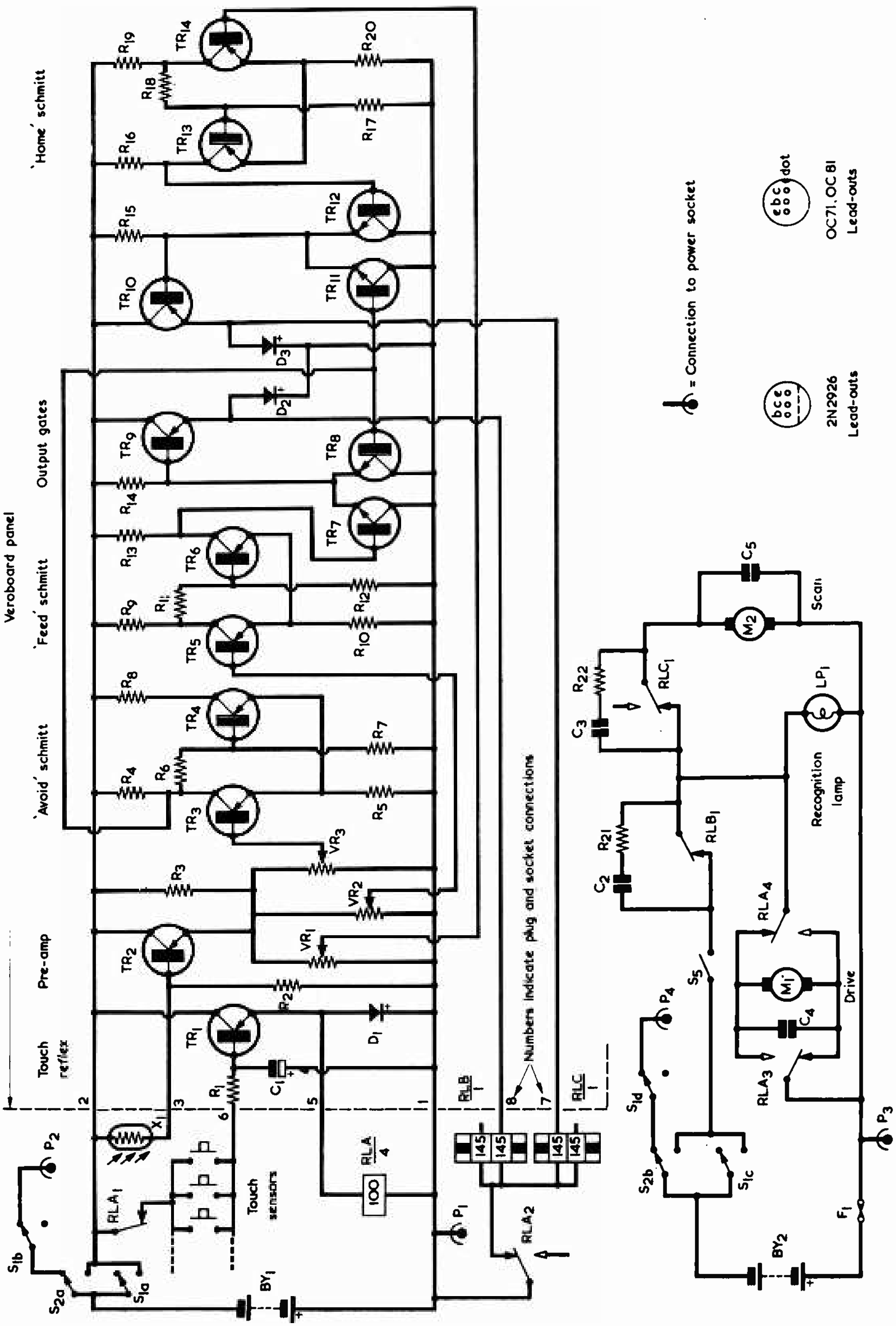


Fig. 14. Circuit for the basic reflex operations of Cyclops

COMPONENTS

Resistors

(All fixed values ½ watt 10%)

R1	1kΩ
R2	47kΩ
R3	47kΩ
R4	4.7kΩ
R5	470Ω
R6	22kΩ
R7	10kΩ
R8	4.7kΩ
R9	4.7kΩ
R10	470Ω
R11	22kΩ
R12	10kΩ
R13	4.7kΩ
R14	1kΩ
R15	1kΩ
R16	4.7kΩ
R17	10kΩ
R18	22kΩ
R19	4.7kΩ
R20	470Ω
R21	10Ω
R22	10Ω,
VR1	10kΩ potentiometer, skeleton
VR2	10kΩ potentiometer, skeleton
VR3	10kΩ potentiometer, skeleton

Capacitors

C1	50µF electrolytic, 12 V.Wkg. (may require adjustment)
C2	0.1µF Mullard polyester, 125 V.Wkg.
C3	0.1µF Mullard polyester, 125 V.Wkg.
C4	0.1µF Mullard polyester, 125 V.Wkg.
C5	0.1µF Mullard polyester, 125 V.Wkg.

Semiconductors

TR1	Any p.n.p. transistor capable of driving relay, e.g. OC81
TR2–TR6	Any p.n.p. transistor, eg. OC71
TR7, TR8	2N2926
TR9, TR10	As TR1
TR11, TR12	2N2926
TR13, TR14	As TR2–TR6
D1–D3	Any silicon diode, e.g. OA200

Photocell

X1	ORP12

Switches

(S1 to S4 are available from G. W. Smith & Co. (Radio) Ltd., 3 Lisle St., London, W.C.2. as a complete unit, described as a 'Standard 4-Button Press-Button Unit'. This offers more contacts than are required for the present application. The 8 microswitches are also available from G. W. Smith & Co. (Radio) Ltd.)

S1	4-pole changeover
S2	3-pole changeover
S3	3-pole changeover
S4	Single-pole, push-to-make release-to-break
S5	s.p.s.t., slide switch
8-off	microswitches, Bonella single-pole normally open

Relays

(All relays are available from G. W. Smith & Co. (Radio) Ltd.)

RLA	Post Office 3000 relay, 100Ω coil, 3 break-before-make changeover contacts, 1 break contact
RLB, RLC	Sealed Siemens High Speed Relay, 145Ω + 145Ω coil, 1 changeover contact

Lamp

LP1	6.3V, 0.3A, m.e.s. lamp

Connectors

Power Supply:	Bulgin P194 6-way plug and socket (Home Radio Cat. No. P194)
Veroboard:	R. S. Components 8-way edge connector (Home Radio Cat. No. BTS41)

Batteries

BY1	6V 225 mA/H Deac rechargeable battery (Ripmax Ltd.)
BY2	6V 2 A/H accumulator, e.g. Yuasa MBC1-6 6N2-2A (Motor-cycle dealers).

Miscellaneous

Verobard, 0.15 in. matrix, 3¾ in. × 2¼ in., 14 strips × 24 holes
1-off Meccano perforated strip, part 2a
1-off Meccano perforated strip, part 3
1-off Meccano perforated strip, part 6a
1-off Meccano coupling, part 63
2-way connector block
Tank clip (for securing BY1) (Ripmax Ltd.)
1-off fuse and holder rated at 5A if accumulator not used
Insulating washers
Perspex brackets
Rods
Torch reflector
Photocell tube

in addition. The contacts of S2 which control the learn circuits will be discussed in a later article. When both switches are in the off position. the battery terminals are connected to a power supply socket for recharging purposes. Because higher voltages are used for recharging than the batteries supply normally, it it was felt that this safety measure which allows the charger to be connected to the batteries only when both switches are off, was desirable. Naturally, if normal batteries are to be used, or if the learn circuitry is either to be omitted or switched on all the time, the switching can be made less complex.

There was also a need in the prototype for the electronics to be switched on without power being supplied to the motors, and S5 is used when Cyclops is to be run whilst 'paralysed'. This feature is useful in all versions of the robot for such purposes as setting the various thresholds, and for testing the electronics; and therefore should be included.

The motor circuitry is quite straightforward. RLC1 cuts power to the scan motor, whilst RLB1 cuts power to the drive motor and to the recognition lamp. Contacts RLA3 and RLA4 reverse the direction in which the drive motor runs. Fuse F1 is included to protect BY2, whilst C2, C3, R21 and R22 and relay contact spark suppressors. C4 and C5 are included to limit interference from the motors.

COMPONENTS

All resistors and capacitors are standard components as specified in the accompanying Components List. The diodes are all silicon, and all the transistors apart from TR7, TR8, TR11 and TR12 are p.n.p. silicon or germanium. Transistors TR7, TR8, TR11 and TR12 are silicon planar n.p.n. devices, and due to the Veroboard configuration, should be the types having plastic enclosures with the wires in the e-c-b sequence. A suitable type is the 2N2926. X1 is an ORP12 light dependent resistor. The Veroboard connector block and the power supply socket are as specified in the Components List.

Relay RLA/4 is a G.P.O. 3000 type having a 100Ω coil and four sets of contacts. Three of these must be changeover and break before make, even though RLA2 is at the moment only used as a break contact. Later on, the make contact will be used as part of the learn circuits. The fourth contact need only be a break contact. Relays RLB/1 and RLC/1 are both identical, and are sealed Siemens high-speed relays having dual coils. These are chosen because, firstly, high speed action is required, especially for RLC/1, since if scanning cuts out too late, Cyclops will miss the light source. Secondly, dual coils were used because it is then much easier to isolate the basic reflex circuitry from the learn circuitry, which comes later. Switches S1 to S4 were, in the prototype, all in one bank. (S3 and S4 are used in the learn circuits). The bank consists of four push-button switches. The two centre ones are interdependent, i.e. if one is pushed the other releases; and the two outside ones are independent, being of the push-to-make push-to-break variety, one of which was modified to be push-to-make release-to-break. However, if it is so desired, the switches could all be independent of one another, and mounted on a control panel. S5 is a miniature slide switch. The recognition lamp LP1 is as specified in the Components List, and is mounted in a reflector taken from an old torch.

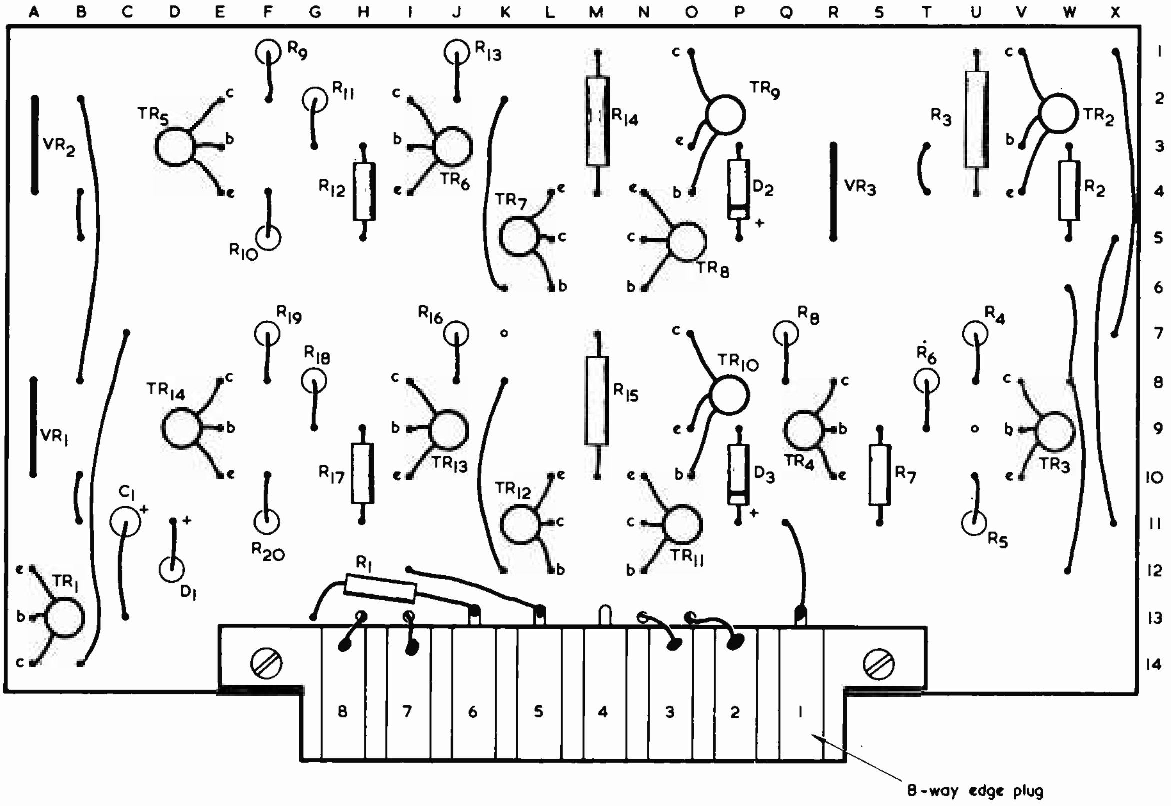


Fig. 15. The component side of the Veroboard which carries the basic reflex electronics

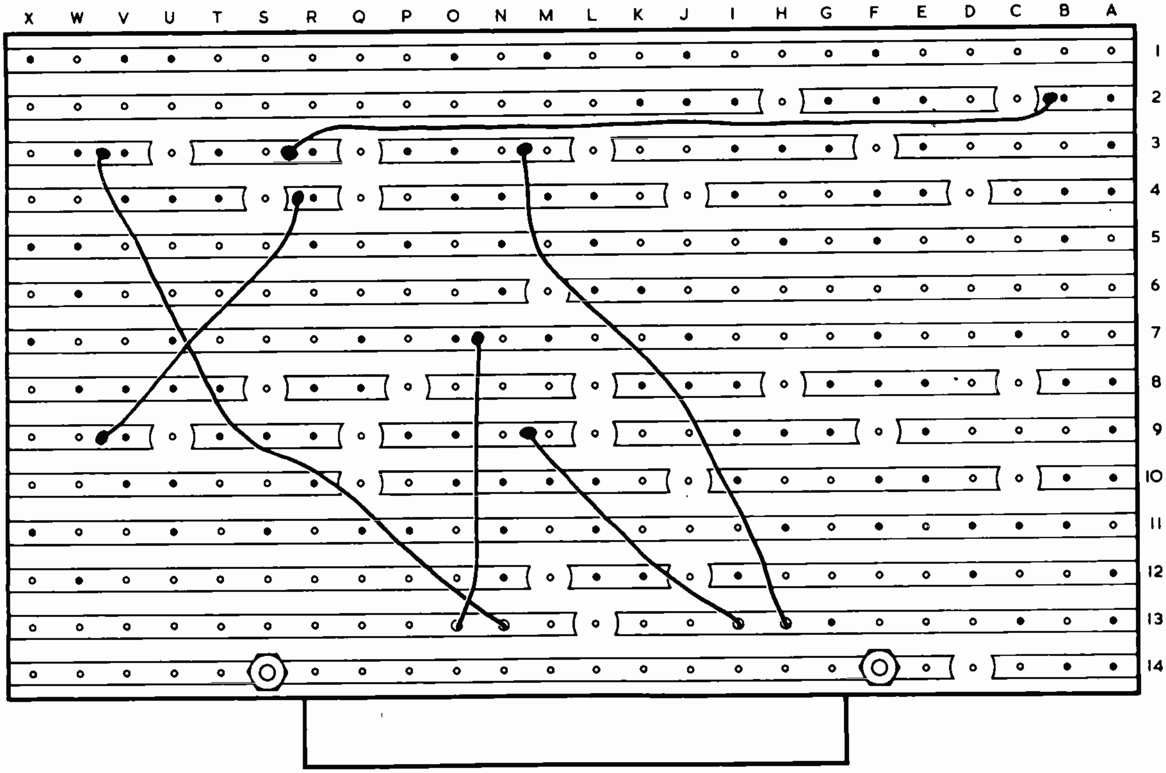


Fig. 16. The copper side of the Veroboard. Note that the links are soldered to the strips between holes and not at the holes themselves

Battery BY1 is a 6V 225mA/H Deac, whilst BY2 is a 6V 2A/H accumulator. On the other hand, if the expense of buying rechargeable power sources is not desired, BY1 could be a PP1, and BY2 could be an Ever Ready 'Lantern' battery type 996. However, both of these are too large to fit in the existing positions on the chassis, and the latter would have to be redesigned to take the batteries if this option was chosen. The fuse F1 is integral with the accumulator, but if batteries are chosen, it must be fitted separately.

VEROBOARD ASSEMBLY

The area of the circuit diagram to the right of the dotted line in Fig. 14 is built on a piece of 0.15 in. Veroboard having 14 strips with 24 holes. This fits into an R.S. Components 8-way edge connector, and a suitable plug for this is required. If necessary, this plug may be cut out, from a further piece of 0.15 in. Veroboard, to the shape shown in Fig. 15, which shows the component side of the board. The copper side is shown in Fig. 16.

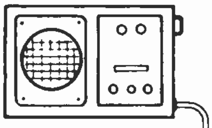
If desired, constructors may wire up the board completely, following Figs. 15 and 16. Alternatively, they may prefer to wait until the main chassis wiring has been completed (to be described in Part 4) whereupon they can then proceed by mounting the components on the board in stages. In this case, the preamplifier should first be built, and then tested. Next, each of the Schmitt triggers should be built, and tested by short-circuiting the top of the respective potentiometer to the negative rail and varying the position of the wiper whilst monitoring the output of the Schmitt trigger. The latter should, at a particular position of the wiper, suddenly jump from approximately 0.75 volt to about 5.5 volt. Finally, the And-gates and relay driver transistor stages should be built and tested. If construction and testing is carried out in this way, all the links and wires should be added *last*. The avoid circuitry (TR1, R1, C1 and D1) may be left till later.

Whatever method of Veroboard assembly is employed, it is first of all necessary to secure the 8-way edge plug to the panel at holes F14 and S14 by means of 6BA nuts and bolts. These two holes will require enlarging for this purpose. Then, the breaks in the Veroboard strips are made, as in Fig. 16, using a spot face cutter or a suitable drill. It should be noted that R1 connects to strip 13 at G13. The wires that pass through to the edge plug at holes H13, I13, N13 and O13 are insulated and do *not* make contact with the strip. The wires used must have insulation that does not melt readily when soldering at the plug tags. The polarities of the diodes and the transistor connections particularly those for TR7, TR8, TR11 and TR12 should be carefully checked.

A Components List accompanies this article, and it should be noted that some of the items listed are referred to in Part 4 of this series, which will be published next month.

(To be continued)

In your workshop



This month Smithy the Serviceman, aided as always by his able assistant Dick, turns his thoughts to equipment suitable for analysing the performance of zener diodes. In the process, Dick is able to construct a simple but quite comprehensive zener diode tester which is capable of checking zener characteristics over a wide range of currents.

With a sigh of satisfaction, Smithy leaned over and turned off the master switch on his bench. This switch controlled all the mains sockets on the bench, including those for test equipment, receivers under repair and his soldering iron.

"Ah well," he grunted contentedly, "that's another day's work over."

He rose and stretched himself luxuriously, then proceeded to divest himself of his overall jacket. He next turned towards his assistant.

"Hallo," he remarked, "what's up with you?"

"With me?"

"Yes, with you," repeated Smithy. "Normally, when it's packing-up time for the day you're straining at the leash to get away. You look as though you're not even *contemplating* getting away tonight."

"To tell you the truth," replied Dick, "I'm thinking of pressing on with a little private job after hours. Can I stay on in the Workshop for a bit, Smithy? I'll lock up afterwards and let you have the keys tomorrow morning."

ZENER DIODES

"A private job, eh?" commented Smithy warily. "What sort of a private job?"

"Well," said Dick, "what's happened is that I've just bought by mail-order a Bumper Bargain Parcel of 200 unmarked and untested manufacturers' surplus zener diodes. What I now want to do is to get these sorted out into their different zener voltages, and I'd need some of the Workshop gear to do this."

A momentary gleam, quickly suppressed, appeared in Smithy's eyes.

"That sounds interesting," he remarked with studied carelessness. "Let's have a look at those diodes."

Eagerly, Dick leaned over towards the rear of his bench, picked up a cardboard box and took off the lid. The box contained a large number of small metal-clad devices, these having varying outlines and colours.

"Humph," grunted Smithy. "you've certainly got a mixed bag there. So far as I can tell from a quick look they all seem to be in the 200 to 400mW range."

"They are," confirmed Dick. "That's what it said in the ad."

"How," asked Smithy, "had you intended checking them to find their zener voltages?"

"I hadn't," confessed Dick, "quite made up my mind as to how I was going to set about that. Have you any suggestions?"

"There are quite a few ways it can be done," said Smithy. "The most obvious approach consists, of course, of fixing up a power supply offering a direct voltage greater than the highest zener voltage to be expected, and of coupling this to each zener diode in turn via a resistor. You then connect a voltmeter across the zener diode whereupon, if the diode is connected right way round, the voltmeter will show its zener voltage at the particular current it happens to be passing." (Fig. 1.)

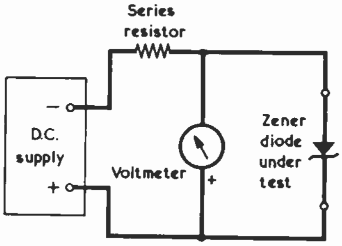


Fig. 1. The zener voltage of a zener diode can be determined with the aid of this circuit. The approach has the disadvantage that zener current varies according to the zener voltage

"That sounds a bit messy to me," objected Dick. "High voltage zener diodes will be passing smaller currents than low voltage ones."

"True enough," agreed Smithy. "The idea is reasonable enough but it doesn't give perfect results."

He paused, pursing his brow in thought.

"What would be much better," he remarked after a few moments, "would be to have a transistor acting as a constant current device in series between the power supply and the zener diode under test. The constant current transistor could be preset to give any current figure you require with the result that, provided the available voltage is higher than any of the zener diode voltages, that constant current will flow through all diodes being checked, regardless of their zener voltages." (Fig. 2.)

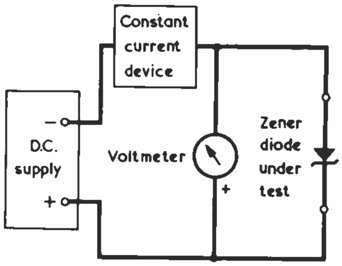


Fig. 2. An attractive alternative approach consists of replacing the series resistor with a transistor connected as a constant current device

"Blimey, Smithy," said Dick enthusiastically, "that sounds a smashing idea. Wouldn't the circuitry involved be rather complicated, though?"

"Not at all," replied Smithy. "You could assemble the whole thing in quite a short time. All the parts would fit on a small chassis with a front panel, and the latter would require holes for – let me see now – two toggle switches, a push-button, two pots, two test sockets or test terminals, and a meter. The latter, incidentally, would be a 0-100μA job."

"I've got an old chassis and panel from a home-made testmeter which I stripped down a month or so ago," said Dick keenly. "Its front panel has got quite a few holes in it for controls, *and* it's got a hole for a meter."

Excitedly, Dick bent down and rummaged amongst the large quantity of tattered cardboard boxes which always seemed to accumulate under his bench. He suddenly gave a cry of triumph and emerged carrying a small chassis and panel assembly, the panel already having the holes he had referred to. Proudly, he blew off the dust, then finally wiped his find clean with a rag.

"That," said Smithy, approvingly, "would seem to be just the job. Now, the next thing to do is to decide what is the range of zener diodes we intend to check. The zener diodes that are available these days cover a pretty fantastic range of voltages and powers. Some diodes, for instance, offer zener voltages of no less than 100 volts. However, in normal home-constructor applications we are much more liable to deal with the lower voltage and lower power types. I'd say that if we had a zener diode checker which coped with zener voltages up to some 25 volts, and which could provide controlled zener currents from 1mA to 100mA, then we would meet virtually all day-to-day requirements."

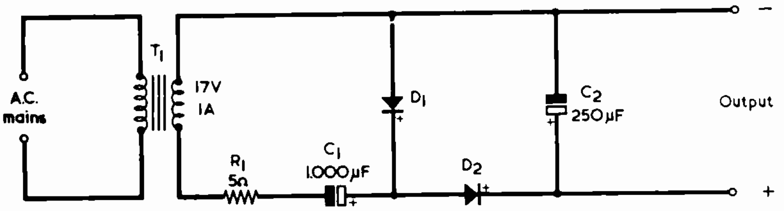


Fig. 3. The voltage doubler power supply circuit employed in Smithy's zener diode checker. A suitable transformer for T1 is Home Radio Cat. No. TC7

VOLTAGE DOUBLER

"Those figures seem to be more than sufficient to me," said Dick. "It sounds as though this zener diode tester will need a power supply offering rather more than 25 volts at up to 100mA."

"True enough," confirmed Smithy. "For reasons which I'll explain shortly, the maximum current required from the supply will be nearer 140mA than 100mA. Dash it, I've just thought of a snag here!"

"What's that?"

"We'll obviously need a mains power supply to provide these voltages and current figures, and this will require a mains transformer offering a secondary voltage of about 30 volts or so. The trouble is that low-cost transformers offering a voltage of this nature aren't all that readily available."

Smithy pondered for a few moments.

"Just a minute, though," he exclaimed as a thought suddenly struck him. "We don't *have* to use a mains transformer giving 30 volts. We could use one of those inexpensive battery charger transformers which offer 17 volts at 1 amp. These are quite cheap, and I'm pretty certain we've got one knocking around in the spares cupboard. All we then need do is to couple the 17 volt secondary to a voltage doubler rectifier and we'll get just the voltage we require."

As Smithy spoke, Dick was already walking towards the spares cupboard. He returned shortly, bearing a small mains transformer.

"Is this the sort of thing you mean?" he enquired. "This transformer's got a 17 volt secondary with taps at 7 and 11 volts."

"That's the type of transformer I mean," confirmed Smithy. "Its normal function is to charge accumulators by way of a rectifier, whereupon the 17 volt tap is employed for 12 volt batteries, the 11 volt tap for 6 volt batteries and the 5 volt tap for 2 volt batteries. Incidentally, you have to be a bit careful when buying charger transformers because the secondary voltages are sometimes quoted in terms of the batteries they are intended to charge. Thus, the 11 volt tap may be referred to as a '6 volt tap, and so on. What we require here is a charger transformer which offers an *actual* a.c. voltage of 17 volts on its secondary."

Smithy turned to his bench and quickly scribbled out a circuit on his note-pad. (Fig. 3.)

"There you are," he remarked, passing the pad over to Dick. "Here's the circuit for the power supply section of the zener diode checker."

Dick looked doubtfully at Smithy's diagram. The most casual of observers would have noted the distinct expression of incomprehension which appeared on his face.

"Okay?" queried Smithy.

"Not really," replied Dick. "To be perfectly frank, I'm not *quite* certain how this circuit works."

"Come on, now," said Smithy a little irritably. "It's nothing other than a straightforward voltage doubler rectifier circuit."

"To *you* it may be straightforward,"

grinned Dick cheerfully. "But to me it's nothing short of unfathomable!"

"Oh, all right then," said Smithy resignedly. "It looks as though I'll have to tell you how it works before we can get any further. To start off with, consider first the mains half-cycles which cause the upper end of the 17 volt transformer secondary to go positive. D1 and C1 form a standard half-wave rectifier circuit and, on these half-cycles, D1 conducts and causes C1 to become charged up such that its right-hand plate is positive. If there is no load on the output of the supply, C1 charges up to the peak value of the alternating voltage on the mains transformer secondary. Are you happy with that bit?"

"Yep," replied Dick. "It's all quite clear up to now."

"Good," returned Smithy. "Now let's look next at the half-cycles which cause the *lower* end of the 17 volt secondary to go positive. D1 does not conduct on these half-cycles and plays no part in what goes on. But D2 does conduct. Relative to the upper negative rail, the voltage applied to D2 consists of the positive half-cycles at the lower end of the secondary *plus* the voltage stored as a charge in C1. Again assuming no load, C2 then becomes charged up to *twice* the peak value of the alternating voltage on the secondary."

"Gosh, I see it all now," exclaimed Dick. "What happens when you connect a load?"

"The voltage across C2," replied Smithy, "drops to a value which is lower than twice the peak voltage according to the current drawn by the load. C1 charges up on the first lot of half-cycles and discharges into C2 on the second lot of half-cycles. Incidentally, I said just now that, without a load, C1 charges to peak value and C2 charges to twice peak value. If we use silicon rectifiers, which in practice we are going to do in our zener diode tester, a voltage of about 0.6 volt is dropped across each rectifier when it conducts. So, under no-load conditions the voltage across C1 will be peak voltage minus 0.6 volt and that across C2 will be twice peak voltage minus 1.2 volts."

"Fair enough," said Dick. "What's the purpose of R1?"

"That's merely a surge limiting resistor," explained Smithy. "It could, incidentally, be 4.7Ω if a 5Ω resistor can't be obtained."

FULL TESTER CIRCUIT

"Well," said Dick, "that's got the power supply bit cleared up. What about the rest of the zener diode tester circuit?"

"I'll draw that up for you now," said Smithy.

For several minutes Smithy worked carefully at his note-pad. He then triumphantly placed his pen on the bench and showed the circuit he had drawn to Dick. (Fig. 4.)

"Here we are," he said proudly. "Now in the complete circuit for the tester we have the voltage doubler supply which we have just discussed. Its output voltage couples to the constant current circuit which incorporates the BD124, this being a silicon power transistor. The base of the BD124 is held firmly at about 1.8 volts positive of the negative supply rail, this being the forward voltage drop across the three silicon rectifiers D3, D4 and D5. R2 causes these rectifiers to pass a forward current of some 30 to 40 mA, which brings them well into

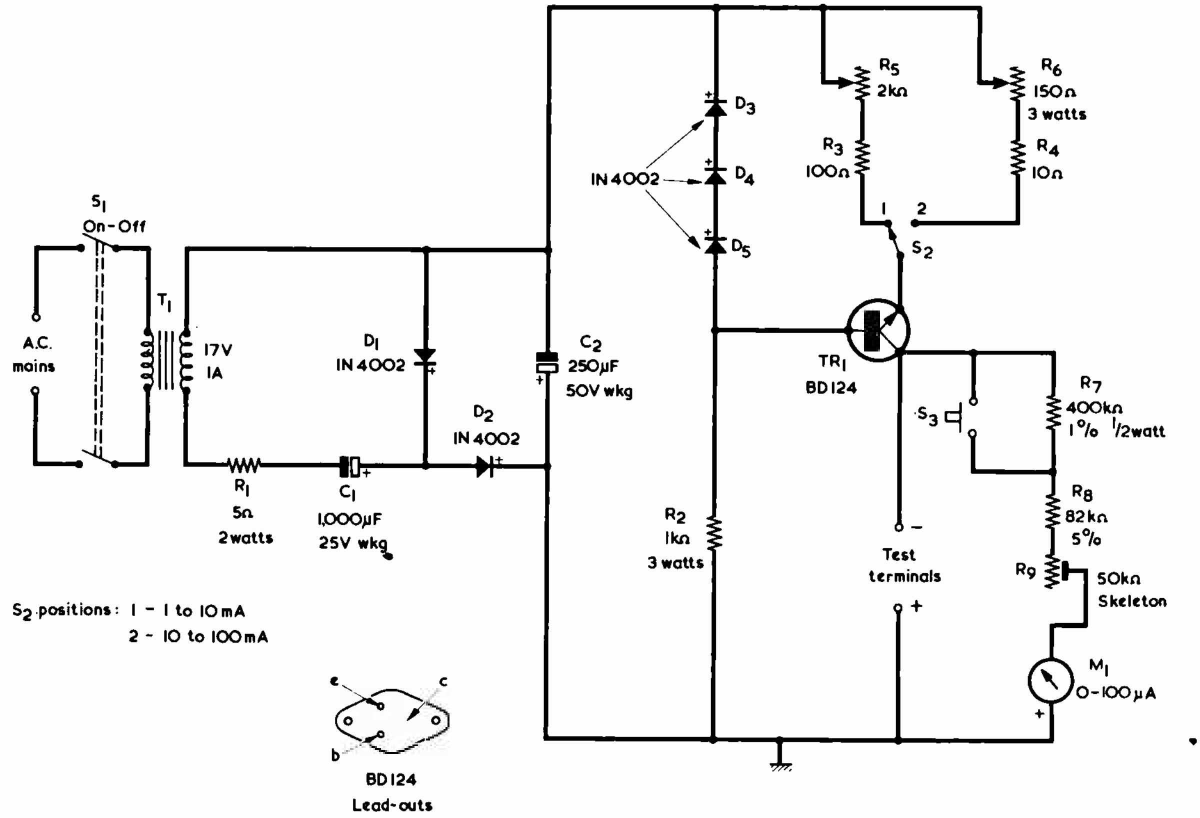


Fig. 4. Complete circuit of the zener diode checker. Full-scale deflection in the meter corresponds to 50 volts when S3 is open and to 10 volts when S3 is pressed. Unless otherwise specified, fixed resistors are ¼ watt 10%. R5 may be a standard-size linear carbon track potentiometer, but a wire-wound component here would be preferable. The zener diode to be checked is connected to the test terminals

their conductive region."

"Isn't that rather a high current?"

"It's a little more than is required for the constant current application," agreed Smithy, "but I've chosen a fairly high current here because it will improve the regulation of the output voltage from the power supply when little or no current is drawn through the BD124."

"That constant current circuit," remarked Dick, "is a pretty familiar arrangement these days, isn't it?"

"Oh, definitely," stated Smithy. "It keeps popping up all over the place and it represents a particularly useful attribute of the transistor. The voltage between the emitter of the BD124 and the negative supply rail is about 1.2 volts, since approximately 0.6 volt is dropped across the base-emitter junction. If we insert variable resistance between the emitter and the negative rail we can vary the constant current which the transistor passes in its collector circuit. Should we set up the emitter resistance such that a constant current of 10mA is given in the collector circuit, that current will flow at all collector potentials from slightly positive of the base voltage to the full voltage on the positive supply rail."

"Is the current in the emitter circuit pretty well the same as that in the collector circuit?"

"Pretty near. Actually it's a little larger, since it's the collector current plus the base current. You'll notice that, in my circuit, you can switch in R5, which offers a current range of 1 to 10mA, or R6, which offers a current range of 10 to 100mA. R3 and R4 are current limiting resistors, and they ensure that you cannot accidentally set up the checker to too high a current."

"I see," said Dick. "Incidentally, why have you chosen a power transistor as the constant current device?"

"Because it may have to dissipate a fair amount of power. Let's assume that you get a voltage of around 32 volts from the power supply and that you short-circuit the test terminals when the emitter resistance is set up for a constant current of 100mA. Very nearly 3.2 watts will then be dissipated in the BD124. In practice it will have to be mounted on a heat sink. A flat metal plate about 2 inches square should be quite adequate."

Dick absorbed this information in silence then turned his attention to another part of the circuit.

"I suppose," he remarked, "that the 100μA meter is used as a voltmeter."

"That's right," confirmed Smithy. "Normally, it has a full-scale deflection corresponding to 50 volts, this changing to 10 volts when S3 is pressed. The idea is that you switch on the unit, whereupon the meter indicates the voltage between the collector of the BD124 and the positive line. You next set up the emitter resistance to the current value you require and connect the zener diode to be checked to the test terminals. The meter reading then drops to the zener voltage of the diode. If this is lower than 10 volts you press the push-button to obtain a more precise reading. The reason for having a push-button rather than an ordinary switch is that there is then less risk of accidentally applying a high current to the meter when it's switched to read 10 volts."

"Why have you put a pre-set potentiometer in series with the meter?"

"Purely for convenience. The sensitivity of a voltmeter incorporating a 100μA meter is 10,000 Ω per volt. R7, at 400kΩ, drops 40 volts at full-scale deflection. At the same time, R8 and R9, together with the meter resistance, drop 10 volts at full-scale deflection. You could, if you liked, have a single close tolerance fixed resistor in place of R8 and R9, this having a value equal to 100kΩ minus the meter resistance. But it's easier to have an ordinary 5% resistor and a pre-set skeleton pot in series instead. All that you then have to do is to set up the pre-set pot with the aid of another voltmeter."

CONSTRUCTION

With an air of finality, Smithy rose and walked towards the hook on which his raincoat was hanging.

"Hey," said Dick, alarmed. "Where are you off to?"

"I'm going home," replied Smithy firmly. "You seem to forget that we packed in work about half an hour ago."

"Couldn't you hang on," asked Dick, "until I've actually made up this zener diode tester?"

"Dash it all," retorted Smithy. "I've already given you the circuit for it. How much longer do you want me to stay here?"

"Only for a little while," wheedled Dick. "I can get the tester made up in no time at all, and I'll just need your help for a few moments in getting it set up."

Smithy sighed.

"Oh, all right then," he said resignedly. "But you'll have to be quick about it. You should be able to find all the components you require in our spares cupboard or out on the benches."

Gleefully, Dick took up the circuit Smithy had drawn out and shot over to the spares cupboard. Consulting the diagram he started to take out the components that were required.

"Hallo," he remarked. "We don't seem to have any 1N4002 rectifiers in stock."

"Not to worry," replied Smithy. "Any small silicon rectifier with a current rating of 1 amp and a peak inverse voltage rating of 100 volts or more will be more than adequate for D1 and D2. D3 to D5 can be any small silicon rectifiers. Incidentally, I should have told you that the two pots in the emitter circuit of the BD124 need to be fitted with pointer knobs, and they'll need scales behind them on the front panel. Temporary paper scales will do for the time being."

Very soon the Workshop was the scene of a great stir and flurry on the part of Dick as, labouring like a man possessed, he set to work with screwdriver, pliers and soldering iron. Fortunately, the chassis and panel assembly he had unearthed already offered quite a number of conveniently positioned holes and the amount of metalwork involved in fitting the zener diode tester components to it was very small. He made the heat sink for the BD124 from a small piece of tinplate. Rather than insulate the transistor from the heat sink he soldered the sink to several tags of a tagstrip so as to insulate it from chassis, and then bolted the transistor directly to it. Smithy nodded his approval at this approach.

After a surprisingly short time, Dick announced that the tester was complete. Smithy walked over to inspect Dick's handiwork and to check for wiring errors.

"Very good," he commented in a satisfied tone. "Despite the rush, you've made quite a nice job of it."

Dick beamed with pleasure.

"I tell you," he remarked proudly, "I may not be too hot on the theory of electronics, but when it comes to the practical side I'm a real gone kiddy, mate!"

"All right, all right," said Smithy, as he consulted his circuit diagram. "Now before we do anything else let's see what sort of voltage we've got available for testing purposes. First set up R9 so that it inserts maximum resistance. Then switch on and measure the voltage across the 1kΩ resistor, R2."

Dick adjusted R9 as Smithy had requested, then connected the zener diode tester to the mains and switched on. The needle of the 0 – 100μA meter on the front panel rose to indicate approximately 72μA.

"So far," he stated, "so good. There are no little puffs of smoke coming out of the works as yet!"

He switched his testmeter to a volts range and applied its test prods across the 1kΩ resistor.

"I'm getting a reading," he called out, "of 36 volts."

"Good," said Smithy, obviously pleased. "This means that, at low currents, this gubbins will be able to check zener voltages very nearly up to that value. Now the next job is to set up R9. Connect your testmeter between the positive supply rail and the junction of R7 and R8 then tell me what it says."

Dick reapplied the test prods and switched his testmeter to a lower voltage range. (Fig. 5.)

"The testmeter's reading about 6.4 volts."

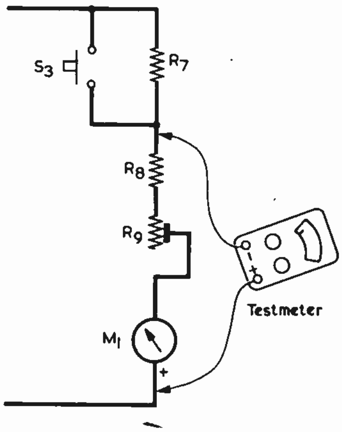


Fig. 5. Setting up R9. This component is adjusted for similar voltage indications in M1 and the testmeter

"Fair enough," commented Smithy. "The actual reading you'll get here depends of course, on the sensitivity of the testmeter. Now adjust R9 until both the testmeter and the 100μA meter give the same reading, with 100μA on the meter in the testmeter corresponding to 10 volts. Don't forget that one needle will rise as the other falls."

With an expression of heavy concentration, Dick carefully adjusted the pre-set potentiometer.

"Both meters are now giving the same reading," he said eventually.

"Good," said Smithy. "You can disconnect the testmeter. The next job is to calibrate R5 and R6. Start off by setting S2 to the '1 to 10mA' position and adjust R5 to give maximum resistance. Then connect your testmeter, switched to read current, across the test terminals. You'd better switch the testmeter to a high current range initially in case there's excessive current due to a fault condition."

As requested, Dick set R5 to insert maximum resistance, switched his testmeter to a high current range and connected it to the test terminals. (Fig. 6.) The testmeter needle was barely deflected. Dick successively selected lower current ranges until he finally obtained a useful reading.

"The testmeter," he remarked, "is indicating about 0.8mA."

"Excellent," said Smithy. "Check next that you can adjust R5 for a range of current readings from 1 to 10mA. There'll be a bit of potentiometer travel outside this range at both ends but that doesn't matter."

Dick quickly checked the current range offered by R5.

"It's just as you say, Smithy," he said. "R5 gives a range, over most of its track, from 1 to 10mA."

"Right," returned Smithy. "The next job is to calibrate R5 in terms of current. For the time being it will be sufficient to mark on its scale just the 1, 2.5, 5, 7.5 and 10mA points. You can make a more comprehensive calibration later on when you've got a bit more time."

CHECKING PERFORMANCE

Dick took a pencil from his pocket and marked, on the temporary paper scale behind the pointer knob of R5, lines corresponding to readings of 1, 2.5, 5, 7.5 and 10mA in his testmeter.

"You now," said Smithy, "put S2 in position 2 and repeat the process with R6, only this time the range is from 10 to 100mA. Just in case there's anything wrong, start off with the testmeter switched to a high current range and with R6 at maximum resistance, then cautiously reduce the resistance given by R6."

Dick followed Smithy's advice and shortly announced that R6 was offering a satisfactory current range from 10 to 100mA. At Smithy's bidding he next calibrated the scale for R6 at the points corresponding to 10, 25, 50, 75 and 100mA.

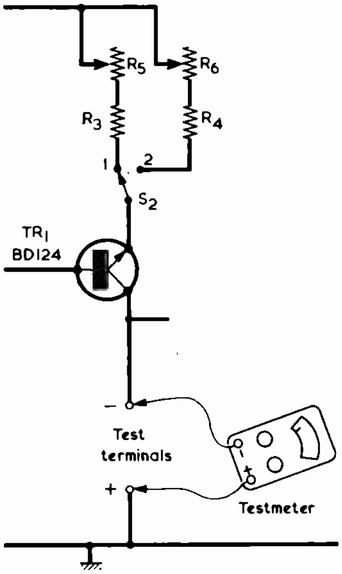


Fig. 6. Calibrating R5 and R6. This process is carried out with the testmeter switched to suitable current ranges

"That's very good," commended Smithy. "We should next check that we *are* getting a constant current from that BD124. Find a 2kΩ standard size pot and insert it in series with the meter."

Smithy's assistant once more visited the spares cupboard. He quickly returned with the potentiometer and connected it in series with his testmeter. (Fig. 7.)

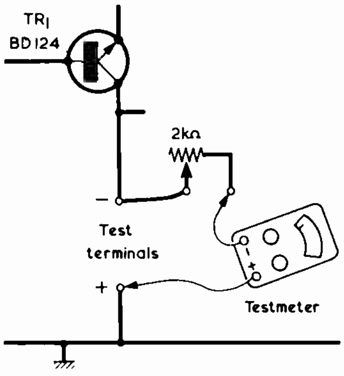


Fig. 7. Inserting a 2KΩ potentiometer in series with the testmeter provides a check on the efficiency of TR1 as a constant current device

"Set up R6 in the tester for a current of 15mA," Smithy continued, "then adjust the 2kΩ potentiometer. That 15mA reading should remain virtually unaltered at all settings of the 2kΩ pot."

Looking closely at his testmeter, Dick turned the spindle of the 2kΩ potentiometer.

"This is quite fantastic," he remarked. "I can't see any movement in the meter needle at all, and it just stays fixed at 15mA. Well, we've certainly got a constant current here! Any other tests, Smithy?"

"Just a few voltage measurements, and then we've finished. Take your testmeter off the test terminals, switch it to read voltage and connect it across R2 again. Next, short circuit the test terminals, then tell me the voltages across R2 for currents of 25mA, 50mA and 100mA. You get those by adjusting R6, of course."

"No sooner said," grinned Dick, "than done! Hang on a jiffy while I reconnect the testmeter. Ah, here we are. Well now, at a current of 25mA, the voltage across R2 is 34 volts, at 50mA it's 32 volts, and at 100mA it's 28 volts."

"That's not bad at all," commented Smithy. "The zener testing voltage is restricted to a little less than 28 volts at 100mA and to a little less than 32 volts at 50mA. These voltages should accommodate pretty well all of the zener diodes we are likely to encounter in simple electronic work. Right now, we're all set to check out those zener diodes of yours. I think a current of 10mA will be adequate for the small diodes that you have here."

Smithy walked over and seated himself in front of the now completed diode tester. He set up R6 for 10mA, took a diode from Dick's box and connected it to the test terminals. The meter reading dropped to 24 on its scale.

"That," remarked Smithy, "is a 12 volt zener diode. Let's try another one."

He picked up another diode and coupled it to the tester. The meter needle fell to around 15. Smithy pressed S3, whereupon the needle rose to 76.

"And that," said Smithy, as he released S3 and then removed the diode, "is a 7.6 volt diode."

He picked up a third diode and connected it to the tester. The meter needle fell almost to zero. Smithy pressed S3 and the meter needle rose to indicate slightly more than half a volt.

"It looks," said Dick, who had been following Smithy's actions with avid attention, "as though you've got a faulty diode there. It must have a short-circuit in it or something."

"It's more probable," replied Smithy "that I've connected it to the tester wrong way round. Don't forget that a zener diode is just an ordinary silicon diode when the current flows through it in the forward direction."

Smithy changed over the diode connections whereupon the tester indicated that the device had a zener voltage of 8.3 volts. Smithy next swung R6 over the range of 10 to 25mA, demonstrating to Dick that the zener voltage increased only slightly at the higher currents.

FURTHER SUPPLY

"This is absolutely fascinating," said Dick. "All you've got to do is to simply connect the zener diode and the tester tells you its zener voltage with no further trouble."

"That's pretty well the substance of it," averred Smithy. "And you can, of course, adjust zener current to any value you like from 1 to 100mA and thereby find the zener characteristic as well. You mustn't, of course, pass more current through the zener diode than its wattage rating allows. The highest voltage appearing across the test terminals is always less than 36 volts, so there's no great shock risk if you should accidentally touch those terminals. If you're worried about shock you can, in any case, switch off the tester whilst you're connecting and disconnecting the zener diodes, switching it on for the reading only."

"I think it's a jolly good tester," said Dick, gazing at the instrument fondly. "Another thing is that it also lets you find the correct polarity for the diode. You could use it for checking the polarity of ordinary diodes too, *and* for finding out whether they're silicon or germanium."

"That's true enough," confirmed Smithy. "A silicon diode will give a forward voltage reading of about 0.6 volt whilst a germanium diode will give a reading of less than 0.25 volt. Now let's have a look in my bench drawer."

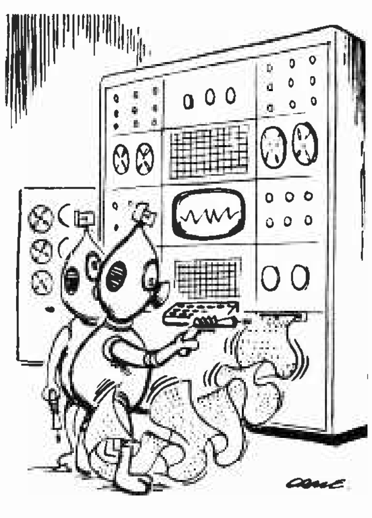
As Dick watched him curiously, Smithy walked over to his own bench, opened a drawer and produced a cardboard box which was an exact duplicate of that on Dick's bench. The look of sudden suspicion on Dick's face rapidly changed to one of furious revelation when Smithy took off the lid of the box, to reveal contents that were precisely similar to those in Dick's box.

"By a strange quirk of circumstances," remarked Smithy casually, "it so happens that I, also, have purchased by mail-order a Bumper Bargain Parcel of 200 unmarked and untested zener diodes. I received mine last week but, I'm afraid, I've felt rather too lazy to actually make up a tester for sorting them out. However, seeing that we now have such a tester available I shall be delighted to take advantage of it when you have finished checking your own diodes."

"Why," spluttered Dick indignantly, "you crafty old twister! You've been pretending all along that you were giving up your spare time to help me out, when what you were actually doing was conning me into making up a tester for *your* components which *you* were too idle to build!"

"Another way of looking at the situation," said Smithy gently, "is that if I hadn't had a need for the tester myself I would not then have had the inducement to devote a considerable amount of my spare time in helping you build it."

And by the time his outraged assistant had mustered up a suitable reply to this argument Smithy had already returned his box of diodes to his bench drawer, picked up his raincoat and quitted the Workshop for the day. ■



"Resistance - is - useless - Take - me - to - your - programmer!"

Radio Topics

By Recorder

GLASS-CASED CARTRIDGE FUSES ARE familiar devices, but it is surprising how little many of us know about their modes of operation.

To start off with, quite a few people have the impression that a glass cartridge fuse blows at the current at which it is rated. If the fuse is of the type familiar in electronic equipment such is *not* the case. The rating of a fuse of this type is normally the maximum *carrying* current it can handle, and the fuse should be capable of passing this current without rupture for 1,000 hours. To find the blowing current you have, theoretically, to look it up in the fuse manufacturer's literature! This is, to say the least, a process which can hardly be described as being convenient. Fortunately, you can be pretty certain in practice that small glass cartridge fuses will blow at 2 to 3 times the current at which they are rated although, even then, they may not break the circuit instantaneously. At higher currents a much quicker blowing, and consequent breaking of the circuit, is given.

CHOOSING A FUSE

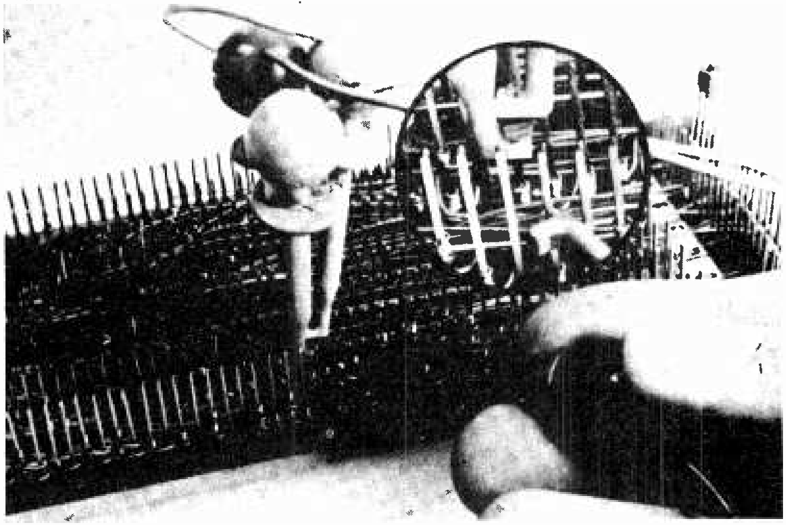
These particulars apply only to glass cartridge fuses of the type we use in electronic gear. Other types of fuse may be rated in different manner. For instance, the glass types with pointed brass end-caps that are encountered in car electrical systems are rated at their blowing current, and not at their maximum carrying current.

Another variant in the cartridge fuse field is the delayed action or anti-surge type, which is capable of withstanding a short surge without blowing. Fuses of this nature are inserted in circuits where there is a relatively heavy switch-on surge, as occurs for instance between the rectifier and reservoir capacitor in a mains power supply. Bulgin 'Pak' fuses are typical examples of the anti-surge type and will normally resist currents of 75% above rating for 120 seconds, and currents of 100 to 175% above rating for 5 to 30 seconds. These fuses blow in less than 1 second at 200% above rating. Other types of anti-surge fuse are also available.

There are several recommended approaches towards selecting the fuse rating for a circuit. One school of thought counsels that a fuse should have a rating which causes it to blow at the 'danger current' in the circuit in which it is to be used, even if this 'danger current' is much higher than the normal standing current. 'Danger current' is the level at which the risk of expensive burn-out in one or other of the components is likely to become serious, and the fuse employed should then be rated at about a third of this current. In electronic work, unfortunately, it is usually difficult to define a 'danger current' because the term tends to be rather meaningless. When the current in an electronic circuit rises by even a small amount above its normal level then it is obvious that something is wrong and it would seem reasonable to expect that the fuse would give some level of protection. This is where an alternative approach towards fuse selection comes into play. This second school of thought recommends that a fuse in an electronic circuit should have a rating which is the next figure above the normal standing current the fuse will have to pass. Should there be surges in the circuit, an anti-surge type should be used.

This second method of choosing a fuse is the better, although most of us know from experience that a fuse rated just above standing current will tend to burn out, even under perfectly normal fault-free running conditions, more frequently than a fuse having a higher current rating again. However, it is impossible to lay down any hard and fast rule here. If fuse failure under fault-free conditions becomes a nuisance, just fit a fuse that is one step higher in current rating. Many service engineers will recall that set-manufacturers occasionally increase the recommended rating of fuses fitted to their products because of a high incidence of unexplained fuse failures in the field. Finding the best fuse rating for a circuit is just one of the many practical problems of electronic design.

Fuses are also, unhappily, not of much use in modern circuits employing silicon semiconductor devices. If an overload causes a silicon device to be taken beyond breakdown level, it will almost always break down before any fuse in series with it breaks the circuit.



A family of 'E-Z-Mini-Hooks' in action. These provide reliable temporary connections in crowded layouts

So, there we are. Fuses are very useful devices, but the selection of a suitable type can sometimes be tricky. And they may not give quite the circuit protection that we fondly imagine they do.

IMPOSSIBLE HOOKER

'Impossible hooker' is the term applied by its manufacturers to the 'E-Z-Mini-Hook', several of which can be seen in the accompanying photograph where they are making temporary connections in a crowded wire-wrap terminal layout. If you pronounce the 'Z' of 'E-Z' in the American manner, i.e. 'zee', the choice of letters becomes more obvious.

The 'E-Z-Mini-Hook' is 2¼ in. long, and has a nylon body down the inside of which travels a gold plated beryllium copper conductor shaped at the end in the form of a hook. This hook emerges against internal spring pressure if the spherical top of the body is pressed, and it may then be passed over any wire or small tag. When the top of the body is released, the wire or tag is held firmly between the hook and the bottom surface of the nylon, thereby providing a reliable connection for testing or jumpering purposes. The connection from the hook is carried by a thin insulated lead which is taken out from the spherical top of the body.

There is a small hole at the bottom of the moulding into which the end of the hook retracts when it is not extended. This hole is large enough to allow small tag spills to pass through, thereby providing another means of temporary connection. In both methods of connection there is no risk of short-circuit to adjacent conductors. In the enlarged section of the photograph, two 'E-Z-Mini-Hooks' are connected to a tag which passes through the hole in the moulding. The third is connected by means of the extended hook.

'E-Z-Mini-Hooks' are flash-tested up to 4kV, will operate on running test up to 2kV, and have a current capability of 1.5A. They are available singly or in a number of assemblies in which they are wired to other 'E-Z-Mini-Hooks' or to plugs and sockets of various types. Further details are available from the U.K. and Ireland distributor, British Central Electrical Co., Ltd., Briticent House, New Street, Ringwood, Hampshire.

RECTIFIER POLARITY

Finally, a little hint which can possibly save you quite a bit of grief.

When wiring up a mains power supply using unbranded silicon rectifiers, always fit the reservoir and smoothing capacitors last. And, before you do so, connect a testmeter switched to a volts range to the circuit points where the reservoir capacitor will connect, and then apply the mains input. This will confirm for certain whether or not the voltage which will be applied to the electrolytics is of correct polarity. The voltmeter will, of course, give a lower reading than will occur when the electrolytics are fitted later, but this doesn't matter. The whole function of the test is simply to confirm polarity.

The reason for the test is that one can never be entirely sure which lead-out of an unbranded rectifier is anode and which is cathode. Ohmmeter tests for rectifier polarity tend to be confusing and the most satisfactory method is to check the polarity when a rectifier is in its working circuit. Better to be safe, with a simple quick voltmeter test, than sorry, with a couple of broken-down electrolytics! ■

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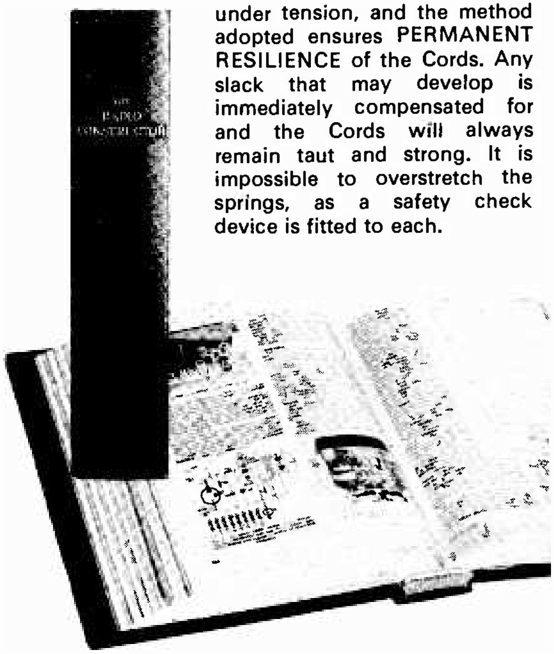

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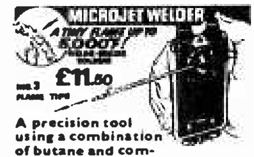

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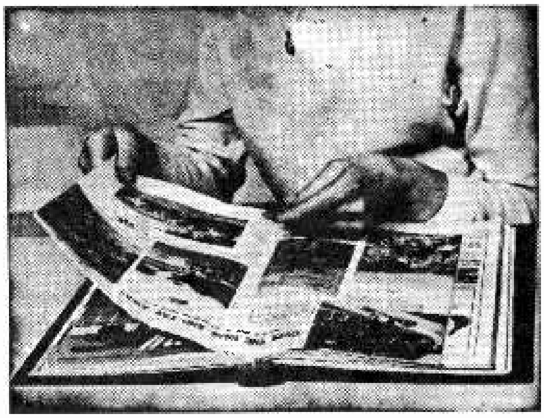

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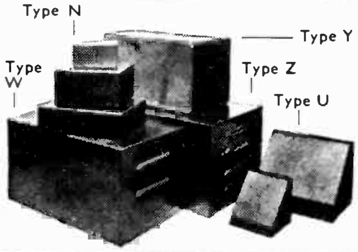

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2.5mfd	50V	3p	250mfd	25V	8p
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16mfd	15V	3p	1000mfd	25V	15p
16mfd	25V	3p	1000mfd	50V	35p
20mfd	25V	3p	2000mfd	12V	10p
25mfd	25V	3p	2000mfd	25V	25p
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200μF	6.4V	5p
40μF	16V	5p
80μF	25V	5p
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66

Meter Shunts I

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Meter Resistance	X3	X10	X30	X100	X300	X1,000	X3,000
25Ω	12.5Ω	2.78Ω	0.862Ω	0.253Ω	0.0839Ω	0.0250Ω	0.00833Ω
50Ω	25Ω	5.55Ω	1.72Ω	0.505Ω	0.167Ω	0.0501Ω	0.0167Ω
75Ω	37.5Ω	8.33Ω	2.59Ω	0.758Ω	0.251Ω	0.0751Ω	0.0250Ω
100Ω	50Ω	11.1Ω	3.45Ω	1.01Ω	0.334Ω	0.100Ω	0.0333Ω
250Ω	125Ω	27.8Ω	8.62Ω	2.53Ω	0.839Ω	0.250Ω	0.0833Ω
500Ω	250Ω	55.5Ω	17.2Ω	5.05Ω	1.67Ω	0.501Ω	0.167Ω
750Ω	375Ω	83.3Ω	25.9Ω	7.58Ω	2.51Ω	0.751Ω	0.250Ω
800Ω	400Ω	88.9Ω	27.6Ω	8.08Ω	2.68Ω	0.801Ω	0.267Ω
850Ω	425Ω	94.4Ω	29.3Ω	8.59Ω	2.84Ω	0.851Ω	0.283Ω
900Ω	450Ω	100Ω	31.0Ω	9.09Ω	3.01Ω	0.901Ω	0.300Ω
950Ω	475Ω	106Ω	32.8Ω	9.60Ω	3.18Ω	0.951Ω	0.317Ω
1,000Ω	500Ω	111Ω	34.5Ω	10.1Ω	3.34Ω	1.00Ω	0.333Ω
1,100Ω	550Ω	122Ω	37.9Ω	11.1Ω	3.68Ω	1.10Ω	0.367Ω
1,200Ω	600Ω	133Ω	41.4Ω	12.1Ω	4.01Ω	1.20Ω	0.400Ω
1,250Ω	625Ω	139Ω	43.1Ω	12.6Ω	4.18Ω	1.25Ω	0.417Ω
1,300Ω	650Ω	144Ω	44.8Ω	13.1Ω	4.35Ω	1.30Ω	0.433Ω
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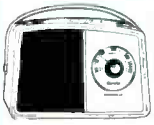

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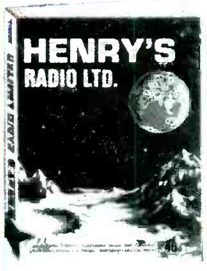

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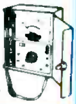

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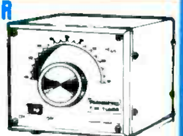

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