RADIO & ELECTRONICS CONSTRUCTOR

JUNE 1976

35p

ALSO FEATURED

BURGLAR ALARM CIRCUITS

RADIO & ELECTRONICS CONSTRUCTOR

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CONTENTS

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6	2	Slide	**20p**
4	2	Lever Slide	**15p**
2	2	Slide	**12p**
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Ex-eqpt. 2 or 4 gang **20p**

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

As total values are too numerous to list, use this price guide to work out your actual requirements
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CAPACITOR GUIDE – maximum 500V
Up to .01 ceramic **3p.** Up to .01 poly **4p** Up to 1000PF silver mica **5p.** 1,200PF up to .01 silver mica **10p.** .013 up to .1 poly etc. **5p** .12 up to .68 poly etc. **6p.**
Over 500 volt order from above guide and few others listed below.
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BC108A/B/109B/C	10p	BD131/2/3/5/7/9	30p	BFY50/1/2	12p
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BC147A/B	8p	BD201/2/3/4	£1.00	BR101 (Programmable Unj Junction)	30p
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BC159B/C, 157A	11p	BF167/173	10p	BSV79/80 F.E.T.s	£1
BC178A/B/179B	10p	BF178/9	20p	BSV81 Mosfet	90p

BSX20/21	13p
BSY40	28p
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BU105-01	93p
CV7042 (OC41 OC44, ASY63)	7p
GET111	40p
OC35	32½p
ON222	30p
TIP30	43p
TIP3055	50p
TIS88A FET	23p
ZTX300	13p
ZTX341	16p
2N393/MA393	30p
2N706	9p
2N929	14p
2N987	35p
2N1507/2219	14p
2N2401/2412/2483	25p
2N2904/5/6/7	10p
2N2907A	13p
2N3053	13p
2N3054/3055 (or equiv)	35p
2N3133	18p
2N3704	9p
2N4037	35p
2N5036	60p
2SA141/2/360	31p
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1N4148	2p
BA145/148	15p
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OA5/7/10	14p
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7483	74p
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74154	£1.20

BRIDGE RECTIFIERS

Amp	Volt		
½	1,600	BYX10	30p
1	140	OSH01-200	20p
1.4	42	BY164	51p
0.6	110	EC433	15p
5	400	Texas	75p

RECTIFIERS

	Amp	Volt	
IN4004	1	400	4p
IN4005	1	600	6p
IN4006	1	800	6p
IN4007	1	1,000	6p
BY103	1	1,500	15p
SR100	1.5	100	7p
SR400	1.5	400	8p
REC53A	1.5	1,250	14p
LT102	2	30	10p
BYX38-600	2.5	600	55p
BYX38-300R	2.5	300	43p
BYX38-900	2.5	900	60p
BYX38-1200	2.5	1,200	65p
BYX49-600	2.5	600	34p
BYX49-300	2.5	300	26p
BYX49-900	2.5	900	40p
BYX49-1200	2.5	1,200	52p
BYX48-300	6	300	40p
BYX48-600	6	600	50p
BYX48-900	6	900	60p
BYX48-1200	6	1,200	80p
BYX72-150R	10	150	35p
BYX72-300R	10	300	45p
BYX72-500R	10	500	55p
BYX42-300	10	300	30p
BYX42-600	10	600	65p
BYX42-900	10	900	80p
BYX42-1200	10	1,200	95p
BYX46-300*	15	300	£1.00
BYX46-400*	15	400	£1.50
BYX46-500*	15	500	£1.75
BYX46-600*	15	600	£2.00
BYX20-200	25	200	60p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.50

*Avalanche type

TRIACS

Amp	Volt		
6	800	Plastic RCA	90p
25	900	BTX94-900	£4.00
25	1200	BTX94-1200	£6.00

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Photo transistor

BPX29	£1.00
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RED	13p
ORANGE, GREEN, YELLOW	15p
CLIP	2p

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THYRISTORS

Amp	Volt		
1	240	BTX18-200	23p
1	400	BTX18-300	25p
1	240	BTX30-200	23p
15	500	BT107	£1.00
6.5	500	BT101-500R	90p
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BCY70/1/2	8p	2G401	10p
BF115	10p	2N711	25p
BY127	9p	2N2926	7p
BZY88 series	5p	2N598/9	6p
HG1005	2p	2N1091	8p
HG5009	2p	2N1302	8p
HG5079	2p	2N1907	2-50
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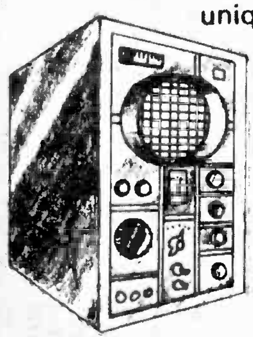

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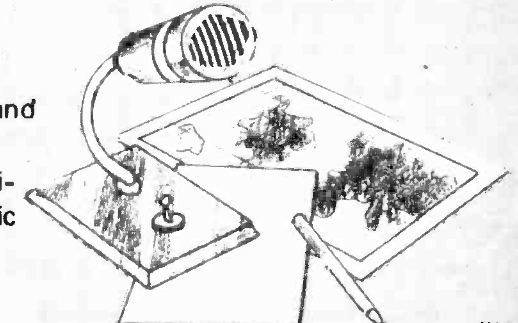

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Celestion HF2000 8 ohms	£8.55
Celestion MH1000 8 or 15 ohms	£13.50
Celestion CO3K	£4.46
Decca London ribbon horn	£28.80
Decca London CO/1000/8 Xover	£6.75
Decca DK30 ribbon horn	£17.25
Decca CO/1/8 Xover (DK30)	£4.50
EMI 14 x 9 Bass 8 ohms 14A770	£11.92
EMI 8 x 5, 10 watt, d/cone, roll surr.	£3.56
EMI 6½" d/cone, roll surr. 8 ohms	£3.93
Elac 59RM109 (15) 59RM114 (8)	£3.38
Elac 6½" d/cone, roll surr. 8 ohms	£3.83
Elac 10" 10RM239 8 ohms	£3.83
Eagle Crossover 3000hz 3, 8 or 15 ohms	£1.75
Eagle FR4	£5.51
Eagle FR65	£8.66
Eagle FR8	£11.08
Eagle FR10	£14.06
Eagle HT15	£3.96
Eagle HT21	£6.13
Eagle MHT10	£4.00
Eagle FF28 multicell. horn	£8.10
Fane Pop 15, 8 or 16 ohms	£5.25
Fane Pop 33T, 8 or 16 ohms	£8.75
Fane Pop 50, 8 or 16 ohms	£12.50
Fane Pop 55, 8 or 16 ohms	£15.50
Fane Pop 60, 8 or 16 ohms	£17.95
Fane Pop 70, 8 or 16 ohms	£18.75
Fane Pop 100, 8 or 16 ohms	£27.95
Fane Crescendo 12A, 8 or 16 ohms	£37.95
Fane Crescendo 12BL, 8 or 16 ohms	£39.95
Fane Crescendo 15/100A, 8 or 16 ohms	£49.95
Fane Crescendo 15/125, 8 or 16 ohms	£57.95

SPEAKERS

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Fane 910 Mk.II horn	£15.75
Fane 920 Mk.II horn	£36.95
Fane HPX1 crossover 200 watt	£2.50
Fane 13 x 8, 15 watt dual cone	£5.50
Fane 801T 8" d/c, roll surr.	£8.95
Goodmans Axent 100	£7.60
Goodmans Audiom 200 8 ohms	£13.46
Goodmans Axiom 402 8 or 15 ohms	£19.80
Goodmans Twinaxiom 8, 8 or 15 ohms	£9.50
Goodmans Twinaxiom 10, 8 or 15 ohms	£9.86
Goodmans 8P 8 or 15 ohms	£5.95
Goodmans 10P 8 or 15 ohms	£6.25
Goodmans 12P 8 or 15 ohms	£14.95
Goodmans 12PG 8 or 15 ohms	£16.50
Goodmans 12PD 8 or 15 ohms	£16.95
Goodmans 12AX 8 or 15 ohms	£39.00
Goodmans 15AX 8 or 15 ohms	£45.00
Goodmans 15P 8 or 15 ohms	£22.50
Goodmans 18P 8 or 15 ohms	£39.00
Goodmans Hifax 750P	£16.00
Goodmans 5" midrange 8 ohms	£4.05
Gauss 12" 200 watt	£84.00
Gauss 15" 200 watt	£96.00
Gauss 18" 200 watt	£129.00
Jordan Watts Module, 4, 8 or 15 ohms	£15.36
Kef T27	£5.18
Kef T15	£6.25
Kef B110	£6.75
Kef B200	£7.85
Kef B139	£15.08
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Kef DN12	£5.39
Kef DN13 SP1015 or SP1017	£4.05
Lowther PM6	£30.60
Lowther PM6 Mk.I	£32.85
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Peerless KO10DT 4 or 8 ohms	£7.25
Peerless DT10HFC 8 ohms	£8.26
Peerless KO40MRF 8 ohms	£9.50
Peerless MT225HFC 8 ohms	£2.95
Richard Allan CA12 12" bass	£19.80
Richard Allan HP8B	£11.93
Richard Allan LP8B	£8.33
Richard Allan DT20	£6.08
Richard Allan CN8280	£16.20
Richard Allan CN820	£3.15
Richard Allan Super Disco 60W 12"	£16.95
STC 4001G	£5.90
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Tannoy 12" HPD	£73.75
Tannoy 15" HPD	£88.15
Wharfedale Super 10 RS/DD 8 ohms	£13.50

SPEAKER KITS

Baker Major Module 3, 8 or 15 ohms	each	£13.28
Goodmans DIN 20 4 or 8 ohms	each	£13.28
Goodmans Mezzo Twin kit	pair	£42.47
Helme XLK 20	pair	£13.50
Helme XLK 30	pair	£17.10
Helme XLK 35	pair	£21.60
Helme XLK 40	pair	£31.50
Helme XLK 50	pair	£50.40
KEFkit 1	pair	£44.10
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Peerless 30-28	each	£21.95
Peerless 20-3	each	£23.90
Peerless 50-4	each	£36.45
Peerless 1060	pair	£50.40
Peerless 1070	each	£41.40
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Richard Allan Twin assembly	each	£13.46
Richard Allan Triple 8	each	£20.25
Richard Allan Triple 12	each	£25.16
Richard Allan Super Triple	each	£29.25
Richard Allan RA8 Kit	pair	£37.80
Richard Allan RA82 Kit	pair	£59.40
Richard Allan RA82L Kit	pair	65.70
Wharfedale Linton II Kit	pair	£20.81
Wharfedale Glendale 3XP Kit	pair	£47.70
Wharfedale Dovedale III Kit	pair	£59.40

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

ALL PRICES INCLUDE VAT (Prices correct at 6/5/76)

Send stamp for free 32-page booklet "Choosing a Speaker"

All units guaranteed new and perfect

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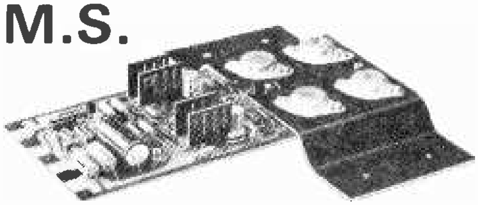
IT'S THE AL250
125 watts R.M.S.



POWER AMPLIFIER

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

The module has a sensitivity of 450mV and a frequency response extending from 25Hz to 20KHz whilst distortion levels are typically below ·1%. The use of 4, 115w transistors in the output stage makes the unit extremely rugged while damage resulting from incorrect or short-circuit loads is prevented by a 4 transistor protection circuit.

SPECIFICATION:

Output Power 125watt R.M.S. Continuous. Operating voltage 50-80. Loads 4-16ohms. Frequency response 25Hz-20kHz *Measured at 100 watts.* Sensitivity for 100watts output at 1kHz. 450mV. Input impedance 33kohms.

Total harmonic distortion 50 watts into 4ohms, 0.1%. 50 watts into 8ohms, 0.06%. S/N radio better than 80dBs. Damping factor, 8ohms, 65. Semiconductor complement, 13 transistors, 5 diodes. Overall size: Heatsink width 190mm, Length 205mm, Height 40mm.

ONLY £15.95 + 8% VAT

MPA 30

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

£2.65

VAT ADD 12½%

POSTAGE & PACKING

Postage and Packing add 25p unless otherwise shown. Add extra airmail minimum £1.00

AL10-20-30

AUDIO AMPLIFIER MODULES

The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S. The versatility of their design makes them ideal for use in record players, tape recorders stereo amplifiers and cassette and cartridge tape players in the home. Harmonic Distortion Po=3 watts f 1KHz 0.25%
Load Impedance 8-16ohm
Frequency response ± 3dB Po=2 watts 50Hz-25KHz
Sensitivity for Rated O/P – Vs=25V. RL=8ohm f=1KHz 75mV. RMS.
Size: 75mm x 63mm x 25mm

AL10 3w R.M.S. **£2.30** *AL20 5w R.M.S.* **£2.65** *AL30 10w R.M.S.* **£2.95**

NEW # PA12

£6.50

NEW PA12 Stereo Pre-Amplifier completely redesigned for use with **AL10/20/30** Amplifier Modules. Features include on/off volume. Balance, Bass, Treble controls. Complete with tape output.
Frequency Response: 20Hz – 20KHz (–3db)
Bass and Treble range ± 12dB
Input Impedence 1 meg ohm
Input Sensitivity 300mV
Supply requirements 24V.5mA
Size 152mm x 84mm x 33mm

PS12

Power supply for **AL10/20/30, PA12, S450 etc** Input voltage 15 – 20v A.C. Output voltage 22 – 30v D.C. Output Current 800 mA Max Size 60mm x 43mm x 26mm.
Transformer T538 £2.30

£1.20

BI-PAK

PO BOX 6, WARE, HERTS.

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NEW BSR HI-FI AUTOCHANGER

STEREO AND MONO

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

With STEREO/MONO CARTRIDGE **£10.95** Post 75p

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Modern design. Size 16" x 15" 7" approx. Post 50p
Large front grille. Hinged Lid. Chrome fittings. Motor board cut for Garrard or BSR deck. Rexine covered, in red and black.

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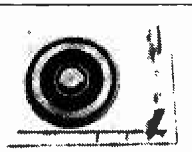

R.C.S. DISCO DECK SINGLE RECORD PLAYER

Fitted with auto stop. stereo/compat. cartridge. Baseplate. Size 11In. x 8¾in. Turntable. Size 7in. diameter. A/C mains. 220/250V motor has a separate winding 14 volt to power a small amplifier.
3 speeds plays all size records. **£6.25** Post 45p
Two for £12.

COMPLETE STEREO SYSTEM

Two full size loudspeakers 13½ x 10 x 3½in. Player unit clips to loudspeakers making it extremely compact. Overall size only 13½ x 10 x 8½in. 3 watts per channel.

plays all records 33 rpm 45 rpm Separate volume & tone controls 240v AC mains

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

SMITH'S CLOCKWORK 15 AMP TIME SWITCH 0-60 MINUTES

Single pole two-way Surface mounting with fixing screws Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights etc. Variable knob Turn on or off at full or intermediate settings. Fully insulated. Makers last list price £4 50. Brand new and fully guaranteed.

OUR PRICE **£2.95** Post 35p
Also available 0-6 hours.

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

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in. sides 6 x 4in. **70p**; 8 x 6in. **90p**; 10 x 7in. **£1.16**; 14 x 9in. **£1.50**; 16 x 6in. **£1.46**; 12 x 3in. **87p**; 16 x 10in. **£1.70.**

ALUMINIUM PANELS 18s.w.g. 6 x 4in. **15p**; 8 x 6in. **25p**; 10 x 7in. **30p**; 12 x 5in. **30p**; 12 x 8in. **40p**; 16 x 6in. **45p**; 14 x 9 in. **50p**; 12 x 12in. **55p**; 16 x 10in. **75p.**
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1½inch DIAMETER WAVECHANGE SWITCHES **45p.** EA.
2 p. 2-way. or 2 p. 6-way, or 3 p. 4-way.
1 p.1 2-way. or 4 p 2-way, or 4 p 3-way

TOGGLE SWITCHES, sp. 20p. dp. 25p dp. dt. 30p.

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

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

NEW ELECTROLYTICS

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

LOW VOLTAGE ELECTROLYTICS

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1, 2, 4, 5, 8, 16, 25, 30 50 100, 200mF 15V 10p.
500mF 12V 15p . 25V 20p . 50V 30p
1000mF 12V 20p 25V 35p . 50V 47p . 100V 70p
2000mF 6V 25p 25V 42p . 50V 57p 4700/63V 95p.
2500mF 50V 62p . 3000mF 25V 47p . 50V 65p
5000mF 6V 25p . 12V 42p 25V 75p . 35V 85p 50V 95p.
500V-0·001 to 0·1 10p, 0·25 12p, 0·47 25p
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TWIN GANG. "0-0" 208pF + 176pF £2
Slow motion drive 365pF+365pF with 25pF+25pF 50p.
500pF standard twin gang 75p. 120 PF twin gang 50p

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

NEON PANEL INDICATORS. 250V Red or Amber. 30p
RESISTORS. ¼w., ½w., 1w 20% 2p. 2w 8p 10 to 10M
HIGH STABILITY. ½ w. 2% 10 ohms to 6 meg. 10p
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5 8. 10. 16v ½a £2 6-0-6v 500mA £1 9v 1a £1
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FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12v outputs 1½a 40p 2a 55p. 4a 85p.

R.C.S. STABILISED POWER PACK KIT

All parts including, printed circuit and instructions to build this unit. Voltages available 6v 7 5v 9v 12v Up to 100mA output
Please state voltage required **£2.95** Post 45p

R.C.S. 3 WAY CROSSOVER

Complete with 12ft twin lead fitted with din speaker plug Ready assembled with leads for speakers, bass mid and tweeter Crossover frequencies 950 cps and 3 000 cps. For systems up to 25 watts **£2.20**

VOLUME CONTROLS

5K ohms to 2 Meg LOG or LIN. L/S 25p. D.P 40p
STEREO L/S 55p D P 75p
Edge 5K S P Transistor 25p

80 Ohm **Coax 8p** yd.

STANDARD VHF TYPE
FRINGE LOW LOSS Ideal 625 and colour **15** p per yd

Wirewound controls 1¼in diam 3 watts 10 ohms to 100K British made with long spindles ¼in dia 85p ea

DUAL CONCENTRIC POT 500k LOG + 500k LIN D P switch Inner spindle 3¼in, outer spindle 2¼in. 75p.

E.M.I. 13½ x 8 in. SPEAKER SALE!

With tweeter And crossover 10 watt State 3 or 8 ohm **£5.25** Post 45p
15 watt version 8 or 15 ohm **£7.95**
20 watt version 8 or 15 ohm as illustrated **£8.95**
Bass units only **£6.95** Post 65p

Bookshelf Cabinet £6.95

16 x 10 x 9in Teak Veneer For above units Post 75p

R.C.S. 10 WATT AMPLIFIER KIT

This kit is suitable for record players, tape play back, guitars electronic instruments or small P A. systems. Two versions are available A mono kit or a stereo kit. The mono kit uses 13 semiconductors The stereo kit uses 22 semiconductors with printed front panel and volume, bass and treble controls Spec 10 watts output into 8 ohm, 7 watts into 15 ohms Response 20 cps to 30K/cs. Input 100 mV high imp Size 9½in x 3in x 2in.

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

LOUDSPEAKERS P M 3 ohms, 7 x 4in £1.25, 6½in. £1.50; 8 x 5in £1 60 8in £1 75, 10 x 6in £1.90, 10in. £2.50.
SPECIAL OFFER LOUDSPEAKERS! All Brand New. 3 ohm 2½in 2¾in 3½in 5in 8 ohm, 2¼in, 2½in, 5 x 3in, 5in 15 ohm 3½in 5in 6 x 4in 5 x 3in, 7 x 4in. 25 ohm 2½in 3in, 5 x 3in 35 ohm, 3in; 5in. 80 ohm 2¼in 2¾in 120 ohm 3in **£1.25** EACH

LOUDSPEAKER VOLUME CONTROL 15 ohm 10 watt with 1in long threaded bush for wood panel mounting 75p

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SPEAKER COVERING MATERIALS. Samples Large S.A.E.
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3 WAY CROSSOVER 850 cps and 3000 cps (25 watt) £2.20

GOODMANS CONE TWEETER

18 000 cps 25 watts 8 ohm Price **£3.25**

ELECTRO MAGNETIC PENDULUM MECHANISM

1 5v d c operation over 250 hrs continuous on SP2 battery, fully adjustable swing and speed Ideal displays teaching electro magnetism or for metronome, strobe etc. 95p. Post 20p

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COAXIAL PLUG 10p PANEL SOCKETS 10p LINE 18p.
OUTLET BOXES SURFACE MOUNTING 25p.
BALANCED TWIN RIBBON FEEDER 300 ohms, 7p yd.
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R.C.S. 100 WATT VALVE AMPLIFIER CHASSIS

Professional model Four inputs, Treble. Bass, Master Volume Controls Ideal disco P A. or groups. 5 speaker outputs very robust job
S A E for details **£85** plus £1.50 carr.

NEW 'DISCO 100 WATT'

ALL PURPOSE TRANSISTOR AMPLIFIER CHASSIS **£52**
2 inputs 4 outputs separate volume treble and bass controls Ideal disco or slave amplifier chassis. Carr. £1

RADIO COMPONENT SPECIALISTS

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Bargains in Semi-Conductors, components, modules & equipment.

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Component Packs

CP1 150 Capacitors, mixed bag of paper, silver mica, electrolytics, etc. Approx quantity, counted by weight. (post & packing) 60p

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TP24 20 BFY64, 2N2904/5, etc. PNP silicon TO-5 uncoded. ***Complementary to PAK TP23.***

TP30 20 NPN silicon planar transistors, TO-18 similar to BC108 etc uncoded.

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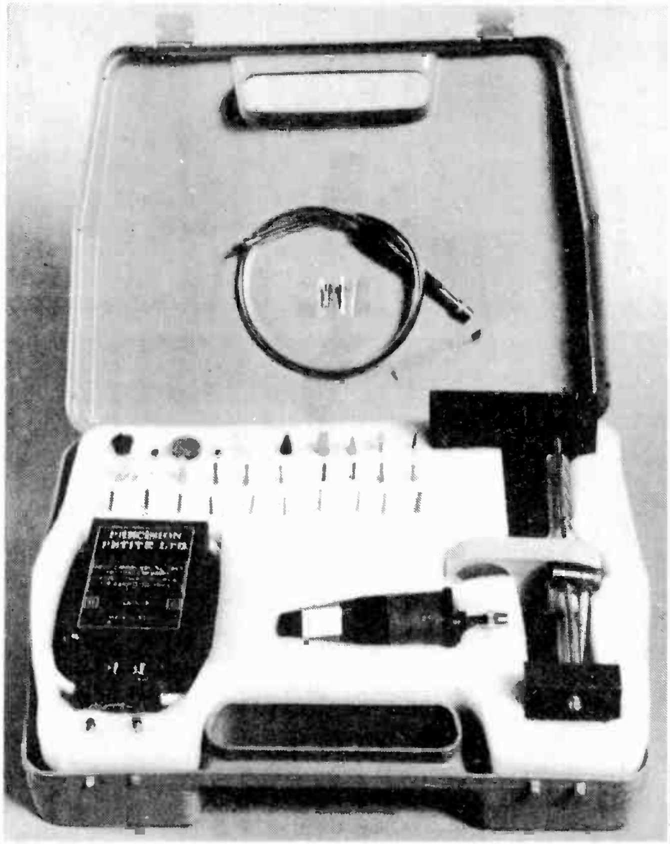

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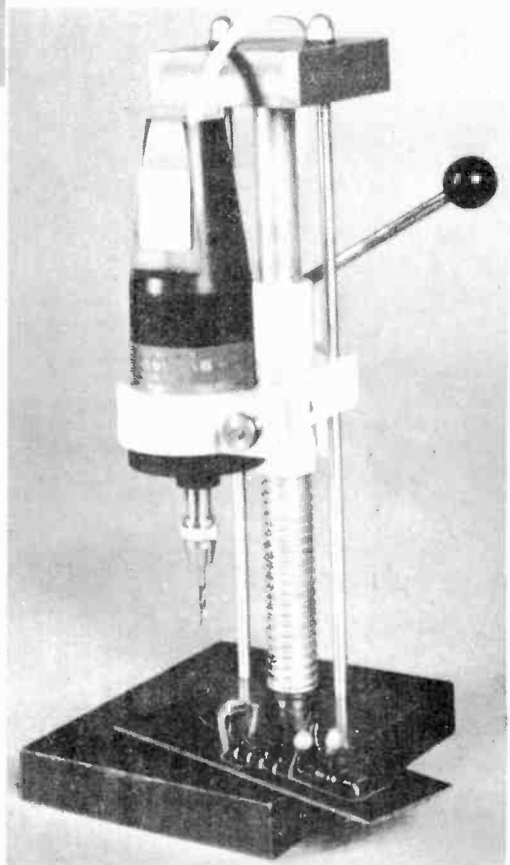

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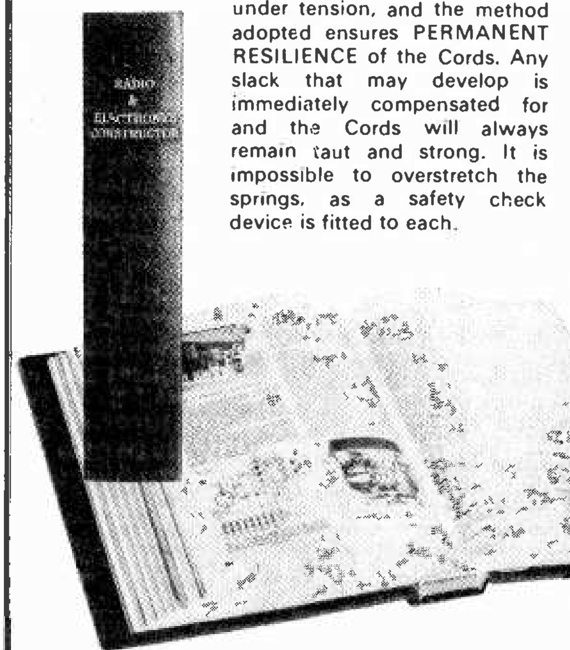

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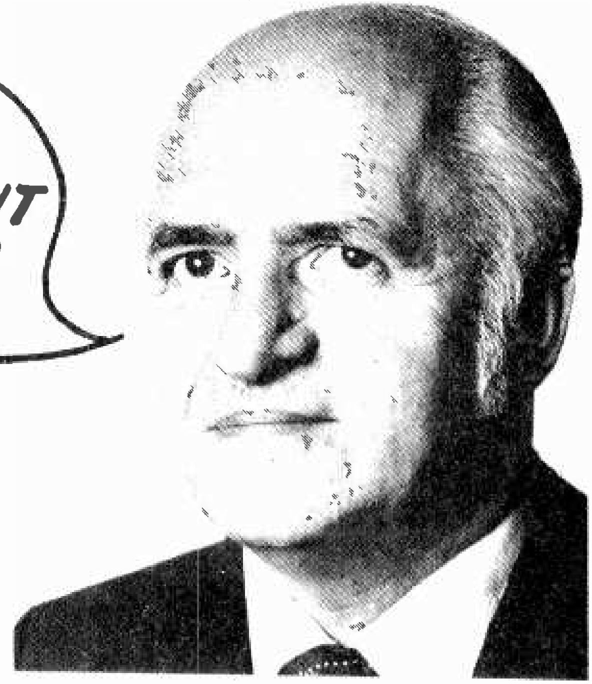

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NEWS . . . AND .

RESULTS OF BI-PAK COMPETITION

WINNERS

1st Prize: 22 in. Colour Television, Mr. and Mrs. Munt of Tooting, London.

2nd Prize: Legionaire Stereo Amplifier, Deck and E.M.I. Speakers, Mr. William J. B. Atrill, of Barking, Essex.

3rd Prize: Black and White Portable T.V., Mr. I. A. Barton, of Loose, Maidstone, Kent.

4th Prize: Electronic Calculator, Mr. R. Attwood, Dept., Electrical Engineering, Imperial College, London.

49 consolation prizes of Electronic Slide Rules were also awarded.

Bi-Pak Semiconductors wish to thank all participants.

We congratulate all the various winners in the competition which was open to readers of our December issue. If you were unlucky this time, perhaps it will be your turn next year! Watch for the date.

Photo shows Mr. Munt accepting the 1st Prize from Mr. Roger Powell of Bi-Pak Semiconductors.

A full list of winners is available on request from: Bi-Pak Semiconductors, P.O. Box 6, Ware, Herts.

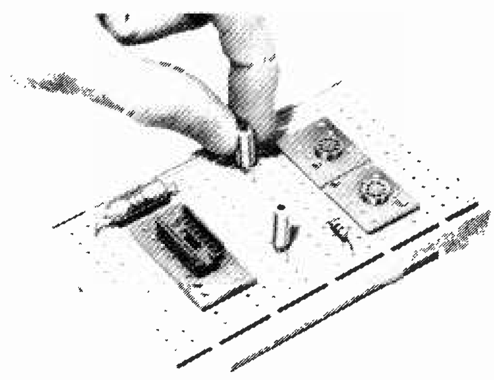
PB SUPER SOLDER BOARDS

PB Electronics of 57 High Street, Saffron Walden, Essex, claim great savings in costs by using their PB breadboards and Super Solder boards, instead of conventional prototype circuit boards where once a component is soldered in it is difficult to remove it without damaging the component and wasting the board.

The PB approach makes the experimenting and construction of electronic circuits simpler and cheaper. Simply insert the components directly into the breadboard, no soldering required, made a mistake simply unplug the components and insert again. Build a medium wave radio — fine. Unplug the components and build a light flasher, not flashing fast enough, unplug the capacitor and try a lower value — a small stock of components can be used over and over again.

Every month the popular electronics and radio construction journalists publish exciting and interesting circuits to build. The hobbiest can build these circuits, experiment with them, learn, without touching a soldering iron and use the components again. When that "SPECIAL" circuit comes along that the hobbiest wants to keep, hė simply takes his PB SUPER SOLDER BOARD, transfers the components from his already working circuit on the breadboard to the same holes on the S.S.B., turns the board over and solders the components into place. All that is left now to do is house the board in a suitable case — PB Electronics also market a range of plastic cases.

Super Solder Boards coupled with the S, T and U-Dec breadboards offer the home constructor a new dimension in constructing a tremendous range of circuits. These go from a simple single transistor circuit to a system using 72 integrated circuits.



. . . COMMENT

MARCONI INTERNATIONAL FELLOWSHIP

By the time these notes appear in print HRH The Duke of Edinburgh, the Society's President, will have presented the 1975 $25,000 Marconi International Fellowship to Dr. Hiroshi Inose, Professor of Engineering at the University of Tokyo.

Dr. Inose, who was born in Tokyo in 1927, is a leading authority on the application of electronic computers. He has led the research and development of Time Division Switching systems which are at the heart of an evolving integrated digital computer communication system.

The Marconi International Fellowship was established in 1974 on the 100th Anniversary of the birth of Guglielmo Marconi by 22 international communication and electronic corporations.

OSCILLOSCOPES

Among the articles on test equipment which we publish, we always find that anything concerning oscilloscopes is popular. For example the article "New Transistorised Oscilloscope", which appeared in our September, October and November 1975 issues did, as we anticipated, arouse great interest.

Next month we are featuring an oscilloscope beam splitter — "4-Way Beam Splitter" — which will convert many single beam instruments for multiple trace display without the necessity for internal modification. It will be very suitable for use with the "New Transistorised Oscilloscope" as well as with many commercial oscilloscopes.

TV JUBILEE — BAIRD'S 1ST SUCCESS

Fifty years ago a packed audience at the Royal Institution in London witnessed the first major public demonstration of television. A BBC World Service item recalled the occasion and the man who inspired it — the Scottish inventor John Logie Baird.

The story of attempts to send pictures over a distance stretches back well over a hundred years. Motionless pictures were transmitted as early as the 1850s, and the principle of breaking a picture down into its elements, or scanning it, was well known in the last century.

But although many scientists and engineers laid down the principles by which a moving picture might be transmitted, it was left to a largely self-taught Scottish inventor, John Logie Baird, to put principles into practice during the 1920s.

It was Baird's stubborn refusal to face scientific facts that led eventually to his first success. Relatively simple calculations proved conclusively that it would be almost impossible to transmit a clear, high-definition picture using the materials and methods of the time.

The early thirties saw a neck and neck race between Baird and his associates on the one hand, trying desperately to raise the standard of their mechanically produced pictures, and the Marconi-EMI company, which was developing an entirely new, all-electronic system.

On 2nd November, 1936, the new service started from the Alexandra Palace in North London, using two systems — Baird's and the EMI system — in alternate weeks. The result of the trial was almost a foregone conclusion.

Despite the valiant efforts of Baird and his team, his 240 line mechanical system did not stand comparison with the 405 line electronic system. Four months later this became the standard for British television, a standard which is only now being gradually phased out in favour of the newer 625 line standard.

INTERCOM MEETS BS415 SAFETY STANDARDS

Eagle International have introduced a new model, the WI 3 wireless intercom, it is an improved version of the WI 2 and transmits on mains circuit. No cable or batteries needed, simply plug into the nearest AC power point.

It is claimed that the WI 3 is the first intercom to comply with BS 415 safety standards and will transmit up to half a mile with both units on the same phase. It has talk, lock and volume controls, plus pilot light. The intercom incorporates a built-in noise suppression "squelch" circuit and buzzer call. Recommended retail price is £26.30.

Testing, Testing, Three . . . Two . . . One . . . !

NICKEL CADMIUM

Rechargeable nickel cadmium cells are becoming increasingly popular in these days of rising battery costs. Because of their low internal resistance they should preferably be charged by constant current sources, and this article describes a unit which is capable of charging up to four 'AA' size nickel cadmium cells. These are similar to standard HP7 dry cells.

Using ordinary dry cells and batteries for supplying electronic and electrical equipment can be an expensive business in the long term. Nickel cadmium (NiCad) rechargeable cells are nowadays proving to be a popular alternative to dry cells and they are frequently used to power such pieces of equipment as electronic flashguns, calculators and portable tape recorders.

Apart from the rechargeable aspect, nickel cadmium cells have a very low internal resistance which can often be an advantage. For instance, the recycling time of a flashgun can be reduced by about half to one-third of the recycling time obtained with ordinary cells.

The principal disadvantages of nickel cadmium cells are a high initial price and the cost of a suitable charger. Nevertheless, they are still in many instances cheaper to use in the long run than ordinary dry cells, this being especially true if the charger is home-constructed at low cost.

Nickel cadmium cells are manufactured in the same sizes as standard dry cells, and a particularly useful type is the Ever Ready NCC50, which is the rechargeable version of the HP7 cell. The nickel cadmium version of the HP7 cell is also referred to as size 'AA'. The charger described in this article is specifically intended for NCC50 cells or equivalents, and it may charge any quantity up to four of these in series. The charger can also be used to charge smaller cells if the value of one resistor is suitably altered.

AA-NCC50 CELLS

Ever Ready NCC50 cells are hermetically sealed and require no maintenance. They have nickel plated steel cases, which provide the negative terminal, and resealable safety vents incorporated in the top cover forming the positive terminal. The vents help to prevent cell damage under conditions of abuse. Normally the cells will remain completely sealed throughout their life and no gas or electrolyte will escape.

It is recommended that NCC50 cells be charged at a constant current between 25 and 65mA until they have received a charge of 0.75 ampere-hour. If they are charged at about 50mA, as occurs with the charger to be described, the charge time for a fully discharged cell works out at 15 hours. When charged, the cell has a capacity of 0.5 ampere-hours at the 5 hour rate.

The nominal voltage of the Ever Ready NCC50 cell is 1.25 volts, this falling to 1 volt when the cell is completely discharged. The voltage rises to 1.4 to 1.5 volts when fully charged.

Nickel cadmium cells should not, in general, be charged at high currents except under conditions stipulated by the manufacturer. Because of their low internal resistance some form of current limiting in the charger is essential. A constant current limiting circuit is preferred as this provides a fixed charge current regardless of cell voltage.

Great care must be taken not to forget the cells once they have been connected to the charger. It must be remembered that the charger will still pass current through the cells even if they are fully charged. A small amount of overcharge, say for several hours, is permissible but is best avoided, if possible.

The figures just quoted refer to Ever Ready size 'AA' cells. Figures given by other manufacturers may vary a little from these.

THE CIRCUIT

The complete circuit diagram of the charger appears in Fig. 1, and it will be apparent from this how simple the unit is.

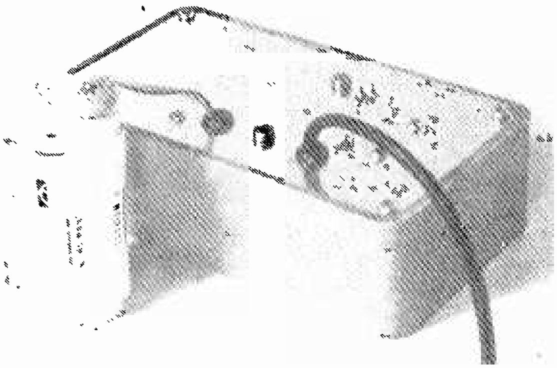
T1 is a mains transformer with a centre-tapped secondary and this feeds a full-wave rectifier and smoothing circuit incorporating D1, D2 and C1. R1, D3, D4 and D5 form a voltage reference source. The diodes are all silicon types and are forward biased by the current flowing via R1. About 0.65 volt is developed across each diode, and as a result (assum-

CELL CHARGER

By A. P. Roberts

ing that TR1 collector is suitably loaded) the base of TR1 is held about 1.95 volts positive of the negative supply rail. About 0.65 volt is also dropped across the base-emitter junction of TR1, and therefore a stabilized voltage of about 1.3 volts appears across the 27 Ω emitter resistor, R2.

From Ohm's Law we can calculate that a current of about 48mA will flow through R2 in the emitter circuit of TR1. As the collector and emitter currents of a reasonably high gain transistor, such as the 2N3404 used here, are very nearly identical, almost the same current will flow between TR1 collector and the positive supply rail when a suitable low impedance path is inserted here.



The charger in use. Cells being charged are fitted to a battery holder

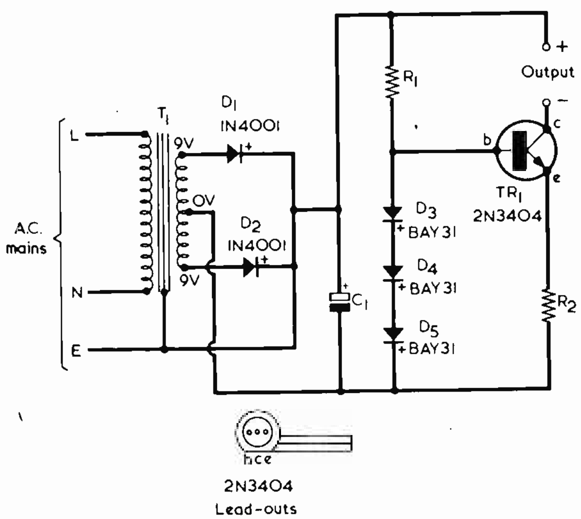


Fig. 1. The circuit of the nickel cadmium cell charger. This produces a constant current of approximately 48mA

COMPONENTS

Resistors
- R1 5.6k Ω, ¼ watt 10%
- R2 27 Ω, ¼ watt 5%

Capacitor
- C1 400μF electrolytic, 16 V Wkg.

Transformer
- T1 Miniature mains transformer, secondary 9-0-9V at 100mA

Semiconductors
- TR1 2N3404
- D1 1N4001
- D2 1N4001
- D3 BAY31
- D4 BAY31
- D5 BAY31

Miscellaneous
- Veroboard, 0.15in. matrix, 15 holes x 10 strips
- Case (see text)
- Battery holder (see text)
- Battery connector, PP3 type
- 2-way tagstrip
- Mains lead
- 2 grommets
- Nuts, bolts, etc.

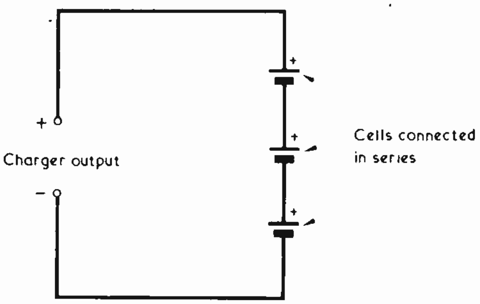


Fig. 2. Cells are connected to the charger in series and with correct polarity. Here, three cells are so connected

A nickel cadmium cell (or cells) provides a suitable current path, and the collector potential of TR1 will always adjust to provide a charge current of about 48mA, regardless of the level of charge in the cell, or whether there is one, two, three or four of them. T1 secondary does not provide sufficient voltage to allow more than four cells to be charged at any one time.

Note that when more than one cell is being charged at a time, the cells are connected in series with the positive of one cell connecting to the negative of the next, as in Fig. 2. The cells must not be connected to the charger wrong way round.

Due to component tolerances the exact charge current will vary slightly in individual chargers made up to the circuit of Fig. 1, but this should always be within a few milliamps of 48mA. The short-circuit current of the prototype was measured and found to be a fraction over 50mA.

CONSTRUCTION

The charger can be fitted in any small metal or plastic box large enough to take all the parts comfortably and which has a lid which is secured in place by screws. The prototype was housed in a ready-made plastic and aluminium box with internal dimensions of about 120 by 65 by 40mm. (4¾ by 2½ by 1½in.) and there are many suitable inexpensive cases of around these dimensions available. To avoid possible mistakes, it is advisable to obtain the mains transformer first, or at least establish its dimensions, before purchasing the case. Some transformers may be a little larger in size than that used in the prototype. The basic layout of the unit can be seen in Fig. 3 and the photographs. However, the layout is in no way critical provided that care is taken to ensure that all mains connections are inaccessible when the lid of the case is in position.

The small components are wired up on a piece of Veroboard of 0.15in. matrix, this having 15 holes by 10 copper strips. Full details of this and the other wiring are given in Fig. 3.

Start by cutting out the Veroboard panel with a hacksaw, and then drill out the two 6BA clearance mounting holes. Next make the seven breaks in the copper strips at the points indicated, using a Vero spot face cutter or a small twist drill held in the hand. The components are then soldered to the panel. TR1 is soldered to the panel such that its body and integral heatsink clip is a little above the body of C1.

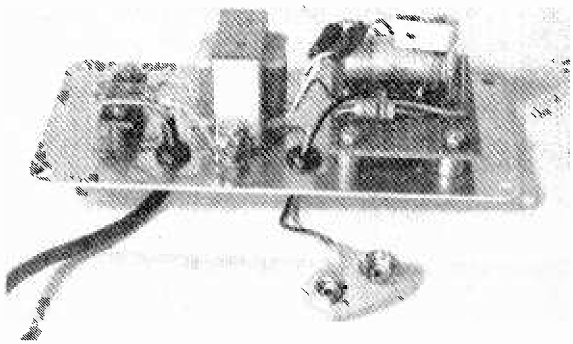
The mounting holes in the case for the various parts can next be drilled. The holes may be marked out with the aid of the parts themselves. Also required are two holes to take grommets for the mains input lead and the charger output lead. A solder tag is secured under one of the mounting nuts for T1 and the earth wire of the mains lead connects to this. This earth connection is made to the transformer frame with either plastic or metal boxes; in the latter instance the connection earths the metal box also. The mains lead should be secured to the case on the inside. Most miniature mains transformers have flying leads rather than tags. A 2-way tagstrip or 2-way connector block is then required for connecting the transformer primary leads to the live and neutral wires of the mains lead. If the transformer secondary leads are too short to reach the Veroboard connection points, extension lengths of thin flexible wire may be soldered to them as required, the joints being covered by sleeving.

The Veroboard panel is spaced away from the inside case surface by 6mm. spacing washers passed over its two 6BA mounting screws. If the case is metal and there is any risk of connections on the underside of the Veroboard panel touching its inside surface, the case area under the board should be covered with plastic insulating tape.

CELL CONNECTIONS

The most convenient means of making connection to the cells being charged is to fit these into a plastic battery holder designed to take HP7 cells. Battery holders are available for either two or four cells and are fitted with connectors similar to those encountered on a PP3 battery. In consequence, the two output leads of the charger are terminated in a PP3

Layout is not critical. In the prototype the components are mounted on the metal lid of a metal and plastic case



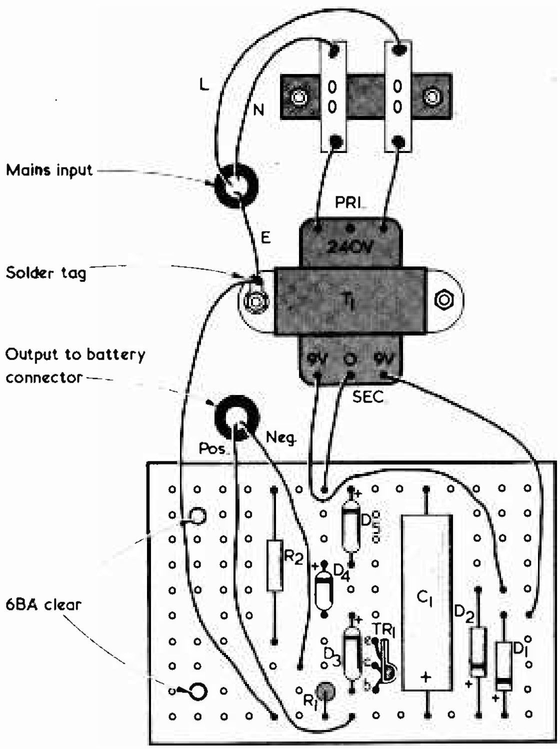
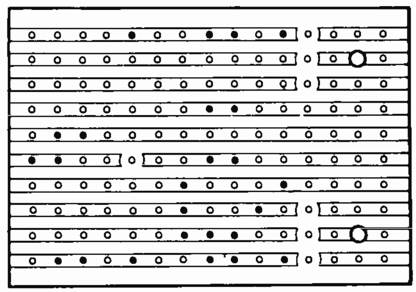


Fig. 3. Illustrating the layout of the components on the Veroboard panel together with general wiring details



battery clip, which is then plugged into the battery holder connectors.

If only one cell is to be charged a holder for two cells may be employed with one cell position short-circuited. Similarly, three cells can be accommodated in a holder for four cells, again with one position short-circuited. It is a simple matter to fit a lead across the battery holder position not occupied by a cell.

After the wiring has been completed and carefully checked the unit may be tested for constant current operation. Connect a testmeter switched to read 0-100mA (or to any other range which enables currents of around 48mA to be indicated) to the output of the charger via a series resistor of 68 Ω, as in Fig. 4. Apply the mains supply to the charger. The meter should give a reading of approximately 48mA. Temporarily short-circuit the 68 Ω resistor and, if there is no sudden increase in meter reading, short-circuit it again to enable a second current reading to be observed. This should be the same as the previous reading, or just slightly greater.

The unit is then ready for use. No on-off switch is provided and the charger is brought into operation simply by plugging it into a mains socket and switching on at the latter.

Cells should not be left connected to the unit when it is not charging. Leaving the cells connected will not damage them, but will cause them to slowly discharge into the charger circuitry.

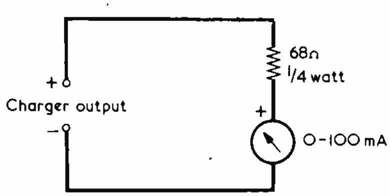
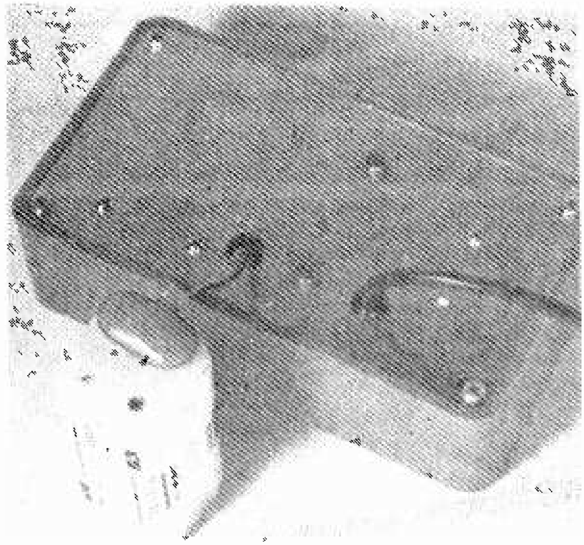


Fig. 4. Test circuit employed for checking the constant current operation of the charger

A further view of the components. Note the integral heatsink clip on the transistor



The completed charger takes up little space, and is simply plugged into the mains supply when it is required

OTHER CURRENTS

The unit may be modified to charge at constant currents lower than 50mA by increasing the value of R2. The new value is calculated by dividing 1,300 by the required charging current in milliamps. Thus, if a charging current of 25mA is to be provided, the calculated value for R2 is 52Ω. The nearest 5% preferred value of 51Ω will be satisfactory in practice. The nearest 5% preferred value may be employed in other instances where the calculated figure is not a preferred value.

The charger must not be modified to provide charging currents greater than 50mA.

COMPONENTS

Apart from the 2N3404 required for TR1, the components are readily obtainable. The 2N3404 is available from Bi-Pak. This transistor is not now in production and there is a small possibility that in time it may be difficult to obtain. Suitable alternatives which have been checked by the author are the 2N1711 and the 2N3053, both of which have the lead-out layout shown in Fig. 5. Unlike the 2N 3404, these do not have the advantage of an integral heatsink and, if used in the circuit, must be fitted with a T05 clip-on heatsink to prevent overheating.

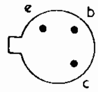


Fig. 5. As described in the text, alternative transistors may be employed. These have the lead-out layout shown here

(For the record, the 2N3404 employed in the unit is the device as manufactured by Brimar and General Electric. There is a Sescosem version of the 2N3404 which has the base and collector lead-outs transposed and which is listed in some references — Editor).

The three silicon diodes, D3, D4 and D5, are general purpose types, and BAY31's were employed in the author's unit. The OA200 or OA202 may alternatively be used. Miniature silicon rectifiers, such as those in the 1N4001 to 1N4007 series, are not suitable for D3, D4 and D5 as they have too low a forward threshold voltage.

So far as the nickel cadmium rechargeable cells themselves are concerned, a selection of those in the Ever Ready range including the NCC50 is available from Doram Electronics. ■

BOOK REVIEW

EXPERIMENTS WITH OPERATIONAL AMPLIFIERS. By G. B. Clayton. 140 pages, 235 x 145mm. (9¼ x 5¾in.) Published by The Macmillan Press, Ltd. Price £2.65 (limp) or £6.50 (hardcover).

The subtitle to this book is "Learning by Doing", a phrase which aptly sums up what the book sets out, successfully, to accomplish.

The first chapter introduces basic operational amplifier concepts and deals with op-amp followers, summing amplifiers, integrators and differentiators. It is followed by a chapter covering basic applications, including resistive feedback circuits, integrator action and drift, frequency to voltage conversion and the production of staircase waveforms. The next chapter discusses non-linear op-amp circuits, amongst which appear log circuits for multiplication, division, the generation of powers and the measurement of transistor current gain; whilst the fourth chapter gives details of signal processing, phase detection and transistor and capacitance measurements. The fifth chapter carries on to comparators, multivibrators and timing circuits; and the final chapter is devoted to op-amp signal generation. There is an appendix dealing with performance errors and the book ends with a detailed index.

All the experiments can be carried out with the 741 op-amp, which is both inexpensive and robust enough to withstand many wiring errors and accidents. The experiments are carefully described and illustrated, and the book forms an authoritative reference on operational amplifiers in addition to its primary function of presenting practical working circuits. The prices quoted at the head of this review are at Special Offer level, the published prices being £3.35 and £7.95 respectively.

SUGGESTED CIRCUIT 307

BURGLAR ALARM CIRCUITS

By G. A. French

It is an unhappy reflection on our current times that there is a continuing increase in interest on the subject of burglar alarms. Simple burglar alarms can be readily home-constructed, and this article describes a number of systems which can be employed to give warning of illegal entry. In all the systems to be described the momentary breaking of a guard circuit causes an electric bell to commence ringing. The bell then continues to ring even if the circuit which has been broken is completed again. The guard circuit is given by normally closed switches at doors and windows which are all connected in series. Opening a door or window causes the appropriate guard switch to break the circuit and the alarm to sound. The alarm will also be given if the wiring between the guard switches is cut.

CATEGORIES

Simple burglar alarms of this type fall into two categories of use. The first category is given by the case where the resident is inside the protected premises and requires warning that an entry is being carried out. Thus, warning is given if the occupant is asleep in bed or is, to quote a classic instance, watching television. Warning can also be given if an attempt is made to break into an outhouse or garage.

The second category of use applies to the instance where the occupant wishes to have the system protect the property when he leaves it unoccupied. If anyone attempts to enter the premises the bell again commences to ring and to keep ringing. This is liable to deter the would-be thief who is, naturally, unwilling to have attention drawn to his activities. In suburban areas, the continual ringing of an electric bell will also be noticed by neighbours, who can take appropriate action.

The systems described in this article are very good for protection in the first category of use but, for reasons which will become apparent when the systems are discussed, have some disadvantages for the second category. They can still, nevertheless, be of considerable help in this second category for forestalling the less experienced class of thief.

All the systems operate from batteries and are therefore independent of the mains supply. Also, all the systems switch on the warning bell by way of a relay rather than by means of a semiconductor device such as a thyristor or a power transistor. The author considers that a relay is to be preferred for home-constructed installations since it enables quick checks of the system to be carried out. The operation of a relay can be *seen*, whereupon it is a very simple matter to check a system after it has been installed. If the relay armature is seen to move to the required position when the guard circuit is broken then this is an obvious indication that the circuitry up to and including the relay coil is operating satisfactorily. Except for the first system to be described, the bell circuit can also be checked by lightly pressing down the relay armature so that it takes up the energised position.

The relay employed in all the circuits is the 'Miniature Open P.C. Relay' with 410 Ω coil which is retailed by Doram Electronics. This versatile relay is rated at coil operate voltages from 4.8 to 35 volts and its single set of changeover contacts can switch currents up to 5 amps at 30 volts d.c. Although intended for printed circuit board mounting, it may also be secured in position by two 8BA bolts passing through holes in its metal frame.

NON-ELECTRONIC SYSTEM

Fig. 1. illustrates a robust burglar alarm system which involves no electronics at all. Here, and in the subsequent circuit diagrams, the relay and its contacts are illustrated with 'detached' presentation: the relay coil is represented as a rectangle whilst its contacts, which can appear anywhere in the diagram, are drawn in the de-energised state.

In Fig. 1 two guard switches are shown, but in practice there can be any number of these, all connected in series and all normally closed. To turn on the alarm S2 is pressed, after which S1 is closed. The 6 volt supply is then applied to the coil of the relay via the guard switches, S2 and S1, with the result that the relay energises. S2 may then be released, whereupon the relay stays energised by way of its own make contact. A momentary current passes

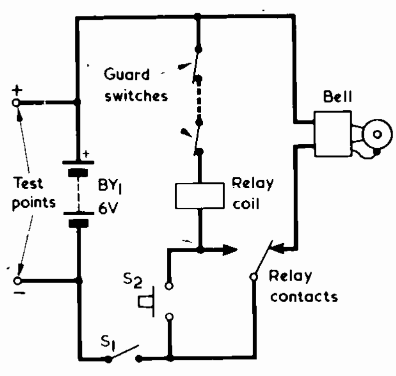


Fig. 1. A very simple but effective burglar alarm system which requires no electronic components

to the bell via the relay break contact at the instant of closing S1. If the bell is quick-acting the striker may move against its gong once, but this is doubtful as the relay specified energises very rapidly.

The alarm is now set up. Should any of the guard switches become open, if only for a very short period, the relay de-energises and its contacts connect the bell across the 6 volt supply, causing it to ring continuously. The relay cannot be energised again by way of the guard switches because the circuit to the negative terminal of the battery has been broken by the relay contacts. The bell can only be silenced by opening S1 or (if all the guard switches are closed again) by pressing S2.

This circuit is of particular value for the first category of use which was referred to earlier. The battery, S1, S2 and the relay are positioned in some part of the premises which would be difficult for an intruder to locate in a short period. With the second category of use there is the disadvantage that S1 and S2 have to be accessible from the outside of the premises as, obviously, the alarm cannot be switched on until the occupants have left and all doors are closed. The provision of a locked outdoor housing for S1 and S2 is feasible, and S1 could itself be a switch which is operated by a key. Switches of this nature are available from many of the larger component houses.

The simplicity of the circuit of Fig. 1 brings with it the shortcoming that a fairly large current, of around 15mA, is drawn from the 6 volt battery when the relay is energised. This current is too high for economic operation with a dry battery, but it would be quite acceptable if a 6 volt accumulator were used. A small 6 volt motor-cycle battery could power the circuit, and would take up little space. Two test points are provided and battery voltage can be checked, from time to time, with a testmeter. When the battery voltage falls to about 5.6 volts the battery may be given a charge to bring it up to a fully charged level of around 6.5 volts.

SINGLE TRANSISTOR CIRCUIT

A more complex circuit incorporating a single transistor appears in Fig. 2. This circuit is intended for operation from a 9 volt dry battery. A separate battery is now employed for the bell, and the relay contacts shown in the diagram connect to this battery and the bell in series. It is desirable to employ a separate battery because many electric bells, including in particular the more inexpensive types, draw high current pulses and produce high voltage transients when they are ringing, and it best to keep these away from the electronic section of the alarm. The separate battery has a voltage suitable for the particular bell employed.

The alarm is turned on by closing

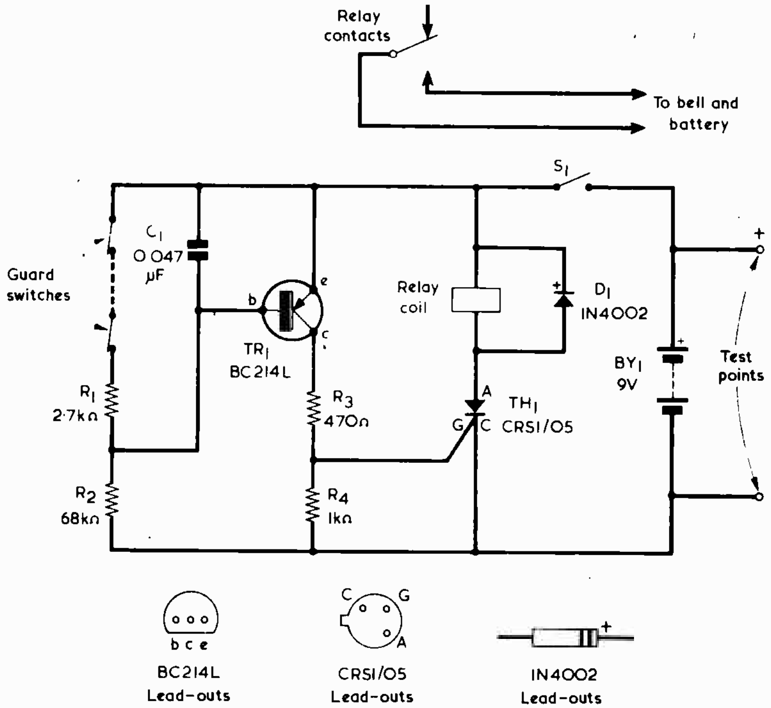


Fig. 2. A more complex alarm system which draws a much lower battery current

S1. If all the guard switches are closed, this causes the voltage at the junction of R1 and R2 to be about 0.35 volt negative of the upper supply rail. This voltage, applied to the base of silicon transistor TR1, is insufficient to turn the transistor on, and the transistor passes a negligibly low collector current in consequence. With the circuit in this condition the relay is de-energised and the bell does not ring.

If any guard switch is opened, R1 is disconnected from the upper supply rail. A current now flows via R2 directly into the base of TR1, thereby turning this transistor on. As a result, a collector current flows through R3 to the gate of thyristor TH1, triggering this device on and energising the relay. Once it has been triggered on TH1 remains conductive, keeping the relay energised even if the guard switch circuit is completed again. Thus, the bell rings continually and may only be silenced by switching off the complete circuit at S1..

R1 carries out two functions. First, it forms a filter in conjunction with C1 which prevents any noise, including mains hum and radio signals, which is picked up on the open-circuit guard wiring from reaching the base of TR1. Such noise could prevent TR1 from turning fully on when a guard switch is opened, and it could cause erratic circuit operation. Secondly, R1 offers some protection against leakage resistance across any of the guard switches. Without R1 in circuit, a leakage resistance of up to some 5k Ω across a guard switch could prevent the alarm from operating when the switch is opened. With R1 present, the leakage resistance needed to disable a guard switch falls to about 2k Ω or less with a battery voltage of 9 volts, and to about 2.3k Ω or less with a battery voltage at the lowest permissible level of 8 volts.

Of the other components, D1 is the usual reverse biased diode which is connected across the relay coil to prevent the appearance of high back-e.m.f. voltages when the relay de-energises. R4 is included merely to keep the gate of the thyristor at the same potential as its cathode when TR1 is turned off. (The author has encountered an instance in the past where a thyristor obtained on the home-constructor market triggered on unpredictably when its gate was open-circuit). The thyristor in the TH1 position is listed in some catalogues as CRS1/05AF and in others as CRS1/05. Both type numbers apply to the same component. All the resistors in the circuit may be ¼ watt 5% types, as may be all the resistors in the circuits which follow.

The fact that a guard switch may not set off the alarm if there is a leakage resistance of up to about 2.3k Ω across it means that care should be observed when a guard switch is mounted in a damp location. It will probably be best to use dry reed switches in such positions and to provide good insulation for the connections. In a normal house conditions should be sufficiently dry, however, to enable virtually any type of switch to be employed.

The current drawn from the 9 volt supply is quite low. With the prototype circuit it was only 0.12mA. The current rises to about 35mA when a guard switch opens and the relay energises.

DELAY CIRCUIT

The circuit of Fig. 2 functions well for the first protection category. With the second category of use, in which the premises are left unoccupied, it is necessary to position S1 externally, whereupon the same remarks apply as occurred with the circuit of Fig. 1.

The electronic nature of the circuit of Fig. 2 makes it possible to modify it for delayed operation. Here, the alarm may be switched on inside the premises, after which it does not become operative until a pre-set time period has elapsed. It is thus possible to turn on the alarm and leave the protected building during the delay period. The alarm will still sound when the occupier returns and regains admittance but, if the alarm on-off switch is positioned near the door at which entry is made, it can soon be switched off again.

The alarm circuit modified to include a switch-on delay is given in Fig. 3. Here, the circuit from the junction of R2 and R1 to the right is the same as in Fig. 2 except that S1 is now an s.p.d.t. switch. Instead of being returned to the lower negative rail, R2 is now returned to the emitter of emitter follower TR2. When S1 is switched on, the 9 volt supply is applied to C2 and R5 in series. C2 commences to charge slowly via R5, and its negative terminal (and hence the emitter of TR2) goes slowly negative. Opening a guard switch will not actuate the alarm until the potential on the emitter of TR2 is at a level where sufficient base current can flow in TR1 to trigger the thyristor. Once the emitter of TR2 has passed this level the circuit of Fig. 3 then functions in the same way as did that of Fig. 2.

The length of the delay period will vary according to the actual value, within tolerance, of C2, the gain of TR1 and the gate triggering current required by TH1. With the prototype the delay was 2¾ minutes. When the alarm circuit has been assembled, the delay period for the particular components employed can be measured in practice by switching on at S1 with one of the guard switches open. The delay period is equal to the time between switching on and the energising of the relay. The period may be reduced, if desired, by reducing the value of C2, and it can be increased by increasing the value of C2 or of R5. However, R5 should not be given a value higher than 1MΩ. The length of the period will be found to be approximately proportional to the values of C2 and R5. Thus, it will be doubled if either C2 or R5 is doubled in value.

Turning S1 to 'Off' short-circuits C2 via the current limiting resistor, R6. C2 is then discharged, ready for the next switch-on cycle.

TWO TRANSISTOR CIRCUIT

A circuit incorporating two transistors appears in Fig. 4. This is similar in operation to that of Fig. 2 except that an emitter follower, TR2, is now interposed between TR1 base and the junction of R1 and R2. Because of the added gain given by TR2, R1 and R2 can have much higher values, and the current drawn from the 9 volt supply when all the guard switches are closed is correspondingly lower. With the prototype circuit it was 12μA only. The current increases to approximately 35mA, as before, when a guard switch opens and the relay energises.

As with Fig. 2, R1 and C1 form a filter to prevent noise on the guard wiring being passed to the base of TR2. The presence of R1 causes a voltage of about 0.8 volt to be applied to the base of TR2 when the guard switches are closed. This is well below the 1.2 volts (the sum of the two 0.6 volt forward voltages acrose the base-emitter junctions of TR2 and TR1) which is required to turn on the transistors. The insulation requirements at the guard switches now become more stringent, as a guard switch will become disabled with battery voltage at 8 volts if there is a leakage resistance of some 60k Ω or less across it. In consequence, the circuit of Fig. 4 may only be used when all the guard switches can be positioned at dry locations.

For the category where the premises are left unoccupied, S1 may again be positioned at some external point. Alternatively, the version with delayed turn-on shown in Fig. 5 can be employed. Here, C2 charges up after switch-on in the same manner as occurred in Fig. 3. Since R2 now has a much higher value, the negative terminal of C2 can connect directly to this resistor instead of via an emitter follower. The length of the delay period is again dependent on the ac-

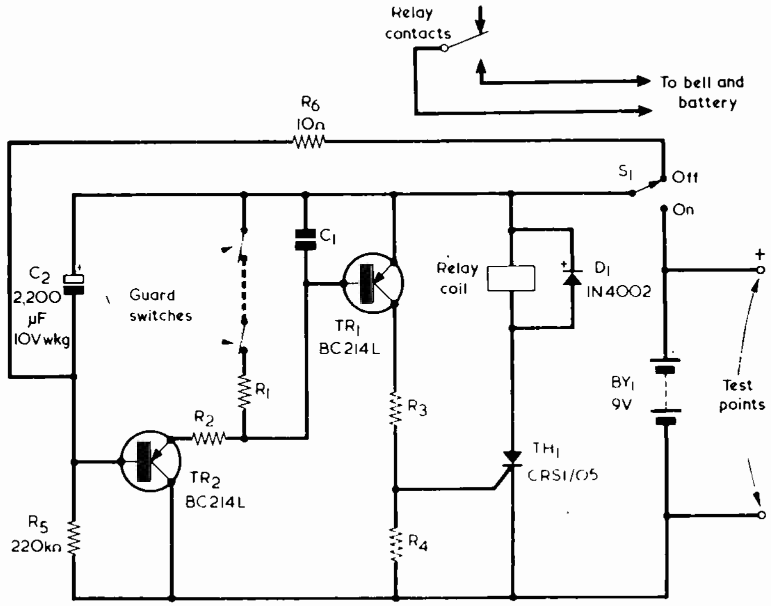


Fig. 3. Here, the single transistor circuit is modified to incorporate a switch-on delay

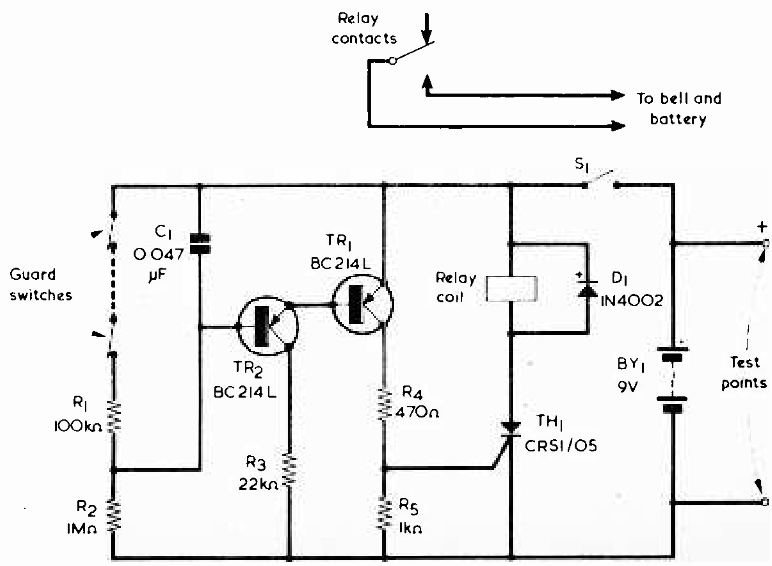


Fig. 4. A system having two transistors. This draws an exceptionally low current from the battery

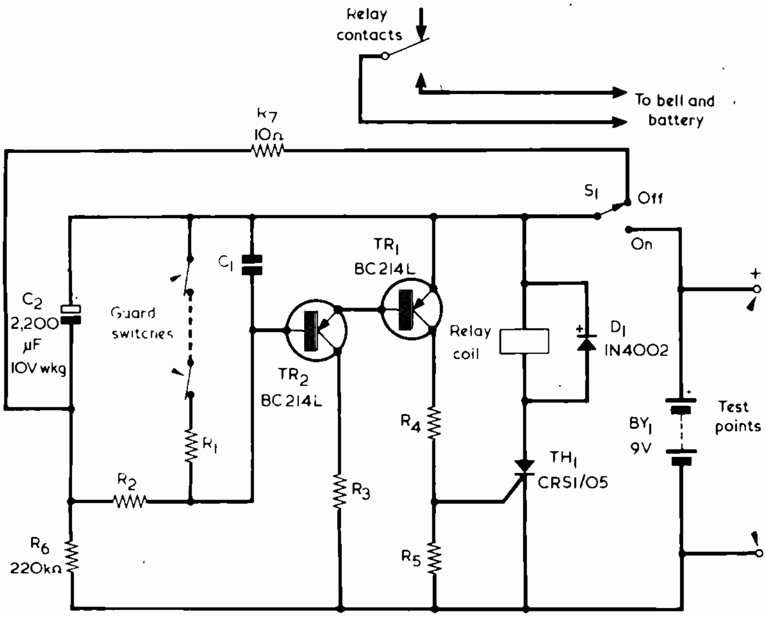


Fig. 5. The circuit of Fig. 4 with switch-on delay components added

tual value of C2, transistor gain and triggering current in TH1, and with the prototype circuit it was a little less than 2 minutes. The delay period may be increased or decreased by changing the value of C2 but not, with this circuit, that of R6. The current drawn from the battery with C2 charged and the guard switches closed, is the same as for Fig. 4 plus leakage current in C2. The latter will typically be about 20 to 30uA.

BATTERY VOLTAGE

All the circuits of Figs. 2 to 5 have test points to enable battery voltage to be checked from time to time. The battery should be discarded when its voltage has fallen to 8 volts.

If desired, the test points may be dispensed with and a voltmeter permanently installed. A suitable circuit is shown in Fig. 6, where a voltage indication is given by pressing the button. The voltmeter is deliberately intended to draw a relatively high current of around 8 to 9mA when a voltage reading is being taken, as this will give a more realistic indication of battery condition than would a high resistance voltmeter drawing a low current. The pre-set potentiometer is a small skeleton component. To set up the circuit a standard voltmeter is initially connected across the battery. The push button is then pressed and the pre-set potentiometer adjusted for a reading in the 0-10mA meter which matches that in the voltmeter. If, for example, the voltmeter indicates 9.1 volts, the potentiometer is adjusted for a reading of 9.1mA in the 0-10mA meter.

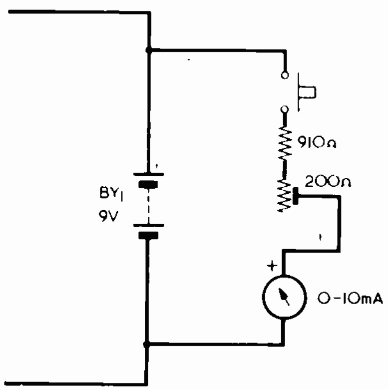


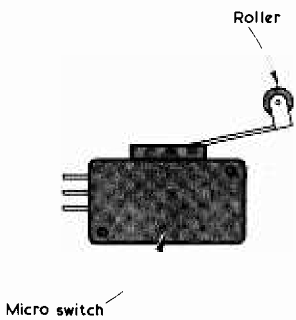
Fig. 6. If desired, a voltmeter to indicate battery condition can be permanently installed

GUARD SWITCHES

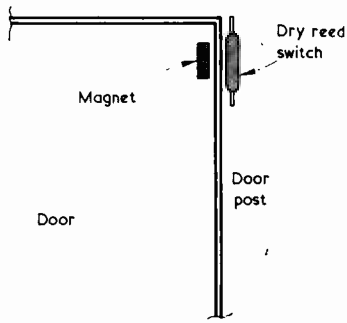
The guard switches can be home-made using pieces of springy metal, but a much better approach consists of employing microswitches or dry reed switches. Particularly suitable are microswitches having an operating lever and roller, as in Fig. 7(a), and it is a simple matter to devise means of actuating such switches by doors and windows. The type of microswitch to obtain is that with changeover, or s.p.d.t. contacts, as there is then a choice of using it with the lever free or depressed when the door or window at which it is fitted is closed. Connection is made to the two contacts of the microswitch which are closed under these conditions. It does not matter, of course, if a microswitch is clearly visible to an intruder *after* a door or window has been opened, since it will by then have carried out its function of setting off the alarm.

A dry reed switch may be mounted at a doorpost edge with a permanent magnet alongside it mounted on the door itself, as in Fig. 7(b). When the door is closed the magnet will keep the two contacts of the switch closed. The contacts will open if the door is opened and the magnet taken away from the switch. A similar arrangement is possible with wooden sash window-frames. A range of dry reed switches and matching permanent magnets is available from Home Radio.

As a final point, it is preferable for the guard switch circuit to employ a single wire routed around the premises in the form of a loop. The wiring to any switch cannot then be as readily short-circuited, and the switch put out of action, as would occur if a twin wire went to the switch. ■



(a)



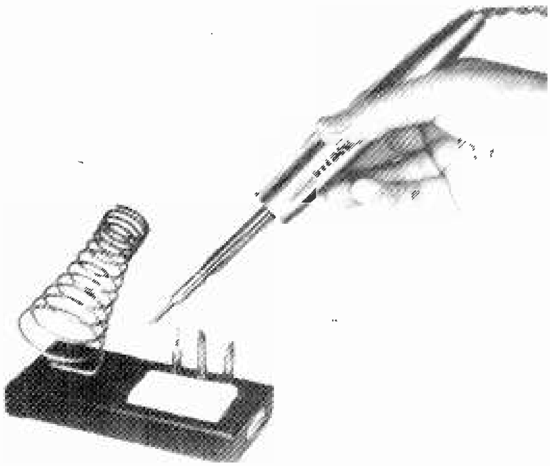
(b)

Fig. 7(a). A microswitch with operating lever and roller is particularly effective for use as a guard switch

Fig. 7(b). A dry reed switch and magnet mounted at a door. The contacts of the switch open when the door is opened

New Products

SOLDERING IRON WITH A THOUSAND USES



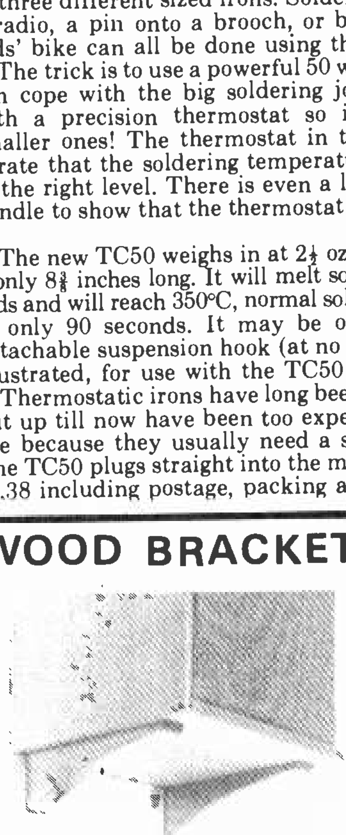
A new type of soldering iron called the Litesold TC50 will do most of the soldering jobs needed around the house which would previously have required two or three different sized irons. Soldering a transistor in a radio, a pin onto a brooch, or brake cable on the kids' bike can all be done using the TC50.

The trick is to use a powerful 50 watt element which can cope with the big soldering jobs, but control it with a precision thermostat so it doesn't fry the smaller ones! The thermostat in the TC50 is so accurate that the soldering temperature is held exactly at the right level. There is even a lamp built into the handle to show that the thermostat is working properly.

The new TC50 weighs in at $2\frac{1}{4}$ ozs. without flex and is only $8\frac{3}{8}$ inches long. It will melt solder in only 40 seconds and will reach 350°C, normal soldering temperature in only 90 seconds. It may be ordered fitted with detachable suspension hook (at no extra charge) or as illustrated, for use with the TC50 Spring Stand.

Thermostatic irons have long been used by industry but up till now have been too expensive for domestic use because they usually need a special power unit. The TC50 plugs straight into the mains and costs only £8.38 including postage, packing and vat direct from Light Soldering Developments, 97-99 Gloucester Road, Croydon, Surrey. Price of the TC50 stand is £2.45, including VAT, post free if ordered with the iron.

WOOD BRACKETS FOR HI-FI SPEAKERS



Why do Astute Hardwood Brackets look so good under this speaker? Because they're elegantly shaped, have invisible fixing and are finished to match.

Astute Hardwood Brackets are much easier to fit than traditional brackets, and are easy to remove when re-decorating. Rubber pads are incorporated to hold the speaker, so that no screws need to be driven into its case.

Astute Hardwood Brackets are supplied sanded ready to finish, complete with screws and plugs. Recommended retail prices:— 14cm — £1.85: 19cm — £2.30: 26cm — £2.90.

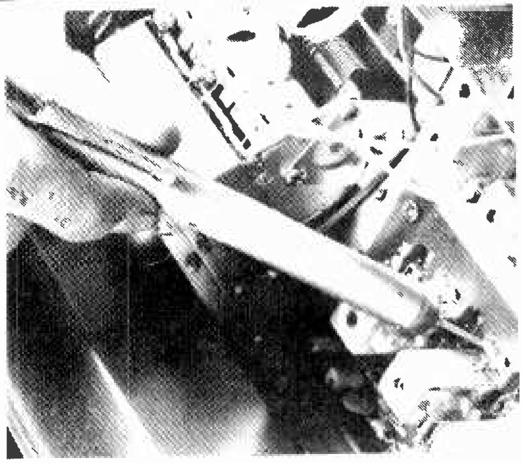
Further details from: —Esta Heating Products Ltd., Green Lane, Walsall, Staffs.

NOVEL DIAGNOSTIC AID FOR RADIO AND TV

The PANTEC "USIJET" is a small and light universal signal injector made in the form of a pen for clipping into the pocket. The circuit consists of two signal generators, one operating at audio frequency and the other at radio frequency. The impulsive waveform derived from a blocking oscillator-type circuit produces a signal with a wide range of harmonic frequencies up to 500 MHz.

By injecting the signal at various points in an amplifier circuit, the USIJET is an effective dynamic analyser for tracing breaks and component failure. The fundamental frequencies are 1 kHz and 500 kHz with an output voltage of 20V peak-to-peak. Maximum permissible voltage at the probe tip is 500V D.C. Powered by a self-contained 1.5V cell, the current consumption is about 25 mA.

Further information from: Carlo Gauazzi (UK) Ltd., North Crawley Road, Newport Pagnell, Bucks.



LOW-VALUE OHMMETER

By M. G. Robertson

Capable of reading resistance values down to 0.1Ω, this very simple instrument requires few components and offers a high level of accuracy.

The resistance ranges of the more inexpensive types of testmeter are notoriously inaccurate, particularly at the smaller resistance figures, and this fact can raise difficulties when work is being carried out with low value resistors. The main reason for the testmeter inaccuracy is that the set-zero control in such instruments normally consists of a variable resistor in series with the internal battery, the variable resistor being set up to compensate for falling voltage in the battery as it ages. In consequence, scale readings only approach accuracy at a particular battery voltage.

A much higher accuracy is obtained with the instrument to be described, which is capable of measuring resistance between 100Ω and 0.1Ω. The only expensive item required is a 0-10mA meter movement and, as is explained at the end of the article, a 0-1mA meter or a 0-100μA meter can alternatively be employed should one of these happen to be on hand. The circuit is so simple that it can be assembled in "lash-up" form in less than an hour, and it could be so wired up to measure the resistances of a batch of low value resistors and then disassembled again.

SHUNT RESISTANCE READING

The ohmmeter takes advantage of what is generally referred to as the "shunt resistance" method of measurement. This is encountered in some testmeters, and the basic circuit employed is illustrated in Fig. 1. A battery inside the testmeter couples via a fixed current limiting resistor and a preset variable resistor to the meter movement. The variable resistor is adjusted for a full-scale deflection reading in the meter with the test terminals open-circuit. If a resistor is connected across the test terminals less current is available for the meter and its needle gives a reading which is lower than f.s.d.; the smaller the value of test resistance the lower the meter reading. An advantage of the circuit is that indications are given for quite low test resistances. Also, the current which flows through the test resistance can be kept relatively small. A disadvantage with the circuit in its Fig. 1 form is that the current flowing from the battery cannot be maintained constant at different meter readings unless the battery is given an inconveniently high voltage.

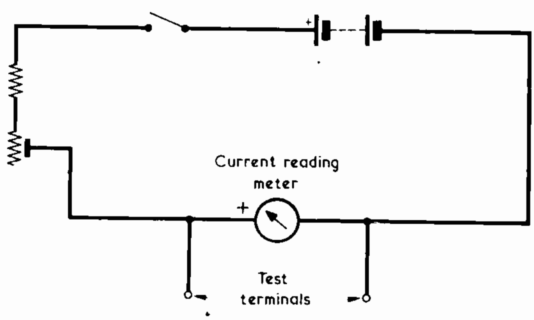


Fig. 1. A basic shunt ohmmeter, as employed in some testmeters

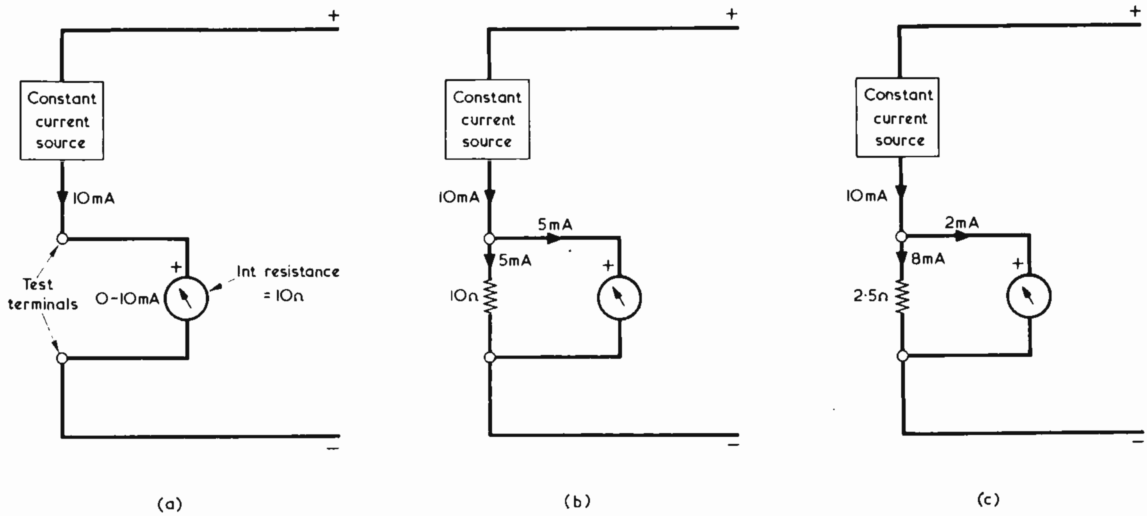


Fig. 2(a). With the circuit conditions shown here the meter gives a reading of full-scale deflection
(b). A test resistance of 10Ω causes the meter to read 5mA
(c). When the test resistance is 2.5Ω the meter passes a current of 2mA

The situation improves considerably if the extra complication of a constant current source for the meter can be accepted. In Fig. 2(a) we have a 0-10mA meter movement which is coupled to a constant current source providing a current of precisely 10mA. Furthermore, the meter has an internal resistance of exactly 10Ω. This is easily achieved in practice if we employ a meter movement having a coil resistance lower than 10☆ and insert in series with it a pre-set variable resistor which is adjusted to bring the overall resistance to that value.

In Fig. 2(b) we connect a resistance of 10Ω across the test terminals. Of the constant current of 10mA, 5mA now flows through the meter and 5mA flows through the test resistance. In consequence, a test resistance of 10Ω is indicated by a reading of 5mA in the meter. In Fig 2(c) a resistance of 2.5Ω is connected across the test terminals. Since this resistance is one-quarter the value of the meter resistance and since the same voltage appears across the two, the current passing through the test resistance must be four times the current passing through the meter. The total current available is 10mA, and so 8mA flows in the test resistance and 2mA in the meter. Thus, the presence of a test resistance of 2.5Ω is indicated by a reading of 2mA in the meter.

It is obvious that other values of resistance will produce corresponding current readings in the meter. The author has calculated the meter indications for test resistances from 0.1Ω to 100Ω, and these are listed in the table. Also, a chart showing resistance values and corresponding meter readings is given in Fig. 3. Either the table or the chart may be employed in finding resistance values with a set-up of the type shown in Fig. 2(a).

TABLE

Meter Reading (mA)	Test Resistance (Ω)
0.099	0.1
0.20	0.2
0.29	0.3
0.38	0.4
0.48	0.5
0.57	0.6
0.65	0.7
0.74	0.8
0.83	0.9
0.91	1.0
1.7	2.0
2.0	2.5
2.3	3.0
2.9	4.0
3.3	5.0
3.8	6.0
4.1	7.0
4.4	8.0
4.7	9.0
5.0	10
6.7	20
7.5	30
8.0	40
8.3	50
8.6	60
8.8	70
8.9	80
9.0	90
9.1	100

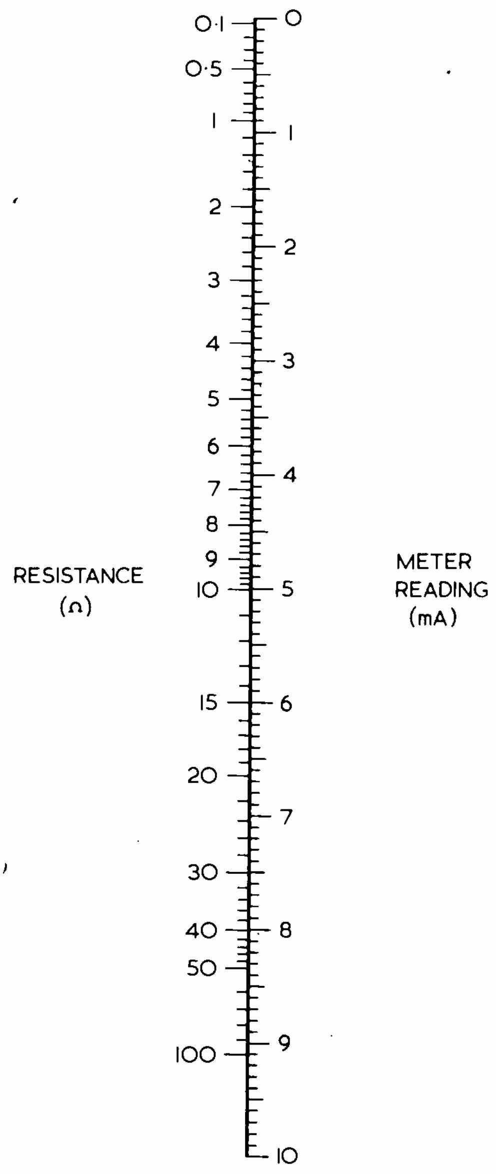


Fig. 3. Chart indicating test resistance value against meter reading

PRACTICAL CIRCUIT

The practical circuit for the low-value ohmmeter is given in Fig. 4. This employs quite simple basic principles.

The constant current source is given by TR1, R1, R2, R4, D1 and D2. Constant current sources have been described in recent articles in this journal and so there should be no need to give a detailed description of circuit operation here. Approximately 1mA flows through R4 and the two silicon diodes, causing a stabilized voltage of about 1.2 volts with reference to the negative rail to appear at the junction of D2 and R4. This is applied to the base of silicon transistor TR1. There is a voltage drop of about 0.6 volt across the base-emitter junction of TR1, whereupon R1 and R2 require a total value which causes an emitter current of 10mA to flow at the remaining 0.6 volt. The required resistance value is of the order of 60Ω. If, however, a single pre-set variable resistor of say 100Ω were connected on its own between TR1 emitter and the negative rail it would be possible to accidentally adjust this so that an emitter current, and a consequent collector current, much higher than 10mA flowed, with the risk of damage to the meter and to the transistor. Inserting R1 in series with R2 ensures that the maximum emitter current which can flow is no greater than some 18mA whatever the setting of R2, and both the meter and the transistor will be capable of passing this current. Even so, it is always good practice in a circuit of this nature to start initial adjustments with the variable resistor inserting maximum resistance, and then to reduce this as required.

R2 may be a small skeleton pre-set potentiometer and it is given a value of 100Ω as this is the lowest

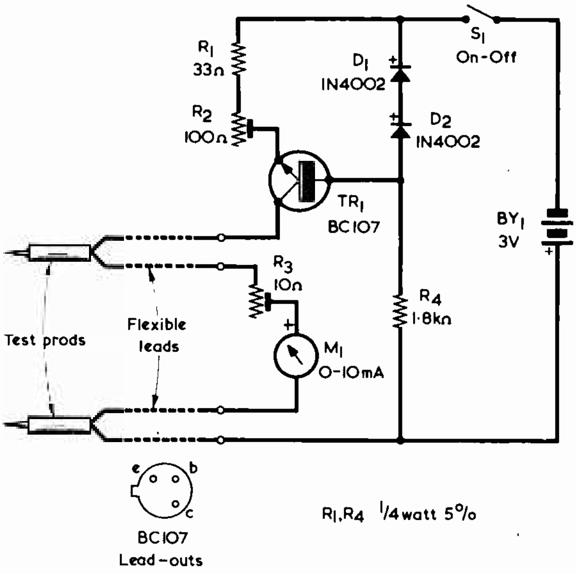


Fig. 4. The complete circuit of the low-value ohmmeter

The current drawn from the battery is about 11mA, this consisting of the 10mA constant current plus the current in R4 and the diodes. A supply potential of 3 volts is quite adequate.

value generally available in potentiometers of this nature. A value of 50Ω for R2 would offer better resolution in setting up and may be used if there are no objections to employing a larger component.

The value of 10Ω meter resistance indicated in Fig. 2(a) has been arbitrarily chosen because virtually all 0-10mA meter movements available on the home-constructor market have internal resistances lower than this figure. The total resistance can then be brought exactly to 10Ω with the aid of the 10Ω pre-set potentiometer, R3. Because of its low value, R3 will have to be a small wire-wound component.

The instrument is set up with the aid of a close-tolerance 10Ω test resistor. Initally, R2 is adjusted to insert maximum resistance into circuit and on-off switch S1 is closed. The resistance inserted by R2 is then reduced with the test prods open-circuit until the meter reads precisely 10mA. The 10Ω test resistor is then connected across the test prods, and R3 is adjusted until the meter reads exactly 5mA. The instrument is then set up and may be used for the measurement of resistance. Re-setting can be carried out from time to time if there is any drift in the variable resistor values.

It will be noted that the test prods are each connected to the remainder of the components via twin flexible wires. This method of connection enables current to flow through the test resistance with the meter and R3 connected across it in the manner of a voltmeter, and it ensures that the instrument wiring does not add to the test resistance. The test prod circuit enables connecting and flexible wires of normal thickness to be employed, and no heavy wiring is required. If any other method of connection is used it will be found that the meter needle does not return fully to zero when there is zero resistance across the prods. The metal parts of the prods should be of thick construction to ensure that they themselves insert negligible resistance.

OTHER METERS

If the current relationships shown in Figs. 2(b) and (c) are studied it may be seen that the same meter readings will be given at constant currents other than 10mA provided that the constant current causes the meter to indicate f.s.d. and that the meter resistance is exactly 10Ω. If, for instance, the constant current were 15mA and the meter read f.s.d. at this current the situation in Fig. 2(b) would result in 7.5 mA passing through the meter, whereupon the latter would once again give an indication of half f.s.d. With a test resistance of 2.5Ω, as in Fig. 2(c), four-fifths of the current, or 12mA, would flow in the test resistance and one-fifth, or 3mA, in the meter. Again, the meter gives an indication of one-fifth f.s.d., as it did when the constant current was 10mA.

The fact that readings are independent of the actual value of the constant current makes it possible to use a 0-10mA meter in the circuit even when this has a coil resistance in excess of 10Ω. The meter can be employed by connecting a shunt across it which brings its effective resistance to less than 10Ω, whereupon R3 can be once more adjusted for a total resistance of 10Ω. As an example, Fig. 5 shows the circuit adapted for a meter whose internal resistance is 15Ω. A 22Ω 5% ¼ watt resistor is connected across the meter to bring its effective resistance down to about 9Ω and the meter then gives an f.s.d. indication at a constant current of about 17mA. The instrument is set up in the same way as before; R2 is adjusted for an f.s.d. reading with the test prods open-circuit, after which R3 is adjusted for a half-scale reading with a close tolerance 10Ω resistor connected across the prods. Due to the higher constant current it would, in this instance, be desirable to reduce R1 to 22Ω.

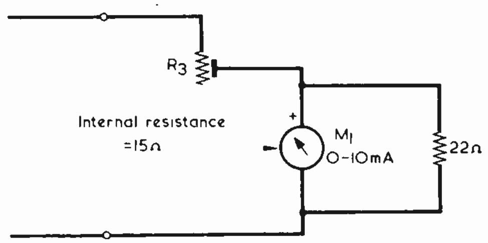


Fig. 5. A meter having an internal resistance greater than 10Ω may be employed if a shunt resistor of suitable value is connected across it

Most 0-1mA and 0-100μA meter movements can be similarly employed if provided with a suitable shunt. The value of the shunt need not be calculated as it is merely required that it brings the effective resistance of the meter to less than 10Ω, and in both cases it could be 8.2Ω 5% ¼ watt. A testmeter switched to one of these current ranges could not, incidentally, be employed instead of an individual meter, as its universal shunt current switching circuits would present too high an internal resistance at the testmeter terminals. ■

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT

Frequencies = kHz

Being an article intended mainly for broadcast band DX listeners, this feature tends to report on those transmissions to be heard in the 60 and 90 metre bands but there are stations in the higher frequency bands which are worthy of note; we list some of them here.

● **NORTH YEMEN**

Sanaa on **9780** at 1943 and also in parallel on **7190** with a programme of Arabic music and songs in the Domestic Service (also to be heard on **4853**).

● **TAIWAN**

Taipei on **7250** at 1322, OM and YL alternate in Chinese then into a programme of local music.

● **ALGERIA**

Algiers on **11910** at 1905, OM with a newscast of both local and world affairs in English (the programme in English is from 1900 to 2000).

● **UGANDA**

Kampala on **9730** at 2015, mixed U.K. and local pop records with announcements in a local dialect.

● **CLANDESTINE**

"Voice of the Free Yemeni South" on **9960** at 1932, YL with song in Arabic after a harangue by OM in the same language.

"Voice of the Thai People" on **9422.5** at 1618, sign-off after choral anthem and slogans.

● **NORTH VIETNAM**

Hanoi on **9840** at 1156, YL in Chinese and local music in the External Service to South East Asia; also on **7512** at 1410, YL in Laotian to Laos in the External Service.

CURRENT SCHEDULES

● **QATAR**

The Domestic Service from Doha may be heard on **9570** from sign-on at 0245 through to sign-off at 2100, all programmes being in Arabic.

● **JORDAN**

Two Domestic Services are radiated in Jordan from the capital Amman, the main programme being in Arabic as follows — from 0330 to 0730 on **11810** and **7155**; from 0730 to 0930 on **11810** only; from 0930 to 1400 on **9530** and **11810**; from 1400 to 1730 on **7155** and **11810**; from 1730 to 1900 on **11810** and from 1900 to 2310 on **11810** (on **7155** to 2200).

The English Service is from sign-on at 1000 to 1300 on **7155** and from 1500 to 1730 on **9560**.

● **VATICAN CITY**

"Vatican Radio" has an External Service in English directed to the U.K. from 1445 to 1500 on **6190, 7250, 9645** and on **11740**; from 2030 to 2045 on **6190, 7250** and on **9645**.

● **ISRAEL**

The Israel Broadcasting Authority, Jerusalem, operates an External Service in English to Europe from 0400 to 0415 on **5900, 7413, 9009** and **17685** (also on **5915** in the Arab World Service); from 1100 to 1130 on **11645, 15100, 15465, 15485** and on **17685** (also on **5915** in the Arab World Service); from 2000 to 2030 on **7413, 9009, 9815** or **9820, 11645, 15100** and on **15485**; from (experimentally) 2230 to 2300 on **7413, 9815** or **9820, 11645** and on **12025.**

● **TURKEY**

Radio Ankara — "The Voice of Turkey" has a programme in English directed to Europe, North Africa and North America from 2200 to 0030 on **11880.**

● **BURMA**

The "Burma Broadcasting Service", Rangoon, has a Domestic Service which is on the air from 0030 to 0230 on **7185**; from 0330 to 0730 on **9725**; from 0930 to 1600 on **5040**. Various local vernacular programmes are radiated from 1000 through to 1415 on **4725.**

● **IRAQ**

"Radio Baghdad" operates an External Service in English to Europe from 1930 to 2030 on **9758.**

● **UGANDA**

The Uganda Broadcasting Corporation, Kampala, presents programmes in English as follows — to East and Central Africa from 1430 to 1530 on **6030**; to South Africa from 1615 to 1730 on **6030**; to West Africa from 1800 to 1830 on **15325** and to North Africa from 2030 to 2100 on **9730.**

● **ETHIOPIA**

"Radio Ethiopia", Addis Ababa, offers a service in English from 1000 to 1030 and from 1500 to 1530 on **6185** and **9610.**

● **SOUTH YEMEN**

"Radio of the Peoples' Democratic Republic of

Yemen", Aden, radiates a Domestic Service from 0300 to 0805 on **5060, 5970** and **7190**; from 1100 to 1845 on **5060, 5970, 7190** (except 1700 to 1715) and on **11770**; from 1900 to 2200 on **5060, 5970, 7190** and on **11770.**

● CLANDESTINE

"Radio Iran Courier" is a pro-communist clandestine transmitter operating in Kurdish, Azerbaijani and Persian from 1430 to 1620 on **9560, 11415** and **11695** and from 1620 to 1810 on **11415** and **11695.**

"Radio Independent Spain" is pro-communist and broadcasts anti-Spanish Government propaganda, the transmitters are located in Bucharest and, possibly, Sofia. From 0600 to 0800 on **7690, 10110** and **12140**; from 1200 to 1400 on **10110, 12140, 14485** and **15505**; from 1235 to 1255 on **15365**; from 1600 to 1800 on **7690, 10110, 12140** and **14485**; from 1800 to 2245 on **10110, 12140** and **14485** and from 2005 to 2025 on **15185.**

● MEXICO

"Radio Mexico" has an External Service in Spanish from 1315 to 1535 and from 2000 to 0335 on **5985, 9705** and on **15385,** identification is occasionally made in French and English.

AROUND THE DIAL

In between recent spells of internal redecorating and gardening, some time has been found for short wave listening, from the logbook we note —

● SIERRA LEONE

Freetown on **3316** at 2156, piano solo until 2200 then OM with the world news in English. This is the Sierra Leone Broadcasting Service domestic programme which is on the air from 0555 to 0730 and from 1745 to 2330. The power is 50kW and the channel is a very difficult one, only occasionally can Freetown be heard.

● CHINA

Radio Beijing on **4190** at 1740, YL with harangue in Chinese then some local classical music.

PLA Fuzhou on **4045** at 1750 with similar programme to that above.

● VENEZUELA

Radio Libertador, Caracas, on **3245** at 0050, OM and YL with announcements in Spanish, jingles with the inevitable commercials, local music then station identification at 0100. Schedule is from 1000 to 0400 and the power is 1kW.

Radio Barcelona, Barcelona, on a measured **3386** at 0115, programme of Latin American music, songs in Spanish. Schedule is from 1000 to 1200 and from 2100 to 0400 and the power is 1kW.

Radio Universidad, Merida, on **3395** at 0121, recorded local pops, songs in Spanish. Schedule is from 1000 to 0400 and the power is 1kW.

Radio Bolivar, Cuidad Bolivar, on **4770** at 0141, programme of Latin American music, OM in Spanish. Schedule is from 1000 to 0430 and the power is 1kW.

● BOLIVIA

Radio Emisora Bolivia, Oruro, on a measured **4753.5** at 0030, very excited sports commentator in Spanish. Schedule is from 1000 to 0400, power is 5kW and this one is noted for wandering between the limits **4753** to **4755.**

Radio Universo, La Paz, on **5005** at 0300, OM with identification in Spanish, local newscast with many mentions of La Paz, news items read alternate by OM and YL. Jingles, commercials and local music from 0320 onwards. This one is listed on **5007** but often varies from **5005** to **5008,** which all adds to the fun I suppose! Schedule is from 1000 to 0400 and the power is 1kW.

Radio San Rafael, Cochabamba, on **5055** at 2228, OM in Spanish, identification at 2230 then into programme of local music in typical style. Schedule is from 0930 to 0500 and the power is 5kW.

● BRAZIL

Radio Anhanguera, Goiania, on **4915** at 0300, identification by OM in Portuguese, local pops on records. Schedule is from 0900 to 0400 and the power is 10kW.

Radio Borborema, Campina, on **5025** at 2110, OM with sports commentary in Portuguese. Schedule is from 0830 to 0430 and the power is 1kW.

● PERU

Radio Andahuaylas on **4840** at 0420, plaintive Andean songs and typical local flute music, some interference from the African transmitter at Bukuvu. Schedule is from 1130 to 1400 and from 2130 to 0530 (variable sign-off). Power is 1kW.

Radio Atlantida, Iquitos, on **4790** at 0433, OM with station identification, guitar music and songs in Spanish. Schedule is from 0900 to 0600 but sometimes observed to be on a 24-hour stint, probably for special occasions. The power is 1kW.

Radio Andina, Huancayo, on a measured **4996** at 0430, OM with station identification, slogans then recorded local pops. Schedule is from 1100 to 0600 (sign-off sometimes known to vary between 0545 and 0900). The power is 1kW.

Radio Samaren, Iquitos, on **4815** at 0430, recorded local pops then OM with station identification in Spanish. Schedule is from 1100 to 0500 (here we go again, sign-off observed to vary between 0400 to 0600). Just to add still more to the fun and games associated with LA-Dxing, most identifications are given simply as "Radio Samaren, Iquitos" but occasionally this one identifies as "Voz de la Revolucion Peruana". The power is 1kW.

● ECUADOR

Sistema de Emisora Atalaya, Guayaquil, on **4790** at 0305, OM in Spanish with commercial for women's stockings, accordion music. Schedule is from 1100 to 1330 and from 0100 to 0500. However, just to add confusion to the shambles, sign-off sometimes varies from 0405 to 0615 and if you think your troubles are now over, watch the frequency, this can vary from **4790** to **4795.** The power is 10kW, at least that remains constant — or does it?

● COLOMBIA

Radio Surcolombiana, Neiva, on **5010** at 0401, OM with station identification, slogans with echo-effect, commercials in Spanish then into programme of Latin American music. Schedule is 24-hour and the power is 2.5kW.

● COSTA RICA

Radio Capital, San Jose, on **4832** at 0645, songs in Spanish and local music in typical style. Schedule is from 1200 to 0600 but sometimes observed on a 24-hour stint. The power is 1kW.

HOMODYNE S.S.B. RECEIVER FOR 80 METRES

By R. A. Penfold

In this ingenious receiver design an aerial input is applied direct to the product detector, a Motorola MC1496 integrated circuit. A local oscillator running at carrier frequency then enables demodulation to be given both for s.s.b. and c.w. signals. Due to this direct conversion technique there are only two tuned circuits, one operating at aerial frequency and the other at oscillator frequency. The description of the receiver will be completed in next month's concluding article.

This unusual receiver is relatively inexpensive and simple to construct, and it will be of interest to anyone wishing to commence listening on the 80 metre amateur band of 3.5 to 3.8MHz. It employs one integrated circuit product detector operating at aerial signal frequency to demodulate s.s.b. and c.w. signals, and a second integrated circuit a.f. amplifier to bring the demodulated signals up to earphone level. The only other active device is a transistor functioning as an oscillator.

The receiver has only two tuned circuits, these appearing in the aerial and oscillator stages. As a result the receiver can be aligned without the necessity for test equipment. A further point is that tuning is carried out by means of varicap diodes. A block diagram showing the various stages of the receiver appears in Fig. 1.

Apart from readers who wish to listen on the 80 metre band, the design will also appeal to those who like novel circuits; and it certainly has some unconventional features.

As is explained later, the receiver can be modified

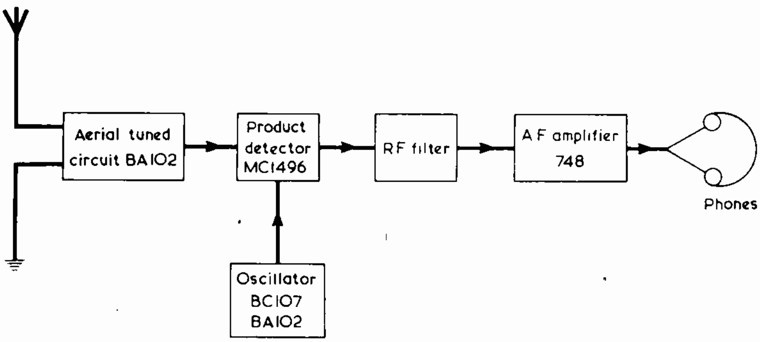
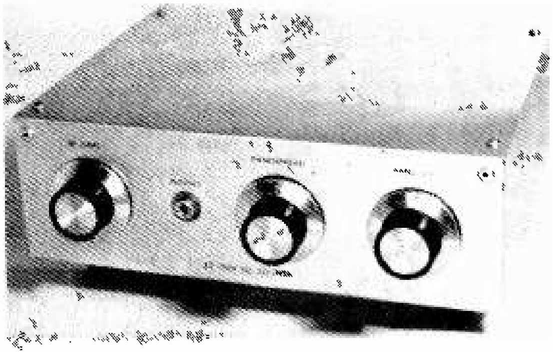


Fig. 1. Block diagram showing the stages in the direct conversion homodyne receiver, together with the associated semiconductor devices. The oscillator feeds the missing carrier frequency into the product detector.



The homodyne receiver has three controls only. These are the bandset and bandspread tuning controls and the combined volume control and on-off switch.

for s.s.b. and c.w. reception on the 40 metre band.

OPERATING PRINCIPLE

Ordinary a.m. transmissions are rarely encountered on the amateur bands these days, and the two main transmission modes in use are c.w. and s.s.b. Although not essential, it is extremely helpful to have a basic understanding of s.s.b. when using a receiver for this mode of transmission.

An s.s.b. signal is often considered as being an ordinary a.m. one with the carrier and one sideband suppressed, although it need not actually be generated in this way. An a.m. transmission consists of three parts, the carrier, the upper sideband and the lower sideband. A simple example is shown in Fig. 2. Here we assume a 1MHz carrier is being modulated by a 2kHz audio tone. The modulation produces two new signals in addition to the 1MHz carrier, these appearing at 2kHz above and 2kHz below the carrier. Their amplitude is relative to the applied modulation level. The sidebands react with the carrier at the detector of an a.m. receiver to produce the original 2kHz audio tone. The phasing of the two sidebands prevents them from reacting with each other to form a 4kHz audio tone.

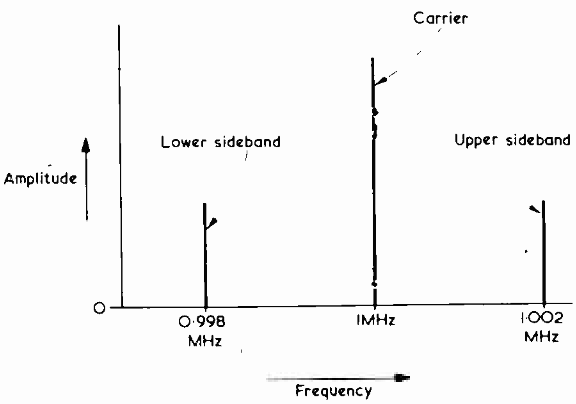


Fig. 2. The signals which are transmitted when a carrier of 1MHz is amplitude modulated by a 2kHz tone.

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
R1 4.7kΩ
R2 4.7kΩ
R3 4.7kΩ
R4 4.7kΩ
R5 680Ω
R6 5.6kΩ
R7 470kΩ
R8 3.9kΩ
R9 3.9kΩ
R10 4.7kΩ
R11 10MΩ
R12 470kΩ
R13 680Ω
R14 4.7kΩ
R15 470kΩ
VR1 5kΩ potentiometer, log with switch S1(a)(b)
VR2 100kΩ potentiometer, linear
VR3 10kΩ potentiometer, linear

Capacitors
C1 10-60pF ceramic trimmer
C2 22pF ceramic plate or silvered mica
C3 47pF polystyrene
C4 0.047µF type C280 (Mullard)
C5 100µF electrolytic, 10 V. Wkg.
C6 0.047µF type C280 (Mullard)
C7 0.47µF type C280 (Mullard)
C8 0.47µF type C280 (Mullard)
C9 2.2pF ceramic plate or silvered mica
C10 100µF electrolytic, 10 V. Wkg.
C11 0.01µF type C280 (Mullard)
C12 470pF ceramic plate or silvered mica
C13 10-60pF ceramic trimmer
C14 68pF ceramic plate or silvered mica
C15 100pF polystyrene
C16 0.47µF type C280 (Mullard)

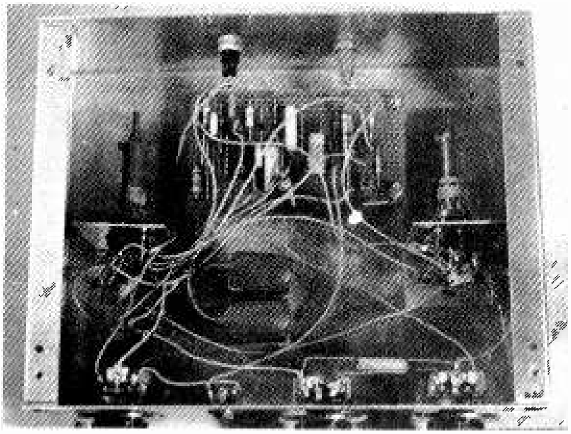
Coils
L1 Miniature Dual-Purpose Transistor Tuning Coil, Blue, Range 3T (Denco)
L2 Miniature Dual-Purpose Transistor Tuning Coil, Red, Range 3T (Denco)

Semiconductors
IC1 MC1496 (see text)
IC2 748 (see text)
TR1 BC107
D1 BA102
D2 BZY88C13V
D3 BA102

Sockets
SK1 Insulated socket
SK2 3.5mm. jack socket
SK3 Insulated socket

Switch
S1(a)(b) d.p.s.t. toggle (part of VR1)

Miscellaneous
Aluminium chassis with base plate, 8 x 6 x 2½in.
2 batteries type PP3 (Ever Ready)
2 battery connectors
3 control knobs
2 B9A valveholders
4 rubber feet
Plain perforated s.r.b. panel, 0.1 in. matrix
20 s.w.g. aluminium sheet (for coil brackets)
Nuts, bolts, wire, etc.



Most of the small components are assembled on a perforated s.r.b.p. panel. There is ample room in the case for this and the two brackets on which the coils are mounted.

In practice, when speech or music is being transmitted many frequencies are produced in the sidebands and the signal is very complex. The basic principle is still the same though, with the audio frequencies being produced at the detector in the same way.

A.M. has severe limitations in the amateur bands where only a very limited maximum transmitter power input and band space are available. One of these limitations is that if two ordinary a.m. transmitters are operating close to each other in terms of frequency, their carriers will produce a beat note which will be heard as a whistling sound from a receiver tuned to them. This effect is frequently apparent when tuning across the medium wave band after dark.

Another drawback with a.m. is that a lot of the transmitter's power is wasted in transmitting the carrier, which does not contain any of the intelligence to be transmitted. It is quite possible to suppress the carrier at the transmitter, and use an oscillator at the receiver to replace the missing part of the signal so that the audio modulation can be recovered. The full power of the transmitter can then be gainfully employed in the sidebands.

The amateur bands are rather narrow, the 80 metre band being for instance only some 300kHz wide. It is therefore desirable for each transmission to take up as little space in the band as possible.

Both of the sidebands of an a.m. signal contain the necessary information to produce the original audio signal, and by filtering out one of these sidebands the remaining signal will occupy less than half the bandwidth of the comparable double sideband signal. The remaining sideband will still react with the oscillator at the receiver to produce the required audio signal.

This type of transmission is known as single sideband suppressed carrier (s.s.b.), and either the upper sideband (u.s.b.) or the lower sideband (l.s.b.) can be transmitted.

DIRECT CONVERSION

A product detector forms the heart of a direct conversion receiver of the type to be described here. The product detector is a form of mixer, and the frequencies at its output are the two input signals together with signals which are equal to the sum and difference of the two input signals. The aerial is coupled to one input of the detector via a tuned circuit which rejects signals outside the required band. An oscillator which is tunable over the desired band is connected to the other input.

Suppose that the detector is used to demodulate a signal which has a suppressed carrier frequency of 3.6MHz. By tuning the oscillator to 3.6MHz, the difference signal output from the detector will be the original audio signal. For instance, if a 1kHz signal is modulating the 3.6MHz carrier in an l.s.b. transmission, the sideband will be at 3.599MHz. This will give a difference signal at the product detector output of 0.001MHz (3.6 minus 3.599) or 1kHz.

A c.w. signal is simply a keyed carrier or morse signal, and the oscillator is tuned slightly above or below this so that it heterodynes with the carrier to produce an audio note of the desired pitch.

Apart from the audio signal, all the signals at the output of the product detector are at radio frequency, and can therefore easily be filtered out.

An important feature of a product detector is that signals appearing at the aerial input do not react with one another to produce an audio output, but only with the oscillator. This is essential if good quality audio is to be produced, and is the reason for the rather poor audio quality produced in the s.s.b. mode by receivers which are not equipped with a proper product detector.

THE CIRCUIT

The complete circuit of the 80 metre direct conversion receiver appears in Fig. 3. It will be seen that there are two 9 volt supplies, one positive of chassis and the other negative of chassis. These are provided by two PP3 batteries.

The aerial is coupled to one input of IC1, which functions as the product detector, by way of L1 and C4. The tuned winding of L1 rejects signals outside the required band. IC1 employs an array of three interconnected differential amplifiers and incorporates the equivalent of eight transistors, three resistors and a diode.

There are two outputs from the i.c., one at pin 6 and one at pin 12. R8 and R9 are the collector load resistors for the output transistors inside the i.c., but only the output at pin 12 is employed in the present receiver. The output at pin 6 is ignored.

C6 filters out the r.f. signals present at pin 12, and the remaining audio signal is fed to the volume control, VR1, via C7.

Bias for the transistors in the i.c. is provided by R1 to R6. Another resistor would normally be connected between pins 2 and 3 to give the device the required gain. However, in the present circuit all the r.f. amplification is provided by the i.c. and it is necessary for this to have as much gain as possible. In consequence, the two pins are simply connected together, whereupon the i.c. offers a considerable degree of r.f. gain.

Audio amplification is given by IC2, and this also offers a high level of gain. The i.c. employed is the 748, and it is connected as an inverting amplifier, with

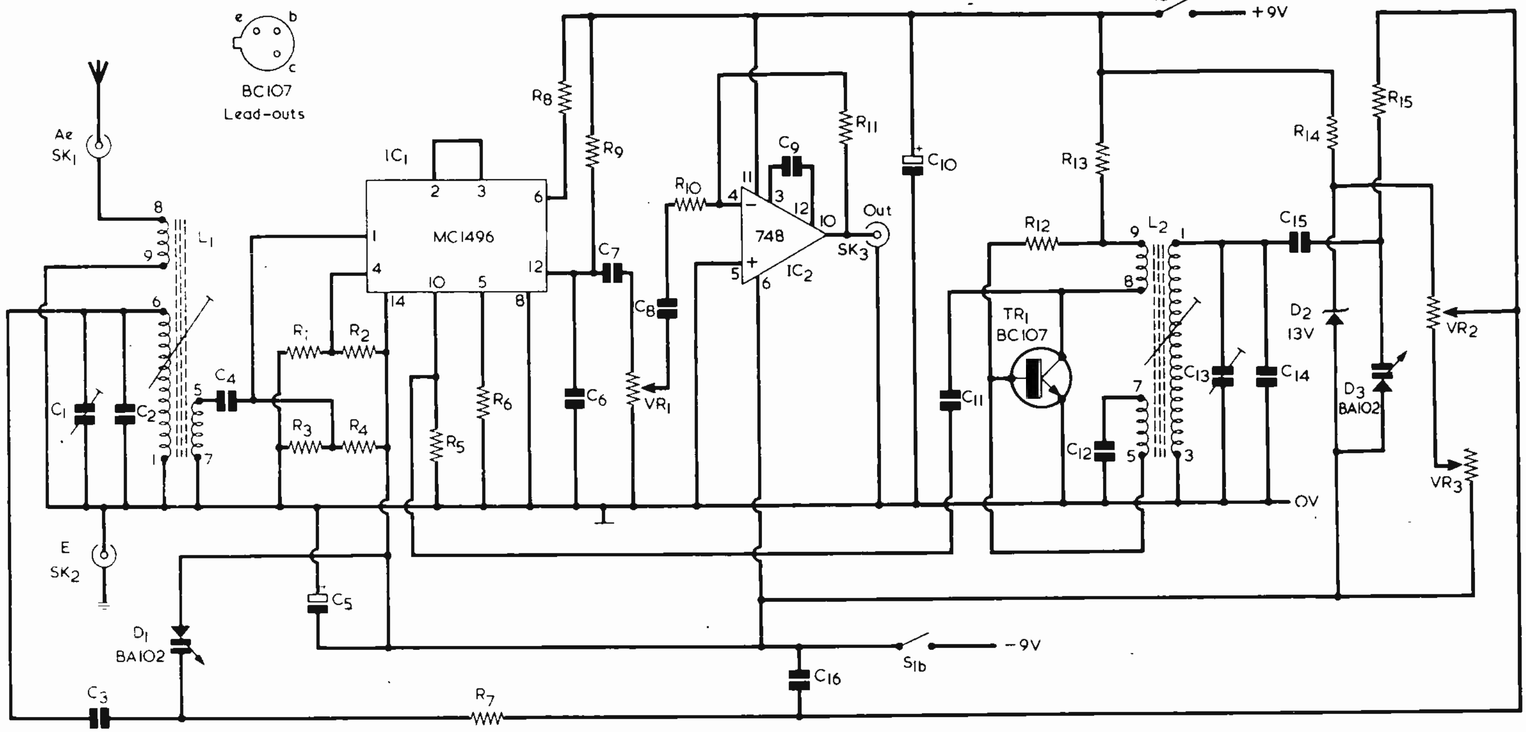


Fig. 3. The circuit of the homodyne s.s.b. and c.w. receiver. This is powered by two 9 volt batteries.

the gain controlled by the values of R11 and R10. The actual gain level is equal to R11 divided by R10, and this is in excess of 2,000 times. The non-inverting input is taken direct to chassis for biasing purposes. Compensation is given by C9.

The output is taken direct from pin 10 of IC2 and this is intended for either crystal headphones or a crystal earphone. Crystal headphones are more satisfactory for short wave listening. Although the output will also feed high resistance (2,000Ω plus 2,000Ω magnetic headphones, the use of such headphones is not really advised as there is then a tendency towards motor-boating when the volume control is turned high and the batteries have aged a little. The motor-boating does not occur with a crystal earphone or crystal headphones. The output could be connected, via a capacitor of around 0.02μF, to a high input impedance amplifier driving a speaker, but the constructor is advised to ensure that the circuit functions adequately with the crystal earphone or headphones first.

Transistor TR1 functions as the oscillator, and it operates in the common emitter mode. L2 allows positive feedback to be given from the collector to the base of TR1 at a frequency determined by its tuned winding. It is necessary for the oscillator to have a fairly high output as it is important that the relevant transistors in the product detector are used in a switching rather than a linear mode. An inadequate oscillator amplitude would result in a loss of audio quality. The oscillator gives an output greater than 2 volts peak-to-peak when loaded, which is more than adequate. The output is coupled to pin 10 of IC1 via C11.

As already mentioned, power is obtained from two 9-volt batteries. These are connected in series with the centre connection earthed to chassis. This type of circuit is rather unusual in a receiver but IC1 is designed to operate from a dual supply, and it is then convenient to operate IC2 from the dual supply also. S1 is the on-off switch and is ganged with VR1. C10 and C5 are supply bypass capacitors. Current consumption is approximately 7mA from the positive supply and 7.2mA from the negative supply.

Tuning is carried out by variable capacitance diodes. Of these, D1 tunes the aerial circuit and D3 the oscillator circuit. R14 and zener diode D2 provide a stabilized voltage for the tuning control potentiometers, VR2 and VR3. VR2 is the main tuning, or bandset control, whilst VR3 is the bandspread control. The values of C3 and C15 have been chosen to give good tracking between the two tuned circuits, although this is not very critical due to the restricted range of frequencies which are covered and the relatively wide bandwidth of L1.

Both the integrated circuits are employed in their 14 pin d.i.l. form. The MC1496 is manufactured in three different packages: MC1496G (round 10 pin), MC1496L (ceramic 14 pin d.i.l.) and MC1496P (plastic 14 pin d.i.l.). The MC1496L is listed by S.C.S. Components, Northfield Industrial Estate, Beresford Avenue, Wembley, Middlesex. Of the remaining parts, the 10-60pF ceramic trimmers required for C1 and C15 are available from Henry's Radio and Doram Electronics.

CASE

The receiver is built in an aluminium chassis with base plate measuring 8 by 6 by 2½in. The chassis is used, in effect, upside-down with the base plate forming

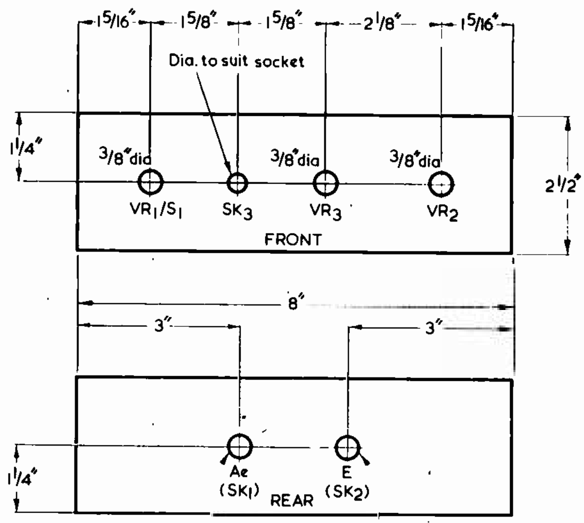
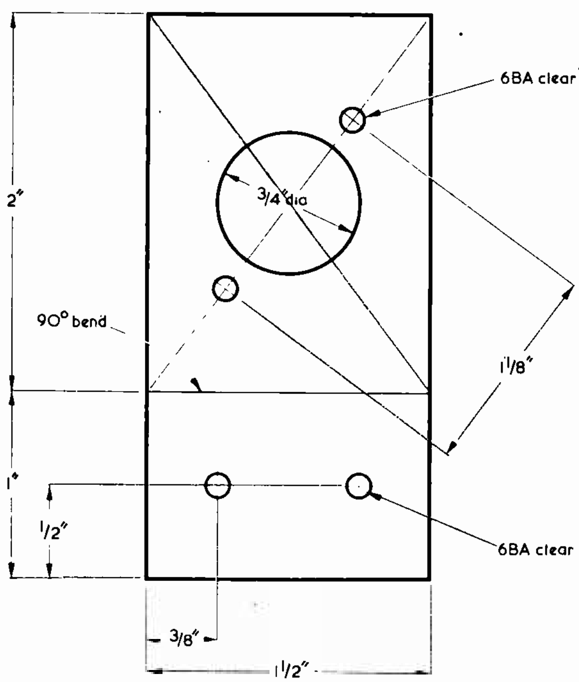


Fig. 4. Drilling details for the front and rear panels.



Material: 20swg aluminium

Fig. 5. Two brackets, each having the dimensions shown here, hold the valveholders into which the coils are plugged.

the lid. The chassis may be home-constructed or purchased ready-made. Drilling details for the front and rear panels are shown in Fig. 4. Four holes near the corners of what is now the bottom of the case are also required, these being employed for mounting four rubber feet.

The coils L1 and L2 plug into B9A valveholders, to the tags of which the circuit connections are made. Each valveholder is mounted on an L-shaped bracket, details of which are given in Fig. 5. The approximate positions taken up by the two brackets can be seen in the photographs. The case bottom may be drilled to take them and the brackets then mounted in place. Their exact positioning is not critical.

COMPONENT PANEL

Most of the small components are assembled on a plain perforated s.r.b.p. panel of 0.1 in. matrix having 36 by 20 holes. Fig. 6 illustrates the component layout and the underside wiring of the panel.

First, cut out the panel to the required size using a small hacksaw. Care should be taken in cutting as board of this type tends to be brittle. The two 6BA clear holes are next drilled out, after which the components are mounted in the positions shown. As each component is fitted its lead-outs are bent over at right angles so that they rest flat against the underside of the panel. The pins of the i.c.'s are similarly bent out

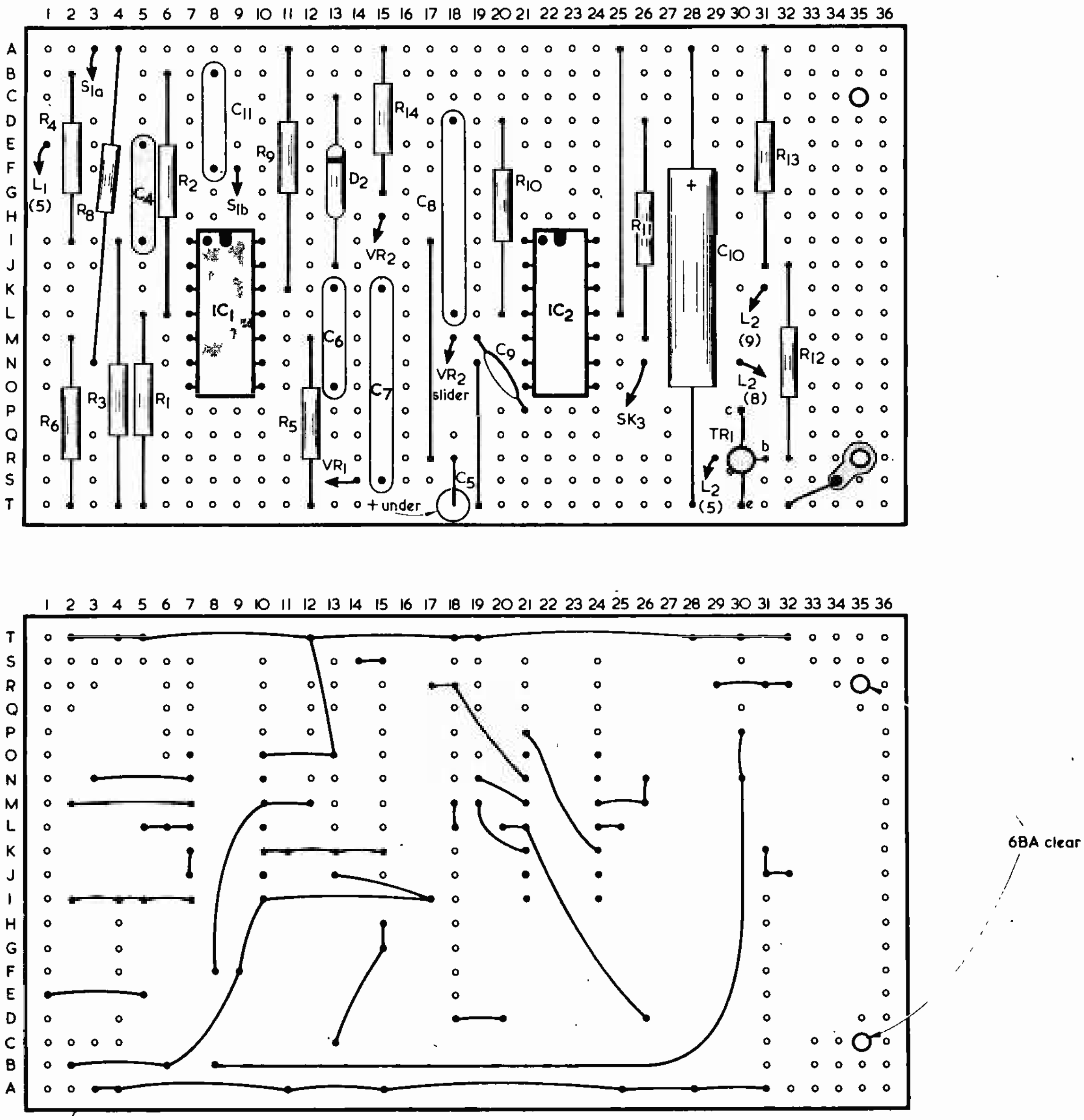
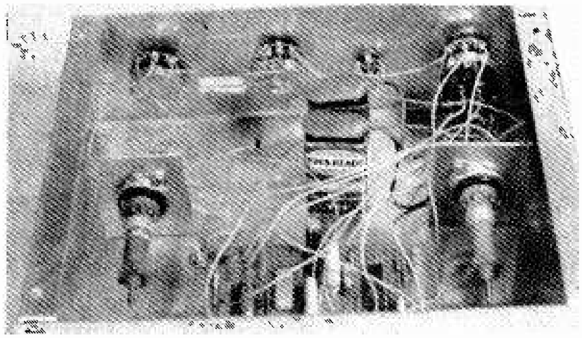


Fig. 6. The layout and wiring on the component panel.



A view from the rear, illustrating the wiring at the back of the front panel.

flat. When all the components are in place, their lead-outs are soldered together as shown. Lengths of tinned copper wire are employed for link wires and for other connections where component lead-out wires cannot be used. Sleeving is passed over any wire which is liable to short-circuit against another wire. It is also passed over the long wire running from hole B8 to hole N30.

A number of flying leads connecting to external components are also wired to the panel. These may consist of flexible insulated wires, each about 10in. long. They will be cut to their final length later when their free ends are connected.

NEXT MONTH

Details will be given of the remaining wiring of the receiver in next month's concluding article. This article will also deal with the adjustment and use of the receiver, and will describe the modification required for operation on 50 metres.

(To be concluded)

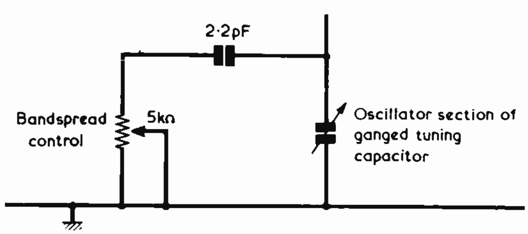
RESISTIVE BANDSPREAD CONTROL

By S. L. Martin

An inexpensive approach for cases where small changes in short wave oscillator frequency are required.

Variable capacitor prices are shooting up these days, so much so that the home constructor has to start thinking of alternative methods of tuning a coil if these can produce a saving in costs.

The accompanying circuit shows a means of obtaining bandspread, or fine tuning, which has been employed in some commercially produced short wave receivers, and it can prove to be of value where small shifts in the resonant frequency of a tuned circuit are all that are required.



An unusual means of obtaining small shifts in the frequency of a short wave radio oscillator

POTENTIOMETER TUNING

The potentiometer is coupled via a 2.2pF capacitor to the oscillator section of the short wave receiver ganged capacitor, and it varies oscillator tuning over a small range. When the potentiometer inserts maximum resistance into circuit the coupling between the oscillator tuned circuit and the 2.2pF capacitor is at a minimum and the detuning effect is low. When the potentiometer inserts zero resistance into circuit, the 2.2pF capacitor is coupled directly across the oscillator tuned circuit and the alteration in oscillator frequency is at a maximum. Intermediate settings of the potentiometer produce intermediate changes in oscillator tuning, whereupon the potentiometer acts as a bandspread tuning control.

Purists will recoil from the circuit with horror but, as already mentioned, it has been used commercially. Naturally, the arrangement is only feasible when very low changes in frequency are required. The potentiometer is a small carbon component with a linear track. Also, of course, the potentiometer and the 2.2pF capacitor must be connected to the main tuning capacitor with short wiring, just as would be required if the bandspread control were a conventional low value variable capacitor. ■

Radio Topics

By Recorder

I was checking through a components list for a project with a colleague the other day and had successfully passed through the resistors, capacitors, mains transformer, semiconductors and switches, when I came to the neon pilot lamp.

"NE1", I called out.

Quick as a flash my colleagues replied, "For tennis?"

All I can say is that worse things happen at sea.

PUN MY SOUL

Nevertheless, my mind started roaming later around the terrible puns that crop up in electronics, and I thought I'd commence this month with a few which you may not have heard before. My apologies in advance if I have unwittingly lifted any from material which has appeared before.

To begin at a really agonising level one may forgivably be excused, I suppose, for assuming that a catering distributor operates a pi network. Or that the most efficient worker at the bus garage is a superconductor.

Possibly, that scorch mark on your trousers could be an ion burn. And, could a tunnel diode be a piece of poetry composed by a Welsh miner? A variable reluctance pick-up might be the sort of thing that happens along seaside promenades. Or, at least, used to happen in the older days.

The noise emanating from a dog kennel at night might perhaps be Barkhausen radiation.

But the one I like best, or the one which is the least excrutiating, has to do with the hi-fi record player which reproduces perfectly every disc played on it, which responds immediately and faultlessly to all adjustments made to its controls, and which contributes no colouring of its own to the sound it produces. It incorporates a deferential amplifier.

ELIMINATOR SNAG

Turning, hastily, to a more serious subject, a friend of mine decided that he had had enough of paying continually increasing prices for the 9 volt battery in his a.m. transistor radio and so he decided to knock up a little mains unit.

This was a very simple arrangement and consisted of a 6.3 volt heater transformer feeding into a bridge rectifier incorporating four 1N4002 diodes, these being followed by a 500μF electrolytic reservoir capacitor. With a reservoir capacitance as high as this the voltage appearing across it, when the radio was playing at low level and drawing around 10mA, would be very nearly the peak value of the rectified transformer secondary voltage. The peak voltage across the 6.3 volt secondary is 1.4 times 6.3, or about 8.8 volts. There are two silicon diodes between the transformer secondary and the reservoir capacitor on each a.c. half-cycle, causing a forward voltage drop of twice 0.6 volt, or 1.2 volts. So, theoretically the peak voltage across the reservoir capacitor would be 8.8 minus 1.2 volts, or 7.6 volts. In practice, it turned out to be just short of 8.5 volts. This is presumably due to the fact that the transformer secondary offered more than its nominal 6.3 volts at the low currents involved, having been provided by its manufacturer with a few extra turns to give the correct voltage when loaded by a normal valve heater circuit consuming an amp or so.

The power unit replaced the transistor radio battery quite satisfactorily, the receiver battery leads now being connected directly to the 500μF reservoir capacitor. There was little trace of hum, although the hum level did increase somewhat when the volume was turned high. However, my friend does not normally have the radio blaring away and he was quite happy with his power unit. I must hasten to add that an elementary battery eliminator of the type I've just described may not be suitable with all transistor radios, and that some may require a more comprehensive type of power supply.

Then my friend encountered a snag. He had been in the habit of turning on the mains supply to the power unit first and then switching on the radio by means of the switch on its rim-operated volume control. One day the switch became erratic and he had to operate it several times before the radio turned on.

SURGE CURRENT

The reason for the switch failure was almost certainly the fact that the surge current, on switch-on, was much higher with the mains unit than it had been with a battery. The receiver had the usual high value electrolytic capacitor of around 200μF connected across its supply rails; with a battery the switch-on surge current which charged this electrolytic would be limited by the internal resistance of the battery, whereas with the mains unit the switch-on surge current would come from the charged 500μF reservoir capacitor. As a matter of interest I measured the short-circuit current of a new PP9 battery recently and found this to be approximately 1 amp. In consequence, one could assume an internal resistance of the order of 9Ω in a battery of this size and a higher internal resistance in smaller batteries. Also, internal resistance in any battery increases as it ages. One would expect much lower internal resistance in a large value electrolytic capacitor.

My friend removed the volume control and was able to reach and clean up the somewhat elementary contact set at its switch. After this he always ensured that the volume control switch was closed before turning on the mains supply, and he has had no trouble with it since. And so ends a little story which carries its own moral for anyone who intends running a transistor radio from a mains supply unit.

PRINTED CIRCUITS

Printed circuits have been with us for many years now and they have been instrumental in keeping down the cost of manufactured entertainment equipment despite general inflation. But they have also brought about a minor change which is particularly beneficial to the home constructor.

In the old days, radio and television sets were mass produced on metal chassis with the individual components connected to tags on tagstrips and the like. As the chassis went down the production line, girls fitted the components in place and soldered their lead-outs.

Now, the process of soldering with an iron and resin cored solder means that the tip of the iron automatically rubs the work to be soldered and physically removes any oxide that may be present. As soon as the flux in the solder reaches the bare metal it is more capable of breaking down further oxides.

When printed circuits first started, solder joints were made typically by passing each board over a solder wave. The lack of abrasion during the soldering process soon became apparent, and lead-out wires which were previously considered perfectly solderable produced a dismal quantity of cold joints. Work was then urgently put in hand to improve the solderability of component lead-outs.

And that, dear reader, is why the modern components you buy these days solder so readily and well! ■

SIMPLE TRANSISTOR TESTER

By Brian Reay

Our contributor describes an item of test equipment employing non-critical components which permits simple go/no-go checking of bipolar transistors. The tester may also be employed as a signal injector and morse code oscillator.

Following repeated domestic requests to "get rid of some of that junk," the author decided to at least dispose of unserviceable components. Thus, the need for a transistor tester arose, and it was felt that this should not incorporate an expensive meter movement. Not possessing any published plans for a suitable tester, or in fact ever having seen any, the author designed his own.

The result is a transistor tester which is cheap and small, which tests both n.p.n. and p.n.p. transistors and which also doubles as a signal injector and morse code oscillator. It should be noted at this stage that the unit merely tests for good or no-good transistors.

MULTIVIBRATOR

The basic circuit is a simple multivibrator with switching to facilitate the checking of both n.p.n. and p.n.p. transistors.

The circuit of the tester appears in Fig. 1. The transistor to be tested is connected to the test socket and S2 and S3 set to the polarity required. If the test transistor is n.p.n. the switches are put to position 1, whereupon the test transistor enters a multivibrator circuit in common with TR1, the upper supply rail being positive. If, when push-button S1 is pressed, an audio tone is heard in a crystal earphone plugged into the jack socket then the test transistor is good.

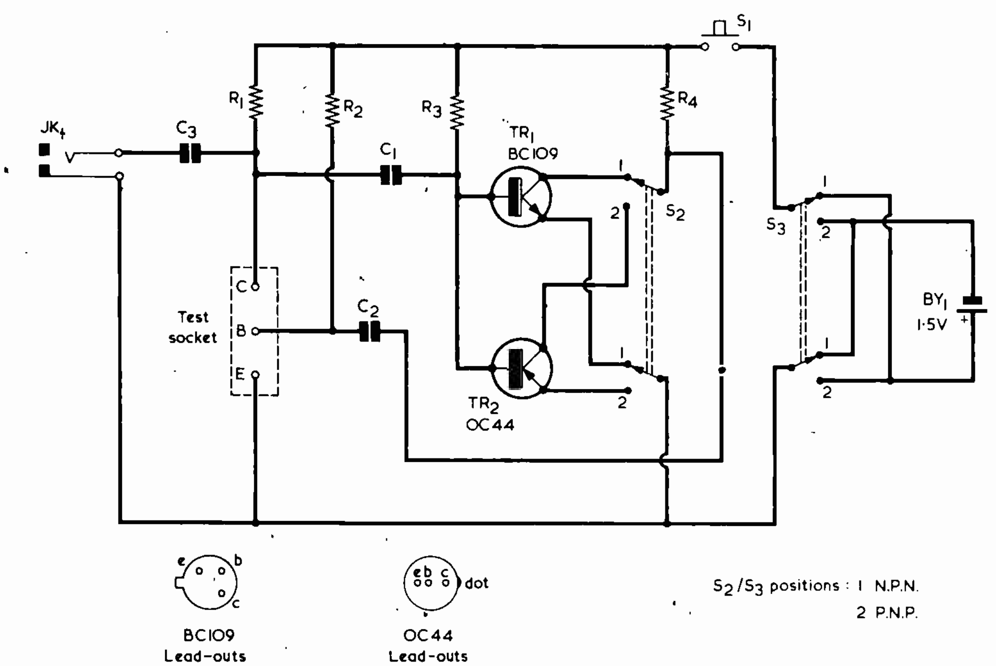


Fig. 1. The circuit of the transistor tester. If the test transistor is serviceable an a.f. tone is produced in a crystal earphone plugged into the jack socket

COMPONENTS

Resistors
(All ¼ watt 10%)
R1 22kΩ
R2 68kΩ
R3 68kΩ
R4 22kΩ

Capacitors
C1 0.01μF plastic foil
C2 0.01μF plastic foil
C3 0.01μF plastic foil

Transistors
TR1 BC109
TR2 OC44

Switches
S1 push-button, press to make
S2 d.p.d.t. slide
S3 d.p.d.t. slide

Socket
JK1 3.5mm. jack socket

Battery
BY1 1.5 volt cell type HP7 (Ever Ready)

Miscellaneous
Crystal earphone with 3.5mm. jack plug
Transistor socket

Should the test transistor be p.n.p., S2 and S3 are set to position 2, causing the upper supply rail to become negative and the test transistor to enter a multivibrator circuit in combination with TR2. Again, the appearance of an a.f. tone in the earphone when S1 is pressed denotes that the test transistor is good.

Because of the low supply voltage of 1.5 volts the a.f. tone produced is lower than the calculated value for R2, R3, C1 and C2. The frequency will vary a little also according to whether the test transistor is germanium or silicon, because of the different forward base-emitter voltages in these two types of transistor. In practice the frequency is of the order of 800Hz. It will be noted that TR1 in the tester is silicon and TR2 is germanium. These both function well, and it is possible that almost any small signal n.p.n. transistor could be used for TR1 and almost any small signal p.n.p. transistor could be used for TR2. However, circuit operation has only been checked with the two transistors specified.

MORSE OSCILLATOR

To use the unit as a morse code oscillator a known good transistor is fitted to the test socket, S2 and S3 adjusted to the required polarity and a crystal earphone connected to the jack socket. The oscillator may then be keyed by S1 or by a morse key connected across S1.

With a known good transistor connected to the test socket, the unit may also be used as a signal injector. For this application two flexible test leads are connected to a 3.5mm. jack plug which is plugged into JK1. The lead connected to the jack plug sleeve is terminated in a crocodile clip whilst that connected to the jack plug tip is terminated in a test prod. The clip is connected to the chassis of the equipment being

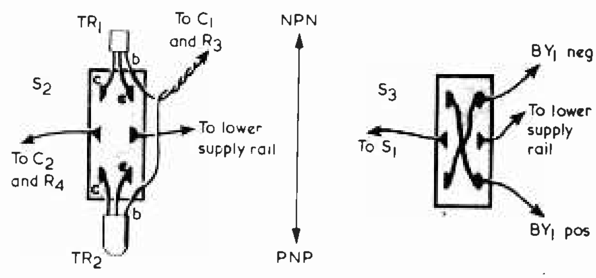


Fig. 2. The wiring at the two slide switches

checked and the test prod is applied to signal test points. The oscillator output contains useful harmonics extending well above 1MHz and so the test prod may be applied to r.f. as well as a.f. circuits. The unit should be used as a signal injector with low voltage transistor equipment only.

The two slide switches are wired up as shown in Fig. 2. Fig. 3. shows how they are "ganged" by fitting a small piece of plastic between their dollies, this being secured with Araldite. S2 and S3 could, if desired, be replaced by a 4-pole 2-way rotary switch. However, such a switch must have break-before-make contacts or the cell will be momentarily short-circuited each time it is operated.

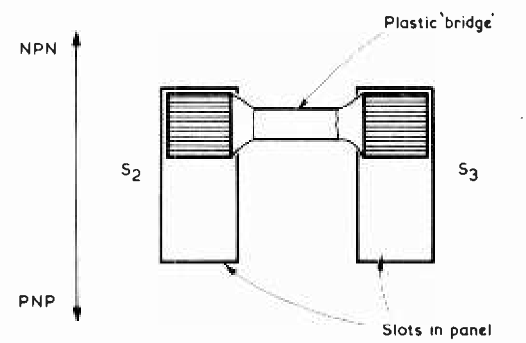


Fig. 3. The slide switches are "ganged" by a plastic "bridge" between their dollies which is secured with Araldite

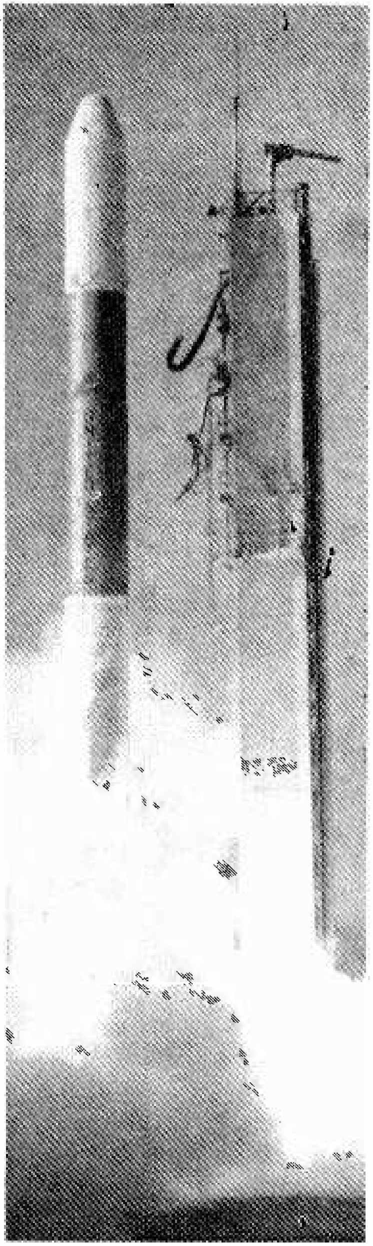
All the parts are assembled in a small plastic case with S1, S2, S3, JK1 and the test socket mounted on the front panel.

The prototype has been employed successfully for checking a wide range of transistors, both marked and unmarked. If it is unknown whether the test transistor is n.p.n. or p.n.p. it may be checked first for one polarity and then for the other. It is very doubtful if the transistor could be harmed by an incorrect connection, due to the low supply voltage and the presence of R1 and R2. Similarly, if the lead layout of the transistor is unknown it may be connected to the test socket in different ways until the correct method of connection is found. ■

OSCAR 8

Future plans for the next amateur radio satellite

By Arthur C. Gee

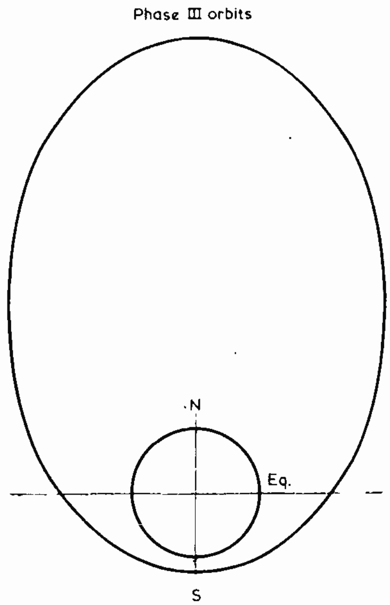


The Thor-Delta rocket used for the launch of Oscars 6 and 7.

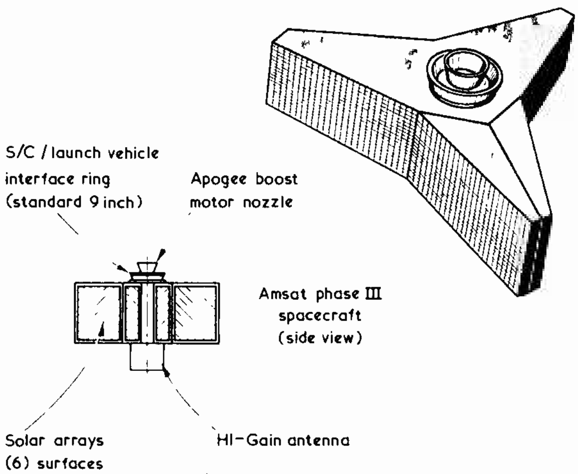
Plans for the next Amateur Radio Satellite are now sufficiently well advanced for some details of the project to be published. Information is coming in from the various agencies involved in the next phase of amateur radio satellite development, which enables an informed description of OSCAR 8, which will be the first of a new order of amateur radio communication satellites, to be published.

The first point of interest about the Phase III satellites is that they will have eliptical orbits, not circular ones as with the earlier OSCARS. The proposed orbit for OSCAR 8 is an apogee (furthest away point) of 36000 Km and a perigee (closest point) of 1500 Km. The apogee would be over the northern part of the earth, and the perigee over the south, with an orbit time of 11 hours. This would give a much longer period of time for communication for stations situated in the northern hemisphere — where most of the activity is. Communication between such stations could take place for periods measured in hours, rather than in minutes, as at present with circular orbits.

Putting a satellite into an eliptical orbit requires a boost motor, to modify the ejection orbit into the required eliptical one. So OSCAR 8 will be the first amateur radio satellite to have a rocket motor. AMSAT-USA who are responsible for co-ordinating the Phase III programme, have located a suitable apogee boost motor and progress is being made in negotiations with a solid propellant motor supply company for its manufacture. The motor will make up two thirds of the total weight of OSCAR 8 before ignition.



The configuration of OSCAR 8 will be in the form of a three pointed star, the centre being the orbit change motor; the three arms containing the rest of the equipment and displaying the solar panels. This spacecraft structure has been selected to allow the maximum possible size that can be placed into the launch vehicle, while maintaining the rotation symmetry and moment of inertia properties imparted to a spinning satellite.



In order to ascertain the most popular frequencies for the transmission and reception transponder, present users of OSCAR's 6 and 7 were asked to write-in their preferencies. A considerable amount of divergence of opinion was expressed and as a result it is hoped to make both frequencies of 435.1 MHz and 145.9 MHz available for both transmission and reception, with facilities for switching over from one mode to the other. That is to say there will be both 435/145 MHz and 145/435 MHz transponders aboard.

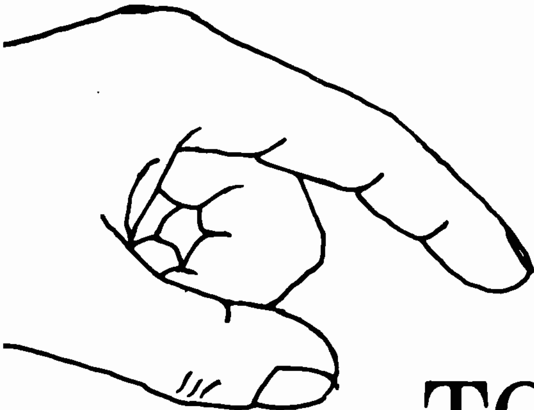
The planned life of OSCAR 8 is for three years, but if it turns out to be as successful as OSCAR 6, one can anticipate a longer life span than this. OSCAR 6 was planned for a life span of one year — and it celebrated its third birthday on October 15th last!

Oscar 8, like its predecessor, will be a joint international project. AMSAT-USA is responsible for managing the overall Phase III programme; for functional testing of the flight spacecraft and for procuring the major space items such as batteries, solar arrays, I.C.s, space certified components and so on.

The AMSAT-VK Group (Project Australis-WIA) is responsble for the ground station control equipment. Use will be made of a 8008 or 8080 microprocessor. It is proposed to use the latest techniques in teletype for command and telemetry purposes, with visual display terminal units.

AMSAT Deutchland is responsible for the engineering design of OSCAR 8 itself. One important unit is that known as the Integrated Housekeeping Unit (IHU) which will include the Command Decoder and will have a microprocessor and a memory unit. The transponders, solar power units and antennas are also the responsibility of AMSAT-DL. AMSAT-Canada are working on the artwork for the flight command decoder printed circuit board and also on the ground checkout equipment which will be needed to test the spacecraft and its sub-systems out.

With such a complex spacecraft to build and check out, it is not to be expected that OSCAR 8 will be ready for launching until well into 1979 or later. When it does go into orbit, it's certainly going to be a most exciting satellite for the OSCAR enthusiasts to learn to use. ■



TWO TRANSISTOR TOUCH BUTTON

An inexpensive touch button circuit which is operated by stray mains hum voltages.

By D. W. Savage

This touch button circuit employs two commonly encountered n.p.n. transistors in a simple configuration which enables a relay to energise whenever a metal button is touched. The prototype was very sensitive, but it has to be mentioned that the sensitivity depends to some extent on the mains wiring and earthed objects in the vicinity of the button.

MAINS OPERATION

An essential feature of the unit is that it has to be mains operated. This does not represent a disadvantage as continuous operation from a battery could prove expensive.

In the circuit, which appears in the accompanying diagram, the mains supply incorporates a heater transformer, T1, the 6.3 volt secondary of which connects to the bridge rectifier given by D2 to D5. These then couple to the large value electrolytic reservoir capacitor, C3. A direct voltage supply which is sufficiently smooth for the present application appears across this capacitor.

TR1 and TR2 are connected in a Darlington pair configuration which gives a very high level of current gain. The base of TR1 is left open with no biasing resistors, and it is found that the transistor passes negligible emitter current under this condition. Voltage excursion at TR1 base is limited, in the positive direction, by forward turn-on in the base-emitter junctions of the two transistors. In the negative direction TR1 base voltage is limited by zener conduction in the two base-emitter junctions at the maximum reverse voltage levels. TR1 base is coupled to the touch button via C2 and a length of screened cable, the braiding of which connects to the negative supply rail.

COMPONENTS

Resistor
R1 30Ω ½ watt 5%

Capacitors
C1 100μF electrolytic, 10 V. Wkg.
C2 0.2μF plastic foil
C3 1,000μF electrolytic, 10 V. Wkg.

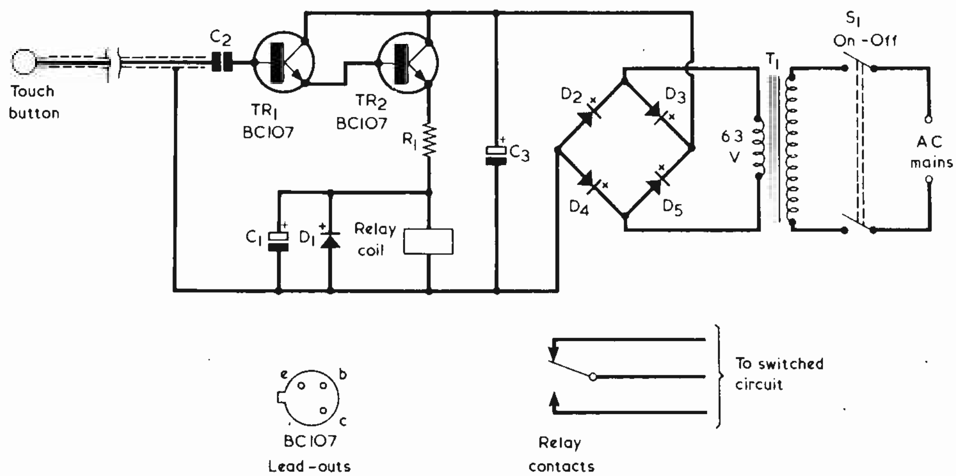
Transformer
T1 Mains heater transformer, secondary 6.3V at 1 amp or more

Semiconductors
TR1 BC107
TR2 BC107
D1-D5 1N4002

Switch
S1 d.p.s.t. toggle

Relay
Miniature Open P.C. Relay, 410Ω coil (Doram)

If the button is touched by a finger a hum voltage at 50Hz is applied to the base of TR1. As readers who have inspected the trace given by random hum pick-up on an oscilloscope will know, the hum voltage may be anything but sinusoidal, but it will still essentially be a 50Hz alternating voltage with added harmonics.



The touch button switch requires few components and is relatively easy to assemble. The relay energises when the button is touched

The consequent small base current in TR1 is considerably amplified by the two transistors, causing pulses of current at 50Hz to be passed to the relay coil. C1, across the relay coil, acts as a reservoir capacitor and charges such that the voltage across the relay coil remains steady at very nearly its peak value. Resistor R1 limits charging current in C1 to 200mA, which is the maximum rated emitter current for TR2. In the prototype the measured voltage drop between TR2 collector and emitter when the button was touched fell to about 1.3 volts only. It could be reduced (and the voltage across the relay coil consequently increased) by increasing the value of C 1, but this tends to make relay release a little sluggish. With the present component values and voltages it would appear that TR2 is hard on for at least part of the incoming hum cycle at TR1 base.

The relay employed is a versatile type available from Doram Electronics which is featuring in quite a number of home-construction designs these days. Its coil voltage operate range is 4.8 to 35 volts, and its changeover contacts are rated 5 amps at 250 volts a.c. or 30 volts d.c. Although primarily intended for fitting to a printed circuit board by means of its tags, it can also be mounted by two 8BA bolts passing through holes in its metal frame. The frame is common to its moving contact whereupon, if the relay is used to switch a mains circuit, care must be taken to ensure that the mounting bolt-heads or nuts are contained inside an insulated housing.

TOUCH BUTTON

The touch button can be a small circle of any shiny metal having a diameter of about 0.5in. It is mounted in an insulated surround and couples to C2 via screened cable. Television coaxial cable should be satisfactory for lengths up to 20ft. or so but it may be necessary to use screened audio wire for longer lengths. The length of unscreened wire at both ends should be about half an inch or less, and the leads of C2 inside the unit should be kept short. This will prevent unnecessary hum pick-up in the base circuit of TR1. The touch button should not be positioned out of doors or in a damp location.

The hum pick-up when the button is touched is due to two causes. First, the finger touching the button injects hum into the circuit in the same way as hum is introduced in an a.f. amplifier by touching a high impedance input point. Second, the negative and positive rails inside the unit couple to the mains supply by way of small stray capacitances in the mains transformer, rectifiers and wiring, whereupon hum is introduced to the input by reason of the capacitance to earth of the person who touches the button. Although not necessarily cumulative, these two effects will normally ensure that a high level of hum is applied to the unit when the button is touched.

Despite the absence of a d.c. return to its base, TR1 passes negligible leakage current. Several transistors have been checked out in the TR1 position and all gave similar results. If the screening to the touch button is carried out effectively, the measured voltage across the relay coil should be zero when the button is not touched, this rising sharply to about 5.4 volts when the button is touched.

D1, across the relay coil, is the usual protective diode which prevents the appearance of a high back-e.m.f. voltage when the relay releases. It is probably unnecessary when it is considered that C1 is also connected across the coil, but it was felt that the low cost of the diode justified what may be an over-cautious approach.

The unit should be assembled in an insulated case, and there is no chassis connection. The low voltage circuitry is isolated from the mains supply by the double-wound transformer but, even so, all precautions must be taken to ensure that there is no risk of accidental shock. This point applies particularly to the relay, for the reasons given earlier. ■

THE 'SUPERALPHADYNE' PORTABLE RECEIVER

Part 2

By Sir Douglas Hall, K.C.M.G.

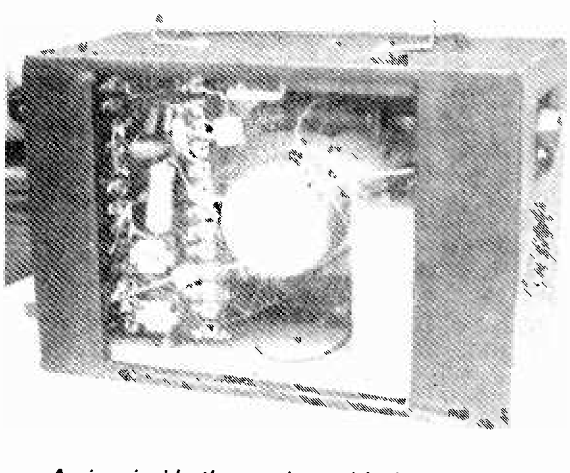
This concluding article deals with the wiring up and checking of this selective reflex receiver. Also given are details of a suitable case.

In the first part of this article, published last month, details were given of the main receiver assembly and the operation of the 8in. ferrite rod which selects the two lower wavelength ranges and actuates the switch S1.

We now proceed to the wiring-up of the receiver.

WIRING

Fit VR1, VC1 and VR2/S2 to the receiver assembly with their tags taking up the positions shown in Fig. 3 (published last month). Then take up the 18-way tagboard and cut off a 5-way section from one end, leaving a 13-way tagboard. With the board one way up it will be found possible to secure its upper end to the item of Fig. 2(a) by means of small woodscrews passed through two new holes drilled at the top, and to secure its lower end to the item of Fig. 2(c) with the aid of a Lektrokit LK2311 bracket mounted at one of the exisiting central holes in theboard. This is made clear in Fig. 3 and 4. In both diagrams thefoot of the bracket points towards the reader. Determine which way up the board should be then drill the two extra holes. The bracket may now be mounted to the board with a short 6BA bolt and nut, the bolt head being on the same side as the tags. The board is not fitted to the receiver assembly yet.



A view inside the receiver with the peg board panel removed

Next wire up the tagboard as illustrated in Fig. 4. The components should not project above the tagboard more than about $\frac{11}{16}$in. as they would then extend over the edge of the item of Fig. 2(c). The lugs of T1 and T2, bent outwards, are soldered to the adjacent tags of the tagboard, the latter tags being bent down to reduce the height of the transformers above the board. If the diameter of C7 is too great it must be mounted on the other side of the board. The component employed by the author was a Siemens axial lead type (available from Electrovalue) which has a body diameter of 13mm., or 0.51in. The external leads identified as A, and C to H, are added after the board is fitted in position, as also are the two leads to the speaker. There are three leads marked B and the components concerned are soldered to a common point outside the board. In practice, R8 crosses over the board and its leads should be covered with sleeving to obviate the risk of short-circuits.

Put the board on one side and then complete the interconnecting wiring shown in Fig. 3. At this stage, also fit the 2in. 4BA bolt which secures the battery. Screw the tagboard to the receiver assembly and complete the remaining wiring, lettered A to H. It will be noted that the common connection for the three leads

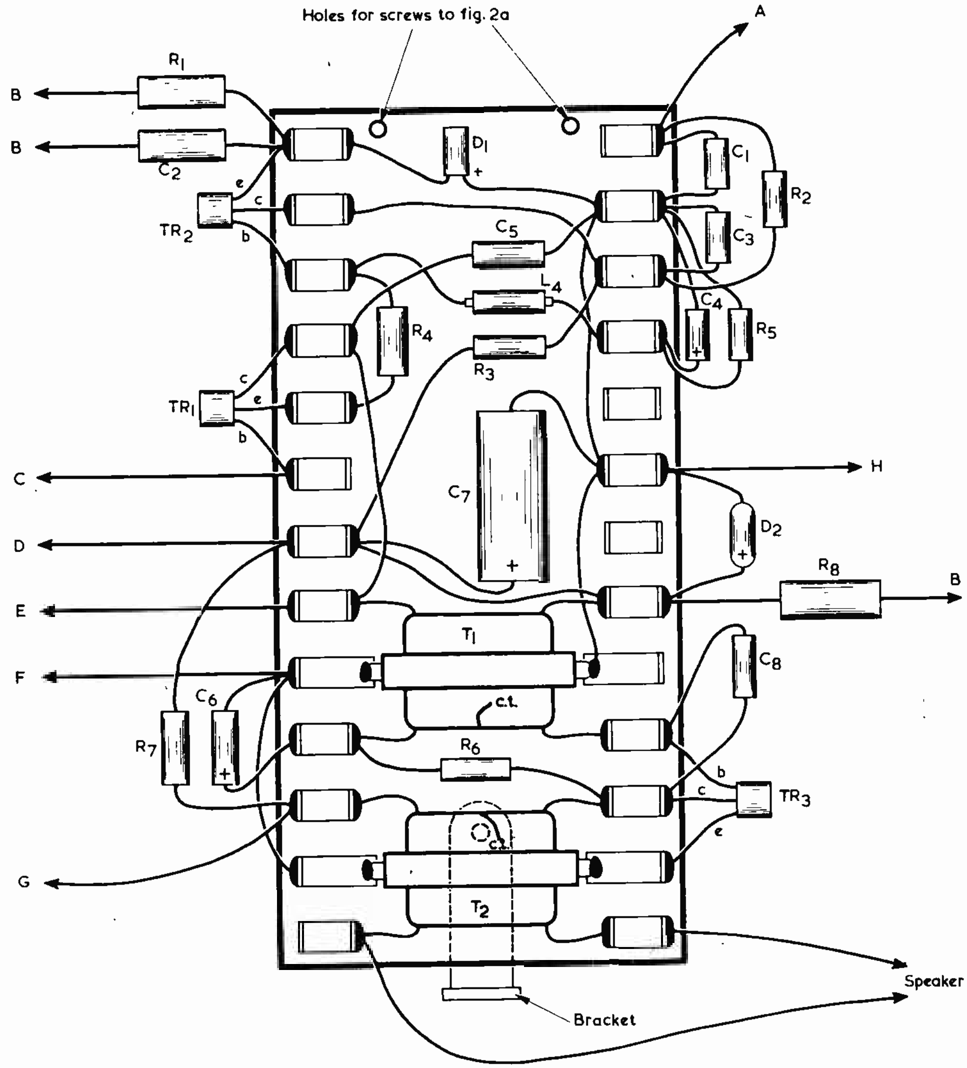


Fig. 4. Wiring up the components on the tagboard. Some of the earthy circuits are completed by way of the metal transformer frames. The letter references correspond with those in Fig. 3, which was published last month

B is at one of the tags of VR1. Also complete the speaker wiring.

No slow motion drive is provided for VC1 and, in consequence, this requires a large knob. A suitable knob can be made quite easily by initially cutting out a circle of Perspex with a diameter of $2\frac{3}{4}$in. This has a hole at its centre to fit the base of a small standard knob and the two are secured together with adhesive. A small knob is also required for fitting to the end of the 8in. ferrite rod. This should be of all-plastic construction and its hole is drilled out to $\frac{3}{8}$in. diameter to take the rod. The projection of the rod outside the case when it is fully in is some $\frac{3}{8}$in. only, but this should enable adequate purchase to be obtained with most small knobs. To reiterate, the ranges selected by the ferrite rod are: Range 1 (120 to 290 metres) rod out and s.r.b.p. projection up, Range 2 (medium waves) rod in and s.r.b.p. projection up, and Range 3 (long waves) rod in and s.r.b.p. projection down.

CHECKING

The receiver chassis is now completed and performance may be checked. Reaction should be very smooth and on the normal medium wave band it should be found that the critical setting for VR1 which gives maximum sensitivity remains constant over nearly the whole of the band. Experimenters may like to replace R8 with a pre-set skeleton potentiometer of 10kΩ, as this component affects the constancy of the reaction setting on medium waves. However, 4.7kΩ represents a good compromise value for most specimens of TR1, TR2 and D1. If a potentiometer is employed, it should not be adjusted to insert very low resistance as it may then pass a somewhat excessive track current.

VR1 has to be advanced a little further for maximum sensitivity on Ranges 1 and 3, and it will also require some adjustment for different settings in VC1. The most sensitive setting for VR1 is just short of oscillation, and the potentiometer should be adjusted to this point when maximum selectivity is required. Volume can then be controlled by VR2. Best quality from local stations is given when VR1 is taken back from the point of maximum sensitivity.

If it is found that no reaction is obtained, check the connections to L3 to ensure that this has been connected into circuit with correct phase.

As has already been described, the position of the third grommet on the 8in. ferrite rod is adjusted to give the required coverage on Range 1. Here, 120 metres is about the high frequency limit for efficient working. The grommet is in the correct position if it allows Radio 4 on 285 metres to be tuned in with VC1 nearly at maximum capacitance. If desired, the adjustment in value to R6 which was referred to last month may also be carried out.

CASE

A suitable case is illustrated in Fig. 5. The receiver slides into this, the Fig. 2(d) item first, whereupon the range change knob appears inside the space cut out for it in Fig. 5(c). The panel of Fig. 2(b) is now the front panel of the set and this may be covered with a thin Perspex sheet to improve appearance. A piece of speaker gauze is cut to fit, and this and the receiver assembly can be inserted into the case at the same time. Alternatively, speaker fabric can be glued to the inside of the piece of Fig. 5(a). In Fig. 5(b) there is a removable peg board which has its lower edge screwed to the item of Fig. 2(c) and its upper end screwed to a small piece of wood fixed to the top of the case. The assembly and the case are held together when these two screws are inserted and tightened up.

The case is covered with Fablon or Contact when complete. The dimensions shown in Fig. 5 are suggested for guidance only, and the actual case dimensions should be taken from the receiver assembly. This approach will take in any errors in

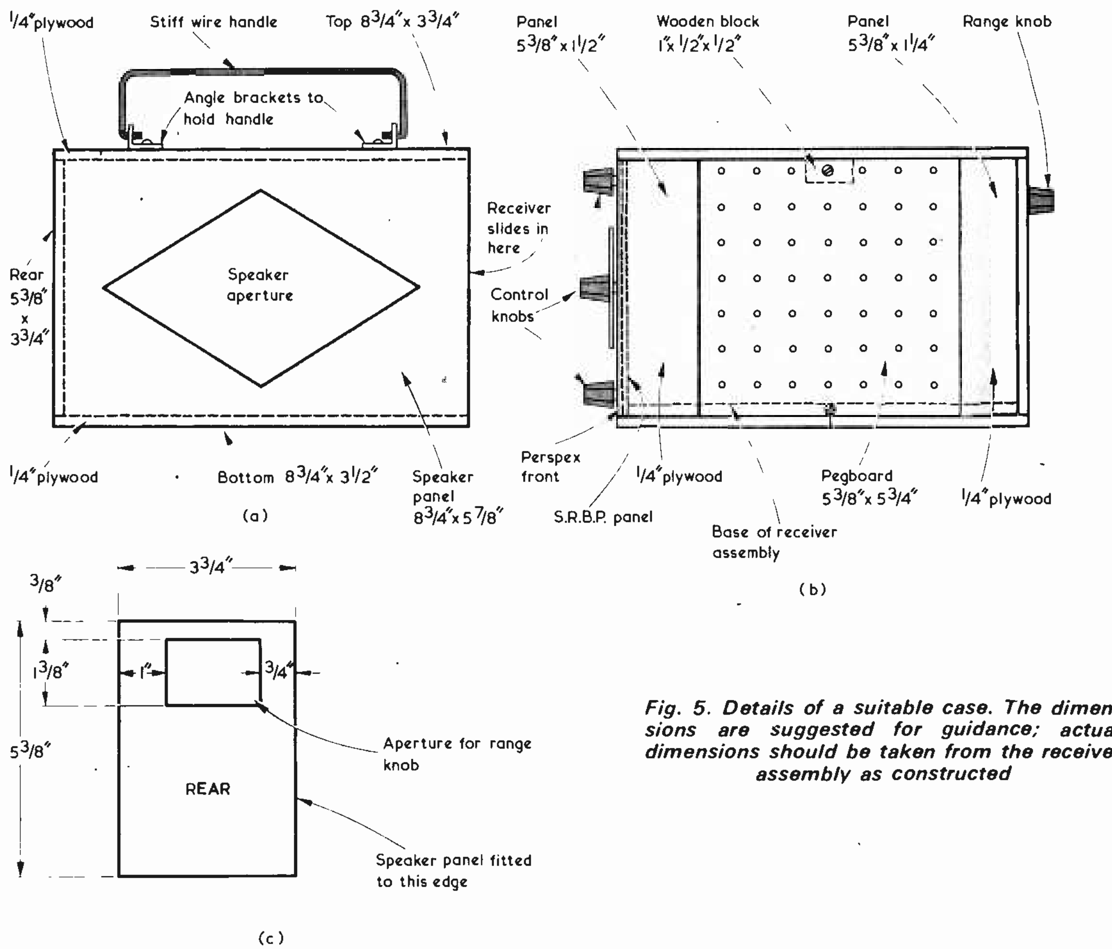
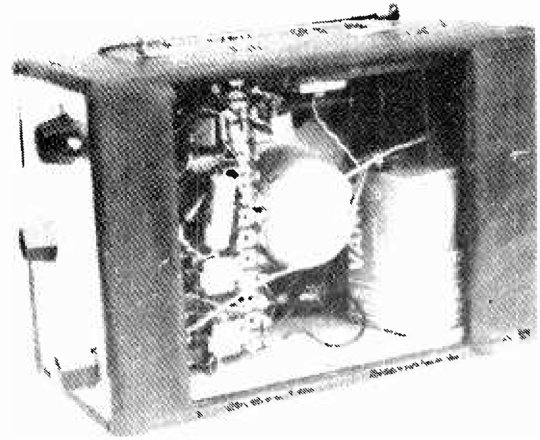


Fig. 5. Details of a suitable case. The dimensions are suggested for guidance; actual dimensions should be taken from the receiver assembly as constructed



Another view of the interior of the receiver

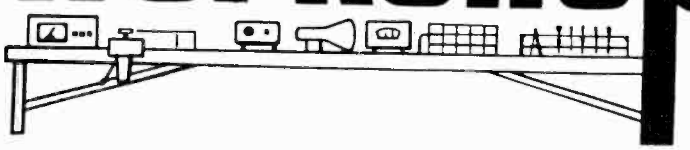
cutting out the items of Fig. 2.

A stiff wire handle is provided, this fitting into a further two of the Lektrokit LK2311 brackets. A wire coat hanger was cut down and bent into shape for the prototype. An annoying rattle on loud notes was traced to the handle ends vibrating in the bracket holes, and two short lengths of insulated sleeving slipped over the ends of the handle soon cured this little trouble.

As a final point, the constructor is urged to employ the specified components including, in particular, the semiconductors. The diode is very important. Ex-equipments OA10's have been found perfectly satisfactory, and it must be remembered that these are very different from manufacturer's rejects. The ex-equipment diodes are cheaper than new specimens. Also, new transistors with the proper manufacturer's type numbers should be employed and not re-brands. ■

(Concluded)

In your workshop



This month Dick and Smithy take a look at some basic aspects of the J-K flip-flop. In the process, Smithy is able to demonstrate to his assistant the functioning of his latest creation: his Binary Gambling Device.

The sun had shone down serenely all through the day and now, as this warm June afternoon sauntered on towards its close, it illuminated the Workshop from an angle well below its zenith. Its rays penetrated the somewhat grubby Workshop windows and created well-defined slanting shafts of light inside, the borders of which were outlined by lazily eddying motes of dust which became radiant on entering the illumination or invisible as they passed into the relative darkness outside.

The soporific atmosphere had taken hold of Smithy, and the Serviceman proceeded leisurely about his tasks. Happilly, all the sets he dealt with augmented the sensation of suspended association with the harder facts of life, and they presented faults which were routine in location and simple in remedy. Smithy's mind wandered back to a long-ago pre-war Workshop in which one of his duties had consisted of the wiring in series of several dozen 2 volt accumulators so that they could be placed on charge,. subsequently to be distributed amongst the households of the neighbourhood where they kept alight the filaments of venerable valves as the HL2 and the PM2DX.

The mood of somnolence had also affected Smithy's assistant Dick, and this was similarly nurtured by sets which obligingly required little art in diagnosis or skill in rectification of their ills. Dick's thoughts wandered not towards the past but towards the future, and he conjured up fantasies of radio wrist-watches whose timing was controlled by a central transmitter, holograph television receivers offering 3-dimensional images, and instant communication equipment which was, at last, taking electronic advantage of the principles of e.s.p.

Thus, dreamily, the pair wandered around within the Workshop. The number of sets on the 'Repaired' rack increased steadily, whilst the quantity on the 'For Repair' rack diminished. Eventually, there were no sets for repair at all.

J-K FLIP-FLOP

"Well," said Smithy contentedly, as he stretched luxuriantly before settling down comfortably on his stool, "this has been one of the most pleasant days I've known for ages."

Dick, perched on the edge of his bench, nodded in agreement.

"It has," he stated, "been just about right. No rush, no awkward snags and everything cleared up in good time. We've still got quarter of an hour to go before packing-up time."

"Have we?" queried Smithy. "Then that's just what I need."

"How come?"

"It will give me time to show off my latest gadget," replied Smithy. "I put the finishing touches to it at home last night."

The Serviceman leaned over and opened a cupboard under his bench. Reaching inside he drew out a small plastic case, on the front panel of which were mounted a toggle switch, a press-button and two small light-emitting diodes fitted in panel-mounting bushes (Fig. 1.)

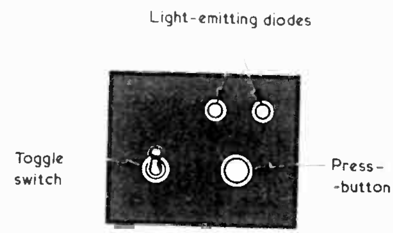


Fig. 1. The front panel of Smithy's Binary Gambling Device. The case may be of metal or plastic with suitable dimensions for the components and battery

Intrigued, Dick eased himself off his bench and walked over to the Serviceman.

"Hello," he remarked curiously. "What have you got there?"

"This," stated Smithy proudly, "is my Binary Gambling Device."

"What's it do?"

"Nothing very complicated," chuckled Smithy. "Actually, all it does is offer an electronic equivalent to the process of tossing a coin. As you can see, there are two l.e.d.'s on the front panel, and I've labelled one 'O' and the other '1'. If the unit is switched on, both the l.e.d.'s glow at the same brilliance. When you press the button one l.e.d. goes out and the other stays on, glowing more brightly. The selection of which l.e.d. remains on is completely random, and it cannot be influenced by the person pressing the button."

"I see," said Dick, interested. "I seem to recall seeing similar gubbinses described before in home-constructor mags."

"You will have," confirmed Smithy. "Quite a few designs for selecting one of two lamps or l.e.d.'s on pressing a button have cropped up in the past. So far as I know, the unit I've got here employs a new approach, since the random selection of the lit l.e.d. is achieved with the aid of a t.t.l. integrated circuit. However, the principle is very simple and I certainly wouldn't claim that it breaks new ground. On the other hand, the gadget is so easy to make up that it represents quite an attractive little electronic plaything."

"How does it work?"

"It has a 555 timer which is wired up as a multivibrator running at an audio frequency," replied Smithy. "The 555 output is then coupled to a J-K flip-flop, and the two l.e.d.'s are fed from the flip-flop Q and not-Q outputs."

Dick sighed.

"I should have known better than to ask," he complained wearily. "All day long I've been doing nothing more complicated than replace capacitors that are obviously broken down, replace resistors that are obviously burnt out and repair connections which have obviously come adrift. My brain has been ticking over comfortably just several degrees above oblivion level, and you've now confronted it with J-K flip-flops and with Q and not-Q outputs."

"Not to worry," returned Smithy soothingly. "The J-K flip-flop is used for an application which is a lot simpler than would be given if it were installed in a computer, and the Q and not-Q business is just part of normal computer jargon. Anyway, here's the circuit of the complete device."

Smithy reached into the cupboard again and produced a sheet of paper on which a circuit had been neatly drawn out. He placed it on the bench in front of his assistant. (Fig. 2.)

STABILIZING CIRCUIT

Dick stared closely at the circuit.

"Well," he remarked, "there's one bit I can recognise, and that's the zener diode stabilizing circuit on the right."

"There's nothing complicated there," stated Smithy. "The J-K flip-flop is a 7470, and integrated circuits in the 74 logic series require a stabilized supply voltage which lies between 4.75 and 5.25 volts. The zener diode has a nominal voltage of 5.1 volts and, since the transistor is a germanium type, about 5 volts appears at its emitter. The transistor acts as an emitter follower, of course."

"That transistor," said Dick critically, "is an AC127, which is a small power type. Do you need a power transistor because the integrated circuits draw a high supply current?"

"Not really," replied Smithy. "The current drawn from the emitter of the AC127 when the device is running is about 25mA only."

"Then why use a power transistor?"

"Because," said Smithy, "there's rather a large surge current at switch-on, due to the 100µF bypass capacitor following the transistor emitter. Immediately after closing the on-off switch the base of the transistor is biased on by way of R7. The emitter of the transistor connects to the discharged 100µF capacitor, and this will initially act virtually as a dead short. In consequence, a brief but high surge current could momentarily flow from the 9 volt positive line through the collector and emitter of the transistor to the discharged capacitor. In the present circuit, the initial surge current is limited to about 330mA by the presence of R6 in the transistor collector circuit, and this is comfortably within the maximum collector current rating of 500mA for the AC127. The surge current flows for an extremely short period of time after switch-on, but it's surge currents of this nature which cause transistors to unexpectedly go pop. After the 100µF capacitor has charged to its full voltage the current flowing in the 27Ω resistor is the 25mA drawn by the integrated circuits and the voltage dropped across it is around 0.7 volt only. The total current drawn from the 9 volt battery is then about 29mA."

"Couldn't you," asked Dick, "have used a silicon transitor instead of a germanium one?"

"I could have done," admitted Smithy, "provided I chose one with a reasonably high maximum collector current rating. The BFY50, with a maximum rating of 1 amp, would have been suitable, for instance. The 5.1 volt zener diode would have to be replaced by one rated at 5.6 volts, because there would then be a voltage drop of around 0.6 volt between the base and emitter of the silicon transistor. Okay?"

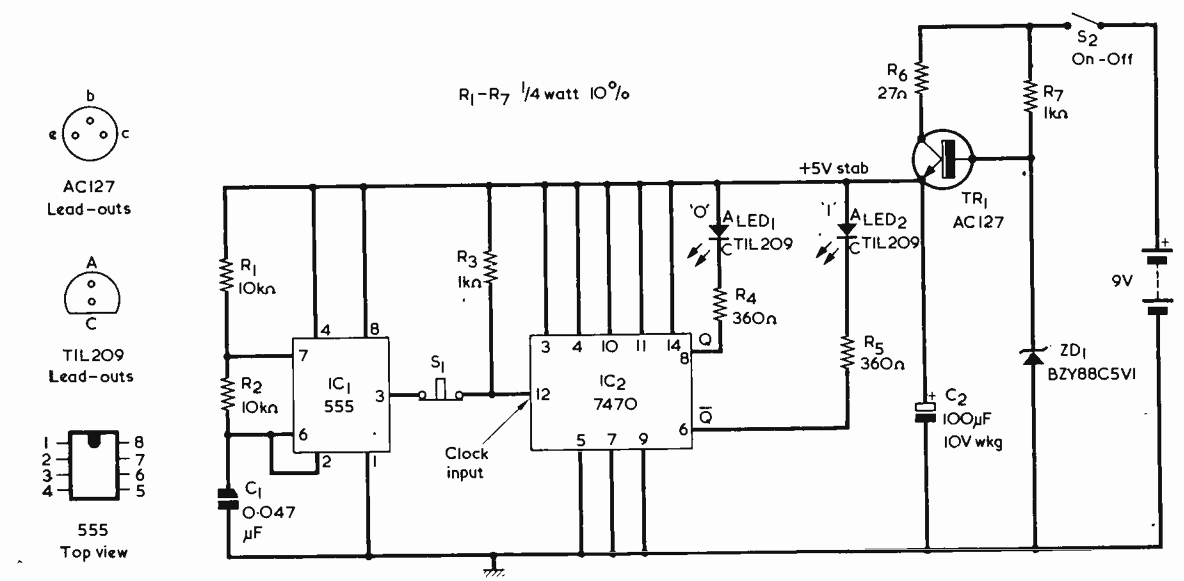


Fig. 2. The circuit of the Gambling Device. The chassis connection is made to the case if this is metal

"Yes", replied Dick. "That seems to have got the stabilized supply all buttoned up. Let's move on to the 555 timer."

"Well," said Smithy, "there's nothing startling about the 555 circuit either, because it's used in quite a standard multivibrator arrangement. The 555 can operate at supply voltages between 4.5 and 16 volts, and so it works quite happily at the 5 volts which is available for it here. After switch-on, C1 commences to charge via R1 and R2 until the voltage across it reaches two-thirds of the supply voltage. This voltage triggers the internal comparator connected to pin 6, whereupon pin 7 is taken down close to chassis potential and C1 discharges via R2 on its own. When the voltage across C1 reaches one-third of supply potential a second internal comparator, connected to pin 2, comes into play and causes pin 7 to become open again. The capacitor then charges once more via R1 and R2 until the voltage across it reaches two-thirds of supply voltage. At this point it starts to discharge again via R2 on its own, and so the cycles proceed. The output at pin 3 is at a high positive state when the capacitor is charging and it is at a low state when the capacitor is discharging. If the output currents are low, as occures in my circuit, the output voltage at pin 3 is about 1.2 volts below the positive supply rail when it's high, and is about 0.25 volts above the negative supply rail when it's low."

"If," said Dick thoughtfully, "the output at pin 3 is high when C1 charges via R1 and R2 and is low when C1 discharges into R2 on its own, the period of time in the cycle when the output is high will be longer than the period when it is low."

"That's true," confirmed Smithy. "The output at pin 3 is not a true 50:50 square wave, but this doesn't matter. All we require here are negative-going waveform edges which are spaced out at equal intervals of time, and the 555 definitely gives us these. The frequency at which it oscillates, incidentally, is approximately 1kHz."

PRESS-BUTTON

"Well," said Dick brightly, "things look nice and easy so far. The trouble is that we now come on to this dratted J-K flip-flop thing."

"Don't trouble yourself too much over the flip-flop," grinned Smithy, "we aren't going to do anything very complicated with it and, in fact, we shan't even be using it anywhere near its full capability. As we already know, we have an output waveform with regularly spaced negative-going pulse edges at pin 3 of the 555 oscillator. This waveform is applied, via the normally closed push-button S1, to pin 12 of the 7470. Pin 12 is its clock input."

"Blimey," said Dick desperately, "a *clock* input, now! How the heck do clocks come into it?"

"Digital computers," stated Smithy, "have a continuously running pulse generator which is referred to as the clock. The devices in the computer which carry out arithmetic functions, such as a J-K flip-flop, are all coupled to the clock, with the result that they all move to the next logic function at the appropriate part of each clock pulse. Usually, this is at the negative-going edge of the clock pulse. In consequence, the whole calculating part of the computer moves from one step to the next at the frequency of the clock. The speed of the computer is, in fact, governed by clock frequency. And, for our present purposes, that's all you need to know about the clock."

"Just that?"

"Just that," confirmed Smithy. "Now, a basic J-K flip-flop has two inputs which are called input J and input K. It also has an output which is referred to as output Q, and another output which is known as not-Q, and which is represented by the letter Q with a bar drawn above it to indicate 'not'." (Fig. 3.)

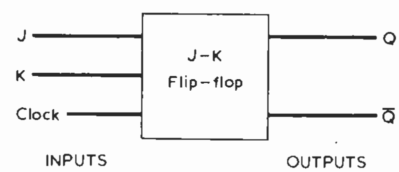


Fig. 3. A simple J-K flip-flop

"This 'not' business raises no difficulties," said Dick confidently. "We've bumped into it on quite a few occasions in the past."

"Good," said Smithy. "Since we are now entering t.t.l.-land, which is the natural habitat of integrated circuits in the 74 series, we have to start using a little t.t.l. language. To start off with, all the devices in the 74 series work with what is known as 'positive logic'. With this, we state that an output or an input which is at a high positive voltage with respect to earth or ground is at logical 1, and that an output or an input which is at a low positive potential is at logical 0. We can apply these terms to the output at pin 3 of the 555 oscillator. When this output is high it's at logical 1, and when it's low it's at logical 0. All right?"

"Yes, sure," replied Dick cheerily. "And, of course, we can't have any numbers other than 1 and 0 because t.t.l. devices work in binary notation, in which the only numbers *are* 1 and 0."

"You've got it," said Smithy approvingly. "Now that basic J-K flip-flop I mentioned a few moments ago has two outputs, Q and not-Q. It follows from what I've just said that when output Q is at 1, output not-Q is at 0. Similarly, when output Q is at 0, output not-Q is at 1. All this production of output voltages is, of course, carried out by the transistors inside the flip-flop, these being connected together in a fairly complex manner."

"I think," said Dick hastily, "we'd better leave the internal circuitry of the flip-flop for another time."

"Such as when ?"

"Oh, around 1996!"

"Fair enough," chuckled Smithy. "We'll keep to simple considerations for the time being and take the flip-flop internal circuitry for granted. I'm now going to draw up a truth table for the J-K flip-flop."

He took a ball-point pen from his pocket and started to draw the truth table alongside the circuit diagram on the piece of paper.

"There's a slightly indigestible bit coming now," he warned. "However, it won't be too difficult if you forget about the not-Q output for the moment and just think about the Q output."

TRUTH TABLE

Smithy completed the table and put his pen back in his pocket. (Fig. 4.)

"That truth table looks a bit different from the ones I've seen in the past," said Dick suspiciously. "For a start it's got two lots of headings for the columns."

"Ah yes," replied Smithy. "Well now, the first two columns apply to the states of J and K at any instant of time between the actuating downward-going edges of two clock pulses. This instant is referred to as Tn. The third column covers the state of Q at a time Tn+1. This is the time period after one clock pulse actuating edge has been applied to the flip-flop."

"Keep at it, Smithy," said Dick. "You haven't lost me yet!"

"Right,' said Smithy briskly. "The top line in the table applies to the instance where both J and K are 0. After the actuating clock pulse edge the value of Q, in the third column, is Qn. This means that Q, at Tn+1, is the same as it was at Tn. If it was 1 before the clock pulse actuating edge it is 1 after the actuating edge. Similarly, if it was 0 before the actuating edge it is 0 after the actuating edge. With J and K at zero, the clock pulse has no effect on the state of Q."

"Okeydoke," said Dick, frowning. "Let's carry on to the second line."

"In the second line," continued Smithy, "J is 1 and K is 0. After the clock pulse Q is also 1, regardless of whether it was 1 or 0 before. Moving on to the third line we have J at 0 and K at 1. Q then becomes 0 after the clock pulse, irrespective of what value it had before. We can sum up the second and third lines by saying that, when J and K are in opposite states the value of Q after the actuating edge of the clock pulse is always equal to the value of J."

"Fair enough," said Dick, "I've absorbed that bit, too."

"We now come to the fourth line", stated Smithy. "Here, both J and K are 1 whereupon, after the clock pulse, the output at Q is not-Qn."

"Look," pronounced Dick. "We stop right here! What do you mean, the output at Q is not-Qn?"

"In the first line," said Smithy in reply, "the value of Q was Qn after the clock pulse. In the fourth line, the value of Q is not-Qn. This means that if Q was 1 before the clock pulse edge it changes to 0 after the clock pulse edge. And if it was 0 before the clock pulse edge it changes to 1 after the pulse edge."

"Now, let's think about this for a moment," said Dick reflectively. "If we keep both the J and the K inputs at 1, and the Q output is also 1, the Q output will change from 1 to 0 after one clock pulse edge, from 0 to 1 after the next clock pulse edge, from 1 back to 0 after the following pulse edge, and so on."

"That's exactly right," confirmed Smithy. "And we can next return to the circuit of this gadget of mine because, in this, both the J and K inputs of the flip-flop are effectively at logical 1. We can achieve this by simply connecting the J and K inputs to the 5 volt positive supply rail. If, now, we feed a train of pulses into the clock input of the flip-flop, output Q will alternate from 0 to 1 and back again with each pulse. Output Q of the flip-flop couples via R4 and LED1 to the positive rail, with the result that LED1 lights up whenever the Q output is low or is at 0, and extinguishes whenever the Q output is high or is at 1." (Fig. 5.)

"Gosh," breathed Dick. "This is beginning to get clearer all the time."

"I said just now," remarked Smithy, "that you should forget the not-Q output for a bit. We can now bring it back into the discussion by pointing out that, in my circuit, it couples to the positive rail via a second resistor, R5, and a second l.e.d., LED2. So, when LED1 is alight, LED2 is extinguished. Conversely, when LED1 is out, LED2 is alight."

Smithy stopped and gazed expectantly at his assistant.

"I've got the whole picture now," stated Dick. "You first of all switch on the gadget at S2 whereupon the 555 i.c. starts oscillating at around 1kHz. The 1kHz output from the 555 is applied to the clock input of the 7470, and it causes LED1 to light up during one cycle and LED2 to light up during the

Tn		Tn+1
J	K	Q
0	0	Qn
1	0	1
0	1	0
1	1	$\bar{Q}n$

Fig. 4. Truth table for the J-K flip-flop.

following cycle. The l.e.d.'s are turned on and off so quickly that they seem to be continually illuminated. If, now, switch S1 is pressed, the switching waveform is disconnected from the clock input of the 7470, and it then stays in the state it was in at the instant of breaking the connection."

"You've got it," affirmed Smithy. "The breaking of the connection at S1 can occur when either LED1 or LED2 is alight, and this is a purely random matter as it is impossible to select the exact instant when either is on. In consequence, pressing the button causes either LED1 or LED2 to remain alight in truly random fashion. Whichever l.e.d. lights up, it glows with a higher intensity than before because it has current applied to it continually instead of for half the time."

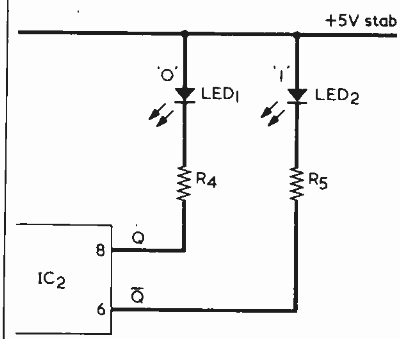


Fig. 5. LED1 is illuminated when the output at pin 8 of IC2 is low, and LED2 lights up when the output at pin 6 is low

FURTHER POINTS

"This is really something," stated Dick enthusiastically, as he looked once more at the circuit of Smithy's device. "Hey, wait a minute, though!"

"What's up?"

"Things aren't quite as simple as you've made out," said Dick accusingly. "For instance, what's that 1kΩ resistor doing between the clock input and the 5 volt positive rail?"

"That's merely to hold the clock input firmly at 1 after you've pressed S1," explained Smithy. "The resistor is quite possibly not necessary, but I added it just to be on the safe side. Its value is not at all critical and it has no effect on circuit operation when the press-button is closed."

"Fair enough," commented Dick slowly. "There's something else that's worrying me, too. You said just now that all we had to do was to connect the J and K inputs to the positive rail. So far as I can see this merely means connecting three pins to the positive rail, two for J and K and one for the positive supply. You've got no less than five pins connecting to positive. Come to think of it, you've got three pins connecting to negative, too."

"I wondered how long it would be before you noticed that," grinned Smithy. "Let's see if I can find a data sheet for the 7470, and show you what is actually given in this integrated circuit."

Smithy hunted through his papers and eventually found the sheet he required. He put it down on his bench and pointed to a diagram illustrating the 7470 in its 14 pin d.i.l. package (Fig. 6.)

"The practical J-K flip-flops you bump into," he went on, "don't have a single J and a single K input, as in the simple version I described to you. Normally, they have two or three J and K inputs going into an AND gate before they hit the flip-flop circuitry. When this happens you have to tie *all* the J and *all* the K inputs to the positive rail to give you the situation where J and K are at 1. If you look at this pinning diagram for the 7470 you'll see that pins 3 and 4 are labelled J1 and J2 and both go to an AND gate. Similarly K1 and K2, at pins 10 and 11, go to another AND gate. So, as a kick-off, we have to connect pins 3, 4, 10 and 11 to the positive rail, as well as the positive supply point at pin 14."

"That doesn't clear up all the J and K connections,' said Dick. "There are two pins, 5 and 9, which are marked as J and K with an asterisk."

"Those inputs are peculiar to the 7470," stated Smithy. "What happens here is that pin 5 goes to the J AND gate via an inverter, and that pin 9 goes to the K AND gate via another inverter. So these two pins have to be connected to the *negative* rail to ensure that all inputs of the two AND gates are at logical 1."

"Blimey," said Dick. "Well, that sounds a bit complicated at first, but I must admit it makes sense when I think about it. Hell's teeth, there's something else, too! There's one pin marked 'Preset' and another marked 'Clear'. We haven't even talked about these yet."

"I know we haven't," replied Smithy. "Those two pins enable further logic functions to be carried out with the flip-flop. Fortunately, we don't need to use them for the present application. In consequence we simply ignore them and make no connections to the pins."

"Suits me," said Dick cheerfully. "I think I've taken in enough gen on the J-K flip-flop for one session. Let's try out this gadget of yours, Smithy."

"Righty-ho," said Smithy obligingly.

He picked up the little plastic box, placed it in front of his assistant and switched it on. At once the two l.e.d.'s glowed.

RANDOM OPERATION

Dick leaned forward and pushed the press-button. The l.e.d. marked '0' glowed on its own. Dick released the press-button and pushed it again. Once more the l.e.d. marked '0' lit up. Dick took his finger off the button then made a further attempt. For the third

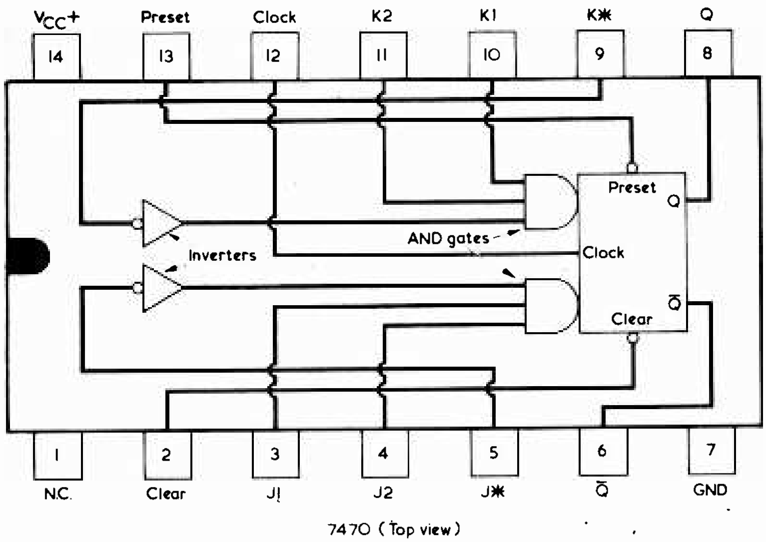


Fig. 6. Block diagram illustrating the pin connections and internal circuitry of the 7470 J-K flip-flop

time the 'O' l.e.d. came alight.

"Hey," he said critically, "this device is a bit one-sided, isn't it?"

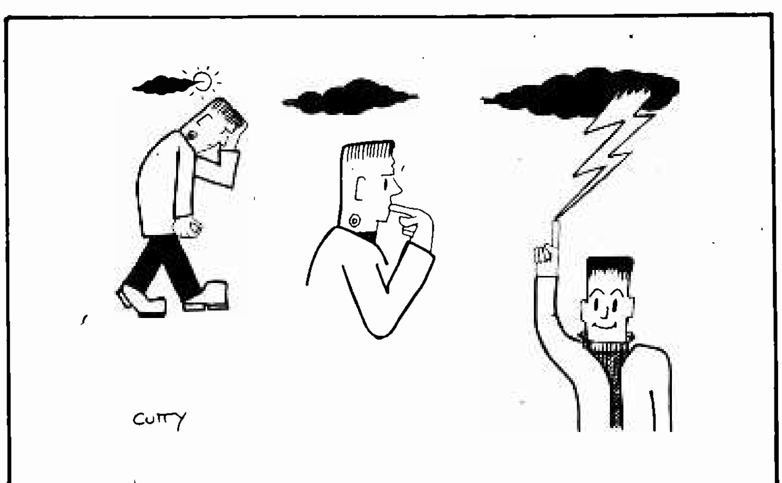
"Don't worry about it," advised Smithy. "You often get runs like that in random 2-way devices. Don't forget that, even if the 'O' light has lit up for as much as six successive times, the chances of it lighting up on the seventh time are still 50:50. If you want to check a gadget like this for bias you have to operate it for something like several hundred times, keeping a score for each l.e.d. After this number of operations the scores for the two l.e.d.'s should be roughly equal if there's no bias towards one."

Tentatively, Dick pushed the press-button once more. This time the '1' l.e.d. came alight.

"Hey," he chuckled, "this is fun. Here, I'll bet you two pence that the next time it will be the 'O' l.e.d."

"You're on," said Smithy, digging into his pocket.

And, such is the lure of gambling for even the most moderate of men that the June sun, already fairly low in the heavens when we joined our intrepid wanderers along the boundless avenues of electronics, had almost completely set as we leave them after they had decided to call it a day and were counting their gains or losses. And such was the random nature of Smithy's Binary Gambling Device that they were both surprised to find that they had each ended with exactly the same amount of money as they had when they started. ■



ZENER-TRANSISTOR CIRCUITS

By F. T. Jones

A minor variation on a familiar theme

We frequently encounter the simple power supply voltage stabilizing circuit shown in Fig. 1. A relatively constant voltage appears across the zener diode and is applied to the emitter follower, TR1. The stabilized voltage at TR1 emitter is equal to the zener voltage less the base-emitter voltage drop in the transistor. If this is a silicon device the voltage drop is around 0.6 to 0.7 volt, and we shall refer to it here as 0.65 volt.

The circuit of Fig. 1 has the advantage that most of the supply current passes through the transistor. The current drawn from the zener diode circuit is then the much smaller base current required by the transistor.

DARLINGTON PAIR

If the supply current is high, or if it is required that the current pass device has a high gain (whereupon current demand from the zener diode circuit is further reduced) it is common practice to add a second transistor, TR2, to form a Darlington pair as in Fig. 2. The base current drawn by TR1 is now approximately equal to the supply current divided by the product of the gains of the two transistors. TR2 passes most of the supply current and will normally be a power transistor.

The circuit offers sufficiently good voltage

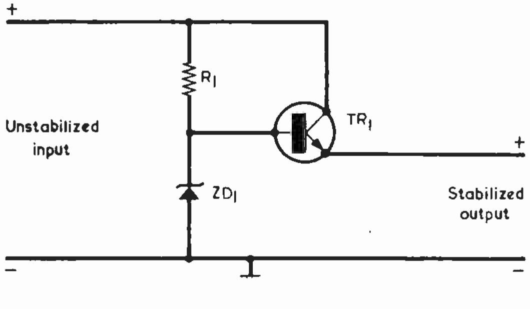


Fig. 1. A simple transistor aided zener diode voltage stabilizing circuit

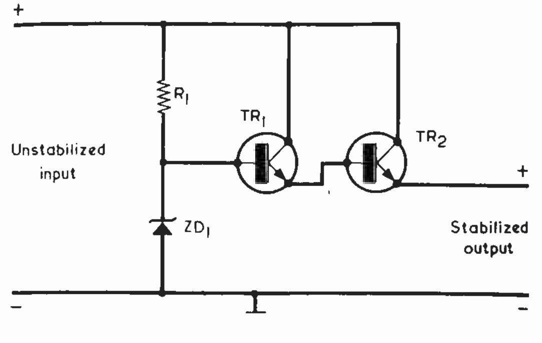
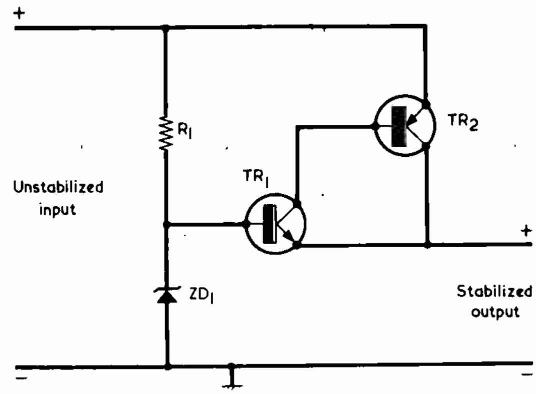


Fig. 2. A second transistor may be added if the supply current is high

Fig. 3. An alternative circuit incorporating two transistors



stabilization for a number of applications, although it may be found that the voltage drop from the base of TR1 to the emitter of TR2 reduces noticeably at very low supply currents. If both transistors are silicon types the voltage drop, at normal supply currents, also becomes rather large, being twice 0.65 volt, or 1.3 volts. Such a voltage drop can be an embarrassment if it is required that the stabilized output voltage be close to the unstabilized input voltage, since the series resistor for the zener diode, R1, then requires a relatively low value. Zener current may consequently vary by an undesirably large amount for shifts in unstabilized input voltage.

A small but useful improvement is given by the circuit of Fig. 3, in which TR2 still passes most of the supply current. The emitter and collector currents in TR1 are virtually equal, and the collector current of TR1 is the base current of TR2. As a result, the emitter current of TR1 is equal to the base current required by TR2 to maintain TR1 emitter (assuming a silicon transistor) at 0.65 volt below the zener voltage. Again, the current drawn from the zener diode circuit is approximately equal to the supply current divided by the product of the two transistor gains, and TR2 may once more be a power device.

The circuit of Fig. 3 has the advantage that, with silicon transistors, the stabilized voltage is only 0.65 volt, instead of 1.3 volts, lower than zener voltage. As with Fig. 2, the voltage drop in the single base-emitter junction of TR1 falls somewhat at very low supply currents, but the effect should be of a lower order.

The circuit of Fig. 3 can, of course, be used in a stabilizing circuit where the upper supply rail is negative. For this application the polarities of the zener diode and the two transistors are all reversed. ■

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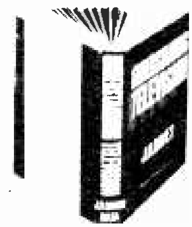

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(Continued on page 709)

SMALL ADVERTISEMENTS

(Continued from page 708)

FOR SALE: Frequency meter TS174 (similar to BC221) 20-280 Mc/s, mains psu, £25. Absorption wavemeters, Marconi TF975, 95kHz/100MHz, £25. STC, R502, 100kHz-48MHz, £20. Signal generators, Marconi TF1446, 85kHz/25MHz, £20. TF801 A/1, 10-300MHz, £30. TF897, 15kHz/35MHz, £40. Advance B4 90kHz/25MHz, £20. Cossor 1049, Mk 3 DB scope, £25. Telequipment 620 scope £30. Metrovick miniscope £20. Avo 7 £14. Avo 8 £20. All in working order. Most have handbooks. S.A.E. enquiries. Carriage extra. Box No. G312.

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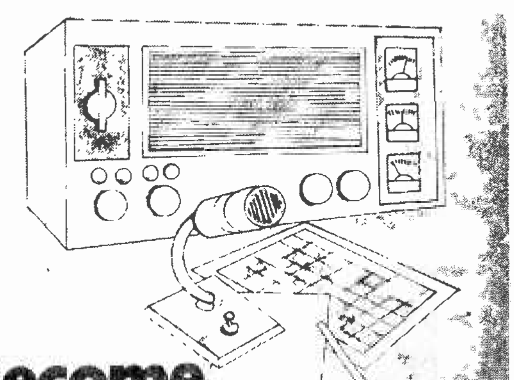
(Continued on page 711)



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(Continued from page 709)

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ELECTRONICS DATA

FOR THE BEGINNER

WHAT RESISTORS DO

If a voltage is applied across a resistor a current flows through it. If a current is caused to flow through a resistor a voltage is dropped across it. The voltage, current and resistance values follow the three Ohm's Law equations in (a), where E is voltage in volts, I is current in amps and R is resistance in ohms. Alternatively, I can be in milliamps and R in kilohms.

In (b) the supply voltage varies between 18 and 20 volts, and a stabilized voltage of 10 volts appears across the zener diode. The 1kΩ series resistor ensures that maximum current flowing to the zener diode is 10mA and minimum current is 8mA.

The input signal at the transistor base in (c) causes the collector current to vary between 0.5mA and 0.7mA, with consequent voltage drops across the 5kΩ resistor of 2.5 and 3.5 volts. The collector signal thus has a total *voltage* amplitude of 1 volt.

A potential divider appears in (d). With no current drawn from their junction, the voltage across each resistor is proportional to its value, whereupon 6 volts appears across the upper resistor and 4 volts across the lower resistor.

A 200kΩ resistor is connected across a parallel tuned circuit in (e) and reduces its efficiency, or *damps* it, thereby causing its response curve to be less sharp. Damping increases as resistance reduces.

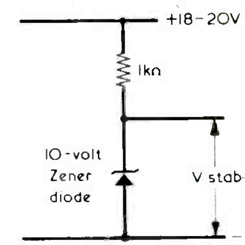
The field-effect transistor in (f) has its gate connected to chassis via a 1MΩ resistor. The current flow in the gate circuit of an f.e.t. is negligibly low and the 1MΩ resistor, despite its high value, holds the gate at chassis potential for bias purposes.

$$R = \frac{E}{I}$$

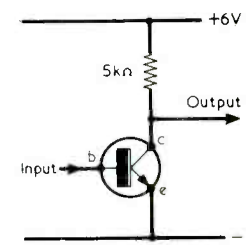
$$I = \frac{E}{R}$$

$$E = IR$$

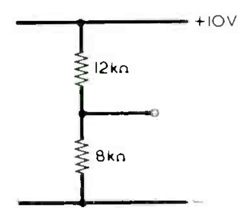
(a)



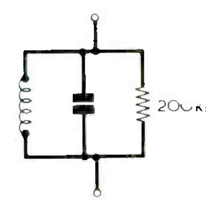
(b)



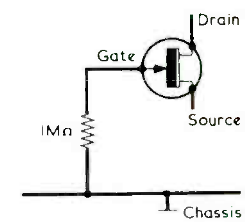
(c)



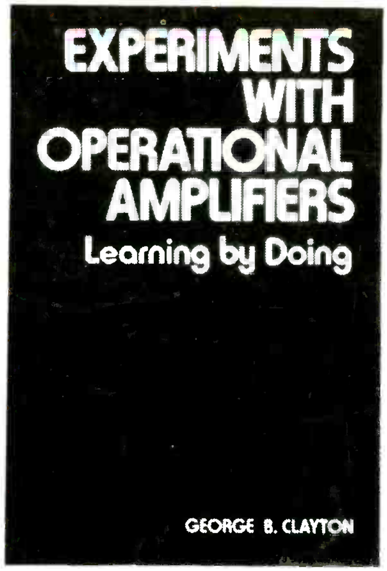
(d)



(e)



(f)



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