RADIO & ELECTRONICS CONSTRUCTOR

MARCH 1979
50p

AN EXCELLENT PROJECT FOR THE NEWCOMER

IC MORSE PRACTICE OSCILLATOR

BAND II PORTABLE

PART ONE

NOVEL TESTING TECHNIQUE

CONSTANT CURRENT TRANSISTOR TESTER

ALSO FEATURED

★ DOPPLER SHIFT ADD-ON UNIT
★ ELECTRONIC 'HANGMAN'

DIODES/ZENERS

QTY.				
	1N914	100v	10mA	.05
	1N4005	600v	1A	.08
	1N4007	1000v	1A	.15
	1N4148	75v	10mA	.05
	1N4733	5.1v	1 W Zener	.25
	1N753A	6.2v	500 mW Zener	.25
	1N758A	10v	"	.25
	1N759A	12v	"	.25
	1N5243	13v	"	.25
	1N5244B	14v	"	.25
	1N5245B	15v	"	.25

SOCKETS/BRIDGES

QTY.					
8-pin	pcb	.20	ww	.35
14-pin	pcb	.20	ww	.40
16-pin	pcb	.20	ww	.40
18-pin	pcb	.25	ww	.95
20-pin	pcb	.35	ww	.95
22-pin	pcb	.35	ww	.95
24-pin	pcb	.35	ww	.95
28-pin	pcb	.45	ww	1.25
40-pin	pcb	.50	ww	1.25
Molex pins	.01	To-3 Sockets		.25
2 Amp Bridge		100-prv		.95
25 Amp Bridge		200-prv		1.50

TRANSISTORS, LEDS, etc.

QTY.		
2N2222	(2N2222 Plastic .10)	.15
2N2222A		.19
2N2907A	PNP	.19
2N3906	PNP (Plastic Unmarked)	.10
2N3904	NPN (Plastic Unmarked)	.10
2N3054	NPN	.45
2N3055	NPN 15A 60v	.60
T1P125	PNP Darlington	1.95
LED Green,	Red, Clear, Yellow	.15
D.L.747	7 seg 5/8" High com-anode	1.95
MAN72	7 seg com-anode (Red)	1.25
MAN3610	7 seg com-anode (Orange)	1.25
MAN82A	7 seg com-anode (Yellow)	1.25
MAN74	7 seg com-cathode (Red)	1.50
FND359	7 seg com-cathode (Red)	1.25

9000 SERIES

QTY.		QTY.	
9301	.85	9322	.65
9309	.35	9601	.20
9316	1.10	9602	.45

MICRO'S, RAMS, CPU'S, E-PROMS

QTY.		QTY.	
8T13	1.50	2107B-4	4.95
8T23	1.50	2114	9.50
8T24	2.00	2513	6.25
8T97	1.00	2708	10.50
74S188	3.00	2716 D.S.	34.00
1488	1.25	2716 (5v)	59.00
1489	1.25	2758 (5v)	23.95
1702A	4.50	3242	10.50
AM 9050	4.00	4116	11.50
		6800	13.95
MM 5314	3.00	6850	7.95
MM 5316	3.50	8080	7.50
MM 5387	3.50	8212	2.75
MM 5369	2.95	8214	4.95
TR 1602B	3.95	8216	3.50
UPD 414	4.95	8224	3.25
Z 80 A	22.50	8228	6.00
Z 80	17.50	8251	7.50
Z 80 PIO	10.50	8253	18.50
2102	1.45	8255	8.50
2102L	1.75	TMS 4044	9.95

C MOS

QTY.		
	4000	.15
	4001	.15
	4002	.20
	4004	3.95
	4006	.95
	4007	.20
	4008	.75
	4009	.35
	4010	.35
	4011	.20
	4012	.20
	4013	.40
	4014	.75
	4015	.75
	4016	.35
	4017	.75
	4018	.75
	4019	.35
	4020	.85
	4021	.75
	4022	.75
	4023	.20
	4024	.75
	4025	.20
	4026	1.95
	4027	.35
	4028	.75
	4029	1.15
	4030	.30
	4033	1.50
	4034	2.45
	4035	.75
	4037	1.80
	4040	.75
	4041	.69
	4042	.65
	4043	.50
	4044	.65
	4046	1.25
	4048	.95
	4049	.45
	4050	.45
	4052	.75
	4053	.75
	4066	.55
	4069/74C04	.35
	4071	.25
	4081	.30
	4082	.30
	4507	.95
	4511	.95
	4512	1.10
	4515	2.95
	4519	.85
	4522	1.10
	4526	.95
	4528	1.10
	4529	.95
	MC14409	14.50
	MC14419	4.85
	74C151	1.50

LINEARS, REGULATORS, etc.

QTY.		QTY.		QTY.	
MCT2	.95	LM323K	5.95	LM380 (8-14 Pin)	1.19
8038	3.95	LM324	1.25	LM709 (8-14 Pin)	.35
LM201	.75	LM339	.75	LM711	.45
LM301	.45	7805 (340T5)	.95	LM723	.40
LM308	.65	LM340T12	.95	LM725	2.50
LM309H	.65	LM340T15	.95	LM739	1.50
LM309K (340K-5)	1.50	LM340T18	.95	LM741 (8-14)	.35
LM310	.85	LM340T24	.95	LM747	1.10
LM311D	.75	LM340K12	1.25	LM1307	1.25
LM318	1.75	LM340K15	1.25	LM1458	.65
LM320H6	.79	LM340K18	1.25	LM3900	.50
LM320H15	.79	LM340K24	1.25	LM75451	.65
LM320H24	.79	LM373	2.95	NE555	.45
7905 (LM320K5)	1.65	LM377	3.95	NE556	.85
LM320K12	1.65	78L05	.75	NE565	.95
LM320K24	1.65	78L12	.75	NE566	1.25
LM320T5	1.65	78L15	.75	NE567	.95
LM320T12	1.65	78M05	.75		
LM320T15	1.65				

– T T L –

QTY.		QTY.		QTY.		QTY.	
7400	.10	7482	.75	74221	1.00	74LS02	.30
7401	.15	7483	.75	74367	.95	74LS04	.30
7402	.15	7485	.55	75108A	.35	74LS05	.35
7403	.15	7486	.25	75491	.50	74LS08	.35
7404	.10	7489	1.05	75492	.50	74LS09	.35
7405	.25	7490	.45	74H00	.15	74LS10	.35
7406	.25	7491	.70	74H01	.20	74LS11	.35
7407	.55	7492	.45	74H04	.20	74LS20	.30
7408	.15	7493	.35	74H05	.20	74LS21	.35
7409	.15	7494	.75	74H08	.35	74LS22	.35
7410	.15	7495	.60	74H10	.35	74LS32	.35
7411	.25	7496	.80	74H11	.25	74LS37	.35
7412	.25	74100	1.15	74H15	.45	74LS38	.45
7413	.25	74107	.25	74H20	.25	74LS40	.40
7414	.75	74121	.35	74H21	.25	74LS42	.75
7416	.25	74122	.55	74H22	.40	74LS51	.45
7417	.40	74123	.35	74H30	.20	74LS74	.45
7420	.15	74125	.45	74H40	.25	74LS76	.50
7426	.25	74126	.35	74H50	.25	74LS86	.45
7427	.25	74132	.75	74H51	.25	74LS90	.65
7430	.15	74141	.90	74H52	.15	74LS93	.65
7432	.20	74150	.85	74H53	.25	74LS107	.50
7437	.20	74151	.65	74H55	.20	74LS123	1.20
7438	.20	74153	.75	74H72	.35	74LS151	.85
7440	.20	74154	.95	74H74	.35	74LS153	.85
7441	1.15	74156	.70	74H101	.75	74LS157	.85
7442	.45	74157	.65	74H103	.55	74LS160	.95
7443	.45	74161	.55	74H106	.95	74LS164	1.20
7444	.45	74163	.85	74L00	.25	74LS193	1.05
7445	.65	74164	.60	74L02	.20	74LS195	.95
7446	.70	74165	1.10	74L03	.25	74LS244	1.70
7447	.70	74166	1.25	74L04	.30	74LS367	.95
7448	.50	74175	.80	74L10	.20	74LS368	.95
7450	.25	74176	.85	74L20	.35	74S00	.35
7451	.25	74180	.55	74L30	.45	74S02	.35
7453	.20	74181	2.25	74L47	1.95	74S03	.25
7454	.25	74182	.75	74L51	.45	74S04	.25
7460	.40	74190	1.25	74L55	.65	74S05	.35
7470	.45	74191	1.25	74L72	.45	74S08	.35
7472	.40	74192	.75	74L73	.40	74S10	.35
7473	.25	74193	.85	74L74	.45	74S11	.35
7474	.30	74194	.95	74L75	.85	74S20	.25
7475	.35	74195	.95	74L93	.55	74S40	.20
7476	.40	74196	.95	74L123	.85	74S50	.20
7480	.55	74197	.95	74LS00	.30	74S51	.25
7481	.75	74198	1.45	74LS01	.30	74S64	.15
						74S74	.35
						74S112	.60
						74S114	.65
						74S133	.40
						74S140	.55
						74S151	.30
						74S153	.35
						74S157	.75
						74S158	.30
						74S194	1.05
						74S257 (8123)	1.05
						8131	2.75

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

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THE APRIL ISSUE
WILL BE PUBLISHED
ON 10th MARCH

SUPERSOUND 13 HI-FI MONO AMPLIFIER

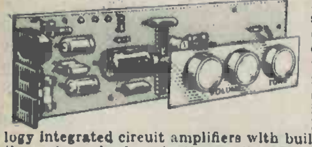
A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power out-put transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz. 30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £16.00. P. & P. £1.20.

HARVERSONIC MODEL P.A. TWO ZERO

An advanced solid state general purpose mono amplifier suitable for Public Address system, Disco, Guitar, Gram., etc. Features 3 individually controlled inputs (each input has a separate 2 stage pre-amp). Input 1, 15mv into 47k. Input 2, 15mv into 47k. (suitable for use with mic. or guitar etc.) Input 3 200mv into 1 meg. suitable for gram, tuner, or tape etc. Full mixing facilities with full range bass & treble controls. All inputs plug into standard jack sockets on front panel. Output socket on rear of chassis for an 8 ohm or 16 ohm speaker. Output in excess of 20 watts R.M.S. Very attractively finished purpose built cabinet made from black vinyl covered steel, with a brushed anodised aluminium front escutcheon. For ac mains operation 200/240v. Size approx. 12½"w. x 5" h. x 7½" d.

Special introductory price £28.00 + £2.50 carr & pkg.

HARVERSONIC STEREO 44



A solid state stereo amplifier chassis, with an output of 3-4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with built in short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets and 5 pin din tape rec./play socket are mounted on the printed circuit panel, size approx. 9½" × 2¾" × 1" max. depth. Supplied brand new and tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically), at only £10.00 plus 50p P. & P. Mains transformer with an output of 17V a/c at 500 m/a can be supplied at £2.00 plus 40p P. & P. if required. Full connection details supplied.

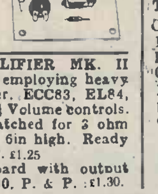
BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240v. Secondary combinations 0-5-10-15-20-25-30-35-40-60v. half wave at 1 amp. or 10-0-10, 20-0-20, 30-0-30v. at 2 amps full wave. Size 3in. long × 3½in. wide × 3in. deep. Price £3.20 P. & P. £1.20.

MAINS TRANSFORMER. For power supplies.
Pri. 200/240v. Sec. 9-0-9 at 500 mA. £1.80 P. & P. 65p.
Pri. 200/240v. Sec. 12-0-12 at 1 amp. £2.00 P. & P. 65p.
Pri. 200/240v. Sec. 10-0-10 at 2 amp. £2.70 P. & P. 90p.
Pri. 200/240v. Sec. 23v. at 1.5 amp, 6v at ·6 amp, 8v. at 50 mA. £2.25 + 65p P. & P.

MAINS TRANSFORMER. Pri. 0.110 and 240 Sec. 28V at 1.8 amps. Also tapped at 12V ·3 amp. Size 2¾in hx 3¼in w x 2¾ in d. £2.50 + £1 P. & P.

ALL PURPOSE POWER SUPPLY UNIT 200/240v. A.C. input. Four switched fully smoothed D.C. outputs giving 6v. and 7½v. and 9v. and 12v. at 1 amp on load. Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case overall size 6" × 3½" × 2¾". Ready built and tested. Price £6.75. P. & P. 95p

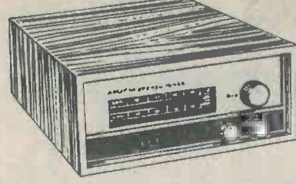
STEREO-DECODER SIZE, 2"×3"×½"



Ready-built. Pre-aligned and tested. Sens. 20-560mV for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £6.00 plus 20p P. & P. Stereo beacon light if required 40p extra.

QUALITY RECORD PLAYER AMPLIFIER MK. II A top quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in wide × 3in deep × 6in high. Ready built and tested. PRICE £7·00, P. & P. £1.25
ALSO AVAILABLE mounted on board with output transformer and speaker. PRICE £8·00. P. & P. £1.30.

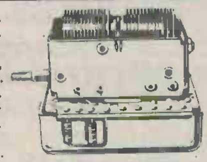
MAINS OPERATED SOLID STATE AM/FM STEREO TUNER



200/240V Mains operated Solid State A/M F/M Stereo Tuner. Covering M.W. A.M. 540-1605 KHZ, VHF/FM 88-108 MHZ. Built-in Ferrite rod aerial for M.W. Full AFC and AGC on AM and FM. Stereo Beacon Lamp Indicator. Built-in Pre-amps with variable output voltage adjustable by pre-set control. Max o/p Voltage 600 m/v RMS into 20K. Simulated teak finish cabinet. Will match almost any amplifier. Size 8½" w. × 4" h. × 9½" d. approx. LIMITED NUMBER ONLY at £28.00 + £1.50 P. & P.

SPECIAL OFFERS

Mullard LP1159 RF-IF Double Tuned Amplifier Module for nominal 470kHz. Size approx. 2¾" × 1½" × ⅝" 7·6V + earth. Brand new pre-aligned. Full specification and connection details supplied. £2·25 + P. & P. 20p.



Pye VHF/FM Tuner Head covering 88-108M/Hz. 10·7M/Hz IF output 7-8V + earth. Supplied pre-aligned, with full circuit diagram. Connection details supplied. Beautifully made with precision-geared FM Gang and 323 Pf + 323 Pf AM Tuning Gang only £3·15 + P. & P. 35p.

PRECISION MADE
Push Button Switch bank. 8 Buttons giving 16 S/P C/O interlocked switches plus 1 Cancel Button Plus 3 d/p c/o. Overall size 5" × 2½" × 1". Supplied complete with chrome finished switch buttons 2 for £1 ·0 + 20p, P. & P.

SPECIAL OFFER
Limited number only!

New but very slightly shop soiled transistor radios by well known manufacturer. Very smart and attractive, vinyl covered with carrying handle.
Two models available:
AC mains or battery operated and covering VHF/FM and MW bands. **£10.00 + £1.30 p&p**

Similar to above but battery operation only. Five wavebands, MW, FM, SW and two VHF bands for reception of aircraft and some public service systems. **£11.00 + £1.30 p&p**

Size (either model), 7in.H x 9½in.W x 4in. D approx. Both types have telescopic aerials for VHF/FM reception and internal ferrite aerials for AM bands, also earphone socket for personal listening. Either model uses four HP11 or SP11 batteries (not supplied).

LOUDSPEAKER BARGAINS
5in. 3 ohm £2.20, P. & P. 35p. 7 x 4in. 3 ohm £2.80, P. & P. 48p. 10 x 6in. 3 or 15 ohm £3.85, P. & P. 75p. 8 x 5in. 3 ohm with high flux magnet £3.60, P. & P 60p. Tweeter. Approx. 3½". Available 3 or 8 or 15 ohms, £2.20, 30p P. & P.

2" PLASTIC CONE HF TWEETER 4 ohm, £3·50 per matched pair + 50p P. & P.

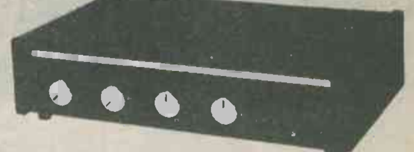
HIGH POWER HI-FI 8 ohm Dome Tweeter. 1" voice coil. Magnet size 3" dia. Suitable for use in up to 50 watt systems. £4·50 each + 60p P. & P.

VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 54 in. wide. Our price £2.00 yd. length. P. & P. 50p per yd. (min. 1 yd.). S.A.E. for samples.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 11¾" × 14¼" × 1⅟₁₆" deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz–20kHz. Can be mounted on ceilings, walls, etc. and used with or without baffle. Send S.A.E. for details. Only £8·40 each. P. & P. 90p for one, £1.10 for two.
Now available in either 8" round version or 4½" x 8½" rectangular 10 watts R.M.S. 60Hz-20KHz £5.25 + P. & P. (one 65p, two 75p)

SONOTONE 9TAHC COMPATIBLE STEREO CARTRIDGE T/O stylus Diamond Stereo LP and Sapphire 78. ONLY £2.50 P. & P. 20p. Also available fitted with twin Diamond T/O stylus for Stereo LP. £3.00. P. & P. 20p.
LATEST CRYSTAL T/O STEREO/COMPATIBLE CARTRIDGE for EP/LP/Stereo 78. £2.00 P. & P. 20p
LATEST T/O MONO COMPATIBLE CARTRIDGE for playing EP/LP/78 mono or stereo records on mono equipment. Only £2.00 P. & P. 20p.
STEREO MAGNETIC PRE-AMP sens. 3mVin for 100m Vout 15 to 35V neg earth. Equ. ± 1db. From 20 Hz to 20 KHz. Input impedance 47k. Size 1½in x 2¾in x 5¾H. £2.60 + 20p P. & P.

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT

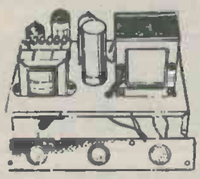


A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specifications: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ± 3dB 12-30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ± 3dB 12-15,000 Hz. Bass, boost approx. to ± 12dB. Treble cut approx. to —16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1·0 amp.
Overall Size 12"w. × 8"d. × 2¾"h.
Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

AMPLIFIER KIT	£14.50	P. & P. 80p
(Magnetic input components 33p extra)		
POWER PACK KIT	£6.00	P. & P. 95p
CABINET	£6.00	P. & P. 95p

Special offer — only £25.00 if all 3 units ordered at one time plus £1.25 P. & P.
Full after sales service
Also available ready built and tested £31·25. P. & P. £1.50.

3-VALVE AUDIO AMPLIFIER HA34 MK II.



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½"w. × 4"d. × 4¾"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £8.50. P. & P. £1.40.

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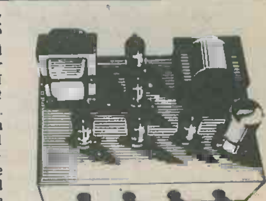

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7403	£0.09	7432	£0.20	7475	£0.27	74118	£0.75	74174	£0.60
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7409	£0.12	7442	£0.38	7484	£0.82	74141	£0.50	74182	£0.55
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7417	£0.22	7450	£0.09	7493	£0.28	74156	£0.48	74195	£0.56
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7422	£0.15	7453	£0.09	7496	£0.48	74161	£0.60	74198	£1.00
7423	£0.20	7454	£0.09	74100	£0.80	74162	£0.60	74199	£1.00
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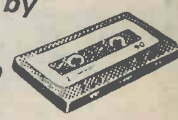

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S103	220 ½watt resistors. Range 100ohms — 10 meg	£2.00*
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S28	6 x 100 K	LOG Single	40p*
S29	6 x 500 K	LOG Single	40p*
S32	6 x 50 K	LIN Single	40p*

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S36	4 x 100 K	LOG Dual	40p*
S37	4 x 1.3 MEG	LOG Dual	40p*
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Min. 3 lbs in weight consisting of a fantastic assortment of Electronic Components — Pots. Resistors. Cons. Switches, Relays, Board-Semiconductors. wire. hardware. Etc., etc., etc.
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STA50 50 watts per channel amplifier kit. Consists: 2 x AL120. 1 x PA200. 1 x SPM120/65. 1 x 2041 transformer. 1 reservoir capacitor 2 x coupling capacitors
£58.20 inc. VAT + £1.16 p&p

STA125 125 watts per channel amplifier kit. Consists: 2 x AL250. 1 x PA200. 2 x SPM120/65. 2 x 2041 Transformers. 1 x reservoir capacitors. 2 x coupling capacitors
£72.85 inc. VAT + £1.25 p&p

TRANSISTORS

BRAND NEW — FULLY GUARANTEED

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC107	25p	BC177	12p	BF194	*9p	TIP32C	36p	2N1613	15p
AC126	14p	BC178	12p	BF195	*9p	TIP41A	34p	2N1711	15p
AC127	16p	BC179	12p	BF196	*12p	TIP41B	35p	2N1893	28p
AC128	16p	BC182	*9p	BF197	*12p	TIP41C	36p	2N2218	15p
AC128K	24p	BC182L	*9p	BF200	25p	TIP42A	36p	2N2218A	18p
AC176	16p	BC183	*9p	BFX29	22p	TIP428	37p	2N2219	15p
AC176K	24p	BC183L	*9p	BFX84	18p	TIP42C	38p	2N2219A	18p
AC187	16p	BC184	*9p	BFY50	12p	TIP2955	65p	2N2221	15p
AC187K	26p	BC184L	*9p	BFY51	12p	TIP3055	42p	2N2221A	16p
AC188	16p	BC212	*10p	BFY52	12p			2N2222	15p
AC188K	26p	BC212L	*10p	MPSA05	*22p	ZTX107	*6p	2N2222A	16p
AD161		BC213	*10p	MPSA06	*22p	ZTX108	*6p	2N2369	10p
162MP	80p	BC213L	*10p	MPSA55	*22p	ZTX109	*7p	2N2904	14p
AF139	30p	BC214	*10p	MPSA56	*22p	ZTX300	*7p	2N2904A	15p
AF239	30p	BC214L	*10p	OC44	12p	ZTX301	*7p	2N2905	14p
BC107	6p	BC251	*10p	OC45	12p	ZTX302	*9p	2N2905A	15p
BC108	6p	BCY70	12p	OC71	9p	ZTX500	*8p	2N2906	12p
BC109	6p	BCY71	12p	OC72	12p	ZTX501	*10p	2N2906A	14p
BC118	*10p	BCY72	12p	OC75	10p	ZTX502	*12p	2N2907	12p
BC147	*8p	BD115	40p	OC81	14p			2N2907A	13p
BC148	*8p	BD131	*35p	TIP29A	35p	2N696	10p	2N2926G	*8p
BC149	*8p	BD132	*37p	TIP29B	36p	2N697	10p	2N2926Y	*7p
BC154	*16p	BF115	17p	TIP29C	38p	2N706	7p	2N3053	12p
BC157	*9p	BF167	19p	TIP30A	36p	2N706A	8p	2N3055	35p
BC158	*9p	BF173	20p	TIP30B	37p	2N708	8p	2N3702	*7p
BC159	*9p	BF180	25p	TIP30C	38p	2N1302	12p	2N3703	*7p
BC169C	*10p	BF181	25p	TIP31A	32p	2N1303	15p	2N3704	*6p
BC170	6p	BF182	25p	TIP31B	33p	2N1304	15p	2N3903	*11p
BC171	*6p	BF183	25p	TIP31C	34p	2M1307	18p	2N3904	*11p
BC172	*6p	BF184	25p	TIP32A	34p	2N1308	22p	2N3905	*11p
BC173	7p	BF185	25p	TIP32B	35p	2N1309	22p	2N3906	*11p

Programable unijunction 2N6027 supplied with data at 24p each

DIODES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AA119	5p	BAX16/		BYZ16	30p	OA85	7p	IS44	3p
AAZ13	4p	OA202	5p	BYZ17	28p	OA90	6p		
BA100	6p			BYZ18	28p	OA91	7p	IN5400	10p
BA115	5p	BY100	15p	BYZ19	28p	OA95	7p	IN5401	11p
BA144	5p	BY127	*10p					IN5402	12p
BA148	10p	BYZ10	32p	OA47	5p	IN34	5p	IN5404	13p
BA173	10p	BYZ11	32p	OA70	5p	IN60	6p	IN5406	16p
BAX13/		BYZ12	32p	OA79	7p	IN914	4p	IN5407	17p
OA200	5p	BYZ13	30p	OA81	7p	IN4148	4p	IN5408	19p

LINEAR I.C.'s

Type	Price	Type	Price	Type	Price
TBA800	*£0.75	uA711	*£0.25	uA748	*£0.28
TBA810	*£0.85	uA703	*£0.20	72558	*£0.45
TBA820	*£0.65	741P	£0.18	MC1310P	*£1.25
LM380	*£0.80	72741	£0.20	76115	*£1.25
LM381	*£1.25	uA741C	£0.20	NE555	£0.22
72709	£0.20	72747	*£0.55	SL414A	*£1.80
uA709	£0.20	748P	*£0.28		

ZN 414 RADIO CHIP 75p*

OPTOELECTRONICS

Displays

No. 1510	707 LED Display	£0.70
No. 1511	747 LED Display	£1.50
No. 1512	727 Dual LED Display	£1.55

LED's

No. S120	.125 Bright Red	£0.09
No. S121	.2 Bright Red	£0.09
No. 1502	.125 Green	£0.12
No. 1505	.2 Green	£0.12
No. 1503	.125 Yellow	£0.12
No. 1506	.2 Yellow	£0.12
No. S82	Clear .2 illuminating Red	£0.10

2nd Quality LED Paks

No. 1507	10 Assorted Colours and Size	£0.75
No. S122	10 x .125 Red	£0.60
No. S123	10 x .2 Red	£0.60

LED Clips

No. 1508/.125	.125	5 for £0.12
No. 1508/.2	.2	5 for £0.15

No. S139 Infra Red Emitter Fairchild FPE100 — £0.50

SPECIAL REDUCTIONS

No. 1514	NORP 12	45p each
No. S76	OCP71	5 for £1.00
No. S83 5,	NIXIE Tubes ITT 5870 ST (including Data)	£2.00
No. S77	Neon Indicator Lamps 230V A.C. state Colour (Red, Amber and Green)	25p each

P.O. RELAYS

S85-2 Off Post Office relays — 40p*

BATTERY HOLDERS

to take 6 x HP7's
Order No. 202 — 10p each

TOOLS All with insulated handles

No. 2011 5 in. wire cutters — £1.55
No. 2012 5 in. long wire plyer — £1.45

EX. G.P.O. MICROSWITCHES

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Unused ex-equipment stabilizer board. Input 30V D.C. Output 20V. Complete with circuit diagram.
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MORSE KEYS: ALL METAL HI-SPEED TYPE **£2.25** PLASTIC TYPE **95p**.

HEADPHONES: 8 OHM STEREO PHONES PADDED EARPIECES AND HEADBAND. CURLY CORD. 30-18KHz ONLY **£3.00**.

OPTO-ISOLATORS, TYPE BX504. INFRA RED LED TO PHOTO CELL 4 LEAD **25p**.

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741 8 PIN D.I.L. I-C's 6 FOR £1.00

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1 1 XENON/TRIAC PULSE TRANSFORMERS 30p. 1:1+1 **PULSE T/F 60p**.

BUZZERS: GPO TYPE 6-12 volts **30p**. 12 volt LARGE PLASTIC DOMED BUZZERS (50mm) LOUD NOTE **50p**. MIN. SOLID STATE BUZZERS. 6-9-12 OR 24 volt. ALL 15mA **75p** each.

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SPECIAL OFFER: ZN414 RADIO CHIPS **75p**. LM380 **80p**. COLVERN 3K 5W wirebound pots **15p**.

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SWITCHES: MIN. TOGGLE SPST 8 x 5 x 7mm **45p**, DPDT 8 x 7 x 7mm **50p**, DPDT CENTRE OFF 12 x 11 x 9mm **75p**, MIN. PUSH TO MAKE OR PUSH TO BREAK 16 x 16mm **15p** EACH TYPE. **SLIDER SWITCHES**: DPDT MIN. **12p**, DPDT C/OFF **20p**. **8-WAY RIBBON CABLE**, MIN. SOLID CORE, **15p** metre.

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CIRCUIT TESTER, simple method of continuity testing...**£1.20**

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PL259 plugs **45p** SO239 sockets **40p** Reducers **12p**

300Ω F.M. INDOOR TAPE AERIALS, T pattern...**35p**

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KRT100, 1,000 Ohms per volt, 1KV AC/DC, 150mA DC current, 0-100K RES, mirror scale, range selector switch...**£4.65**

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Small synchronous 240VAC Motores, with gearbox, 1/5th RPM..................**70p**

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LA1230 ADJ.CORE 15MM DIAM. 14MH. HI Q **6 for 50p**.

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A breadboard as big as your ideas.

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The ideal Breadboard for 1 chip circuits. Accepts 8, 14, 16 and up to 22 pin IC's. Has 130 contact points including two 10-point bus-bars.

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The Breadboard for quick construction of Microprocessors and other circuits. EXP 600 has 550 contacts including two 40-point bus-bars with 0.6" centres.

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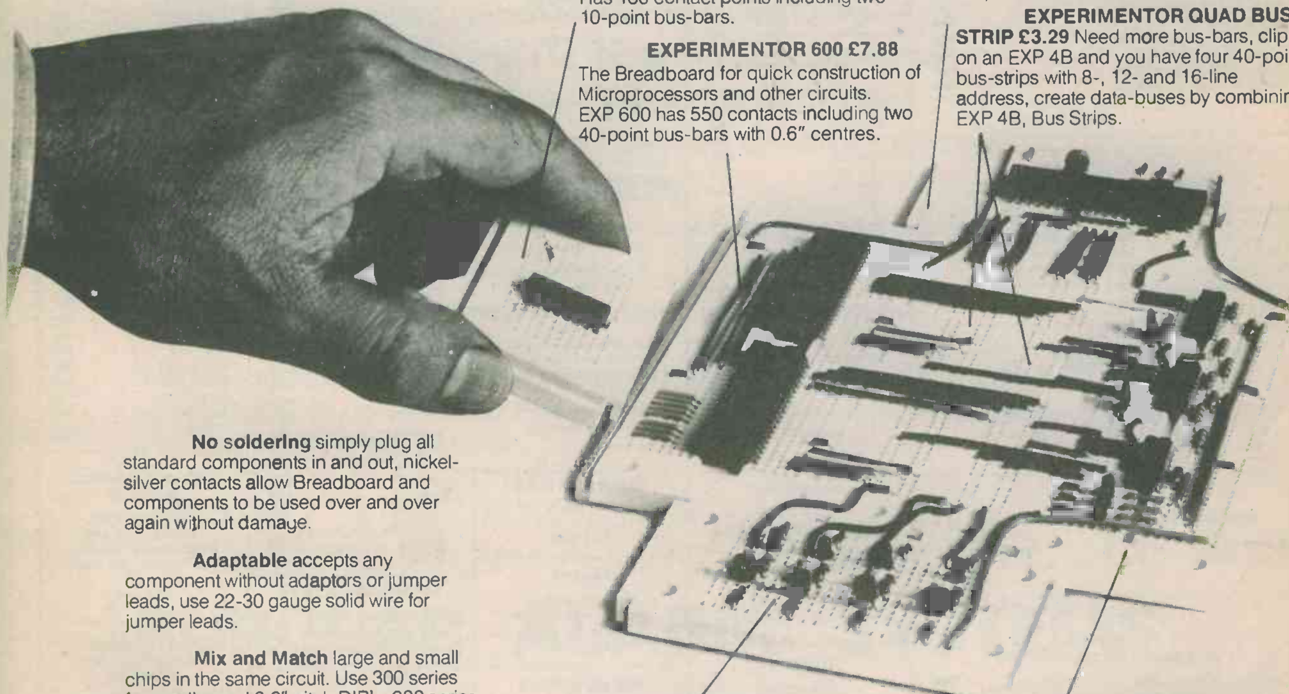

No soldering simply plug all standard components in and out, nickel-silver contacts allow Breadboard and components to be used over and over again without damage.

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Mix and Match large and small chips in the same circuit. Use 300 series for smaller and 0.3" pitch DIP's. 600 series for Microprocessors with 0.6" centre channel for full fan-out with larger chips.

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EXPERIMENTOR 350 £4.21
EXP 350, specifically designed for the hobbyist working with up to 3 x 14 DIP IC's. With 270 contact points including two 20-point bus-bars the EXP 350 accepts any size DIP with 0.3" spacing.

Marked Contact Points transfer component by component from letter/number position on Breadboard to finished P.C. Board or Wiring Table.

Ruggedly built of abrasion-resistant materials that withstand 100°C.

EXPERIMENTOR 300 £7.29
The hobbyists ideal Breadboard, accepts 6 x 14 DIP or 5 x 16 DIP, has 550 contact points including two 40-point bus-bars, accepts any size DIP with 0.3" spacing.

Tailor-Made Breadboards e.g. a project requires up to 5 x 14 DIP chips and needs up to six bus-bars. Which to buy? Easy from the table below select an EXP 300 plus an EXP 4B, total cost £10.58.

Pick any project that you want to build, or any part of a project that you want to test or modify.
Count up the number of IC's you need for the project.
Then simply look up in the box opposite the Breadboard you require.
If you need more than two bus-bars simply add the correct number of Quad-Bus Strips. GET STARTED NOW FOR AS LITTLE AS £2.54.

MODEL NO.	NUMBER OF CONTACT HOLES	IC CAPACITY (14-pin DIP's)	UNIT PRICE (includes Post & VAT)
EXP 300	550	6	£7.29
EXP 600	550	use with 0.6" PITCH DIP's	£7.88
EXP 350	270	3	£4.21
EXP 650	270	use with 0.6" PITCH DIP's	£4.70
EXP 325	130	1	£2.54
EXP 4B	FOUR 40-point Bus-Bars		£3.29

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Six rotary pots	44p
Twenty W/W resistors	36p
Six photo transistors	45p
Twenty electrolytics	32p
Six 2N3819 type FET's	75p
Twenty BC108	40p
Four assorted trimmers	38p
Forty ½ and ¼ w resistors	26p
Six p-channel FET's	55p
Twenty BC109	40p
Fifty assorted diodes	44p
Ten assorted new I.C.'s	28p
Thirty C280 capacitors	25p
Thirty ceramic capacitors	25p
Thirty polystyrene capacitors	25p
Twenty AC128	40p
Twenty 2W zener diodes	32p
Ten vari-cap diodes	25p
Thirty assorted transistors	55p
Forty assorted capacitors	36p

WIREBOUND RESISTORS

1.5 ohm 5W	3p	680 ohm 4W	3p
30 ohm 5W	3p	1k ohm 10W	4p
56 ohm 5W	3p	1k2 ohm 4W	3p
100 ohm 5W	3p	2.2k ohm 5W	3p
500 ohm 10W	4p	2.7k ohm 5W	3p
560 ohm 5W	3p	6.8k ohm 5W	3p

TRIMMERS

Solder-in tubular types: 3pF, 6pF, 8pF, 12pF al' 'o each

Compression types: 10pF, 30pF, 50pF, 1,000pF all 15p each

THYRISTORS

10 amp 100piv	35p
10 amp 800piv	75p

Small glass reed relays 8p each

CAN-TYPE ELECTROLYTIC CAPACITORS

32 + 32uf 275V wkg	16p
32 + 32uf 350V wkg	29p
50 + 50uf 275V wkg	22p
3300uf 16V wkg	22p
100 mfd + 500 mfd 210V wkg	18p

DRYFIT BATTERIES

These are sealed lead acid jellified electrolyte rechargable batteries, all ex-equip. but in very good condition and tested

6V 900ma	£1.80
6V 2.6AH	£3.50
6V 6AH	£4.60
6V 7.5AH	£6.75

Please add extra 50p postage per battety

GLASS BEAD INSULATORS

Feedthrough types, overall diameter 5mm
Ten for 18p

PUSH BUTTON LATCH-SWITCHES

Single switch d.p. changeover 12p
Three banked switches each with 4 d.p. changeovers 24p
Five banked switches, three with d.p. changeovers, two with 3 d.p. changeovers 29p
All brand new.

100-0-100ua TUNING METERS

1⅝" x 1⅝"
£1.30

AUDIO TRANSFORMERS

Miniature transistor output types:

¾ pin 50mW	18p
¾ pin 100mW	20p
¾ pin 250mW	24p
¾ pin 500mW	28p
¾ pin 750mW	34p
Interstage types	24p

★ ★ ★ ★ STAR OFFER

Ten plastic power — medium power — some metal assorted transistors, all coded and new 80p

SLIDER-POTS

470R lin	12p
1K lin	12p
4.7K log	12p
5K lin	12p
10K lin	12p
25K lin	12p
100K lin	12p

C280 CAPACITORS

AU 250V wkg

0.10uF	3p
0.15uF	3p
0.47uF	3p
0.68uF	3p
15000pF	4p
47000pF	4p
56000pF	4p

EAR-PIECES

Magnetic, 8 ohm 3.5mm or 2.5mm plug only 24p each

INSULATION COVERS

to fit over TO3 power transistors. Nylon material up to 30Kv ins 5p each

I.C.SKTS

Low profile

8 pin	10p
14 pin	13p
16 pin	14p

PHOTO RESISTOR

ORP12 at 52p each

TOGGLE SWITCH

S/P type but very good quality and strong 29p each

TERMINAL BLOCKS

2-way 5A rating 7p each

13A RUBBER SKTS

For fly lead extension cables 40p each

AMPLIFIER I.C.'s

Wideband Radar type 10 to 150 mhz new but untested with data 18p each

WIREWOUND POTS

All new

5 ohm H/D	22p
15 ohm	18p
20 ohm	18p
25 ohm	18p
250 ohm	18p
250K	18p
1m	18p
2.5m	18p

POTS

Rotary carbon modern types

680 ohm lin	15p
2K7 lin	15p
4K7 lin	15p
10K lin	15p
25K lin	15p
50K lin	15p
100K lin	15p
200K lin	14p
500K lin	14p
1 meg lin	14p
2 meg lin	14p
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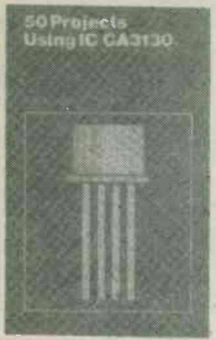

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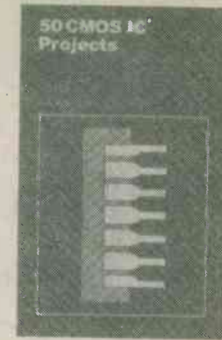

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CONSTANT CURRENT TRANSISTOR TESTER

By John Baker

NOVEL TESTING TECHNIQUE MEASURES TRANSISTOR GAIN AT A CONSTANT COLLECTOR CURRENT

This relatively simple transistor tester has practical gain measuring ranges of 10 to 250 and 100 to 2,500 at collector currents of 1mA and 10mA. The unit incorporates a meter which gives a direct read-out in terms of current gain and the base current drawn by the device under test. The correct collector current is automatically fed to the test device and it is not necessary to adjust the current manually before a reading can be made.

The unit can also be used to make leakage measurements and there are three leakage current ranges: 0-10μA, 0-100μA and 0-1,000μA.

METHOD OF OPERATION

A simple form of transistor tester having direct meter read-out is shown in Fig. 1(a). Here, the transistor being tested is fed with a known current via a base bias resistor. The resultant collector current is measured by a meter connected in the collector circuit of the transistor.

In a practical circuit the base current could be 1μA, and the meter could have an f.s.d. sensitivity of 1mA. the test transistor would then require a gain of 1,000 to produce f.s.d. in the meter. Lower

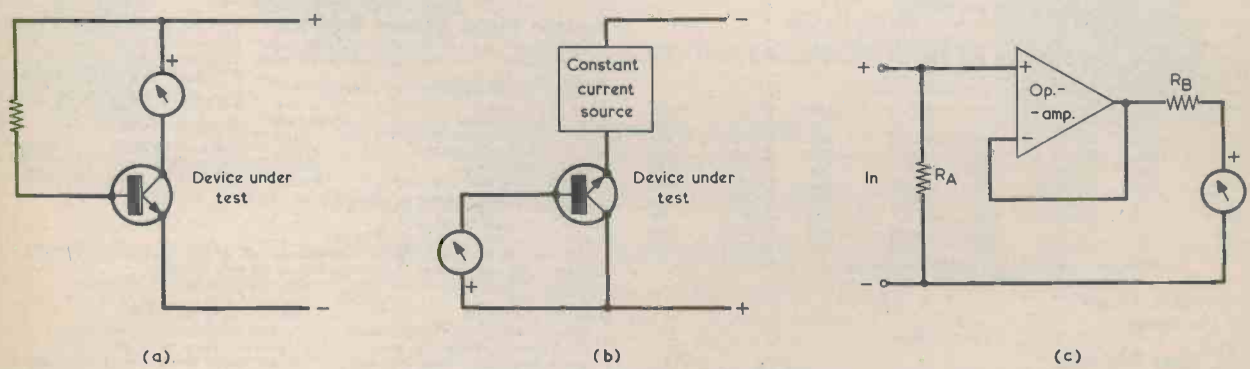
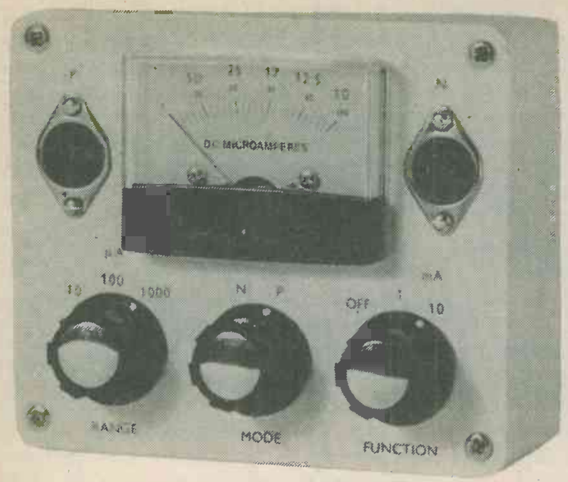


Fig. 1(a). A simple form of transistor tester. A fixed base current is applied to the transistor under test and the meter indicates the consequent collector current
(b) An alternative approach in which a constant current is allowed to flow through the emitter and collector of the test transistor. The meter reads the base current needed to maintain the collector current
(c) An electronic current-reading meter. Its functioning is described in the text



An angled view of the tester. The case dimensions are 120 by 100 by 45mm. deep

gains would obviously give proportionately lower meter readings. A gain of 200, for example, would give a meter reading of 200μA, and a gain of 100 would give a meter reading of 100μA. Thus, a direct read-out in gain can be obtained with little or no recalibration of the meter.

One slight flaw in this arrangement is that the gain of the transistor is not measured at any predetermined collector current. In the example just given the collector current would vary from about 1mA for a very high gain device to a few microamps for a low gain one.

The gain of a transistor normally varies considerably with changes in collector current with, in general, reduced collector current resulting in reduced gain. This can result in the simple arrangement of Fig. 1(a) giving rather low readings for devices which have moderate levels of gain, and extremely low readings for devices which have low but acceptable gain levels.

The difficulty can be overcome by using the arrangement shown in Fig. 1(b). In this, a constant current flows through the emitter and collector terminals, and a meter connected between the collector and base terminals measures the base current that is drawn by the test transistor. The meter has a significant internal resistance, with the result that, in addition to measuring current, it allows a voltage to appear between the collector and the base of the transistor under test. The current indicated by the meter will be the base current needed to maintain the constant current which flows through the emitter and the collector. What we have done, in consequence, is to change the test approach from using a fixed base bias current and measuring the resulting collector current to using a fixed collector current and measuring the consequent base current.

The internal resistance of the meter must not, of course, be too high as it would then prevent the flow of adequate base current with a low gain test transistor. A suitable resistance would be one which drops a little more than half the supply voltage when the meter is at full-scale deflection.

The meter read-out will not be as convenient as in the previous arrangement because base current is inversely proportional to the gain of the transistor. In other words, the higher the gain of the test transistor the lower the resultant base current and meter reading. Ideally, the meter should be given an additional scale calibrated in terms of current gain, but this is not absolutely necessary as it is a simple matter to mentally convert base current into terms of current gain. In fact, once the user has become familiar with a tester employing a base current read-out, conversion to gain figures tends to be carried out automatically with hardly any conscious thought.

A possible shortcoming with the arrangement is that the transistor emitter current is really collector current plus base current, so that with a very low gain device a significant amount of the constant current would be drawn by the base. The collector current would then be lower than the nominal value of the constant current, whilst the base current indicated by the meter would be that needed for this reduced collector current.

However, all transistors in common usage have minimum gain figures of 20 or more, whereupon the effect will not introduce serious errors and can be considered to be of academic importance only.

CURRENT METER

Another factor which has to be considered is that the base current drawn by a high gain transistor will be very small, perhaps less than 2uA for a collector current of 1mA. Panel-mounting meters having f.s.d. sensitivities of the order of 10μA or so as would be required here are not readily available, but this problem is easily overcome by using an amplifier to boost the sensitivity of a standard meter.

A practical meter amplifier circuit is shown in Fig. 1(c). An operational amplifier has its output connected back to its inverting input, giving 100% d.c. negative feedback. The amplifier is a unity gain voltage follower, and the voltage at its output is virtually equal to the voltage at its non-inverting input.

If, assuming negligible resistance in the meter movement, RA is equal to RB and a positive voltage is applied to the non-inverting input, the current flowing through RB will be equal to the current flowing through RA. This must be so, because both resistors have the same value and the same voltage appears across each. If RA has ten times the value of RB then, for any positive voltage at the non-inverting input, the current in RA will be one-tenth of that in RB. The circuit may then be used as an electronic current meter, with the current to be measured passing through RA and the meter indicating this current multiplied by ten. The sensitivity of the meter is therefore increased by ten times. Should RA have one-tenth the value of RB, it follows that the meter will indicate one-tenth of the current flowing through RA.

Thus, the sensitivity of the circuit can be easily varied by simply choosing appropriate values for RA and RB, and the f.s.d. sensitivity may be made equal to, greater than or smaller than the actual f.s.d. sensitivity of the meter movement itself.

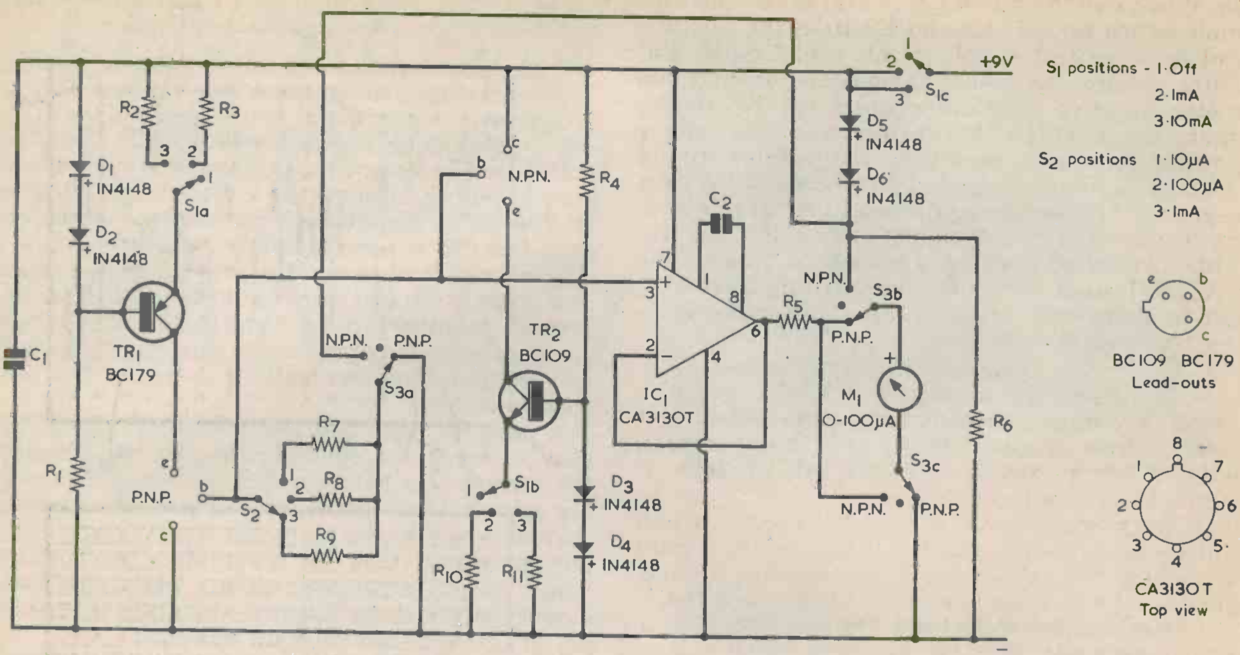


Fig. 2. The circuit of the constant current transistor tester

THE CIRCUIT

The complete circuit of the transistor tester is given in Fig. 2. In order to minimise the n.p.n.-p.n.p. switching needed, separate constant current generators and test sockets are used for the n.p.n. and p.n.p. testing modes. TR1 is the p.n.p. constant current source and the base of this transistor is held about 1.3 volts negative of the positive supply rail by the simple stabilizer formed by R1 and the forward biased silicon diodes, D1 and D2. There is a voltage drop of some 0.6 to 0.65 volt across the base-emitter junction of the transistor, leaving 0.7 to 0.65 volt across whichever of the two emitter resistors is selected by S1(a). R3 has a value of 680 Ω and causes a constant current with a nominal value of 1mA to be given. The resistance of R2 is 68 Ω resulting in a constant current having a nominal value of 10mA.

In the p.n.p. mode the electronic current meter is the same as that shown in Fig. 1(c), with RA being replaced by R7, R8 or R9, according to the setting of S2, and RB being replaced by R5. The f.s.d. meter sensitivities selected by S2 are 10μA, 100μA and 1mA respectively.

TR2 is the constant current generator for the n.p.n. test mode. The circuit around this transistor is identical to that for TR1 except that all the polarities are reversed.

S3 provides polarity reversal when changing from the p.n.p. to the n.p.n. test mode and vice ver-

COMPONENTS

Resistors
(All ¼watt 5% unless otherwise stated)
- R1 4.7kΩ
- R2 68Ω 2%
- R3 680Ω 2%
- R4 4.7kΩ
- R5 56kΩ 2%
- R6 2.7kΩ
- R7 560kΩ 2%
- R8 56kΩ 2%
- R9 5.6kΩ 2%
- R10 680Ω 2%
- R11 68Ω 2%

Capacitors
- C1 0.1μF type C280 (Mullard)
- C2 100pF ceramic plate

Semiconductors
- IC1 CA3130T
- TR1 BC179
- TR2 BC109
- D1-D6 1N4148

Switches
- S1 3-way 3-pole rotary (see text)
- S2 3-way 1-pole rotary (see text)
- S3 3-way 3-pole rotary (see text)

Meter
- M1 0-100μA moving-coil (see text)

Miscellaneous
- Plastic case (see text)
- 9-volt battery type PP3
- Battery connector
- 3-off control knobs
- 2-off 3-way DIN sockets
- 3-way DIN plug
- Veroboard, 0.1in. matrix
- Test leads
- 3-off crocodile clips
- Wire, solder, etc.

sa. When switching to n.p.n., S3(a) takes the common return for R7, R8 and R9 from the negative rail to a positive supply point, whilst S3(b) and S3(c) change the meter connections so that the meter negative terminal couples via R5 to the operational amplifier output and the meter positive terminal connects to the positive supply point. The positive supply point is about 1.3 volts negative of the positive rail, being held at this level by the forward biased silicon diodes, D5 and D6. This method of working is necessary because the CA3130T used as the operational amplifier does not function well when its inputs are close to its positive supply potential.

C1 is the supply decoupling capacitor and C2 is the compensation capacitor for IC1. S1(c) provides on-off switching. The tester has a quiescent current consumption of about 9mA, and this increases, when a test transistor is connected, by 1mA or 10mA according to the setting of S1.

In the prototype, M1 is a 0-100μA meter with a resistance of 580 Ω, and it has a plastic front measuring 60 by 45mm. It is available from a number of suppliers, including Maplin Electronic Supplies. Switches S1 and S3 are 4-pole 3-way miniature rotary types with one pole unused. S2, in the prototype, was one pole of a 3-pole 4-way miniature rotary switch, with an adjustable end stop set for 3-way operation. It could alternatively be one pole of a 4 pole 3 way switch. S3, it will be noted, has a central blank position. This is because most miniature rotary switches have a make-before-break action. If two adjacent contacts of such a switch were used for polarity changing, the supply could be momentarily short-circuited via D5 and D6 as the switch was moved from one setting to the other.

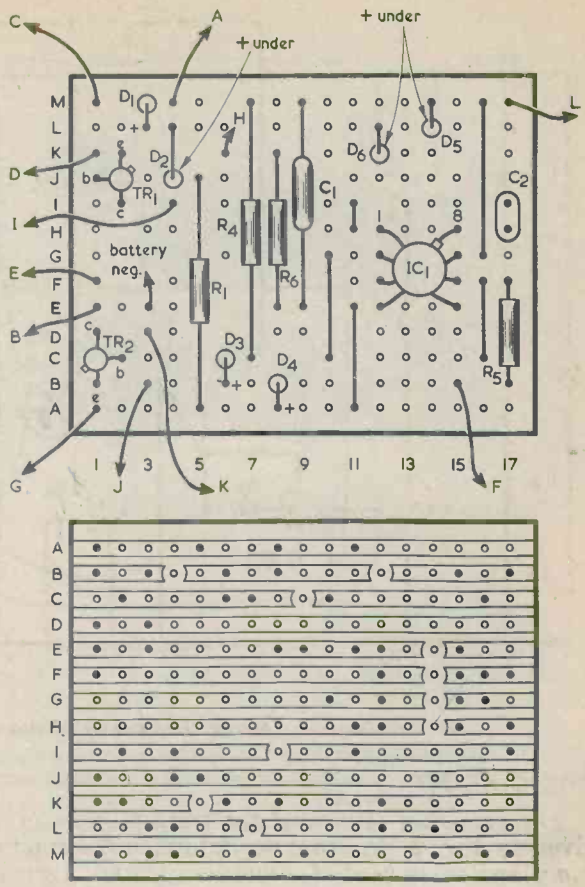
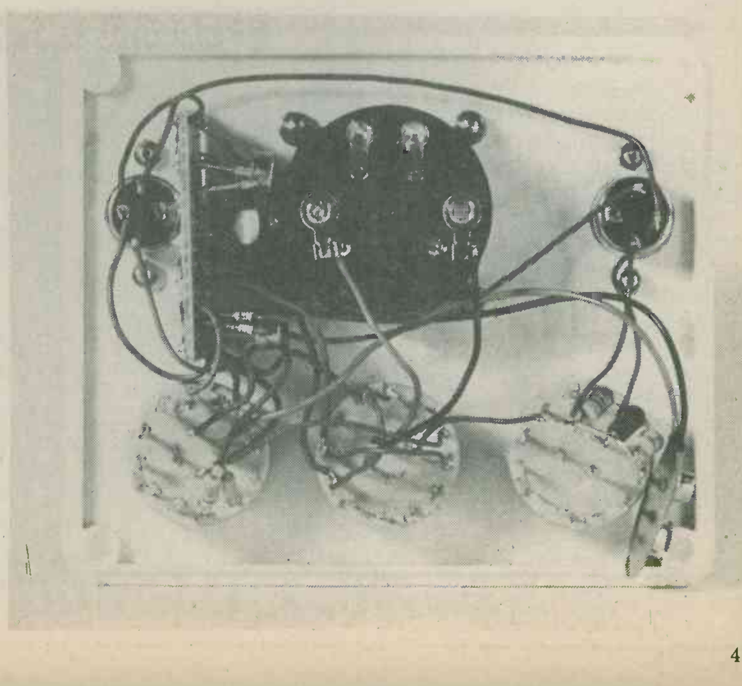


Fig. 3. Much of the circuit is constructed on a Veroboard panel of 0.1in. matrix

CONSTRUCTION

The transistor tester is assembled in a white plastic case measuring approximately 120 by 100 by 45mm. This is a case type V219, available from Greenweld, 443 Millbrook Road, Southampton, S01 0HX. The parts are mounted on the lid, which then effectively becomes the front panel of the unit. The general layout can be seen from the photographs. Looking at the front of the tester, the p.n.p. test socket is to the left of the meter and the n.p.n. socket is to the right. The three switches are

Apart from the battery, all the parts are mounted behind the front panel. There is adequate space for the battery inside the case, and this may be secured in place with a simple home-made clamp



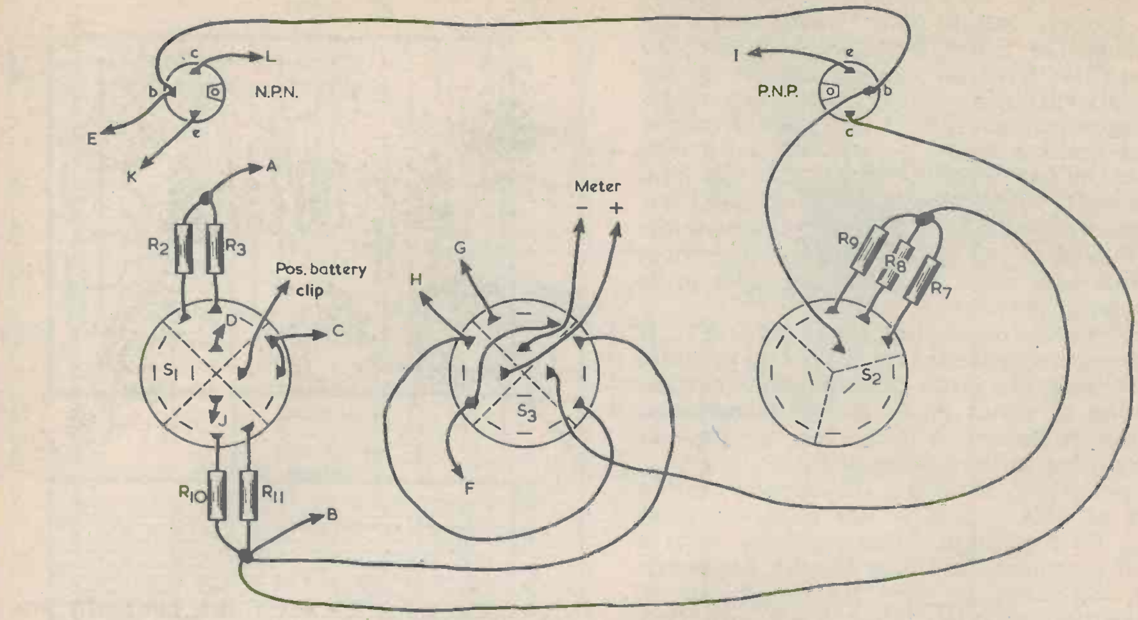
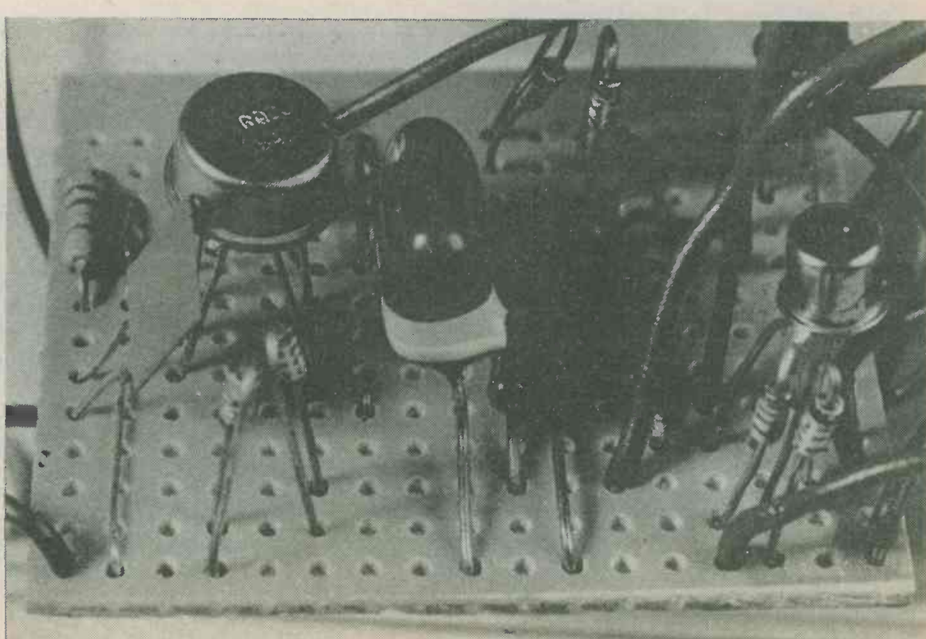


Fig. 4. The remaining wiring is to the meter and the front panel components. Before connecting to the switches check visually, or with a continuity tester, the outer tags corresponding to each inner tag. Their relative positioning may differ, with some switches, from that shown here

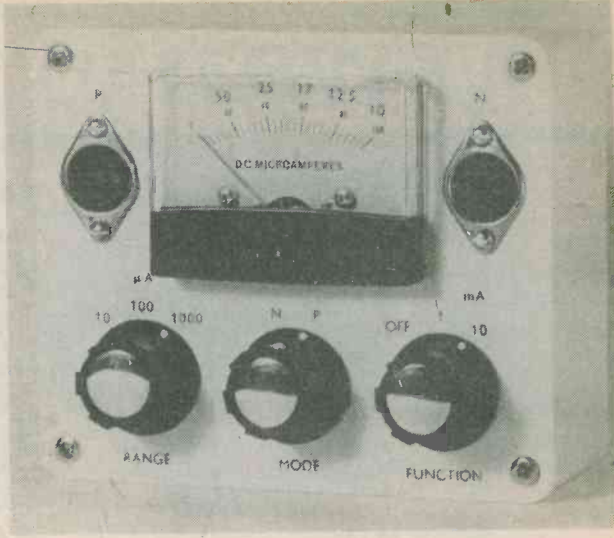
in a horizontal row below the meter with S2 ("Range") to the left, S3 ("Mode") in the centre and S1 ("Function") on the right.

3-way DIN sockets are used as test transistor sockets, and TO18 and TO5 transistors will readily plug into these, as will certain other types. A set of test leads is made up for other transistor styles. This merely consists of a 3-way DIN plug to which

The Veroboard panel, which takes most of the smaller components



The front panel of the constant current transistor tester. The lettering and legends are taken from "Panel Signs" Set No. 4



three short insulated flexible wires of different colours are connected. The wires are terminated in small crocodile clips, which clip on to the leads of the transistor being tested.

Most of the smaller components are wired up on a small 0.1in. matrix Veroboard having 13 copper strips by 17 holes. The Veroboard assembly is shown in Fig. 3. IC1 has a PMOS input stage and can therefore be damaged by high static voltages. It will normally be supplied in a protective package and should be left in this until it is soldered to the Veroboard. The i.c. should be the last component to be fitted to the board, and its lead-out should be soldered with an iron having a reliably earthed bit.

Fig. 4 shows the component layout behind the front panel, and it will be seen that some of the resistors are soldered to the switch tags. Interconnections between the front panel components and the Veroboard are identified by the letters "A" to "L" in Figs. 3 and 4. The board is positioned vertically between the meter and the n.p.n. test socket, with the component side towards the meter. If fairly stout and short wires are used for the connections between the Veroboard and the panel components, these will provide the board with quite a firm mounting, and no other means of securing it are then necessary.

USING THE TESTER

The transistor under test is either plugged into the appropriate test socket or connected to it by the test leads, and S3 is switched to the correct mode. When testing most small transistors S1 should be switched to the 1mA position, as small signal transistors usually have their gain quoted at a current of about this level in brief form data sources. Some small signal devices, mainly r.f. and switching types, have their gain levels quoted at a higher collector current of about 10 or 20mA. In such instances the 10mA setting of S1 should obviously be used.

The 10mA setting should also be used when checking medium and high power transistors. It must then be borne in mind that these devices normally have their gains quoted at a collector current of 100mA or more. However, it is not really practicable to provide such high currents in a small battery powered unit such as this, and so the lower current must be used. This will tend to give a slightly low gain figure with the power transistors.

When S1 is in the 1mA position only the 10μA and 100μA ranges of the tester are used. The 10μA range represents a gain of 100 at full-scale deflection, rising to a gain of 2,500 at the first meter scale division of 4μA. The corresponding levels on the 100μA range are 10 and 250. With S1 in the 10mA position, only the 100μA and 1mA meter ranges are employed, and again these provide scale limits of 100 to 2,500 and 10 to 250 respectively.

If desired, numbers taken from "Panel Signs" Set No. 4 can be affixed to the meter scale as a guide to the gain figures. The number "10" can be added above the 100 on the meter scale, "12.5" above 80, "17" above 60, "25" above 40 and "50" above 20. The fronts of modern meters simply unclip to allow access to the scale, but the addition of the numbers should only be carried out by constructors who feel competent to undertake the task; the meter has a delicate mechanical construction which can be very easily damaged by careless handling or the ingress of dirt or dust particles.

Leakage current (the current which flows between emitter and collector when the base is open-circuit) can be measured by connecting the emitter normally, and the collector to the base socket, or base test clip. No connection is made to the base. Silicon transistors, when they are fully functional, usually have very low leakage currents of less than 1μA. On the other hand germanium transistors, including power types in particular, can often exhibit quite high leakage currents even when they are fully serviceable. Of course, if a device does have a very high leakage current the gain figure provided by the tester will be higher than the true value. This is because a significant part of the collector current will be leakage current, whereupon a correspondingly lower base current is required. Fortunately, this state of affairs can be detected by the leakage current test, and it will in any case only apply with a small proportion of obsolescent germanium transistors. ■

NEWS . . . AND

NEW DIGITAL PHOTO TACHOMETER

New from Power Instruments of the USA is a touchless, digital photo tachometer, designed for measuring the rpm of rotating objects from distances of between $\frac{1}{4}$" to 30" using a beam of light and readout on a digital scale.

A piece of reflective tape, provided with the tachometer, is fixed on the surface of an object, and when it is rotated, a beam of light from the probe is focused on it. A "target eye" lights up on the tachometer, showing when contact is made, and a rpm readout is given on five $\frac{3}{8}$" LED's on the digital scale. An exclusive "never forget" memory holds the reading indefinitely.

Powered by ordinary batteries, the model 1891 touchless tachomoeter is provided with a robust, aluminium carrying case, reflective tape and other accessories. Measuring only $8\frac{1}{2}$" x $4\frac{1}{2}$" x 2", it weighs $1\frac{1}{2}$ lbs. and is 100% solid state optional extra accessories include measuring wheels, hand held or permanent surface mounted to measure linear speed.

Price is £155, plus VAT and carriage, from the sole UK importers, Electronics Brokers Ltd, 49/53 Pancras Road, London NW1 2QB.

As regular readers will know we have always borne in mind the short wave interest of so many electronics enthusiasts. Following last month's *3 Band Short wave Preselector* article we feature in this issue an *I.C. Morse Practice Oscillator.* It is a simple to build project particularly suitable for beginners who aspire to become radio amateurs with their own call sign.

Short Wave enthusiasts, in particular, when in London may very well like to visit *HMS Belfast* moored in the Pool of London, between Tower Bridge and London Bridge. There is an amateur station aboard which, last autumn, was granted a special Amateur Radio call sign, GB2RN. During the summer months the ship is open to the public from 1100 to 1800 hours and from 1100 to 1630 hours in the winter, British local time.

The station is especially interested in establishing schedules with other special interest stations worldwide, these and other stations requiring schedules should contact Don Walmsley, 153 Worple Road, Isleworth, Middlesex TW7 7HT.

All HF bands from 1.8 to 28MHz are covered CW or SSB. The station operates under the auspices of the Royal Naval Amateur Radio Society.

BATTERY HOLDER OF SIMPLE CLIP-IN DESIGN

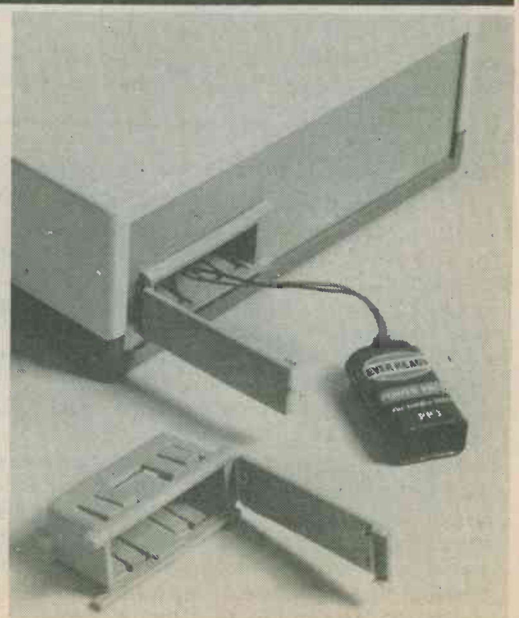
Mosr small enclosures on the market today make no provision for battery housing and dismantling a complete instrument in order to replace an exhausted battery is both tedious and time consuming.

Vero Electronics Limited now make available an injection-moulded battery housing of simple clip-in design offering access for battery changing from outside the instrument.

The holder accepts a 9V battery and may be easily fitted to a panel of enclosure with a thickness of 1.5 to 3mm. All that is required for fitting is a rectangular cut-out into which the holder is pressed home, where it is firmly held by the unique clip-type retention feature.

The cover, with a flip-over type hinge moulded as part of the housing opens easily for battery changing and snaps closed securely.

Supplied as a kit, the battery holder comes complete with battery connector and lead for less than £1.00.



. . . COMMENT

FULLY SELF CONTAINED CURRENT-TIME INTEGRATING METERS

Mega Electronics Ltd., of 9 Radwinter Road, Saffron Walden, Essex, have announced a new range of current-time integrating meters designed primarily for applications in electroplating.

These new, low-cost units can be supplied with counting units of either ampere minutes or ampere seconds, or can be alternatively factory adjusted to meet individual requirements. They feature linearities of 1.0% or 0.2%.

Two basic models are available. One reads up to 99999 units and is manually resettable, while the other incorporates a presettable counter which operates a changeover contact when the integrating meter reaches the preset number. Both can be supplied as free standing or panel mounted (DIN) units, and only require connection to the a.c. mains supply and two current sensing wires preparatory to operation. There are no operator controls.

Operational features include normal sensitivities of 50mV or 75mV, and a maximum count rate of 20 units per second. They are priced from £65.00.

ELECTRONIC PROJECTS INDEX

A very commendable non-profit making venture has been set up by the Principal Librarian (Technical) of North Tyneside Libraries and Arts Department. The venture is the publication of an index covering all electronic projects which have appeared *Radio & Electronics Constructor* and other electronic journals over the period of 1972 to 1977. Projects are listed under subject headings such as "Calculators", "Disco Equipment", "Displays", etc., and each entry consists of the title of the article presenting the project together with a succinct description of the project itself. The Index comprises 119 large pages, and is well printed and laid out.

The Electronic Projects Index may be obtained by post from M. L. Scaife, Central Library, Northumberland Square, North Shields, Tyne & Wear, NE30 1QU. Postal orders and cheques should be made payable to "North Tyneside M.B.C.". Prices, which include postage and packing, are £1.50 each for 1 to 2 copies, £1.40 each for 3 to 6 copies and £1.35 each for 7 to 10 copies.

TV FOR THE DEAF

The Independent Broadcasting Authority (IBA) and the Independent Television Companies Association (ITCA) are jointly supporting a reasearch project at Southampton University to help the deaf and partially deaf to benefit more fully from television programmes.

The work expected to cost over £50,000 is aimed at providing optional sub-titling for the deaf and hard of hearing by means of the ORACLE teletext system.

The project, expected to take three years, will be to establish the form of sub-titling which would most benefit the deaf and hard of hearing. Since the commencement of the ORACLE service, it has been appreciated that teletext offers a valuable means of providing an optional sub-titling service without distraction to other viewers.

HOME RADIO CATALOGUE

The latest edition of the catalogue of Home Radio (Components) Ltd. has now been published and brings up to date the listing of this well known company's stocks. Containing 128 large pages, the catalogue is profusely illustrated with photographs and line drawings.

The various items proceed through the catalogue in alphabetical order, starting with Aerials, followed by Batteries, then Books, and so on. The ability to locate any individual component is assisted by a comprehensive cross-reference index at the end of the catalogue.

Of particular interest are the "Bargain Lists", which are being increased in size. These offer new and unused components at very low prices, and apply while stocks of these components last.

The general component listing follows the helpful approach evident in previous Home Radio catalogues. The very wide range takes in such items as tuning drive parts, all types of capacitor and resistor, tools, test gear, transformers, and many other categories of electronic component. The price of the catalogue is £1 plus 25p postage and packing, or it may be obtained for £1 and the special coupon in the Home Radio advertisement in this issue.

"It's either a remote control footballer or the latest details of our Early Warning System!"

RECENT PUBLICATIONS

WORLD COMMUNICATION: THREAT OR PROMISE? By Colin Cherry. 243 pages, 270 x 190mm. ($10\frac{1}{2}$ x $7\frac{1}{2}$in.) Published by John Wiley & Sons Limited. Price £11.00.

This very perceptive book covers such a vast range that there must inevitably be shortcomings in any attempt to discuss it in a short review. It does not deal with communications from the engineering point of view; instead it discusses the effects that the present communications explosion is having upon the social structures of the world, both in the Western nations and in the developing countries.

The general viewpoint of the book would appear to be that the present advanced and future advancing systems of communications are beneficial rather than otherwise, for instance, domestic communications systems such as radio and television do not reduce the ability of people to think for themselves but enhance it. The book also deals with communications in the economic sphere, with telephone communication, newspapers, railways and roads, all in the light of environmental change, and is particularly concerned with the very different communications conditions which exist in the poor and the rich countries of the world.

Professor Cherry contends that the outcome of wide-ranging international communications will be the creation of overlapping federations rather than a centralised fount of control. He points out that "progress" is achieved only by *dissent.* A situation will never be altered by those who are satisfied with it; evolution, and hence change, must almost inevitably proceed with each rising generation. All discussion in the book is backed by extensive research and the bibliography extends to no fewer than 391 titles.

This is a book for the thoughtful and the concerned. Originally appearing in 1971, it is a revised edition which updates statistical data and diagrams, and takes into account comments arising from the earlier version.

SPECIMEN ANSWERS TO EXAMINATION PAPERS 1972-1976. By John G. Halley, T. Eng. (C.E.I.), F.S.E.R.T. 102 pages, 215 x 135mm. ($8\frac{1}{2}$ x $5\frac{1}{4}$in.) plus 6 fold-out diagrams. Published by Norman Price (Publishers) Ltd. Price £2.95.

The full title of this volume is "Television (Colour and Monochrome) Part III: 4th Year. Specimen Answers To Examination Papers 1972-1976", and it is particularly intended for students studying for the City and Guilds examination in Television (Colour and Monochrome) Course 222, Part III, 4th Year. In addition to the answers, additional explanatory notes have been given where it is considered necessary to assist the reader.

The book is very well produced, with clear text and diagrams. The fold-out diagrams are the circuits of complete commercial television chassis. So far as the student at which it is aimed is concerned, the book offers quite excellent value for its cost. Whilst it is obviously not a textbook, service engineers and others interested in television engineering could find the book a useful aid towards testing and brushing up their technical knowledge of colour and monochrome television reception.

CLOSED CIRCUIT TELEVISION FOR TECHNICIANS, Volume 1. By K. J. Bohlman, T. Eng. (C.E.I.), F.S.E.R.T., A.M.Inst.E. 255 pages, 215 x 130mm. ($8\frac{1}{2}$ x 5in.) Published by Norman Price (Publishers) Ltd. Price £4.50.

Another exceptionally good book from Norman Price, the work under review has been written for the technician who is required to adjust and maintain CCTV equipment in industrial and commercial applications. The present volume is concerned mainly with monochrome television, and a later volume will deal with the implications of colour. The approach is largely non-mathematical, and it is assumed that the reader already has a basic knowledge of semiconductors and electronic circuits. Also kept in mind are domestic television service engineers who are considering entering the CCTV field.

The first chapter in the book gives an introduction to its subject and then deals with basic elements of light. This is followed by chapters covering lenses, CCTV signals and principles, camera tubes, camera circuit operation, video monitors and monitor tubes, camera and monitor adjustments, lighting, and special features of the signal cable in CCTV. The final chapter is devoted to fault finding and presents a series of fault finding charts. There follow four appendices dealing with sync separation, transistor reactance, maximum viewing distance and the lens equation.

The book has many helpful diagrams as well as some well produced photographs. The author is Senior Lecturer in Television at Lincoln College of Technology.

SUGGESTED CIRCUIT

ELECTRONIC "HANGMAN"

By G. A. French

In the last October issue the author introduced a method of causing an ordinary domestic eletric bell to give a single "ping" when activated instead of a sustained ringing. In the article, "Pinging Bell Circuits", it was pointed out that a "ping" can have a more pleasant sound than is given by continuous ringing.

The author has returned to this subject and hopes to produce some unusual "pinging" circuits in the future. In the meantime, the present article describes a simple novelty project which enables a single "ping" to be given when a finger is applied to a touch-button.

CIRCUIT OPERATION

The circuit of the project appears in Fig. 1. Transistors TR1 and TR2 are two emitter followers coupled in cascade, with the emitter of TR2 connecting to the base of TR3. TR1 and TR2 are small signal devices whilst TR3 is a power transistor with a maximum peak collector current rating of 4 amps. The circuit is powered by the mains supply consisting of transformer T1, half-wave rectifier D2 and reservoir capacitor C3.

When the unit is switched on at S1 the rectified supply voltage appears across R5 and C2 in series, whereupon C2 charges rapidly to the supply voltage. Transistors TR1, TR2 and TR3 are all cut off since the base of TR1 is held at the potential of the negative supply rail by R3.

If a finger is applied to the touch-button, bridging its two contacts, a small current flows through the skin of the finger and then through R1 into the base of TR1. There is a very high level of current gain from the base of TR1 to the base of TR3, and the small current at TR1 base causes TR3 to turn hard on. In so doing TR3 allows capacitor C2 to discharge through the bell, producing a single "ping". When the finger is removed from the touch-button TR3 turns off again and C2 is allowed to charge rapidly once more via R5. Applying a finger to the touch-button again will produce a further "ping" of the bell.

Diode D1 is connected across the bell to prevent the possible formation of high reverse e.m.f. voltages which could damage TR3. R2 and R4 are merely current limiting resistors which ensure that unnecessarily high currents are not passed by TR1 and TR2. The connection to the touch-button is made by screened cable since the lead to TR1 base, if unscreened, could pick up mains hum and r.f. with consequent irregularity of opera-

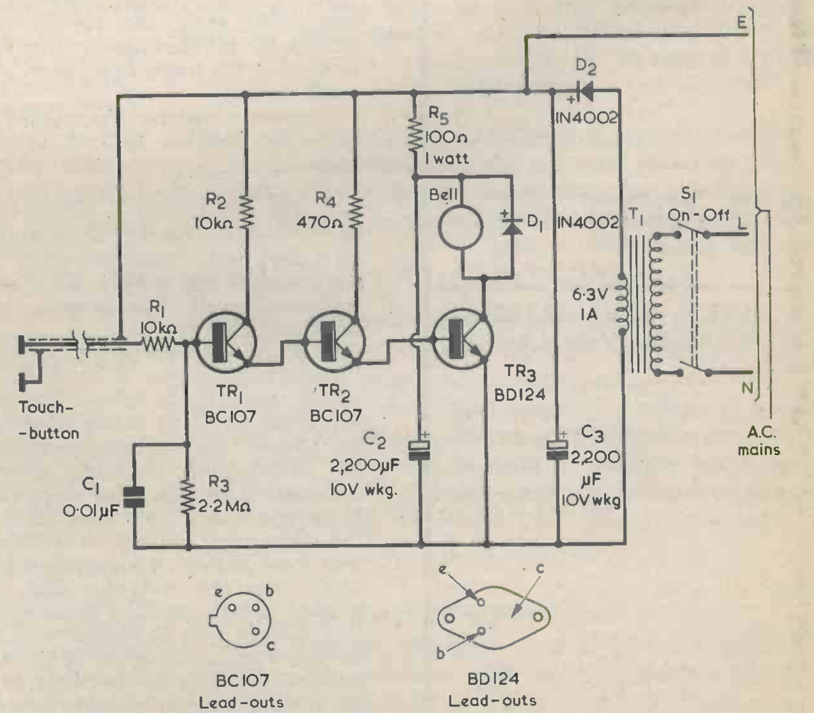


Fig. 1. The circuit of the touch-button "pinger". Bridging the touch-button contacts with a finger causes TR3 to turn on and discharge C2 through the bell

tion. R1 and C1 provide r.f. filtering. If the unit is employed in an extremely noisy environment so far as hum and r.f. are concerned, there is a possibility that the circuit will trigger if the finger is applied to the touch-button contact which couples to R1 as well as to both touch-button contacts. This is because the body acts as an aerial and is effectively applying the local noise to the base of TR1. With the prototype, however, it was found that the screened wire and the presence of R1 and C1 were quite adequate to prevent such an event occurring. If the lead coupling the circuit to the touch-button is less than say, a foot in length, the screened wire is not needed and connection can be made via two unscreened wires.

MAINS TRANSFORMER

The mains transformer used in the author's circuit was a 6.3 volt 1 amp "heater" transformer. Mains transformers with 6.3 volt secondaries were very common in the days of valves and many of the older experimenters will have a suitable transformer in their spares box. They are not so readily available at present (although it is noted that a 6.3 volt 1.5 amp transformer is listed in the Electrovalue catalogue). A transformer with a 6 volt secondary could also, of course, be used, but it is advisable to employ one whose secondary is rated at 500mA or more. The current drawn by the circuit when TR3 is turned on is only about 80mA, but a transformer with a secondary rated at 500mA or more will allow the supply rail voltage to recover quickly to its full level when the finger is taken off the touch-button.

A power transistor is employed in the TR3 position because of the high initial peak current which flows when C2 discharges into the bell. The dissipation in TR3 is low and it does not need to be mounted on a heat sink. Apart from R5, all the resistors are ¼ watt. R5 is a 1 watt component. The resistors may be 5% or 10% types.

The bell consists of a Friedland "Underdome" type 792, which is widely available in shops retailing electrical goods. It is modified for the present application by having its interruptor contacts short-circuited. The thin base plate and the gong of the bell are removed and the interruptor contacts identified. The fixed contact is secured with a screw, and one end of a thin insulated wire is carefully soldered to this contact close to the screw. The moving contact, actuated by the armature, connects to one of the two terminal screws on the upper side of the bell. The thin wire is passed through the hole through which the bell supply wires pass, and its end is secured under the terminal screw,

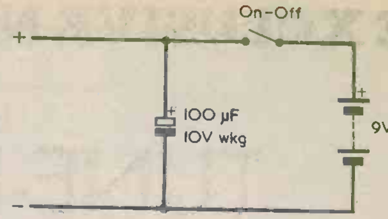


Fig. 2. For non-continuous use, the circuit may be powered by a 9 volt battery

in company with one of the supply wires. The second supply wire connects in normal fashion to the remaining terminal screw on the upper side of the bell, after which the base plate and gong are refitted. The link wire can easily be removed without damage to the bell if it is later intended to use it for normal operation.

The mains connections in the circuit should be suitably covered to ensure that there is no risk of accidental shock. It is essential that the positive supply rail be connected to a reliable mains earth, as shown in Fig. 1.

The circuit of Fig. 1 can be left switched on continually, the current drawn from the mains being negligibly small. The circuit will also function with a 9 volt battery. In this case the mains transformer, D2 and C3 are omitted, and a 100μF decoupling capacitor is connected across the supply rails, as illustrated in Fig. 2. The 9 volt battery is then applied across the supply coils via an on-off switch. The current drawn from the 9 volt battery is relatively high, at about 90mA, when the touch-button contacts are bridged by a finger, and a large battery, such as a PP9, should be used. Continual operation from a battery is not recommended. The quiescent current drawn by the circuit consists only of leakage current in the transistors and electrolytic capacitors, but this can rise to some 10μA or more in some instances. Battery operation would then be uneconomic if the unit were left switched on for periods of days or weeks.

The touch-button is home-made and consists of two flat pieces of shiny metal mounted close to each other on a sheet of insulating material. The contacts could, for instance, be provided by the heads of two chrome plated panel-headed screws.

Finally, it should be pointed out that, with both the mains and battery powered versions, capacitor C2 can only charge after the finger has been taken *off* the touch-button. A period of about half a second has then to elapse before the circuit is capable of producing a further "ping". ■

TUNE-IN TO PROGRAMS

Part 2

By Ian Sinclair

The second in our down-to-earth series on calculator programming.

The keyboard of the Texas Instruments TI-57 programmable calculator. Most keys have a second function, whereupon facilities are nearly double the number of keys provided

SETTING UP A PROGRAM

When we use a calculator to solve a problem, we make use of the normal range of number and function keys such as 1, 2, 3, +, −, = and others. If we want to make use of the action of these keys as part of a program of instructions, we need some method of signalling to the calculator that the key-strokes are part of a program. This is done on the Texas Instruments TI-57 programmable calculator by pressing the key marked [LRN]. Once the [LRN] (for learn) key has been pressed, every following key-stroke forms part of a program which will be stored in a separate memory. Pressing the [LRN] key again signals that the program is complete, and the calculator can be used normally again. Meanwhile, the program is stored until the calculator is switched off.

What can we instruct the calculator to do? Well, on a calculator such as the TI-57 the prospects are pretty wide, but we must get one important point clear. Any function key, whether it is part of a program or not, always operates on the number which is in the X-register. That, in normal language means the number that you are looking at in the display. Before we can ask a program to do anything, we must make sure that there is a number in the display to work on. If that number is zero, then some operations are possible, but others are not.

For example, suppose that our program starts with the instructions

[+] [1] [=].

What the machine will do when this program runs is to take the number that is displayed, add 1 to that number, and display the result. You can then pat it on the head. If, however, the instructions had been

[X] [2] [=],

the program would run if the number had been —1, 1, 5, 8.9 or anything else, but ***not*** zero. Zero is the number that is displayed if nothing else is keyed into the display, and zero times anything is still zero. You can add or subtract with zero in the display and get an answer, but multiplication or division will give zero or the flashing display that indicates an error. It's the laws of arithmetic that you're up against here, and not the rules of programming.

RUNNING AND STOPPING

Let's suppose that we have a simple program stored in the machine, and we're itching to try it. First of all, we need to make sure that there is a number showing in the display, because that is the number that the program will operate on (later we'll look at other methods). Ready to start? No, not yet,

[LRN]	[LRN]	[LRN]	[LRN]	[LRN]
[+]	[+]	[X]	[+]	[X]
[1]	[1]	[5]	[1]	[2]
[=]	[=]	[=]	[=]	[=]
[R/S]	[R/S]	[R/S]	[Pause]	[Pause]
[LRN]	[RST]	[RST]	[RST]	[RST]
	[LRN]	[LRN]	[LRN]	[LRN]
Fig. 1.	Fig. 2.	Fig. 3.	Fig. 4.	Fig. 5.

there's one more point. When the machine was programmed, it was instructed step by step. We now have to give one additional instruction — go back to the start of the program. If we don't add this instruction somewhere, then the machine will start at a blank part of the program with no instructions stored, just where the program ended when the [LRN] key was pressed for the second time. The [RST] (reset) key is the one we need to make the program start at the beginning.

Now we can run the program. Press the [R/S] key (run/stop) and the program runs. How do we instruct it to stop? Easy, we make [R/S] the last step in the program. Let's go through a program now, a really simple one which just adds 1 to the number shown in the display. See Fig. 1. The [LRN] key instructs the calculator that this is the start of a program, and the [+] [1] [=] key-strokes instruct the calculator to add 1 to the number that was displayed, and then to display the new number. [R/S] then stops the program, so that the answer is displayed steadily, and the second press of the [LRN] key completes the program so that any other key-strokes are not part of the program. Now we can put a number into the display by pressing the appropriate key or keys (take your pick!) and we press [RST] to reset the program. Now press [R/S], the display flickers and obediently changes to the next number up. To repeat, press [RST] and [R/S] again.

PROGRAM START

1. Make sure that the program is complete (the [LRN] key completes the program, and the reference numbers which appear on the left hand side of the display during programming disappear).
2. Clear the display, using [CLR].
3. Reset the program ready to start, using [RST].
4. Key in any figures which must be present at the start of the program.
5. Start the program running, using [R/S].

Wait a minute though, why are we having to press the [RST] key each time? Can't we instruct the calculator to do this for itself? We certainly can and the best place to have the [RST] instruction is right after the [R/S]. Then next time the program runs and gets to the [R/S] it will display the number which is the result of its calculation; but the next time [R/S] is pressed, starting the program running, the next instruction in the program is [RST], so that the program goes back and starts at the beginning again. We have therefore made the reset automatic, by incorporating it into the program. We've saved an operation each time, and that's what it's all about. The revised program looks as shown in Fig. 2, with the [RST] step now included. Each depression of the [R/S] key will now cause the number in the display to be increased by 1. We must, of course, start our program by clearing the display, using [CLR], setting to the start using [RST], keying in whatever figure we want at the start for the program to operate on, and then starting everything off with the [R/S] key.

Very interesting, but useless, you think? Well, we have to start somewhere and it's not so useless as it might seem. Suppose we want to calculate the reactance of a capacitor at 1kHz frequency intervals from 1kHz upwards. The little program of Fig. 2 would have to be part of our reactance calculating program (we call such a part a **subroutine**) to ensure that the value of frequency is changed by 1kHz each time. There's a bit more to that one, though, which must wait for later.

We can just as easily now set up a program which will **multiply** the number in the display by 5, and continue to do so. The program is shown in Fig. 3, but we have to remember to start with a number such as 1 in the display, because if we start with zero, then the answer will be zero. Couldn't we place that 1 into the program, do I hear you say? We could, but then the answer would always be 5, because we would always be starting with 1, and not with the result of the previous calculation. It can be done, but not at this stage!

AUTOMATIC RECYCLING

All this key-pressing wears your fingers flat, so let's look for a way of making the whole process automatic. If we left out the [R/S] step in the programs of Fig. 2 and Fig. 3, then the machine would return to the start of a program automatically, and we would need to press the [R/S] key only once. There's one small snag here; the calculator works rapidly, so that there is no chance that we would be able to see each answer as it flashed on the display. Texas have thought about that one, though. Above the [SST] key is the instruction [Pause] which we activate by pressing [2nd] [SST] in that sequence. Now when this pause instruction is written into a program, the program will do just that, pausing for about $\frac{3}{4}$ of a second so that you can take a look at the display. If you want more time, perhaps to write down the number, then you can program in [Pause] [Pause], or even three of them to increase the time at the expense of the number of program steps.

Let's try it. The program of Fig. 4 should do what we want, with the display counting up 1 at a time. If it happened that one cycle of the program took exactly 1 second, we could even use this to check the time we have spent on it!

Successive multiplication is just as easy; the program of Fig. 5 multiplies by 2 each time, so that it generates the numbers of the binary scale, 1, 2, 4, 8, 16, 32 and so on, as long as we remember to start with 1. It doesn't take very long to get to some rather impressive numbers, either.

Now have a go for yourself. We convert voltage gain figures into decibels by using the formula

$$db = 20 \log G,$$

where G is the voltage gain. Can you write a program which will convert a voltage gain figure in the display into decibels when the [R/S] key is pressed? One point of information is needed. We take the log of a number in the display by pressing the log key, and we don't have to follow it with [=]. (Answer on page 446.)

So far, so good, but it restricts us to working with the number which is in the display and no others except those fixed in the program. To make our programs more useful, we need some method of working with more than one number at a time, and this means using the memories. For example, going back to the idea of calculating capacitor reactance in 1kHz steps, using the formula

$$Xc = \frac{1}{2\pi f C}$$

we can use our counting program for the frequency f, but we need at some stage to multiply by 2 π and by the value of C, as well as adjusting the figures for the use of kHz rather than Hz, and μF rather than F. Each operation of this type places a new number into the display, so that the others are lost unless they have been stored somewhere ready to use again.

In the next part, then, we shall be looking at the [STO] (store) and [RCL] (recall) steps, along with [SUM] and [Prd] (product) keys. The TI-57 has eight memories, which leaves room for some rather impressive number juggling. Watch this space!

PRO100 DIFFERENCES

For readers using the CBM PRO100, the following important differences exist.

1. A 3-position switch is used in place of the [LRN] key of the TI-57. To load a program, this switch is put to the [LOAD] setting. When the program steps have been completed, the switch is returned to the [RUN] position. The program can be erased completely by setting the switch to [CLEAR] and pressing [R/S].

2. There is no [Pause] key on the PRO100. In the programs using a pause, this must be replaced by [R/S], and the [R/S] key will have to be pressed after each display of an answer.

3. There is no [RST] key on the PRO100. The instructions [GOTO] [O] [O] must be used in place of [RST] both in the program and in preparing the calculator to run a program.

Other differences will be dealt with in future parts.

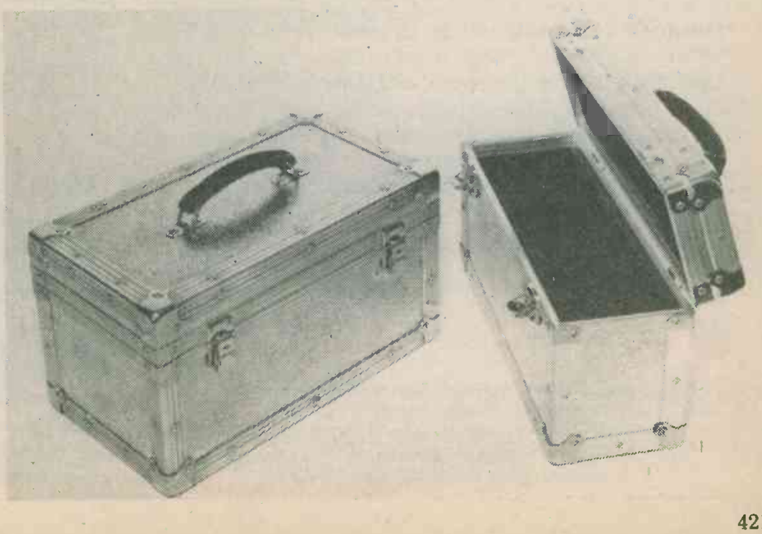
(To be continued)

NEW CASES FOR TEST EQUIPMENT

Rossmayne Limited of 16a Reading Road South, Fleet, Hampshire, have introduced aluminium flight cases designed to carry instruments and test equipment.

Monitor Flight Cases have internal dimensions from 8 x 6 x 6 inches to 21 x x12 x 15 inches. Special sizes and internal designs can be made without additional tool costs, enabling equipment to be custom fitted, for transportation, if required.

Manufactured in 24 SWG embossed patterned aluminium, they are also lined with 6 mm plywood for resilient strength. All corners and edges are reinforced, and the total unit will withstand the weight of a man. All fastenings are lockable for extra security.



TUNNEL DIODE OSCILLATORS

By P. R. Arthur

Tunnel diode negative resistance eliminates need for oscillator feedback.

Although tunnel diodes have been readily available to the amateur electronics enthusiast for well over ten years now, these interesting devices are very rarely featured in the amateur electronics magazines. It must be admitted that the tunnel diode is rather limited in its practical applications so far as the home-constructor is concerned, but it does represent an interesting and unusual component for the experimenter to use.

OPERATING THEORY

The operating theory of the tunnel diode is complicated, and is different from that of other semiconductor devices. The tunnel diode has a p-n junction in the same way as other semiconductor devices, but it uses germanium which has a much higher level of doping than would normally be the case; about 1,000 or more times the normal level in fact. When slightly forward biased the diode will conduct due to electrons "tunnelling" through the depletion layer, and it is from this effect rather than from any physical characteristic that the device derives its name.

Increasing the forward bias voltage results in the tunnelling effect falling away, and the current flow through the device reduces. Still further increasing the bias causes the device to conduct in the same way as does a normal germanium diode.

The circuit symbol normally used for a tunnel diode is shown in Fig. 1(a), but occasionally a different symbol may be used and there seems to be no general standard here. The symbol of Fig. 1(a) is also sometimes used for the zener diode, of course. Tunnel diodes have a wide variety of encapsulations and lead-out configurations, but the AEY11 device which is employed in the circuits described in this article has a standard TO-18 encapsulation with the lead-out configuration shown in Fig. 1(b). Note that there are three lead-out wires, two of which connect to the anode of the component.

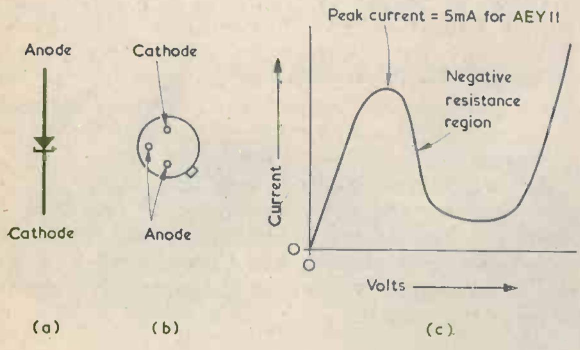


Fig. 1(a). Circuit symbol commonly used for the tunnel diode
(b). Lead-out layout for the AEY11 diode
(c). Typical forward voltage — current characteristic for a tunnel diode

NEGATIVE RESISTANCE

The voltage versus current characteristic for a forward biased tunnel diode is shown in Fig. 1(c). As just explained, as the bias voltage is increased the current flow first rises to a peak point, then rapidly falls away into a valley region, and finally increases steadily as the device begins to function as an ordinary diode. The significant part of this characteristic is the section between the peak and valley regions. Here the current actually falls with increasing voltage, or rises with decreasing voltage, which is of course the exact opposite to normal!

This effect is often called "negative resistance", but the term is rather misleading since resistance is equal to voltage divided by current, and since some applied voltage is needed in order to produce a current flow through the diode, the component always has a positive resistance. "Negative resistance" simply means that on some part of the voltage — current characteristic of a device the normal relationship of increased voltage producing increased current is reversed. Incidentally, this effect is not unique to the tunnel diode, and occasionally f.e.t. and bipolar transistors are used in circuits which produce the same result.

TUNNEL DIODE OSCILLATOR

Tunnel diodes can be employed in various switching applications, but to the amateur they are probably most useful as oscillators, and a typical basic example is shown in Fig. 2. This merely consists of a potential divider network, RA and RB, which biases the diode into its negative resistance region, and a tuned circuit which is connected in series with the tunnel diode. In a normal circuit the natural oscillations which are produced in a tuned circuit when it is excited soon die away due to the effects of positive resistance. In the negative

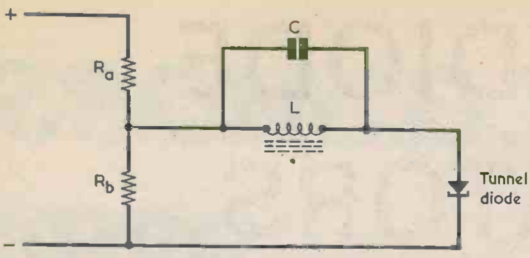


Fig. 2. A possible tunnel diode oscillator circuit. The diode is biased onto the negative resistance section of its characteristic

resistance circuit of Fig. 2 the negative resistance overcomes the positive resistance and continuous oscillation results.

In practice the circuit tends not to work very well, since in addition to the required oscillations there is also quite a high wide-band noise output. Better results were obtained by either making one connection to a tapping in the coil, or connecting the circuit to an untuned winding of an r.f. transformer. This is shown in the practical circuits of Figs. 3 and 4 respectively. Presumably the lower impedance coupled to the tunnel diode results in reduced loading on the tuned circuit with a consequently higher effective Q and lower spurious output.

The circuit of Fig. 3 is for a b.f.o. or i.f. alignment generator working at a frequency of around 455 to 470kHz, adjustable by means of the core of T1. T1 is a Denco i.f. transformer type IFT13, although the circuit would probably work using any other transistor type i.f. transformer with one winding untuned in the appropriate frequency range. C1 is an integral part of the i.f. transformer. R1 is adjusted to bias D1 into its negative resistance region, and this occurs with about 0.15 volt at the junction of R1 and R2.

If a readily adjustable frequency shift control is required, this can be provided by either connecting a variable capacitor of about 10pF in parallel with C1, or by connecting it across D1. The second method of connection has the advantage of allowing one side of the capacitor to connect to an earthy part of the circuit.

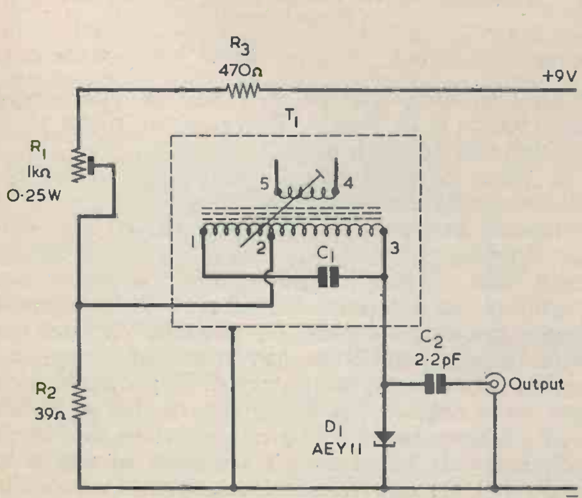


Fig. 3. A practical tunnel diode oscillator with a frequency range of around 455 to 470kHz

If the output from the circuit is found to be rather noisy and lacking in purity, adding a resistor of about 2.2Ω in series with D1 should rectify this.

WIDE RANGE

The circuit of Fig. 4 uses Denco Miniature Dual Purpose Green coils (originally designed for valve usage) and it can cover a wide range of frequencies. Green coils in Ranges 2 to 5 can be employed, giving the following coverage: Range 2, 0.525 to 1.7MHz; Range 3, 1.6 to 6MHz; Range 4, 5 to 16MHz; Range 5, 10 to 33MHz. Thus the circuit could, for example, form the basis of a wide range signal generator.

For those who are unfamiliar with the Denco coils, these have a 9-pin base which enables them to be plugged into a standard B9A valveholder so that plug-in range changing can be carried out. They have an adjustable core which can be adjusted here so that about 10mm. of metal screw thread protrudes above the top of the coil.

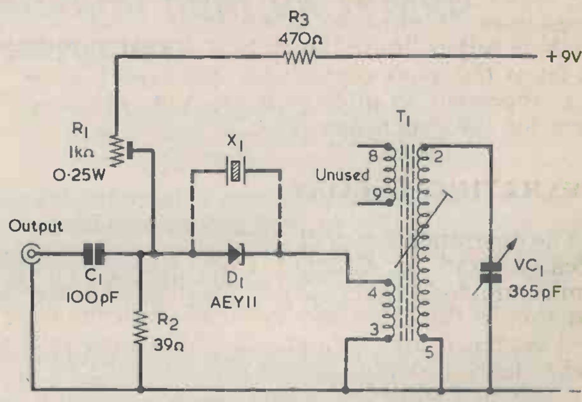


Fig. 4. Employing four plug-in coils for range changing, this oscillator can cover 0.525 to 33MHz. Crystal control can be achieved by adding the crystal X1 and resonating the tuned circuit at crystal frequency

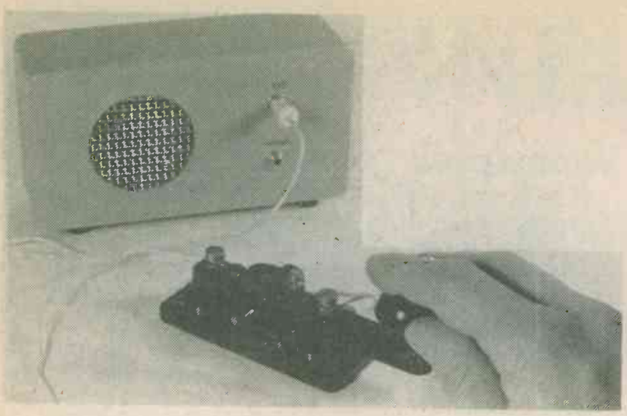
The circuit of Fig. 4 can readily be made to operate as a crystal controlled oscillator by adding a crystal across D1, and resonating T1 at the crystal frequency. In this application VC1 would be replaced by a trimmer capacitor. It should be noted that, if T1 is resonant at a frequency well away from the crystal frequency, oscillations will be produced at the T1 frequency. Also, care must be taken to adjust VC1 to a setting which gives reliable operation. If it is somewhat off-tune the circuit may not always start when the supply is connected (as is the case with many crystal oscillators which also employ an LC tuned circuit).

The current consumption of the circuits shown in Figs. 3 and 4 is about 9mA.

Tunnel diodes can be made to operate at frequencies from the sub-audio range to hundreds of MHz. The upper limit is often governed by the encapsulation inductance, and tunnel diodes having special housings can operate at frequencies beyond 10GHz (10,000MHz)!

AVAILABILITY

The AEY11 tunnel diode employed in the circuits is available from Watford Electronics, 33/35 Cardiff Road, Watford, Herts, WD1 8ED. ■



I.C. MORSE OSCIL

AN EXCELLENT PROJECT FOR T NEWCOMER

A simple to build self-contained unit, having an internal speaker and battery supply with an output for high impedance headphones or tape recorder provided

Many people find it necessary to learn the Morse code, and the ability to send and receive Morse is needed in order to obtain an amateur transmitting license type A. It is also a desirable asset for the short wave listener, and is useful in many other fields.

A Morse practice oscillator is a very useful piece of equipment to have when learning the code, and a simple unit of this type is described here. The unit is self-contained, having an internal speaker and battery supply, but an output for high impedance headphones or a tape recorder is provided. The circuit is very simple and utilises an audio power amplifier i.c. plus a few passive components. It makes an excellent project for the newcomer to electronics.

WIEN NETWORK

Obviously any audio tone generator can be used in this application, but a sine wave oscillator has the advantage of producing a signal of the same type as that given by a real c.w. signal, and it is also less tiring to listen to for long periods than other waveforms. It was therefore decided to design the unit to generate a reasonably pure sine wave signal, and the circuit is based on the well known Wien Bridge type oscillator circuit.

A Wien network is shown in Fig. 1(a) and, as will be apparent from this, it merely consists of two resistors and two capacitors. The attenuation provided by the network varies with frequency, minimum loss occuring at a frequency determined by the values of the resistors and capacitors. It is frequently convenient to have RA equal to RB, and CA equal to CB, whereupon the minimum loss is 9.5 dB. The frequency at minimum loss is then equal to

$$\frac{1}{2\pi\, RA.CA}$$

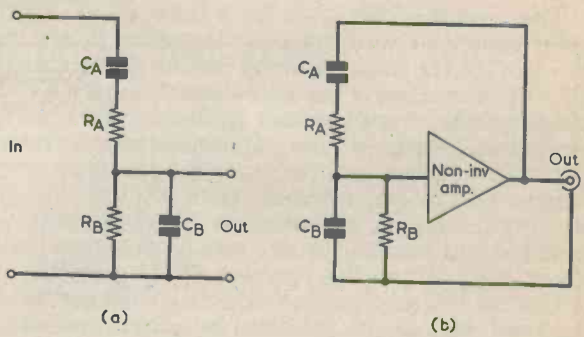


Fig. 1(a). The Wien network

(b). The Wien network inserted in a positive feedback loop. With the requisite amplifier gain, the circuit oscillates at a frequency dependent on the values of the resistors and capacitors

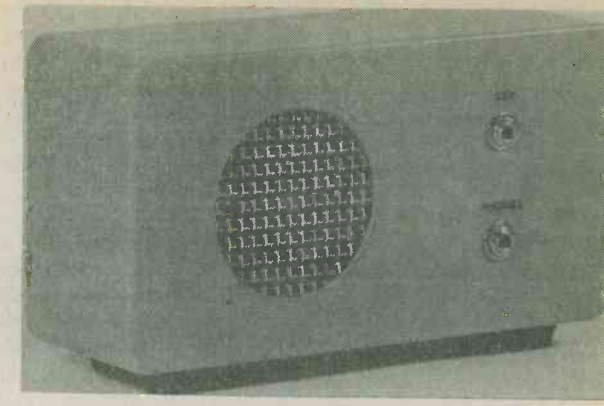
where frequency is in Hz, resistance is in ohms and capacitance is in farads. There is zero phase shift through the network at this frequency.

A Wien network can be employed in the oscillator configuration shown in Fig. 1(b). Here it is connected between the input and output of a non-inverting amplifier (i.e. an amplifier which has its input and output in phase) and, provided the amplifier has a gain of more than 9.5 dB (about 3 times), it will compensate for the losses through the Wien network and there will be sufficient positive feedback to sustain oscillation. In order to obtain a sine wave output signal the gain of the amplifier must be just adequate to give oscillation, and there will then only be sufficient feedback to maintain oscillation at the Wien network frequency. If amplifier gain is too high the circuit will oscillate violently, with consequent clipping and distortion of the output signal.

PRACTICE
LATOR

THE

By I. M. Attrill



The only items on the front panel are the speaker, the socket for the key and the socket for optional headphones. An on-off switch is not required as the oscillator is only turned on when the Morse key plug is inserted and the key is pressed

COMPLETE CIRCUIT

The complete circuit of the Morse practice oscillator is given in Fig. 2, and it is based on an LM380 audio power amplifier integrated circuit. This i.c. has both inverting and non-inverting inputs, and only the latter is required for the present application. The inverting input, at pin 6, is connected to the negative supply rail.

The Wien network consists of C3, R2, R1 and C1, and these produce an operating frequency of about 1kHz. The gain of the LM380 is internally pre-set at approximately 34dB (50 times), which is far higher than the gain needed for oscillation at the Wien network frequency. The Wien network is,

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
R1 3.3kΩ
R2 3.3kΩ
R3 3.3kΩ
R4 470Ω pre-set potentiometer, 0.1 watt, horizontal
R5 27Ω

Capacitors
C1 0.047μF type C280
C2 10μF electrolytic, 10V. Wkg.
C3 0.047μF type C280
C4 6.8μF electrolytic, 10V. Wkg.

Semiconductor
IC1 LM380

Speaker
LS1 50Ω to 80Ω, miniature

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

Miscellaneous
Plastic case (see text)
Veroboard, 0.1in. matrix
Morse key
3.5mm. jackplug
9 volt battery type PP3
Battery connector
14-way d.i.l. i.c. holder
Speaker fabric
Wire, nuts, bolts, etc.

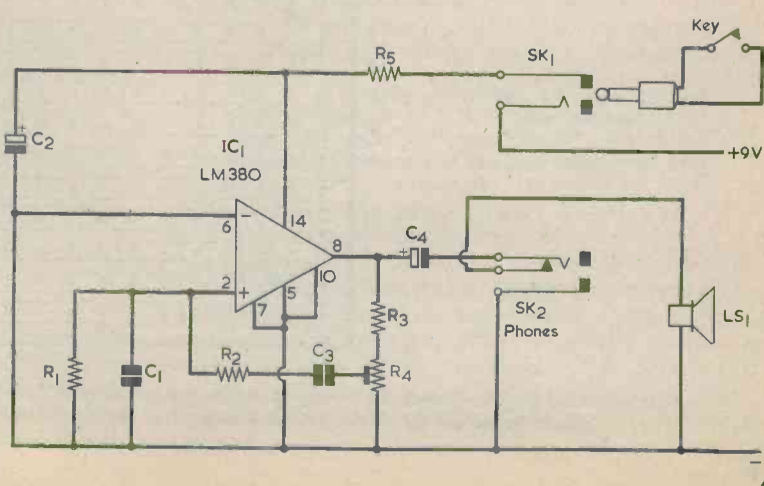


Fig. 2. The circuit of the Morse practice oscillator. High impedance or crystal headphones may be plugged into SK2, whereupon the speaker is automatically muted

therefore, not fed directly from the output of the amplifier, but from a potential divider consisting of R3 and R4. The latter is adjusted so that the level of feedback is just sufficient to sustain oscillation at an adequate amplitude, enabling a good output waveform and volume level to be obtained.

C4 is the output d.c. blocking capacitor, and this feeds the loudspeaker by way of a break contact on the phone socket, SK2. The contact automatically disconnects the internal speaker when a pair of headphones is connected to the unit. C2 is a supply decoupling capacitor, and it helps to give a good keying characteristic. It discharges very rapidly when the key is raised and does not alter the formation of the Morse characters. R5 is a current limiting resistor and prevents the very high current surges which would otherwise flow, due to charging current in C2, when the key closes. R5 also helps to give a good keying characteristic as well as preventing sparking at the key contacts, with a consequent improvement in the contact life.

No on-off switch is required as no power is consumed by the unit until the key is pressed. With the key down, current consumption is about 20mA, but the precise figure will depend to a large extent on the setting of R4. The author used a PP3 battery in the prototype, but a larger 9 volt battery, such as the PP7, could be employed if desired. The larger battery will, of course, have a longer life than the PP3.

The two electrolytic capacitors in the circuit are specified as 10 volts working. It is, of course, quite in order to use capacitors having higher working voltages, when these are more readily available.

CONSTRUCTION

The unit can be housed in any small plastic case capable of taking the parts and the battery, and that used by the author measured about 150 by 80 by 50mm.

The case stands on its side and what would otherwise be the bottom becomes the front panel. As can be seen from the photographs, the front panel layout is very simple. SK1 and SK2 are mounted to the right, with SK1 above SK2. The circular speaker aperture, which can have a diameter of about 48mm., is to the left. A miniature speaker having any impedance between 50Ω and 80Ω can be used, and its diameter can be of the order of 60mm. or so. One way of cutting out the

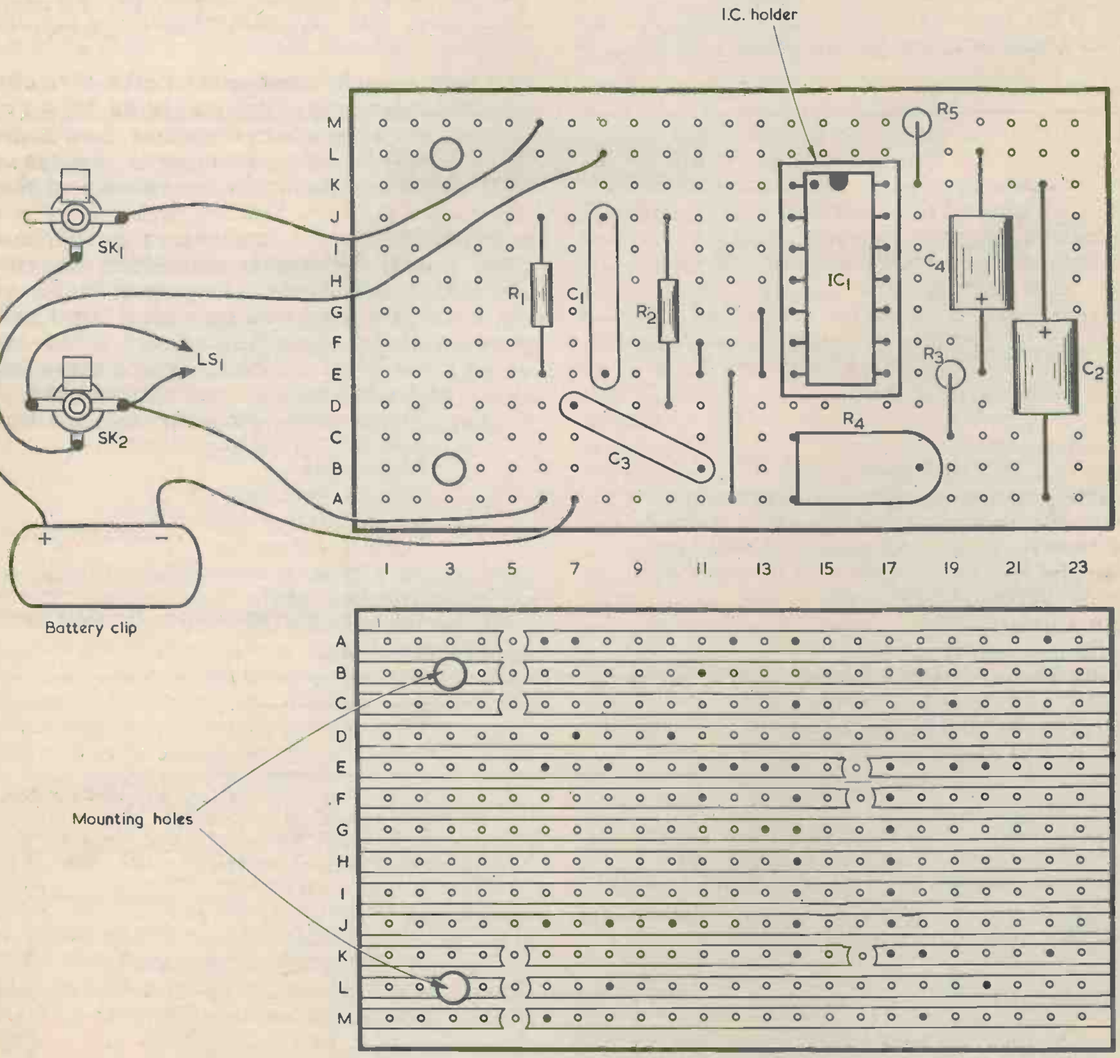
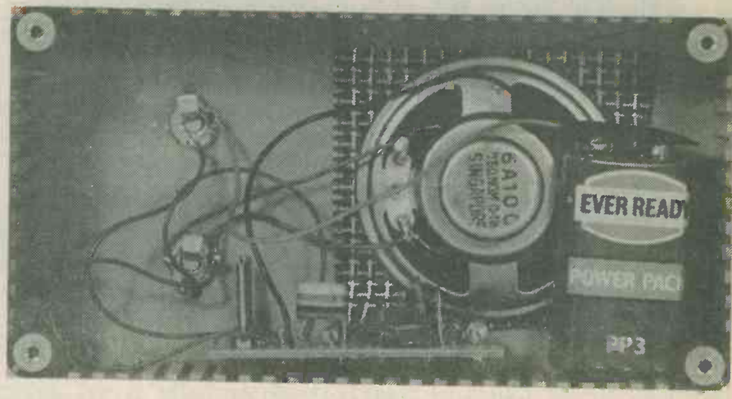


Fig. 3. Wiring details. Nearly all the components are assembled on a Veroboard panel of 0.1in. matrix. The strips should be cut at the points indicated in the lower view before commencing wiring

Apart from the two sockets and the speaker, all the oscillator components are assembled on a small Veroboard panel



aperture in the front panel is to drill a ring of small holes, say about 3 to 4mm. in diameter, just inside the periphery of the required aperture. Provided the holes are closely spaced it should then be possible to punch out the material at the centre. A large half-round file is then used to smooth the inevitable rough outline of the cut-out and also to enlarge the hole to the appropriate size. An alternative method consists of simply cutting out the circle with a miniature round file or a fretsaw. A piece of speaker fabric is glued in place on the inside of the aperture, and the speaker is then glued to the fabric. It is important to ensure that the adhesive is applied only around the outer rim of the speaker; if any adhesive becomes smeared over the speaker diaphragm or its surround the performance of the speaker may be impaired.

The remaining components are assembled on a piece of 0.1in. Veroboard having 13 copper strips by 23 holes. The layout and connections here, as well as external wiring, are illustrated in Fig. 3. The two mounting holes may be 6BA or M3 clearance. The i.c. is mounted in a 14-way d.i.l. holder; this is soldered to the Veroboard and the i.c. is inserted later. The panel is mounted on the bottom of the case with R4 towards the rear, so that it can be adjusted easily. Spacing washers are required between the inside of the case and the Veroboard underside. Without such washers the panel will be strained and is liable to crack when the mounting bolts and nuts are tightened. The panel should not be finally mounted until it has been wired up to SK1, SK2 and the battery connector.

The wiring is finally completed by making the two connections between SK2 and the speaker, and by connecting the positive battery connector lead to the appropriate tag of SK1. There should be plenty of space for the battery inside the case, and it may be held in place by a simple home-made clamp. Alternatively, foam rubber or plastic may be placed over it so that it is secured in position when the rear of the case is screwed on.

ADJUSTMENT

The slider of R4 is set to the fully anti-clockwise position and the key is then plugged in and pressed, whereupon the unit should oscillate. (If it does not do so, the wiring should be carefully checked for errors.) At this stage the output waveform will lack purity and will be virtually a square wave. A more pleasant tone will be produced if R4 slider is adjusted in a clockwise direction, but the slider must not be advanced too far or the volume level will become very low, or the oscillation will cease altogether. The final setting for R4 is a good compromise between purity of tone and output volume level.

A pair of high impedance or crystal headphones can be plugged into SK2 and, as explained earlier, this will mute the internal speaker. Low impedance headphones should not be plugged in as the volume in these will probably be excessive and they will also cause a heavy battery drain. It is in order, however, to use low impedance headphones if a 100Ω $\frac{1}{4}$ watt resistor is connected externally in series with the phones. The output can be coupled via a screened lead to a high level input of a tape recorder. It should not be applied to a tape recorder microphone input, as the latter will almost certainly be overloaded unless a suitable attenuator is interposed between the oscillator and the recorder.

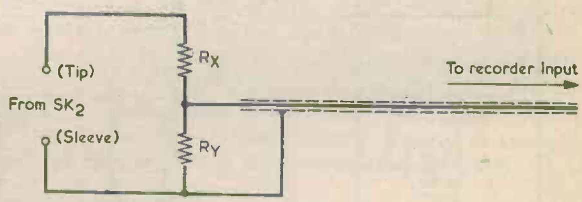


Fig. 4. A simple attenuator for coupling the oscillator output to a low level tape recorder input. The terms "tip" and "sleeve" apply to the appropriate contacts of the jack plug fitted into SK2

The attenuator may take the form shown in Fig. 4, in which the signal voltage fed to the recorder is equal to the fraction RY/(RX+RY) of the oscillator output. If, for example, RY is 10Ω and RX is 1kΩ, the input to the recorder will be very slightly less than one-hundredth of the output of the oscillator. ■

DOUBLE DECCERS — *A SPECIAL NEW SERIES FEATURING S-DeCs*

No. 5

By
IAN SINCLAIR

THE DECISION MAKER

Instructive circuit incorporates serial multivibrator and binary divider

The decision maker, or coin-toss, circuit is one which gives a yes-no decision at random, just as the toss of a coin should. Decision-maker circuits of this type can be used as an amusement, but can also be the basis of serious work since they can generate random numbers for use in draws or statistical work. Since the output of each decision circuit will be a 1 or a 0, each circuit gives a binary digit, and a large number of such circuits can give large binary numbers. For example, a six stage decision maker could give numbers between 000000 (zero) and 111111 (63) at random. This could give instant random numbers for football pools or other selections.

Simple single-DeC versions of the decision maker often suffer from the problem of trying to do too much with too few transistors, and the present circuit achieves greater reliability by separating the different parts of the circuit.

SERIAL MULTIVIBRATOR

TR1 and TR2 form an oscillator circuit. To keep the number of components down, a serial multivibrator has been used, with the collector of the p.n.p. transistor TR1 connected directly to the base of the n.p.n. TR2. The base of TR1 is also connected directly to the oollector of TR2, completing a positive feedback loop around these two transistors. R2 is the collector load resistor for TR2, whilst R1 and C1 are oscillator timing components connected to the emitter of TR1.

To understand the operation of this oscillator, imagine that the circuit is just being switched on with C1 discharged, so that the emitter of TR1 is at zero volts with respect to the negative rail. The collector of TR2 will start at 3 volts, because of the equal value resistors R2 and R3, so that the base of TR1 is also held at this voltage. Since TR1 is a p.n.p. silicon transistor it will only start to conduct

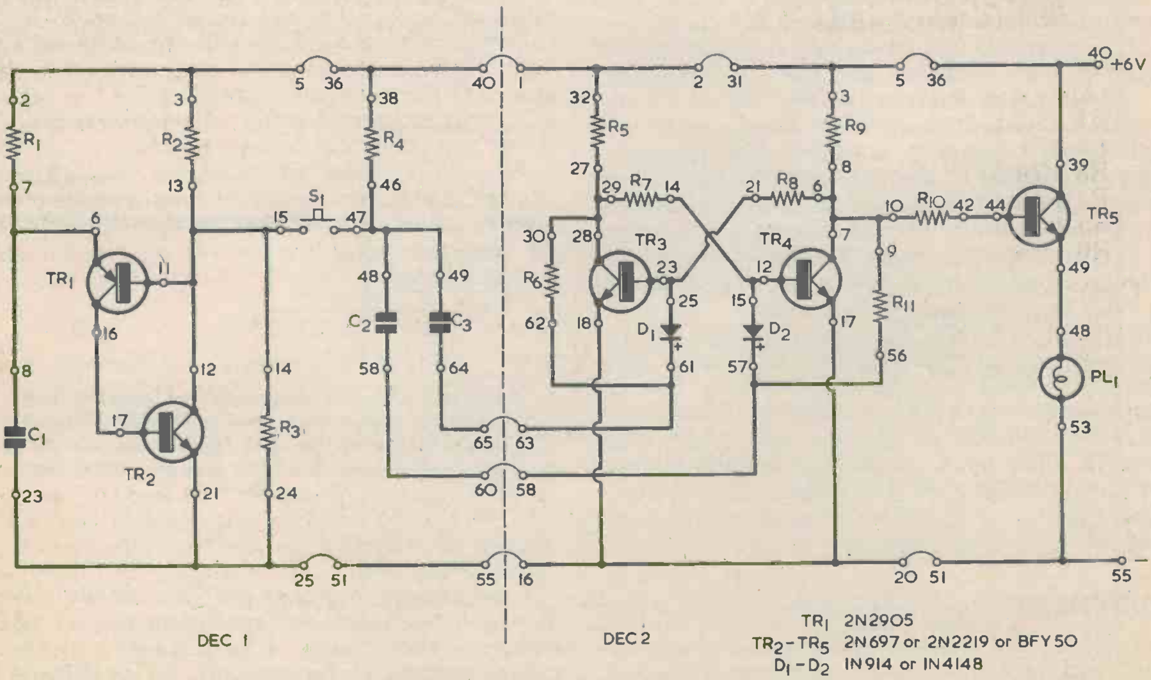


Fig. 1. The decision maker circuit. TR1 and TR2 form a serial multivibrator, TR3 and TR4 a bistable, and TR5 functions as a lamp driver

when the base voltage is about 0.5 volt *negative* of the emitter (or, of course, when the emitter is 0.5 volt positive of the base). At the instant of switch-on, therefore, with the base of TR1 3 volts positive of its emitter, TR1 does not conduct. With TR1 non-conducting, there is no base bias current for TR2 so that this transistor is also cut off.

Immediately after switch-on C1 commences to charge through R1. After a period rather less than the time constant of R1 and C1, the voltage at the emitter of TR1 will reach 3.5 volts positive of the negative rail, causing its base to be 0.5 volt negative of the emitter. TR1 will now start to conduct, and an initially small current will flow into the base of TR2, turning on this transistor. TR2 collector draws an amplified current through the base of TR1, turning this transistor hard on and, in consequence, turning TR2 hard on as well. The two transistors then cause C1 to be rapidly discharged; and a steep negative-going pulse edge appears at TR2 collector.

When C1 discharges to a level below 1 volt, the current from this capacitor flowing into TR1 emitter commences to reduce. There is a corresponding reduction in the base current of TR2 with, at a certain level, a reduction in TR2 collector current. The voltage at TR2 collector rises, taking the base of TR1 positive with respect to its emitter. TR1 collector current reduces further and the two transistors very quickly turn off, allowing TR2 collector to return to its starting voltage of 3 volts positive. Capacitor C1 commences to charge again via R1, and another cycle begins.

The output waveform at TR2 collector has steep negative-going and positive-going pulse edges. The frequency is of the order of 1kHz. Note that in this serial multivibrator the transistors are either both on or both off, unlike the usual type of circuit.

COMPONENTS

Resistors
(All ¼ watt 5%)

R1 150kΩ	
R2 4.7kΩ	R7 22kΩ
R3 4.7kΩ	R8 22kΩ
R4 150kΩ	R9 1.8kΩ
R5 1.8kΩ	R10 4.7kΩ
R6 150kΩ	R11 150kΩ

Capacitors
C1 0.01μF polyester or mylar
C2 0.001μF polyester or mylar
C3 0.001μF polyester or mylar

Semiconductors
TR1 2N2905
TR2-TR5 2N697 or 2N2219 or BFY50
D1, D2 1N914 or 1N4148

Switch
S1 push-button, press to close

Lamp
PL1 6V, 60mA, m.e.s.

Miscellaneous
2-off S-DeC
6V battery
Lampholder, m.e.s.

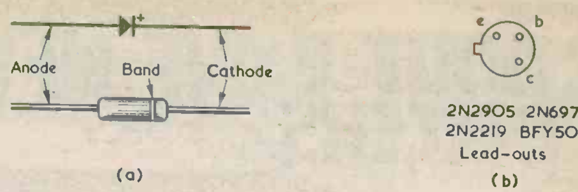


Fig. 2(a). The cathode end of a silicon diode is usually identified by a white band on the diode body

(b). Lead-out layout of the transistors employed in the circuit

BISTABLE

The oscillator output is taken to the decision switch, S1. When this switch is closed, the pulses from TR2 collector are fed through C2 and C3 to the steering diodes of the bistable circuit incorporating TR3 and TR4. This is the usual bistable circuit, such as was described in the third article in the Double Deccer series. An output is taken from TR4. On each negative pulse from TR2 the bistable changes states, so that the output at TR4 collector is alternately high and low for successive pulses from TR2.

The collector of TR4 is coupled through R10 to the base of TR5, which is connected as an emitter follower with the 6 volt lamp, PL1, in its emitter circuit. When TR4 is cut off and its collector is high, current can flow through R9 and R10 to the base of TR5, allowing the lamp to glow. The lamp is extinguished when TR4 collector voltage is low. With the oscillator connected to the bistable circuit (S1 on) the output of the bistable is a square wave having a frequency which is half that of the oscillator. This frequency is too high for the lamp to follow, so that it merely glows very faintly.

When S1 is opened, however, the bistable is no longer triggered and will remain in the state it was switched to by the last pulse passed to it. The collector voltage of TR4 will therefore be either high or low, and will not change until S1 is closed again. If the collector voltage of TR4 is high the lamp will be lit, and if the collector voltage of TR4 is low the lamp will be extinguished.

We can call the lit condition the YES or 1 answer, and the extinguished condition the NO or 0 answer. Since either of these is equally likely when we open the switch the answer we get is purely a matter of chance, a truly random decision.

S-DEC CONSTRUCTION

To construct this circuit as a Double Deccer, first clip the two DeCs together, end to end, to form one long DeC. Plug in the nine wire links, noting the long links from points 60 and 65 of DeC 1 to points 58 and 63 of DeC 2. These link wires carry the trigger pulses. The switch S1 and the lamp PL1 can be mounted on the front panel of one DeC, or positioned remotely, as desired. Remember that single strand wire should be used for connections.

Now plug in the capacitors, followed by the diodes. The capacitors are not electrolytic in this circuit, so that they may be plugged in either way round, but care should be taken to ensure that the diodes are inserted with correct polarity. Diodes generally have a red spot or white band to identify

Continued on Page 431

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

● **BRASIL**

Radio Relogio, Rio de Janeiro, on **4905** at 0058, OM with announcements in Portuguese, time signals (pips) in the background. The schedule is from 0800 to 0300 and the power is 5kW.

Radio Sociedad, Feira de Santana, on **4865** at 0150, OM with announcements then into a programme of recorded local pops. The schedule is from 0730 to 0400 and the power is 2kW.

Radio Aparecida, Aparecida, on **5035** at 0205, OM with announcements, OM with a local ballad. The schedule is from 0900 to 0300 and the power is 1kW.

Radio Itatiata, Belo Horizonte, on **4805** at 0225, OM with a sports commentary in Portuguese. The schedule is on a 24-hour basis and the power is 25kW.

Radio Tabajara, Joao Pessoa, on **4795** at 0133, OM with a love song in Portuguese, OM with identification at 0135. The schedule is from 0730 to 0400 and the power is 2kW.

Radio Riberao Preto, Riberao Preto, on **3205** at 0020, OM with a sports commentary in Portuguese, the schedule of this one being from 0800 to 0400 and the power is 5kW.

Radio Clube do Para, Belem, on **4855** at 0432, OM with announcements, local pops on records. The schedule is from 0800 to 0500 and the power is *10kW*.

Radio Globo, Rio de Janeiro, on **11805** at 0100, OM with identification in Portuguese under interference from Radio Moscow. Radio Clobo has a schedule from 0800 to 0330 (the closing time can vary) and the power is 10kW.

Radio Clube de Pernambuco, Pernambuco, on **11865** at 0115, OM with a sports commentary in Portuguese. The schedule is from 0800 to 0430 and the power is 1kW.

Next month some Colombian stations which may be logged on the LF 60 metre band will be featured here.

● **SOUTH AFRICA**

RSA Johannesburg on **11900** at 1800, interval signal, identification, six 'pips' time-check followed the programme in German, scheduled from 1800 to 1850.

SABC Meyerton on **4835** at 1811, pops on records, OM announcer in English. This is the English programme radiated from September through to May from 0358 (Saturday 0430, Sunday 0500) to 0635 and from 1520 to 2115 (Saturday until 2205). The power is 100kW.

● **U.S.S.R.**

Ashkhabad, Turkmen SSR, on **4930** at 0116, classical orchestral music. Ashkhabad relays Moscow 2 on a 24-hour schedule.

Naryn, Kirgiz SSR, on **4795** at 1805, OM with a ballad in Russian. Naryn relays Frunze 1 from 2300 through to 1930.

Osh, Kirghiz SSR, on **4810** at same time as above and with the same programme. This transmitter operates in parallel with Naryn.

Kalinin, Moscow Oblast, on **4860** at 1817, OM with a talk in Russian. This one transmits the Foreign Service to North America in English, Spanish and Ukrainian from 2200 through to 0530 and at other times, schedule unknown, relays Moscow 2.

Kiev, Ukrainian SSR, on **4940** at 1836, opera in Ukrainian. Kiev 2 relay in Ukrainian is scheduled from 0300 through to 2330. The schedule is from 0300 through to 2300.

Tbilisi, Georgian SSR, on **5040** at 0248, OM with local folk songs. This transmitter relays Tbilisi 1 mostly but also includes relays of Moscow 1. The schedule is from 0200 to 2105 and the languages used are Armenian, Azerbaijani, Georgian and Russian.

Alma Ata, Kazakh SSR, on **5035** at 1842, OM and YL alternate in Chinese. The schedule is from 0000 to 1200 relaying Alma Ata 1, from 1200 to 1630 relaying the Tashkent/Alma Ata Foreign Service in Kazakh and Uigher and from 1630 to 2300 with the Moscow Foreign Service and 'Peace and Progress' in Chinese.

Yerevan, Armenian SSR, on **4810** at 0207, OM and YL alternate with news in Armenian. This one relays Yerevan 1 from 0200 to 1300 and Yerevan 2 from 1300 to 2000.

Petrozavodsk, Karelian ASSR, on **4780** at 0226, YL with instructions for physical exercises to music. The schedule is from 0200 to 2100 relaying Moscow 1 except for the period 1500 to 1530 when local programmes are featured.

Tyumen, Tyumen Oblast, on **4895** at 0120, YL with instructions for physical exercises to piano music. The schedule is from 0100 to 2005 relaying Moscow 1 except for local programmes at the following times; Monday to Friday from 0235 to 0300, from 0315 to 0400, from 0420 to 0430, from 1445 to 1530. Saturday from 0230 to 0300, 0420 to 0430 and from 0515 to 0600. Sunday from 0215 to 0300.

Dushanbe, Tadzhik SSR, on **4975** at 0010, OM with a newscast in Russian. The schedule is from

0000 to 1200 relaying Dushanbe 1, 1200 to 1300 local programmes in Russian and Tadzhik and from 1300 to 1330 relaying the Moscow Foreign Service in Farsi (Persian).

Radio Moscow on **11750** at 0421, OM with the Spanish programme for Latin America ("Peace and Progress"), scheduled from 0400 to 0430 on this channel and in parallel on **11850, 11890, 11900** and on **11920.**

Radio Moscow on **11880** at 0425, YL with the English programme to Africa, scheduled from 0400 to 0600 here and in parallel on 11980 — and many other channels on other bands.

● HUNGARY

Radio Budapest on **11910** at 1505, OM with local songs in the Hungarian programme for Europe, scheduled from 1500 to 1630 (Sunday only, Saturday only until 1530).

● AFGHANISTAN

Kabul on **4775** at 0130, 4 pips time-check, readings from the Holy Qur'an. This is the Home Service 1 scheduled here from 0100 to 0330, 1230 to 1740 except for the periods 1300 to 1530 when the Foreign Service is radiated (English from 1400 to 1430). The power is 100kW.

● GUINEA

Conakry on **4910** at 0405, OM with a talk in French on national affairs. The schedule is from 1230 through to 0730 and the power is 18kW.

● ALBANIA

Gjirocaster on a measured **5057** at 1755, local music on an accordian-type instrument in the Tirana Home Service, scheduled here from 0400 (October to April from 0500) to 1930. The power is 50kW.

● CHAD

Ndjamana on a measured **4904·5** at 1835, African drums and instruments with YL's chanting. The schedule is from 0425 to 0630 and from 1740 to 2200 (Saturday until 2300). The power is 100kW.

● AUSTRALIA

ABC Brisbane on **4920** at 1923, pops on records, OM announcing in English. The schedule of this local transmitter is from 1900 (Sunday from 1930) to 1402 and the power is 10kW.

● ECUADOR

Radio Splendit, Cuenca, on **5025** at 0400, OM with identification, OM song in Spanish, local-type music. The schedule is from 0900 to 0500 but closing can vary to 0430 and, just to confuse matters, sometimes operates around the clock and can vary in frequency to **5026.** The power is 5kW — at least that is constant — we hope!

● HONDURAS

La Voz Evangelica, Tegucigalpa, on **4820** at 0332, OM with a religious programme in English. The schedule is from 1030 to 0500 with programmes in English from 1500 to 1600, 0300 to 0400 and from 0415 to 0430. The power is 5kW.

● CHINA

CPBS Peking on **3920** at 2014, OM with the Domestic Service 1 Programme, scheduled here from 1000 to 1735 and from 2000 to 2400.

CPBS Peking on a measured **7504** at 2020, OM and YL announcing a Chinese music programme in the Domestic Service 1, scheduled here from 2000 to 1735.

Radio Peking on **15045** at 1310, OM with a programme in Malay, scheduled from 1300 to 1400.

Radio Peking on **15030** at 1945, YL with the Italian programme for Somalia, scheduled from 1930 to 2000.

● HUNGARY

Radio Budapest on **15225** at 0328, YL with identification in English and interval signal at the end of the English programme to North America, scheduled from 0300 to 0330.

● ROMANIA

Bucharest on **15250** at 1300, OM with identification in English in the programme for Europe, scheduled from 1300 to 1330.

● FINLAND

Helsinki on **15265** at 1305, OM with the English programme to Europe, North America, the Far East and Australasia, scheduled from 1300 to 1325.

● EGYPT

Radio Cairo on **15175** at 1250, OM with identification in Arabic in the Domestic Service, radiated here from 0700 to 1300.

Radio Cairo on **15475** at 0530, OM with a newscast in Arabic.

● CZECHOSLAVAKIA

Radio Prague on **15395** at 0920, OM and YL with the English programme to Africa, the Far East, South Asia, Australia and New Zealand, scheduled here from 0830 to 0900 (Saturday and Sunday until 0930).

● AUSTRIA

Vienna on **15335** at 1812, local-type music in the German programme to Europe, East and South Africa and the Middle East, scheduled from 1700 to 1830.

THE DECISION MAKER *(Continued from Page 429)*

the cathode lead-out, but unmarked diodes will need to have their polarity determined. If a multimeter switched to an ohms range is used to check diodes, remember that the terminal polarity is reversed when the ohms range is used. With the diode connected to the multimeter in the manner which causes the needle to be deflected (due to the diode conducting) the "+" terminal of the meter is connected to the diode cathode, and the cathode end of the diode body should be marked using quick-drying paint. The multimeter will not normally indicate zero ohms when the diode is connected to it so that it conducts, this being due to the forward voltage drop in the diode itself.

The transistors can now be fitted to the DeCs. Remember that TR1, the p.n.p. type, has the same lead-out arrangement as the n.p.n. types used in the remainder of the circuit. If necessary, make sure that the p.n.p. type can be identified should the type number rub off.

Finally, plug in the resistors and connect the battery. The Decision Maker is then ready for use.

BAND II PORTABLE

Part 1 By Sir Douglas Hall, Bt., KCMG

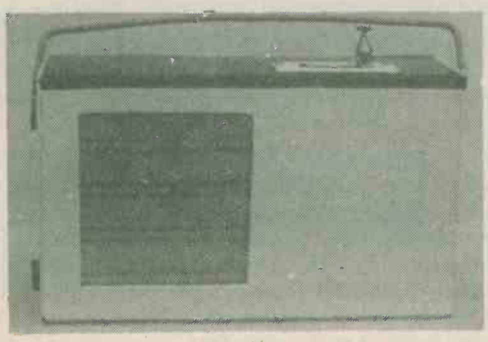
Unique and highly sensitive receiver design for v.h.f. f.m. transmissions

The author has published a number of receiver designs, both a.m. and f.m., incorporating his "Spontaflex" r.f.-a.f. reflex circuitry. This article deals with the latest f.m. version, which is the most sensitive so far and which can be relied on to receive Band II signals very well in most parts of the British Isles. An output power of about 400mW is available.

CIRCUIT OPERATION

The circuit of the receiver appears in Fig. 1, in which the vertical dashed line shows how the components are divided, in construction, between two tagboards. The aerial signal is applied to the emitter of TR1 through the isolating capacitor, C1, and is amplified by TR1 in the common base mode. The amplified signal at TR1 collector next passes via C2 to the tuned circuit, VC1, L1, and thence to the base of TR2, operating as an emitter follower. TR2 is in a gently oscillating state, and demodulation takes place at the germanium diode, D1, by the synchronous method. The amplitude of oscillation is set by VR2 which, due to silicon diode D2, has a stabilized direct voltage across it of about 0.6 volt. When the slider of VR2 is at the top of its track as shown in the circuit, or when its central knob is turned fully anti-clockwise, a forward current of a few hundred microamps flows through the detector diode D1. This reduces the impedance of the diode, thereby increasing the damping across the tuned circuit. As the control is turned clockwise, causing the slider to approach the negative rail, damping of the tuned circuit reduces until oscillation starts. Oscillation takes place in the capacitive or Colpitts mode, due to C5, C7 and internal capacitances in TR2.

Three advantages accrue from this method of oscillation control. First, adjustment of VR2 has practically no effect on tuning in Band II (although this standard of performance is not so good at lower frequencies, for which the present receiver is not designed). Second, the audio gain of TR2, in the common base mode, is greater when the impedance of D1 is reduced by the forward current passing through it than it would be if the only current flowing through the diode were TR2 emitter current on its own. Third, there is a compensating effect as the battery runs down. With reduced battery voltage there will be a smaller current flowing through D2 and the zener diode D3, resulting in a slight lowering of the voltage across D2 and, hence, the current in D1. The reduced damping imposed by D1 on the tuned circuit then counteracts the slightly reduced supply voltage for TR2 and helps to maintain TR2 in the gently oscillating condition. In practice, the setting of VR2 remains reasonably constant throughout the useful life of the battery. Note that D1 must be a high efficiency diode as specified, whilst almost any silicon diode will do for D2. C5 is in parallel with C6 in order to provide a low impedance circuit path at v.h.f. The leads of C5 must, in the assembled circuit, be kept as short as possible.



Although it is completely home-constructed, the case of the portable Band II receiver has an effective appearance

As has just been mentioned, TR2 provides a.f. gain as a common base amplifier, the a.f. signal at its collector being built up across VR1 and applied back to the base of TR1. TR1 now operates as a common emitter a.f. amplifier with the a.f. output appearing mainly across R1. The a.f. input impedance at TR1 base is high because of the small amount of negative feedback given by R3, the high amplification factor of TR1 and the low current which passes through it. This high input impedance matches adequately with the similarly high a.f. impedance at TR2 collector.

COMPONENTS

(All fixed values $\frac{1}{4}$ watt 10%)
R1 8.2k Ω
R2 2.2k Ω
R3 330 Ω
R4 2.7k Ω
R5 1.2k Ω
R6 2.2k Ω
R7 1.5k Ω
R8 12k Ω
R9 12k Ω
R10 3.3k Ω
R11 47k Ω
R12 4.7 Ω
VR1 100k Ω pre-set potentiometer, 0.25 watt, horizontal
VR2 4.7k Ω potentiometer, linear
VR3 22k Ω potentiometer, log
VR4 4.7k Ω pre-set potentiometer, 0.25 watt, horizontal

Capacitors
C1 22pF silvered mica or ceramic
C2 1pF silvered mica
C3 470pF silvered mica or ceramic
C4 470pF silvered mica or ceramic
C5 0.1μF polyester
C6 160μF or 150uF electrolytic, 3 V. Wkg.
C7 6.8pF silvered mica or ceramic
C8 200μF electrolytic, 3 V. Wkg.
C9 10μ F electrolytic, 6 V. Wkg.
C10 47μF electrolytic, 3 V. Wkg.
C11 0.1μF polyester
C12 100pF silvered mica or ceramic
C13 1,000μF electrolytic, 10 V. Wkg.
VC1 5pF variable, type C804 (Jackson)

Inductor
L1 see text

Semiconductors
TR1 BC169C
TR2 2N3663
TR3 2N4289
TR4 2N3707
TR5 2N3405
D1 0A81 or 0A91
D2 1S44
D3 BZY88C6V2
D4 BZY88C3V0
D5 1S44

Switch
S1(a) (b) d.p.d.t. slide switch, standard size

Speaker
LS1 15 Ω 5in. (see text)

Miscellaneous
9 volt battery type PP3
9 volt battery type PP9
Battery connectors
Telescopic aerial (see text)
18-way group panel (see text)
2 polystyrene rods, $\frac{1}{4}$in. dia. (see text)
$\frac{1}{4}$in. grommets (see text)
3 knobs (see text)
Materials for receiver assembly and case (see text)

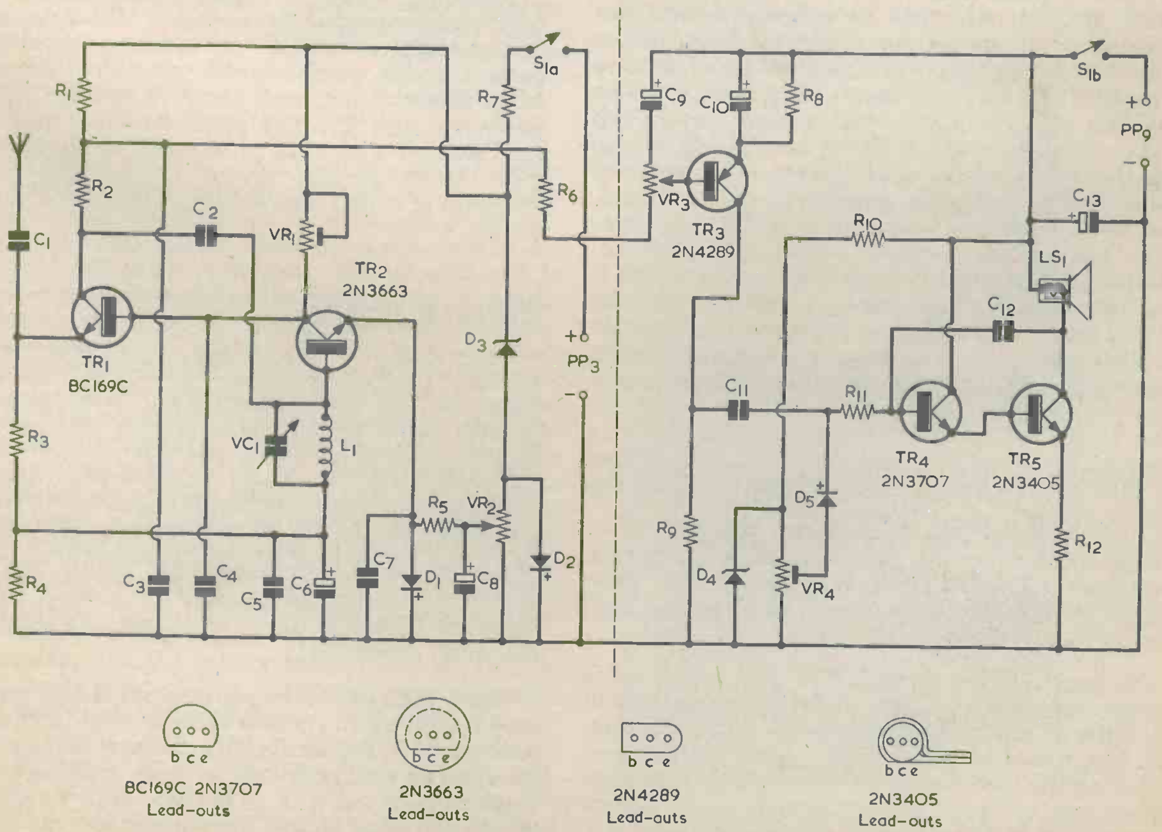
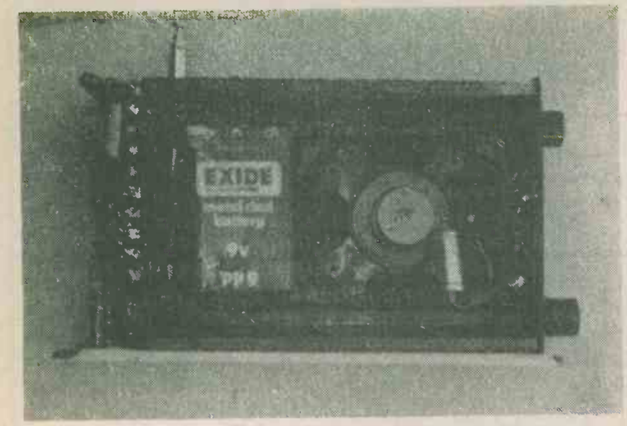


Fig. 1. The circuit of the Band II portable receiver. The vertical dashed line divides the tuner section from the a.f. amplifier section



Looking at the receiver assembly from the side opposite the speaker. The 13 way tagboard is at the left and the 5 way tagboard is to the right

A.F SECTION

All the processes so far described take place on the first of the two tagboards on which the receiver components are assembled. The a.f. signal now passes through the r.f. stopper R6 to the volume control, VR3, on the other side of the vertical dashed line in Fig. 1. The slider of VR3 connects to the base of TR3, which gives a high level of gain in the common emitter mode, with its collector signal passing via C11 and R11 to the base of emitter follower TR4. TR4 emitter couples directly into the base of the output transistor. TR5.

It will be noted that diode D5 is also in the base circuit of TR4, and that its cathode is returned to the slider of pre-set potentiometer VR4, across whose track appears a stabilized voltage of about 3 volts. In the absence of signal, VR4 is set up such that TR4 and TR5 pass a low current only. When an a.f. signal is applied, D5 causes C11 to charge such that its right hand plate goes positive to a level corresponding with the amplitude of the signal. The result is that the base current of TR4 increases with increasing input signal amplitude, automatically taking TR5 to the state in which it can handle the signal level. Consequently, the battery supplying TR5 is only required to provide the current which is necessary for the incoming signal. Thus, although the circuit is in the form of a Class A amplifier, it exhibits the economy attributes of a Class B amplifier. Since VR4 is supplied by the zener diode D4, the standing bias for TR4 and TR5 is kept reasonably steady as the battery voltage falls.

A small level of negative feedback in the output stage is given by R12, in the emitter circuit of TR5. C12 provides a necessary degree of selective feedback across TR4 and TR5.

The tuner section to the left of the dashed line is powered by a PP3 battery, whilst the a.f. section to the right of the line has a separate PP9 battery. The use of two batteries gives several advantages, including the fact that tuner supply voltage is completely free of variations resulting from large output currents in the a.f. section when high level a.f. signals are being reproduced. There is also a considerable simplification in supply decoupling. Since the current drawn from the PP3 battery is only about 2mA, its life is very long.

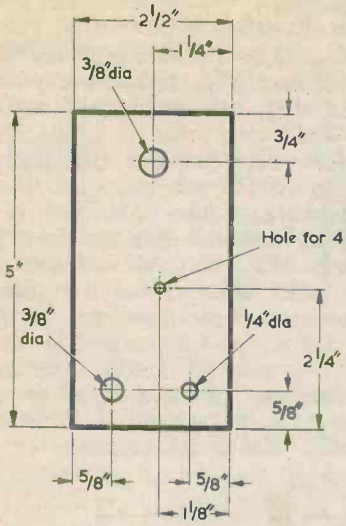
Some points need to be dicussed concerning components. Both C2 and VC1 are low capacitance components, and they are available from Home Radio. The 2N3663 transistor can be obtained from Electrovalue. The 0A81, 0A91 and 1S44 diodes are listed by several suppliers, including Bi-Pak Semiconductors. The 15Ω 5in speaker employed by the author was obtained from Radio Component Specialists, 337 Whitehorse Road, West Croydon. Other speakers of the same impedance and nominal size may be employed, although they might not fit as readily into the receiver layout. (As will be made clear in next month's concluding article, the speaker is not bolted directly to its panel but is fitted, instead, by a non-microphonic floating mounting.)

The two tagboards on which most of the receiver components are wired consist of a Doram "Standard" 18 way group panel cut into two sections. This group panel can also be obtained from Home Radio. Extension spindles are required for VR2 and VC1, and these consist of two ¼in diameter polystyrene rods 12in. long, which are cut to length after the assembly of the receiver. The rods couple to the component spindles by way of home-constructed flexible couplers, each of which is made up of two grommets having ¼in. central holes. A further grommet of this type is used at the forward end of the extension rod for VC1 to keep the rod centralised. Suitable grommets are available, in packets of 25, as Type G10 from Electrovalue. A telescopic aerial with an extended length of some 3 to 4ft. is employed, this being preferably a type which, when extended, can be set to different angles. The telescopic aerials most commonly available have tapped 4BA holes at the centre of the bottom for mounting purposes. The control knobs on the prototype were Type JV18 from Electrovalue, and these fit neatly into the receiver assembly. The potentiometers employed for VR2 and VR3 need to be small in physical size to fit into the receiver layout. These having a body diameter of 0.79in. and a depth behind the panel of 0.45in.

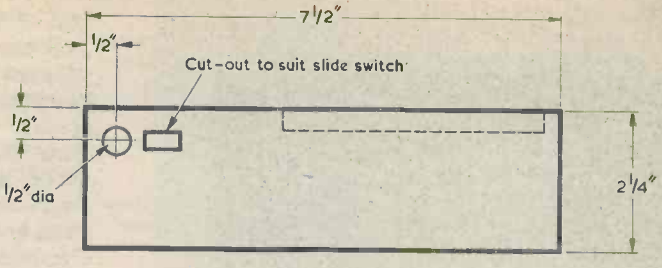
CONSTRUCTION

Turn to Fig. 2 and start construction by cutting out the three sections shown, using ⅛in. thick s.r.b.p. for Fig. 2(a) and ¼in. plywood for Figs. 2(b) and 2(c). Two sections cut to the dimensions of Fig. 2(b) are required; one is an upper section having the ½in. hole and the slide switch cut-out shown in the diagram, whilst the other is a lower section without the hole or the cut-out. The bottom section of the telescopic aerial passes through the ½in. hole. If the particular aerial used requires a hole of different diameter, the size of the hole should be amended accordingly.

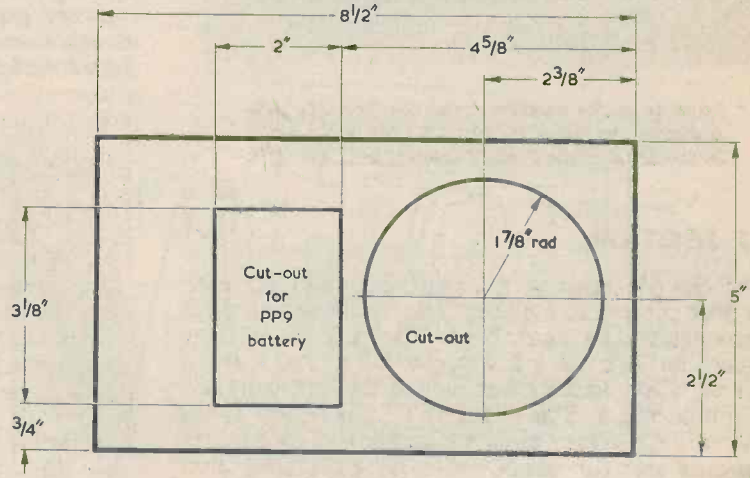
Next, take the 18 way group panel and cut a 13 way section from it. This section must be 5in. long and it will be found that to achieve this the cut will be close to the 14th pair of tags. Drill two small holes at each end ⅛in. in to take small woodscrews which will later secure the tagboard to the ends of the upper and lower sections of Fig. 2(b), as in Fig. 3(e). Drill a ⅜in. hole at the upper end of the tagboard, as shown in Fig. 3(e), this being central



(a)



(b)



(c)

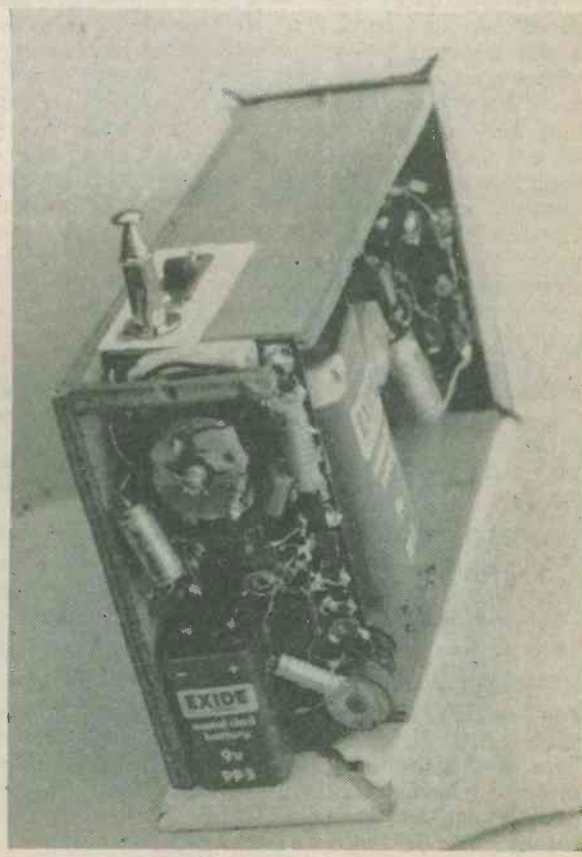
Fig. 2(a). S.R.B.P. panel on which are mounted the 5-way tagboard and, in the lower left hole, VR3. As will be shown next month, extension control spindles for VR2 and VC1 pass through the ¼in. lower right hole and the upper ⅜in. hole

(b). Top panel of the receiver assembly. The bottom panel has the same outside dimensions but does not have the circular and rectangular cut-outs. The material is ¼in. plywood

(c) The speaker panel, again consisting of ¼in. plywood. The PP9 battery fits in the rectangular cut-out and is held in place when the case is fitted onto the receiver assembly

on the board and ¾in. down from the top. The spindle of VC1 passes centrally through this hole. Still following Fig. 3(e), remove the three tags at the bottom right hand corner. Drill out a ⅜in. hole in the board at the point indicated. VR2 is mounted to this hole with its body on the same side as the tags.

Cut out and drill the section shown in Fig. 3(a). This is made up of ⅛in. s.r.b.p. and will later have VC1 mounted on it. Because of the high audio gain in the receiver it is necessary for VC1 to be secured on a pliable mounting as, otherwise, howling can occur due to acoustic and mechanical feedback from the speaker at audio frequencies. Take a standard rubber pencil eraser measuring about 1¼in. by 1in. by ¼in. and cut it down the middle, leaving two sections measuring 1¼in. by ½in. by ¼in. Drill a ⅛in. hole through the centre of one of the sections, then drill two ⅛in. holes in both sections about ⅛in. from the ends, ensuring that the holes match up section to section. Bolt the rubber section with the central hole to the item of Fig. 3(a) using a countersunk 6BA bolt passing through the rubber into the ⅛in. hole in the s.r.b.p., and with a 6BA nut on the s.r.b.p. piece. Cut off the screw flush with the nut. Mount VC1 on the item of Fig. 3(a). Using the rubber pieces as a template mark out two holes at the top end of the 13-way tagboard which will enable thin woodscrews to be passed, later, through the rubber and the tagboard into the end of the up-



End view of the receiver. VC1 is readily visible at the upper end of the 13 way tagboard

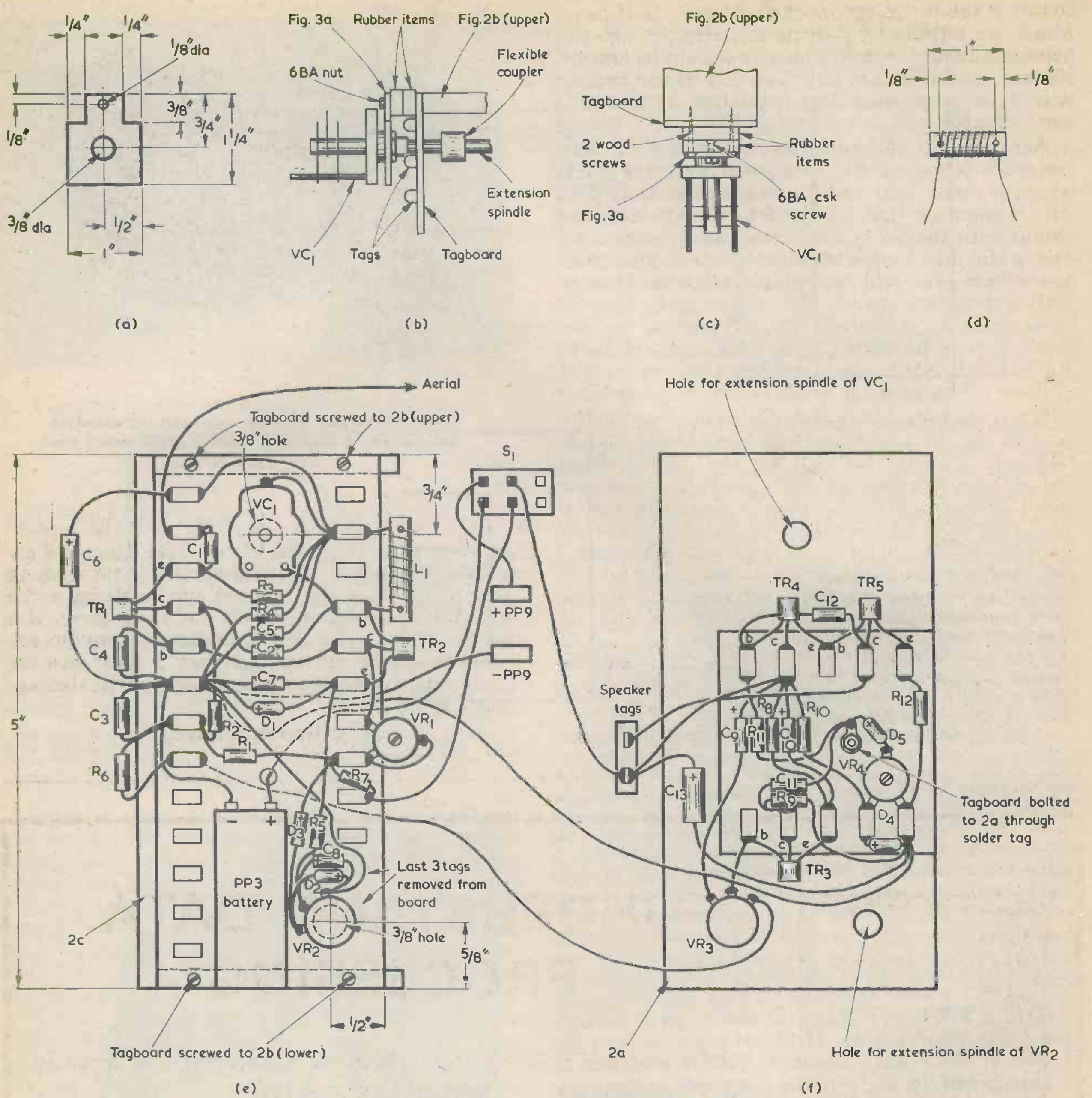


Fig. 3(a). The s.r.b.p. item on which VC1 is mounted
(b) Side view showing the non-microphonic mounting for VC1

(c) Looking down on the mounting. The two woodscrews pass through both the rubber items, through the tagboard and then into Fig. 2(b) upper. The 6BA screw passes through only one rubber piece

(d). Winding coil L1. Details of the former are given in the text

(e). The wiring on the 13-way tagboard. For ease of presentation the PP3 battery is shown smaller than actual size

(f). The 5-way tagboard is mounted on the item of Fig. 2(a). The manner in which the receiver sections are assembled will be shown in detail in next month's issue.

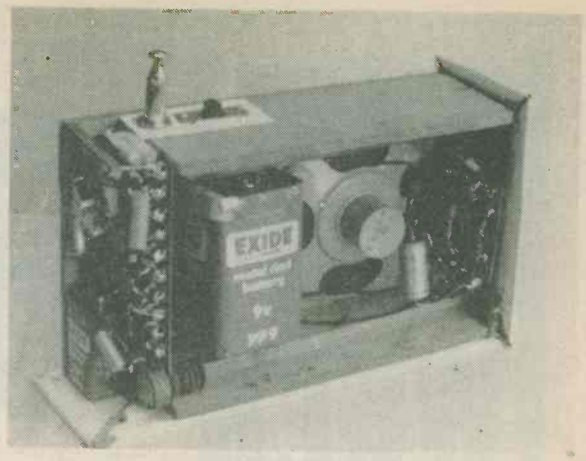
per Fig. 2(b) item. These holes should be positioned such that the spindle of VC1 is central in the $\frac{3}{8}$in. hole in the tagboard and will not touch it. This provides the non-microphonic mounting for VC1, and further details are given in Figs. 3(b) and (c). Put the rubber and s.r.b.p. assembly, with VC1 mounted on it, on one side for the time being. Incidentally, the woodscrews passing through the rubber items are clear of Fig. 3(a) because the corners of the latter are cut away.

Coil L1 is next wound, and this is illustrated in Fig. 3(d). The former is a 1in. length cut from the outer casing of a "Bic" ball-point pen. Drill two $\frac{1}{16}$in. holes $\frac{1}{8}$in. in, at the ends of the former, so that there is $\frac{3}{4}$in. between the holes. Wind on 8 turns of wire, as illustrated in Fig. 3(d). When counting the turns, ignore the two extra half turns which are formed by passing the wire through the holes to anchor the coil. The wire should be around 20s.w.g., and ordinary single strand tinned copper wiring-up wire with the insulation removed is very suitable.

Wire up all the components on the 13 way tagboard following Fig. 3(e), but omitting VC1, which is fitted later and for which room should be left. Remember that C5 should be connected into circuit with the leads as short as are possible. All wiring should be kept reasonably short, and component bodies should not lie outside the board area. They are shown spread out in Fig. 3(e) for ease of presentation. The PP3 battery takes up the approximate position shown, and the connections to the aerial, to S1, to the audio amplifier board and to the PP9 battery are made later.

The remaining 5 way tagboard is mounted to the item of Fig. 2(a) in the manner shown in Fig. 3(f). A 4BA bolt is passed through the 4BA clear hole in Fig. 2(a) and this secures the tagboard, as well as a solder tag which provides a useful extra connection point. Fit VR3 to the panel of Fig. 2(a) with its body on the same side as the tagboard. Then complete the wiring illustrated, omitting C13 and the wiring to the tuner board and the speaker. No connection is made to the integral heat sink of TR5. In Figs. 3(e) and (f) the cathodes of zener diodes D3 and D4 are indicated by plus signs. The cathode lead is identified by a white band on the actual component.

Constructional details will be completed in next month's issue, and the next article will also explain the manner in which the items so far discussed are assembled together. Readers should, on no account, attempt to bring the receiver into working order from the information which has been given this month. There are some important setting-up adjustments to be carried out and if these are not done properly incorrect operation or even damage could result.



The PP9 battery fits into a cut-out provided on the speaker panel. It is held in place when the receiver case is fitted

(To be concluded)

In your workshop

STEREO RECORD PLAYER TROUBLE

"This looks like a nice little job to finish off the day."

Smithy took up a stereo record player, which was all that was left on the "For Repair" rack, placed it carefully on his bench and spent a minute or two examining it externally for any obvious signs of disrepair. Straightening up, he was surprised to see that its two small speakers had mysteriously appeared at either end of his bench. Dick's voice became audible behind him.

"I thought I'd just give you a hand, Smithy."

Smithy turned round.

"Blimey, where did you spring up from? The last time I looked over at your bench you had your nose poked inside a cassette recorder."

"I've just fixed that," said Dick. "And since there's nothing else in for repair I decided to join you on this record player."

DISTORTION

"Fair enough," stated Smithy. "Well, perhaps you could start to make yourself useful by getting out the service manual for it."

Dick noted the make and type number of the player and cheerfully made his way towards the filing cabinet. As he did so, Smithy plugged the record player into the mains and connected up its two speakers. He then reached up to the shelf over his bench, took up an l.p. disc and put it on the turntable. He next started the turntable, placed the pick-up stylus on the outside groove of the record and turned up the volume.

The music from the right hand speaker was a splendid reproduction of all the instruments of the orchestra whose sound was entrapped in the grooves of the revolving disc. The woodwind played like the trilling of early wakening birds, the cadences of the strings swept sensually along their scale, the brass called stridently in concord and the tympani was as the fulminating resonance of approaching thunder.

The noise from the left hand speaker, on the other hand, was *terrible*.

Smithy turned off the record player.

"Gosh," came Dick's voice as he returned from the filing cabinet, "what was that ghastly racket?"

"Very heavy distortion in the left hand channel," stated Smithy briefly. "Let's take a butcher's at the circuit diagram."

He took the service manual which Dick had extracted from the filing cabinet, opened it out at its circuit diagram and laid it down flat on the surface of his bench. (Fig. 1.)

"It looks," ventured Dick, "pretty straightforward."

"Yes," agreed Smithy, "it's one of those nice simple amplifier circuits with discrete transistors which are still being used in some of the lower price record players. As you can see, there's a ceramic pick-up which couples via a 1MΩ series resistor into the base of the first transistor. The presence of the 1MΩ resistor ensures that the pick-up response is reasonably flat although there is, of course, quite a loss of signal voltage in it. The first transistor is a straightforward common emitter amplifier with a fair amount of negative feedback given by the unbypassed 3.3kΩ resistor in its emitter circuit. The amplified signal at its collector passes to a top-cut tone control consisting of a 0.047μF capacitor in series with a 47kΩ pot and also to the volume control. After that we get the main amplifier part of the circuit. Which has a voltage gain of 100 times."

"You caught me out on this voltage gain business once before," chuckled Dick, "but you're not going to do so this time. Let's see, now. Is the voltage gain 100 times because of the 1kΩ resistor going back from the output transistor emitters to the emitter of TR2?"

"That's half of it. The 1kΩ resistor forms an a.f. feedback circuit coupling through the 220μF electrolytic down to the 10Ω resistor going to chassis. It's a classic negative feedback circuit from an amplifier output to its inverting input, and since 1kΩ divided by 10Ω is 100, the voltage gain of the amplifier is held at 100 times." (Fig. 2.)

"Let's just trace the feedback loop all the way through," said Dick. "The 1kΩ resistor connects to the emitter of TR2, and the signal at the collector of this transistor will be in phase with that at its emitter. This signal is next applied to the base of TR3, whose collector is *out* of phase with its base."

"Right," put in Smithy briskly, "and this out-of-phase signal is then fed to the two output transistors, which are both emitter followers and which do not therefore change

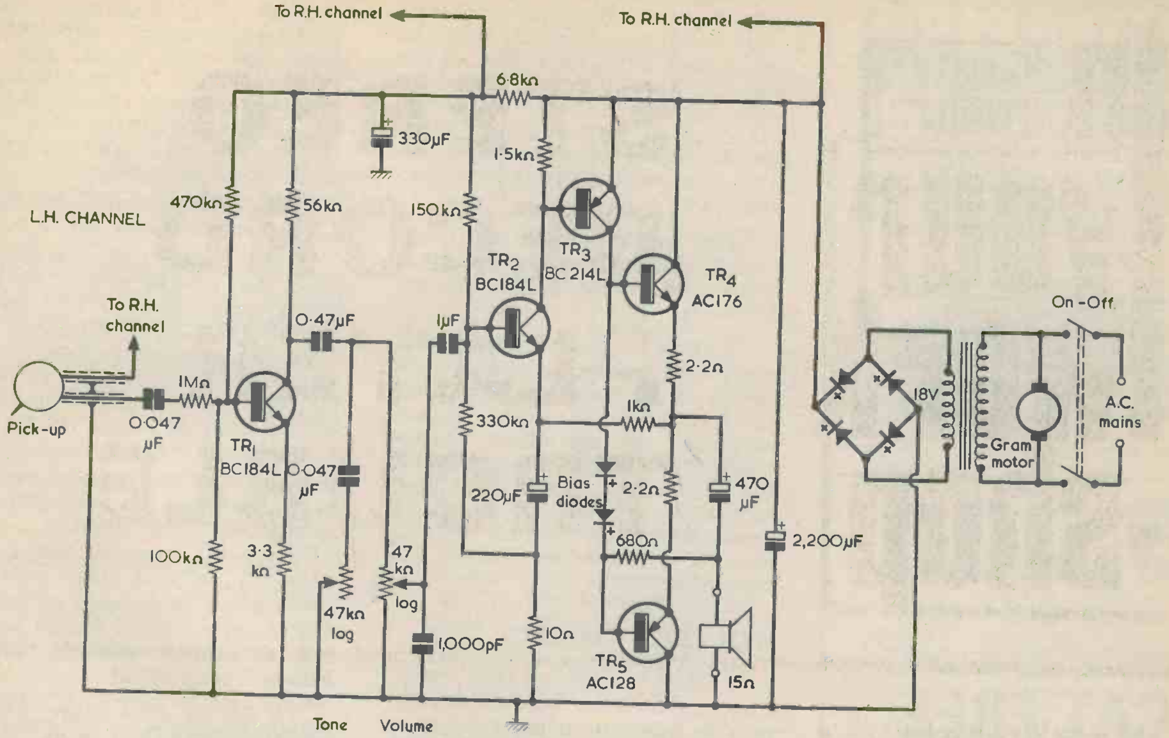


Fig. 1. Despite the availability of a.f. integrated circuits, many current stereo record players continue to use the basic amplifier circuit shown here. The right hand channel is identical, and the 6.8k Ω and 330μF decoupling components are common to both channels. Component values are representative of commercial practice

the phase at their bases. The overall result is that the signal at the output emitters is an inverted version of that at the emitter of TR2. Just what is required for negative feedback. Here, what on earth are you up to?"

PSYCHIC SERVICING

With sudden alarm, Smithy stood back and watched his assistant. Dick had taken a pin from the lapel of his overall jacket and, his eyes closed, was now holding it with its point down over the service manual circuit. He swung the pin across the surface of the manual and then suddenly brought it down. Its point went through the exact centre of the upper output transistor, TR4.

Dick opened his eyes.

"There you are," he grinned. "That's what's wrong with the left hand channel of this record player amplifier. TR4 has gone faulty!"

"What in heaven's name are you raving about?"

"It's my new type of servicing," explained Dick. "I've just been reading in a book about a champion water diviner who can detect the presence of water anywhere simply by working with a *map* of the district concerned. I'm carrying out the same principle for servicing. I'm divining the presence of a fault by just working with the *circuit* of the faulty equipment!"

"You must," spluttered Smithy, "be out of your tiny mind."

"We'll see," stated Dick mysteriously. "Don't forget that there are many strange unexplained things these days, even in the technological world of 1979. Tell you what, I'll bet you 20 pence that the faulty part in this amplifier channel *is* TR4."

Smithy glanced suspiciously at his assistant.

"I'm not a betting man," he said abruptly. "I would suggest that the best thing you can do next is stop messing around with pins and get the printed board out of this record player so that we can do a few voltage checks on it and find the *real* fault."

"Which," intoned Dick darkly, "will be TR4. You just wait and see."

As Smithy looked at him irritably, Dick set about removing the printed circuit board from the record player cabinet. Eventually he was able to withdraw it completely, still connected to its input, speaker and supply leads.

"Why," he asked, as he neared the completion of his task, "do these record players still use discrete transistor amplifiers. You'd have thought the manufacturers would have gone over to integrated circuit amplifiers ages ago."

"That's a very good question," replied Smithy, manifestly relieved that the conversation had changed from the subject of Dick's fault-divining powers. "A lot of record players do use i.c.'s, of course, but discrete transistor amplifiers of the type we have here still keep cropping up, even in the very newest models. The amplifiers all have the same basic stage line-up after the volume control, although you'll frequently find that the transistor

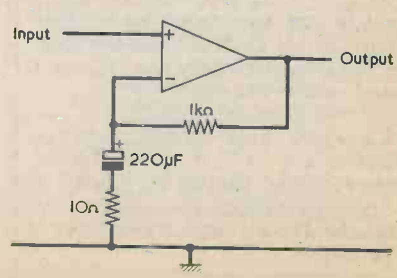


Fig. 2. The amplifier stages between the emitter and base of TR2, and the emitters of TR4 and TR5, may be reduced to the block diagram shown here. A.F. negative feedback is via the 1k Ω resistor from the output to the inverting input, with the 10 Ω resistor coupling to chassis. Voltage gain is 100 times

and supply polarities are reversed. In that case TR2 would be p.n.p., TR3 would be n.p.n., TR4 would be p.n.p. and TR5 n.p.n. But all the circuits have the first transistor with negative feedback applied to its emitter, a second common emitter driver transistor and, finally, the two output emitter followers."

"This one," pointed out Dick, "uses old-fashioned germanium transistors as the output emitter followers."

"I know," agreed Smithy, "and you'll find germanium output transistors in quite recent amplifiers, too. I think that the latest amplifiers do use silicon output transistors, though. At any event, the basic circuit is a very well established one so far as relatively inexpensive record players offering about 3 to 4 watts per channel are concerned."

VOLTAGE CHECKS

"I notice," continued Dick, "that this circuit uses two diodes to provide quiescent biasing between the output transistor bases."

"Those will be two forward biased germanium diodes," replied Smithy, "with a drop of about 0.1 to 0.15 volt across each. Just enough to keep the germanium output transistors conducting when there's no signal. Incidentally, there are quite a few current paths in the circuit from the positive to the negative rail, and if you are interested in tracing out any of these you simply follow the arrows."

"Follow the arrows?"

"That's right. 'Conventional current', which is assumed to flow from positive to negative, flows in the direction of the emitter arrow in a transistor and in the direction of the arrow-head which is implicit in the symbol for a diode. As an example, current flows from the positive rail into the emitter of TR3, passes out at the collector, goes next through the two bias diodes and finally ends up at the negative rail by way of the 680Ω resistor and the speaker."

"Follow the arrows, eh? Right, I'll remember that."

"Good," said Smithy. "Well, let's do a few voltage checks on that board next. Since it's a stereo amplifier with two channels we can, if we like, compare voltages on the serviceable channel with those in the duffy channel. Switch on, Dick, and see what the supply voltage is."

Obediently, Dick turned on the record player and applied his test prods between chassis and the positive rail. (Fig. 3(a).)

"I'm getting about 24 volts here," he called out.

"Now try the output emitters," said Smithy. "They should be sitting at around half the supply voltage." (Fig. 3(b).)

"Okeydoke," said Dick. "I'll try the serviceable right hand channel first. The output emitters here are giving — just a jiffy — 11 volts."

"And the left hand channel?"

Dick reapplied the positive test prod of his meter to the output emitters of the faulty channel.

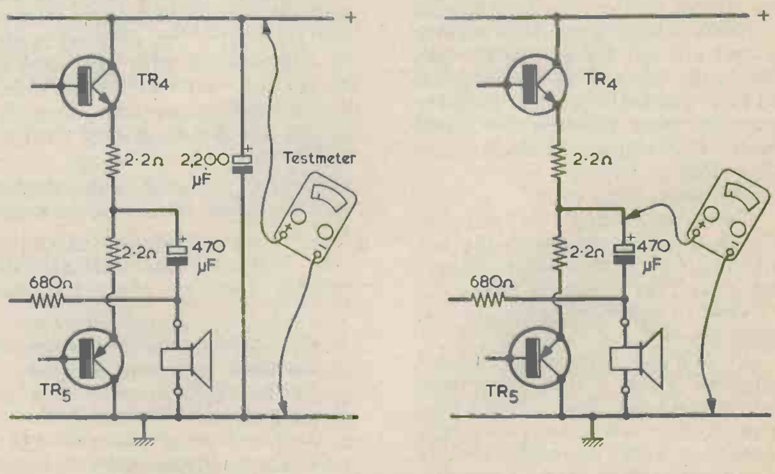
"Just under 11 volts."

A gleam appeared in Smithy's eyes.

"Are you still willing to bet that it's TR4 which is faulty? You mentioned 20 pence just now."

"You wouldn't take me up on it."

"I've changed my mind," said Smithy hastily. "What's more, I'm even prepared to increase the bet to a pound. If, as you say it is, TR4 is causing the trouble, I give you a pound."



(a) (b)

Fig. 3(a). Measuring the supply voltage across the 2,200µF reservoir capacitor
(b). In a serviceable amplifier the quiescent voltage at the output emitters will be approximately half the supply voltage

"And if it isn't?"

"You give me a pound!"

"Hey," protested Dick, "take it easy, Smithy. I meant that original bet to be more of a joke than anything else."

"Come on," retorted the Serviceman. "You were keen enough to risk a bet then. Don't say that you're now chickening out."

"Oh, all right," said Dick, incensed. "A pound it is, then."

"And you've lost it," crowed Smithy triumphantly. "That last voltage check has proved that the output stage is perfectly all right. So TR4 *can't* be faulty."

"How do you make that out?"

"You remember that audio feedback circuit with the 1kΩ and 10Ω resistors?"

"Yes."

"Well, there's a d.c. negative feedback circuit there as well. If we assume that the 220µF electrolytic capacitor connecting to TR2 emitter has almost infinite resistance, there is 100% d.c. feedback." (Fig. 4.)

"How come?"

"Look at the circuit," replied Smithy. "The base of TR2 is held somewhat higher than half supply voltage by the 150kΩ and 330kΩ resistors which connect to it. In the absence of signal, the output emitters then stabilize at a slightly lower voltage which, in practice, is about equal to half the supply voltage. This allows just sufficient direct current to flow through the 1kΩ resistor connecting to the emitter of TR2 to stabilize the output emitters at the half supply point. If, for some reason, the output emitters try to go positive the emitter current for TR2 falls. TR2 collector current, and hence TR3 base current, also falls, and the collector of TR3 goes negative. This counteracts the initial attempt of the output emitters to go positive."

"I suppose," said Dick gloomily, as he gazed at the circuit, "if the output emitters try to go negative the opposite happens and the collector of TR3 pulls them positive again. And, since we're getting the correct half supply voltage at those output emitters, all this means that TR4 simply cannot be faulty."

"Precisely," beamed Smithy. "One pound please!"

"Don't go so fast, Smithy. I'll wait until we've finally found the fault."

"As you wish," said Smithy magnanimously. "I'm a patient sort of a bloke and I don't mind waiting for my money."

Dick was clearly annoyed at the turn of events.

"Let's try some other voltage checks."

"Fair enough," replied Smithy airily. "Now that we know that the output stage is all right we should soon be able to trace the fault in this left hand channel."

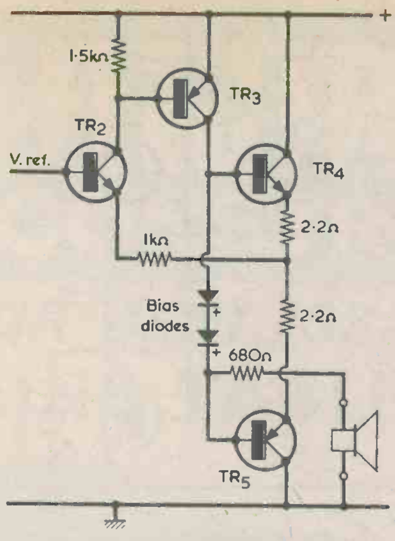


Fig. 4. With the capacitors removed, the d.c. negative feedback loop incorporating TR2 to TR5 is readily apparent. The quiescent voltage at the output emitters is controlled by the voltage at TR2 base

FOLLOW THE ARROWS

But, despite exhaustive comparative checks by Dick under the instructions of Smithy, there were no differencies in voltage readings between the two channels at any point in their circuits.

Smithy frowned.

"We'd better check some voltages with a signal going through," he announced gruffly. "Back to those output emitters again, Dick!"

"Righty-ho, Smithy. I've got my test prod on the right hand channel output emitters now."

Smithy started the turntable and placed the pick-up on the record lead-in groove. The undistorted output from the right hand speaker and the heavily distorted sound from the left hand speaker once more became audible.

"The meter needle's just quivering a bit," stated Dick, looking down at his testmeter."

"Try the left hand output."

"Okeydoke, Smithy!"

There was a pause as Dick shifted his test prod to the output emitters of the left hand channel. The sound from the speakers was suddenly drowned in a cry of amazement from Dick.

"What's the matter?"

"It's this meter reading," stuttered Dick. "The voltage it's showing just goes down and down as the music gets louder. It only goes back to the half supply level during very quiet passages."

Smithy leaned over to look at the meter. The needle was, indeed, showing a voltage which very noticeably reduced in sympathy

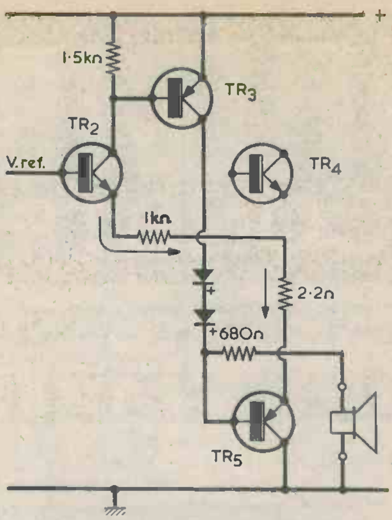


Fig. 5. Closer examination shows that TR4 plays no significant part in setting up the quiescent output emitter voltage. The current flowing in the 1k Ω resistor connecting to TR2 emitter can only be passed by TR5

with the volume from the record.

Irately, he took the pick-up off the record and switched the record player off. As Smithy rubbed his chin reflectively Dick removed the test prods and pulled the service manual towards him.

"That upper output transistor, TR4, *must* be faulty after all," he called out. "Otherwise, why does the output emitter voltage go down when the music gets louder?"

"It can't be faulty," retorted Smithy dogmatically. "We were getting the half supply voltage reading with no signal going through."

Dick ran his finger along the lines of the circuit diagram.

"Hang on a minute," he said. "You don't *need* the upper output transistor to get that half supply voltage reading!"

"What d'you mean?"

"Let's say," said Dick excitedly, "that TR4 is removed from the circuit and see what result that gives." (Fig. 5.).

"Well?"

"You've still got a complete d.c. feedback loop," went on Dick, "just with TR2, TR3 and TR5. It's as you said — follow the arrows. If we talk about current going from positive to negative, it flows from the emitter of TR2 through the 1kΩ resistor into the emitter of TR5. It can't flow into the emitter of TR4 because TR4 emitter arrow is pointing in the wrong direction!"

Smithy studied the circuit diagram.

"Ye gods," he muttered weakly, "You're right, too. Here, let's have that testmeter."

He grabbed the test leads, switched the meter to a low ohms range and first checked the 2.2 Ω resistor in series with TR4 emitter. Obligingly, the meter read approximately 2.2 Ω. Smithy then applied the test prods first one way round and then the other way round to the base and collector of TR4. In both instances there was a small deflection of the meter needle due to the circuitry around the transistor, but in neither case did the meter indicate the very low resistance which would be given by a forward biased base-collector junction. Patently, there was an internal open-circuit between the base and the collector of the transistor.

With a stunned expression Smithy walked over to the spares cupboard. He returned, stony faced, with a replacement transistor and in utter silence proceeded to remove the faulty transistor and solder in the new one. He then switched on the record player and, watched by his jubilant assistant, started the record up again. This time the left hand channel reproduced the sound from the record with just as much excellence as did the right hand channel. Huffily, Smithy returned the pick-up to its stand and switched the player off again.

"You made a boo-boo, didn't you?"

Smithy stubbornly refused to reply.

"I've been waiting years," chortled Dick, "for something like this to happen. Years!"

There was still no comment from the Serviceman.

"Just for once," exulted Dick, "it's *me* that's been right on a technical point and *you* that's been wrong. I never thought I'd live to see the day when I would actually shoot you down in flames!"

PAYING UP

"All right, all right," snorted Smithy crossly. "Don't keep rubbing it in."

"What I particularly like," said Dick happily, "is that it was you who raised the bet from 20 pence to a pound. So how about it, Smithy?"

"Don't keep on about it," retorted Smithy. "I know when I've lost a bet. I'll pay you up in full."

And pay up in full he did, after he had sorted through the contents of his bench drawer. Whereupon a protesting Dick became the richer by one fully stamped Co-op book (recovery value 40 pence), two 5 pence vouchers cut out of an electronics catalogue, three 10 pence fruit-machine tokens and two brand-new shiny 10 pence pieces. Which represent, after all, a fitting alternative for the current diminutive, single serial number, luncheon voucher, English one pound note. ■

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Doppler shift add-on unit

By R. A. Penfold

Gives Doppler intruder surveillance in conjunction with last month's ultrasonic control system

The "Ultrasensitive Ultrasonic Remote Control" system described in last month's issue forms a very useful project having a number of remote control applications. It also, with the aid of a small amount of additional circuitry, lends itself to use as a Doppler proximity detector. Equipment of this nature is commonly employed in burglar alarms, and there are probably many other possible uses for it. This article describes an add-on unit which provides the extra circuitry required.

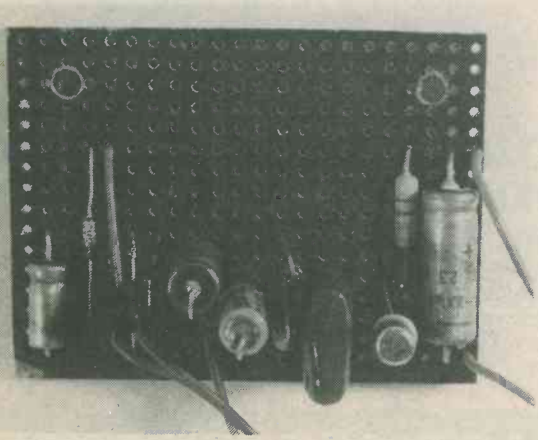
DOPPLER SHIFT

A Doppler alarm uses the well known Doppler Shift effect to detect the movement of a person or object in the vicinity of the transmitting and receiving transducers. Most readers will be familiar with the Doppler Shift effect, particularly with regard to sound waves. If a source of sound is moving towards an observer the latter perceives an apparent increase in the frequency of that sound. This is because a greater number of cycles per second are impinging on the observer due to the movement of the sound source. Similarly, when a source of sound moves away from an observer the apparent frequency of the sound falls. The effect is commonly encountered in ordinary life, a typical instance being given when an ambulance sounding its two-tone siren passes by.

Doppler Shift of frequency will also be given if the source of sound and the observer are stationary and the sound is reflected by a moving object. This effect is exploited in Doppler Shift proximity detectors.

When a 40kHz transmitting transducer and a 40kHz receiving transducer are placed side by side and aimed into an unoccupied room, some of the transmitter signal will be picked up by the receiver after reflections from walls, ceiling and furniture, etc., and there will probably be a certain amount of direct pick up as well. All these signals will be at the actual transmitter frequency.

An object moving in front of the transducers will also reflect some cf the transmitter signal to the receiver, but the reflected signal, due to Doppler Shift, will be shifted slightly in frequency. If the received signal is fed to an a.m. receiver detector, the shifted and unshifted frequencies will produce a relatively low frequency beat note at the output of the detector. This note, which in practice will be at a frequency between a few Hertz and a few hundred Hertz, depending on the speed and direction of the moving object, can be rectified and smoothed to produce a d.c. bias controlling a relay energising circuit.



The few components required for the Doppler Shift add-on unit are wired up on a small Veroboard panel

MODIFICATIONS

A few simple modifications are required to the transmitter and receiver of the "Ultrasensitive Ultrasonic Remote Control" and readers are asked to consult the diagrams for this which appeared last month.

The only modification required to the transmitter is to replace the push-button on-off switch with an ordinary toggle switch so that the transmitter can operate continually.

D1 in the receiver is now omitted and no load is driven from the output stage of the NE567 phase locked loop. (As is explained later, an l.e.d. and series resistor can, however, be used as a load to indicate when the p.l.l. output transistor has switched on.) The additional Doppler Shift circuitry is shown in Fig. 1 of the present article, and its input

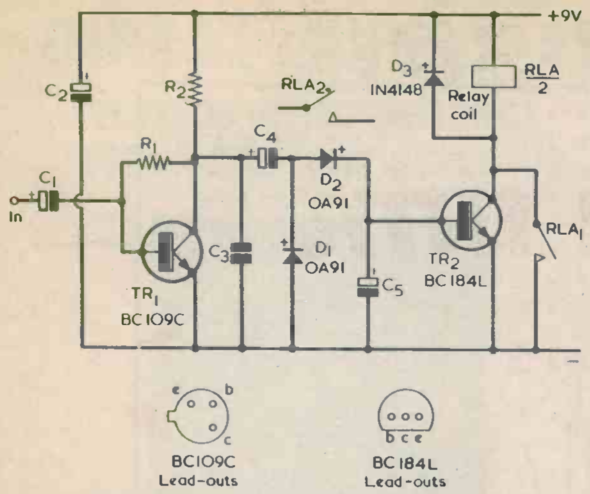


Fig. 1. The circuit of the Doppler Shift add-on unit. The input is taken from the NE567 i.c. which forms part of the ultrasonic remote control system described in last month's issue

is fed from pin 1 of the NE567. This connection may be made at hole L20 of the receiver Veroboard panel. Fortunately, the NE567 incorporates an a.m. detector circuit, the output of which appears at pin 1 of the i.c. This fact makes it extremely simple to adapt the receiver for the present application. Also, the negative supply rails of the receiver and the add-on unit are connected together.

The additional circuit of Fig. 1 is very simple, and TR1 is a conventional high gain common emitter amplifier which is used to boost the output from the detector. R2 is the collector load resistor for TR1, R1 provides base biasing and C1 is a d.c. blocking capacitor. C3 filters out any ultrasonic signal present in the output from the detector, which could otherwise block the operation of the unit.

C4 couples the output from TR1 to a simple voltage doubling rectifier and smoothing network consisting of D1, D2 and C5. TR2 will normally be cut off and the relay in its collector circuit will not be energised but, in the presence of an input signal to the circuit due to a Doppler Shift being detected, the positive bias produced across C5 will be sufficient to turn on TR2 and energise the relay.

D3 is a protective diode and suppresses the high reverse voltage which would otherwise be generated across the relay coil when it de-energises, and which could damage the semiconductor devices in the circuit if it were not eliminated. The relay has two contact sets, RLA1 and RLA2. RLA1 is a normally open contact set; it closes when the relay is energised by TR2, thereby latching the relay in the energised state once the circuit has been activated. Should this latching action not be required, RLA1 can simply be omitted. If, on the other hand, a "reset" control is desired, a normally closed push-button can be added in series with RLA1 as shown in Fig. 2. RLA2 is another normally open relay contact set, and this can be used to operate an audible alarm. Alternatively, either a normally open or a normally closed contact set, as appropriate, can be wired into a comprehensive alarm circuit if one is already installed in the protected property.

The relay used with the prototype was one with a 185Ω coil and two changeover contact sets, available from Maplin Electronic Supplies. Each of the changeover contact sets can, of course, be wired to act as normally open or normally closed, as desired.

The stand-by current of the circuit is less than 1mA, but this rises to some 45mA when the circuit is activated.

COMPONENTS

Resistors
(All ¼ watt 5%)
- R1 2.2MΩ
- R2 6.8kΩ

Capacitors
- C1 3.3μF electrolytic, 10 V. Wkg.
- C2 100μF electrolytic, 10 V. Wkg.
- C3 0.22μF mylar or type C280
- C4 10μF electrolytic, 10 V. Wkg.
- C5 10μF electrolytic, 10 V. Wkg.

Semiconductors
- TR1 BC109C
- TR2 BC184L
- D1 OA91
- D2 OA91
- D3 1N4148

Relay
- RLA see text

Miscellaneous
- Veroboard, 0.1in. matrix
- Normally closed push-button (if required)
- Wire, solder, etc.

CONSTRUCTION AND USE

Apart from the relay (and, if fitted, the "reset" push-button) all the components are assembled on a 0.1in. matrix Veroboard which has 16 copper strips by 22 holes. The component layout is shown in Fig. 3. The two mounting holes may be either 6BA or M3 clearance. There are no breaks in any of the copper strips.

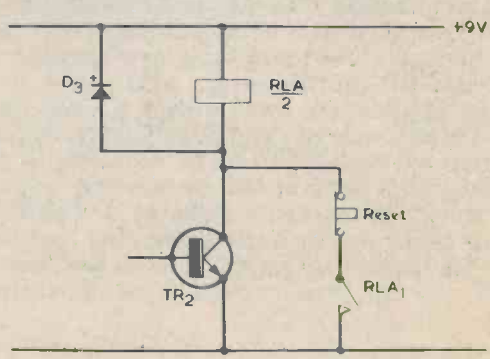


Fig. 2. Wiring a normally closed push-button in series with contact set RLA1 provides a reset facility

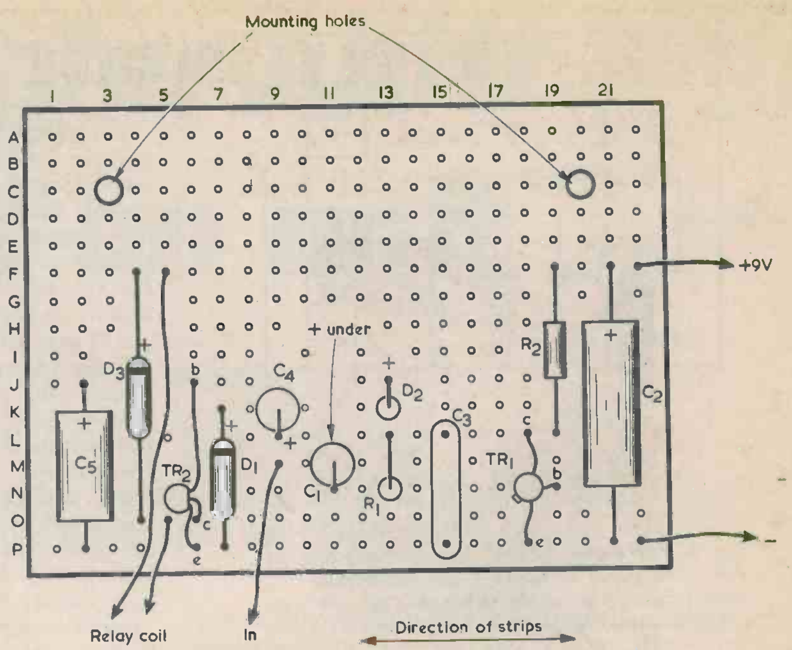


Fig. 3. Illustrating the wiring of the Veroboard panel on which the components of the add-on unit are assembled.

Conventionally, Doppler alarm equipment has the transmitter and receiver circuits both contained within the same housing, with the two transducers mounted side by side or one above the other on the front panel, spaced by several inches. With the present units this will give good sensitivity for 3 or 4 metres directly in front of the transducers, and for a somewhat smaller distance on either side of centre. Even just the movement of a hand within the sensitive area should be sufficient to trigger the circuit.

The transmitter and receiver sections of the system can, instead, be treated as separate items, and it is found possible to increase the area covered by the system by doing this, with careful positioning of the two sections for optimum results. For instance, by positioning the transmitter and receiver units at opposite ends of a room, with the two transducers roughly aimed at one another, the system appears to be effective for movement almost anywhere within the room.

SETTING UP

The setting up of the transmitter and receiver is the same whether they are to be employed as a remote control system or as a Doppler Shift proximity detector, and the details for alignment were given last month. However, when used in the Doppler application, there will be no load for the NE567 in the receiver, and a temporary load must be connected here to act as an indicator in order that R6 in the receiver can be correctly adjusted. Such an indicator can consist of a TIL209, or similar l.e.d., and a current limiting resistor of about 1kΩ wired in series between pin 8 of the NE567 and the positive supply, as illustrated in Fig. 4.

As was mentioned last month, when used in the Doppler system the transmitter is switched on continually, and it is desirable to employ a larger 9 volt battery than the PP3, which is normally adequate for intermittent use. The receiver and the Doppler add-on unit can have separate 9 volt batteries or can share a single 9 volt battery. As both the receiver and the add-on unit have adequate supply decoupling, no difficulties have been experienced with the use of a single supply. Due to the relatively high current which is drawn by the relay coil when it energises, a large battery such as a PP9 should be employed. ■

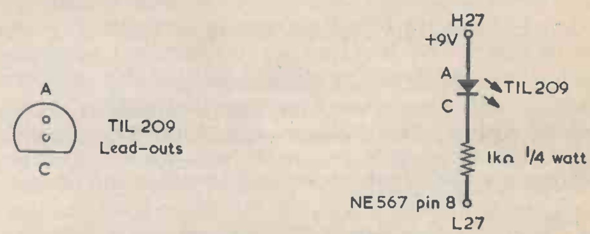


Fig. 4. A temporary load, which can consist of an l.e.d. and a series resistor, is connected to the ultrasonic receiver and functions as an indicator during setting up. The letter and number references apply to Fig. 4 in the article published last month

Answer to problem Page 421

[LRN]
[log]
[X]
[20]
[=]
[R/S]
[RST]
[LRN]

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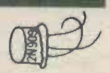

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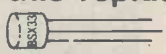

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A DRILL FOR PRINTED BOARDS

By P. B. Brodribb

Modifying a battery shaver to act as a hand-held electric drill.

Anyone who has made his own printed circuits will know that drilling the component holes with a hand drill can be both tedious and expensive. 1mm. drills break easily.

Some years ago the author bought a battery shaver for holiday use. This was the type which utilised a small motor to rotate a cutting head against a thin metal foil; in time the foil became damaged and the age of the shaver made it difficult to obtain a replacement. It was decided to see whether it could be adapted to take a twist drill and to see also whether the motor could develop sufficient torque to make a useful tool.

PIN VICE

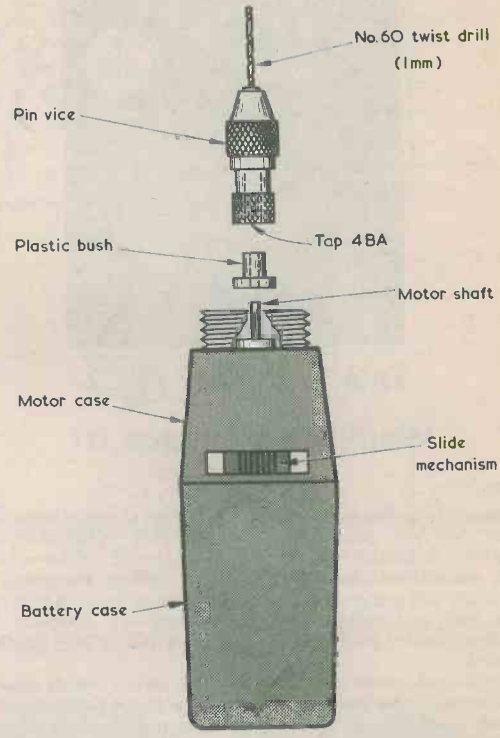
A pin vice was cut down so that only about half an inch of the shank remained. The remaining shank was then tapped 4BA and forcibly screwed on to the plastic bush which had previously fixed the shaver cutters to the motor shaft. The assembly of pin vice and bush was next pushed back on to the motor shaft. An Eclipse No. 121 pin vice was used in this instance, but a smaller size known as a "Pin Tong" would be just as suitable. The diagram shows the main details.

The only other modification needed was to ensure that the direction of rotation was correct. When used as a shaver the motor rotated the shaft clockwise, whereas a twist drill requires counter-clockwise rotation (as viewed from the cutting end). This particular motor was capable of rotation in either direction and the switch on the motor casing was a centre-off type. However, a small protrusion on the plastic case prevented the switch slide mechanism from taking the motor switch into the counter-clockwise position. The protrusion was cut off with a sharp knife, with the result that the casing slide mechanism could now push the motor switch to either side of centre and the motor could be made to rotate in either direction. Correct rotation could also have been obtained by reversing the supply connections. The drill was now ready for field trials.

SINGLE CELL

A single dry cell gave a surprising amount of torque but not quite sufficient to permit a 1mm. drill to pass easily through a printed circuit board. Two dry cells in series supplied enough power to drill through copper-clad fibreglass board fairly easily. The no-load current of this particular motor is about 250mA, rising to 500mA or more when on load. The starting current probably approaches 1 amp. Thus the dry cells should be the high power variety such as HP2.

The supply that the author finally settled for was made with an old 6.3 volt valve heater transformer and a 1 amp silicon bridge rectifier. The load voltage with the unfiltered rectified supply is about 4 volts. The drill is connected to the supply by a few feet of twin lighting flex passing through a hole in the bottom of what was the battery compartment of the shaver. The 1.5 volt motor is somewhat overdriven but does not seem to object, and perhaps the intermittent nature of the load helps. At any rate, quite a number of printed boards have now been drilled with no trouble at all. The only proviso is that the drill be kept sharp. Fibreglass board is particularly hard on drills.



The steps involved in adapting the shaver to its new function. It is primarily intended for drilling 1mm. holes in printed circuit boards

A 1mm. drill is about the largest practicable size that the low power motor can handle, but this size is standard for most components that find their way on to printed boards. Larger holes may be located with the 1mm. drill and then opened out with a hand drill.

As a guide to the type of shaver employed, the one modified by the author was bought at Boots and was marked "Swiss Made, 1.5 Volt". A later version, still used on holiday for its original purpose, is described as the "Companion 1.5". It is also Swiss made for Boots and is very similar to the modified shaver except that it has a flat on the shaft and a slightly different case and switch style. ■

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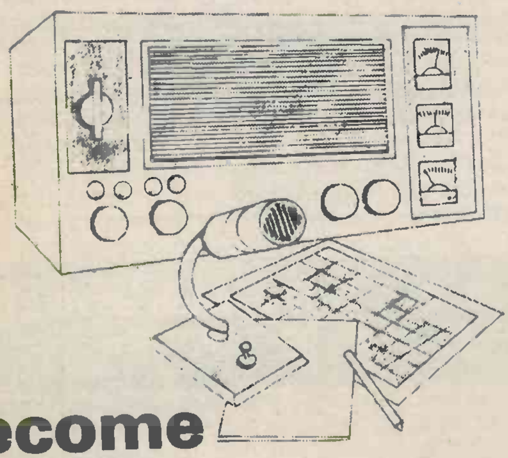

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BF 173	20	ZN 3053	20
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IN 645	9
IN 4001	5
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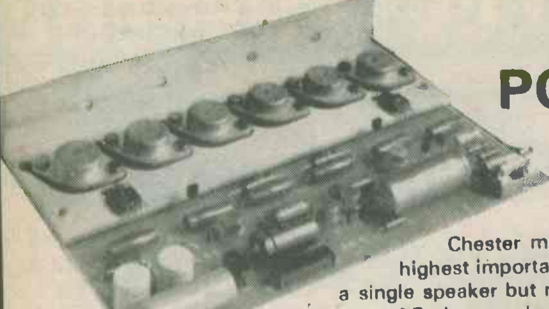

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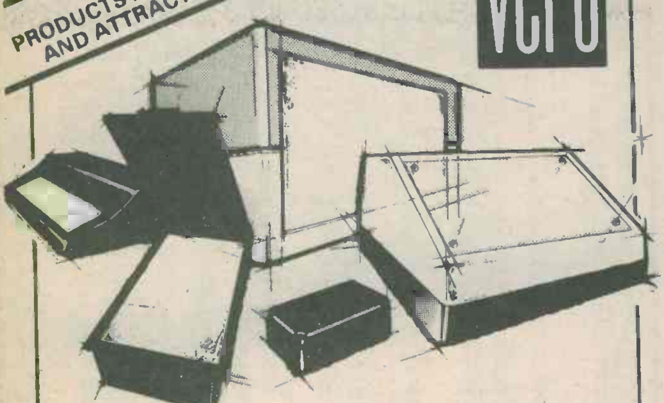

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(Continued from page 451)

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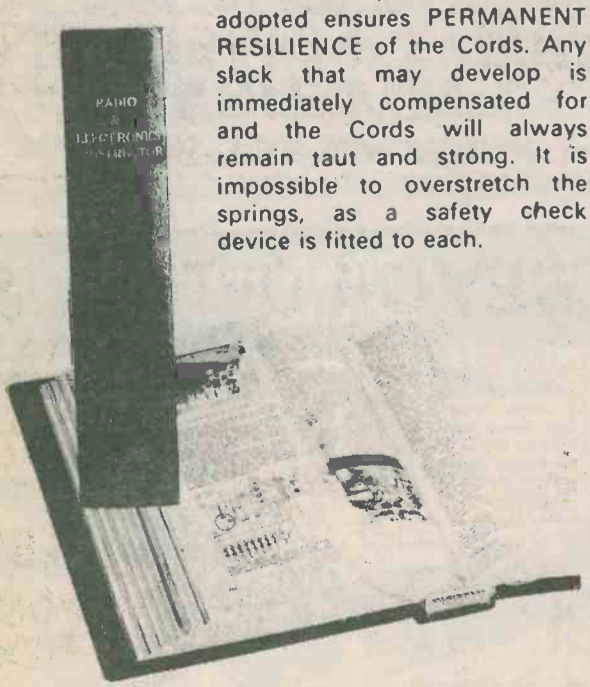
(Continued on page 454)



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(Continued from page 453)

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(Continued on page 455)

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(Continued from page 454)

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FOR THE BEGINNER

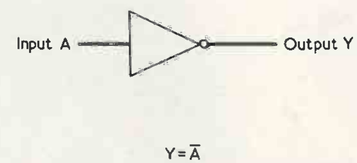
LOGIC INVERTERS

In the almost universally employed "positive logic" a high positive voltage corresponds to binary 1 and a low positive voltage to binary 0. An inverter, which converts a 1 to a 0 and vice versa, has the symbol shown in (a). This consists of an amplifier triangle with a circle after the apex to indicate inversion. Output Y is equal to not-A (the bar above the letter signifies "not").

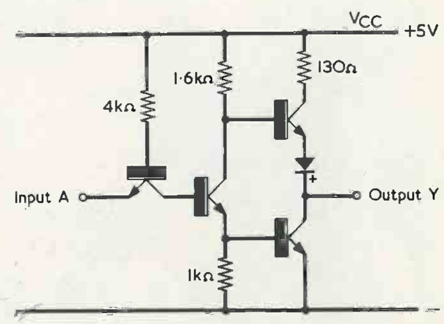
The circuit of a t.t.l. (transistor-transistor logic) inverter appears in (b), in which the resistor values shown are nominal. A 1 at the input is any voltage between 2 volts with respect to supply negative and the positive supply, whilst a 0 at the input is any voltage lower than 0.8 volt. Note that the input current requirements are not symmetric. The current required at the input for 1 is normally a matter of microamps only since the input transistor emitter-base junction is then at or near cut-off; whereas the input current required for 0 can rise to 1.6mA as the input has to "pull down" (i.e. draw negative) the now conductive emitter-base junction of the first transistor.

For economic reasons a t.t.l. i.c. chip will have more than one inverter on it. As an example, the SN7404 hex inverter ("hex" means "six") has six individual inverters, as shown in (c). These all share the same power supply voltage.

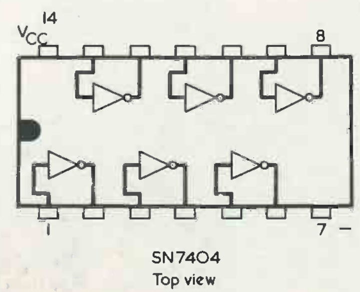
A simple CMOS inverter appears in (d). The insulated input gates require virtually zero input current and are symmetric in this respect. A 1 input is close to or at positive supply voltage and a 0 input is close to or at negative supply voltage.



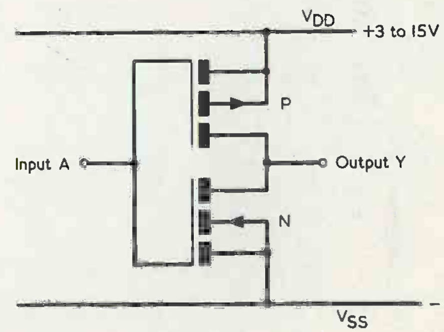
(a)



(b)



(c)



(d)