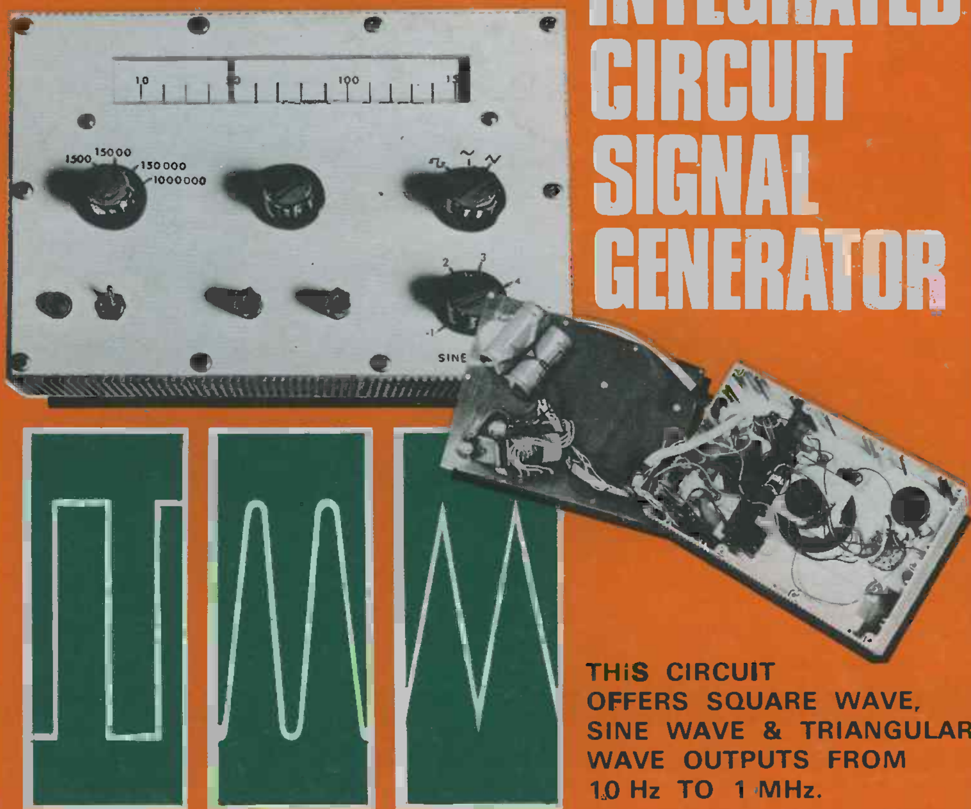
RADIO & ELECTRONICS CONSTRUCTOR

AUGUST 1975

30p

PART ONE
(IN TWO PARTS)

INTEGRATED CIRCUIT SIGNAL GENERATOR



THIS CIRCUIT OFFERS SQUARE WAVE, SINE WAVE & TRIANGULAR WAVE OUTPUTS FROM 10 Hz TO 1 MHz.

ALSO FEATURED

IMPROVED COURTESY LIGHT FOR CARS
NEW MULTIPLE TUNING DIODES


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

WILMSLOW AUDIO

THE Firm for speakers!

SPEAKERS

Baker Group 25, 3, 8 or 15 ohm	£8.64
Baker Group 35, 3, 8 or 15 ohm	£10.25
Baker Group 50/12, 8 or 15 ohm	£14.00
Baker Deluxe 12", 8 or 15 ohm	£13.75
Baker Major 3, 8 or 15 ohm	£11.87
Baker Superb 8 or 15 ohm	£18.12
Baker Regent 8 or 15 ohm	£10.00
Baker Auditorium 12"	£16.25
Celestion PST8 (for Unilex)	£3.75
Celestion G12H 8 or 15 ohm	£15.00
Celestion G12M 8 or 15 ohm	£12.00
Celestion G15C 8 or 15 ohm	£24.00
Celestion G18C 8 or 15 ohm	£33.00
Celestion MF1000 8 or 15 ohm	£10.95
EMI 13 x 8, 150 d/cone, 8 ohm	£2.94
EMI 13 x 8 type 350, 8 or 15 ohm	£9.56
EMI 13 x 8 20 watt bass	£7.69
EMI 5" 14A/730 mid-range 8 ohm	£3.50
EMI 6½" 93850 4 or 8 ohm	£2.90
EMI 8 x 5, cer. mag. 8 ohm	£1.87
EMI 8 x 5, 10 watt, d/c roll/s 8 ohm	£3.44
EMI 10 x 6 93870 8 ohm	£2.69
EMI 2¼" tweeter 8 ohm	.77
Elac 9 x 5, 59RM109 15 ohm, 59RM114 8 ohm	£3.64
Elac 6½" d/cone, roll surr. 8 ohm	£4.06
Elac 6½" d/cone 8 ohm	£3.12
Elac TW4 4" tweeter	£1.75
Elac 10" 10RM239 d/c 8 ohm	£3.12
Elac 8" 3 ohm	£2.87
Eagle Crossover 3, 8 or 16 ohm	£1.75
Eagle CT5 cone tweeter 8 ohm	£2.06
Eagle CT10 tweeter 8 or 16 ohm	£3.00
Eagle DT33 dome tweeter 8 ohm	£6.31
Eagle FF5 3 way crossover	£3.62
Eagle SN75 crossover with tw. control	£4.69
Eagle FF28 multicell, horn	£9.00
Eagle HT15 horn tw. 16 ohm	£4.40
Eagle HT21 horn tw. 8 ohm	£6.81
Eagle MHT10 horn tw. 8 ohm	£4.44
Eagle FR4 4" full range	£6.12
Eagle FR65 6½" full range	£9.62
Eagle FR8 8" full range	£12.31
Fane Pop 15 watt 12"	£5.25
Fane Pop 25T 30 watt 12"	£7.50
Fane Pop watt 12"	£12.00
Fane Pop 55 12" 60 watt	£12.95
Fane Pop 60 watt 15"	£13.75
Fane Pop 100 watt 18"	£25.95

SPEAKERS

Fane Crescendo 12A 8 or 15 ohm	£34.50
Fane Crescendo 12B 8 or 15 ohm	£36.50
Fane Crescendo 15, 8 or 15 ohm	£47.50
Fane Crescendo 18, 8 or 15 ohm	£62.95
Fane 910 horn	£14.95
Fane 920 horn	£33.95
Fane 152/12a 15" 15 ohm	£16.00
Fane 801T 8" d/cone roll surr.	£8.12
Fane 808T 8" d/cone	£3.44
Fane 807T 8" d/cone roll surr.	£4.62
Goodmans 8P 8 or 15 ohm	£5.50
Goodsmans 10P 8 or 15 ohm	£5.80
Goodmans 12P 8 or 15 ohm	£13.95
Goodmans 12P–D 8 or 15 ohm	£16.95
Goodmans 12P–G 8 or 15 ohm	£15.95
Goodman 12AX 100 watt 8 or 15 ohm	£36.50
Goodsmans 15AX 100 watt 8 or 15 ohm	£40.25
Goodmans 15P 8 or 15 ohm	£21.00
Goodmans 18P 8 or 15 ohm	£36.00
Goodmans Hifax 750	£16.00
Goodmans Axent 100 tweeter & crossover	£7.44
Goodmans Audiom 100, 8 or 15 ohm	£13.90
Goodmans Axiom 401, 8 or 15 ohm	£20.00
Goodsmans Twinaxiom 8" 8 or 15 ohm	£10.14
Goodsmans Twinaxiom 10" 8 or 15 ohm	£10.75
Gauss 12" full range 8 ohm	£69.50
Gauss 12" Bass 8 ohm	£69.50
Gauss 15" full range 8 ohm	£75.00
Gauss 15" Bass 8 ohm	£75.00
Gauss 18" full range 8 ohm	£80.00
Gauss 18" Bass 8 ohm	£80.00

All the above Gauss (American) speakers are fitted with 4½" voice coils and can handle 200 watts RMS.

Kef T27	£6.06
Kef T15	£6.94
Kef B110	£8.37
Kef B200	£9.50
Kef B139	£16.50
Kef DN8	£2.31
Kef DN12	£5.75
Kef DN13	£3.87
Richard Allan CG8T 8" d/c roll rurr. 8 ohms	£7.37
STC 4001G super tweeter	£6.56
2¼" 64 ohm, 70mm 8 ohm, 70mm 80 ohm	.77
2¼" 75 ohm	.55
7" x 4" 3, 8 or 15 ohm	£1.63
8" x 5" 3, 8 or 15 ohm	£1.75
10" x 6" 6, 8 or 15 ohm	£2.69

SPEAKER KITS (Carr. 75p each. £1.50 pair)

Baker Major Module 3, 8 or 15 ohm	each	£13.44
Goodmans Mezzo Twinkit	pair	£47.19
Goodsmans DIN 20 4 ohm	each	£13.44
Helme XLK25	pair	£25.44
Helme XLK30	pair	£17.19
Helme XLK50	pair	£46.25
Kefkit 1	pair	£48.44
Kefkit 3	each	£42.50
Peerless 3–15 (3 sp. system)	each	£17.19
Peerless 20/2	each	£17.44
Peerless 30/2	each	£24.38
Peerless 20/3	each	£26.56
Peerless 50/4	each	£40.50
Richard Allan Twinkit	each	£10.37
Richard Allan Triple 8	each	£15.94
Richard Allan Triple	each	£23.12
Richard Allan Super Triple	each	£27.50
Wharfedale Linton 2 kit	pair	£23.12
Wharfedale Glendale 3 kit	pair	£40.61
Wharfedale Dovedale 3 kit	pair	£63.12

PA/DISCO AMPLIFIERS (Carr. and ins. £1)

Baker Major 100 watt	£57.25
Linear 30/40	£30.00
Linear 40/60	£35.00
Linear 80/100	£58.95
Linear 100 watt slave	£44.00
Eagle PRO A120, 120 watts RMS	£129.00
Eagle PRO A65, 65 watts RMS	£98.50
Eagle PRO A35, 35 watts RMS	£77.00
Eagles TPA40 mains/12v mobile	£50.00
Eagle HHS 36 watts. mobile 12v.	£37.50
Eagle TPA20 paging amplifier	£45.00
Eagle RA859 Reverb (p. & p. 75p)	£18.25
Eagle RA856 Reverb (p. & p. 75p)	£12.50

MICROPHONES (p. & p. 50p)

Shure 515 SB Low Impedance	£17.31
Shure 515 SA High Impedance	£18.25
Shure 545 Dual Impedance	£34.69
Shure 588 SB Low Impedance	£23.12
Shure 588 SA High Impedance	£23.75

FREE with loudspeaker orders over £7 – "HiFi Loudspeaker Enclosures" book

All items guaranteed new and perfect

Prompt despatch

Carriage: 38p per speaker 12" and up 50p each, 25p per tweeter, crossover or 2¼"/70mm speaker kits 75p each (£1.50 pair)

Including VAT – 25% on Hi Fi and 8% on PRO and PA.

Send stamp for free booklet 'Choosing a speaker'

Big discounts on Grundig, ITT, Koyo, etc. Send stamp for list

WILMSLOW AUDIO

DEPT RC

LOUDSPEAKERS: SWAN WORKS
BANK SQUARE, WILMSLOW, CHESHIRE

AMPLIFIERS, RADIO ETC.
10 SWAN ST., WILMSLOW, CHESHIRE

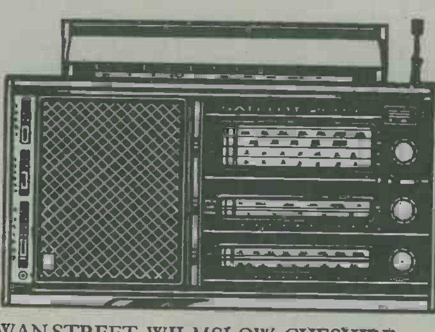
The Ultimate Radio!

GRUNDIG SATELLIT 2000

You've got your yacht, private aircraft, Rolls Comiche? — then all you need for a full set of status symbols is this latest model Grundig Satellit, Germany's top radio! Radio performance, appearance and sound quality are all superb. VHF/FM, MW, LW 10 SW bands plus bandspread, 27 transistors and 22 diodes, Battery/Mains (110/240v.), 2 speakers, 57" telescopic aerial.

Our Price £149.95
inc. VAT, carr. & ins.

Big discounts on Grundig, ITT, Koyo, etc. Send stamp for list.



WILMSLOW AUDIO, 10 SWAN STREET, WILMSLOW, CHESHIRE

SEMICONDUCTORS

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

AC107	14p	BC179B	14p	BF184/5	15p
AC127/128/176	11p	BC184C	10p	BF194/5/6/7	8p
ACY28	18p	BC186/7	18p	BF194A/195C	12p
AD149	40p	BC213L/214B	10p	BF200	20p
AD161/2 matched pr.	69p	BC261B	10p	BF258	33p
AF116/7	12p	BC327/8	15p	BF262/3	23p
AF124/6/7	20p	BC337/8	14p	BF336	25p
AF139/178	30p	BC547/558A	11p	BFS28 Dual Mosfet	92p
AF180/1	30p	BC548	9p	BFW10/11 F.E.T.	28p
AF239	20p	BCX32/36	12p	BFW30	£1.35
ASY27/73	25p	BCY40	60p	BFW57/58	20p
BC107A or B	9p	BCY70/1/2	9p	BFX12	20p
BC107/8/9	7p	BD112/3/5/6	50p	BFX29/30/84/88	16p
BC108A/B/109B/C	10p	BD131/2/3/5	30p	BFY50/1/2	12p
BC147/8/9	7p	BD201/2/3/4	£1.00	BFY90	50p
BC147A/B	8p	BD232/4/5	47p	BR101 Programmable Unj Junction	30p
BC148A/B, 9B/C/S	8p	BDX77	£1.40	BRY39 Programmable Unj Junction	34p
BC157/8/9	9p	BF115	12p	BRY56 Programmable Unj Junction	34p
BC158A/B	11p	BF167/173	15p	BSV64	40p
BC159B/C, 157A	11p	BF178/9	25p	BSV79/80 F.E.T.s	£1
BC178A/B	13p	BF180/1/2/3	22p	BSV81 Mosfet	90p

BSX20/21	13p			
BSY40	28p			
BU105-01	93p			
CV7042 (OC41 OC44, ASY63)	7p			
GET111	40p			
OC35	32½p			
ON222	30p			
TIP30	52p			
TIP3055	50p			
TIS88A FET	33p			
ZTX300	11p			
2N393/MA393	30p			
2N706	10p			
2N929	14p			
2N987	35p			
2N1507/2219	18p			
2N2401/2412/2483	25p			
2N2904/5/6/7	13p			
2N2907A	15p			
2N3053	13p			
2N3054/3055 (or equiv)	37p			
2N3704	10p			
2N3133	18p			
2N3819 FET	16p			
2N4037	35p			
2N5036	60p			
2SA141/2/360	31p			
2SB135/6/457	20p			
40250	60p			

OTHER DIODES

IN916	6p
IN4148	1.5p
BA145/148	12p
Centercel	10p
BZY61	10p
BB103/110 Varicap	20p
BA182	24p
OA5/7/10	10p
BZY88 Up to 33 volt	6p
BZX61 11 volt	16p
BR100 Diac.	19p

INTEGRATED CIRCUITS

741 8 pin d.i.l. op. Amp	20p
TAD100 AMRF	£1.00
TAA570	£1.20
CA3001 R. F. Amp	£1.00
TAA300 1wt Amp	£1.25
NE555v Timer	42p
TAA550 Y or G	40p
TAA263 Amp	65p
7483	80p
7400/2/10/20/30	13p
7404	14p
ZN414 RX	88p
7414	60p
7438/74/86	27p
LM300, 2-20 volt	£1.50
74154	£1.50

BRIDGE RECTIFIERS

Amp	Volt		
½	1,600	BYX10	30p
1	140	OSH01-200	30p
1.4	42	BY164	35p
2	30	LT120 type	30p
0.6	110	EC433	15p
5	400	Texas	75p

THYRISTORS

Amp	Volt		
1	240	BTX18-200	50p
1	400	BTX18-300	65p
1	240	BTX30-200	40p
6.5	500	BT102-500R	75p
10	700	BT106	90p
15	500	BT107	£1.00
6.5	500	BT101-500R	90p
6.5	500	BT109-500R	75p
20	600	BTW92-600RM	£3.00
15	800	BTX95-800R Pulse Modulated	£10.00
30	1000	28T10 (Less Nut)	£4.00

RECTIFIERS

	Amp	Volt	
IN4004	1	400	5p
IN4005	1	600	6p
IN4006	1	800	6p
IN4007	1	1,000	6p
BY103	1	1,500	15p
SR100	1.5	100	7p
SR400	1.5	400	8p
REC53A	1.5	1,250	14p
LT102	2	30	10p
BYX38-600	2.5	600	40p
BYX38-300R	2.5	300	36p
BYX38-900	2.5	900	45p
BYX38-1200	2.5	1,200	50p
BYX49-600	2.5	600	34p
BYX49-300	2.5	300	26p
BYX49-900	2.5	900	40p
BYX49-1200	2.5	1,200	52p
BYX48-300	6	300	40p
BYX48-600	6	600	50p
BYX48-900	6	900	60p
BYX48-1200	6	1,200	80p
BYX72-150R	10	150	35p
BYX72-300R	10	300	45p
BYX72-500R	10	500	55p
BYX42-300	10	300	30p
BYX42-600	10	600	65p
BYX42-900	10	900	80p
BYX42-1200	10	1,200	95p
BYX46-300*	15	300	£2.00
BYX46-400*	15	400	£2.50
BYX46-500*	15	500	£2.75
BYX46-600*	15	600	£3.00
BYX20-200	25	200	60p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.50

*Avalanche type

TRIACS

Amp	Volt		
6	400	Plastic	74p
25	900	BTX94-900	£5.00
25	1200	BTX94-1200	£7.00

12-0-12 50M/A Min. Txfmr. 90p

Pair of LA2407 Ferrox cores with adjuster 25p

Chrome Car Radio facia 15p
Rubber Car Radio gasket 5p

DLI Pal Delayline 80p

Relay socket 10p
Take miniature 2PCO relay

B7G or B9A valve can 2p

0-30, or 0-15, black pvc, 360° dial, silver digits, self adhesive, 4¼" dia. 10p

OPTO ELECTRONICS

ORP12	44p
BPX40	65p
BPX42	£1.50
BPY10 (VOLTIAC)	£1.00
BPY68 / BPY69 / BPY77 Diodes	£1.00

Photo transistor

BPX29	£1.00
OCP71	44p

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

RED	14p
ORANGE / GREEN / YELLOW	16p

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp £1.00

.3" red 7 segment L.E.D. 14 D.I.L. 0-9 + D.P. display 1.9v, 10m/a segment 73p

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

Wire ended glass neons 5p

Plastic, Transistor or Diode Holder 1p
Transistor or Diode Pad 1p
Holdersorpads 50pper100

PAPER BLOCK CONDENSER

0.25MFD	800 volt	30p
1MFD	250 volt	15p
2MFD	250 volt	20p
10MFD	500 volt	80p
4MFD	250 volt	20p
15MFD	150 volt	50p

METAL CHASSIS SOCKETS

Car Aerial
Coax
5 or 6 pin 240° din
Speaker din switched
3.5mm Switched Socket
9p

Philips Iron Thermostat 15p
Bulgin 2-pin flat plug and socket 10p
McMurdo PP108 8 way edge plug 10p

TO3 HEATSINK

Europlec HP1 TO3B individual 'curly' power transistor type. Ready drilled 20p

Tested unmarked, or marked ample lead ex new equipment

ACY17-20	8p	OC71/2	5p
ASZ20	8p	OC200-5	10p
ASZ21	15p	TIC44	24p
BC186	11p	2G240	2-50
BCY30-34	10p	2G302	6p
BCY70/1/2	8p	2G401	10p
BF115	10p	2N711	25p
BY127	8p	2N2926	7p
BZY88 series	5p	2N598/9	6p
HG1005	2p	2N1091	8p
HG5009	2p	2N1302	8p
HG5079	2p	2N1907	2-50
L78/9	2p	Germ. diode	1p
M3	10p	GET120 (AC128 in 1" sq. heat sink)	20p
OA81	2p		
OA47	2p		
OA200-2	3p	GET872	12p
OC23	20p	2S3230	30p

8 way Cinch standard 0.15 pitch edge socket 20p

U.E.C.L. 10 way pin connector 2B6000 OA1P10 10p

U.E.C.L. 20 way pin connector 2A60000A1P20 20p

U.E.C.L. 10 way pin socket 2B606001R10 10p

U.E.C.L. 20 way pin socketB260800A1R20 20p

BELLING LEE L1354 TV Aerial diplexer 10p

Philips electronic engineer kits add on series E1004 £1.00 each

RG4-1250 Mercury vapour rectifier £5.00

SOLDER

Multicore - 2½p foot

ENAM. COPPER WIRE

SWG.	PER YD.
18	3p
20-24	2p
26-42	1p

GARRARD

GCS23T Crystal Stereo Cartridge £1.00

HANDLES

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

14 D.I.L. socket, gold plated contacts, NOT cheap type 13p

Miniature Axial Lead Ferrite Choke formers 2p

DEE PLUG

McMurdo DA15P 15 way chassis plug 15p

Fairway 18009 Coax. socket 3p

TIE CLIPS

Nylon self locking 7" or 3½" 2p

CINCH 150

12 way edge socket 10p

1lb Mixed nuts, bolts, washers etc. 35p

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

MAIL ORDER CUSTOMERS ONLY ADD 8% V.A.T.

BI-PRE-PAK

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

Bargains from our FREE Catalogue

20 large pages, filled with real bargains in transistors, I.Cs, components, equipment, etc. Send large S.A.E. with 7p stamp for your FREE copy of 6th Edition by return. Meanwhile, for prompt delivery order from this month's ad. NOW.

TRANSISTOR PACKS ALL 50p each TESTED AND GUARANTEED

- B79 **4** IN4007 Sil. Rec. diodes. 1,000PIV 1 amp. plastic
- B81 **10** Reed Switches, 1" long ⅛" dia. High-speed P.O. type
- H35 **100** Mixed Diodes, Germ. Gold bonded, etc. Marked and Unmarked
- H38 **30** Short lead Transistors, NPN Silicon Planar types
- H39 **6** Integrated circuits 4 gates BMC 962, 2 flip flops BMC 945
- H41 **2** BD131/BD132 Complementary Plastic Transistors
- H65 **4** 40361 Type NPN Sil. Transistors TO-5 can comp. to H66
- H66 **4** 40362. Type PNP Sil. Transistors TO-5 can comp. to H65

UNMARKED & UNTESTED

- B1 **50** Germanium Transistors PNP, AF and RF
- B66 **150** Germanium Diodes Min. glass type
- B84 **100** Silicon Diodes DO-7 glass equiv. to OA200, OA202
- B86 **100** Dil. Diodes sub. min. IN914 and IN916 types
- H20 **20** BY126/7 Type Silicon Rectifiers 1 amp. plastic. Mixed volts
- H34 **15** Power Transistors, PNP. Germ. NPN Silicon TO-3 Can
- H67 **10** 3819N Channel FET's plastic case type

SILICON POWER TRANSISTORS—

Type	Gain	VCE		PLASTIC Price
40 WATT ●				
40N1	15	15	NPN	20p
40N2	40	40	NPN	30p
40P1	15	15	PNP	20p
40P2	40	40	PNP	30p
90 WATT ●				
90N1	15	15	NPN	25p
90N2	40	40	NPN	35p
90P1	15	15	PNP	25p
90P2	40	40	PNP	35p

NEW X-HATCH GENERATOR Mk.2

Essential for Colour T.V. alignment of 4 patterns. Featuring plug in IC's and a more sensitive sync. pick-up circuit. The case is virtually unbreakable—ideal for the engineer's toolbox—only measures 3" x 5½" x 3". Operates from 3 U.2 type batteries (extra).

P & P add 33p kit or complete — Complete kit **£7.93●** — Ready built unit only **£9.93●**

OVER 1,000,000 TRANSISTORS IN STOCK!

CAPACITOR DISCHARGE IGNITION UNITS
Transistorised. Simple to Fit. Improves performance, cuts fuel costs
P & P add 27p **£7.50●**

MNFRS. AM/FM CHASSIS
To clear. NO instructions or tuning drives, useful for experimenters. Not too difficult to get working. Make good portables
EACH **£1**

SUNDRY

Metrication Pocket Charts 12p. 8 assorted relays £1·00 (8%). Rev. counter device (for cars) £1·00. U.H.F/TV Tuner Units, 625 lines, Rotary Tuning £2·50. L.M.380 Audio I.C. £1·00 and technical books of all kinds.

TERMS OF BUSINESS

V.A.T. Prices shown do NOT include V.A.T. Please add 25% to total value of your order, except for items marked with a ●, or (8%) for which the V.A.T. rate is 8%. No V.A.T. on overseas orders.

POSTAGE Except where stated, add 22p for postage & packing in U.K. Overseas—add £1, any difference being charged or refunded.

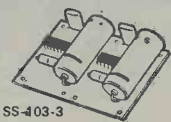
PAYMENT Cash with order, Cheque or money order. Minimum value–£1. You can also pay by ACCESS.

IMPORTANT—*Every effort is made to ensure accuracy of prices and description at time of preparing this advertisement and going to press. Prices are subject to alteration without notice.*

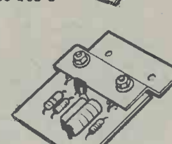
challenging values!

Stirling Sound

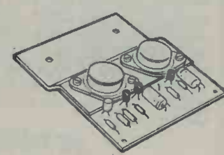
STIRLING SOUND AUDIO MODULES come to you as basic units assembled on P.C.Bs enabling you to add required components in layouts of your own choice. Modules are tested and boxed before despatched and include well printed instructions.



SS-103-3



SS.105



AMPLIFIER MODULES

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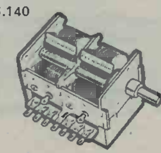

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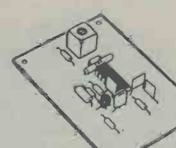

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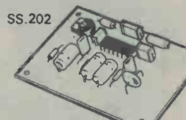

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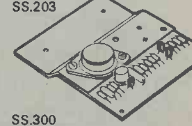

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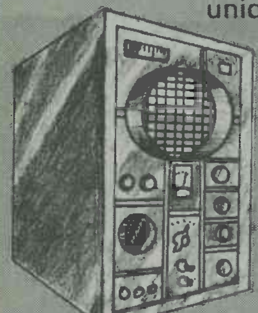

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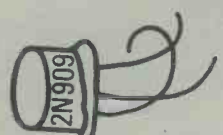

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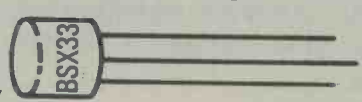

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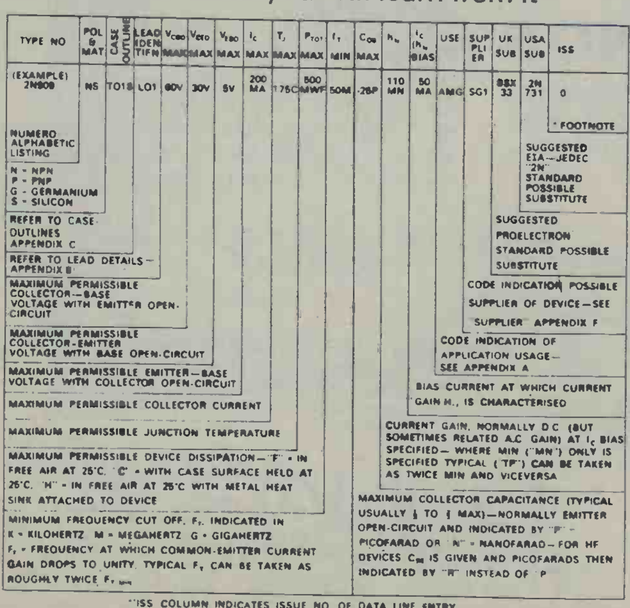

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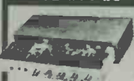

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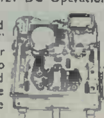

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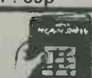

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SEPTEMBER ISSUE WILL BE PUBLISHED ON 1st SEPTEMBER

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By J. Hart

An inexpensive unit which provides a delay facility found only in a few luxury models.

IN MOST CARS THE INTERIOR LIGHT IS CONNECTED TO switches fitted in the door pillars so that whilst a door is open the light is switched on, this being a convenience for anyone entering or leaving the vehicle. The simple circuits described in this article are designed to give a time delay between the closing of the car doors and the switching off of the interior light. The result is an improvement on the normal arrangement; for instance, when parked at night the delay is sufficient to allow the driver to put on his seat belt and to start the car before the light is automatically extinguished. It is also of benefit when leaving the car in an unlighted garage, the delay giving time for the driver to lock the car and to see his way out.

NEGATIVE EARTH

Fig. 1 shows a circuit suitable for cars having a 12 volt negative earth system with the door switches connected to earth. This arrangement is used in a wide range of popular cars, including the author's Hillman Imp in which the unit has been installed. A single component change will cater for positive earth systems.

The circuit operates in the following manner. When a door is opened the appropriate switch closes and extends the earth connection to the junction of resistors R1 and R2. Transistor TR1 is then forward biased by

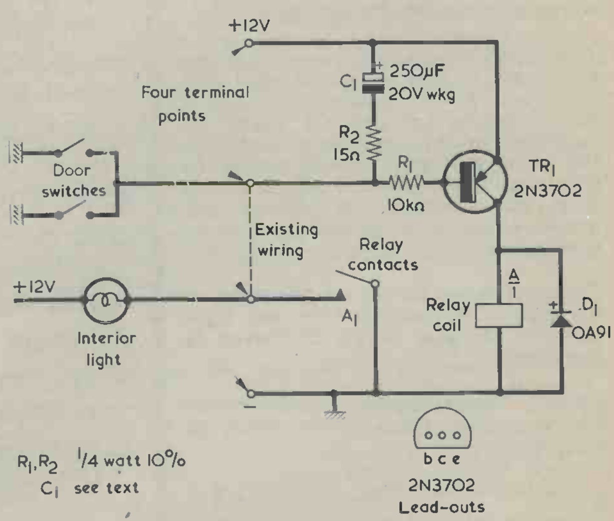
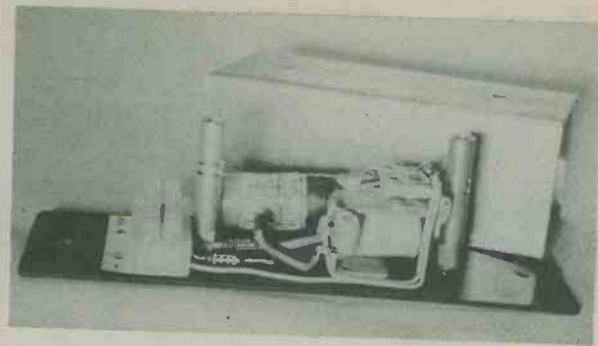


Fig. 1. The circuit of the delay unit as used with cars having a negative earth. The relay contacts are illustrated in the non-energised position. The existing wiring, which is now removed, is shown in broken line



Side view of the author's delay unit. Note the two internally threaded pillars and the folded aluminium cover

way of R1, its consequent collector current causes relay A/1 to energise, and the relay contacts A1 complete the earth circuit to the interior light which becomes illuminated. At the same time, capacitor C1 charges rapidly via R2.

When the door is closed the door switch contacts open. Capacitor C1 maintains a bias current for TR1, and relay A/1 remains energised. C1 then slowly discharges through R1 until the collector current of TR1 is insufficient to hold the relay energised. The breaking of the relay contacts causes the interior light to be extinguished and the circuit is back to its normal state.

With the values shown a delay of some 12 seconds was obtained, and this has proved to be quite adequate. The length of the delay may, however, vary from this figure in individual circuits according to the gain of the particular transistor used for TR1 and the release current value of the relay. The timing period may be altered by varying the value of C1 and constructors can, if they wish, determine in practice the capacitance required in this component for a particular time delay before installing the unit permanently.

The low value resistor R2 is included to limit the initial charging current when the door switch closes, whilst diode D1 prevents TR1 from being damaged by any high back e.m.f. which may appear across the relay coil when the relay de-energises. It is important that D1 be connected into circuit correct way round or excessive current may flow through it and the transistor.

RELAY

The construction will depend on the relay used. This is not a critical component; it should have a coil resistance of at least 200Ω and be capable of energising at some 10 volts or less. It requires a set of normally open contacts which should be capable of controlling the current for the interior light. In the author's case this was a 6 volt festoon lamp and so the relay contacts needed to be suitable for a switched current of 0.5 amp. A wide range of relays are suitable here. The relay employed in the prototype unit was a small ex-Services surplus type.

The relay and other components were mounted on a solid s.r.b.p. ('Paxolin') base, together with a plastic screw terminal block for connection to the car electrical circuits. A terminal block is recommended here as this avoids the need for soldering in the car. Two 2 in. internally threaded pillars were also fitted to the s.r.b.p. board and these enabled a simple folded aluminium cover to be screwed down to complete the unit and protect the components.

After examination of the car wiring diagram the unit was firmly mounted under the instrument fascia, where it was convenient to pick up the battery and earth supplies and to intercept the cable connecting to the interior light and the door switches. It is, of course, essential that a delay unit of this nature be fitted only by someone who has an accurate knowledge of the electrical system in the car concerned.

For cars having a 12 volt positive earth system it is only necessary to change TR1 for an n.p.n. type and to reverse the polarities of C1 and D1. The transistor may be a BC108 and the circuit is shown in Fig. 2. The same comments apply to the components here as in Fig. 1.

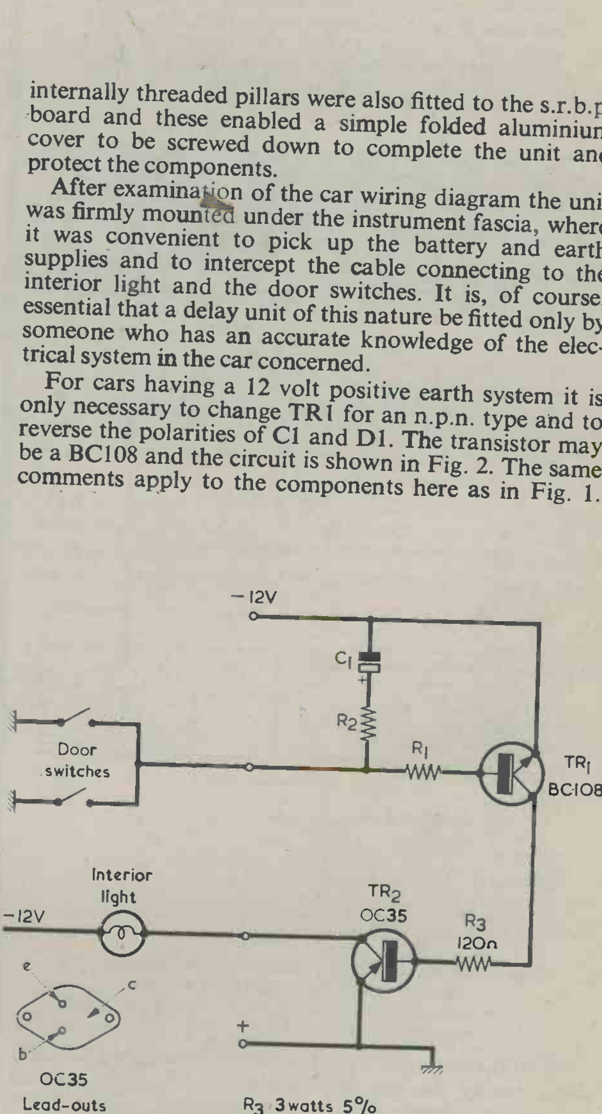
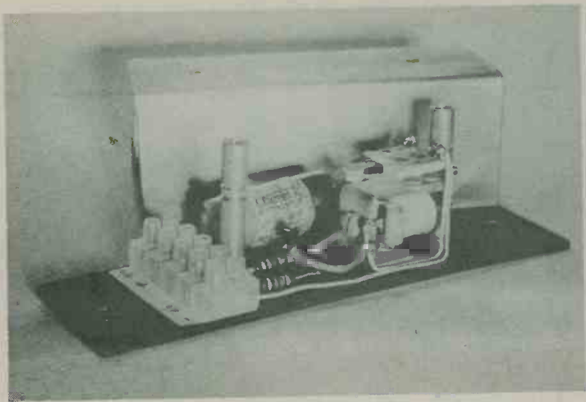


Fig. 2. The basic circuit of Fig. 1 may be employed in cars having a positive earth if TR1 is made an n.p.n. transistor and the polarities of C1 and D1 are reversed



Another view of the unit showing, in particular, the type of terminal block employed. One of the terminals is unused and the remaining four correspond with those indicated in the circuit diagrams

Fig. 3 shows an all-electronic delay unit for cars having a positive earth, a power transistor being employed as an alternative to the relay. An OC35 can be used as a switch to handle the current drawn by the interior light, and its base is coupled to the collector of TR1 via the current limiting resistor, R3. With loads of the order of 6 watts, the OC35 does not need to be mounted on a heat sink.

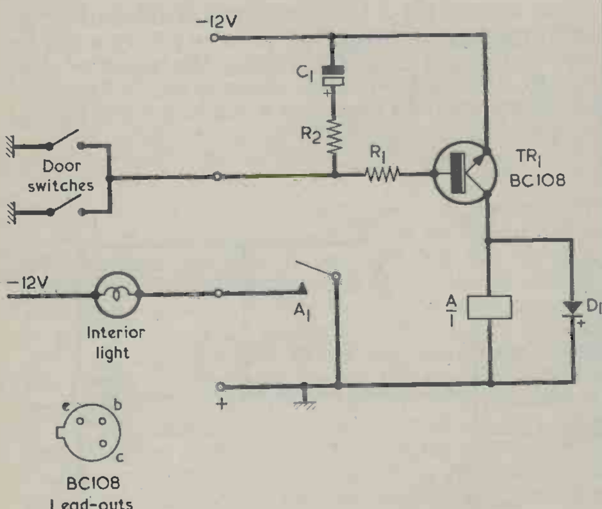


Fig. 3. An all-electronic delay unit incorporating a power transistor instead of a relay

With the circuit of Fig. 3, however, the light gradually dims during the last few seconds of the delay period before becoming finally extinguished. The more precise on-off action of a relay was preferred by the writer, and no failures with the unit whose circuit is shown in Fig. 1 have occurred since it was installed a year ago.

THYRISTOR BISTABLE

By J. R. Davies

A look at an infrequently encountered circuit

A SEMICONDUCTOR DEVICE WHICH HAS NOT, PERHAPS, received as much attention as is its due is the thyristor, or silicon controlled rectifier. As readers will be aware, a thyristor is a switching device which may be inserted in series with a load coupled to a source of direct current. If a small current is momentarily passed through the thyristor gate to its cathode the device becomes conductive and switches on the load. Provided that the load current is above its holding level the thyristor then remains conductive, and can only be turned off again by reducing the load current below the holding level. The polarity of the load current must be such that conventional current (from positive to negative) flows in at the anode and out at the cathode of the thyristor.

The gate current has to be applied continually if the load is powered by an alternating voltage, since the thyristor otherwise turns off on the half-cycles which take the anode negative of the cathode.

The thyristor has the advantages that it can pass relatively high currents and that, for direct voltage applications, it can be turned on by a momentary gate current only. When conductive, there is a voltage drop of the order of 1 volt across the anode and cathode of the device.

BISTABLE CIRCUIT

Two thyristors can be employed in a bistable circuit, as shown in Fig. 1. The thyristors used here are type CRS1/05 which, although encapsulated in a small TO5 can, can pass average currents up to 1 amp, and non-repetitive surge currents up to 15 amps.

When, in Fig. 1, the 9 volt supply is initially applied, both thyristors are non-conductive. If, now, S1 is pressed, a gate current flows to TH1 via R1, and this thyristor turns on. The anode of TH1 goes rapidly negative, and a holding current flows through R2. Capacitor C1 charges via TH1 and R3 with its right-hand plate positive. Further closure of S1 has no effect on thyristor operation and the circuit is in one of its two stable states.

If, on the other hand, S2 is pressed, a gate current flows into TH2 and this thyristor turns on. Its anode goes negative, taking the anode of TH1 negative also by way of the charged capacitor, C1. In consequence, TH1 turns off, and C1 charges up via R2 and TH2 with its left-hand plate positive. The circuit is now in the second of its two stable states. It may be brought back to the first state by pressing S1, whereupon TH1 turns on and TH2 is turned off by the consequent negative excursion of its anode due to C1.

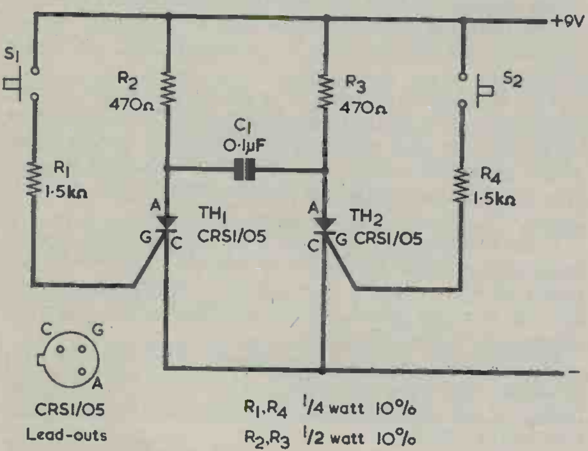


Fig. 1. The thyristor bistable. Turning on TH1 causes TH2 to turn off, and vice versa

Thus, a momentary closure of S1 causes TH1 to turn on and stay on, whilst a momentary closure of S2 causes TH2 to turn on and stay on. Apart from the instants of changeover only one thyristor is conductive at any time.

CAPACITOR VALUE

The value required for C1 depends on the anode loads (R2 and R3 in Fig. 1), supply voltage and the turn-off time of the thyristors, and is best determined empirically. With the thyristor types and component values shown in Fig. 1, it was found that the thyristors could not turn each other off when C1 had a value of 0.01μF, but that they did so reliably when C1 was made 0.02μF. The higher value of 0.1μF shown in the diagram is therefore comfortably above the minimum capacitance required.

A disadvantage with the circuit of Fig. 1 is that both thyristors are off when the 9 volt supply is initially applied, and that it is necessary to press one of the two switches to bring the circuit to one of its two operating states. The modification shown in Fig. 2 ensures that TH1 is always turned on at switch-on. In Fig. 2, R1

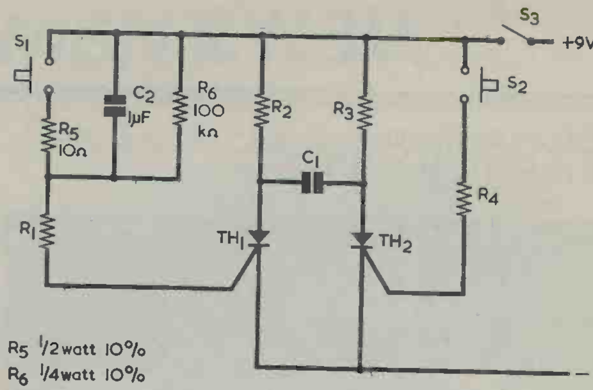


Fig. 2. A circuit modification which ensures that TH1 is always turned on when on-off switch S3 is closed

to R4, TH1, TH2, S1, S2 and C1 are the same as in Fig. 1, whilst R5, R6, S3 and C2 are added components. C2 is a plastic foil capacitor. When on-off switch S3 is closed a charging current for C2 flows through R1 to the gate of TH1. The current is sufficient to turn on this thyristor and the circuit then reverts to its previous mode of operation with TH2 turning on when S2 is closed and TH1 turning on when S1 is closed. Resistor R5 is included to limit surge current at S1 contacts when this switch is subsequently closed since it then discharges C2. When S3 is turned off, C2 discharges into R6 and is then ready to turn on TH1 when the circuit is next switched on. It is necessary for S3 to be a toggle switch which applies the supply abruptly when it closes. TH1 will not turn on automatically if switch-on is more gradual, as would occur if the 9 volt supply were provided by a mains power unit with the on-off switch at the mains input.

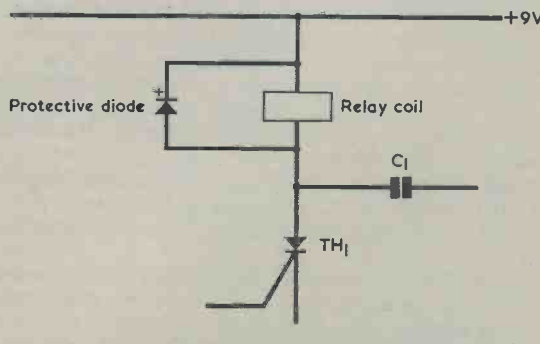


Fig. 3. If a relay coil is used as a load, a protective diode must be connected across it. Here, the relay coil replaces R2

Alternative loads can, of course, be employed in place of R2 or R3, with a possible consequent alteration in the value of C1. If a relay coil forms a load, a protective diode should be connected across it as in Fig. 3 to prevent the formation of a high back e.m.f. when the associated thyristor turns off. The diode can be a small silicon rectifier such as the 1N4002. ■

NEWS . . . AND .

DIGITAL RADIO DIRECTION FINDER

The new Heathkit MR-1010 Digital Radio Direction Finder, brings marine navigation into the digital age. What you see, is what you hear in the new revolutionary MR-1010. Just tune the dial to the stations you want on either of two switch-selected bands (AM broadcast and LW beacon).

Frequencies are read out directly in big bright digits on the Beckman planer gas discharge tubes on the front panel – with resolution down to 1 kHz and accuracy within $\pm$ 2 kHz. If the station is broadcasting, that's what you'll hear. No more fumbling with hard-to-reach dials at night or during a storm searching for elusive, hard-to-identify beacon stations. And the digital readout automatically dims at night for added convenience and safety.

While designed as a precision navigational aid, the MR-1010 serves double duty as a AM radio entertainment centre with impressive performance specifications.

The MR-1010 is designed to be used with a boat's 12 VDC electrical system – or it becomes completely portable with its own built-in power source consisting of 6 1.5V flashlight batteries (not included with kit). To prolong battery life, the digital readout display automatically shuts off after approximately 20 seconds – but can be recalled instantly at the touch of a front panel switch.

Kit K/MR-1010 £124.00 including 8% VAT and delivery within the United Kingdom.

FREE Catalogue with full details of the MR-1010 and the complete range of Heathkit kits, available from: **Heath (Gloucester) Ltd.,** Bristol Road, Gloucester. GL2 6EE.

GREENWICH MEAN TIME

Throughout the world, local time is measured by how many hours it is before, or after, GMT. Why GMT?

The answer, explained an item on BBC World Service, lies with the Royal Observatory, which recently celebrated its 300th anniversary.

In 1675 there was no way of finding longitude at sea, nor of measuring currents. The consequences were shipwreck, death and destruction of valuable cargoes. King Charles II, who was expanding his navy, said:

"I must have the stars anew observed and corrected for the use of my seamen."

So he appointed John Flamsteed to become the first astronomer Royal, and commissioned Christopher Wren – the greatest architect of his age – to build an Observatory on top of a hill at Greenwich.

The building still stands though Greenwich, then a riverside village, is now a pleasant part of inner London.

The first need was for a precise knowledge of the fixed stars. The second was to observe the movements of the moon and planets, and produce tables from which mariners could calculate their position at sea. The third was to make an accurate shipborne chronometer.

It took more than 40 years to produce the first British catalogue of stars from the thousands of observations taken by Flamsteed. It was this work which established him as the first great systematic astronomer since the invention of the telescope.

In 1766, the Royal Observatory published its first Nautical Almanac, and each year since it has provided tables of all astronomical information for navigators and astronomers.

All this data had to relate to a standard meridian and time, and in 1884, by international agreement, the Greenwich Meridian was adopted as the world's prime meridian, and the basis for the international time zone system – hence GMT.

Though the Wren building no longer houses the Royal Observatory – it moved to Herstmonceux Castle, Sussex, in 1948 – there is still much to see in Greenwich in 1975.

A special tercentenary exhibition at the National Maritime Museum throughout 1975 contains a magnificent array of ancient and modern maps, models, portraits, manuscripts and instruments to enable the visitor to follow the history of the oldest scientific institution in Britain.

● *A radio programme about the Greenwich Observatory can be heard on BBC World Service on Saturday, August 9 at 0030 GMT; Sunday, August 10 at 1709 GMT and Tuesday, August 12 at 1130 GMT.*

. . . COMMENT

ELECTRONICS DATA

The Constructor's Data Sheets which appeared on our inside back cover reached maturity at No. 100 in our last issue. Starting in January 1968, they have covered the most important electronic information which can be satisfactorily presented in tabular form, and they now go into a well earned retirement.

Commencing with this issue, they are followed by a new series, 'Electronics Data', which will deal each month with a specific aspect of electronics. Starting with a series for the beginner each will feature a pictorial display combined with a brief and concise text.

LOW-DEFINITION A/TV ASSOCIATION INAUGURATED

Tape recording, stereo, the semiconductor revolution and the extension of its technology into opto-electronics, integrated circuits and improvements in flexible lightguides etc., has led a number of enthusiasts to consider using such aids to provide a modernised version of the original Baird TV system of 40 years ago.

In the Spring a LDTV Convention was held at the Nottingham College of Education, discussions resulted in the inauguration of a formal association.

F. C. Ward, G2CVV, Secretary of the Derby & District Amateur Radio Society accepted an invitation to become the association's first President.

A prime mover in the formation of the association was D. B. Pitt of 1 Burnwood Drive, Wollaton, Nottingham, from whom details may be obtained.

NEW AGFA CASSETTE ALBUM

This new album contains all the advantages of the old, but with the following improved features:-

Colour–each album contains 1 of each, C60 red, C60 lilac and C60 yellow, plus 1 of each C90 red, C90 lilac and C90 yellow AND corresponding, coloured index reference cards.

Presentation – each "Color Album" is attractively wrapped in an individual polythene bag complete with carrying handle and a colourful descriptive photograph on the back of the package.

Recommended retail price is £6.65 (incl. V.A.T.).

IN BRIEF

■ Henry's Radio Ltd., had to twice postpone the printing of their 1975 catalogue due to the V.A.T. changes in the Spring Budget. As soon as they received clarification of the changes to the rates for their components, the necessary alterations to the catalogue were made and the printers instructed to proceed.

Henry's Radio wish to apologise to those of our readers who may have been inconvenienced by the delays.

■ A Radio Amateur Course is to be held at the North East Essex Technical College, Sheepen Road, Colchester, Essex. For further information contact D. Mason of the Electrical Engineering Department at the College.

■ Coupled with the little publicised dissolution on 31st March, 1975, of the Permanent Magnet Association which has served both makers and users of Magnets so well over the past 30 years, has been the establishment of a Permanent Magnet Centre at Sunderland Polytechnic, Chester Road, Sunderland.

Details from Mr. W. Wright, or Dr. A. G. Clegg, at the Polytechnic.

"Come in Vicar. I told my husband to make me a Room Divider and I hope he's finished by now!"

SPECIAL PRE-PUBLICATION OFFER

We would draw readers' attention to the Special Pre-Publication Offer which appears on the outside back cover of this issue.

We have been able to arrange for our readers to obtain copies of *Linear I.C. Circuit Applications* by G. Clayton, published by MacMillan, at a special pre-publication price which will give a substantial discount over the full selling price.

Full details appear in the advertisement.

F.M. SIGNAL BOOSTER

By A. Sydenham

A Band II aerial pre-amplifier which was primarily designed to improve f.m. stereo reception.

THE PRE-AMPLIFIER TO BE DESCRIBED WAS BUILT FOR use with a commercially manufactured f.m. stereo tuner-amplifier, but it could without doubt be employed equally well with any other f.m. receiver or tuner, whether intended for stereo or for mono reproduction.

As is well-known, good hiss-free stereo reception requires a stronger aerial signal than that needed for adequate mono reception. Because of this, stereo reception in fringe areas may cause dissatisfaction even when a good multi-element beam aerial is being employed. Under these conditions the use of a pre-amplifier with a high gain level is worth consideration. It must be noted, however, that a pre-amplifier should never be used in an attempt to make up the losses incurred with a poor aerial system. It should, instead, be looked upon as a possible addition to a good aerial installation when all else fails.

CASCODE CIRCUIT

Of various pre-amplifiers tried by the writer, the one whose circuit is depicted in Fig. 1 has performed best. As may be seen, it employs two field-effect transistors in a cascode configuration, the first f.e.t. working as a grounded source amplifier and the second in a grounded gate stage. Both the input and the output of the pre-amplifier are at 75Ω impedance. Construction tends to fall into the subminiature category and it is essential to have a really small soldering iron with a pencil bit.

In the author's case the pre-amplifier obtains its power from the tuner-amplifier with which it is

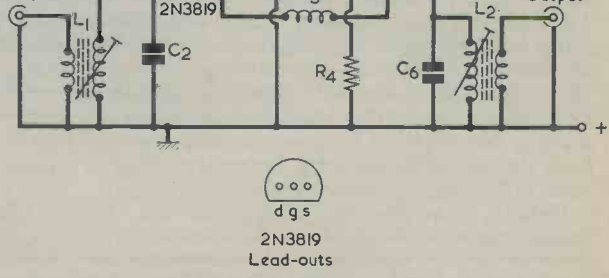


Fig. 1. The circuit of the f.m. signal booster. The aerial connects to SK1 and the booster output is then fed to the aerial input socket of the f.m. tuner or receiver

employed. The tuner-amplifier supply is negative of chassis, and it is for this reason that the pre-amplifier has a positive chassis connection. The pre-amplifier can, of course, alternatively be powered by a small mains power unit or a battery. The current consumption is of the order of 2 to 3mA only.

CONSTRUCTION

The parts are assembled on a piece of copper-clad board measuring 3 by $1\frac{1}{2}$ in. Layout is as shown in Fig. 2, in which diagram the copper side of the board is towards the reader. There is ample space for two 6BA clear holes which can take screws for mounting the board, and these can be drilled at any convenient points.

The terminal point indicated as SK1 is the centre tag of a coaxial socket whose body is on the board side away from the reader. This socket is the largest item in the pre-amplifier! The resistors and wire-ended capacitors are all miniature types, and resistor and capacitor lead-outs are drastically pruned to produce a taut and almost lead-less assembly. The feed-through capacitors are fitted in suitably sized holes, and their skirts are soldered to the copper foil. The item marked 'SO1' is a miniature stand-off insulator.

The two r.f. transformers, L1 and L2, are wound on 5mm. formers fitted with dust cores. Formers of this size can often be obtained from the 'biscuits' of discarded TV tuners. 5mm. formers and dust cores, are, alternatively, listed in the Home Radio catalogue. The formers are fitted into holes of suitable size drilled in

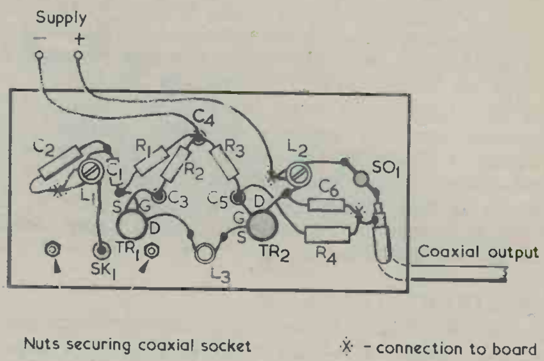


Fig. 2. Layout of the pre-amplifier, which is assembled on a small piece of copper-clad board. The output is taken by way of a coaxial cable which passes through a hole in the board

the board. Each tuned winding consists of 6 turns of 28 s.w.g. enamelled copper wire with the turns spaced by wire thickness. The windings are not intended to peak sharply, hence the small values assigned to capacitors C2 and C6. If the tuned windings are first made around a drill shank or other round object slightly smaller in diameter than the coil formers, they can then be gently sprung onto the formers and a firm fit will result. Each coupling winding consists of 2 turns of thin plastic covered wire wound between the tuned winding wire at the earthy end. They are most easily fitted after the coil formers have been mounted on the board.

Coil L3 consists of 13 turns of 34 s.w.g. d.s.c. wire close-wound on a former with a diameter of approximately 3mm. This coil is not very critical, incidentally, and the pre-amplifier will function reasonably well without it.

The three feed-through capacitors provide anchoring points for some of the components, but there are also a few 'mid-air joints'. These joints are quite stable mechanically due to the short component lead-outs. Note that some connections are soldered directly to the copper of the board. The f.e.t.'s should be soldered in last of all, using a soldering iron whose bit is earthed.

TESTING

When completed, the pre-amplifier can be initially checked by measuring the current it draws from a 9 volt battery. This should be approximately 2 to 2.5mA. The f.m. tuner or receiver with which the pre-amplifier is to be used is then turned on with its aerial connected in the normal manner, and a weak signal is tuned in. This should, preferably, be at a central frequency in the f.m. band. The pre-amplifier is next introduced between the aerial and the tuner or receiver, and signal strength is noted as the cores of L1 and L2 are adjusted. Normally, the cores will need to be almost fully inside the coils for maximum signal strength. As already stated, the tuning of the two coils is not sharp. Once they have been adjusted the cores should be left alone. Comparisons can then be made

COMPONENTS

Resistors
(All $\frac{1}{4}$ watt 5%)

R1	220kΩ
R2	470Ω
R3	82kΩ
R4	82kΩ

Capacitors

C1	100pF ceramic
C2	4.7pF ceramic
C3	1,000pF ceramic feed-through
C4	1,000pF ceramic feed-through
C5	1,000pF ceramic feed-through
C6	4.7pF ceramic

Inductors
L1, L2, L3 see text

Transistors

TR1	2N3819
TR2	2N3819

Socket
SK1 coaxial aerial socket

Insulator
SO1 miniature stand-off insulator

Miscellaneous
Copper-clad board
Coaxial cable.

with the pre-amplifier in and out of circuit, whereupon it should be found that it gives a significant improvement in signal strength.

As a point of interest, at the writer's location in the West country the chimney-mounted stereo beam aerial is headed on Wenvoe, which is some 50 miles away with the Mendip Hills rising to over 800 feet above sea level in between. With no pre-amplifier in circuit stereo signals are not entirely hiss-free, particularly on Radio 3. Radio Solent (mono) at a distance of about 60 miles comes in on the back of the beam and is too weak to copy. When the pre-amplifier is inserted Radio Solent is another 'local' and stereo reception from Wenvoe Radio 3 is excellent.

MODIFICATIONS

An alternative pre-amplifier circuit which has the chassis negative is illustrated in Fig. 3. Component values are the same as in Fig. 1 and, since TR1 source bias resistor is now returned to chassis, there is no need for R1 and C1. The circuit could be assembled on a piece of copper-clad board with much the same basic layout as in Fig. 2, and with the copper corresponding to chassis. The author has not checked the circuit of Fig. 3 in practice, but there is little reason to doubt that it should not give equivalent results to that of Fig. 1.

As a final point, the design could also be modified to cover the 2 metre amateur band of 144 to 146MHz

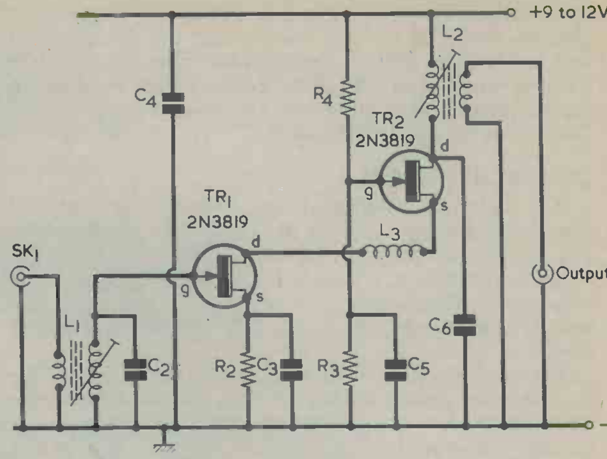


Fig. 3. An alternative circuit in which the chassis connection is common with the negative supply rail. R1 and C1 are not required in this version

All that would be required is to reduce the tuned windings of L1 and L2 to 4½ turns each, and then tune these to the centre of the 2 metre band. ■

IN NEXT MONTH'S ATTRACTIVE ISSUE

NEW TRANSISTORISED OSCILLOSCOPE

Part 1 (3 Parts) By R. A. Penfold

Regular readers will recall the popular and successful transistorised oscilloscope design published in the December 1972 and January 1973 issues of this magazine. Our contributor has now produced a more modern and up-dated version of this design which incorporates many important improvements.

The new oscilloscope is introduced, and constructional details are given of metalwork and the power supply section in part one.

PLUS

MANY OTHER ARTICLES

ON SALE 1st SEPTEMBER

PRICE 30p

VOLTMETER WITH A MEMORY

By G. A. French

Suggested Circuit 297

One of the difficulties of taking voltage measurements when fault-finding on a small and crowded printed circuit board is that it is necessary to keep an eye on the board to ensure that the test prods are at the correct points whilst at the same time trying to observe the voltage reading indicated by the testmeter. The voltmeter design which forms the subject of this month's article in the 'Suggested Circuit' series overcomes the problem in a novel way: the voltmeter has a 'memory' which enables it to retain any voltage reading after the test prods have been removed from the circuit being checked. Thus it is possible to apply one's complete attention to applying the test prods to the appropriate points in the circuit being checked; the prods may then be removed, whereupon the voltmeter will continue to indicate the voltage that was last applied to them.

The voltmeter has a rather limited range with a maximum voltage reading of 20 volts, but this is adequate for nearly all battery operated transistor equipment. If the voltmeter is used with the memory facility switched out of circuit it draws a negligibly low current from the circuit points being checked. If the memory function is switched in, the voltmeter draws an initial current limited to a maximum of about 200μA for a very short period whilst a capacitor charges, after which the current falls to the same negligibly low value as is given with the memory switched out. The voltmeter may be built complete with its own meter movement and series multiplier resistors. Alternatively, these may be omitted and two terminals provided to which any testmeter with a resistance of 10,000Ω per volt or better on its voltage ranges may be connected. If this second method of construction is adopted the voltmeter requires only two inexpensive transistors and a small quantity of other components.

The voltmeter circuit has to be described as being slightly experimental because it is assumed that the transistors employed have leakage currents lower than the maximum figures specified by the manufacturer. As is explained later, general experience shows that the risk of any particular transistors not having the low leakage currents required for the present application is extremely small.

CIRCUIT DIAGRAM

The circuit of the voltmeter appears in Fig. 1. This consists basically of the

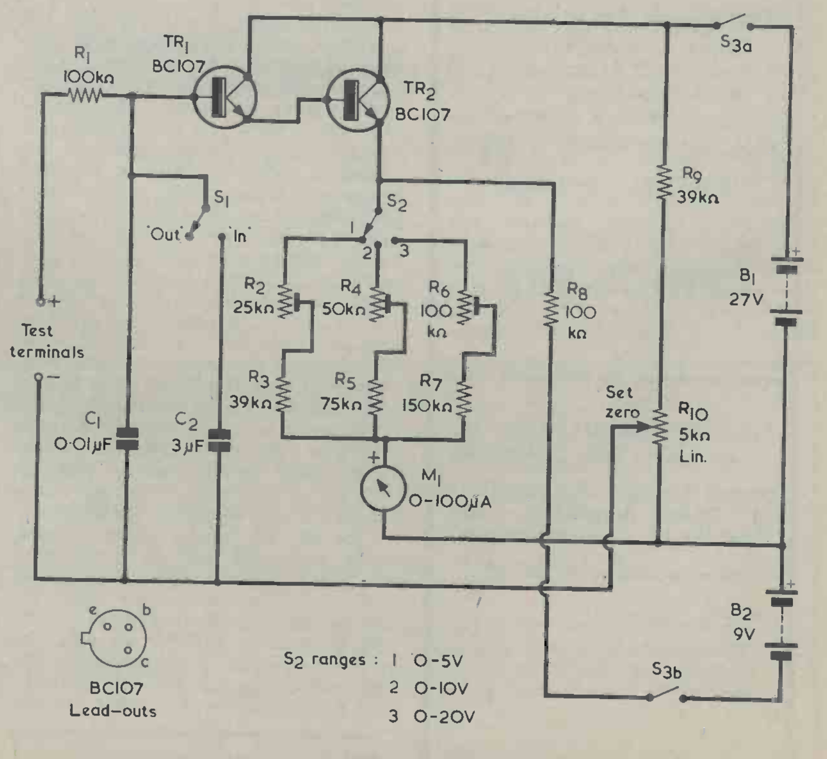


Fig. 1. The circuit of the voltmeter. The memory facility is switched in or out by means of S1

two BC107 emitter followers, TR1 and TR2, these coupling into the effective voltmeter given by M1 and whatever series resistors are switched into circuit by range switch S2. The use of two emitter followers in this manner is not new and a similar circuit was published several years ago in this journal.* In addition to incorporating the memory facility, the present circuit differs in several other aspects from the previous design.

The input resistance at the base of TR1 is very high and, in practice, it is possible to insert at least several megohms in series with the positive input without causing a significant alteration in any reading given by meter M1. This very high input resistance relies on the assumption, just mentioned, that the transistors employed for TR1 and TR2 will, in practice, have leakage currents lower than their maximum specified values. The author has used this particular circuit a considerable number of times in the past and has yet to encounter any BC107's or similar silicon planar transistors which did not function adequately in it. Also, no reports from readers have indicated that the previously published voltmeter design gave unsatisfactory results. Thus, whilst it is feasible that some BC107's may not have sufficiently low leakage currents to be employed in the present circuit, the possibility is extremely low. The transistors used should, of course, be properly branded specimens in good condition.

The voltage at the positive test terminal causes a corresponding voltage to appear at the emitter of TR2. Due to the voltage drop in the two base-emitter junctions, the second voltage is about 1.2 volts negative of that at the positive test terminal. The effective voltmeter given by M1 and its series resistors measures the voltage between TR2 emitter and the negative rail from battery B1, and M1 gives a zero reading when the positive test terminal is about 1.2 volts positive of this rail. The negative test terminal is taken up to the same potential by means of the Set Zero control, R10. R8 couples the emitter of TR2 to a potential, given by B2, which is 9 volts negative of the negative rail from B1. This ensures that emitter current still flows in TR2 when meter M1 is at a zero setting. In consequence, linearity is maintained when low voltages down to zero are applied to the test terminals.

Switch S2 selects three ranges, these being 0–5 volts, 0–10 volts and 0–20 volts. Meter M1 has an f.s.d. value of 100μA and so the sensitivity of the voltage measuring circuit switched in by S2 is 10,000Ω per volt. On the 0–5 range R2 is adjusted such that the total resistance offered by itself, R3 and the meter is 50,000Ω. On the 0–10 volt range R4 is adjusted for a total resistance of 100,000Ω, and on the 0–20 volt range R6 for a total resistance of 200,000Ω. In practice these potentiometers are set up with the aid of known voltages at the test terminals.

MEMORY FACILITY

S1 is the memory switch and, when this is set to 'Out', the voltage applied to the test terminals passes via R1 to the base of TR1 and the 0.01μF capacitor C1. C1 is included to ensure that the voltmeter is not affected by static or hum pick-up on the positive test lead. When S1 is put to 'In' the 3μF capacitor, C2, is connected across C1. C2 charges to the level of any voltage applied to the test terminals and, because of its relatively high capacitance, retains the charge for at least five seconds after the voltage has been removed. With the author's prototype circuit, C2 retained its charge for considerably longer than the five second period. In consequence, two test prods connected to the test terminals may be applied to any two points having a voltage between them and may then be removed. Meter M1 will then continue to indicate the voltage.

Resistor R1 is included in circuit to limit the input charge current to C2. If C2 is discharged and a voltage of 20 volts is applied to the test terminals, the initial charge current in the circuit is limited by R1 to 200μA. This current rapidly reduces as C2 charges. As a result R1 ensures that the circuit whose voltage is being checked is not unduly affected by charge current in C2. R1 also limits input current if a voltage of incorrect polarity is applied to the test terminals. Further, in company with C1, or C1 and C2 in parallel, it ensures that the meter is not affected by pick-up on the positive test lead, as was just stated.

As with all voltmeters, care should be taken to ensure that excessively high voltages or voltages of incorrect polarity are not applied to the test terminals. If a low voltage of incorrect polarity is applied, TR1 and TR2 are merely cut off and the meter gives a reverse reading. Should the applied voltage of incorrect polarity be sufficiently high to exceed the reverse breakdown voltages in the base-emitter junctions of TR1 and TR2, these junctions will function as zener diodes and allow a reverse current to flow. This reverse current flows also through meter M1, whose needle is in consequence once more deflected in the reverse direction. Unless the voltage of incorrect polarity is relatively high, i.e. well above 20 volts, the reverse current should not be sufficiently high to damage the transistors or the meter, but it obviously should not be allowed to remain at the test terminals for a long period. If C2 is switched into circuit, it will rapidly

*P. James, 'High Resistance Voltmeter', *Radio & Electronics Constructor*, April 1973.

discharge when a high voltage of incorrect polarity is removed.

Battery B1 can consist of three small 9 volt batteries, such as the PP3, connected in series. The current it supplies is of the order of 0.6 to 0.7mA. B2 can be another small 9 volt battery, and the current drawn from it is even lower, ranging from some 0.09 to 0.3mA according to the applied test voltage. The life of both B1 and B2 should not be much shorter than their shelf life.

The six fixed resistors may all be ¼ watt 10% types. R2, R4 and R6 are small skeleton pre-set potentiometers. R10 is a standard carbon track potentiometer fitted to the front panel of the meter, as also are S1, S2, S3 and meter M1. S1 can be a single-pole toggle switch and S3 a double-pole toggle switch. S2 is single-pole 3-way rotary.

Capacitor C1 is a plastic foil component, as also is C2. An electrolytic capacitor must *not* be used for C2. The value of C2 is not particularly critical and capacitors having slightly higher values than 3μF may be employed if these are to hand. If necessary, it may be made up of two or more capacitors in parallel. In the prototype circuit the author used a parallel combination of three Mullard type C280 capacitors, each with a value of 1μF. The insulation around the positive input terminal and the base of TR1 must be of very good quality.

The parts may be assembled in a plastic case, or in a home-made plywood case. A metal case is not recommended because of possible small leakage currents between the batteries and their metal housings.

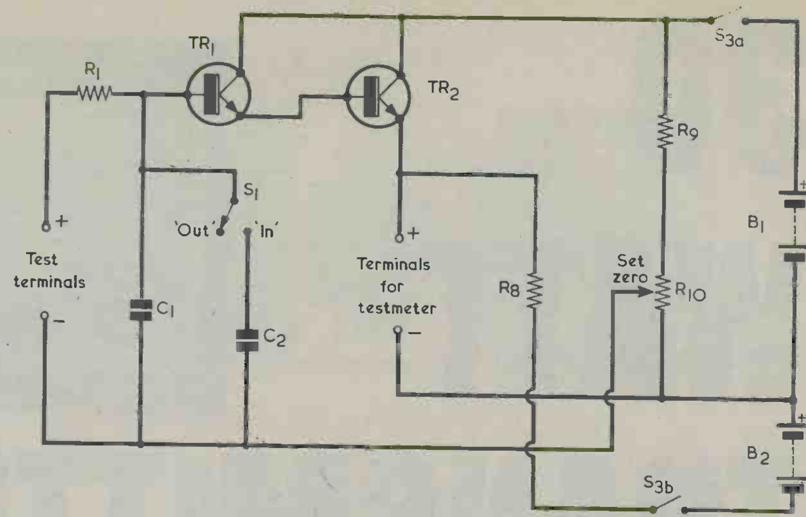


Fig. 2. A less expensive version of the circuit. This allows voltage indications to be given by a standard testmeter switched to a suitable volts range

SETTING UP

After the meter has been completed it is necessary to set up R2, R4 and R6. This is done with the aid of known test voltages which are monitored by another external voltmeter.

First set the three pre-set potentiometers to a central setting. Put S1 to 'Out' and switch on at S3. Short-circuit the two test terminals and adjust R10 for a zero reading in M1.

Next put S2 to the 0–5 volt range and connect a 4.5 volt battery with the external monitoring voltmeter across it to the test terminals. Then adjust R2 for a reading in M1 which corresponds with that in the external voltmeter. If, for instance, the latter indicates 4.6 volts, R2 is adjusted so that M1 indicates 92μA. The process is then repeated with a 9 volt battery for the 0–10 volt range and with an 18 volt battery (two 9 volt batteries in series) for the 0–20 volt range. Alternative sources of test voltage, such as a variable voltage power supply, may also be employed if this is more convenient than using batteries.

After the pre-set potentiometers have been set up, S1 may be put to the 'In' position and the memory facility checked. There should be no significant change in the reading given by M1 after the removal of any test voltage between zero and f.s.d. on whatever range is switched in.

When the voltmeter is in use with S1 in the 'In' position, C2 should be discharged between test readings by temporarily short-circuiting the test terminals together. The setting of the Set Zero control R10 should also be checked, with the test terminals short-circuited together, from time to time. With the prototype circuit is was found that there was very little drift in the zero setting.

As was stated at the start of this article an economy can be effected by providing two terminals to which a testmeter switched to a volts range can be connected. The revised circuit is shown in Fig. 2, in which R2 to R7 and meter M1 are omitted. The circuit is employed in the same way as is that of Fig. 1 so far as zero setting is concerned, but the voltage range given is that selected on the range switch of the testmeter itself. The testmeter scale can be read directly, and the voltage it indicates will be that applied to the test terminals. Test voltages should still be limited to a maximum figure of 20 volts. ■

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received for to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

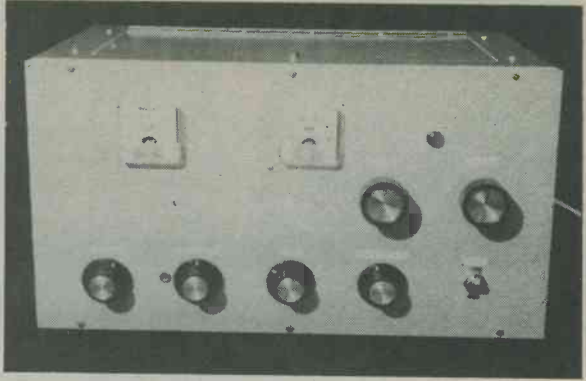
Radio Constructor for March and April 1962 – T. R. Smith, 7 Purbeck Court, Park Barn, Guildford, Surrey – Borrow or purchase.

"How To Use Grid-dip Oscillators" – Hayden – E. J. Randall, 13 Charles Avenue, Greenfields, East London, South Africa – Borrow or purchase.

Contact cooled metal rectifier type ZA26612 (also marked 280 70 167C) – R. E. Simms, 18 Osborne Drive, Sompting, Lancing, Sussex, BN15 9UY – Technical data and circuit information.

Roband Oscilloscope RO55 with Type B Plug-in Unit – D. L. Williams, P.O. Box 305, 24 Alexandra Street, Florida 1710, Transvaal, South Africa – Service Manual, Instruction Book, Wiring Diagram or Photostats – reasonable costs paid for this urgently required information.

30 WATT TRANSMITTER



Part 2

By F. G. Rayer

This article concludes the description of the 30 watt transmitter whose circuit functioning was described last month. The final article in the 28MHz series will appear next month, and will deal with 10 metre aerials.

THE COMPONENTS FOR THE TRANSMITTER ARE ASSEMBLED on a type 'K' chassis measuring 13 by 8 by 2½ in., this fitting into a type 'W' case measuring 15 by 9 by 8 in. Both the chassis and the case are available from H. L. Smith & Co. Ltd., 287/289 Edgware Road, London, W2. The case is supplied complete with front panel. There is a possibility, however, that the two mains transformers obtained may be significantly larger in physical size than those employed by the author. The constructor is advised to initially obtain the mains and modulation transformers and check whether these will fit into a chassis and case of the dimensions just given. If the chassis and case need to be larger to accommodate the transformers then the appropriate changes need to be made to their dimensions. In this instance, the case may need to be home-constructed.

CHASSIS PREPARATION

The positions for the valveholders and other items are shown in Fig. 3, whilst Fig. 4 shows the under-chassis wiring. V1, V3 and V4 are fitted in skirted valveholders with screening cans, the remaining valveholders being plain types without skirts. The valveholder holes should be made such that the valveholder tags will have the orientation shown in Fig. 4. Six holes, about ¼ in. or ⅜ in. in diameter, are punched around V2 valveholder as shown in Fig. 3.

COMPONENTS

Chassis type 'K', 13 × 8 × 2½ in. – see text (H. L. Smith & Co.)
Case type 'W', 15 × 9 × 8 in. having front panel 15 × 8 in. – see text (H. L. Smith & Co.)
Universal Chassis side, 4 × 5 in., (Home Radio)
4 knobs, 1¼ in.
2 knobs, 1½ in.
4 rubber feet
2 metal strips, 7 × 1 in.
12 in. hinge
Valve top cap connector
Tagstrips (see Figs. 3 and 4)
Nuts, bolts, solder tags, etc.

With the transformers employed by the author for T2 and T3, the former requires a rectangular aperture to clear its tags whilst the latter has all its tags above the chassis. A grommet near T2 allows leads from T3 to pass through the chassis without running near audio circuits underneath.

When T1 is a modulation transformer type 747, as specified, its tag positioning will be different from that shown in Fig. 4 for this transformer. (The transformer initially used by the author became unobtainable just before preparation of this material. The transformer type 747 has been fully checked in the transmitter.) Clearance holes should be punched out to agree with the actual tag positions of the transformer. Alternatively a rectangular cut-out to clear all the tags may be made. The tag numbers of the type 747 transformer agree with the numbers shown in Fig. 4.

The crystal holder types fitted can be as chosen by the constructor. The author fitted one small holder for

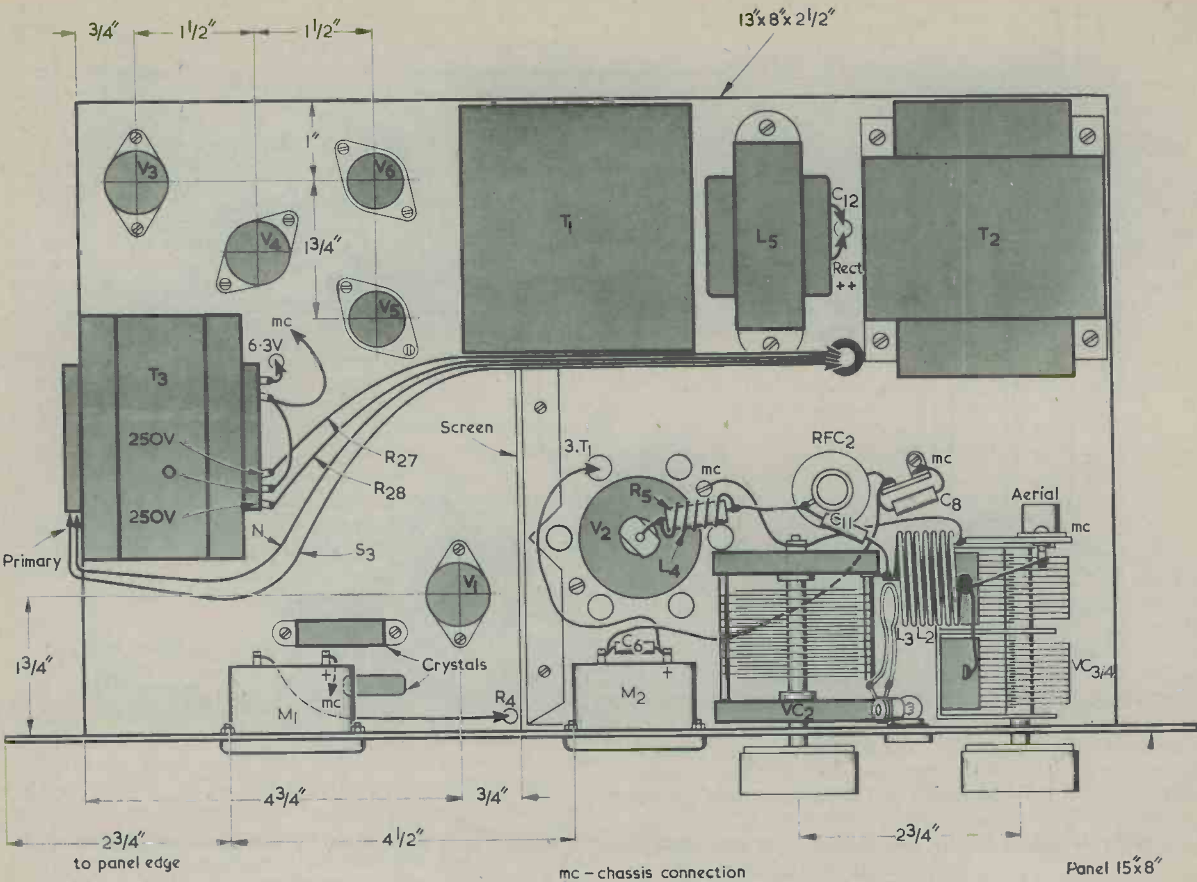


Fig. 3. The components and wiring above the chassis. Valve pin orientation should conform with that shown in Fig. 4

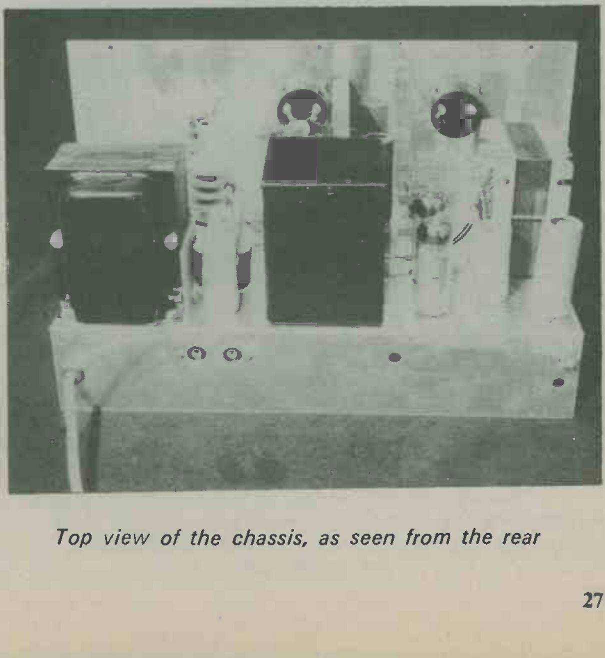
HC25U crystals, the other holder being a 3-socket type taking larger crystals with either ½ in. or ¾ in. pin spacing. A few other small holes are also needed, as indicated.

Under the chassis, holes are required for the under-chassis controls, the 2-way external control socket, the microphone input socket and the v.f.o. input socket. The author used a phono socket for the v.f.o. input. The microphone input socket and aerial output socket (fitted later) were both standard 75Ω coaxial types.

With the ease used here, the lower edge of the panel must project ½ in. below the chassis. The chassis and panel are eventually fixed together by the mounting bush nuts of the under-chassis controls. Correct matching of holes can be assured by marking out the panel through the holes in the chassis runner.

Also required in the panel are holes for the meters and for VC2 and VC3,4, as illustrated in the photographs and Fig. 3. If VC2 and VC3,4 are the types specified in the Components List published last month they are mounted by screws passing through the panel into the tapped holes provided.

The vertical screen shown in Fig. 3 can also be fitted now. This was cut from a Home Radio 'Universal



Top view of the chassis, as seen from the rear

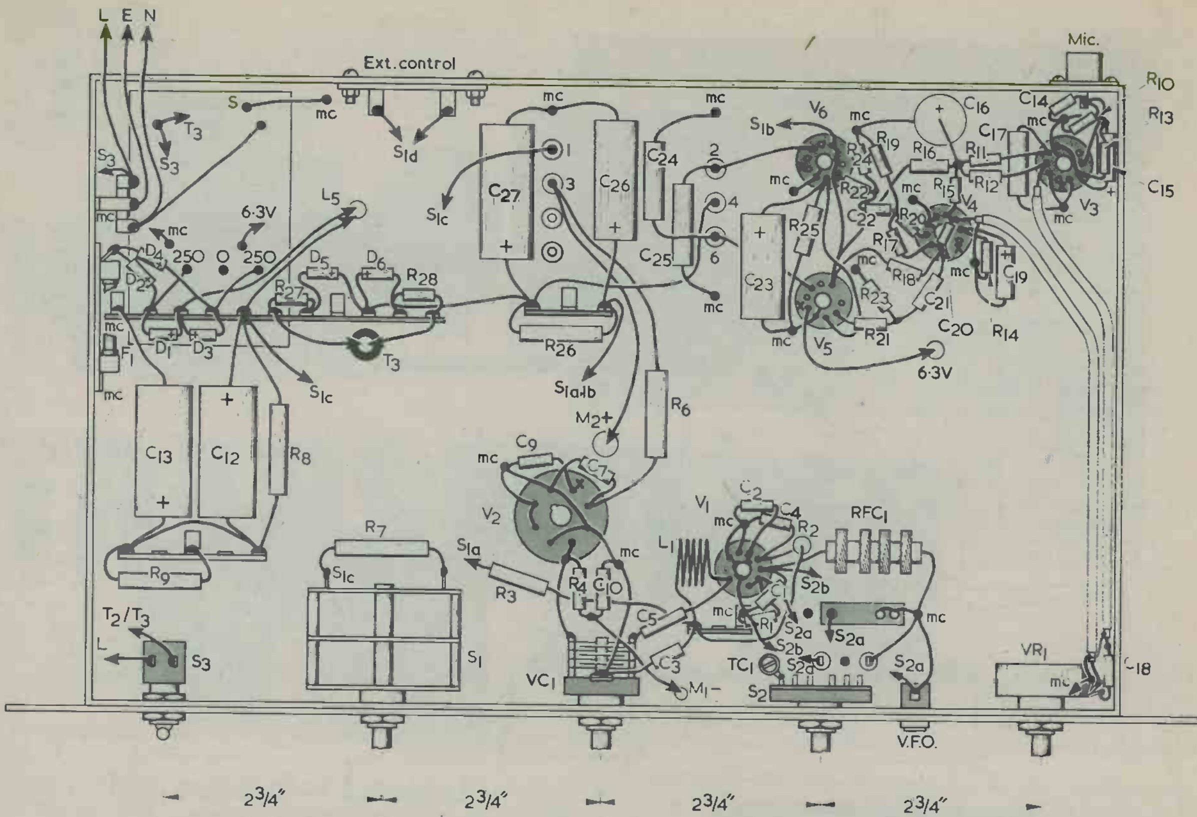
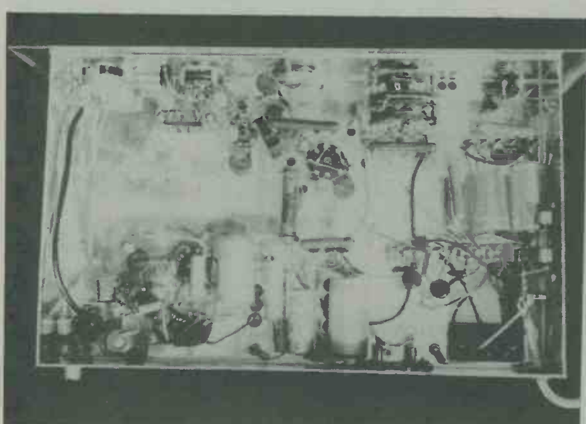


Fig. 4. Wiring below the chassis. The text should be consulted with respect to transformer connections

Chassis' side measuring 4 by 5 in. and, when fitted, is 4 in. high and extends back from the front panel by approximately 4½ in. This screen separates the oscillator and the p.a. stage, and also makes the panel more rigid when the equipment is out of the case.



Quite a number of components appear under the chassis, but there is room for these to be spaced out comfortably

WIRING

Most of the wiring details can be seen from the diagrams, but a few further notes need to be made.

The heater current requirements for V1 and V2 total 2 amps, and the heaters of these two valves are supplied by the 6.3 volt secondary of T2. The heater current for V3 to V6 similarly totals 2 amps, and these heaters are supplied by the 6.3 volt secondary of T3. The non-earthy 6.3 volt wiring runs against the chassis underside to the valveholder tags marked 'X' in Fig. 4. Any spare heater secondaries which may be available are unused.

The connections to transformers T1, T2 and T3 shown in the diagrams apply to the particular transformers employed by the author. If the transformer used for T2 has its tags above the chassis, then the leads to these tags pass through suitably positioned holes fitted with grommets. If either mains transformer has a screen tag, this connects to chassis. Such a connection is shown at T2, where the tag marked 'S' is wired to chassis.

The 3-core mains wire is terminated at a 3-way tagstrip, as in Fig. 4. The neutral lead connects to the 'OV' tag of the primaries of T2 and T3. The live wire connects, via on-off switch S3, to the appropriate primary voltage tap (normally 240 volts) on T2 and T3. The mains earth lead connects to chassis. The mains wire should be suitably anchored inside the chassis.

The rectifier wiring to T2 h.t. secondary can be seen in Fig. 4. Note that the h.t. secondary centre-tap is *not* used. Mount the rectifiers by their lead-outs. The negative lead-outs of D2 and D4 connect to the fuse, the other tag of which is returned to chassis. The positive lead-outs of D1 and D3 connect to the smoothing choke, L5. C12 and C13 are in series, supported by tagstrips, with R8 and R9 in parallel. If C12 is housed in a non-insulated metal can, this must not touch the chassis. Nor must it touch C13 if this is similarly in a non-insulated metal can.

The h.t. secondary centre-tap of T3 connects to chassis above the chassis surface. The two leads from the outside ends of the h.t. secondary pass through the grommet adjacent to T2, and then connect to R27 and R28 on the tagstrip shown. R27 and R28 then connect to D5 and D6, and these in turn connect to C27. Remember that h.t. remains permanently on the modulator output anodes.

In the audio section, grid and anode leads are kept close to chassis, especially in the earlier stages. The long leads to VR1 are screened, the braiding being earthed to the chassis. The pairs of resistors R18 and R19, R21 and R22, and R23 and R24, should be approximately matched in value by checking from a batch with an ohmmeter or by fitting 5% components here. It is not quite so important for R21 and R22 to be closely matched, although this assists in providing circuit symmetry.

All r.f. connections around the oscillator, V1, should be short and direct. The wiring to switch S2 is shown in Fig. 5. Before making connections here, ascertain with an ohmmeter the three outside contact tags corresponding to each centre tag, as their relative positioning may vary with some switches from that shown in the diagram. If a 2-pole 3-way switch cannot be obtained, a 4-pole 3-way switch may be used, with no connections made to two of the poles. One tag of the trimmer, TC1, is soldered to one of the outer switch tags. A tagstrip adjacent to the valveholder holds one end of coil L1, and C3 is wired directly between L1 and the moving vanes tag of VC1.

The valveholder for V2 is mounted under the chassis. Extremely short connections should be made to its tags. The earthing leads are connected as shown in Fig. 4 using stout tinned copper wire, this being soldered well down the valveholder tags and not at the tag ends. The grid lead to pin 5 should also be of stout wire and this is kept clear of the chassis as, similarly, are R4 and C5. A lead from the junction of R4 and C10 runs through the chassis to the negative terminal of meter M1. The positive terminal of the meter connects to chassis at the panel.

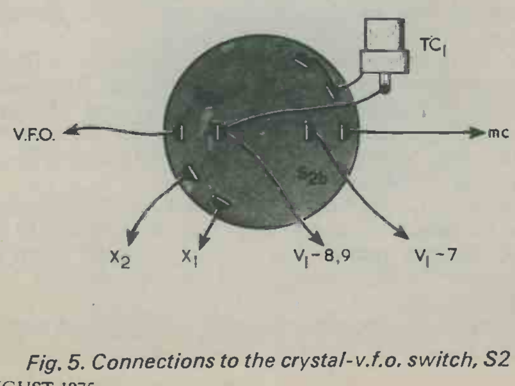


Fig. 5. Connections to the crystal-v.f.o. switch, S2

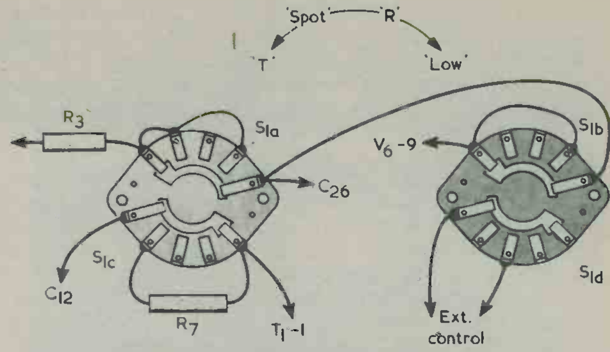


Fig. 6. The function switch, S1, has two wafers, these being wired as illustrated here

Above the chassis, the lead from R5 to the top cap of V2 is as short as possible, with just sufficient flexible wire to the top of RFC2 to allow the top cap connector to be fitted and removed. A 2-way tagstrip takes the lower end of RFC2 and capacitor C8. A wire from the junction of RFC2 and C8 runs along the chassis then up to the negative terminal of meter M2. A wire from the positive terminal of this meter runs through one of the holes around V2 valveholder to tag 3 of the modulator transformer, T1. As is shown in Fig. 3, a stout tinned copper wire runs from the frame of VC3,4 to the rotor tag of VC2 and from here to the 'MC' tag at V2 valveholder. A piece of scrap metal bolted to VC3,4 carries the aerial coaxial socket.

Because of the voltages at its contacts, switch S1 should be a standard sized switch with two wafers, and not a miniature component. Connections to it are made as illustrated in Fig. 6. These connections may be checked through with an ohmmeter after wiring has been completed to ensure that they are correct. The panel should be marked with the switch functions, these being 'Low', 'Receive', 'Spot' and 'Transmit'.

In Figs. 3 and 4, connections to chassis are, with one exception, made by way of solder tags or the earthed tags of tagstrips at the points marked 'MC'. The tags are secured under component mounting bolts or nuts at the places indicated. The exception just mentioned is at VR1, where the chassis connection is to the metal frame of the potentiometer.

COIL DETAILS

For operation with the 28MHz band equipment described in the preceding articles, only 28MHz coils are required in the L1 and L2 positions. These inductors may, then, be fitted permanently. Both are self-supporting.

L1 consists of 6 turns of 18 s.w.g. enamelled wire. Its outside diameter is $\frac{7}{8}$ in. and its length is $\frac{5}{16}$ in. It is soldered directly between tag 1 of V1 valveholder and the tag of the adjacent tagstrip, as shown in Fig. 4.

L2 has 7 turns of 16 s.w.g. tinned copper wire, and is $\frac{7}{8}$ in. long with a diameter of $1\frac{3}{16}$ in. Its ends are just long enough to solder to the variable capacitors.

If different coils are wound, a check should be made to ensure that they cannot be tuned to the wrong harmonics of the crystal fitted.

L3 is 1 turn of insulated wire about 1 in. in diameter, and it is positioned such that the indicator bulb lights at moderate brilliance when the p.a. stage is tuned. The power consumed by this lamp is not really significant.

The anti-parasitic choke, L4, has 5 turns of 18 s.w.g. enamelled wire with an inside diameter of $\frac{3}{8}$ in. and a length of $\frac{5}{8}$ in. It is slipped over the body of R5 and soldered to the resistor lead-outs. One resistor lead-out is soldered to the top cap connector for V2 and the other has a length of flexible wire soldered to it. As already mentioned, these connections are kept short.

It will be apparent that the transmitter can be used on other bands by employing a suitable crystal or v.f.o. and changing L1 and L2 only. Details of alternative coils are given later.

OSCILLATOR TUNING

With 14MHz band crystals, multiplying by 2 gives the working frequency of the transmitter. As an example, a 14.25MHz crystal will give 28.5MHz. with 7MHz crystals the frequency is multiplied by 4. All 14MHz and 7MHz amateur band crystals will give a frequency which, when multiplied by 2 or 4, falls into the 28MHz band.

With a 14MHz crystal plugged in and selected by S2, and with S1 at 'Spot', tune VC1 for grid current in M1. This may well be too great, so VC1 is adjusted for a reading of about 2mA. The drive can be lowered by reducing the capcitance of TC1. With an optimum adjustment of TC1, over 5mA grid drive was obtainable, so even sluggish crystals should work satisfactorily in the transmitter. It is because it provides such an ample drive that V1 is operated with the reduced voltage which is given by R3.

If it is intended to use only 7MHz or lower frequency crystals, TC1 can be changed for a 22pF silvered mica fixed capacitor, or a 30pF trimmer, with C1 being increased to 220pF silvered mica.

The transmitter is never switched to either 'Low' or normal transmission until M1 is indicating a grid current of approximately 2mA.

P.A. TUNING

An artificial load consisting of a 25 watt or 40 watt domestic mains lamp can be plugged into the aerial socket for initial tests. After tuning VC1 for grid current as just described, set VC3,4 to full capacitance and switch S1 to 'Low'. Tune VC2 for a *dip* in current in M2. The capacitance of VC3,4 is then reduced, with VC2 being re-adjusted to maintain the dip in current shown by M2. As the loading is increased by the reduction of capacitance in VC3,4, the current taken at the dip will rise. Provided that p.a. tuning is taking place in this manner, S1 can be set to 'Transmit' and the loading adjusted for a reading of about 75mA in M2, whereupon the artificial load bulb should be well lit. Grid tuning can then also be checked, to set grid current correctly. In no circumstance must the p.a. be left off-tune with a full h.t. input, as excess power is then dissipated in the p.a. valve itself.

If an oscilloscope is available this can be used to check modulation. If not, a receiver can be employed. Its aerial should be removed and its r.f. and i.f. gain controls turned back. It is then tuned in to the transmitter, and VR1 is adjusted until speech sounds clear and full. If the receiver has a loudspeaker, take care that the sound from this does not reach the transmitter microphone or there will be acoustic feedback and howling. The super-regenerative receiver described in the third article in this series may also be used to monitor modulation quality.

CASE PREPARATION

The metal case, when this is as used by the author, is modified to provide extra ventilation, and is also fitted with a hinged lid.

First, cut out nine holes of about 1 in. diameter in the case bottom. These are distributed in three rows of three holes each. Then fit four rubber feet about $\frac{7}{8}$ in. high at the corners, to allow cool air to flow to the holes.

At the back, eight holes of $\frac{3}{4}$ in. diameter are cut in a row $1\frac{1}{2}$ in. from the case top. The coaxial aerial lead is passed through the end hole at the right to reach the aerial socket. A 1 in. hole is cut level with the microphone socket on the chassis. Two $1\frac{3}{4}$ in. holes are cut side by side level with the mains lead entry point. The metal between these holes is then cut away, giving a slot through which the mains plug can pass.

At the top, carefully mark out a rectangle measuring 12 by $6\frac{1}{2}$ in., this being 1 in. from the front of the case and central along its width. Drill enough small holes closely together to enable a small thin saw blade to be inserted, and cut the rectangle out completely. After cleaning up its edges, this becomes the lid. Obtain two strips, 7 by 1 in., of any suitable metal, and bolt these to the case top underside along the rectangle $6\frac{1}{2}$ in. sides, with $\frac{1}{4}$ in. projecting to support the lid when closed. Screw on a 12 in. hinge (available in metal or plastic from most 'do-it-yourself' shops) at the rear of the rectangle. Finally, fit the lid with a small knob or terminal near the front so that it can be raised.

OTHER BANDS

For operation on other bands, coils L1 and L2 can be wound in the following manner.

15 metres. For 15 metre working, L1 has 12 turns of 24 s.w.g. enamelled wire wound side by side on a $\frac{7}{16}$ in. diameter former. L2 is self-supporting and consists of 8 turns of 16 s.w.g. tinned copper wire with an outside diameter of $1\frac{1}{8}$ in. and a length of 1in.

20 metres. For this band, L1 requires 25 turns of 24 s.w.g. enamelled wire wound side by side on a $\frac{7}{16}$ in. diameter former. L2 is again self-supporting and consists of 11 turns of 16 s.w.g. tinned copper wire with an outside diameter of $1\frac{1}{8}$ in. and a length of $1\frac{1}{8}$ in.

40 metres. Here, L1 has 30 turns of 24 s.w.g. enamelled wire wound side by side on a $\frac{1}{2}$ in. diameter former with dust core. L2 comprises 25 turns of 18 s.w.g. enamelled wire occupying $1\frac{1}{2}$ in. on a $\frac{7}{8}$ in. diameter former.

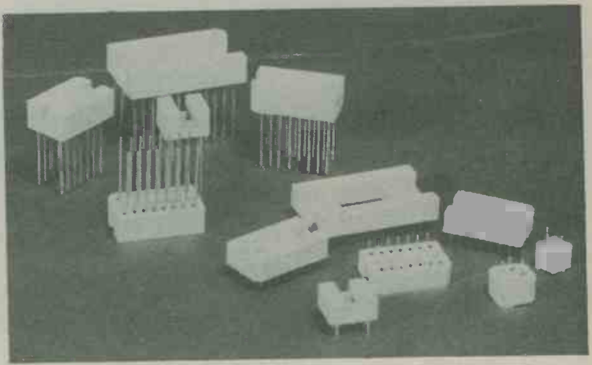
80 metres. For 80 metres, L1 consists of a Denco Miniature Dual Purpose Coil, valve usage, Red Range 2, with the small winding removed, and 28 turns removed from the remaining winding. L2 has 32 turns of 18 s.w.g. enamelled wire spaced to occupy $2\frac{1}{4}$ in. on a $1\frac{3}{8}$ in. diameter former.

160 metres. On this band, L1 is a Denco Miniature Dual Purpose Coil, valve usage, Blue Range 2, with the small winding removed. L2 consists of 70 turns of 24 s.w.g. enamelled wire wound side by side on a 1 in. diameter former.

All these coils permit operation into 75Ω and similar loads. ■

Trade News . . .

VERO I.C. SOCKETS



The heart of the Vero Socket is the Dual Leaf Wiping Contact which makes contact with both of the wide flat surfaces of I.C. Leads. This provides considerably greater surface contact for positive electrical connection than I.C. Sockets which mate with the narrow edge of I.C. Leads.

To further improve the quality of the Vero Sockets received by customers they are all individually tested for continuity and contact performance before packing. A high quality pack then ensures the sockets reach the customer undamaged and they retain their good performance characteristics.

8, 14, 16 and 24 way Sockets are now available in tin plated, gold plated, flow solder and mini wrap styles.

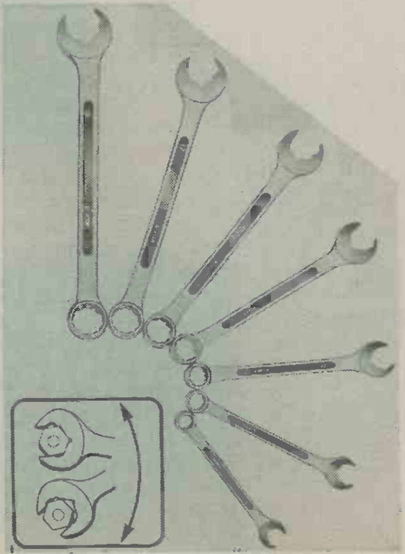
COMPONENT STORAGE

One of the minor problems which besets the home constructor is that of finding storage for small components including, in particular, transistors and integrated circuits. The idea of just throwing everything into the odd cardboard box cannot be countenanced these days, and something which enables different transistors and integrated circuits to be stored away according to type number or function is well-nigh essential.

We have just seen some very neat rectangular transparent plastic boxes which seem to provide all the answers here. Measuring approximately $1\frac{3}{4}$ by $1\frac{1}{2}$ by $\frac{3}{4}$in. deep, these have a sliding lid which clicks into position when pushed fully home. They are just the job for holding transistors and integrated circuits, as well as small resistors, capacitors and, of course, nuts and bolts. The fact that the boxes are transparent means that you don't necessarily have to stick labels on them. You can see what's inside simply by looking through the transparent sides or top.

The boxes are available from The Radio Shack, 161 St. Johns Hill, Battersea, London, SW11, and they could also lend themselves to use as attractive housings for small constructional projects.

THUNDER V-CUT SPANNERS



Thunder Screw Anchors Ltd., of the Industrial Estate, Southwater, Horsham, Sussex RH13 7HQ, have introduced a new design in combination spanners which enables the operator to use the open end of the spanner in a ratchet action. The nut is tightened as far as space permits, the spanner is then slipped back to its original position without removing it from the nut, then further torque is applied. The ratchet type action makes the spanner easier and quicker to use.

They are made from chrome vanadium steel and are available in seven metric sizes (10mm – 19mm) and seven A.F. sizes ($\frac{3}{8}''$ – $\frac{3}{4}''$). They are packed individually or available in a wallet of seven. For resale display a unit is available holding six of each size of spanner. Prices range from £0.64 each (excl. VAT) to £1.10 each (excl. VAT). A complete set of seven £6.22 (excl. VAT). Delivery from stock.

INTEGRAT
SIGNAL G

Pa

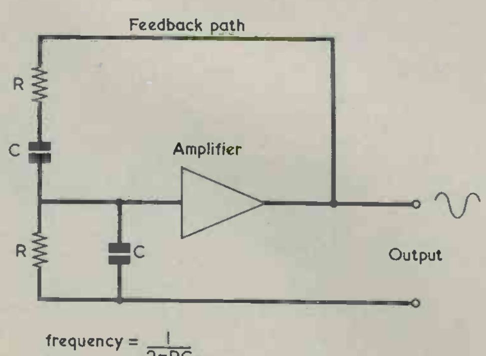
By Joh

Employing a recently introduce generator offers square wave, outputs from 10Hz to 1MHz. Con issue, and methods of calibration concluding

ANYBODY WISHING TO TAKE UP ELECTRONICS SERIOUSLY soon feels the need for some items of test gear. An item which can be built very easily by the home constructor is a low frequency signal generator, and many designs have been published. These are frequently based on the Wien Bridge principle using circuits similar to that shown in Fig. 1. The amplifier may be built either from discrete transistors or from a suitable operational amplifier, and it produces a sine wave which has then to be passed through a suitable squaring circuit should a square wave be required. Typical drawbacks with circuits of this nature are that they require ganged potentiometers, and that the scale is non-linear and so will be cramped towards one end. Further, two sets of expensive close tolerance capacitors are required and the oscillator frequency can vary both with temperature and supply voltage fluctuations.

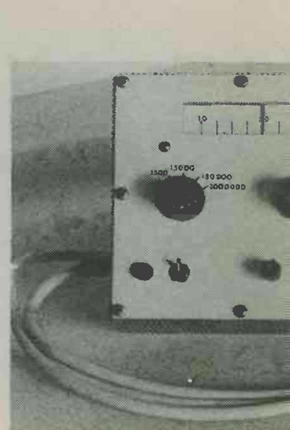
8038 I.C.

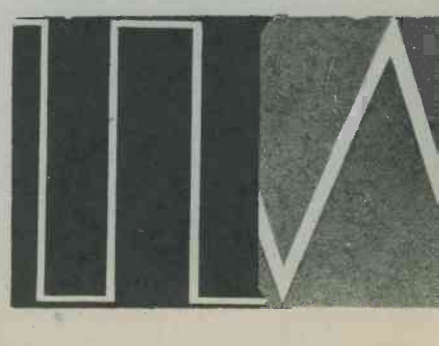
A relatively new integrated circuit, the 8038 Waveform Generator, can be used to overcome these problems and provide the basis for a very simple, yet versatile, signal generator. This is not only inherently stable but offers a frequency range from 0.001Hz to over 1MHz. The 8038 is available from Ambit International, 37 High Street, Brentwood, Essex, CM14 4RH.



$$\text{frequency} = \frac{1}{2\pi RC}$$

Fig. 1. A simple RC oscillator, commonly used for signal generator purposes



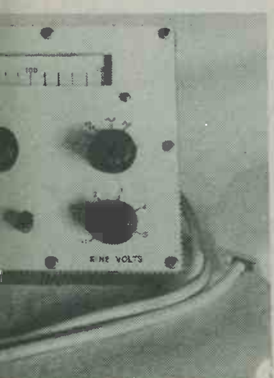


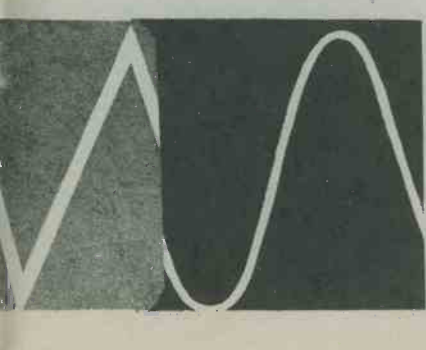
ED CIRCUIT
ENERATOR

t 1

n Lewis

d integrated circuit, this signal triangular wave and sine wave tructional details are given in this will be described in next month's article.





A functional diagram for the i.c. can be seen in Fig. 2. Internally it contains over 50 transistors and 40 resistors on its chip to fulfil the functions shown. The two comparators sense the charging and discharging potential differences across the external capacitor, C. Comparator 1 is set to respond to a potential level of $\frac{2}{3}$ Vcc whilst Comparator 2 responds to $\frac{1}{3}$ Vcc. As the capacitor charges up through Current Source 1 so the voltage across it increases uniformly until it reaches a value of $\frac{2}{3}$ Vcc. At this point Comparator 1 triggers, causing the flip-flop to change state and allowing the capacitor to start discharging through Current Source 2. The current in Current Source 2 is normally twice that in Current Source 1, with the result that the effective discharge current is the same as the charge current.

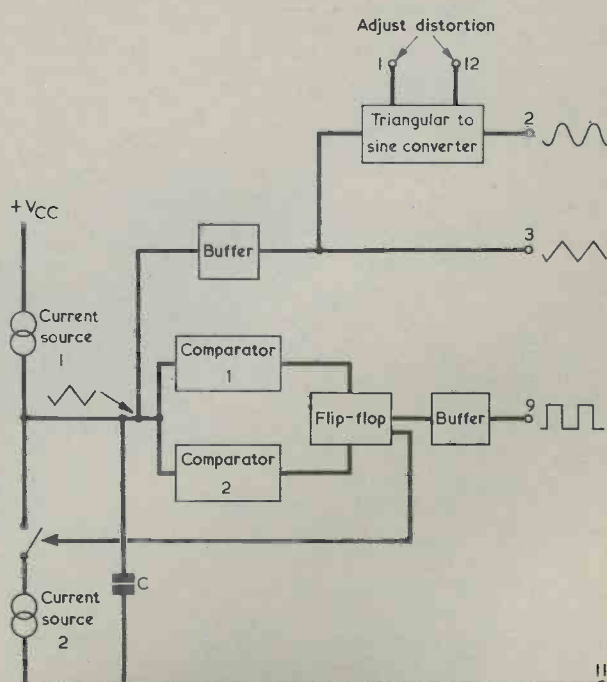


Fig. 2. Simplified functional diagram for the 8038 waveform generator

When the potential difference across the capacitor reaches $\frac{1}{3}$ Vcc Comparator 2 responds, the flip-flop changes state once more and the capacitor begins to re-charge through Current Source 1. The cycle will repeat itself, the frequency of operation obviously depending on the values of the capacitor and the charge and discharge currents. Note that the supply voltage does not enter into this calculation since the comparators are set to a certain proportion of Vcc and hence the output frequency remains constant even though the supply voltage may change. The quoted typical figure is 0.05% per volt change for frequency drift due to supply voltage variations, with a typical frequency drift due to temperature changes of 50 parts per million per °C.

From the diagram it will be seen that two waveforms are available, a square wave from the flip-flop output and a triangular waveform across the capacitor. These waveforms are fed to buffer amplifiers and are then available at pins 9 and 3 respectively. The triangular wave is also fed into a non-linear network of 16 transistors which produce a sine wave at pin 2. The amount of distortion on this sine wave can be adjusted externally by potentiometers connected to pins 1 and 12; by careful adjustment one can bring the distortion of the sine wave to less than 0.5%. However, at frequencies above some 10kHz the distortion starts to increase, rising to about 12% at 1MHz. It will also be found that there are 'blips' on the sine wave which are due to internal switching transients.

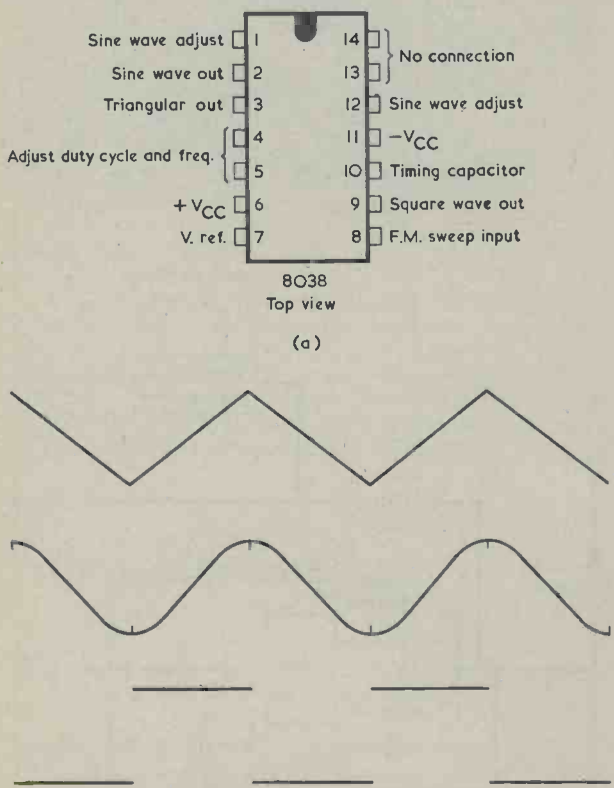


Fig. 3 (a). Pin functions for the waveform generator
(b). The appearance of the triangular, sine and square waves produced by the 8038

The charge and discharge currents, and hence the frequency of oscillation, can be varied by two external resistors, RA and RB, connected between the positive supply rail and pins 4 and 5 of the integrated circuit. If a reference voltage of 0.8 Vcc is applied to pin 8 of the i.c. and if RA and RB are equal, then oscillator frequency in Hz is equal to $\frac{0.3}{RC}$, where R is RA or RB. (The connections to pins 4, 5 and 8 are not shown in the simplified diagram of Fig. 2.) This arrangement gives a square wave having a mark-space ratio of 1:1 and symmetrical sine and triangular waves. If RA and RB are not equal the charge time is not the same as the discharge time, with the result that a square wave of a different mark-space ratio is obtained together with non-symmetrical sine and triangular waves. Also, the equation for frequency becomes more complicated.

The reference voltage of 0.8 Vcc just mentioned is available at pin 7 of the i.c. and for fixed frequency operation this pin is connected direct to pin 8. If the voltage on pin 8 is varied, between Vcc and $\frac{2}{3}$ Vcc, the output frequency can be swept over a theoretical range of 1,000:1. It is possible to frequency modulate the output frequency by way of this pin.

Fig. 3 (a) gives details of the pin assignments for the 8038, whilst Fig. 3 (b) shows typical output waveforms. Note the 'blips' at the sine wave peaks.

PROTOTYPE CIRCUIT

The circuit of the prototype signal generator appears in Fig. 4. The power supply section is a conventional dual voltage supply using zener diodes and transistors which provides one rail that is positive of earth and another rail that is negative of earth. This arrangement was chosen since a dual supply helps to reduce overall distortion and keeps the current flowing through RA and RB (which now appears as VR3 and VR4) constant, thereby assisting further in producing a good waveform. The 8038 is connected across the positive and negative rails and the various outputs from pins 2, 3 and 9 are taken to S2. This switch selects the required waveform, which is then fed to TR3 connected as an emitter follower to give a final output at low impedance.

The frequency is partly determined by VR3, VR4 and C4 to C8, and it was decided to give these values which produce frequencies of 100Hz, 1kHz, etc., according to whichever capacitor is switched in, when pin 8 of the 8038 is at 0.8 Vcc. This assists in the process of calibration later. The capacitors are 0.33µF, 0.033µF, 0.0033µF, 330pF and 33pF. From the formula $\frac{0.3}{RC}$, a combination of 10kΩ and 0.33µF produces a frequency of 90.9Hz. For 0.033µF the frequency is 909Hz, and so on. If, however, the value of R is made 9.09kΩ then the frequency becomes 100Hz with the 0.33µF capacitor, 1kHz with the 0.033µF capacitor, and so on for the other capacitors. To achieve the desired value in R of 9.09kΩ, VR3 and VR4 are specified as trimpots. An advantage to using trimpots here is that they can both be set to exactly the same value with the aid of an ohmmeter and thereby cause a symmetrical output waveform to be produced. The required capcitor is switched into circuit by range switch S1.

The frequency is swept by VR5, which is the main frequency control, and it was decided to use a sweep

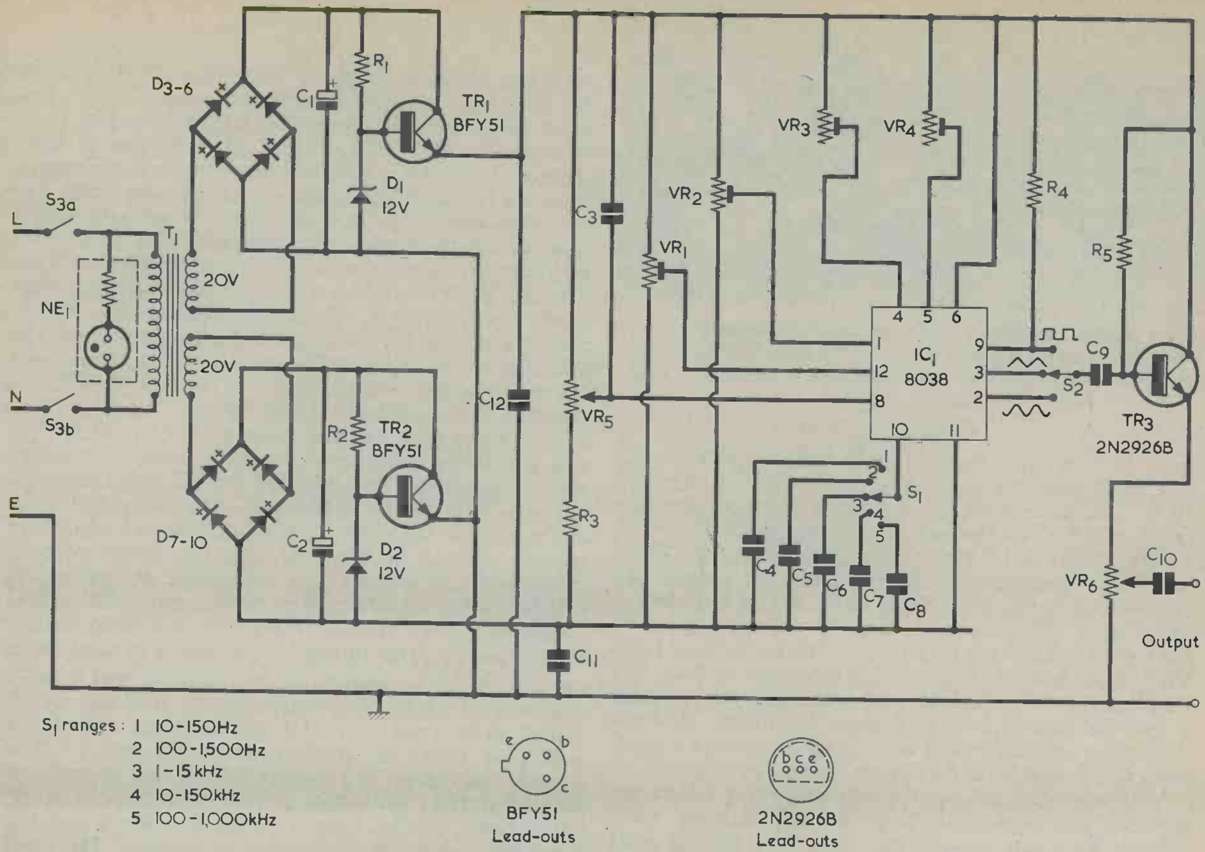


Fig. 4. Complete circuit of the i.c. signal generator

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)

R1	6.8kΩ
R2	6.8kΩ
R3	20kΩ
R4	10kΩ
R5	270kΩ
VR1	100kΩ potentiometer, miniature skeleton
VR2	100kΩ potentiometer, miniature skeleton
VR3	10kΩ potentiometer, miniature trimpot
VR4	10kΩ potentiometer, miniature trimpot
VR5	10kΩ potentiometer, wire-wound
VR6	5kΩ potentiometer, linear

Capacitors

C1	1,000μF electrolytic, 40 V. Wkg.
C2	1,000μF electrolytic, 40 V. Wkg.
C3	0.1μF
C4	0.33μF close tolerance
C5	0.033μF close tolerance
C6	3,300pF close tolerance
C7	330pF close tolerance
C8	33pF close tolerance
C9	0.1μF
C10	0.1μF
C11	0.1μF
C12	0.1μF

Semiconductors

IC1	8038
TR1	BFY51
TR2	BFY51
TR3	2N2926 Brown
D1	12 volt zener type BZY88/C12
D2	12 volt zener type BZY88/C12
D3-D10	1N4001

Transformer

T1	Mains transformer, secondaries 20V 150mA (3VA), 20V 150mA (3VA), miniature (R.S. Components)

Neon

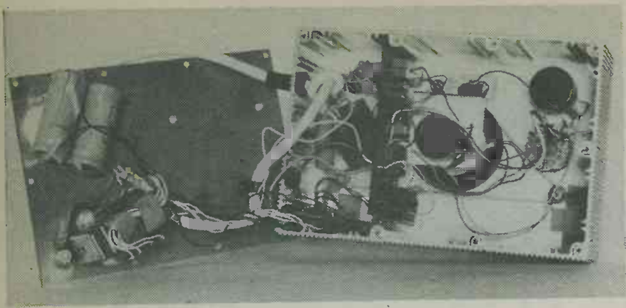
NE1	250 volt neon assembly, sub-miniature (R.S. Components)

Switches

S1	1-pole 5-way rotary
S2	1-pole 3-way rotary
S3	d.p.s.t. toggle

Miscellaneous

Case (see text)
2 terminals, 2 mm. (R.S. Components)
4 knobs
Veroboard, 0.1 in. matrix
Pulley or tuning drum (see text)
3 core mains lead
2 TO5 heat sinks
Nylon cord
4 rubber feet.



The mains transformer and reservoir capacitors are mounted on the rear panel of the box. In this view the output terminals appear at the top and the tuning scale at the bottom

ratio of 1 to 15, with the 100Hz calibration frequency just mentioned corresponding to 10. Thus, Range 1 is 10 to 150Hz, with 100Hz appearing when pin 8 of the i.c. is at 0.8 Vcc. The subsequent ranges are 100Hz to 1.5kHz, 1kHz to 15kHz, 10kHz to 150kHz and 100kHz to 1MHz. Frequencies above 1MHz are outside the specified performance of the 8038. R3 is included in series with VR5 to ensure that the voltage applied to pin 8 does not fall below $\frac{2}{3}$ Vcc. When the voltage from VR5 slider is at its highest, i.e. the same as Vcc, the frequency is at its lowest, and when the voltage is at $\frac{2}{3}$ Vcc the output is at its highest frequency. Between these two extremes there is a linear frequency adjustment which enables a truly linear scale to be obtained.

VR1 and VR2 are pre-set potentiometers which are adjusted for minimum distortion of the sine wave output. VR6 acts as a simple attenuator for the final output.

CONSTRUCTION

Layout is not at all critical, and constructors may employ any reasonable method of assembly which they prefer. The author's unit is built in a Verobox measuring 158 mm. wide by 108 mm. high by 50 mm. deep. This has the part number EVB/F/100–150/50, and can be obtained, in case of difficulty, direct from Vero Electronics Ltd., Industrial Estate, Chandlers Ford, Hampshire, SO5 3ZR. Fig. 5 gives details of front panel drilling. It will be noted that there is a rectangular aperture behind which is affixed a frequency scale. The two 6BA clear holes are for screws fitted with collars over which the scale cord can pass. The panel hole positioning is applicable for small or miniature controls. The two rotary switches employed by the author were made up from R.S. Components Miniature Maka-Switch kits, that for S1 employing a 2-pole 6-way wafer and that for S2 a 4-pole 3-way wafer. No connections are made to the unused poles. S1 was an R.S. Components sub-miniature toggle switch. Another R.S. Components part was the neon assembly, NE1. This was a sub-miniature neon assembly incorporating its own series resistor and intended for 250 volt operation.

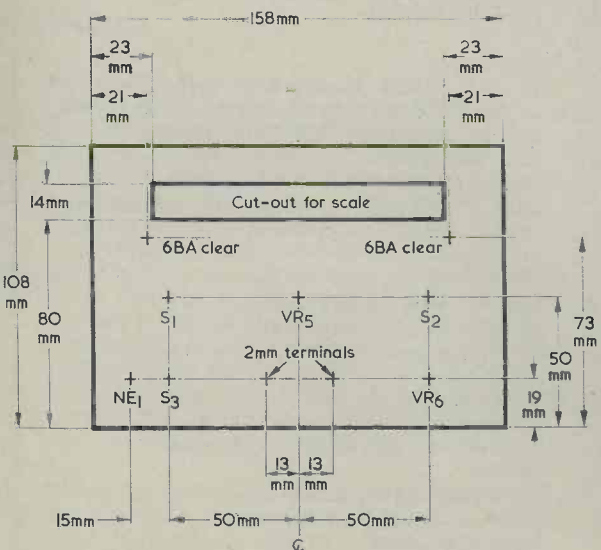
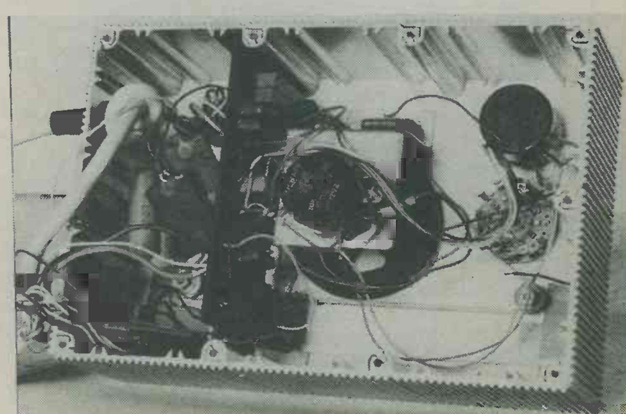


Fig. 5. Drilling details for the front panel, showing hole centres and the rectangular cut-out for the scale

Fig. 6 gives details of the scale cord assembly. In the author's case the pulley affixed to the potentiometer spindle was a 2 in. diameter Meccano pulley with its centre bush drilled out, this then being secured to the spindle with Araldite. An easier approach would consist of using a tuning Drum (Home Radio) instead of the pulley. The tuning drum has a central bush capable of being secured to a $\frac{1}{4}$ in. spindle, and it has a diameter of $1\frac{3}{4}$ in. The scale cord is standard nylon tuning drive cord and it is passed twice round the pulley or drum on the potentiometer spindle. The bracket on which the potentiometer is mounted is secured to the front panel at two holes corresponding with those for the output terminals. Mounting the terminals also holds the bracket in position. The scale is fixed at its two ends to the rear of the front panel with adhesive, suitable packing pieces being employed to space it back. The pointer is simply a piece of wire crimped onto the cord.

The two sets of power supply rectifiers are assembled on the Veroboard panel shown in Fig. 7. This has a matrix of 0.1 in. Individual holes are not shown in the diagram as there is plenty of space for the components and precise positioning of these is unimportant. The copper strips should be cut at the points marked with crosses. Similarly, holes are not indicated in the Vero-



A closer look inside the case. Part of the pulley fitted to VR5 spindle and the scale drive assembly can also be seen

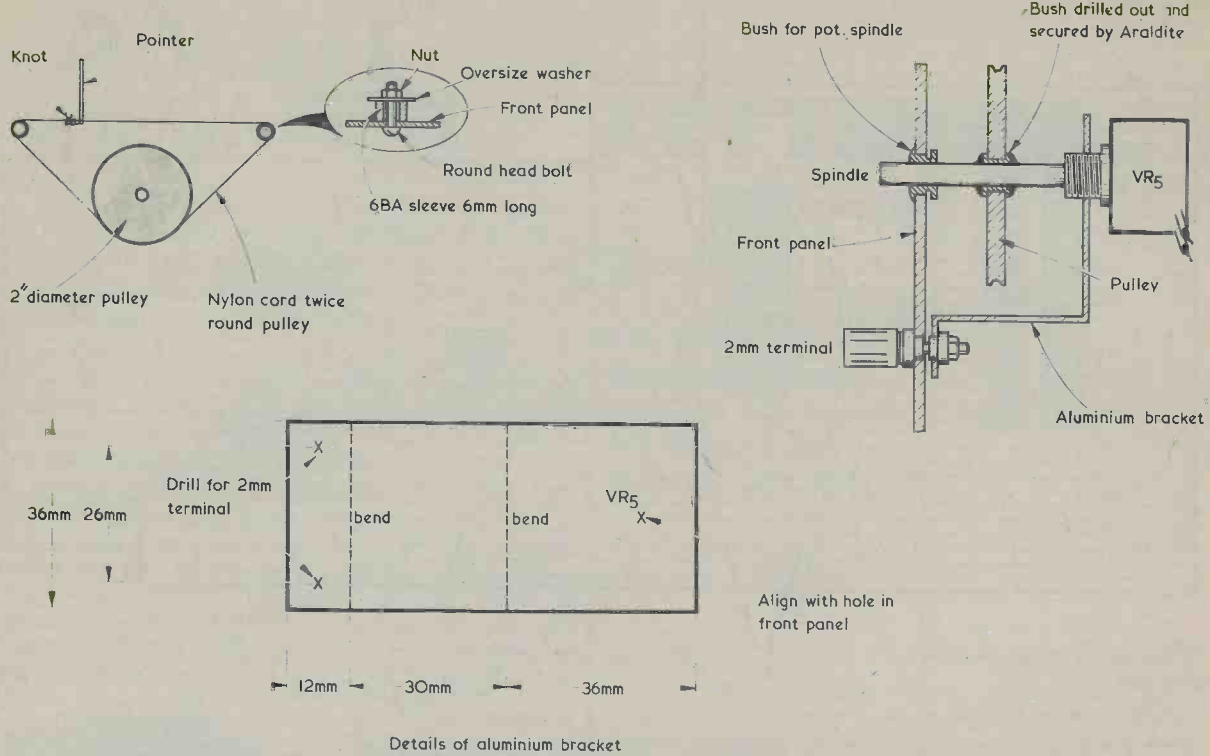


Fig. 6. The spindle of VR5 is coupled to the scale pointer. Details of the scale assembly and the bracket on which VR5 is mounted are given here

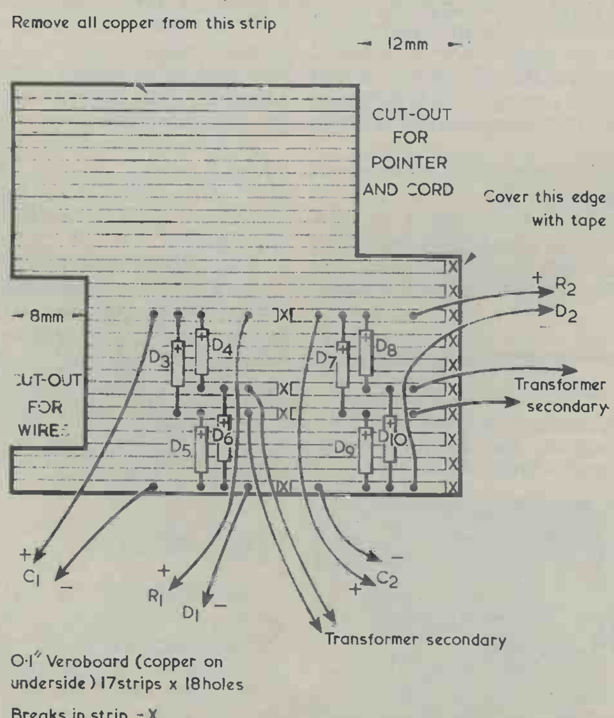


Fig. 7. The eight rectifier diodes are assembled on a small piece of Veroboard, as shown here. This view is of the component side of the board

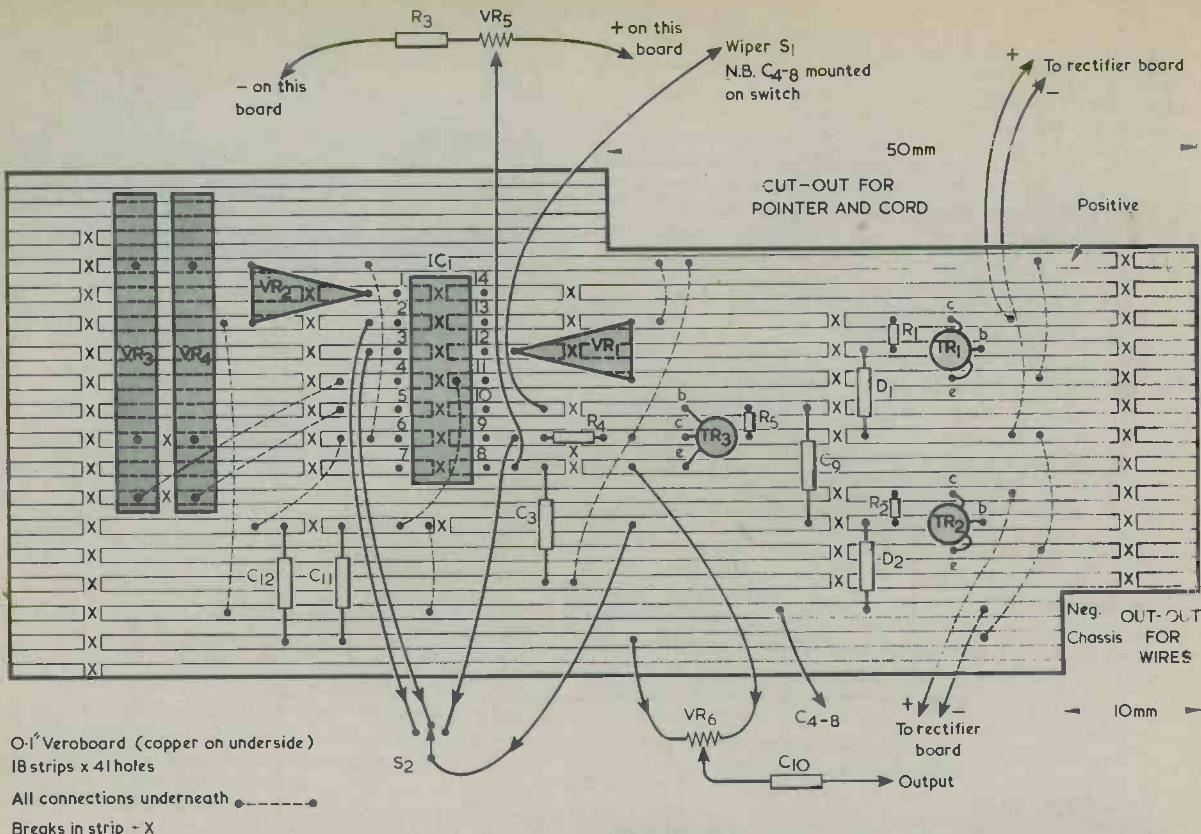


Fig. 8. The remaining small parts are fitted to a second piece of Veroboard. Again, the view is of the component side of the board

board assembly of Fig. 8. This Veroboard is, once again, of 0.1 in. matrix and strips are cut as indicated by the crosses. The two trimpots should be miniature types and it may be necessary to amend the Veroboard wiring to suit if their pins have different spacing to that shown in Fig. 8. TR1 and TR2 are fitted with TO5 heat sinks, these being the type H2 available from Henry's Radio, Ltd.

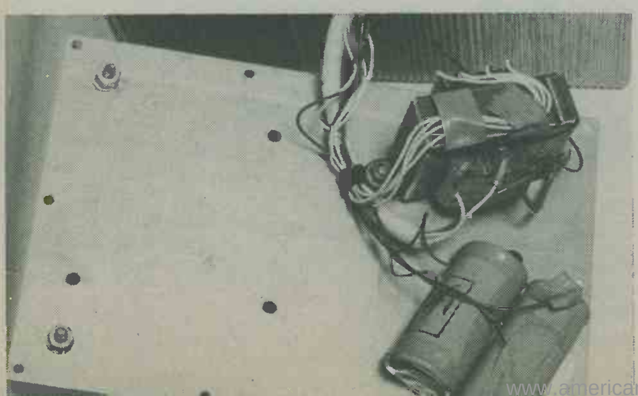
The large Veroboard panel is fitted, with the trimpots at the bottom, vertically between VR5 and S1, and the smaller board is positioned horizontally above the 6BA screw on the S1 side of the front panel. This board has one edge located in an internal Verobox groove. The other edge bears against the copper side of the larger board and an additional means of securing it may be devised, if this is considered desirable.

The mains transformer and the two reservoir capacitors, C1 and C2, are fitted to the rear panel of the case in positions which ensure that they will not interfere with the internal components when the rear panel is fitted in place.

A 3-core mains wire is required and its earth lead should connect to the metal case. All mains wiring and connections in the unit must, of course, have the insulation and clearance which are needed at mains voltages.

The capacitors C4 to C8 are soldered direct to the tags of S1. These should all be close tolerance components. This is easy to arrange so far as C6 to C8 are concerned, since all three can be 1% silvered mica. The author was able to select C4 and C5 from wider tolerance components. If necessary, C4 could consist of a 1μF capacitor and a 0.5μF capacitor in series, and C5 of a 0.1μF and a 0.05μF capacitor in series. Wider tolerance capacitors can, of course, be employed at the expense of some accuracy of frequency calibration.

The mains transformer is bolted to the rear panel. The two reservoir capacitors may be secured with a suitable clamp



NEXT MONTH

As is explained in next month's concluding article, setting up adjustments are required to VR3 and VR4 before they are finally soldered into circuit. Also, a modification may be required to the circuit incorporating VR1 and VR2 which results in these potentiometers being omitted. In consequence, the following article should be consulted before carrying out work involving these four potentiometers.

(*To be concluded*)

LETTERS...

The Editor,
Readers' Letters,
Radio & Electronics Constructor,
57 Maida Vale,
London, W9 1SN.

Dear Sir,

In the December issue of your magazine you were kind enough to insert in your "Can Anyone Help?" feature a request for information concerning a South African manufactured radiogram which I have and for which I required the circuit.

I have just received from a gentleman there a copy of the circuit required, and an offer of any further assistance that I may require.

These are a few lines to express my grateful thanks for your valuable assistance, as without the help of this gentleman my set is useless. It also shows the extent of the circulation of your valuable magazine.

Again thanking you for your assistance, which was, as you know, given free.

J. N. Shaw – Slough

Dear Sir,

About five years ago we formed a buying group among the small Electronic Component Retailers. The main object is to buy goods at cheaper prices by bulk buying, in addition, as we have no body to represent us over such thorny questions as V.A.T., we do this also. Our membership is at present twenty-five but for obvious reasons we would like to enlarge it. We have insufficient funds to advertise as our total revenue is derived from a modest £6 a year subscription.

I am confident that there are several hundreds who would join us if they knew we existed.

Would those interested please write to Alan Sproxton, c/o Home Radio (Components) Ltd., 240 London Road, Mitcham, Surrey CR4 3HD.

Thanking you in anticipation,

A. Sproxton – Mitcham

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times=GMT *Frequencies*=kHz

Now is the time for that late night and early morning (very early!) Latin American listening session, just before the summer ends and autumn commences. It is at this time of year that some of our best Dx log entries have been made.

It is probably true that most enthusiasts tend to favour the 60m band when Dxing for the LA's but a careful search over the 90m band may well result in even greater Dx rewards. A couple of good check points when ascertaining current conditions are **3325** for Radio Monogas, Venezuela, and **3375** for Radio Olinda, Pernambuco, Brazil. If these two stations are coming through at good signal strengths then that is the time to clap on the headphones and start operating. Of course, if you wish to be an unpopular member of the household you could use the speaker at 0200 or so!

Some of the LA stations on the 90m band being currently reported in the SWL press are – Radio Emisora Educacao Rural, Brazil on **2410**; Ondas Panamericanas, Venezuela on **3215**; La Voz del Napo, Ecuador, on **3280**; Action Radio, Guyana on **3290**; Radio Cultural, Guatemala on **3300**; Puerto la Cruz, Venezuela on **3365**; Cayenne, French Guyana on **3385**; Radio Zaracay, Ecuador on **3390** and Radio Universidad, Venezuela on **3395**.

Success on this band however is largely dependent on the selectivity of the receiver as commercial QRM abounds from end to end and this prerequisite will be in addition to the skill of the operator and the efficiency of the installation as a whole.

CURRENT SCHEDULES

● **NETHERLANDS**

"Radio Nederland", Hilversum, operate an External Service in English as follows – from 0200 to 0320 to North America on **6165**; from 0500 to 0620 to North America (West Coast) on **6165** and **9715**; from 0630 to 0750 to New Zealand on **11730**; from 0800 to 0920 to Australia and New Zealand on **9715**; from 0930 to 1050 to Europe on **5995, 6045** and **7210**; from 1400 to 1520 to Europe, South and Southeast Asia on **5955, 6045, 11740, 15415, 17810** and on **21480**; from 1830 to 1950 to Africa and Europe on **6020, 11730** and on **17700**; from 2000 to 2120 to West Europe on **11730**; from 2130 to 2250 to North America (not Sundays) on **9715** and **11730**.

● **AUSTRALIA**

"Radio Australia", Melbourne, presents an Overseas Service in English from 0100 to 0300 to North America on **15320** and **17795**; from 0400 to 0530 to Africa on **15290** and **17820**; from 0700 to 0845 (in simple English) to Papua, New Guinea, on **9760, 11825 and 11885**; from 0645 to 0745 to the U.K., Europe and the Pacific on **9570** and on **11765** from 0700; also from 0815 to 0830. From 1115 to 1245 to North America on **9580**.

● **SWEDEN**

"Radio Sweden", Stockholm, radiates in English from 0230 to 0300 to North America on **9695 and 11705**; from 1100 to 1130 to Europe and Africa on **9630** and **21690**; from 1230 to 1300 to Africa, the Far East and North America on **15275, 15310** and on **21690**; from 1400 to 1430 to North America and South Asia on **15240, 15310** and on **17770**; from 1600 to 1630 to Europe and the Middle East on **6065, 9520** and on **15240**; from 1830 to 1900 to Europe and Africa on **6065, 11790** and on **15240**; from 2030 to 2100 to Europe, Africa and the Middle East on **6065, 9605** and on **11790** and from 2300 to 2330 to Europe and North America on **6035, 9605** and on **11705**.

● **SEYCHELLES**

The "Far Eastern Broadcasting Association" (FEBA) Mahe, broadcasts to South Asia in English from 0600 to 0830 (Saturdays and Sundays) and from 0630 to 0830 (Mondays to Fridays) on **11915** and **15160**; from 1530 to 1645 on **11810, 11865** and **15325**. To the Middle East and Africa from 1745 to 1800 on Tuesdays and Wednesdays only on **11715** and **11865**.

● **PHILIPPINES**

The "Far Eastern Broadcasting Company", Manila, operate in English from 0600 to 1000 (Sundays only) to South East Asia and Australasia on **15440** and **21515**; from 0800 to 1000 (weekdays) on **11890** and **11920**, also on **9505** from 0800 to 0900. To South East Asia from 1100 to 1130 on **11855**; from 1245 to 1630 on **15440** and on **15300** from 1400; from 2330 to 0600 to South and South East Asia, Far East and Australasia on **9715** (from 0001 to 0100), **11855** (to 0001), **15440** (from 2330 to 2400, 0100 to 0600), **17810** (from 0001) and on **21515**.

● **PAKISTAN**

"Radio Pakistan", Karachi, schedules a World Service to the U.K. from 1915 to 2145 on **7085** and **9460** (1915 to 2145 in Urdu, 2045 to 2100 in Sylheti, 2100 to 2145 in English). A World Service programme entirely in Urdu is directed to the U.K. from 0830 to 1100 on **15110** and **17665**. A newscast read at slow speed is directed to West Europe from 1100 to 1115 on **15110** and **17665**. Note however that the actual frequencies of

Radio Pakistan are apt to vary from nominal.

● CHINA
"Radio Peking", Peking, presents a programme in English to Europe from 2030 to 2130 on **6410**, **6860**, **7590** and on **11675**; from 2130 to 2230 on **6860**, **9030** and on **11675**.

The Chinese Regional Services are of great interest to Dxers and the following information may assist in the logging of such transmissions.

Changsha, Hunan Provincial Service, from 0845 to 1620 and from 2105 to 0520 on Tuesdays and Fridays, from 2105 to 1620 (not Tuesdays and Fridays) on **4990** in Standard Chinese.

Kunming, Provincial Service No. 1, from 0920 to 1620 and from 2150 to 0600 (not Tuesdays and Sundays), from 2150 to 1620 (Tuesdays and Sundays) on **4760** in Standard Chinese.

Kunming, Provincial Service No. 2, from 1030 to 1605 and from 2155 to 0100 on **6937** in Standard Chinese and minority languages.

Kweiyang Provincial Service, from 0950 to 1605, 2115 to 0005 and from 0150 to 0620 on **3260** and on **7275** in Standard Chinese and Kweichow dialect.

● NORTH VIETNAM
Also of interest to Dxers are the following regional services –

Viet Bac, from 1130 to 1400 and from 2330 to 0200 on **3990**, **6810** and on **7237**.

Tay Bac, from 0930 to 1145, from 1200 to 1430 and from 0156 to 0400 on **4770**, **6333** and on **9645**. Note that all the regional service frequencies are subject to slight variations.

● SOUTH VIETNAM
Saigon Radio now radiates from 0400 to 1700 and from 2200 to 0300 on **4875**, **6165**, **7175**, **7245**, **9620** and on **9755**.

● CLANDESTINE
"Radio Pathet Lao" now has two networks. The first, in Laotion, operates from 0900 to 1500 on **4250**, **6200** and on **7310**; from 2230 to 0230 on **4250**, **6200** and on **7310**; from 0400 to 0600 on **4250**, **6200**, **7310** and on **8660**. The second network, in local languages (including French from 0045 to 0100) is from 1100 to 1415 and from 2300 to 0100 on **4600** and on **5100**.

AROUND THE DIAL
On the higher frequencies our log shows the following entries.

● NORWAY
Oslo at 1403 on **21730** with a programme devoted to news of local affairs, Norwegian North Sea oil and shipbuilding industries.

● SOUTH AFRICA
Johannesburg at 1410 on **21535** with pop records programme, YL announcer.

● ROUMANIA
Bucharest at 1942 on **7225**, news in English then talk about country life in Roumania.

● ITALY
Rome at 1935 on **7275** with identification, news of Italian domestic affairs then Italian/English language lesson.

● CHINA
Radio Peking at 1920 on the unlisted **6575** with programme in French, music and songs in the Chinese style.

● ISRAEL
Jerusalem at 2005 on **9815** with news in English of Israeli events and current foreign policy etc. Also heard in parallel on **12025**.

For the Dxer, the following recent loggings may be of some interest.

● CLANDESTINE
"Voice of the Free Yemeni South" at 1725 on a measured **9962**, OM with harangue in Arabic interspersed with local music. Schedule of this one is from 1630 to 2000 and the transmission is subject to jamming.

● RHODESIA
Gwelo at 1905 on **2425**, programme of light orchestral music, just audible at times. This is the General Service with an evening schedule from 1700 to 2200.

Gwelo at 1820 on **3396**, OM in English with a talk about composers and their music.

● PAKISTAN
Radio Pakistan at 1840 on **3329.5** (subject to nightly variations), local music, OM with songs, announcements with identification at 1859. Off suddenly at 1900 without National Anthem.

● RWANDA
Radio Rwanda, Kigali, at 1904 on **3330** (audible after Pakistan sign-off), OM in vernacular and local music heard through to 1024. This is the Home Service which has an afternoon/evening schedule from 1330 to 2100.

● CAPE VERDE IS.
Radio Clube Cabo Verde at 2044 on a measured **3886** (listed **3883**), OM in Portuguese announcing dance music records, Schedule 2000 to 2400, power is 5kW and the channel is subject to severe commercial QRM.

● CAMEROON
Radio Buea at 2050 on **3970**, typical African native music, songs by YL in vernacular.

● INDONESIA
Jakarta at 2200 on **4804.5**, upsetting all previous experience by still being audible on odd occasions around this time, OM with news after series of chimes.

● BURUNDI
Radio Cordac at 1918 on **4900**, YL with religious talk in French, OM with announcements at 1927, off suddenly, without National Anthem, at 1932.

● ANGOLA
Radio Clube do Huambo, at 1843 on **3345**, OM with talk in Portuguese. Schedule is from 1900 to 2100 and the power is 10kW.

● TANZANIA
Zanzibar at 1848 on **3339**, local orchestra with Arabic-type music, YL with songs. Announcements in Swahili and identification 1900. Schedule is from 1430 to 2000 and the power is10kW.

NEW MULITPLE TUNING DIODES

By J. B. Dance

Facts and figures on recently introduced varactor diodes having a very wide capacitance range.

VARICAP OR VARACTOR DIODES ARE WIDELY USED FOR tuning f.m. receivers, but up to the present time the only diodes suitable for tuning a.m. receivers have been rather expensive. For a.m. tuning it is necessary to have diodes with a capacitance swing of over 10:1, a maximum capacitance value of some hundreds of pF, a reasonably high Q factor and tight tolerances on the capacitance value at all voltages within the working range. The last requirement is difficult to meet.

The development and introduction by Motorola of a.m. tuning diodes is especially welcome, since it will facilitate the switched and remote tuning of a.m. receivers. In the past the f.m. section of f.m.-a.m. tuners has been tuned with a variable ganged capacitor, but the availability of the new diodes will enable a single potentiometer to be used for the varicap tuning of both the a.m. and f.m. bands.

THE MVAM-1

The MVAM-1 is a variable capacitance a.m. triple tuning diode which has recently been released. This device has a common cathode and three separate anodes in the 4 pin dual-in-line encapsulation shown in Fig. 1. Typical variation of capacitance value with applied voltage is shown in Fig. 2. The use of ion implantation techniques in the manufacturing process enables a guarantee to be given that the capacitance value of the three diodes in any one package will be matched to within ±1.5% throughout the whole of the working range (namely 1 volt to 25 volts).

The capacitance is between 400pF and 560pF at a reverse potential of 1 volt. The minimum capacitance swing is 15:1 over the bias range of 1 volt to 25 volts, but the typical swing is 26:1. The minimum Q factor is 150 at 1 volt and 1MHz, with a typical Q value of 575 increasing with applied voltage to over 1,000 at 4 volts and 4,000 at 20 volts.

The absolute maximum permissable reverse voltage (or minimum breakdown voltage) is 28 volts. The maximum reverse current is 0.15μA at 25 volts and 25°C, so the use of a 470kΩ series resistor will reduce the voltage across the diode by less than 0.1 volt. The temperature coefficient of capacitance is typically 435 parts per million per °C at 1 volt over the range —40°C to +85°C.

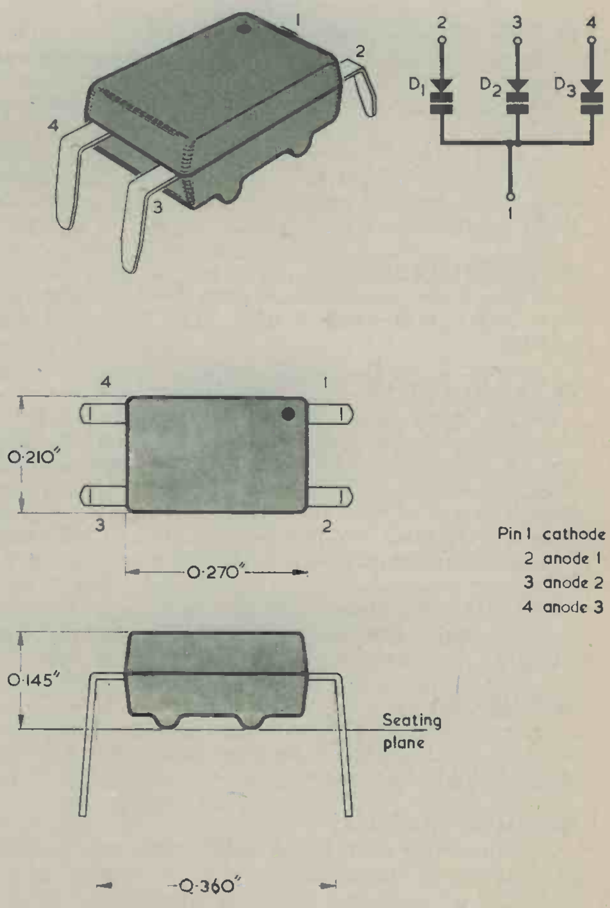


Fig. 1. Basic details of pin layout and appearance of the MVAM-1 triple tuning diode. The dimensions shown are typical

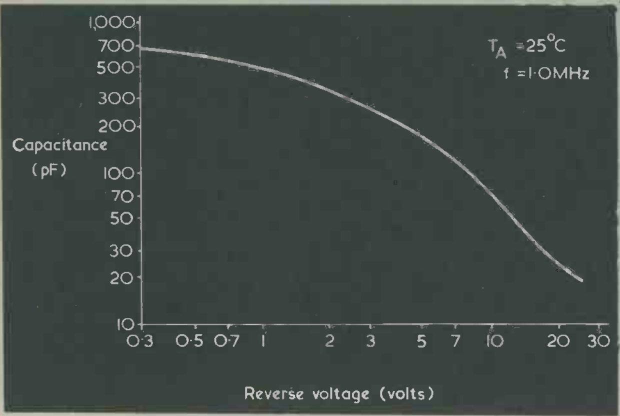


Fig. 2. Typical capacitance-voltage characteristic for an MVAM-1 diode

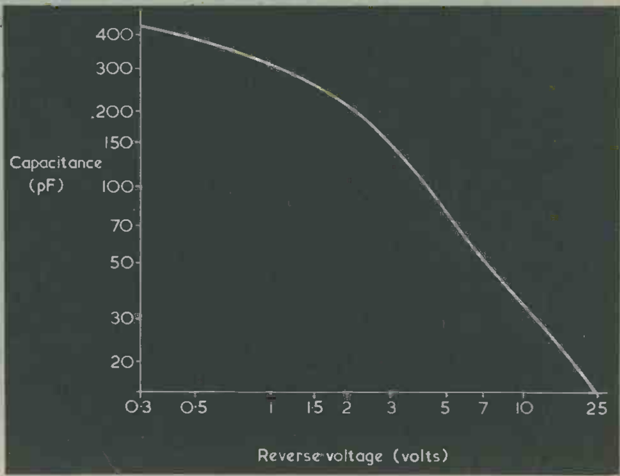


Fig. 3. Typical capacitance variation against tuning voltage for an MVAM-2 diode

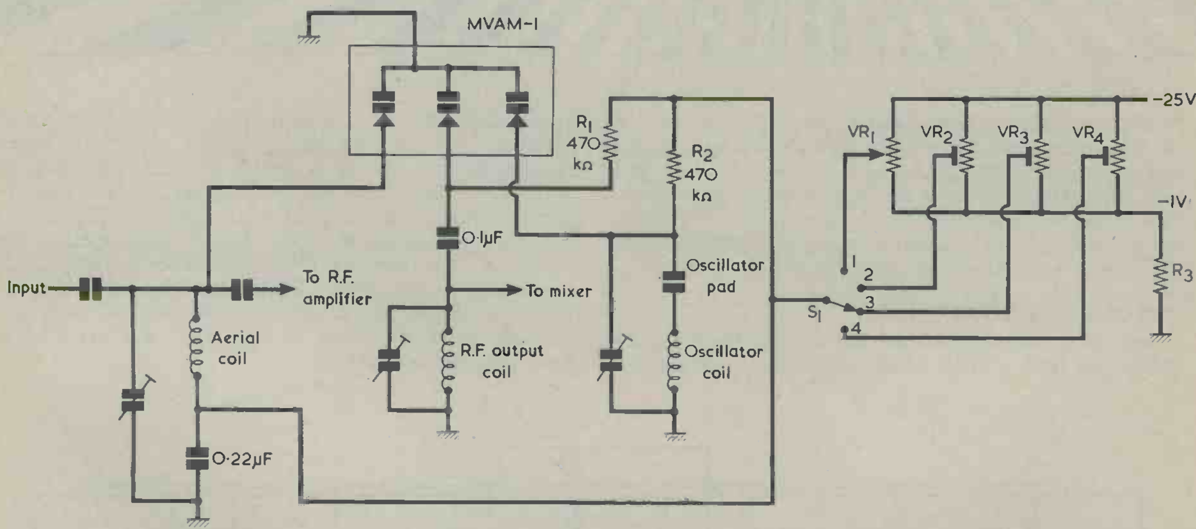


Fig. 4. Illustrating how the three diodes of the MVAM-1 may be coupled to the aerial, r.f. and oscillator tuned circuits of an a.m. receiver

THE MVAM-2

An even more recent device is the MVAM-2. This is a dual a.m. tuning diode in a TO92 encapsulation, the central lead being the common cathode. As shown in Fig. 3, the capacitance of each diode is somewhat lower than in the case of the MVAM-1. The capacitance swing has a minimum value of 18:1 for the range 1 volt to 25 volts, the two diodes of each diode being matched to within $\pm 1.5\%$ throughout the voltage range.

The MVAM-2 has a capacitance of 330pF $\pm 10\%$ at 1 volt. The minimum Q factor and the breakdown voltage are the same as for the MVAM-1. Both the MVAM-1 and the MVAM-2 are available from Ambit International, 37 High Street, Brentwood, Essex, CM14 4RH.

RECEIVER CIRCUIT

The MVAM-1 may be used in the basic type of aerial, r.f. and oscillator circuit shown in Fig. 4. The switch S1 selects the tuning voltage from that provided by one of the potentiometers. The writer has used a 100kΩ Beckman 'Helipot' for continuous coverage and a number of pre-set potentiometers for switched tuning. The continuous tuning is provided when switch S1 in the circuit is set to position 1, and the pre-set tuning is given at positions, 2, 3 and 4. The tuning voltage is applied through the aerial coil to one of the tuning diodes and via R1 and R2 to the other diodes.

The oscillator voltage swing across the diode in the oscillator section should be kept small to prevent capacitance modulation of the oscillator frequency. Special circuits have been developed for this purpose. Work is being carried out on temperature compensation of circuits tuned by the diodes.

A Motorola Applications Engineering report has shown that the MVAM-1 can be used in high quality car radio receivers which are smaller and more easily manufactured designs, whilst being cost competitive. A d.c. to d.c. converter has been employed to generate a negative tuning supply voltage from the car supply. ■

ELECTRONIC SIREN

By M. Harding

This circuit employs two multivibrators and a linear integrator to produce a tone whose frequency rises and falls smoothly in the manner of a siren.

THE CIRCUIT TO BE DESCRIBED IS CAPABLE OF PRODUCING a sound very similar to the well-known siren wail of an American police car. As such it is suitable for use in any application where a distinctive alarm is required. The range of application could vary from that of intruder alarms to novelty circuits and party games. In fact the limit is only set by the constructor's ingenuity.

CIRCUIT DESCRIPTION

The circuit required is one that will produce a slowly rising and falling pitch which, of course, characterises the well-known siren sound. Fig. 1 shows the circuit configuration. It can be seen that the main sound producing circuit is a multivibrator consisting of transistors TR4 and TR5. However, it will also be noticed that the base bias resistors R8 and R9 are not returned to the supply rail but are connected to the collector of transistors TR3. This is for a reason that will be explained shortly. Transistor TR3 functions as a linear integrator and produces a triangular waveform at its collector in response to a square wave drive at its base bias resistor, R5.

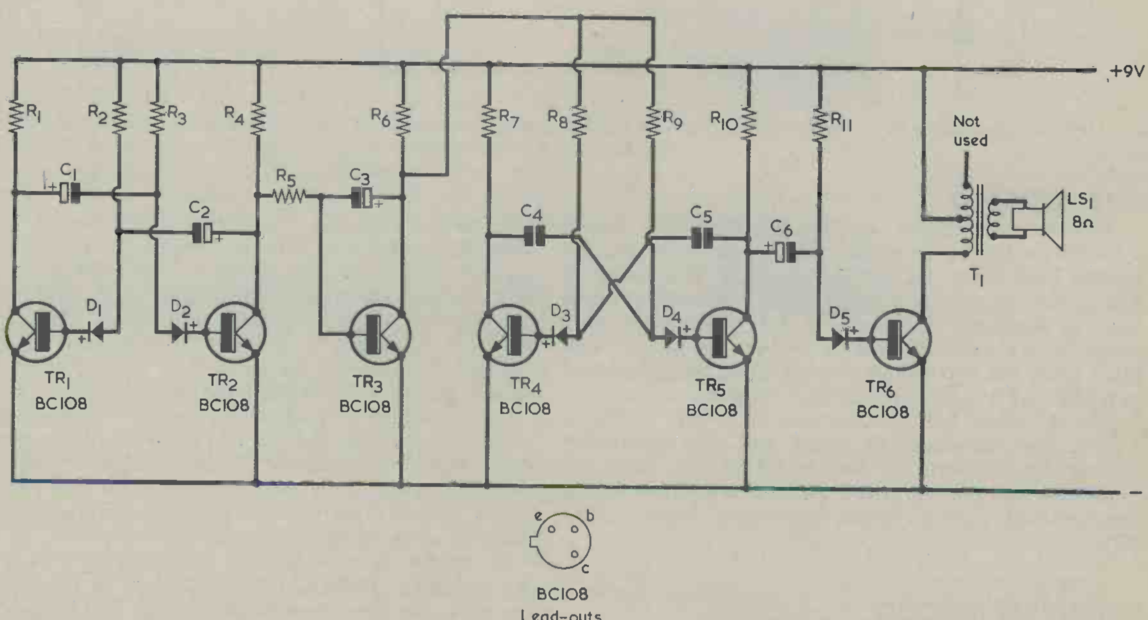


Fig. 1. The circuit of the electronic siren. This produces a tone which continually rises and falls in frequency

The square wave drive required by the integrator is provided by the multivibrator consisting of transistors TR1 and TR2. This is a low frequency multivibrator and completes one cycle in approximately 4 seconds. The waveform at TR3 collector is shown in Fig. 2, and it can be seen that the mean potential, with the component values specified, is just over 3 volts. When the square wave drive is applied from the low frequency multivibrator the collector potential runs smoothly up and down between the limits indicated in Fig. 2.

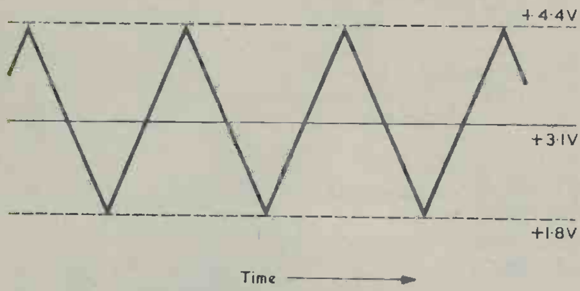


Fig. 2. The waveform produced at the collector of TR3

This voltage is used to frequency modulate the main tone producing multivibrator comprising TR4 and TR5, and thereby generate the characteristic rising and falling pitch of the siren sound. The pitch range produced by this circuit arrangement is approximately 660Hz to 1.2kHz, rising for about 2 seconds and falling for about 2 seconds.

The frequency modulated square wave output from the collector of TR5 is fed to the base of TR6 which acts as a switching mode output stage. This transistor is transformer coupled to an 8Ω speaker using an Eagle LT700 miniature output transformer. Only half the centre-tapped primary winding is employed.

Five silicon diodes, D1 to D5, are included in the circuit in series with the bases of TR1, TR2, TR4, TR5 and TR6. These diodes ensure that the maximum reverse base voltage rating of 5 volts for the BC108's employed is not exceeded, and they do not have any other significant effect on circuit operation. The reverse base voltage rating would not be exceeded during normal operation of TR4 and TR5, but could be immediately after switch-on.

CONSTRUCTION

The author employed a compact form of construction and assembled the components on a small piece of 0.1 in. pitch plain Veroboard having 29 by 16 holes. The layout is shown in Fig. 3. Component lead-outs are simply passed through the board and then linked together, short pieces of 22 s.w.g. tinned copper wire being added where necessary to complete connections. Sleeving is passed over any leads where there is a risk of short-circuit to other wires.

It should be noted that the layout is in no way critical and that a less cramped form of assembly can be adopted, if desired.

The average current consumption from the 9 volt battery was 7mA with an 8Ω speaker connected. Because the output stage is operating in a switching mode it is highly efficient and the sound level from a small 3 in. speaker is adequate for many applications. A 3Ω speaker may alternatively be used, whereupon the current consumption increases to about 10mA and there is a consequent increase in the volume of the output.

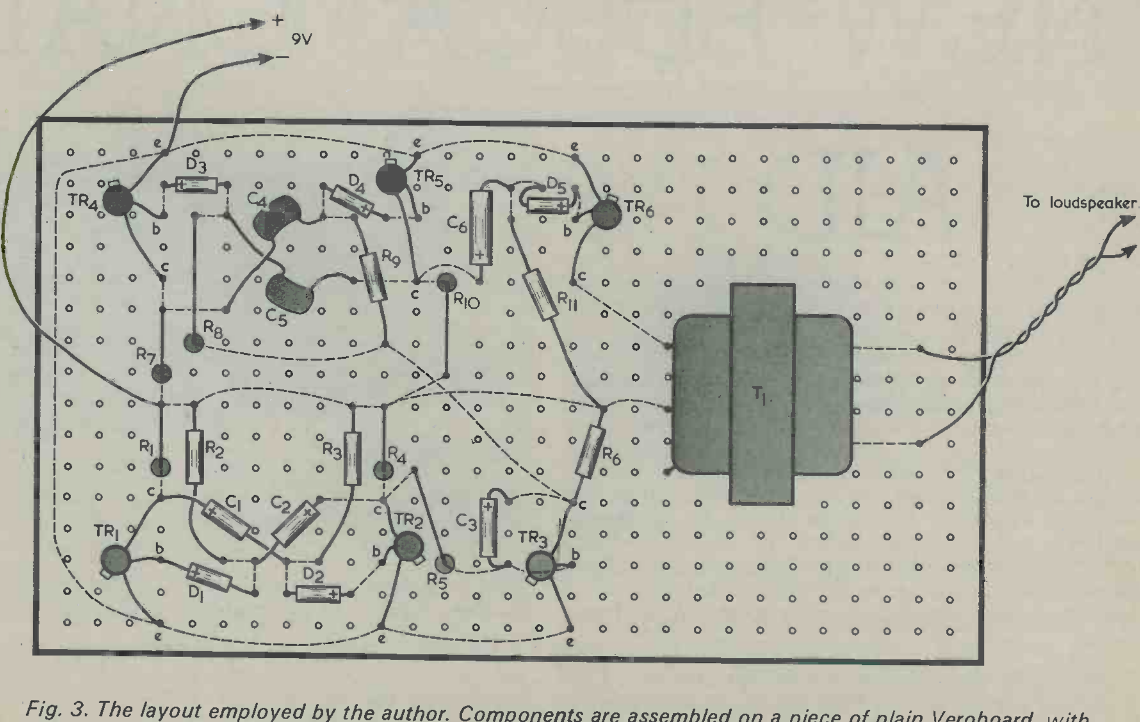


Fig. 3. The layout employed by the author. Components are assembled on a piece of plain Veroboard, with wiring under the board being indicated in broken line

COMPONENTS

Resistors
(All ¼ watt 5%)

R1	10kΩ
R2	120kΩ
R3	120kΩ
R4	10kΩ
R5	560kΩ
R6	5.6kΩ
R7	4.7kΩ
R8	39kΩ
R9	39kΩ
R10	4.7kΩ
R11	560kΩ

Capacitors

C1	20μF electrolytic, 10 V. Wkg.
C2	20μF electrolytic, 10 V. Wkg.
C3	1μF electrolytic, 10 V. Wkg.
C4	0.01μF plastic foil
C5	0.01μF plastic foil
C6	8μF electrolytic, 10 V. Wkg.

Transformer

T1	Output transformer type LT700 (Eagle)

Semiconductors

TR1–TR6	BC108
D1–D5	1N4148

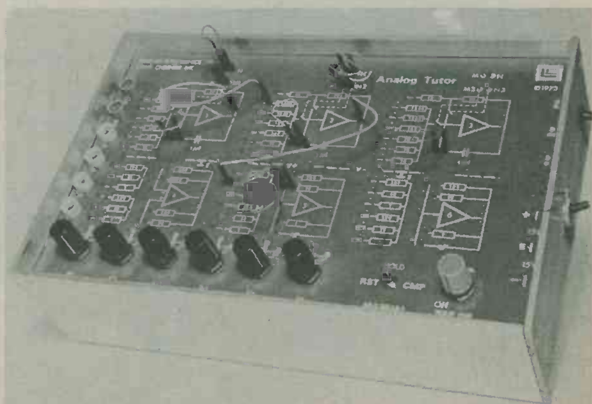
Loudspeaker

LS1	8Ω speaker, 3 in. round (see text)

Miscellaneous
Plain Veroboard, 0.1 in. pitch
9 volt battery
Battery connectors
Wire, etc.

This has proved to be a useful circuit for novelty applications and for more serious alarm applications. When the output is fed into a public address system the unit forms a useful 'stage effects' arrangement for appropriate productions.

NEW EDUCATIONAL AID



A low-cost analogue computer which can be used in schools and colleges for teaching the basic principles of analogue and hybrid computation has been developed by Limrose Electronics.

The Analog Tutor which is available in two sizes for student use and classroom demonstration respectively, uses solid-state electronics throughout. It has six operational amplifiers and six potentiometers and has many design features in common with large analogue computers. These advanced facilities include independent mode control of the integrators, single shot and repetitive operation and remote control.

Up to third order differential equations can be solved on a single unit and two or more units can be connected together for simulating higher order systems. Reaction kinetics, feedback control systems and social and economic systems such as population growth are but a few examples of problems which can be simulated on the Analog Tutor.

An instruction book dealing with the subject from first principles entitled "Introduction to Analogue Computers" accompanies the Analog Tutor. Prices from £99. Further information can be obtained from Limrose Electronics Ltd., 8-10 Kingsway, Altrincham, Cheshire, WA14 1PJ.

QSL CARDS

How To Collect Them

By Steve A. Money

A varied collection of QSL cards will impress both friends and family. Here are some notes on how to set about this interesting side-line of short wave listening.

ONE OF THE FASCINATING SIDE ACTIVITIES OF SHORT WAVE radio listening is collecting QSL cards. What is a QSL card? For the uninitiated a QSL card is a printed postcard, or a letter, sent out by a short wave broadcast or amateur radio station in reply to a valid reception report sent in by a listener. The QSL verifies the report and confirms that the listener has received the station in question.

It seems that the practice of confirming radio contacts by exchanging QSL cards was originated by amateur radio operators. Possession of the appropriate QSL card was at least one way of convincing fellow enthusiasts that you really had made contact with some rare or exotic DX station. Later the international short wave broadcast stations also began to send out QSL cards to confirm reports from their listeners. Today most of the short wave broadcast stations around the world will confirm listener reports by sending either a QSL card or letter.

SIGNAL REPORTS

To obtain a QSL from a broadcast station you must first of all be able to hear the station. Then you need to send in a reception report on the transmission you heard. Many of the international broadcast stations transmit programmes in the English language at some time during the day and these should be easiest for making a report.

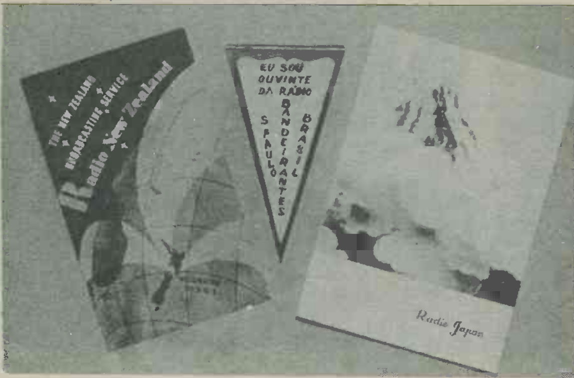
If possible, listen to the station for half an hour or more. If there are other frequencies in use, it may be worth-while to check for signals on these alternative frequencies as well. Note how strong the signal is and whether it is fading or not. Make a note also of any interference or noise on the signal.

In making the signal report you can use one of the signal report codes, such as the SINPO code. In this code each letter corresponds to one particular aspect of the reception conditions and is graded from 1 to 5. Firstly, the S stands for carrier Strength and runs from S1 (just audible) up to S5 (excellent). The I is for Interference from other stations on the same or adjacent channels. Here the five steps proceed from I1 (very severe interference) up to I5 (nil interference). Noise, either from electrical storms or from local electrical equipment, is represented by N and the steps are the same as with I for Interference. Fading is covered by P, for Propagation disturbance, and ranges from P1 (very severe fading) to P5 (nil disturbance). Finally, the Overall reception conditions are assessed and graded from O1 (unusable) to O5 (excellent). As an example a local medium wave station might rate 55555 and a weak signal with bad fading underneath a jamming signal would rate 11111.

Although the SINPO code is a convenient shorthand way of indicating the signal conditions it is as well to make a full comment on each of the aspects of signal reception. For instance you might point out that there was some bad interference for a time from an adjacent channel station and that at another point in the programme the signal faded out almost completely for a minute or so. Try to give a word picture of how well or how badly the station was being received. If possible, attempt to provide a report covering two or three periods of reception on different days since this will give the station engineers a much better picture of the reception conditions. Of course with some of the rarer and more difficult to receive stations you may only get one chance but it is still worth-while to check again on the following day before sending the report, just in case the signal is still there.

PROGRAMME DETAILS

Don't just send in a bare signal report. In order to be able to verify that your report is genuine the station staff will need details of the programme you heard in order to check them against the entries in the station log. It has been known for some unscrupulous listeners to simply look up the station frequency and programme



Two QSL cards and a pennant

schedule in 'World Radio and TV Handbook' and then send in a purely fictitious report in an attempt to receive a QSL card.

What sort of details should be given? First, make a note of the general content of the programme such as talks, music, news, etc. Try to get details of the names of people presenting or appearing in the programme. If songs or music are transmitted note the titles of the pieces and whether the singers are male, female or a group. In the case of a talk or a news type programme make a few notes of the general subject matter with perhaps details of some of the items, but there is no need to go into minute detail. If the station is commercial it is fairly easy to make a report because the commercials are always noted in the station log and if they are quoted it is easy to verify the report.

A tape recorder is a great asset when preparing a report. Record the whole of the programme on tape whilst you make rough notes of the programme content and the times of the various items. By playing back the tape a number of times it should be possible to extract the details which you have missed whilst listening to the original broadcast. This is especially useful in the case of weaker stations where reception is difficult and more concentration would be required to note details during the actual broadcast.

Remember to give the frequency, or at least the waveband, of the station you are reporting on. Times are best quoted in G.M.T. but if local times are mentioned during the programme it is worth-while giving these as well.

RETURN POSTAGE

The larger international broadcasters, such as Voice of America and Radio Australia, are pleased to have letters and reports from their listeners since this gives a useful guide to the popularity of their programmes. They usually verify valid reports with a QSL card and programme guide.

Smaller stations, especially those intended for local broadcasting, often operate on a lower budget and are not particularly interested in overseas reports. However, most of them will send a QSL card or letter if the report is a useful one and you enclose the return postage.

British stamps are useless for postage from a foreign country so don't enclose them for return postage. The proper method is to enclose an International Reply Coupon which is obtainable at most Post Offices and costs 10p. This coupon can be exchanged in the foreign country for sufficient postage stamps for a normal sea mail letter or card. If you want your reply to come by Air Mail then enclose two or three International Reply Coupons to cover the higher postage cost.

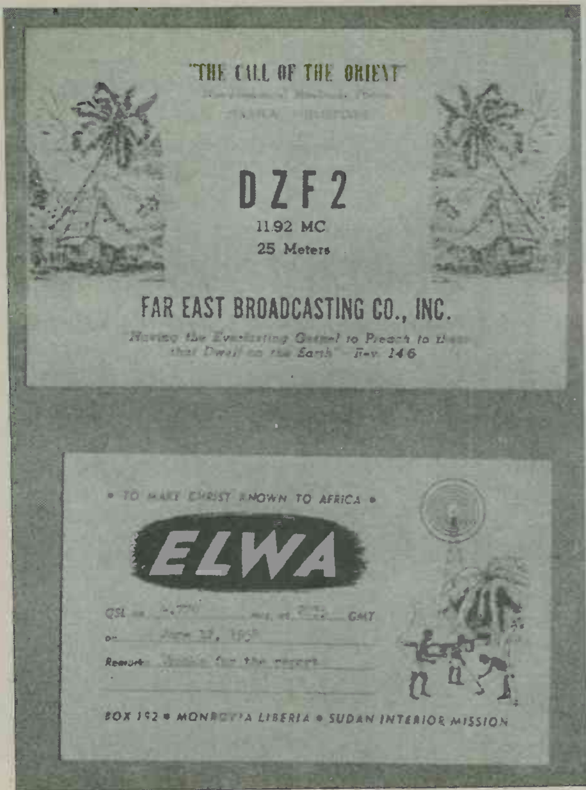
Whilst on the subject of postage stamps, it will be of interest for stamp collectors to know that some of the broadcast stations will, if asked nicely, send along a selection of the stamps of their country. Although most of the larger stations use franking machines many of the smaller ones will put stamps on the card or letter anyway.

ADDRESSES

Some stations run special programmes for listeners during which the address for reports and letters is given. In other cases send your report to the Chief Engineer of the station. Most of the larger stations are well known to the local postal authorities and it is often sufficient to write just the name of the station, the town and the country.

Addresses of all broadcasting stations around the world are listed in 'World Radio and TV Handbook' which is published annually. This book is a valuable aid

Another group of broadcast QSL cards



Two further examples of the QSL cards which may be obtained by the short wave listener

to the short wave listener since it gives frequencies and operating schedules for all radio and television stations around the world as well as much other useful information. It may be obtained from The Modern Book Company.

AMATEUR STATIONS

In general amateur radio stations are not as interested in listener reports as their broadcast counterparts. Many of them will however send you their QSL card in return for a useful report. Note who the station is in contact with and the call signs of any other stations calling him. Basically the signal report can be much the same as that for a short wave broadcast station except that there are no programme details.

Amateur station addresses are listed in 'Amateur Radio Call Book' which is published annually by the Radio Society of Great Britain, 35 Doughty Street, London, W.C.1. Most countries also have QSL bureaux run by the national radio club which will handle cards for amateurs operating from that country.

PENNANTS

Many broadcast stations, especially in South America where the practice started, send listeners a pennant as well as their QSL card. These pennants come in various sizes and types from small paper ones 4 inches long up to large screen printed cloth ones more than á foot long. Usually they are brightly coloured, triangular in shape and carry the station name, call sign and slogan.

Some stations will send a pennant with the QSL card as a matter of course but others will send one only if you ask for it. Send in a good comprehensive report and mention that you collect pennants and would like to add theirs to your collection and you will probably have one sent to you.

In Britain it is possible to receive broadcasts from more than 120 different countries and out of these at least a hundred broadcast programmes in English at some time during the day. Naturally, not all of these stations are easy to receive and, in fact, some will require a lot of patient listening and a few late nights before you finally hear them. It is something of a thrill, though, when one night you suddenly hear the elusive station you have, perhaps for months, been searching for. So now all you have to do is start listening and send out those reports and soon you too can have QSL cards from around the world arriving in your mail. ■

BOOK REVIEW

RADIO CONTROL HANDBOOK. By Howard G. McEntee. 326 pages, 215 x 130 mm. ($8\frac{1}{2}$ x $5\frac{1}{4}$ in.). Published by Foulsham-Tab Limited. Price £1.90.

This is an American text with an introductory chapter for English readers, and it deals in considerable detail with radio control techniques intended mainly for use in model aircraft. The approach is largely towards the hobbyist who likes to make up his own mechanisms and electronic assemblies, and there are many mechanical and circuit diagrams to illustrate what is required here.

Amongst the subjects dealt with are sequence control systems, pulse proportional control systems, engine speed control, expanding proportional and multi-control systems, servos, receivers, transmitters, power supplies, relays, test instruments and component installation. The author is clearly an enthusiast in his field and the text is full of practical advice arising from his own experiences. The American radio control scene closely matches that over here, and the book will be of interest to the British RC devotee.

In your workshop

As is their custom at August, Dick and Smithy leave the Workshop this month and sally forth into the big wide world outside. Despite their circumstances, Smithy still takes the opportunity to expound to his assistant on circuits in which transistor base-emitter junctions have to be given particular consideration.

Apprehensively, Dick followed Smithy through the doorway.

He looked around the small room they had entered. A worn sofa was ranged against one wall together with several small chairs. On one of these sat a young man engrossed in a copy of *Penthouse* magazine. A large anchor was tattooed on each of his wrists.

Facing Dick was a closed green door. Two of the chairs were positioned on either side of a small table; Smithy settled himself comfortably on one of these and Dick perched uncomfortably on the edge of the other. He glanced sideways and saw, through the torn lace curtain of the only window in the room, an unkempt garden. An emaciated cat prowled haphazardly through the weeds.

CHANGEOVER RELAY

"Is this all we have to do then, Smithy?" Dick whispered to the Serviceman. "Just walk in like this?"

"That's right," confirmed Smithy heartily. "I made a phone call yesterday to set it all up."

Dick gazed nervously around the room.

"And what happens next?" he went on, glancing uneasily at the green door. "Do we sit here and wait?"

"That's right," grinned Smithy. "Everybody takes their turn here. You'll be seeing the action soon enough."

Dick heaved a tremendous sigh.

"Well," he remarked tentatively, "it makes a change from the Workshop."

"True enough," agreed Smithy, "although I must admit that the Workshop has been rather congenial recently so far as I've been concerned."

"How's that?"

"For one reason or another," said Smithy, "I've found myself knocking up gadgets for people. I love dreaming up gadgets because it makes such a pleasant break from ordinary servicing."

"What sort of gadgets?"

"Oh, simple little things," replied the Serviceman. "For instance, one customer wanted me to make a mains eliminator for a rather expensive transistor radio he's got. The unusual bit was that he wanted the supply to switch automatically to battery operation whenever there was a power cut or the mains supply was disconnected."

"A job like that," remarked Dick, hooked as ever by the discussion of any electronic matter, "seems to call for a relay."

"You *could*," conceded Smithy, "use a relay. This would have its coil connected across the output of the mains section of the supply. If it had a set of changeover contacts these could switch the supplied equipment to the mains section when the coil was energised and to the battery when there was no output from the mains supply." (Fig. 1.)

"Well, you couldn't have anything much simpler than that," commented Dick. "Are there any snags in such a design?"

"There are two minor points which might be considered shortcomings," stated Smithy. "To start off with, people nowadays tend to look on relays as being old-fashioned, because most of the things they do can be done more neatly, and without moving parts, by semiconductors. Still, there are plenty of modern relays being offered for sale these days both for industrial and amateur use, so it would seem that the relay is by no means as outdated as all that. Also, a relay does have a *complete* switching effect. If a

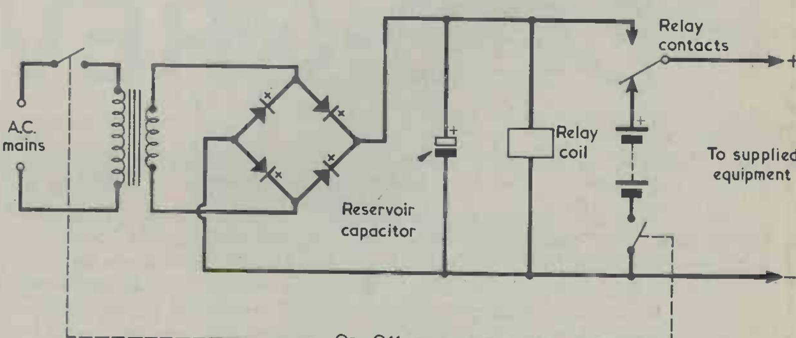


Fig. 1. A simple mains-battery power supply. The relay contacts are shown in the de-energised position, and the two switches are ganged to form a double-pole on-off switch. In the absence of a mains supply the relay de-energises and couples the battery to the output

relay contact set opens a circuit, that circuit is well and truly open. When, on the other hand, a semiconductor device opens a circuit there is still usually a small leakage current flowing, even if it's only a small fraction of a microamp."

"Humph," grunted Dick. "It sounds as though the disadvantages and advantages more or less cancel each other out. What's the second shortcoming of a relay in this power supply circuit?"

"The second snag," said Smithy, "is that the voltage fed to the supplied equipment can fall to a small value before the relay de-energises after the cessation of the mains supply, with the result that the supply voltage does not change instantaneously to the battery. Instead, it will fall to a relatively low value for a moment until the relay releases and the battery takes over. This could be a serious disadvantage if the supplied equipment has to have a continuous supply voltage."

"Fair enough," said Dick. "Can you overcome this second snag?"

"Without the relay it can be done quite easily," replied Smithy. "All you need to do is to couple the battery to the rectified mains supply via a silicon rectifier. If the rectified mains voltage is a little higher than the battery voltage the rectifier in series with the battery will be reverse biased when the mains supply is present. If the mains supply is removed, the output voltage to the supplied equipment will fall slightly until the rectifier starts to conduct, whereupon the supply current will then be provided by the battery. There will be a drop in output voltage when changing from mains to battery, after which the output will remain steady at the voltage provided by the battery. There won't be the intermediate fall to a relatively low voltage that occurs with a relay."

SWITCHING DIODE

At that instant there came a rattling sound from the handle of the green door. It turned, and the door swung slowly open to reveal a thick-set man of about thirty dressed in a jersey and jeans. He closed the door behind him, stretched luxuriantly then, with a slightly swaying walk, left by way of the door through which Dick and Smithy had entered. Open-mouthed, Dick gaped after him.

The green door opened again and a middle-aged woman with greying hair and a hard gaze looked out into the room. She gave a nod of recognition on seeing Smithy, then turned her eyes to the young man with the *Penthouse* magazine. She curled her finger and beckoned him towards her. Rising, he dropped his magazine on the table between Dick and Smithy, gave the now petrified Dick a knowing wink, then passed out of view. The green door closed behind him.

"Ye gods," breathed Dick. "It's a bit like a production line, isn't it?"

"I suppose," agreed Smithy, "it *is* a bit soulless."

"I feel," remarked Dick unhappily, "as though someone's pouring cold water down my spine."

"There's nothing to be nervous about."

"It's all very well for you," complained Dick. "Don't forget that this is the very first time I've ever been here."

"There has," stated Smithy philosophically, "to be a first time for everything."

"Tell me," asked Dick, suddenly curious, "how long have you been coming here?"

"Oh," replied Smithy thoughtfully, "let me see now. I should say I've been popping in here off and on over the last fifteen years or so."

"Do you come often?"

"That," said Smithy, "depends on how I feel. If things are going well with me there might be quite a spell between visits. But whatever happens I make a particular point of coming here at least once every six months. Dash it all, your health can suffer if you don't pay attention to these things."

Dick threw a glance of reluctant admiration at the Serviceman.

"One thing I must say about you, Smithy," he remarked with thinly veiled respect, "you certainly know how to get yourself organised."

"If," replied Smithy loftily, "I can't get myself fixed up nobody else is going to do it for me. Now, let's get back to that battery rectifier circuit."

"Rectifier circuit?"

"I was telling you how you could couple a battery into a mains power supply by way of a series rectifier."

"Cripes, I'd forgotten all about that"

"Well, you'd better remember it again."

Smithy pulled the *Penthouse* magazine towards him, turned its pages until he found one with a fairly large clear area, then drew a ball point pen from his pocket. He scribbled out a circuit on the magazine page. (Fig. 2.)

"Here's the basic idea of the power supply," he went on. "The mains part of the supply is quite straightforward and uses a bridge rectifier feeding into a reservoir capacitor. Any other sort of rectifier and reservoir capacitor arrangement will do equally well. The only important requirement is that the smoothed voltage from the reservoir capacitor must be equal to or greater than the battery voltage. Since the rectifier is a silicon type it will need a forward voltage of about 0.6 volt across it before it conducts. In consequence the rectifier is reverse biased when the rectified mains voltage is present, and the battery is then effectively out of circuit. As soon as the rectified voltage disappears, the voltage across the reservoir capacitor drops until it is 0.6 volt lower than the battery voltage. The series rectifier then conducts and the battery provides all the current for the supplied equipment. Should the mains come back on again the voltage across the reservoir capacitor will rise, and the rectifier in series with the battery will cease to conduct. All the power will then be provided once more by the mains circuit."

"That's neat," commented Dick. "Just a minute, though! Isn't the battery likely to discharge through the bridge rectifier when there's no mains supply?"

"It can't do that," said Smithy. "If you trace the circuit through you'll find that the bridge rectifier diodes are reverse biased so far as current through them from the battery is concerned."

LEAKAGE CURRENT

Dick passed a finger along Smithy's sketch, tracing the circuit from the battery back to the bridge rectifier.

"Yes, I see what you mean," he remarked. "What about leakage current through the rectifier in series with the battery when the mains is on?"

"This current will be very small," said Smithy. "Actually, it's advisable to keep it as low as possible because the leakage current represents a charge

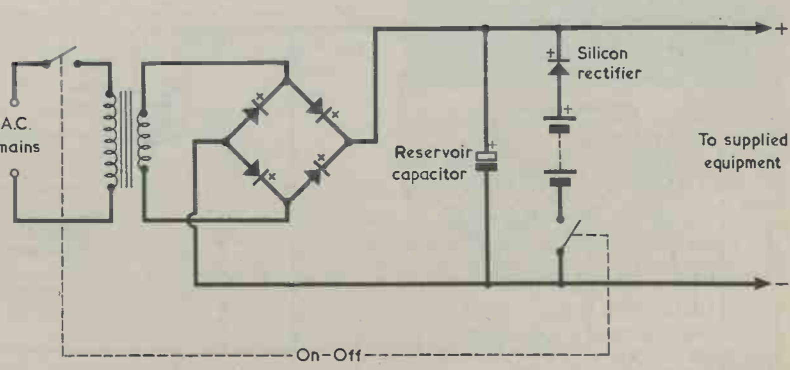


Fig. 2. Another mains-battery supply. On cessation of the mains input the voltage across the reservoir capacitor falls to a level which allows the silicon rectifier in series with the battery to become conductive. The battery then provides the output current

current for the battery. It's a little difficult to be precise about leakage current because all silicon rectifiers have very low leakage current figures when they are reverse biased. Nevertheless, a good choice here would be the BY100, which has a typical reverse current well below 0.1μA at room temperatures. The fact that this is a high voltage type doesn't prevent its being used in this present circuit. It also has a reasonably high forward current rating and this will enable it to withstand switch-on current surges if the circuit is switched on with the mains off. Initial switch-on current will in any case be provided by the battery even if the mains is present because it will take a moment or so for the voltage across the reservoir capacitor to reach full value from the bridge rectifier. Switch-on current surges will, of course, be due to the high value electrolytic capacitor which will in almost all cases be connected across the rails of the supplied equipment."

"If the leakage current in the series silicon rectifier charges the battery," asked Dick, "won't there be a slight risk that the battery will overcharge, so that it could generate internal gases and explode?"

"That is just about possible," agreed Smithy, "and the risk has to be mentioned when the circuit is discussed. In practice, the short stabs of current taken from the battery on switch-on should cancel out the minute leakage currents in the rectifier later on. If the circuit is continually switched on with the mains applied it might be advisable to disconnect the mains occasionally, just to draw a little current from the battery."

Smithy proceeded to sketch out another circuit. (Fig. 3.)

"Hullo," said Dick, "what's this?"

"It's another mains-battery power supply circuit," replied Smithy. "It's an extremely simple and effective circuit if you don't object to a little current being drawn from the battery when the mains supply is present. The output voltage is approximately the same both for mains and battery operation and the battery also gives automatic electronic smoothing."

"This sounds interesting," said Dick. "How does it work?"

"Well," said Smithy, "let's start off by saying that we have the mains supply available. The mains part of the circuit is arranged so that the voltage across the reservoir capacitor is at least a couple of volts higher than the battery voltage. Under these conditions the transistor in the circuit functions as an emitter follower, and a voltage which is 0.6 volt lower than battery voltage appears at the output. Nearly all the output current is provided by the mains part of the circuit, with only a small current from the battery flowing into the transistor base."

"How small a current?"

"Let's say that the transistor has a current gain of about 50. This is what we could expect in practice because we would be using a power transistor here. If the supplied equipment consumes 50mA the current drawn from the battery is then only 1mA."

"That seems reasonable enough," said Dick. "What happens when the mains supply is cut off?"

"The collector voltage for the transistor disappears," replied Smithy, "and the total current consumed by the equipment is then drawn from the battery through the base-emitter junction of the transistor. This now acts as a forward biased silicon rectifier, and the output voltage is still 0.6 volt lower than the battery voltage. The battery voltage will drop a little when the full current is drawn from it because of its own internal resistance. But there will be no cessation of output voltage at all when the mains is cut off."

"Where," asked Dick, "does the automatic smoothing bit come in?"

"It's given," explained Smithy, "because the battery represents a low impedance reference voltage source coupled to the base of the transistor. Even if there's a ripple across the reservoir capacitor, this won't appear at the emitter of the transistor. So you have a circuit with the advantage of extreme simplicity, the only disadvantage being that the battery gradually runs down, although at a much lower rate than would occur if it supplied the equipment directly."

POWER TRANSISTOR

"That certainly represents a neat approach," commented Dick. "Blimey, I've just thought about something!"

"What's that?"

"Why in heaven's name are we rabbitting on about electronics in a place like this?"

"You," retorted Smithy drily, "would be nattering about electronics on your death-bed. Or, come to think about it, on any other bed."

Dick's eyes darted nervously towards the green door.

"That chap," he said querulously, "seems to have been in there quite a bit."

"There's no exact time," explained Smithy. "With some people it's quick and with others it's slow. Aren't you glad you came?"

"I think so," said Dick dubiously. "You certainly went to a lot of trouble persuading me."

"That was entirely for your own benefit," stated Smithy. "There's no reason why you shouldn't enjoy the same facilities that I do. Also, I know that you'll be in capable and experienced hands here."

Dick blenched, then turned hastily to the circuit Smithy had drawn in the *Penthouse* magazine.

"It's the waiting that's hard to take," he said. "Let's get back to that circuit of yours, even if only to pass the time."

"Fair enough," replied Smithy. "Now, this last circuit arrangement is the one I employed for the customer I was telling you about. I used a small heater transformer in the mains part of the circuit. This had two 6.3 volt windings which I connected in series to give 12.6 volts. Since a heater transformer secondary has a much lower resistance than is given in transformers specifically intended to supply low current transistor equipment I also inserted a 10Ω surge limiting resistor in series with the bridge rectifier. This isn't entirely essential but it does reduce reservoir capacitor switch-on surge currents. The rectifiers were 1N4002's. The rest of the circuit is the same as the theoretical one. The battery is a PP9 and the transistor a 2N3055."

As he spoke, Smithy drew a further circuit giving the component details he had outlined. (Fig. 4.)

"A 2N3055?" repeated Dick incredulously. "That's using a whacking great sledgehammer to crack a very tiny nut, isn't it?"

"The 2N3055 is considerably underrun," agreed Smithy. "The only reason for using it here is because its base-emitter junction will stand the high switch-on current surges from the

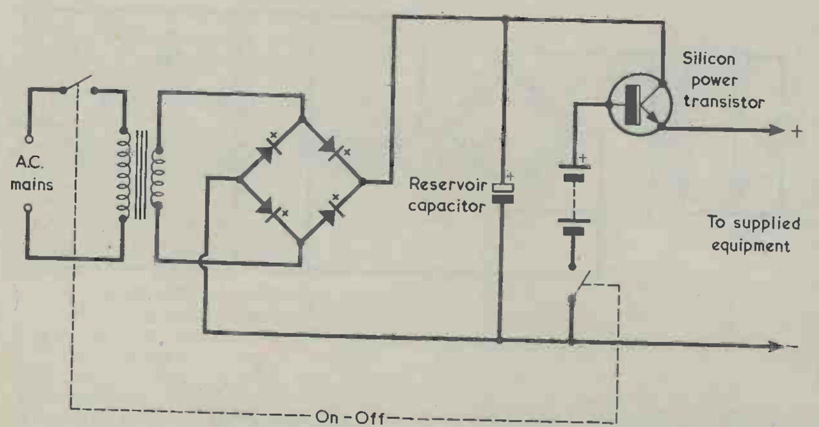


Fig. 3. In this circuit the output voltage is 0.6 volt less than battery voltage both on mains and battery operation

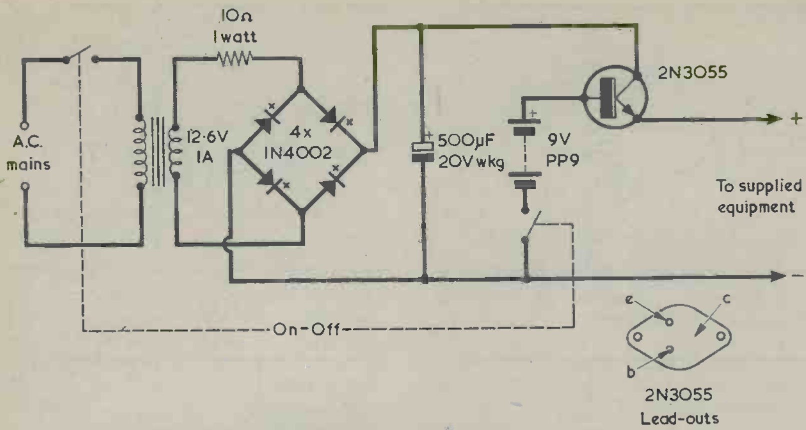


Fig. 4. A practical version of the circuit of Fig. 3. This was employed by Smithy in a supply unit for a transistor radio

battery which pass through it. As I said just now, the supplied equipment is almost certain to have a high value electrolytic across its supply rails, and at a first approximation this can be looked upon as a dead short at the instant of switch-on. At the same time, a new PP9 battery has an internal resistance of around 6Ω and so instantaneous switch-on surge current can theoretically be greater than an amp. In practice, there'll be an ohm or two in the electrolytic in the equipment but, even so, it's desirable to use a transistor which can withstand currents of the order of an amp in its base-emitter junction. The 2N3055 will run quite cool and it won't need to be mounted on a heat sink."

"I must say," remarked Dick, "that this business of the transistor changing over from an emitter follower to a forward biased rectifier is quite fascinating."

"It is rather," agreed Smithy. "Incidentally, the effect I've just described can cause some quite puzzling fault symptoms in practical emitter follower circuits."

"How do you mean?"

"Take a look at this circuit arrangement I'm drawing now," remarked Smithy. "It's for a standard emitter follower configuration." (Fig. 5 (a).)

"That seems pretty straightforward to me," commented Dick, looking critically at Smithy's sketch. "It's the sort of thing you bump into quite frequently."

"True," agreed Smithy. "Now, you'll notice that the base of the transistor is taken up to the positive rail by way of a resistor to which I've given a value of 100kΩ. At the same time the emitter load is a second resistor having a value of 1kΩ. If we assume that the transistor has a current gain of about 100 times, what will be the potential at its emitter?"

"If the current gain is about 100," remarked Dick, "then the current flowing in the 100kΩ resistor will be one-hundredth of the current flowing in the 1kΩ resistor."

"So?"

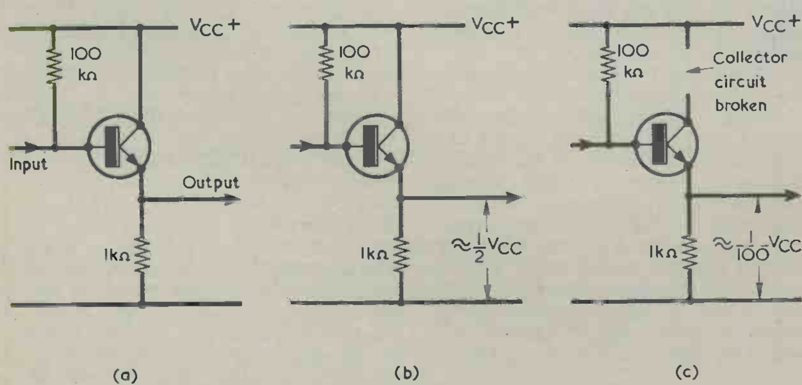


Fig. 5 (a). A standard emitter follower circuit
(b). If the current gain of the transistor is about 100 times, the emitter potential is approximately half supply voltage
(c). The emitter voltage falls to a very low level if the collector circuit is interrupted

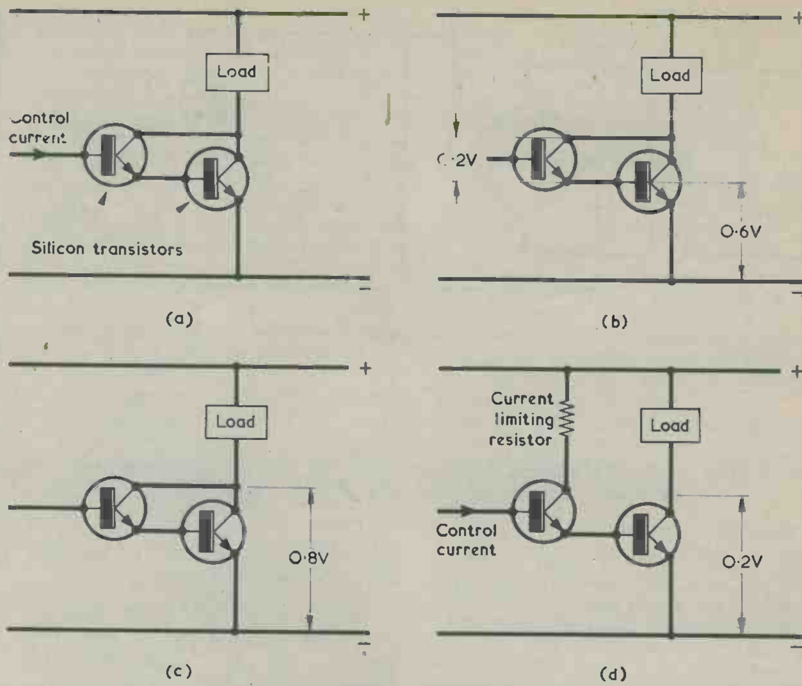


Fig. 6 (a). A commonly encountered switching circuit. A small control current flowing into the base of the first transistor allows the second transistor to turn on a high current load
(b). Voltages appearing in the circuit when the load is switched on
(c). The voltage across the second transistor cannot be made less than the sum of the two voltages shown in (b)
(d). If the circuit is modified in the manner shown here, it is possible to achieve a much lower voltage across the second transistor when it is turned on

"So," went on Dick, his brow furrowed, "since the resistance of the base resistor is 100 times that of the emitter resistor the voltages across them will be – let me see now – why, the voltages will be equal."

"And what will be the result of that situation?"

"Well," continued Dick, "the voltage at the emitter will be approximately half the supply voltage." (Fig. 5 (b).)

"Good," commended Smithy. "Now what will happen if, for some reason, the collector goes open-circuit?" (Fig. 5 (c).)

"Let's think now," said Dick, resuming the frown that inevitably accompanied cerebral exercise on his part. "If the collector is open-circuit the effect will be the same as we had with that power supply of yours. The base-emitter junction will act like a forward biased rectifier and current will simply flow through the 100kΩ resistor, through the base-emitter junction and then through the 1kΩ emitter resistor."

"And the voltage on the emitter?"

"It will be much lower now. With the resistor values you've chosen, it will be around one-hundredth part of the supply voltage."

"That's it," confirmed Smithy. "In this little exercise we've been ignoring the voltage drop across the base and emitter and we have in any case been dealing with approximate quantities. But it does show you one thing."

"What's that?"

"In an emitter follower circuit, the main thing that holds the emitter voltage up is the collector current!"

COMPOUND AMPLIFIERS

"That's a new way of looking at it," commented Dick.

His face grew more serious as he looked up and surveyed his surroundings.

"Gosh, Smithy," he said, his earlier nervousness returning, "that chap is taking *ages*."

"Don't get so agitated," said Smithy soothingly. "Your turn will come soon enough. Let me show you another circuit in which a transistor base-emitter junction is of importance."

"Oh, all right, then," said Dick reluctantly. "But this hanging around is beginning to be quite an ordeal."

"It will soon be over," comforted Smithy, "and then you'll really be grateful to me for having brought you here. Now, take a look at a circuit which is often used when it is required that small currents be used to turn on heavy current loads."

Smithy turned the leaves of the *Penthouse* magazine and drew a circuit in the margin of a new page. (Fig. 6 (a).)

"This," he continued, "is a very common switching circuit, and it comprises two silicon transistors. The first transistor acts as an emitter follower with its emitter connecting to the base of the second transistor, which is a common emitter amplifier. Both the collectors are connected together. When the circuit is used as a switch the two transistors are turned off when there's no base current flowing to the first transistor. The two transistors are then turned on when a base current is fed to the first transistor. Due to the combined amplification in the two transistors that base current can be quite low."

"What about power dissipation in the two transistors?"

"That," said Smithy, "is the next thing I want to discuss. When the two transistors are turned on the second transistor passes a high current because this is the current which is consumed by the load. The current passed by the first transistor need only be that which is needed at the base of the second transistor. The result of all this is that in most applications the second transistor will be a power type whilst the first transistor can be a small signal type."

"If," remarked Dick, "the controlling base current to the first transistor is applied and removed quickly, will that mean that the two transistors will spend nearly all the time either turned off or fully turned on, so that the overall average dissipation will be quite low?"

"That's the general idea," confirmed Smithy. "When the two transistors are turned off the dissipation in them is, obviously, zero. When the two transistors are turned on the dissipation will be relatively low because of the low voltage which appears across them. The dissipation in each transistor is, of course, the product of its collector current and the voltage between its collector and emitter."

"Well," queried Dick, "what's wrong with this set-up?"

"Not a great deal, really," replied Smithy, "apart from the fact that it's possible to reduce the turned on dissipation in the second transistor by more than a half just by a slight rearrangement of the circuit. Now, a fully turned on silicon transistor has the voltage drop of about 0.6 volt between its base and emitter which we've already been talking about. At the same time, the voltage between its collector and emitter is much lower, being about 0.1 to 0.3 volt. For the sake of explanation, let's say that it's 0.2 volt. If we look at these two transistors of ours we can say that, when they are turned on, the voltage across the collector and emitter of the first transistor is 0.2 volt, whilst the voltage across the base and emitter of the second transistor is 0.6 volt."

Smithy added the voltages to the transistors in his sketch. (Fig. 6 (b).)

"I think I see what you're driving at here," remarked Dick thoughtfully. "Does it have to do with the fact that the two transistor collectors are connected together?"

"It does," confirmed Smithy. "Now, the first transistor has to have its 0.2 volt between collector and emitter if it is to pass the requisite base current into the second transistor. Since the emitter of the first transistor connects directly to the base of the second transistor the two voltages can be added together, whereupon the voltage between the collector and emitter of the second transistor comes to no less than 0.8 volts. No matter how much current within reason you put into the base of the first transistor, the voltage between the collector and emitter of the second transistor cannot become less than 0.8 volt." (Fig. 6 (c).)

"0.8 volt, eh?" repeated Dick. "If there are a few amps flowing in the collector of the second transistor it could be dissipating several watts even when the transistors are considered to be fully turned on."

"Exactly," agreed Smithy. "Now, this dissipation can be considerably reduced by disconnecting the collector of the first transistor from the collector of the second transistor and connecting it, instead, to the upper supply rail by way of a current limiting resistor."

Smithy sketched out the new circuit. (Fig. 6 (d).)

"This time," he continued, "we have quite a different set of circumstances. If no bias current is applied to the base of the first transistor then both transistors are turned off, just as before. If a bias current of sufficiently high value is applied to the base of the first transistor, both transistors turn on. In this case, though, the second transistor is able to turn fully on, with the result that the voltage between its collector and emitter can fall to 0.2 volt, instead of to the 0.8 volt given with the previous arrangement. So the dissipation in the output transistor is considerably reduced."

"What value should the limiting resistor have?"

"A value which allows rather more than enough base current to flow into the second transistor to turn it on," responded Smithy. "Hello, something seems to be happening."

EXTRACTION

And, indeed, something was happening. The green door opened and the young man who had previously entered came out, smiling broadly.

"Phew," he remarked. "That's a relief. I've been meaning to have it away for ages."

The middle-aged woman put her head round the door, and looked at the trembling and now virtually inarticulate Dick.

"Is he the one?" she asked Smithy.

"That's him," confirmed Smithy.

"Right," she said, beckoning Dick towards the door.

Dick turned an anguished glance at the Serviceman.

"Go on," urged Smithy. "If you don't go now you never will."

Quaking, Dick rose and tottered precariously through the green door. It closed behind him firmly.

"What," Smithy asked the young man, "did you have away?"

"This tooth," replied the young man, opening his mouth and pointing to a very evident gap in his top front teeth. "It's been giving me gyp for weeks and I've only just plucked up the courage to come in here today and get it pulled out."

Spying the *Penthouse* magazine on the table alongside Smithy, he picked it up and, unaware of the circuit diagrams which had been added to its pages, walked out happily with it tucked under his arm.

Left to himself, Smithy settled back comfortably on his chair in the dentist's waiting-room, reflecting that it wouldn't be long before he was in here again on his own account for his next six-monthly check-up. He then mused cheerfully on the fact that after considerable exhortation he had at last overcome Dick's obsessional fear of dentists, and had now persuaded him to visit Smithy's own dentist for the very first examination of his teeth since leaving school. ■

The 'Slide Rule' Receiver Cum Capacitance Meter

In Part 1 of the 2-part article describing this equipment, which appeared in the last May and June issues, it was stated that range switch S1 is set to medium waves when measuring capacitances above 56pF. A better method of measuring capacitance consists of maintaining the range switch in the central position for all three capacitance ranges. Radio 1 is then tuned in for test capacitances from zero to 56pF, Radio 3 for test capacitances from 56pF to 560pF, and Radio 2 for test capacitances from 560pF to 5,000pF.

Radio Topics

By Recorder

ONE WAY OF GIVING A REALLY professional appearance to a home-built electronic project is to assemble the parts on a printed circuit board. There is a certain almost creative pleasure to be obtained from this process, particularly if the design of the copper pattern is carried out by the constructor himself.

ETCHING KIT

These words are prompted as a result of examining a new etching kit which is now available from Home Radio (Components) Ltd. The contents of the kit are comprehensive, consisting of pieces of copper-clad board, ferric chloride crystals, an etch resist pen, a plastic dish, plastic tweezers, a plastic spoon (for measuring out the ferric chloride crystals), a laminate cutter and, most important of all, a set of detailed instructions.

We have rather a personal interest in these instructions as they draw freely from A. C. Gee's article 'Making Printed Circuit Boards', which appeared in *Radio & Electronics Constructor* for May, 1974. The instructions are both helpful and amusing and include an account of the lessons learned by the compiler in his own first steps in making up ferric chloride solution. For instance, when he added the crystals to the water in a plastic dish the resultant heat melted a hole in the dish! It is finally recommended that the ferric chloride crystals be added slowly to the water in an old jam jar which is then thrown away afterwards. The crystals should always be added to the water and not the other way round. If water is poured on the crystals they may 'spit' and fly around; this is a dangerous situation since the ferric chloride could then get on the skin or, worse, in the eyes.

The instructions also give very useful advice on the actual designing and etching of a printed circuit board, and there are a number of tips on the most economical use of the copper-clad board, of the etch resist pen and, also, of the ferric chloride crystals themselves.

Just to show how old I am I can still refer to the ancient story in which the young lady is allured to her admirer's flat so that he can show her his etchings. Perhaps, in this all-electronic age, successfully completed printed circuit boards could provide an equally attractive enticement.

MCM AND ALL THAT

Much TV time these days is taken up by old films, and it is always a matter of interest to find out when they were released. You can of course always tell really old films because everyone wears hats and they kiss with their mouths closed, but there is a more precise method of determining the year of issue.

All films carry a copyright notice in the credits which consists of the word 'Copyright', or a letter C inside a circle, followed by the year when the film was released. Film producers are not at all keen on stating too obviously the year of issue of a film because it may then appear dated if it appears in a cinema some two or more years later. In consequence, the copyright year is nearly always given in Roman numerals which, the producers fondly hope, will not be understood by many of their audiences.

They're right, too. On checking with friends and acquaintances I have been amazed to find how few are able to work out those Roman copyright year figures on the films they see.

Fortunately, it's dead easy. The Roman letter for 1000 is M and that for 100 is C. So MCM, the first three letters to be found with all films, stands for 1900. You put a C in front of an M to make 1000 minus 100, or 900, in just the same way as you put an I in front of an X on a clock face to make 10 minus 1, or 9. So, MCM means 1000 (the first M) plus 900 (the following C and M), or 1900.

The Roman numerals after MCM are then added to 1900, and all you have to remember here is that L stands for 50. The remaining characters are X, V and I, which are familiar from the clock face. MCML is 1950, MCMLI is 1951, MCMLV is 1955 and MCMLVII is 1957.

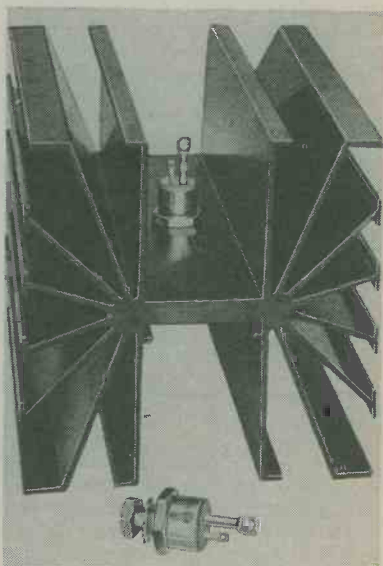
MCMXL is, wait for it, 1940. The X in front of the L gives 50 minus 10, or 40. MCMXLII is 1942 and MCMXLVI is 1946. For the 1930's you have MCMXXX followed, for years above 1930, by the final year figure. Thus, MCMXXXIV is 1934.

Coming up to more recent times, MCMLX is 1960 and MCMLXX is 1970. And our present year of grace? MCMLXXV. But you'll have to go to the cinema if you want to see a non-TV film with that copyright year on the screen.

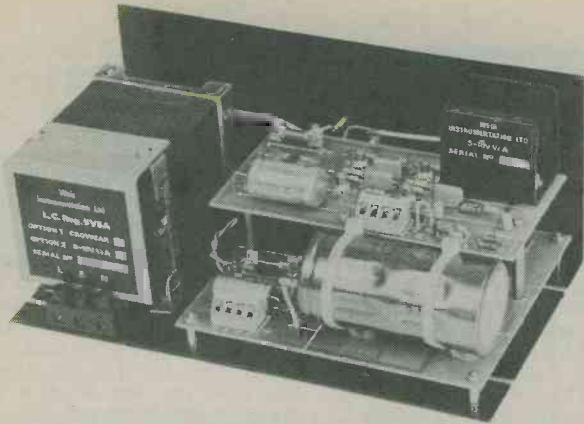
HIGH CURRENT S.C.R.

Both of the accompanying photographs illustrate items which are now available from Jermyn Industries, Sevenoaks, Kent.

The first shows examples of a new range of high current silicon controlled rectifiers, or thyristors, which are manufactured by the American General Electric Company. These are rated at 63 amps r.m.s. and are available in twelve different voltage grades from 100 to 1,200 volts. The range is known as the C147 series and is recommended for applications where a high surge current rating is required. The maximum capability is achieved when the thyristor is mounted on a Jermyn HP55 heatsink, as is the thyristor illustrated. Particularly useful for work at U.K. mains voltage is the



Mounted on a really man-sized heatsink, the G.E. thyristors shown here are rated at 63 amps at voltages ranging from 100 to 1,200 volts



The Weir Instrumentation power supply type 5V5A, with 5–18V circuit board fitted. This combination is suitable for powering hybrid systems incorporating both t.t.l. and CMOS logic

thyristor type C147D, which is rated at 400 volts.

A power supply capable of powering hybrid systems incorporating t.t.l. and CMOS logic appears in the second photograph. Made by Weir Instrumentation, Ltd., the basic supply type 5V5A produces an output of 5 volts at 5 amps. The output is fused and has foldback current limiting. If desired an optional crowbar over-voltage protection circuit may be fitted.

Alternatively, a second supply offering currents up to 250mA at a voltage variable from 5 to 18 volts can be added. This accessory is the type 5–18V unit, and it consists of the upper circuit board seen in the illustration.

THE U.S. SCENE

A 2N3055 costs about 1 dollar by mail order, a 709 i.c. costs about 29 cents, a 741 some 35 cents and a 555 timer about 99 cents. I've just been doing a little window-shopping through the advertisement pages of our U.S. contemporary *Radio-Electronics*, and these are some of the prices currently quoted by American mail order suppliers. If we work to two and a third dollars to the pound, a dollar becomes equal to approximately 44 pence, and it would appear that the American home-constructor can buy his transistors and integrated circuits rather more cheaply in terms of real cash (if such a concept still exists in these inflation-cursed times) than we can.

Whereas many of our English mail order advertisers list a very large number of transistors in their magazine advertisements the American practice is to quote quite a small range. The large ranges may of course be given in advertisers' catalogues which I haven't seen. However, one advertiser does quote a long list reminiscent of English advertising style, but this is for Japanese transistors in the 2SA to 2SD range. Advertisements for t.t.l. 74 series i.c.'s are much the same as in this country, with the full range listed.

It is always interesting to visualise the scene on the other side of the Atlantic, but what is even more fascinating is the international flavour of electronics as a hobby. In this country both the R.S. Components and Doram Electronics catalogues employ the pleasant practice of quoting country of origin for some of their semiconductors, and one finds oneself making a mini-world tour stopping here at Singapore and then at Japan, W. Germany, Israel, Italy and finally, for a few rectifiers in the 1N4000 series, at no less exotic a place than Taiwan.

The world gets tinier and tinier. You can almost feel its surface contracting under your feet.

ELECTRONIC IGNITION

Quite a lot of argument still continues about the usefulness or otherwise of electronic ignition for cars. One of our contributors, Frank Osborn, G2CVO, has just had some practical experience with a commercially made electronic ignition unit and his findings may well be of interest to readers who are contemplating a similar modification to their cars.

'I suppose a lot of people like myself,' writes G2CVO, 'have thought electronic ignition a bit gimmicky. However, the recent heavy increase in the price of petrol made me turn a jaundiced eye on my car which was not presenting any startlingly economical consumption figures. Understandably so, as this is a Hillman Minx of 1969 vintage with automatic transmission and around 70,000 miles on the clock. It was also approaching its 6,000 mile service, so it could hardly be called in fine fettle.

'On the reasonable assumption that with any small improvement I must eventually recoup my outlay on fitting electronic ignition, I invested in a Sparkrite ready made unit at a little under £14. It was claimed that in addition to better miles per gallon, one could expect longer life on points, plugs, coils and batteries. Also quieter running, better acceleration and top speed, and complete burning of the mixture.

'This unit retained the use of the contact breaker, was extremely easy to fit and the operation was carried out on a wet and wintry February day. A careful log of mileages and types of journey has been kept and some very interesting figures emerge.

'Before fitting the electronic unit petrol consumption for local shopping runs within an 8 mile radius was 22 m.p.g., whilst on runs on trunk roads at 50 m.p.h. it was 30 m.p.g. After the unit had been installed the consumption for the local shopping runs remained at 22 m.p.g., but the figure increased to 36.6 m.p.g. for runs on trunk roads at 50 m.p.h. Also, on trunk roads plus some local runs the consumption, at 34 m.p.g., was still a significant improvement.

'After the 6,000 mile service, when the clean plug points amazed me, the trunk road mileage remained at the 36 m.p.g. figure but the local mileage had improved to 25 m.p.g. It will be readily seen that regular servicing also plays an important part in enabling the electronic device to give of its best. Local stop-start motoring is the most damaging to engines, creating wear from the use of the choke and the subsequent rich mixture, together with oil sludging in wintry conditions. The man on the trunk road has the best of it and the modern high speed engine then clearly shows the improvement in miles per gallon.'

HUNTING

Most engineers who have had experience with servo systems have encountered the phenomenon known as 'hunting'. A servo system is an automatic control system in which the output is intended to follow the input. Generally, there is an amplifier between the input and the output together with a feedback loop from the output back to the input. A servo system can be employed, for instance, in the control of a rotatable outdoor aerial. A dial at the receiving or transmitting position is set up for a particular direction and an outside motor then turns the aerial to the desired position.

Continuing with this rotatable aerial example, hunting occurs if the system allows the outside motor to be a little too energetic. Say, for instance, that the inside controller is adjusted to change the aerial position from due west to due north. The outside motor turns the aerial to the north position, but the inertia in the system causes it to go a little beyond north to, say, a few degrees to the east. The motor stops, the system senses the error and the motor reverses to take the aerial back to north. Again it passes the due north position and stops a few degrees to the west. And thus the system settles down to a hunting condition, with the aerial motor continually taking the aerial a few degrees on either side of the desired north setting, first in one direction and then in the other.

This hunting situation appears in many facets of life which are quite remote from electronic or mechanical operation. A classic example is given when two people bump into each other in a corridor. Each moves sideways in the same direction to get past the other, and it is not until several moves have been made that they decide to move in opposite directions and thus get by. Hunting is particularly noticeable in the governing patterns of democratic countries. There is no precise government party policy which can please the greatest number of the electorate and so the government hunts first to one side of centre and then to the other side of centre. In the U.K. the government hunts continually between Tory and Labour. There is, of course, considerable inertia in the electoral system because the feedback is made via general elections which may be spaced apart by up to some four years or so. But the hunting is there for all to see.

If you can accept that you are part of an enormous servomechanism then I need only add: Happy Hunting! ■

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(Continued on page 60)

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(Continued from page 59)

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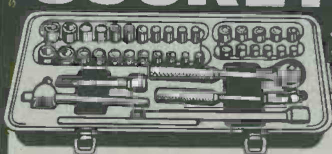

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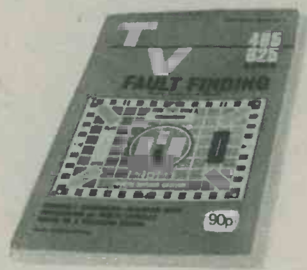

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ELECTRONICS DATA

1

FOR THE BEGINNER

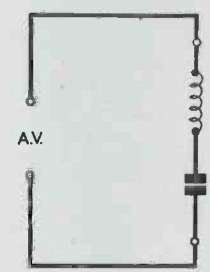
SERIES RESONANCE

In (a) an alternating voltage whose frequency can be varied is applied to a series tuned circuit consisting of an inductor (or coil) and a capacitor in series. At a low frequency the capacitive reactance of the capacitor is greater than the inductive reactance of the inductor and at a high frequency the reverse applies. There must then be a frequency in between at which the two reactances are equal. This is the resonant frequency.

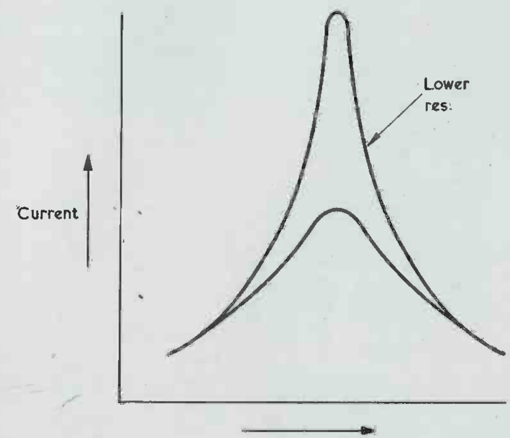
At the resonant frequency the two reactances cancel out and the only opposition to alternating current flow is the inevitable resistance in the tuned circuit. At frequencies below some 20MHz this resistance is mainly provided by the wire of the inductor. Typical response curves for the circuit appear in (b). The curve peaks appear at the resonant frequency and the sharper curve corresponds to a tuned circuit with lower resistance.

The alternating voltages across the inductor and capacitor at resonance are equal and opposite in phase, and are greater than the applied voltage. The ratio between the voltage across the inductor or capacitor and the applied voltage represents the magnification factor of the tuned circuit. This is also equal to the quality factor, or Q, of the tuned circuit. Q increases as the resistance in the tuned circuit decreases.

Resonant frequency is defined by the equation in (c), where f is in Hz, L is in henrys and C is in farads. It may be varied by making the capacitance variable, as in (d), or the inductance variable, as in (e). A typical method of varying inductance consists of moving an iron-dust core into or out of the windings of the inductor.



(a)



b

$$f = \frac{1}{2\pi\sqrt{LC}}$$

(c)

(d)

(e)

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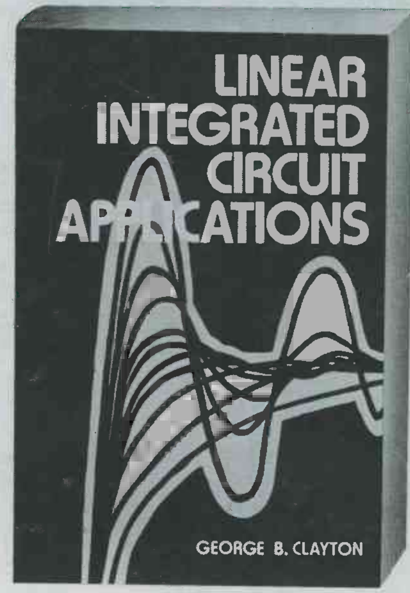

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The great practical value of integrated circuits is now fully established in the design of electronic circuits and systems. However, it has only been in recent times following the general acceptance of the first linear integrated circuits—operation amplifiers—that manufacturers have turned their efforts to a wider range of linear integrated circuits.

This book is concerned with these newer circuits now available which find their main use in signal measurement and processing systems.

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In this book the applications of operational amplifiers as measurement amplifiers and the use of operational amplifiers in active filter circuits are dealt with. Subsequent chapters are concerned with the more recently introduced linear integrated circuits, monolithic integrated circuit modulators, four quadrant multipliers, timers, waveform generators and phase locked loops.

Numerical exercises are included at the end of each chapter. The book should prove useful to both the practising experimental scientist and the undergraduate student in scientific or engineering disciplines. The practical approach which it adopts should serve as a balance to the rather intensive theoretical treatment given in many undergraduate courses in electronic engineering.

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