RADIO & ELECTRONICS CONSTRUCTOR

FEBRUARY 1976

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DESIGN DATA TABLES

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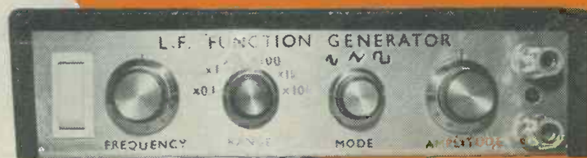
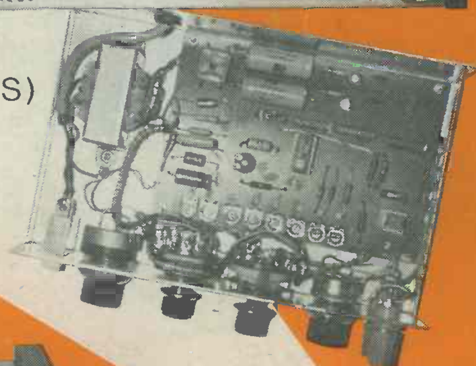


PART 1
(2 PARTS)



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Address..

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20/9468

RADIO & ELECTRONICS CONSTRUCTOR

FEBRUARY 1976
Volume 29 No. 7

Published Monthly (1st of Month)
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JUST A FEW OF OUR BARGAINS ARE LISTED BELOW - SEND STAMPED ADDRESSED ENVELOPE FOR A QUOTE ON OTHER REQUIREMENTS. PAY US A VISIT. OVER 90% OF STOCK BELOW QUANTITY WHOLESALE PRICE. RETURN POSTAL SERVICE UNLESS CHEQUE.

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Speaker, 6" x 4", 5 ohm, ideal for car radio etc. £1

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9 way **5p** Single **1p**

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Takes ECC 85 **80p**

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Closed 9½", open 38½"
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Brand new Boxed 6K7G **25p** 1.5m, log edge pot .. 8p
PVC or metal clip on M.E.S. bulb holder 5p
Geared Knob, Inner to Outer Ratio 8:1 .. .. .. 60p
Bulgin, 5mm Jack plug and switched socket (pair) 30p
12 volt solenoid and plunger 30p
250 RPM 50 c/s locked frequency miniature mains motor .. 50p
200 OHM coil, 2¼" long, hollow centre 10p
Belling Lee white plastic surface coax outlet Box 30p
R.S. 12 way standard plug and shell 20p

SWITCHES

Pole	*Way*	*Type*	
4	2	Sub. Min. Slide	18p
6	2	Slide	20p
4	2	Lever Slide	15p
2	2	Slide	12p
1	3	+ off Sub. min. edge	10p
1	3	13 amp small rotary	12p
2	2	Locking with 2 to 3 keys	£1.50
2	1	2 Amp 250V A.C. rotary	24p

Wafer Rotary, all types **30p**
S.P.S.T. 10 amp 240v. white rocker switch with neon. 1" square flush panel fitting **30p**

RESISTORS

⅛–¼–½ watt .. 1p
1 watt 2p
Up to 5 watt wire 10p
10 watt wire wound 12p
15 watt 14p

Philips transformer, safety fused. In 200-220-240v. Out 240v 60ma + 6.3v 1a approx 2" x 2¼" x 2½" **£1.50**

AUDIO LEADS

5 pin din plug 180° both ends ½ Mtr., **80p**
3 pin din to open end, 1⅓yd twin screened **35p**
Phono to Phono plug, 6ft. **35p**

POTS

Log or Lin carbon **13p**
Switched **25p**
Dual Pots **38p**
Dual & switch **50p**
Lin wirewound **25p**
Slider Pot **25p**
Dual Slider **35p**

COMPUTER AND AUDIO BOARDS

VARYING PANELS WITH ZENER, GOLD BOND, SILICON, GERMANIUM, LOW AND HIGH POWER TRANSISTORS AND DIODES, HI STAB RESISTORS, CAPACITORS, ELECTROLYTICS, TRIMPOTS, POT CORES, CHOKES ETC.
3lb for **85p** + 75p post and packing
7lb for **£1.75** + £1 post and packing

Skeleton Presets
Slider, horizontal or vertical standard or submin. 5p

Clear Plastic Boxes
For component storage or projects, sliding lid. 1¾" x 1½" x 1" 10p

THERMISTORS

VA1008, VA1034, VA1039, VA1040, VA1055, VA1066, VA1082, VA1100 } 10p
VA1077, VA1005, VA1026 } 15p

KNOBS

SILVER METAL PUSH ON WITH POINTER, OR WHITE PLASTIC, GRUB SCREW WITH POINTER AND GOLD CENTRE **8p** EACH.
1" DIAM. WITH 1½" SKIRT SPUN ALUMINIUM GRUB SCREW FIXING, ¼" 30p EACH.

RELAYS

12 volt S.P.C.O octal mercury wetted high speed **75p**
P.O. 3000 type, 1,000 OHM coil, 4 pole c/o **60p**
Mains or 12v d.p.c.o. heavy duty octal **60p**

ZM1162A INDICATOR TUBE

0-9 Inline End View. Rectangular Envelope 170V 2·5M/A **£1.50**

RESETTABLE COUNTER

English Numbering Machines LTD.
MODEL 4436-159-989
6-14 volt, 6 digit, illuminated, fully enclosed. **£2.50**

Ferric Chloride, Anhydrous mil. spec. 1lb. bag **50p**

Boxed GEC KT88 valve **£2**

JAP 4 gang min. sealed tuning condensers New **25p**
Ex-eqpt. 2 or 4 gang **15p**

ELECTROLYTICS MFD/VOLT. Many others in stock

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

As total values are too numerous to list, use this price guide to work out your actual requirements
8/20, 10/20, 12/20 **Tubular tantalum 15p each**
16–32/275, 32–32/275, 100–100/150, 100–100/275 50–50/300 .. .. **20p each**
50/50–385 .. .. .. **30p**
12,000/12, 32–32–50/300, 700/200 100–100–100–150–150/320 .. .. **50p each**
20–20–20/350 .. .. **40p each**

RS 100–0–100 micro amp null indicator
Approx. 2" x ¾" x ¾" **£1.50**

INDICATORS

Bulgin D676 red, takes M.E.S. bulb **20p**
12 volt Mains neon, red, pushfit **20p**
R.F. Scale Print, pressure transfer sheet **10p**

CAPACITOR GUIDE – maximum 500V

Up to .01 ceramic **2p**. Up to .01 poly **3p**. Up to 1000PF silver mica **5p**. 1,200PF up to .01 silver mica **10p**. .013 up to .25 poly etc. **4p**. .27 up to .68 poly etc. **6p**
Over 500 volt order from above guide and few others listed below.
6p. .1/600: **10p**. .01/1000, 1/350, 8/20, .1/900, .22/900, 4/16. .25/250 AC (600vDC) .1/1500 **40p**. 5/150, 9/275AC, 10/150, 15/150, 40/150.

TRIMMERS, 20p each

100PF Ceramic, 30PF Beehive, 12PF PTFE 2500PF 750 volt, 33PF MIN. AIR SPACED 50PF CERAMIC.

CONNECTOR STRIP

Belling Lee L1469, 4 way polythene. **3p each**

Strong grey plastic box same design as die cast ali 4⅜" x 2⅜" x 1¼" **40p**

1" or 1⅜" or ¾" CAN CLIPS .. **2p**

MAINS DROPPERS

36+79 ohm **15p**
66+66+158 ohm, 66+66+137 ohm
17+14+6 ohm, 266+14+193 ohm **20p**
50+40+1k5 ohm
285+575+148+35 ohm } **30p**
25+35+97+59+30 ohm

5¼" x 2¾" Speaker, ex-equipment 3 ohm **30p**
2 Amp Suppression Choke **5p**
3 x 2½ x 1/16" } **PAXOLINE** .. **2p**
4⅝ x ½ x ⅛", } .. .. .. **2 for 1p**
220K & 100 ohm 3 watt resistors .. **4p**
VALVE RETAINER CLIP, adjustable **2p**

OUTPUT TRANSFORMERS

Sub-miniature Transistor Type .. **25p**
Valve type, centre tapped or straight **40p**

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Open 10 a.m. till 7 p.m. Monday to Saturday – Also Sunday afternoons
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Whiteley Stentorian 3 ohm constant impedance volume control way below trade at **80p**
Drive Cord **1p per yd.**

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SEMICONDUCTORS

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

AC107	12p	BC179B	11p	BF180/1/2/3	15p	BSX20/21	13p
AC128	5p	BC184C	9p	BF184/5	15p	BSY40	28p
AC176	9p	BC186/7	13p	BF194/5/6/7	4p	BU105-01	93p
ACY28	18p	BC213L/214B	9p	BF194A/195C/200	10p	CV7042 (OC41 OC44, ASY63)	7p
AD149	40p	BC261B	10p	BF258/262/263	20p	GET111	40p
AD161/2 matched pr.	69p	BC327	12p	BF336	25p	OC35	32½p
AF116	12p	BC328	10p	BFS28 Dual Mosfet	92p	ON222	30p
AF124/6/7	20p	BC337/8	11p	BFW10/11 F.E.T.	26p	TIP30	43p
AF139/178/180/181	30p	BC547/558A	7p	BFW30	£1.35	TIP3055	50p
AF239	20p	BC548/557	9p	BFW57/58	20p	TIS88A FET	23p
ASY27/73	25p	BCX32/36	12p	BFX12	20p	ZTX300	5p
BC107A or B	9p	BCY40	60p	BFX29/30/84/88	16p	ZTX341	15p
BC107/8/9	6p	BCY70/1/2	9p	BFX89	35p	2N393/MA393	30p
BC108A/B/109B/C	10p	BD112/3/5/6	40p	BFY90	50p	2N706	6p
BC147/8/9	6p	BD131/2/3/5/7/9	30p	BR101 (Programmable Unj Junction)	30p	2N929	14p
BC147A/B	8p	BD201/2/3/4	£1.00	BRY39 (Programmable Unj Junction)	31p	2N987	35p
BC148A/B, 9B/C/S	8p	BD232/4/5	46p	BRY56 (Programmable Unj Junction)	34p	2N1507/2219	14p
BC157/8/9	6p	BDX77	£1.40	BSV64	40p	2N2401/2412/2483	25p
BC158A/B	11p	BF115	10p	BSV79/80 F.E.T.s	£1	2N2904/5/6/7	10p
BC159B/C, 157A	11p	BF167/173	10p	BSV81 Mosfet	90p	2N2907A	13p
BC178A/B	12p	BF178/9	20p			2N3053	13p
						2N3054/3055 (or equiv)	35p
						2N3133	18p
						2N3704	9p
						2N4037	35p
						2N5036	60p
						2SA141/2/360	31p
						2SB135/6/457	20p
						40250	60p

OTHER DIODES

1N916	6p
1N4148	1.5p
BA145/148	11p
Centercel	10p
BZY61	10p
BB103/110 Varicap	18p
BB113 Triple Varicap	60p
BA182	18p
OA5/7/10	10p
BZY88 Up to 33 volt	6p
BZX61 11 volt	16p
BR100 Diac.	19p

INTEGRATED CIRCUITS

TAA700	£2.95
741 8 pin d.i.l. op. Amp	18p
TAD100 AMRF	£1.00
CA3001 R. F. Amp	50p
TAA300 1wt Amp	£1.25
NE555v Timer	40p
TAA550 Y or G	31p
TAA263 Amp	65p
7400/2/10/20/30	11p
7404	12p
7414	45p
7438/74/86	25p
7483	80p
LM300, 2-20 volt	50p
74154	67p

BRIDGE RECTIFIERS

Amp	Volt			Amp	Volt		
½	1,600	BYX10	30p	2	30	LT120 type	30p
1	140	OSH01-200	20p	0.6	110	EC433	15p
1.4	42	BY164	28p	5	400	Texas	75p

RECTIFIERS

	Amp	Volt	
IN4004	1	400	3p
IN4005	1	600	4p
IN4006	1	800	4p
IN4007	1	1,000	4p
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	£1.00
BYX46-400*	15	400	£1.50
BYX46-500*	15	500	£1.75
BYX46-600*	15	600	£2.00
BYX20-200	25	200	60p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.50

*Avalanche type

TRIACS

Amp	Volt		
25	900	BTX94-900	£4.00
25	1200	BTX94-1200	£6.00

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

RS 2mm Terminals Blue & Black .... 5 for 40p

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

DLI Pal Delayline 50p

Relay socket 10p
Take miniature 2PCO relay

B7G or B9A valve can .. 2p

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

OPTO ELECTRONICS

BPX40	65p
BPX42	£1.00
BPY10	£1.00
(VOLTIAC)	
BPY68, BPY69, BPY77 Diodes	£1.00

Photo transistor

BPX29	£1.00
OCP71	30p

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

RED	13p
ORANGE, GREEN, YELLOW	15p

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp £1.00

THYRISTORS

Amp	Volt		
1	240	BTX18-200	23p
1	400	BTX18-300	25p
1	240	BTX30-200	23p
15	500	BT107	£1.00
6.5	500	BT101-500R	90p
6.5	500	BT109-500R	75p
20	600	BTW92-600RM	£3.00
15	800	BTX95-800R Pulse Modulated	£8.00
30	1000	28T10 (Less Nut)	£3.00

.3" red 7 segment L.E.D. 14 D.I.L. 0-9 + D.P. display 1.9v, 10m/a segment 65p

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

SOLDER

Multicore - 2½p foot

ENAM. COPPER WIRE

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

GARRARD GCS23T or GP93/1 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

RS 10 Turn Pot 1% 250, 500 Ω; 1, 50, 100K £1.50

Copper coated board 10" x 9" approx. 32p

TIE CLIPS

Nylon self locking 7" or 3½" 2p

CINCH 150

12 way edge socket 10p

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

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	7p	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 socket B260800A1R20 20p

3.5mm STEREO PLUG Metal screened 35p

Philips electronic engineer kits add on series E1004 £1.00 each

RS Yellow Wander Plug Box of 12, 25p

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

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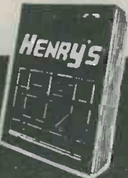

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Don't buy another electronic component until you've consulted the Henry's 1975 issue! It's packed with more items than ever before – over 5000 in all, making the Henry's range of electronic components the largest in the UK for the home constructor.
There are literally dozens of new lines and new ranges to get excited about! And many components are selling at reduced prices. Get your copy soon, and start reading these 200 pages of vital statistics about electronic components. If you don't, you'll miss out on a lot of kits, projects and test gear, apart from all the other products.

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DEMONSTRATIONS NOW IN ALL CENTRES!

TEXAN STEREO AMPLIFIER

Features glass fibre PC board. Gardners low field transformers. 6–Cls. 10-transistors plus diodes, etc. Designed by Texas instruments engineers for Henry's and P.W. 1972. Overall size 15¼ x 2¾ x 6¾ in. Mains operated. Free teak sleeve with every kit.

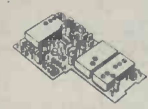
£35.00 inc VAT (p&p 50p) (also built and tested £45.00 inc VAT)

TEXAN STEREO FM TUNER

Features capacity diode tuning, LED and tuning meter indicators, mains operated. High performance and sensitivity. Overall size in teak sleeve 8 x 2¾ x 6¾ in. Complete kit with teak sleeve.

£26.25 (p&p 50p) (also built and tested **£31.20**)

AM/FM & DECODER BOARD



Containing Mullard Modules LP1185, LP1186 and LP1181 with MC1310 decoder IC on compact printed circuit board. Ready aligned, requires only Ferrite Aerial Tuning Gang and AM Oscillator Coil, Tuning Pot and Zener 15V supply, output 300mV, 75 ohms aerial input. Input circuit and instructions supplied.

£16.50 inc. VAT & Postage

UHF TV TUNERS

625 line receiver UHF transistorised tuners U.K. operation. Brand new. (Post packing 25p each)

TYPE B 4-button push button (adjustable) £4.60.
TYPE C variable tuning £2.90.
TYPE D 6-button UHF/VHF tuner £5.75

AM/FM MODULES

Combined AM/FM tuner modules, together with a small number of R + C's Ferrite Aerial, make up a sensitive FM/MW/LW tuner.
6 Volts supply, supplied with data and circuit sheets.

LP1179 LP1171

LP1171 combined IF strip £4.60
LP1179 FM front end and AM gang £4.60.
£8.62 the pair.
Suitable Ferrite aerial 87p.

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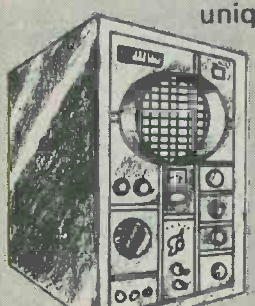

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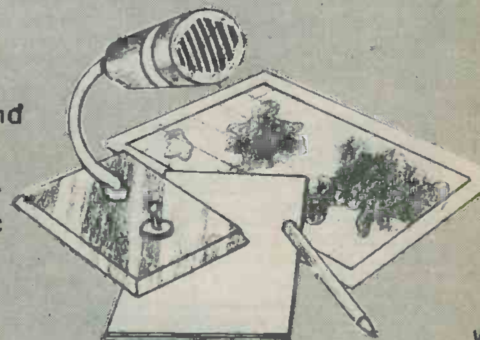

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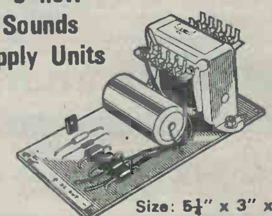

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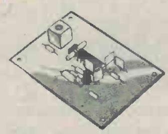
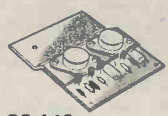


SS.202

SS.203



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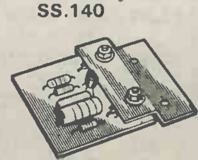

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BA154	*0.12	BY128	*0.16	OA81	*0.07	1N914	*0.06
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10	*0.13	*0.15	—	—	—	—	—	—	—	—
20	*0.15	*0.18	—	—	—	—	—	—	—	—
30	*0.19	*0.22	—	—	—	—	—	—	—	—
50	*0.22	*0.28	*0.20	*0.25	*0.36	*0.36	*0.48	*0.51	*0.54	*£1.18
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600	0.08	0.16	IN4005	0.09	0.16	0.33	*0.42	*£1.76
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PS	12	Jack ¼" Screened	0.20
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PS	14	Phono	0.09
PS	15	Car Aerial	0.14
PS	16	Co-Axial	0.14

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PS	23	D.I.N. 5 Pin 180°	0.19
PS	24	D.I.N. 5 Pin 240°	0.19
PS	25	Jack 2.5mm Plastic	0.16
PS	26	Jack 3.5mm Plastic	0.16
PS	27	Jack ¼" Plastic	0.28
PS	28	Jack ¼" Screened	0.32
PS	29	Jack Stereo Plastic	0.28
PS	30	Jack Stereo Screened	0.35
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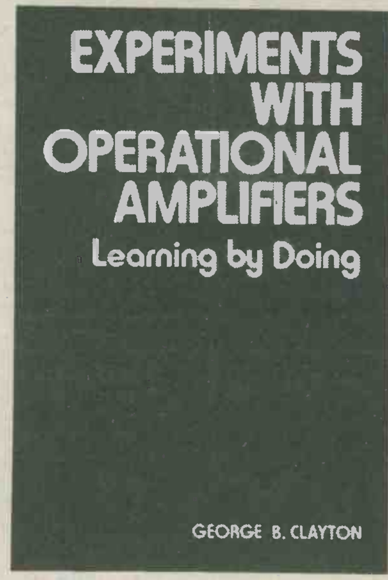

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FROM THE AUTHOR

'. . . the quickest way to learn about operational amplifiers is actually to use them in working circuits. It does not matter very much if a wrong connection is made in the experimental circuits, the operational amplifier type suggested for use in this book will tolerate quite a few mistakes and even if you destroy it it should not break you. If resistor values suggested in the circuits are not at hand try other values, electronic systems will work (in a fashion) with a considerable range of component values.

CONTENTS

1 Basic Operational Amplifier Ideas
2 Basic Operational Amplifier Applications
3 Operational Amplifier Circuits with a Non-linear Response
4 Some Signal Processing and Measurement Applications
5 Operational Amplifiers used in Switching and Timing Applications
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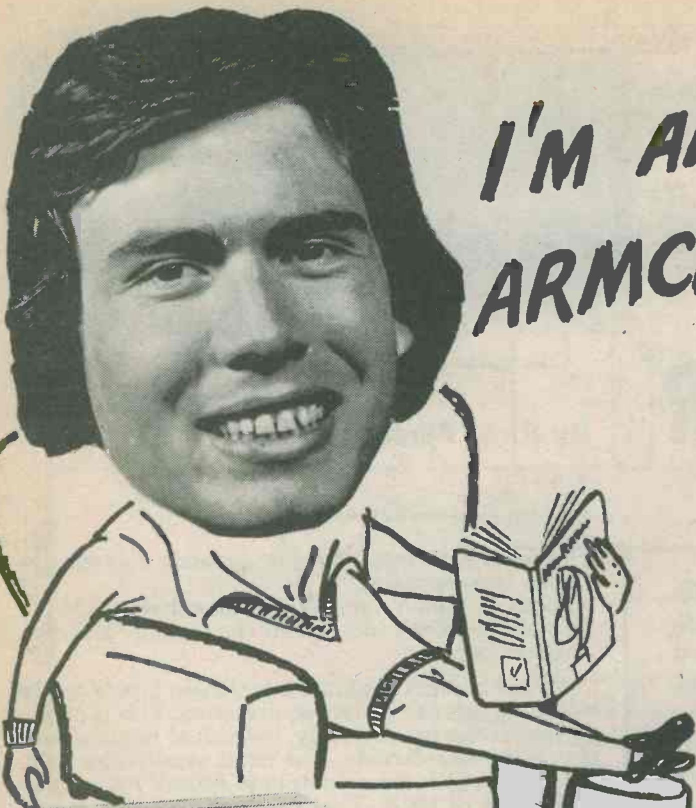

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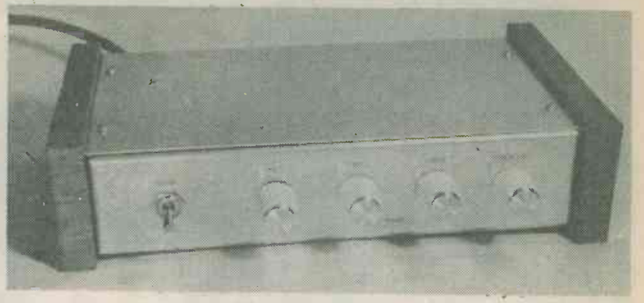


4 CHANNEL STEREO MIXER

By R. A. Penfold

A comprehensive design which allows four separate stereo signals to be combined at any required mixing level. A particularly attractive feature is that the constructor may adapt the circuit to obtain input impedances and sensitivities tailored to his particular requirements.

A multi-channel audio mixer is one of the most useful pieces of equipment to have around the audio workshop, especially if one is interested in tape recording or electronic music. Many would-be constructors are no doubt daunted at the prospect of building such a unit due to the circuit complexity of a mixer having integral pre-amplifiers and giving stereo operation.

The mixer described in this article has four stereo inputs as well as built-in pre-amplifiers, but by using modern integrated circuits the unit has been kept as simple as possible. Only three integrated circuits are used to provide an array of no less than ten amplifiers.

Approximate input sensitivities (r.m.s.) and impedances of the unit are as follows:

Input A, 0.2mV into 200Ω (for dynamic microphones),
Input B, 4mV into 50kΩ (for dynamic microphones with transformers),
Input C, 25m V into 100kΩ (for guitars, etc),
Input D, 135mV into 1.5MΩ (for ceramic pick-ups, tuners, etc.).

As will become apparent later, these inputs can be altered to suit particular requirements. This is an important factor as, obviously, individual requirements may vary considerably. The input sensitivities mentioned above are for an output of 500mV r.m.s. at an impedance of 100Ω. The pre-amplifiers have a considerable overload margin before serious distortion occurs.

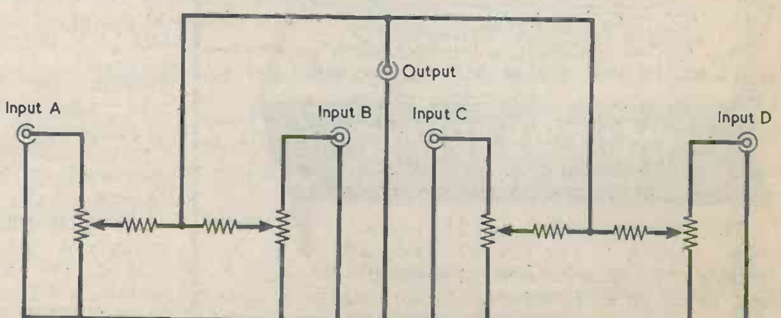
A mains power supply is employed, as the current consumption of 30 to 40mA at 12 volts would make battery operation uneconomic.

BASIC MIXER CIRCUIT

Fig. 1 shows the basic circuit of a four channel audio mixer. This is a simple passive network and is really an adding circuit, the output being the sum of the inputs.

Four equal value potentiometers provide individual gain controls for the four channels. The four fixed resistors give isolation between the potentiometers; if these were omitted the setting of each gain control would affect the output level of the other three channels. The values of the fixed resistors should be at least equal to the value of each potentiometer multiplied by the number of channels, and should preferably be a good deal greater than this to give really good isolation between the controls.

Fig. 1. A simple four channel passive mixing network. The fixed resistors should have values well in excess of those of the potentiometers.



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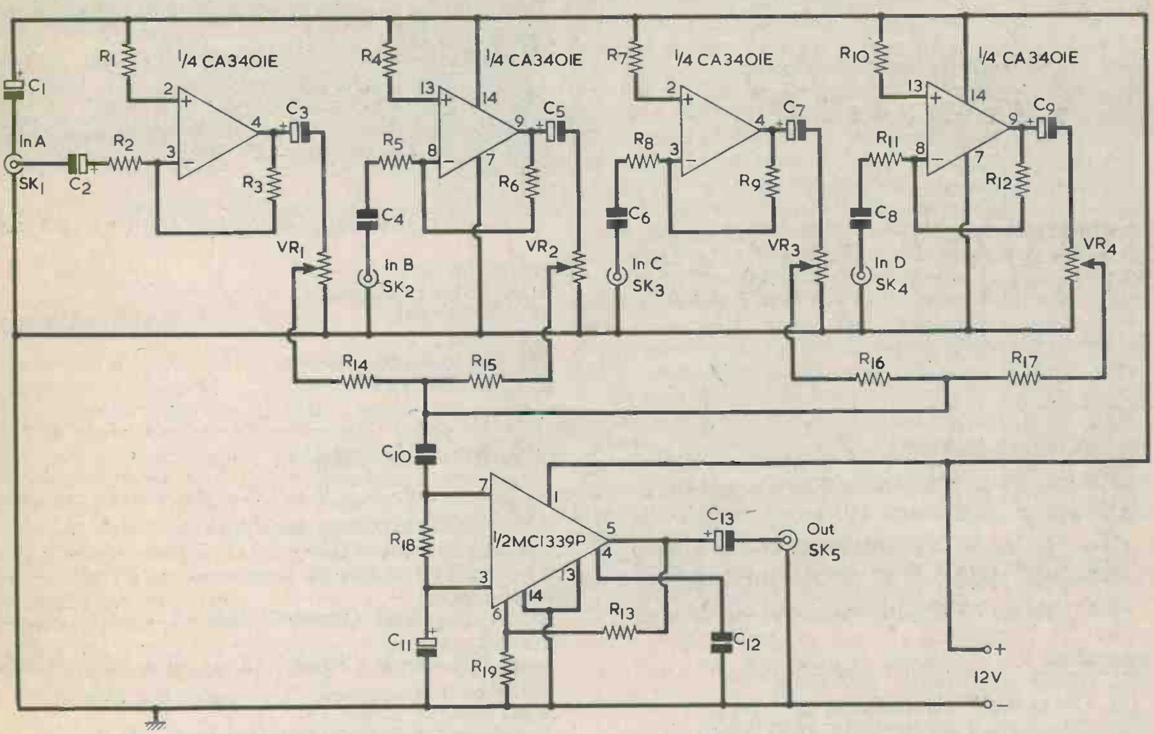

Fig. 2. The circuit of the left-hand channel of the stereo mixer, less the power supply. The right-hand channel is identical and employs the unused sections of the three integrated circuits

PRACTICAL CIRCUIT

The circuit diagram of the four channel stereo mixer is given in Fig. 2. This is less the power supply section, and is shown for one stereo channel only.

VR1 to VR4 and R14 to R17 form the actual mixing part of the circuit. A separate pre-amplifier is provided ahead of each potentiometer to give the required sensitivity and input impedance. The output from the mixer circuit is then fed to a further amplifier. This makes good the losses in the mixer and boosts the output to a high enough level to drive virtually any tape recorder or amplifier. It also provides the unit with a low output impedance.

Two R.C.A. CA3401E integrated circuits are used as the basis for the pre-amplifiers. Each of these i.c.'s comprises what are described as four operational amplifiers. However, although these have the usual inverting and non-inverting inputs, they cannot be used in quite the same circuit configurations as a conventional operational amplifier such as the 741.

These devices are intended to operate from a single rather than a double supply. They are biased by a resistor connected between the output and the inverting input, and a second resistor which connects between the non-inverting input and the positive supply rail. The resistors can have values lying between a few kilohms and a few megohms. The input signal is coupled to the inverting input of the amplifier via a d.c. blocking capacitor and a third resistor.

This third resistor determines the input impedance of the circuit and also helps to determine the voltage gain. Selecting resistor values for specific input impedances and gains is extremely simple. The resistor in the input circuit is given the value of the required input impedance. This value is then multiplied by the required voltage gain and the result gives the value of the resistor which connects between the output and the inverting input. The remaining bias resistor is approximately double this value.

As will be seen by referring to Fig. 2, all four pre-amplifiers use this simple arrangement. The circuit has purposely been designed this way so that the pre-amplifiers can be easily adapted to suit individual requirements. If, for instance, a mixer for four dynamic microphones were required, this would be achieved by simply using the component values shown for the dynamic microphone pre-amplifier in all the pre-amplifiers. By following the details just given, one could also design for input sensitivities and impedances to meet other requirements, within reason, while still retaining the physical component layout of the prototype.

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COMPONENTS

Resistors

(All fixed values miniature ¼ watt or ⅛ watt 5%)

R1, R1(a) 100kΩ
R2, R2(a) 220Ω
R3, R3(a) 56kΩ
R4, R4(a) 1MΩ
R5, R5(a) 47kΩ
R6, R6(a) 560kΩ
R7, R7(a) 390kΩ
R8, R8(a) 100kΩ
R9, R9(a) 220kΩ
R10, R10(a) 1MΩ
R11, R11(a) 1.5MΩ
R12, R12(a) 560kΩ
R13, R13(a) 3.3kΩ
R14, R14(a) 47kΩ
R15, R15(a) 47kΩ
R16, R16(a) 47kΩ
R17, R17(a) 47kΩ
R18, R18(a) 39kΩ
R19, R19(a) 82Ω
R20 470Ω
VR1, VR1(a) 5kΩ potentiometer, log, 2-gang
VR2, VR2(a) 5kΩ potentiometer, log, 2-gang
VR3, VR3(a) 5kΩ potentiometer, log, 2-gang
VR4, VR4(a) 5kΩ potentiometer, log, 2-gang

Capacitors

C1 100μF electrolytic, 16V Wkg.
C2, C2(a) 32μF electrolytic, 10V Wkg.
C3, C3(a) 10μF electrolytic, 16V Wkg.
C4, C4(a) 0.47μF plastic foil, type C280 (Mullard)
C5, C5(a) 10μF electrolytic, 16V Wkg.
C6, C6(a) 0.1μF plastic foil, type C280 (Mullard)
C7, C7(a) 10μF electrolytic, 16V Wkg.
C8, C8(a) 0.047μF plastic foil, type C280 (Mullard)
C9, C9(a) 10μF electrolytic, 16V Wkg.
C10, C10(a) 0.47μF plastic foil, type C280 (Mullard)
C11, C11(a) 100μF electrolytic, 10V Wkg.
C12, C12(a) 2,200pF polystyrene
C13, C13(a) 10μF electrolytic, 16V Wkg.
C14 1,000μF electrolytic, 25V Wkg.
C15 400μF electrolytic, 16V Wkg.

Transformer

T1 Mains transformer, secondary 6-0-6V at 100mA

Semiconductors

IC1, IC1(a) CA3401E
IC2 MC1339P
TR1 2N5172
D1-D4 1N4002
D5 BZY88C13V

Switch

S1(a)(b) d.p.s.t. toggle

Sockets

SK1, SK1(a) 3.5mm. jack socket
SK2-SK5 3-way DIN

Miscellaneous

2-off "Universal Chassis" sides, 2 x 14in. (Home Radio)
2-off "Universal Chassis" plates, 5 x 10in. (Home Radio)
4-off control knobs
Veroboard, 0.1in. matrix (see text)
Veroboard, 0.15in. matrix (see text)
Veropins (for 0.1in. Veroboard)
Aluminium sheet, for screen
Screened wire
3-core mains lead
Hardware, materials for case, etc.

OUTPUT AMPLIFIER

The output amplifier is based on the Motorola MC1339P integrated circuit, which is an inexpensive high quality low noise stereo pre-amplifier. It has a typical channel separation of 70dB and an open loop gain of 66dB.

Each of the input pre-amplifiers has an output of 50mV, but after the attenuation of the mixer network this is reduced to only about 12.5mV. The output amplifier therefore needs a voltage gain of about 32dB or 40 times, to raise the output to the required 500mV level. The ratio between the feedback resistors R13 and R19 sets the voltage gain at approximately this level.

C12 provides high frequency roll-off and prevents the circuit from oscillating at an ultrasonic frequency. The input of the device receives a bias current via R18 and an internal resistor in the i.c. C11 prevents a.c. negative feedback via these resistors, and the remaining high level of d.c. feedback produces very stable biasing.

Signals at the output of the mixer network are coupled to the input of the i.c. via C10, and the output of the i.c. is taken via C13 to the output socket.

As the MC1339P has internal supply filtering and regulation, C1 is the only discrete decoupling component that is required for the complete circuit.

The pin functions for the CA3401E and MC1339P are shown in Fig. 3. A regulated output is available at pin 2 of the MC1339P, but this is not employed in the present circuit and no connection is made to the pin. Both the i.c.'s are available from several retail sources.

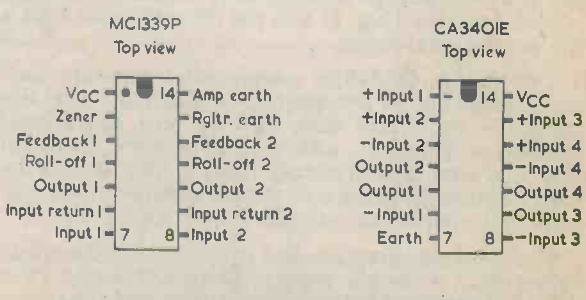

Fig. 3. Pin functions of the integrated circuits employed in the four channel mixer

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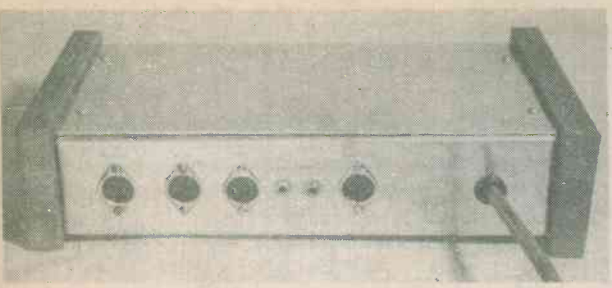

The rear of the mixer unit, illustrating the input and output sockets

POWER SUPPLY

The circuit diagram of the mains power supply section is shown in Fig. 4.

T1 is a mains transformer with a 6-0-6 volt secondary. The centre-tap on this secondary is ignored. D1 to D4 provide full-wave rectification and C14 provides smoothing. R20 and D5 produce a stabilised 13 volts, which is applied to the base of TR1. This is the emitter follower supply output transistor and, with a drop of almost 1 volt between its base and emitter, gives a low impedance output of fractionally more than 12 volts.

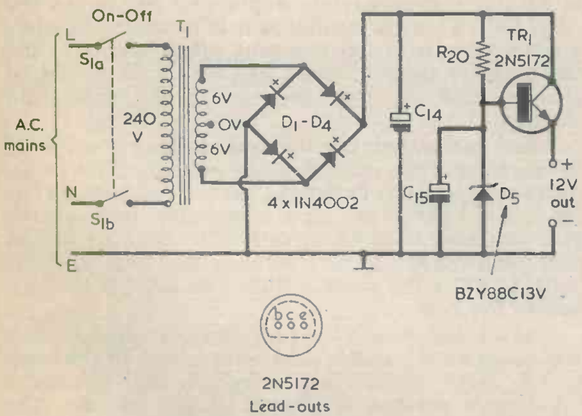

Fig. 4. The circuit of the power supply section

COMPONENTS

The accompanying Components List shows all the parts required for the stereo mixer. Since there are two stereo channels a number of components are duplicated, and this is indicated by listing a second component with the suffix '(a)'. The choice of stereo channel is quite arbitrary, and it will be assumed that the components without a suffix letter appear in the left-hand channel, whilst those with the suffix '(a)' are in the right-hand channel. The potentiometers VR1, VR1(a) to VR4, VR4(a) are four two-gang potentiometers. Four of the sockets, SK2 to SK5, are 3-way types common to both channels.

CASE CONSTRUCTION

An attractive home-made case for the mixer is easily constructed from Home Radio "Universal Chassis" members. Two 14in. by 2in. sides form the main framework of the case, and these are drilled as detailed in Fig. 5.

In the prototype mixer 3-way DIN sockets are used for SK2 to SK5, and 3.5mm. jack sockets are used for SK1 and SK1(a). These can of course be altered to other types should it be felt necessary. The hole for the mains input lead is fitted with a grommet.

Four 90° sections are cut out of the two flanges of each "Universal Chassis" side, two out of each flange. These are removed 2½in. from the flange ends, as shown in Fig. 5. The two members can then easily be bent at right angles at these points to form two U-shaped pieces. These are bolted together using short 4BA bolts with nuts. The method of assembly is shown clearly in the photographs of the interior. The pieces should be bolted together such that the holes for S1 and the mains lead are both at the left side of the case, as seen from the front.

Next, cut out two 5½ by 2½ by ½in. pieces of chipboard, and cover these with a self-adhesive plastic material having a wood-grain pattern. These are then screwed to the ends of the framework, to produce a case of the "book-ends" type.

Two 10in. by 5in. "Universal Chassis" plates form the top and bottom panels of the case. These are cut

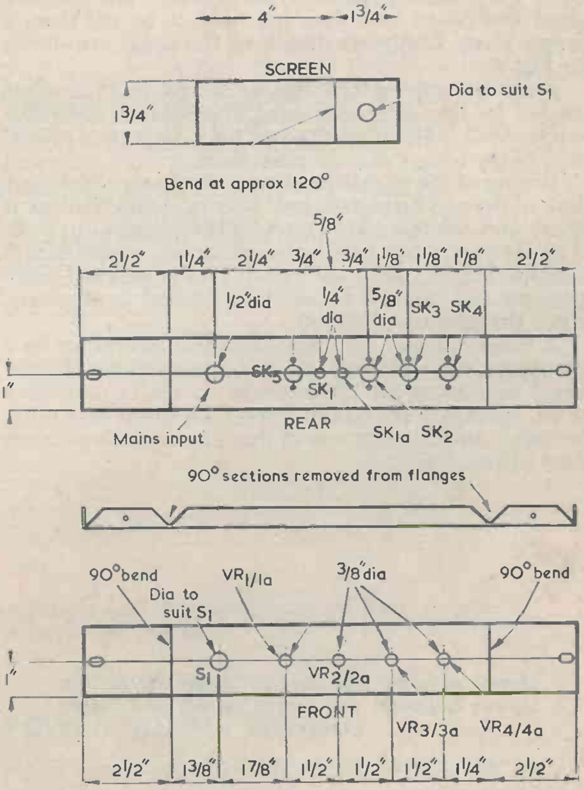

Fig. 5. Details of the screen and the two chassis members which, after bending, form the sides of the case

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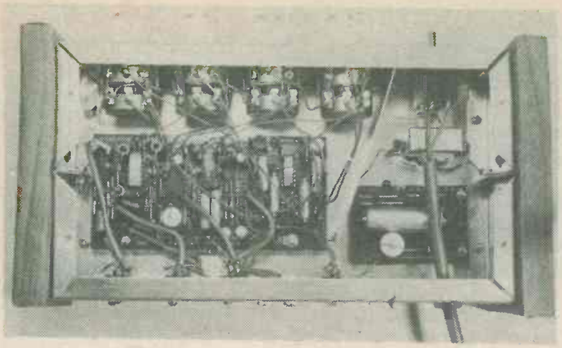

Looking down into the chassis. The positioning and orientation of the two Veroboard panels is clearly visible here

down in length so that they become a snug fit between the end cheeks of the case. The base plate is bolted to the bottom set of flanges of the case by four short 6BA bolts with nuts. The top plate is secured to the upper set of flanges using four self-tapping screws.

An internal screen shields the power supply section from the mixer circuitry. This is very easily made from 16 to 24 s.w.g. aluminium, as shown in Fig. 5, and it is secured behind the front panel on the mounting bush of S1.

MAIN CIRCUITRY

The bulk of the circuitry is assembled on a 5 by 2½in. Veroboard panel of 0.1in. matrix. This is a standard size board and does not need to be cut from a larger piece. Complete details of the panel are shown in Fig. 6.

Start by cutting the copper strips at the points shown in the diagram, using the special spot face cutter tool. Then drill the two 6BA clearance mounting holes with a No. 31 twist drill.

Wiring of the panel can then commence. The longer link wires are insulated, and it is probably easiest if these and the integrated circuits are soldered in first. The latter are not fitted in sockets but are carefully mounted direct onto the panel. The remaining components can then be fitted and soldered, one by one, until the panel is finished.

A large number of components are assembled in a comparatively small space, and a soldering iron having a miniature bit ($\frac{3}{32}$in. or less) is really necessary when wiring up the panel. Even then, great care must be taken not to bridge any of the copper strips with excess drips of solder.

Veropins are used where leads from the potentiometers and sockets, etc., connect to the panel. The negative supply is carried to the panel via a lead which connects to a 6BA solder tag secured under one of the mounting nuts for the panel.

Eight leads are indicated in Fig. 6 as connecting to VR1 to VR4(a). These leads connect to the maximum volume (i.e. non-earthy) ends of the tracks of these potentiometers. Since R14 to R17 all have the same value the sliders of the left-hand channel potentiometers can connect to any of these and do not necessarily have to follow the circuit diagram. In consequence, the four sliders of VR1 to VR4 connect to any of the four points marked "L.H. IN". The same applies to R14(a) to R17(a), and the sliders of VR1(a) to VR4(a) can connect to any of the points marked "R.H.IN". To avoid confusion it is necessary to adopt a convention with the two-gang potentiometers, and the front sections of these can be in the left-hand channel and the rear sections in the right-hand channel.

When completed, the Veroboard panel is mounted on the base of the cabinet using two 1½in. 6BA bolts, with the bolt heads under the base. It is positioned as far to the right of the case as possible, between the gain controls and input sockets. Extra nuts are placed over each mounting bolt between the base and the panel to space the panel a little way clear of the bottom of the case.

The wiring between the gain controls, input sockets and component panel is then completed. All the leads to the input sockets are screened, and the outer braiding is earthed to chassis at the sockets. The earthy ends of the gain control potentiometer tracks,

Detail showing the position taken up by the screen between the power supply and signal sections

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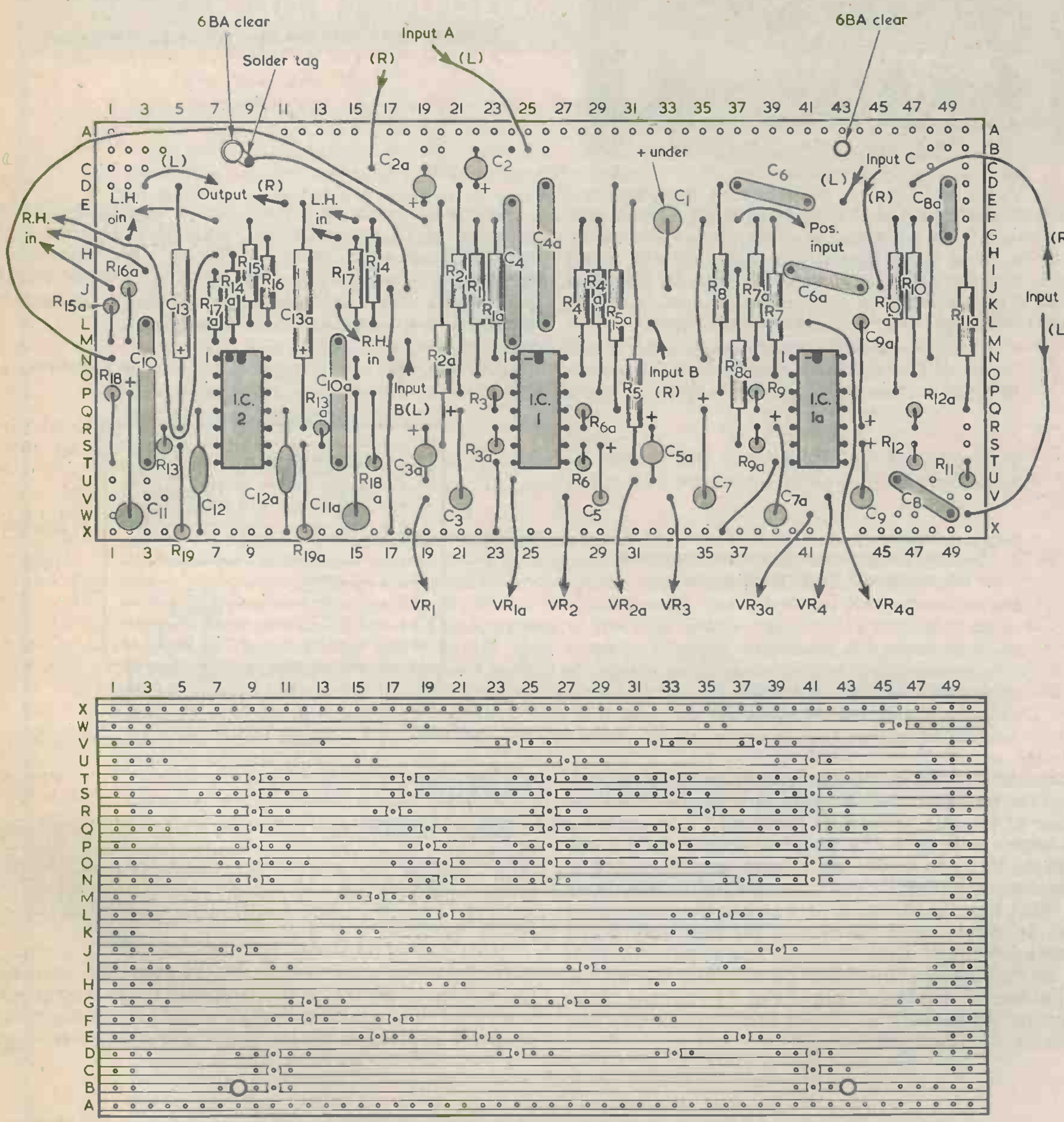

Fig. 6. The mixer components are assembled on a Veroboard panel. Connections to the input sockets and the gain controls are described in the text

both left and right channel, are all connected together, and are then taken to chassis at a solder tag at the VR4/4(a) end, the tag being held under one of the nuts securing the base plate. The wiring between the potentiometers and the component panel does not have to be screened, but the leads should be kept as short and direct as is reasonably possible.

POWER SUPPLY WIRING

The power supply section, apart from the mains transformer, is wired up on a 0.15in. matrix Veroboard panel having 11 by 16 holes. The copper strips run across the width of the board and none of these are cut. Details of the panel are given in Fig. 7.

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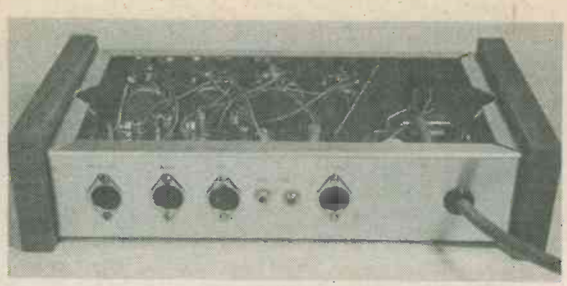

A view from the rear with the cover removed

Start construction of this by cutting an 11 hole section of board from a piece 2½in. wide, then drill out the two 6BA clear mounting holes. The various components and the single link wire can then be soldered in position.

Next connect the two secondary leads from transformer T1. Solder a lead from the negative output on the panel to a solder tag which can be fitted under one of the mounting nuts securing T1. Fit, also, a lead which will take the positive output to the appropriate Veropin on the main component panel. The power supply panel is then mounted by means of two 1½in. 6BA bolts in the same way as was the component panel. It should be to the rear of the case and on the extreme left-hand side. Connect the positive output lead to the main component panel, then mount T1 just behind S1. Fit the screen of Fig. 5 by means of the mounting bush of S1, so that it takes up the position shown in the photographs.

To complete the unit, the 3-core mains lead and the primary of T1 are wired up, with S1 in the live and neutral leads as indicated in Fig. 4. The mains lead earth wire is soldered to the tag under the mounting nut for T1. The mains lead should be correctly terminated in a fused 3-way plug.

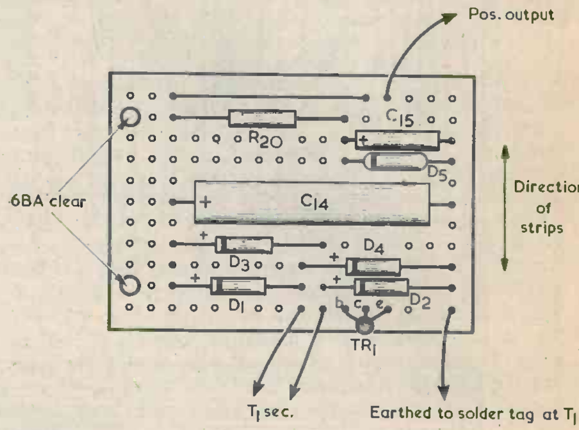

Fig. 7. The power supply components are wired up on a second Veroboard panel

TESTING

Before turning the unit on, check all the wiring thoroughly then connect a multimeter switched to read voltages around 12 volts across the supply rails. Upon switching on this should give a reading of 12 volts. If a significantly different reading is obtained, switch off at once and recheck the wiring.

If and when a correct reading is obtained, connect the output of the mixer to an amplifier via a screened lead, and then confirm that all eight inputs are being properly controlled by the four potentiometers. ■

BACK NUMBERS

For the benefit of new readers we would draw attention to our back number service.

We retain past issues for a period of two years and we can, occasionally, supply copies more than two years old. The cost is the cover price stated on the issue, plus 11p postage.

Before undertaking any constructional project described in a back issue, it must be borne in mind that components readily available at the time of publication may no longer be so.

We regret that we are unable to supply photo copies of articles where an issue is not available. Libraries and members of local radio clubs can often be very helpful where an issue is not available for sale.

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RECENT PUBLICATIONS

HI-FI LOUDSPEAKERS AND ENCLOSURES, 2nd Edition. By Abraham B. Cohen. 448 pages, 210 x 135mm. ($8\frac{1}{4}$ x $5\frac{1}{4}$in.) Published by Newnes-Butterworths. Price £5.80.

The arrival of this book on the reviewer's desk was like the re-appearance of an old friend, since in the past he has obtained much help and information from it in its first edition form. Appearing now as an extensively revised and updated second edition, the book covers recent advances in stereo reproduction, dealing also with three-element stereo and advances in enclosure design.

The book is divided into five parts, the first four of these discussing the loudspeaker, the enclosure, the listening room and stereo practice. The fifth part describes acoustic measurements and the building of enclosures. In the latter instance dimensioned drawings are given for no less than 27 different enclosures, the constructional information for which was provided by seven leading loudspeaker manufacturers.

This work is of an authoritative nature and will be of especial value to the home-constructor who is interested in high fidelity reproduction and to the owner or prospective purchaser of a packaged audio system. It is extensively illustrated with clear line drawings and photographs, and the text is at all times straightforward and lucid.

TRANSISTOR ELECTRONIC ORGANS FOR THE AMATEUR, 3rd Edition. By Alan Douglas, Sen.M.I.E.E.E., A.I.S.O.B. and S. Astley. 127 pages, 135 x 220mm. ($5\frac{1}{4}$ x $8\frac{1}{2}$in.) Published by Pitman Publishing Ltd. Price £4.50.

This third edition of ***Transistor Electronic Organs For The Amateur*** has been completely revised for its present printing. As with the previous editions the emphasis is towards providing information which will be of assistance to the amateur constructor and designer of electronic organs.

The first chapter of the book deals with the terminology employed in the field of organs whilst the second gives an introduction to transistor basics. The third chapter, devoted to electronic organ designs, is the longest in the book and takes in power supplies, oscillators, frequency dividers, vibrato, waveshaping and other relevant aspects of organ functioning. Integrated ciruits encountered in this chapter include the TCA430-N, which can provide four RC oscillators, the SAJ110 seven-stage frequency divider and the TCA250A double filter amplifier. The fourth chapter provides further transistor organ circuits whilst the fifth and last deals with miscellaneous experimental circuits, amplifiers and speakers.

There are five appendices which give colour coding, a frequency table for tonal derivations, a glossary of organ stops, a table relating British and American instrument wires and a nomogram for inductive and capacitive resonance at audio frequencies.

PRACTICAL TRIAC/SCR PROJECTS FOR THE EXPERIMENTER. By R. W. Fox. 197 pages, 215 x 130mm. ($8\frac{1}{2}$ x $5\frac{1}{4}$in.) Published by Foulshan-Tab Limited. Price £1.80.

This book consists of an American text with an introductory chapter for English readers, and it covers the whole field of triggered solid-state devices. In addition to the triacs and SCR's in the title these include diacs, unijunction transistors, programmable unijunction transistors, silicon unilateral switches and silicon bilateral switches.

The theoretical treatment in the book can be of considerable help to a technician or experimenter commencing work with these devices and there are very many practical working circuits illustrating the various ways in which trigger devices can be controlled. These are dealt with broadly in terms of static control and phase control. Other sections of the book cover motor control circuits, the heat-sinking of thyristors and the choice of thyristors for particular applications.

Some of the circuits dealing with a.c. mains switching and control are applicable to American 117 volt 60Hz supplies, but this does not detract greatly from what is an informative and detailed work.

SERVICING TRANSISTOR RADIOS. By Leonard D'Airo. 230 pages, 215 x 130 mm. ($8\frac{1}{2}$ x $5\frac{1}{4}$in.) Published by Foulsham-Tab Limited. Price £1.95.

This is another book having an American text with an introductory chapter for English readers. It is also a book which was written quite some years ago, although it has now been re-issued in 1975.

These points having been made the book, whilst not being fully representative of the present scene, nevertheless provides a useful introduction to transistor operation and to transistor receivers. Much of the servicing information is straightforward and sensible, and is applicable in general to almost any generation of radio receiving equipment. It is apparent that this book has been popular over the years and this factor may well be the reason for its appearance now.

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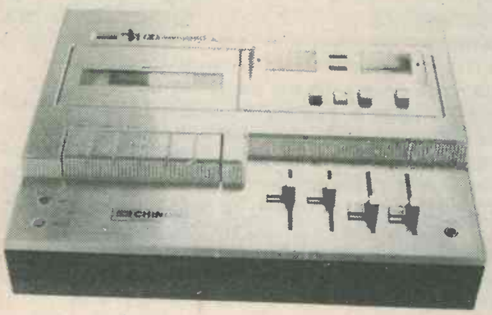
NEWS . . . . AND .

NEW RANGE OF CHINON HI-FI EQUIPMENT



A completely new range of hi-fi equipment has been launched by Dixons under their exclusive Chinon brand name. This new equipment is also available in Wallace Heaton shops — part of the Dixons Group.

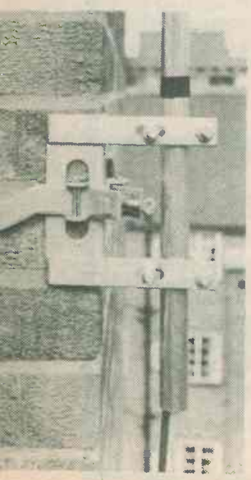
We show in the accompanying photograph the Chinon TC5000D Cassette Deck. A switchable Dolby noise reduction circuit is built into the TC5000D. This deck, too, has facilities for both normal and chrome tape. The twin 'VU' meters are supplemented by peak signal warning indicators. Separate sliding level controls are provided for recording from microphones or auxiliary sound sources making Mic/Line mixing possible. In addition to the usual digital tape counter the TC5000D has a built-in Memory system. A button — operated switch, coupled with the auto stop facility, enables a specific point to be fixed on a cassette — in either recording or playback mode — so that the cassette stops automatically at the pre-determined point on the tape. Price £99.95.

NEW TECHNOLOGY FOR OLD ESTABLISHED FOOTBALL CLUB

One of the founder-members of the Football League, first division Aston Villa, are to become the next football club to equip with a GEC 2050 seat reservation system from GEC Computers Limited. An order has been placed for a system to be installed early next year.

Aston Villa's present box office methods are manual and involve a considerable amount of handling, sorting and storing of books of pre-printed tickets. The new GEC 2050 system will enable box office staff to rapidly call up a visual display showing the state of sale of any chosen block of seats for any forthcoming match. Tickets are printed on the spot as required and, simultaneously with the action of printing, accountancy and statistical records are updated on the computer memory automatically. No specialist computer knowledge is necessary to operate the system.

INGENIOUS AERIAL MAST FIXING FROM RAWLPLUG



The Rawlplug Company Limited have just released an ingenious new fixing for television and radio aerial masts. Called the Rawlplug SSB1, the new self-supporting bracket outdates the traditional and time-consuming lashing kit. With the SSB1, aerial rigs can be safely and strongly fixed in less than two minutes.

The SSB1 is ready assembled and features two adjustable arms which are clipped into the mortar joints of brickwork and locked by a single bolt.

The SSB1 offers professional aerial riggers more rigging opportunities a day and yet is simple enough for the do-it-yourself enthusiast.

Ideal for the majority of domestic aerial installations, the Rawlplug SSB1 has a recommended retail price of £2.21 plus VAT at 8%. Trade enquiries to Roger Walker, The Rawlplug Company Limited, Rawlplug House, 147 London Road, Kingston-upon-Thames, Surrey, KT2 6NR.

SSB1 Product Manager, Roger Walker, demonstrates his complete faith in the product on the 4th floor of Rawlplug House.

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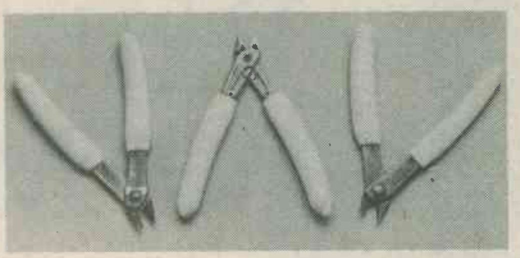
VEROELECTRONICS LEADSHEARS



Vero Electronics Ltd of the Industrial Estate, Chandler's Ford, Eastleigh, Hants have announced the introduction of their Leadshear range of low cost, high quality cutters. Leadshears have been designed to offer a long life with efficient economical cutting of wire.

A quick return spring allows continuous operation without adjustment. The cutters themselves are oil hardened and are fitted with non-slip light weight grips for ease of use.

Type 74-0476D has a unique cut'n'catch action which guarantees against flying ends and thus meets the new safety requirements which are being applied in industry. All types are available on an ex-stock basis.

WORLD RADIO CLUB

Consequent upon a recent World Radio Club broadcast in the BBC's World Service, in which our Technical and Production editors were guests, we have taken an increasing interest in this weekly transmission. Although primarily intended for overseas listeners, the programme can be picked up satisfactorily in most parts of the UK. In addition to giving information of use to DX listeners, technical matters of interest are dealt with in an informative and not too technical fashion, and are therefore of particular value to less advanced constructors. In the broadcast received just before these notes were written, the subjects of resonance and aerial tuning units were dealt with in an easily assimilated manner.

Broadcasts are on Wednesdays at 13.30 repeated on Sundays at 08.15 G.M.T. In Southern and Eastern England we found reception was best on 276 metres, and in the West Country on 49 metres.

Readers interested in becoming members of the World Radio Club should write to World Radio Club, BBC World Service, Bush House, London.

LASERS MEASURE RUST

Lasers have been used in a novel way for measuring in an inaccessible part of a nuclear power station. Britain's Central Electricity Generating Board has devised an instrument, cylindrical in shape and only 150 millimetres in diameter which can be lowered into steel tubes to check for corrosion, it was reported on a BBC science programme.

It contains two lasers. One laser produces pulses of focused which actually blast a tiny hole in the rust. The other laser a beam of light into the hole. The instrument can detect the light which is reflected back when the bright metal underneath the rust is exposed. The number of laser pulses needed to penetrate the rust is an indication of its thickness.

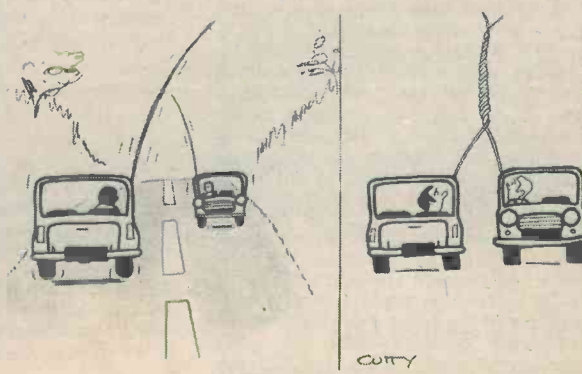
Dr D. T. Swift-Hook, who described the instrument at a meeting at the Royal Society in London, said that it was like measuring rust by scraping it off with a penknife — but more accurate.

HENRY'S-LINDAIR OPERATE NEW 'PART EXCHANGE SCHEME'

Henry's-Lindair, one of Europe's largest hi-fi and audio retail groups, operate a new Part Exchange Department within the group. This scheme is one more step in the planned expansion programme of the company which coincides with the opening of two new units in Reading and Notting Hill Gate, London.

While Part Exchange has been an accepted part of allied electrical goods retailing, there is no such 'trade-in' facility for customers in the hi-fi and audio business which gives customers the opportunity to offset the cost of their new equipment with such a straightforward transaction in one store.

Customers who bring their old equipment into any Henry's-Lindair store will be given a reasonable 'trade-in' allowance by fully trained salesmen which they may then use against the purchase of new equipment from that particular store. The trade-in equipment will then be passed to the Service Department, if necessary, where it will be tested and overhauled. It will then be sold through one of the group's newly established Bargain Centres in Edgware Road and Tottenham Court Road, London, with a three months guarantee.



SUGGESTED CIRCUIT 303

Battery Voltage Monitor

By G. A. French

It is common practice in battery operated test equipment to fit a simple zener diode voltage stabilizer circuit for any stages which require a constant supply voltage. In many instances this consists of a zener diode coupled to an emitter follower. Alternatively the circuit may quite simply employ a zener diode on its own.

The only disadvantage with these circuits is that if the supply voltage is not monitored it may fall, as the battery ages, to a level which is too low for the stabilizing action to take place. The user of the test equipment may continue to employ it unaware that the stabilized voltage is no longer present, whereupon the equipment may offer incorrect readings or results.

This article describes a comparator circuit which causes the stabilized voltage to be abruptly reduced to a very low value when the supply battery voltage falls to a predetermined level. Thus, as soon as battery voltage approaches the level at which stabilization ceases, the equipment shuts down and will not function until a new battery has been fitted.

ZENER CIRCUIT

A typical zener diode and emitter follower circuit is illustrated in Fig. 1. In this, a small current flows via R1 into the zener diode ZD1, across which a stabilized voltage appears. The junction of R1 and ZD1 connects to the base of the transistor TR1, the emitter of which feeds the stabilized voltage, less the voltage dropped in the base-emitter junction, to the stage or stages being supplied. The circuit has the merit that nearly all of the stabilized supply current flows through the transistor, whereupon the current flowing in R1 alters only slightly despite wide changes in the current drawn from the transistor emitter. Also, the zener diode current can be kept low, thereby giving an economy in overall battery current.

Fig. 2 shows the stabilizing circuit of Fig. 1 modified to function as a battery voltage monitor. The components which are added are a 741 operational amplifier functioning as a voltage comparator, a pre-set potentiometer, a fixed resistor and another zener diode. The idea of using a 741 i.c. as a battery voltage comparator is not new, and was employed in the "Battery Condition Indicator" described by P. R. Arthur in the October 1975 issue of this journal. The present circuit differs from the previous design, which caused a light-emitting diode to be illuminated at the pre-set battery voltage level.

Circuit operation in Fig. 2. is very simple. The stabilized voltage across ZD2 is applied to the inverting input of the i.c. whilst the voltage on the slider of R2 is applied to the non-inverting input. When the non-inverting input is positive of the inverting input the i.c. output is fully positive, allowing a current to flow through R1 to ZD1, whereupon the stabilized voltage is present, as in Fig. 1, at the emitter of TR1. When the non-inverting input is negative of the inverting input the i.c. output swings fully negative, whereupon the voltage across ZD1 and that at the emitter of TR1 falls to a very low level. R2 is adjusted such that the changeover in i.c. output occurs when the battery voltage is at the minimum level for which satisfactory stabilization can take place.

In practice the voltage at the 741 output, when this is fully positive, is approximately 0.8 volt below the voltage on the positive supply rail. When it is fully negative the 741 output is about 1.75 volts above the negative rail. The output can readily supply currents up to some 10mA or so for R1 and ZD1.

COMPONENTS

In Fig. 2, TR1, R1 and ZD1 may be the same components that would be employed in the circuit of Fig. 1. R2 can be a small skeleton pre-set potentiometer and R3 a ¼watt 10% resistor. ZD2 may be a zener diode from the BZY88 series, having a zener voltage approximately equal to half the battery voltage. Thus it may be BZY88C4V7 for a 9 volt battery. The 6.2 volt version may be used for a 12 volt supply and the 7.5 volt version for a 15 volt supply.

Fig. 2 shows the 741 in its 14 pin d.i.l. form. The 8 pin package may

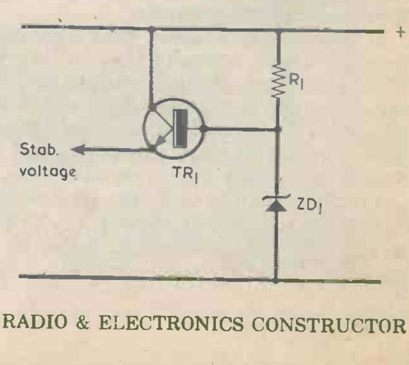


Fig. 1. A standard voltage stabilizing circuit for battery operated equipment

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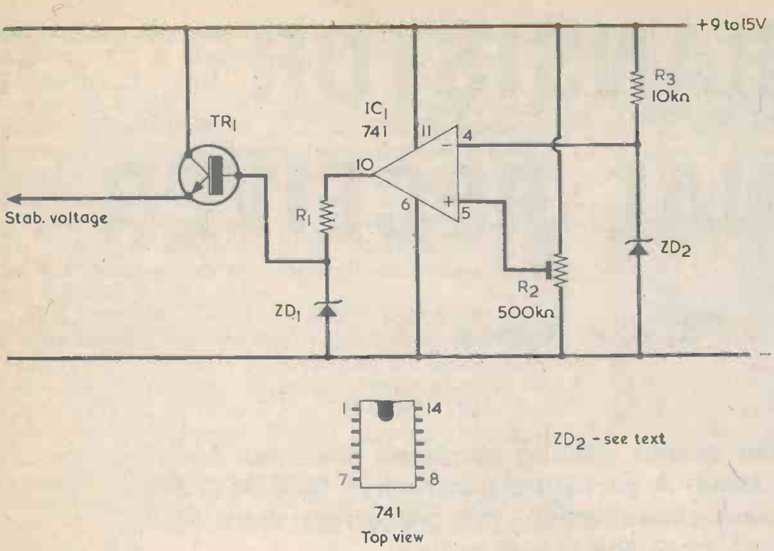

Fig. 2. The stabilizing circuit modified to function as a battery voltage monitor

alternatively be employed. With this, pin 2 is the inverting input, pin 3 the non-inverting input and pin 6 the output. Also, pin 7 of the 8 pin package connects to the positive supply and pin 4 to the negative supply.

To set up the circuit, R2 slider is initially set to the centre of its travel and a voltage equal to that at which it is desired the circuit should trip is applied to the supply rails. A testmeter switched to a suitable volts range is connected between the 741 output and the negative supply rail. If the i.c. output is high the slider of R2 is moved slowly towards the negative end of its track until the point is reached at which the output suddenly changes to the low state. Conversely, if the i.c. output is low the slider of the potentiometer is moved towards the positive end of the track until the point of changeover is reached.

If the battery supply is in excess of 15 volts it is preferable to insert resistors in series with R2 as illustrated in Fig. 3. This circuit is suitable for battery voltages up to 24 volts. Again, ZD2 should have a zener voltage approximately equal to half the battery voltage.

The current drawn from the supply by the 741 circuit is approximately 1.2mA at 9 volts, rising to about 2.6mA at 24 volts. ■

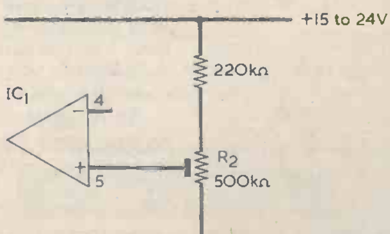

Fig. 3. Resistors should be inserted in series with R2 if the supply voltage is high

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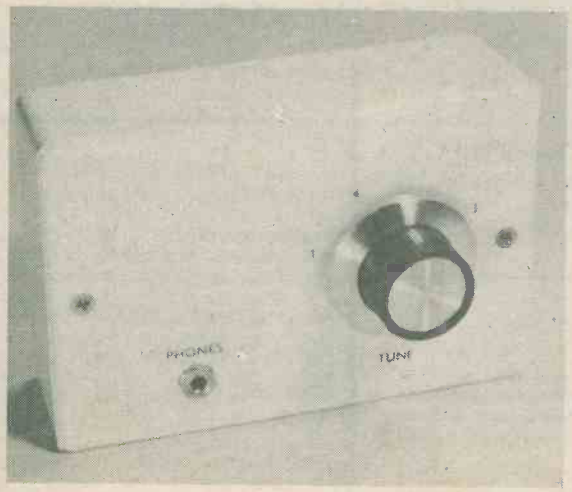
2 TRANSISTOR PERSONAL RECEIVER

By A. P. Roberts

A simple receiver design offering earphone reception on the medium wave band. A particularly attractive feature is the very low current consumption, this being less than 1mA from the 9 volt battery.

Dual gate m.o.s.f.e.t.'s can now be purchased at reasonable prices and this fact, together with their high performance as r.f. amplifiers, makes them an ideal choice for use in a simple medium wave t.r.f. receiver. The receiver described in this article employs a dual gate m.o.s.f.e.t. as a regenerative detector followed by a conventional high gain single transistor audio stage.

Good reception of the usual B.B.C. medium wave transmissions is possible, and after dark (in the South-East of England) the author has also received many foreign stations. The output is suitable for a crystal earphone only, from which very good volume is obtained. An output in excess of 1 volt r.m.s. is possible on strong stations.



The receiver is very simple to operate and has a single control only

The receiver is quite compact, being housed in a commercially made plastic case having approximate dimensions of 4½ by 3 by 1½in. There is no undue cramping of the components inside the case, and so the receiver is suitable for construction by a near-beginner.

CIRCUIT OPERATION

A very simple circuit is used, and this is shown in Fig. 1.

Dual gate m.o.s.f.e.t.'s have extremely high input impedances and so it is possible to connect a tuned circuit direct to gate 1 of TR1 with a negligible loss of efficiency. In the present receiver, the tuned circuit given by L2 and VC1 is so connected. L2 is wound on a ferrite rod, and therby acts as a ferrite aerial coil. It also provides negative gate bias to TR1 by holding the gate 1 at the same d.c. potential as the negative supply rail. VC1 is the receiver tuning capacitor and provides coverage of the entire medium wave band.

R2 is the source bias resistor for TR1, with C2 as its bypass capacitor. Positive feedback, or regeneration, is provided between TR1 drain and the ferrite aerial by way of L1. Regeneration has several beneficial effects. First, it increases the gain of the circuit and, second, it gives a very marked increase in selectivity. A regenerative detector relies on the fact that the amplifying device amplifies half-cycles of one polarity more than those of the opposite polarity, and this provides a form of rectification and detection. Regeneration tends to increase the inequality of the two levels of amplification, and so also increases the efficiency of the detector.

R1 is the drain load for TR1, and C1 bypasses most of the r.f. signal which is present across it. The remaining audio signal is fed to the base of TR2 via d.c. blocking capacitor C3.

TR2 is a high gain transistor and is used as a common emitter amplifier. It has R4 as its collector load resistor and R3 as its base bias resistor. Any small residual r.f. signal present at the collector of TR2 will

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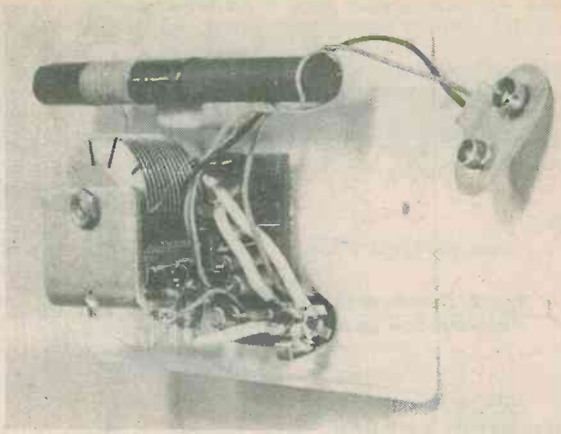
be in phase with gate 1 of TR1, and could cause instability. C4 is therefore included to bypass this remaining r.f. signal.

The a.f. signal at TR2 collector is directly coupled to the crystal earphone. JK1 has a single make contact which switches the set on when the jack plug is inserted into the socket, and turns it off again when the plug is removed.

Power is obtained from a PP3 9 volt battery, and as the current consumption of the receiver is less than 1mA, this has a very prolonged life and running costs are extremely low.

TR1 may be a 3N140 or a 40673. Both have similar characteristics, but the 40673 also has integral diodes which protect the gate insulation from damage due to excessive gate voltage. There is a choice also for TR2, which may be a BC108C or BC109C. These transistors can be obtained from a number of retailers. For example, the 3N140, 40673 and BC109C are available from Technomatic Ltd., 54 Sandhurst Road, London, N.W.9. The plastic case is available from H. L. Smith & Co. Ltd., 287 Edgware Road, London, W.2.



All the parts for the receiver are secured to the front panel of its case

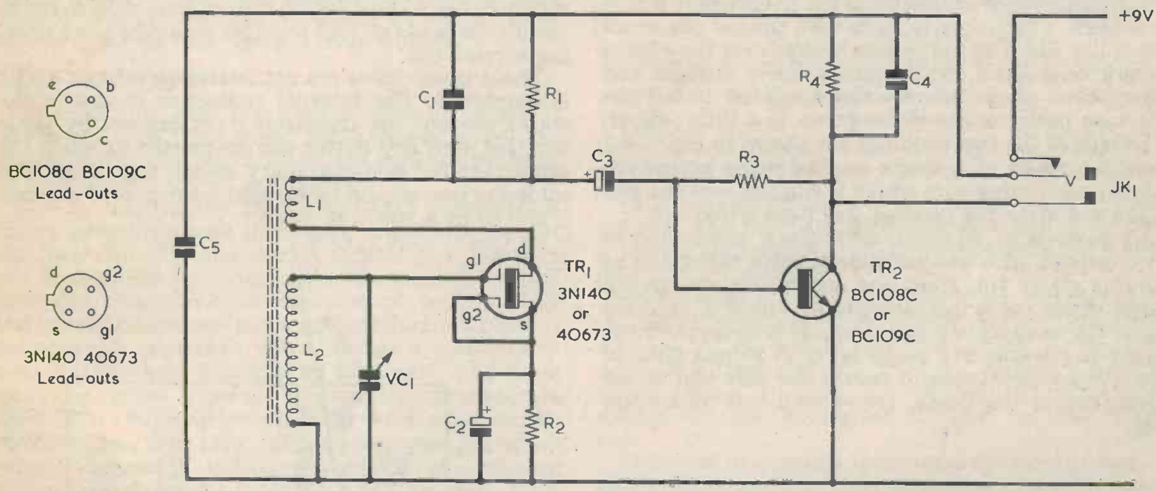


Fig. 1. The circuit of the 2 transistor personal receiver. This switches on when an earphone plug is inserted in the output jack socket

COMPONENTS

Resistors
(All ¼ watt 10%)
R1 5.6kΩ   R3 2.7MΩ
R2 4.7kΩ   R4 6.8kΩ

Capacitors
C1 0.01μF plastic foil, type C280 (Mullard)
C2 10μF electrolytic, 10 V. Wkg.
C3 2.2μF electrolytic, 10 V. Wkg.
C4 0.01μF plastic foil, type C280 (Mullard)
C5 0.1μF plastic foil, type C280 (Mullard)
VC1 air-spaced variable (see text)

Transistors
TR1 3N140 or 40673
TR2 BC108C or BC109C

Socket
JK1 3.5mm. jack socket (see text)

Miscellaneous
9 volt battery type PP3 (Ever Ready)
Battery connector
Crystal earphone with 3.5mm. jack plug
Ferrite rod (see text)
Large control knob
Plastic case, 4½ x 3 x 1½in. approx. (H. L. Smith & Co., Ltd.)
Plain Veroboard, 0.15in. matrix
Connecting wire, etc.

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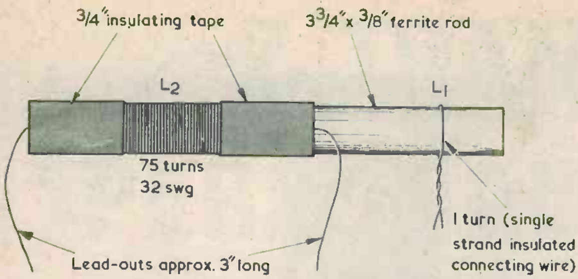

Fig. 2. Details of the ferrite rod aerial assembly. Regeneration level is controlled by moving L1 along the rod

FERRITE AERIAL

The ferrite aerial is home-made, and is wound on a 3¾ by ⅜in. diameter ferrite rod. A rod of this length is not readily obtainable, and it will then be necessary to break a 3¾in. length from a longer rod. This is easily done by first cutting a deep V-shaped groove around the circumference of the rod at the point where it is to be broken. The groove is made with the aid of a small triangular file. The rod is then broken over the edge of a workbench, and should give a fairly straight and clean break at the groove. There will be no adverse effect on performance if the break is a little jagged.

Details of the two windings are shown in Fig. 2. L1 merely consists of a single loop of single strand insulated connecting wire which is slipped over one end of the rod after the receiver has been wired up.

L2 consists of 75 turns of 32 s.w.g. enamelled or d.s.c. copper wire wound directly onto the rod. The winding starts ¾in. from one end of the rod, and a length of ¾in. wide insulating tape is used to hold the end of the winding in place. The coil is close-wound as neatly as possible in a single layer. A second piece of insulating tape is used to secure the wire end to the ferrite rod at the finish. Leave lead-outs about 3in. long.

Looking straight at the rear of the front panel. There is adequate space for the components

Readers who would prefer not to cut down a longer ferrite rod may use a 4 by ⅜in. ferrite rod, which is available from Henry's Radio, Ltd. The slightly increased length will not have any serious effect on tuning range and there is adequate space for the 4in. rod in the plastic case.

COMPONENT PANEL

Most of the components are wired up on a plain (i.e. without copper strips) 0.15in. matrix Veroboard panel. This has 10 by 5 holes, and is cut from a larger board by means of a hacksaw. The component layout and details of the underside wiring are shown in Fig. 3.

Mount the components in the positions shown in the diagram, and then bend their lead-out wires flat against the underside of the panel. Making reference to the underside view in Fig. 3, solder together the lead-outs accordingly.

If TR1 is a 3N140 it will be supplied with a metal clip short-circuiting the four lead-outs together and to the case. This clip must not be removed until all the wiring to the receiver has been completed. If at any future time it is necessary to carry out work on the receiver, use a short length of thin bare wire to short-circuit the leads of TR1 together while the work is being carried out.

These precautions are not necessary when a 40673 is employed. The internal protective diodes in the 40673 prevent the transistor from damage by static voltages, and this device can be treated in much the same manner as an ordinary silicon transistor. The soldering iron should be earthed regardless of whether a 3N140 or a 40673 is used.

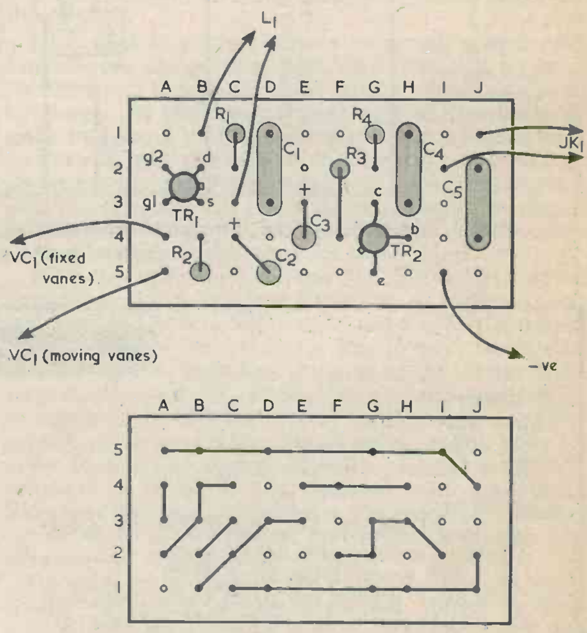

Fig. 3. Most of the parts are assembled on a component panel, and are wired up as shown here

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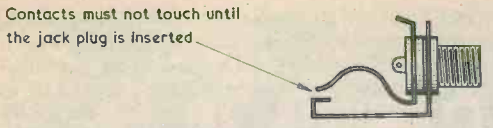

Fig. 4. The output jack is modified to provide an on-off switching function

JACK SOCKET

The jack socket is required to make a contact when the jack plug is inserted, but 3.5mm. sockets fitted with such a contact are not readily available. It is, however, a simple matter to modify a 3.5mm. jack socket of open construction which has a contact which breaks when the plug is fitted. Most, if not all, open construction 3.5mm. jack sockets have this break contact.

The unmodified jack socket has two contacts, a fixed upper one and a flexible lower one. The modification merely consists of carefully bending the fixed contact down below the flexible one, so that the socket takes up the appearance shown in Fig. 4. Note that whereas the contacts were previously touching until the plug was inserted, now they do not do so until the plug is fitted. If it is found difficult to insert the jack plug, or if it will not enter properly at all, the fixed contact must be bent down a little further.

CASE LAYOUT

The specified case has a removable lid which is used here as the front panel. The receiver is built up on this panel, and Fig. 5 shows the general layout of the components inside the case.

VC1 is mounted by three short 4BA countersunk screws passed through the panel, and these are not supplied with the capacitor. A central ⅜in. diameter hole is required for its spindle. The positions of the three 4BA clearance mounting holes can be located by first pressing a piece of paper against the front plate of the capacitor and then using this as a template to mark out the hole positions on the panel. The three mounting screws must not be permitted to penetrate more than fractionally inside the front plate of the capacitor, as they may then damage the capacitor vanes. If necessary, spacing washers can be used over the mounting screws, between the capacitor front plate and the inside surface of the case front panel.

The value of VC1 is not very critical, and any air-spaced variable capacitor small enough to fit in the case and having a value between 170 and 210pF may be employed. A single gang Jackson type '01' with a value of 208pF would be suitable, as also would the 176pF section of a 2-gang Jackson type '00' capacitor.

The ferrite aerial rod is mounted on a wooden block measuring ¾ by ¾ by ¾in. and having a semicircular groove across one surface into which the rod fits. First take up a piece of ¾ by ¾in. timber and drill a ⅜in. hole with its centre ¾in. from one end. Then cut the timber across the hole centre, and the block with its groove will be produced. The aerial rod is glued to the wooden block which, in turn, is glued to the inside of the front panel.

When these components have been mounted, the component panel is wired into circuit. Fig. 5 illustrates the remaining wiring of the receiver. The tag layout shown for JK1 should conform with normal jack sockets of open construction, but if any doubt exists about tag positioning a continuity tester or ohmmeter may be employed to determine the tags which connect to the individual socket contacts. The socket may then be wired up to agree with the circuit of Fig. 1.

Heavy gauge single strand insulated wire of around 18 s.w.g. is used to complete the connections between JK1, VC1 and the component panel. If these leads are kept reasonably short the component panel will be held quite firmly in position and will require no further mounting.

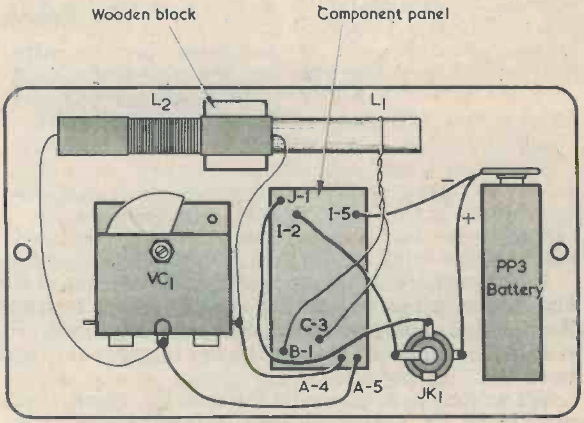

Fig. 5. Component layout and wiring behind the front panel

ADJUSTMENT

Only a single adjustment is required to the finished receiver, and that is to set the regeneration level. This is carried out by sliding L1 along the ferrite rod to find its optimum position.

Start with L1 at the very end of the rod and, with the earphone plugged in, adjust VC1 in search of stations. A few should be received, but if there are none or if they are very weak L1 probably has the wrong phase. It must be removed from the rod, rotated through 180 degrees, and then replaced on the rod.

It should be possible to increase the level of received signals by sliding L1 further along the rod towards L2. If it is taken too far along the rod, however, the circuit will begin to oscillate, this being heard as a whistle when the receiver is tuned across a station. L1 is taken as far towards L2 as is possible without the set breaking into oscillation at any setting of VC1. The receiver will then have maximum sensitivity and selectivity. If preferred, the level of regeneration can be reduced slightly whereupon, at the cost of lower sensitivity and selectivity, improved audio quality will result.

When the optimum position for L1 has been found it can be glued or taped to the rod, care being taken to ensure that its position is not significantly altered in the process.

Finally, legends indicating function can, if desired, be affixed to the front panel below JK1 and the knob for VC1, these being taken from 'Panel Signs' Set No. 4 (available from the publishers of this journal). Also, a simple scale may be fitted behind the knob. A piece of foam rubber or plastic may be glued to the rear of the case behind the battery, to hold the latter in place when the two parts of the case are screwed together. ■

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SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT   *Frequencies* = kHz

In the past few issues we have discussed some of the Dx transmissions emanating from the East and Far East and, I trust, some readers who have recently joined the ranks of Dxers will have logged a few that have been highlighted here.

We now come to the really difficult Dx which, if you manage to log, award yourself an accolade!

Radio Bougainville, Papua New Guinea, operates on **3322** with a power of 10kW from 1930 to 2200 with the District Service and has been reported here in the UK around 2000, the languages being English, Pidgin and a multitude of local dialects.

Radio Wewak on **3335,** also in Papua New Guinea, has a power of 10kW and radiates the District Service from 2000 to 2200.

Then there is Port Moresby on **3925** with a power of 10kW with the National Service from 1945 to 2230. A good time for this one is around 2015, we heard them with a report of the Darwin disaster, in English, way back in December 1974. Port Moresby also operates on **4890** with a power of 10kW and can sometimes be heard here in the UK when opening transmission at 2000. Schedule is from 2000 to 2215.

Or, of course, you could switch the receiver and your attention to South Korea in the shape of KBC Seoul which has a power of 5kW and operates from 2000 to 1700 with the Home Service 1. Nominally on **3918,** we recently logged it on a measured **3917.5** at 2040.

NOW HEAR THIS

Current schedules being rather sparse, regular followers of this feature will probably be interested in some of the more unusual loggings that have taken place within the past few weeks.

● CHINA

Kunming on **6936.5** at 1550, programme of local classical music in Provincial Service 2. Sign-off with choral "Internationale" at 1600.

● VIETNAM

Radio Hanoi on **7374** at 1506, YL in Vietnamese, local songs in 1st Network programme directed to South Vietnam (replacing Saigon — now Ho Chi Min City, programmes). Also logged in parallel on a measured **10060.5**.

Radio Hanoi on **6449** at 1640, YL with a rousingly patriotic song in Vietnamese, in the 1st Network programme to South Vietnam. Sign-off at 1657 after identification in Vietnamese, without National Anthem. Also logged at 2216, YL announcer with many mentions of Vietnam.

● INDONESIA

Jakarta on **6045** at 1604, OM with religious chants ater announcements by OM in Malindo.

● ISRAEL

Jerusalem on **9400** at 1906, songs and music from British musical comedy in the Domestic Service 2 programme to Europe and N. America, announcements in Hebrew. Schedule 1900 to 2305, also logged in parallel on **12045.**

Jerusalem on **15512.5** at 1443, OM with songs in Hebrew in Demostic Service 2 programme to Europe and N. America. Schedule from 0600 to 1845, also logged in parallel on **12080.**

● MEXICO

Radio Mexico on **15385** at 2031, OM with identification in Spanish, local songs and music.

AROUND THE DIAL

The introductory paragraphs in the past few issues have dealt with the reception of broadcast stations located in the East, Far East and South-East Asia on the low frequency bands so here are listed some of the transmitters in these areas which have been recently entered in the log book.

● INDIA

Hyderabad on **4800** at 1525, typical local-style music, 6 pips at 1530, station identification and world news in English by OM newscaster. Schedule 1130 to 1830.

Delhi on **3365** at 1605, YL announcer in local dialect, songs and music for local consumption. Afternoon schedule is from 1230 to 1735 with the news in English at 1530 and 1730.

Delhi on **3925** at 1502, OM with local songs, orchestra with Indian music. Schedule is from 1330 to 1735 with the news in English at 1430, 1530 and 1730.

Lucknow on **3205** at 1529, OM with a talk in Hindi then newscast in English at 1530. Schedule (afternoon) is from 1130 to 1830.

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Gahauti on **3375** at 1513, songs by YL, local music, talk by OM in Asian dialect (programmes are mostly in Assamese). Full schedule is from 0025 to 0145 and from 1145 to 1730. A newscast in English is scheduled at 1530.

● **PAKISTAN**
Quetta on **3870** at 1518, YL and OM alternate with announcements in local dialect then into programme of songs and music. I well remember "discovering" this station some three years ago. The schedule is from 1315 to 1810; additionally May to October from 0100 to 0400, November to April from 0115 to 0430.
Karachi on **3890** at 1525, OM with a seemingly endless talk in vernacular. Schedule (November to April) is from 1415 to 1810.

● **BANGLADESH**
Dacca on **4890** at 1450, YL with songs in local-style, OM announcer. Schedule is from 0030 to 0400 and from 1200 to 1545.

● **NEPAL**
Kathmandu on **5007** at 0055, OM in Nepali. This one can also be heard during afternoons, appearing in our log at 1435, YL with songs, music typical of the area and announcements in Nepali. This is the Home Service having a schedule from 0020 to 0350 and from 1150 to 1730 and can also be heard in parallel on **3425.**

● **SRI LANKA**
Colombo on **4870** at 1618, local-style music, songs in Sinhala in the Channel 2 programme which has a schedule from 0015 to 0300 and from 1030 to 1730.

● **BURMA**
Rangoon on **4725** at 1404, YL with songs, music in the appealing (to me) local-style; sign-off without National Anthem, after a few bars of local music, at 1415. The schedule is from 1100 to 1415. Also logged on **5039** at 1440, OM with a talk on foreign affairs in English. Schedule is from 0930 to 1600 with the programmes in English being from 1430 to 1600.

● **THAILAND**
Bankok on **4830** at 1427, programme of Euro-style dance music records complete with vocals in English. Schedule is from 2300 to 1600.

● **MALAYSIA**
Kuching (Sarawak) on **4950** at 1550, YL with local pops, OM with announcements in English. Schedule of this one is from 0800 to 1600 and from 2200 to 0100 in both English and Chinese.
Penang on **4985** at 1553, dance music, songs in English and announcements. Schedule, in English and vernaculars, is from 0530 to 0630, 0930 to 1630 and from 2230 to 0130.

● **CHINA**
Lanchow on **4866** at 2141, OM and YL alternate in Chinese, local music at 2146. Schedule is from 0950 to 1600 and from 2120 to 0600.
Peking on **4905** at 1607, OM with a talk in Chinese in Home Service 1 programme. Schedule is from 1353 to 1735 and from 2000 to 0020 (March to October until 2300).
Urumchi on **4110** at 1458, military music in the Sinkiang Regional programme, also logged on **4500.**
Peking on **4960** at 1445, YL with a talk in Japanese. Schedule (Foreign Service in Japanese) is from 0930 to 1525, additionally May to October from 2130 to 2155.
PLA Fukien on **3200** at 1859, OM in Chinese, local orchestral music. Schedule is from 1000 to 2000 (May to October from 1215), from 2005 to 0040.
Foochow on **4975** at 2102, OM in Chinese, military music. Schedule is from 0740 to 1600, 2050 to 0540; to Taiwan from 1600 to 1810.
Kunming on **4759** at 1605, OM and YL alternate in Chinese in Provincial Service 1. Sign-off at 1620 after choral rendition of the "Internationale". Schedule is from 0950 to 1620 and from 2150 to 0800, relaying Yunnan 1.
PLA Fukien on **3640** at 1440, OM with a talk in Standard Chinese in the Network 1 Service to Taiwan and other offshore islands, also logged in parallel on **4042.5**. Schedule is from 1150 to 2240.
PLA Fukien on **2430** at 1605, OM in Amoy in the Network 2 Service to Taiwan and other offshore islands, also logged in parallel on **3300** and on **4380.**

● **SINGAPORE**
Radio Singapore on **5010** at 1602, programme of light classical music, songs in English and announcements, also in parallel on **5052.**

● **INDONESIA**
Jakarta on **4804.5** at 2202, OM with a newscast in Malindo after station sign-on at 2200. Schedule is from 1000 to 1600 and from 2200 to 0100 in the Programme Nasional.
Banda Aceh on **4955** at 1542, OM in Malindo, local music in the distinctive style of Indonesia, song by YL. Schedule 0500 to 0800, 1000 to 1600 and 2300 to 0100.
Palembang on **4855** at 1547, local-style music, songs and announcements in Malindo. Schedule 0900 to 1600 and from 2200 to 0100 (Sundays 0000 to 0700).
Yogyakarta on **5047** at 1550, OM announcer, local music, gongs, chimes. Schedule is from 1000 to 1600 and from 2200 to 0230.
Ujang Padang on **4719** at 1400, OM in Malindo then into programme of local music. Schedule is from 1225 to 1520.
Medan on **4764** at 1417, OM in Malindo, military music. Schedule is from 1000 to 1600.
Jambi on **4927** at 1545, YL with announcements, religious chants, sign-off with "Love Ambon" at 1600. Schedule is from 1000 to 1600 and from 2200 to 0100.

LATE LOGGINGS
Since the above was written, several other loggings of interest have taken place such as—

● **PAKISTAN**
Rawalpindi on **3405** at 1750, OM with announcements in English, pop records (U.K. made). Identification and news in Urdu at 1800. Listed **3400.**

● **INDIA**
Kurseong on **3355** at 1511, OM with songs in vernacular, local-style music.

● **CLANDESTINE**
Azad Kashmir on a measured **3939** at 1415, signing-on with the usual long anthem, choral style.

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INTEGR
FUNCT

Offering triangular, square and sine wave outputs from 0.1Hz to 100kHz, this function generator is built around the Intersil 8038 integrated circuit. The use of this i.c. enables a relatively simple assembly procedure to be adopted. Construction and setting up, which requires the use of an oscilloscope, will be described in the concluding article to be published next month.

One of the more useful weapons in the armoury of the electronics experimenter is the signal source. Although signal generators of several types would be required to cover the entire frequency spectrum, for many applications a generator which covers only the lower frequency ranges, up to around 100kHz, is often adequate. Of course where radio or television receiver alignment is involved an r.f. type of generator would be needed.

OUTPUT WAVEFORM

Most of the older designs of generator covering the low frequency ranges provide only sine wave output, which is adequate for audio work. When one is working with modern electronic equipment, however, it is an advantage to have triangular and square waveforms available in addition to the sine wave. Modern laboratory generators often provide such outputs, instruments of this type being referred to as function generators.

By making use of integrated circuit techniques the normally complex circuit arrangement needed for a function generator can be greatly simplified, so far as construction is concerned, and at the same time the cost can be reduced to the point where it is not likely to put too great a strain on the average amateur constructor's bank balance.

In this article the construction of a simple function generator will be described. This unit covers the frequency range from 0.1Hz to 100kHz and provides either sine, triangular or square wave outputs at up to 4 volts peak-to-peak. It would have been possible to incorporate sawtooth and pulse outputs as well but it was felt that the basic facilities provided would meet most of the needs of the average experimenter. An oscilloscope is required for setting up the generator.

In order to obtain an understanding of how this type of instrument works it might be as well to examine the circuit techniques involved before proceeding to describe the construction of the unit.

SINE WAVE OSCILLATORS

Most of the older and simpler designs of low frequency generator make use of some form of sine wave oscillator as the initial signal source. Because of the problems which may be encountered when LC tuned circuits are used at low frequencies it is usual for the oscillator to be of the RC tuned type.

Commonly used oscillator circuits are the Twin Tee, Wien Bridge and Phase Shift types in which two, or more, sets of resistor-capacitor timing components are employed to determine the frequency of oscillation. To give optimum performance such circuits usually require that two or more resistors are varied in unison when the oscillator is tuned through its frequency range. This inevitably leads to the use of multiple ganged potentiometers for the frequency control. Range switching also becomes somewhat complex because of the need to switch a number of timing capacitors simultaneously.

Although it is possible to devise simplified versions of these RC tuned oscillators in which only one resistor or capacitor is varied to alter the frequency, this usually involves a compromise in which the amplitude or waveform of the output signal may be affected as the frequency of operation moves away from its optimum value.

A further problem associated with sine wave RC tuned oscillators is that of stabilizing the output amplitude. Some form of automatic gain or bias control is required to ensure constant output level.

Generation of triangular and square wave outputs from the basic sine wave signal can also pose problems. It is not too difficult to derive a square wave output from the sine wave by merely passing the signal through a high gain limiting amplifier, the output of which will go from one limit to the other each time the sine wave passes through zero volts. Triangular waves can be produced by feeding the square wave through an integrator circuit but unfortunately this type of circuit is frequency sensitive so

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RATED L.F.
ION GENERATOR

Part 1
By Steve A. Money

that the amplitude of the triangular wave will vary with frequency.

Of course it would be possible to generate a square wave as the initial signal. This type of waveform is quite readily produced by means of a simple multivibrator circuit and it is possible to control the frequency of such a circuit by using only one resistor and capacitor without any compromises on output waveform or amplitude. Unfortunately, the problems posed by the production of sine and triangular waveforms from the square wave can perhaps be more difficult than are those which occur when starting off with a sine wave signal.

TRIANGLE WAVE GENERATOR

The third possible approach to a function generator would be to start off by generating a triangular wave and then to derive the sine and square wave outputs from it.

For a triangular waveform the voltage follows the simple law,

$$V = k.t$$

where V is the instantaneous voltage, t is time and k is a constant which will be positive for the rising slopes of the waveform and negative for the falling slopes.

A triangular waveform is easily generated by charging and discharging a capacitor. The voltage across the capacitor will follow the law,

$$V = \frac{Q}{C} = \frac{I.t.}{C}$$

where I is the charge or discharge current and C is the capacitance. If a fixed capacitor is used then C will be a constant value, leaving only I and t as variables.

In the simple resitor and capacitor circuit shown in Fig. 1 the capacitor charges and discharges through the resistor R. The charging or discharging current, IC, depends upon the voltage drop across R and therefore will vary as the voltage across the capacitor changes. This gives rise to the familiar exponential charging and discharging characteristics shown in Fig. 1.

If the current in the capacitor were held constant then the voltage across it would follow the law,

$$V = k.t$$

and a linear triangular waveform would be produced. These conditions can be met by using "constant current" source circuits to control the values of the charge and discharge currents through the capacitor.

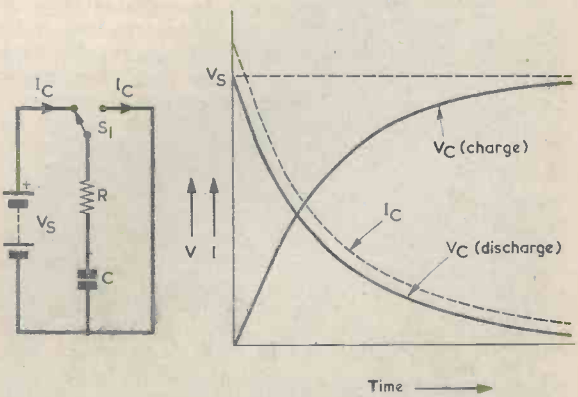

Fig. 1. A simple circuit in which a capacitor may be made to charge and discharge by actuating a switch

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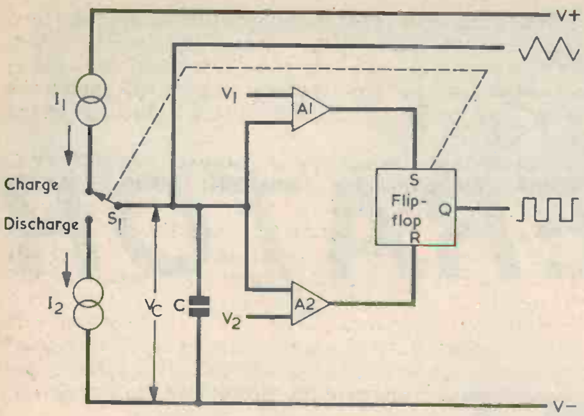

Fig. 2. By the use of constant current sources and a switching system controlled by a flip-flop and two comparators, the waveform across the capacitor becomes triangular. A square wave is available, also, from the flip-flop

Fig. 2 shows a basic circuit arrangement for the production of a triangular wave. Here the capacitor voltage, VC, is fed to the inputs of two voltage comparator stages A1 and A2 which compare it with the reference voltage levels V1 and V2. The output signals from the two comparators are used to trigger a bistable flip-flop circuit which in turn operates the charge and discharge control switch S1.

Suppose that initially the capacitor is discharged and switch S1 has just been set to the charge position. The capacitor now begins to charge up from the "constant current" source I1, and the voltage, VC, across it increases linearly with time until it reaches the level V1. At this point the comparator stage A1 operates. The output from A1 is used to trigger the bistable which, in turn, switches S1 into the discharge position. The capacitor will now start discharging through the second "constant current" source I2. Discharge continues until the capacitor voltage has fallen to the second reference level, V2. When the voltage reaches this level the second comparator, A2, comes into action and its output causes the bistable circuit to be reset. Switch S1 now returns to its original condition so that a new charging period can commence. This sequence of events will repeat continuously, and the capacitor voltage VC will rise and fall linearly between the voltage limits V1 and V2 to produce a constant amplitude triangular waveform.

The output from the bistable circuit will be a square wave of constant amplitude and with the same frequency as the triangle wave. The frequency of oscillation is governed by the capacitor value and the levels of the currents I1 and I2. If I1 and I2 are equal the output waveform is symmetrical. When the two currents are unequal then, as the ratio of one to the other increases, the triangular wave will gradually change to a sawtooth shape and the square wave become a pulse with a progressively greater mark-to-space ratio.

SINE FUNCTION GENERATOR

It is possible to derive a sine wave output from a triangular wave input by utilising techniques originally developed for use in analogue computer systems. In this type of computer there is a frequent requirement for circuits in which the output follows some mathematical law in relation to the input voltage. Typical examples are circuits where the output is proportional to the square or perhaps the square root of the input signal. For our purpose we need a circuit where the output voltage follows the law,

$$Vout = \sin(Vin).$$

The basic principle on which these function generator circuits operate is to build up an approximation to the desired output function curve by means of a series of straight line segments. Fig. 3 shows this technique in the formation of the positive half-cycle of a sine wave signal.

At first it might be assumed that, to achieve reasonable accuracy, a large number of straight line segments would be required, but in fact quite good approximations can be obtained by using surprisingly few segments. In the case of a sine wave an output within ±1% of the correct wave shape can be achieved by using only five segments to build up each quarter-cycle of the waveform. For most purposes this degree of accuracy is perfectly adequate.

A typical arrangement for a "curve fitting" circuit is shown in Fig. 4. A symmetrical triangular waveform is applied at the input of this circuit.

At the start of a positive half-cycle of the input waveform all of the diodes D1 to D4 are reverse biased, so that the input signal is simply attenuated by the

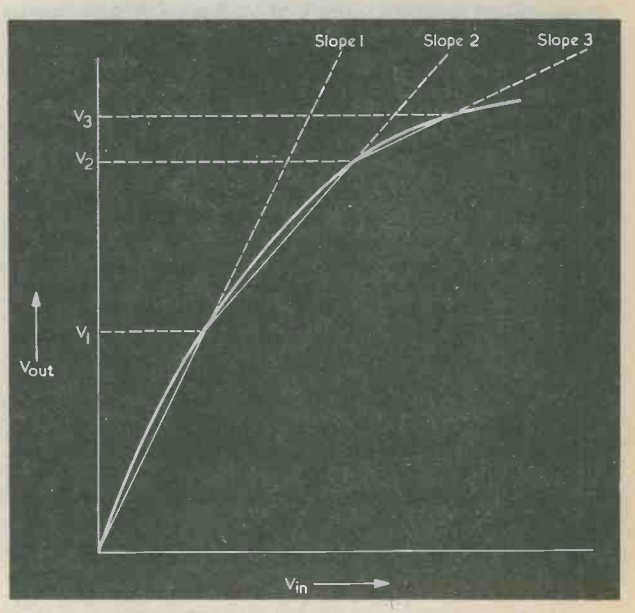

Fig. 3. Illustrating the operation of the "curve fitting" process. By changing slope at carefully selected break points it is possible to cause a triangular wave to approximate closely to a sine wave. Both the simulated and a true sine wave are shown

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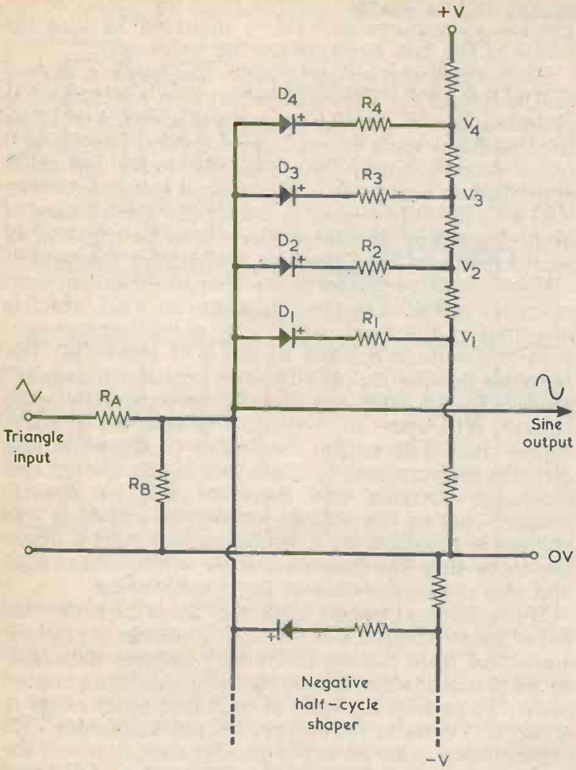


Fig. 4. A sine wave shaping circuit

potential divider consisting of RA and RB. If the values of these two resistors are chosen correctly the slope of the output waveform can be made to match closely that of the desired sine wave curve over approximately the first 22° of the cycle.

When the output voltage reaches level V1 diode D1 starts to conduct and effectively connects resistor R1 across RB. This increases the attenuation ratio of the circuit and has the effect of reducing the slope of the output waveform above level V1. Here it is assumed that the impedence of the biasing network between the zero and positive supply voltage rails is negligible in comparison with the values of the resistors RA, RB and R1, so that the network has no significant effect upon the output signal. By careful choice of the value of R1 the new slope of the output signal can be made to match the desired sine curve over a further segment of the cycle.

The output signal continues to rise with this new slope until the level V2 is reached, whereupon diode D2 conducts and brings R2 into circuit to produce a further reduction in the slope of the output signal. Similarly, R3 and R4 are brought into use as the output voltage passes through the levels V3 and V4 respectively, and they give two more short segments of the desired output waveform. Careful choice of the values of the resistors will give the correct slope for each of the segments of the output curve. By choosing appropriate voltage levels for V1 to V4 the break points in the resultant output curve can be selected so that the output waveform matches closely the desired sine wave law over the first quarter-cycle of the waveform.

Since the triangular waveform falls during the next quarter-cycle with a slope equal but opposite to that of the first quarter-cycle the diodes will turn off in reverse order and the resultant output will match the sine wave as closely as it did during the rising part of the cycle.

For the negative half-cycle, however, a second set of diodes and resistors is needed. Here, the diodes are wired in the opposite polarity and the bias levels are negative but the principle of operation is the same. This network operates with the same two basic resistors, RA and RB, to produce the negative half-cycle of the sine wave.

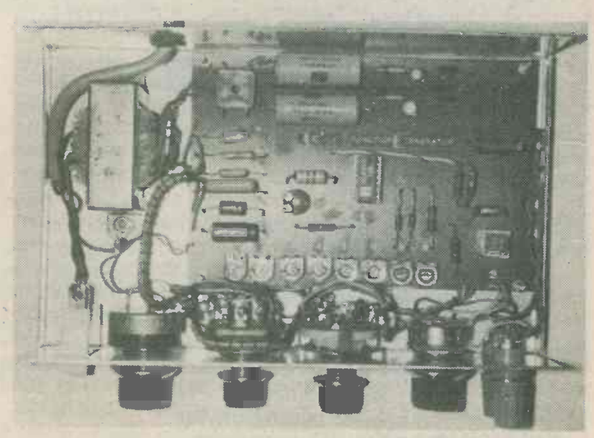
Since the circuit is purely resistive its output will not be affected by changes in frequency. The output voltage levels are determined entirely by the input level, the attenuation of the circuit and the bias levels.

INTEGRATED CIRCUIT

It will be seen that the shaping circuit is complex but fortunately it lends itself very nicely to fabrication on an integrated circuit chip. If discrete components were used, precision resistors would be required to produce the correct ratios in the shaping network and its associated bias chain. In an integrated circuit it is difficult to produce precise values of resistance because the resistance depends on the level of doping of the silicon in the chip, which can vary from one batch to another. It is, however, quite easy to provide precise ratios between the resistors on the same chip, because this is determined by the geometry of the chip layout which can be closely controlled in production.

Intersil have produced an integrated circuit known as the 8038 which incorporates not only the wave shaping circuits but also the current sources, comparators and flip-flop to make up the primary oscillator. This i.c. is available from Ambit International, 37 High Street, Brentwood, Essex. Transistors are used in the wave shaping circuits instead of diodes because they give greater isolation between the signal path and the bias network. In all there are 56 transistors on the chip, which is mounted in a 14 pin dual-in-line package.

Two external resistors connected between pins 4 and 5 of the i.c. and the positive supply rail are used, in conjunction with a voltage applied to pin 8, to con-



A view inside the function generator case. Nearly all the small components are assembled on a printed circuit board

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trol the current levels in the "constant current" sources. Frequency can then be controlled by simply varying the voltage on pin 8.

Three separate pins on the package bring out the sine, square and triangular wave signals so that all three outputs are available simultaneously if required. An open collector buffer stage is provided at the square wave output and for proper operation this needs a pull-up resistor of the order of 4.7kΩ between the output pin and the positive supply rail. The other outputs are of fairly high output impedance and can only tolerate load impedances of 100kΩ or greater if the signal is not to be affected. Therefore, it is advisable to have a buffer amplifier stage between the integrated circuit and the output terminals of an instrument incorporating the i.c. In the unit to be described only one of the outputs is selected at any time so that a single buffer amplifier can be used. The appropriate output waveform is switched to the input of the buffer amplifier as desired.

A supply voltage of between 10 and 30 volts can be employed with the integrated circuit. It is convenient to use a centre-tapped supply since the output waveform will be roughly symmetrical about the supply mid-point.

GENERATOR CIRCUIT

Fig. 5 shows the circuit for the l.f. generator using the 8038 integrated circuit.

Six frequency ranges, each covering a little over a decade, are provided by this instrument. One bank, S1(b), of the range selector switch is used to connect one of the six timing capacitors, C1 to C6, between pin 10 of the 8038 and the negative supply rail.

For the four higher frequency ranges polystyrene or polyester capacitors can be used. To provide the large values of capacitance needed for the two lower frequency ranges electrolytic capacitors are required. Aluminium foil types were used in the prototype unit and found to be quite satisfactory.

The levels of the charging and discharging currents are largely determined by the resistors R1 and R2. For proper operation in the sine wave mode the two half-cycles must have equal periods and therefore the charge and discharge currents must be exactly equal. Pre-set potentiometer VR7 is included so that the levels of the two currents can be balanced.

Since there can be quite wide tolerances in the actual values of the timing capacitors an adjustment is included in the current controlling circuits to allow the frequency scale on each range to be set up correctly. A second bank, S1(a), of the range switch is employed to bring one of the pre-set potentiometers, VR1 to VR6, into circuit to enable the overall level of both charge and discharge currents to be adjusted on each range and thus produce the correct frequency.

Continuous variation of the frequency within each range is controlled by the potentiometer VR9, which is mounted on the front panel. This potentiometer controls the voltage applied to pin 8 of the 8038. The currents flowing through the two "constant current" sources in the 8038 are directly proportional to the voltage difference between pin 8 and the positive supply rail. The output frequency produced is also directly proportional to the levels of the charge and discharge currents and therefore will be directly proportional to the voltage applied to pin 8. If this voltage is provided by a potentiometer with a linear law track then the frequency scale will be linear also, and this makes for ease of scale calibration.

If the voltage applied to pin 8 of the 8038 is allowed to fall below about 0.8 of the supply voltage the output waveform from the oscillator may become distorted, so R4 is included to ensure that this condition cannot occur. To restrict the span of each frequency range to about 11:1 resistor R3 and pre-set potentiometer VR8 are included in series at the positive supply end of the frequency control VR9. If the total value of R3 and VR8 is set equal to one-tenth of the value of VR9 the frequency sweep for each range will be 11:1. Once set, this span is identical on all six ranges.

BUFFER AMPLIFIER

To provide a low impedance output a buffer amplifier, IC2, is included between the 8038 and the output terminals. Switch S2(b) selects one of the three output waveforms from the 8038 and couples it to the input of the buffet amplifier stage.

The square wave output from pin 9 of IC1 has a

COMPONENTS

Resistors
(All fixed values ¼watt 5%. Pre-set potentiometers 0.1 watt skeleton, horizontal mounting.)
R1 4.7kΩ
R2 4.7kΩ
R3 330Ω
R4 22kΩ
R5 4.7kΩ
R6 47kΩ
R7 390kΩ
R8 47kΩ
VR1 500Ω pre-set potentiometer
VR2 500Ω pre-set potentiometer
VR3 500Ω pre-set potentiometer
VR4 500Ω pre-set potentiometer
VR5 500Ω pre-set potentiometer
VR6 500Ω pre-set potentiometer
VR7 1kΩ pre-set potentiometer
VR8 330Ω (or 470Ω) pre-set potentiometer
VR9 5kΩ potentiometer, linear
VR10 100kΩ pre-set potentiometer
VR11 100kΩ potentiometer, linear

Capacitors
C1 47μF electrolytic, 20 V. Wkg.
C2 4.7μF electrolytic, 20 V. Wkg.
C3 0.47μF polyester, type C280 (Mullard)
C4 0.047μF polyester, type C280 (Mullard)
C5 0.0047μF polyester or polystyrene
C6 470pF polystyrene
C7 100pF polystyrene (see text)

Semiconductors
IC1 8038
IC2 NE531V (or 741, see text)

Switches
S1(a)(b) 2-pole 6-way rotary
S2(a)(b) 4-pole 3-way rotary (2 poles unused)

Miscellaneous
I.C. socket, 14 pin d.i.l.
I.C. socket, 8 pin d.i.l.

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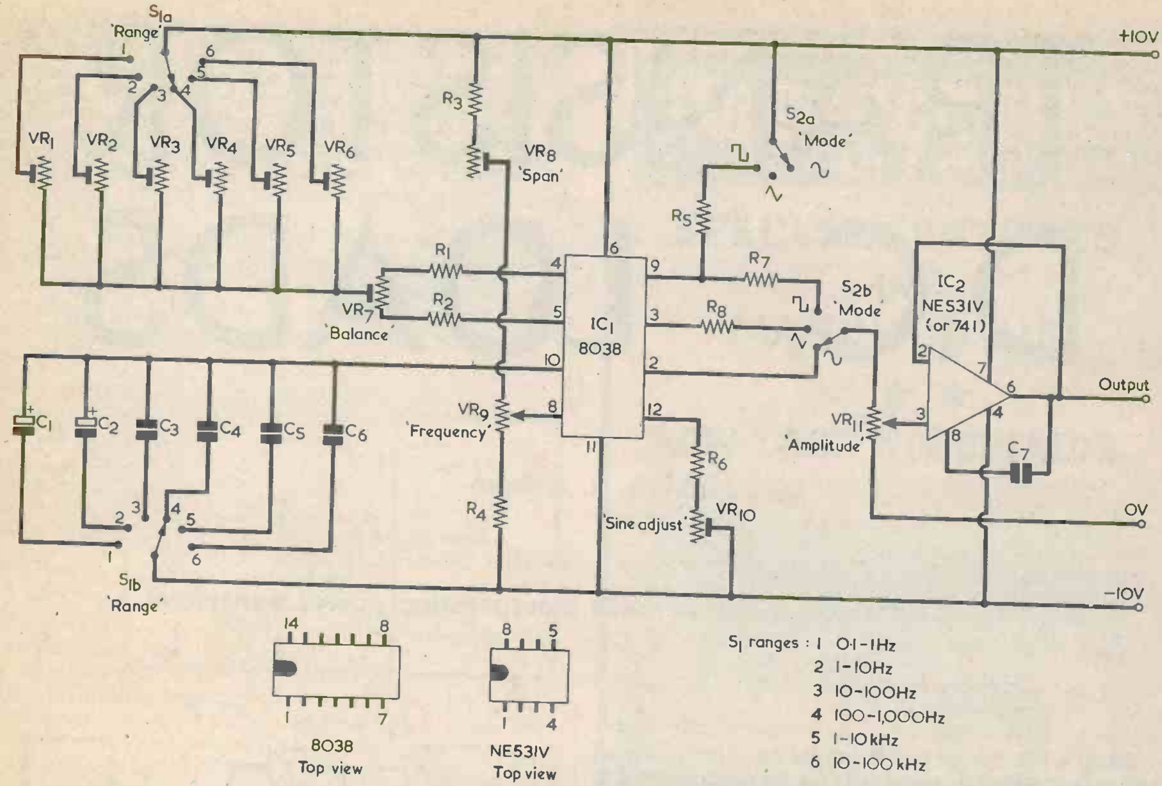

Fig. 5. The circuit of the l.f. function generator. This provides square, triangular and sine waveforms over the frequency ranges indicated.

peak-to-peak amplitude which is nearly equal to the supply voltage. In the case of the triangular waveform on pin 3, however, only a third of this amplitude is produced whilst the sine wave output from pin 2 has a peak-to-peak amplitude of only 0.22 of the supply voltage. Resistors R7 and R8 are included in the square and triangular waveform feeds to switch S2(b) and serve to reduce the levels of these two waveforms to match that of the sine wave. Potentiometer VR11 acts as the output level control.

A 741 type amplifier could be used in the buffer stage but it has some limitations on the higher frequencies. The rate at which the output voltage from the amplifier can change is its output slew rate, and for a 741 amplifier at unity gain this is 0.5 volt per microsecond. For a 2 volt peak sine wave the output from the 741 would be unable to follow a sine wave shape at frequencies above about 40kHz. If the output level is limited to about 0.75 volt peak a 741 type amplifier can work properly up to 100kHz.

To obtain the full 2 volts peak output undistorted at frequencies up to 100kHz a high slew rate amplifier will be required. The Signetics NE531 has a slew rate of some 30 volts per microsecond and is capable of good reproduction of all three waveforms at full amplitude up to 100kHz. The NE531 is in an 8 pin d.i.l. package and has the same basic pin layout as the 741 except that it requires a compensation capacitor of about 100pF between pins 6 and 8. This capacitor is C7 in Fig. 5, and is not of course needed if a 741 is to be used. In any event, pin 8 of the 741 in 8 pin d.i.l. is "NC."

When sine or triangular waves are being produced it is preferable that the load resistor at the square wave output be disconnected. This reduces the possibility of spiky transient signals being coupled to the sine and triangular circuits and producing distortion in the output waveforms. The disconnection is carried out by S2(a).

A small distortion of the sine wave output may be found due to slight manufacturing tolerances in the sine wave shaping circuit. This distortion can usually be reduced to less than 1% by adjusting VR10, which alters the bias conditions in the network.

NEXT MONTH

In the concluding article, to appear next month, details will be given of the power supply and of the construction of the l.f. generator. The article will include a full-size diagram of a suitable printed circuit board.

The accompanying Components List specifies the parts employed in the circuit of Fig. 5. A further Components List will be given next month, and this will list the remaining parts that are needed. Constructors are advised to wait until the following article appears before obtaining the pre-set potentiometers, as the printed circuit diagram will more clearly indicate the type of potentiometers that are employed.

The NE531V is available from S.C.S. Components, 5 Northfield Industrial Estate, Beresford Avenue, Wembley, Middlesex, HA0 1SD.

(To be concluded)

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TRANSISTOR D.C. LOADS

By R. J. Caborn

Some notes on d.c. test loads incorporating power transistors.

When a laboratory power supply has been designed and assembled, it is necessary for its performance to be checked. This is particularly the case when the supply offers variable voltage output and overload current trip facilities.

OUTPUT CURRENT

An obvious test load for a power supply consists of a variable wire-wound resistor, as shown in Fig. 1. The output voltage at various output currents can then be checked by altering the value of the resistor. This approach is feasible under normal home-constructor conditions if the maximum power supply output current is of the order of 100mA or so. Indeed, a suitable variable resistor is then offered by a valve heater chain dropper resistor having an adjustable tap. Such dropper resistors are not readily available as new components in these transistor orientated days, but many of the older hands may still have one knocking around in their spares box.

If the maximum output current of the power supply is of the order of several amps then the use of a variable resistor is not in most instances practicable, as it would require an exceptionally high wattage rating if the wire in its track were to carry the output current.

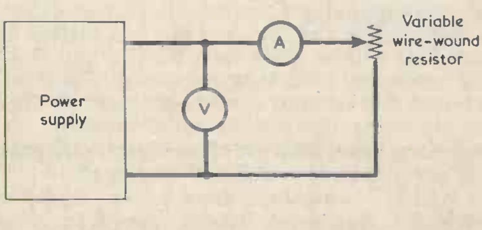

Fig. 1. Using a variable resistor to check the performance of a power supply.

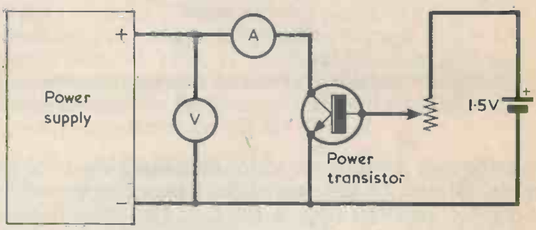

Fig. 2. An alternative test load can consist of a power transistor mounted on a heat sink. Care has to be taken to ensure that the variable resistor in the base circuit is not accidentally set to insert too low a resistance.

A more attractive output load, both for high and low current supplies, is given by the use of a power transistor, as in Fig. 2. This is mounted on a suitably large heat sink, and its collector current is varied by altering the current flowing in its base-emitter junction. The latter can be controlled by a variable resistor connected between the base and a 1.5 volt cell as indicated.

The arrangement of Fig. 2 is adequate for a quick one-off check, but even in a simple circuit such as this the question of current in the variable resistor has to be considered. An excellent choice for the power transistor would be the 2N3055, which has an h_{FE} range of 20 to 70. If a low gain 2N3055 passes a collector

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current of 2 amps its base current will be no less than 100mA. The wire of the variable resistor track must be capable of passing this current, which means that, should a 3 watt component be employed, it cannot have a value higher than 300Ω. It must be remembered that the wattage rating of a potentiometer applies to its *entire* track, and specifies the maximum current any section of the wire in its track can safely carry.

When using the circuit of Fig. 2, care has to be taken to ensure that the variable resistor is not accidentally adjusted to offer too low a resistance. Also, the rate of increase in collector current against change in resistance becomes greater as the resistance is reduced.

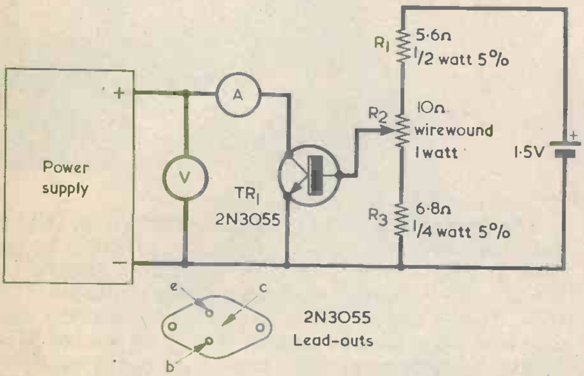

Fig. 3. An improved circuit which limits maximum base current in the 2N3055 to 100mA, and which offers a smoother control of collector current.

BETTER METHOD

The circuit of Fig. 2 is useful for quick hook-up conditions, but a better method which requires only two more resistors is shown in Fig. 3. The values of the resistors in this diagram are such that when the potentiometer slider is at the lower end of its track the base of the 2N3055 is about 0.5 volt positive of the emitter, whereupon the transistor is cut off. Near this setting the potentiometer functions as a voltage potential divider. As the slider moves upward base current to the transistor flows through the upper section of the track, with the result that the potentiometer acts less and less as a potential divider and more and more as a series variable resistor. Maximum base current is approximately 100mA.

The component values shown are suitable for a low gain 2N3055 giving a maximum collector current of 2 amps. A typical 2N3055 will have an h_{FE} in excess of 20 and the possible collector current will then be greater than 2 amps. The change of collector current with potentiometer adjustment is smoother than occurs in the circuit of Fig. 2.

The current drawn from the 1.5 volt cell in Fig. 3 varies from about 66 to 140mA according to the setting of R2. A high power cell, such as the Ever Ready HP2, would be suitable. There is little point in attempting to stabilize the voltage applied to R1, R2 and R3. If the cell voltage falls markedly with use the maximum collector current passed by the 2N3055 will simply become lower. ■

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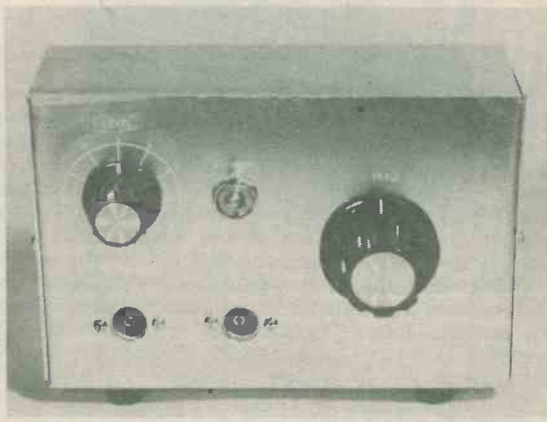

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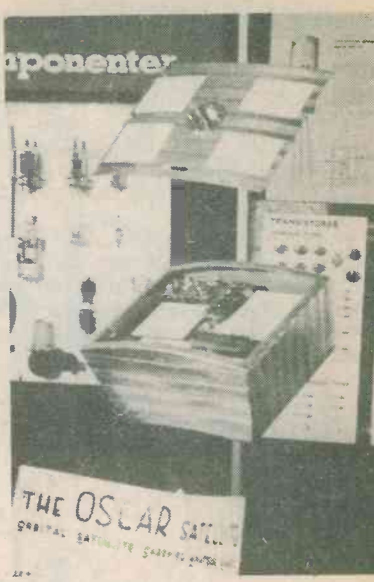
THE OSCARS

By Arthur C. Gee



This article is based on a paper read to the 4th Congress of the International Union of Amateur Astronomers, held at MacMaster University, Hamilton, Ontario, Canada, by the author. It brings together an account of the various satellites which have contributed to the Orbital Satellite Carrying Amateur Radio (OSCAR) project. As such, we feel it will enable those of our readers who are interested in this latest aspect of the amateur radio scene, to view the development of this project from its inception to the latest developments in the radio amateurs' "space" activities.

When the Russians launched Sputnik 1, its simple radio transmitter could be heard wherever there was a suitable radio receiver. Who were most likely to have such radio receivers? — Radio Amateurs. The Russians knew this and it must be assumed, therefore, that the choice of a transmitting frequency for Sputnik's transmitter near the 21 MHz amateur radio frequency band was not just by chance. Within minutes of the announcement on Radio Moscow, radio amateurs were at their receivers anxious to hear the first radio signals from space.

Early satellites, both Russian and American, were one-way devices, transmitting mainly beacon-type signals, with occasional information about conditions on the satellite telemetred back to earth. Getting payloads of appreciable size into orbit was the primary consideration at first, but the communications people were hard at work on satellite systems which eventually provided world wide radio communications of a reliability never before attained over long distances with earth-bound methods.

The idea of a satellite for use in amateur radio communications, began to take shape very early in the United States Satellite Programme. Many problems — technical, financial and even political — stood in the way of this dream's fulfilment, but none of these difficulties stopped the group of advanced radio amateurs who first proposed the plans for amateur radio satellites. A group of U.S.A. West Coast radio amateurs, many of whom were engineers working professionally in the Space field, designed and built a series of amateur satellites, and succeeded in convincing the right people that these should be put into space.

The first of these was known as **OSCAR 1**: Orbital Satellite Carrying Amateur Radio — to give it its full title. It "hitch-hiked" a ride into space aboard the USAF's Discoverer 36 Rocket on December 12th 1961. It had aboard, a simple radio transmitter sending in morse code the signal "Hi Hi" on the 145 MHz amateur radio band. The news that radio amateurs now had a satellite of their own in orbit around the earth had an impact in non-amateur circles, seldom — if ever — equalled in the long history of an always exciting hobby! The satellite, designed deliberately to be short-lived, transmitted its message until noon on December 30th. This short but active life brought in over 5,000 separate and detailed reports from over 570 amateur radio stations in 28 countries. The satellite was a 10 pound weight package and it completed 312 orbits.

OSCAR 2, transmitting in much the same manner as its predecessor, was launched on June 2nd 1962. It completed 295 orbits and was last heard eighteen days later on June 20th. It transmitted information about its temperature, speeding or slowing, its keying rate according to its temperature.

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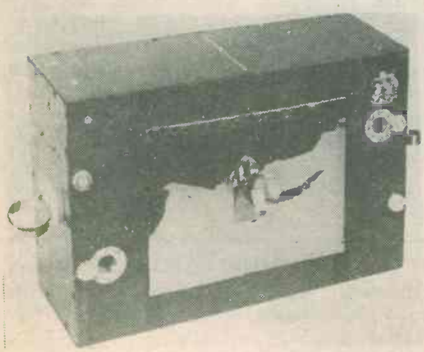
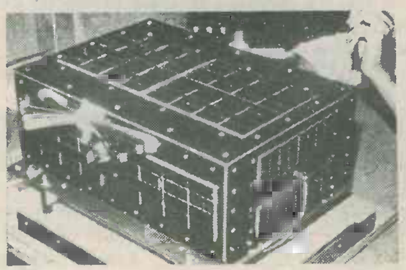
OSCAR 3 was the first true communications satellite for amateur use. It was put into a 570 mile high orbit on March 9th 1965. It carried a receiver and a transmitter, working in the 145 MHz amateur band. The receiver received signals sent to it from ground stations at one end of the band, and the transmitter relayed them back to earth, at the other end of the band. 176 two way contacts were made by amateur radio stations through OSCAR 3, by 98 participating stations — 67 in North America, and 31 in Europe.

OSCAR 4 was a disappointment, due to a malfunction in the launch vehicle. It did, however, enable the first satellite communication exchange to take place between the USSR and the USA, by any satellite whatever — not just amateur.

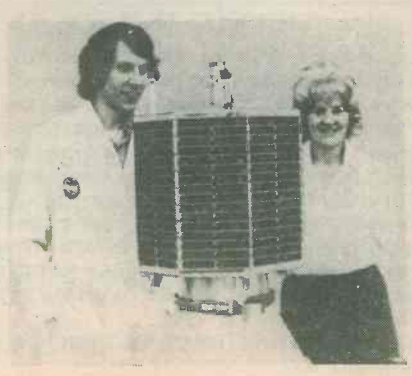


OSCAR 5 was launched from a Delta N. Booster Rocket on January 23rd 1970. It weighed 39lbs, and measured 12in. x 17in. x 6in., and it carried 20lbs. of batteries! This was before the days of solar panels — on amateur satellites at any rate. It was unique in several ways. Most important of all, it was an international effort, the package having been designed and built by students at Melbourne University, Australia.

It was the first satellite project carried through by a new amateur group, the Radio Amateur Satellite Corporation — AMSAT — based in Washington, D.C., U.S.A. This group worked with many of the original OSCAR people in bringing the effort to fruition. It was mainly an educational satellite, designed to transmit only. Signals were radiated in the 2 and 10 metre amateur bands, permitting study of the ionosphere near the peak of the sunspot cycle. It was the first to be used by the Talcott Mountain Science Center at Avon, Connecticut, in their educational programmes. It was particularly interesting in that it carried two bar magnets, which it was hoped would stabilise its orientation in space, preventing the "tumbling" which had been troublesome on earlier satellites, leading to much fading of the radio signals from them.



OSCAR 6 and **OSCAR 7** are both currently in orbit and functioning. They are primarily communications satellites. Technically they are a great advance on the earlier models. They are the first of the AMSAT-OSCAR-B series of amateur radio satellites, representing a second generation of OSCAR spacecraft. They are solar-powered and designed for operating lifetimes of a year or more. Several subsystems have been developed for this series of satellites by radio amateurs in several countries of the world. A linear repeater was developed by amateurs at the University of Marburg in West Germany. It has an input frequency of 432 MHz and an output frequency of 146 MHz. A second linear repeater was fabricated by amateurs in the Washington D.C. area. The input frequency of this was in the 146 MHz amateur band and its output around 29.5 MHz. A third repeater was developed by amateurs in Melbourne, Australia. A morse code and teletype message storage unit called CODESTORE was also developed for storage and forward communication applications. A particularly interesting feature of this



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series of satellites is the telemetry systems they carry, giving information on many parameters of the satellite, such as solar panel currents, battery voltages, temperature, power output and so on. These are transmitted both by morse code and teletype, the former giving students a most excellent opportunity of copying signals which they can then convert into real information.

OSCAR 6 was launched along with a NOAA 2 weather satellite on October 15th, 1972 by a Thor Delta Rocket. It was designed for a life-time of one year, but it is still going strong. Both it and OSCAR 7 are controllable from ground control stations, and in this way, conservation of batteries has been possible. It is in a circular polar orbit 910 miles high. Orbit time is 115 minutes with an inclination of 101.77 degrees.

OSCAR 7 was launched on November 15th 1974. It was launched by NASA from the Western Test Range in California. It was launched from a Delta Rocket along with the NOA 4 weather satellite, and the Spanish INTASAT communications satellite. It went into an orbit similar to that of OSCAR 6.

OSCAR 7 was built by radio amateurs in Australia, Canada, Germany and the United States and is the culmination of a four year project by the Radio Amateur Satellite Corporation (AMSAT) — now a world-wide organisation of amateur radio operators. According to Project Manager, Jan A. King of the Goddard Space Flight Centre, a satellite performing the functions of OSCAR 7 would cost nearly two million dollars to build commercially.

OSCAR 7 was in fact built largely from volunteer help with a cash investment of about 60,000 dollars. These funds came from contributions by individuals and organisations sympathetic to the project.

Space-qualified components and test equipment worth thousands of dollars were donated by a number of aerospace companies, including RCA, Amatek-Hunter Spring, Hi-Shear, Eimac, Yellow Springs Instruments, Microwave Semiconductor Corp., Communications Transistor Corp., Flike Manufacturing Co., Wide-Band Engineering, and Savoy Electronics. In addition, surplus satellite hardware, such as solar cell panels and nickel cadmium rechargeable batteries all left over from other space projects, were made available for OSCAR.

Dr. Perry I. Klein, AMSAT's President, reports that 2,400 amateur radio stations in 87 countries have been using OSCAR 6 since that space-craft's launch over two years ago. Among the users are 180 stations in eastern Europe, including 40 in Czechoslovakia and 55 in the Soviet Union. Apart from the interest afforded radio amateurs in communications via these satellites, they have introduced many students in the sciences, as well as many who have only an "amateur" interest, to an understanding and participation in space techniques.

For a proper use of these satellites, prediction systems must be used, and with the aid of predictions issued from various sources and orbital calculators, participants can calculate the times and position of orbits near their locations. In fact a whole educational system using facilities provided by these satellites has been built up, covering many scientific disciplines. In the Fall term of 1971, a graduate workshop on amateur satellites was conducted by the University of Hartford College of Education, USA, to develop curricula on the use of amateur satellites in the classroom. From their studies it was apparent that in *Physics* basic orbital mechanisms can be studied; the relationship between orbital altitudes, velocity and period, Doppler shifts, their calculation and subsequent actual satellite observations; radio wave propagation such as polarization, Faraday fading and skip propagation, can all be explained and illustrated by means of the received satellite beacon signals.

In Mathematics the orbit equations and Doppler shift relationships can be derived. The data from the satellite telemetry can be decoded and interpreted in terms of linear algebraic equations and simple graphs.

The Spacecraft environment can be explained and illustrated by means of the satellite's "housekeeping" telemetry, which provides information on the spacecraft's temperature and orientation. The day-to-day variations of various telemetered parameters can be recorded and students encouraged to explain trends in the measurements.

In Space Science, propulsion, radiation, Van Allen belts, weightlessness, conduction, radiation eclipse and reliability are among the many concepts that can be illustrated and tied to interpretation of the spacecraft's telemetry transmissions.

Many other similar scientific disciplines were similarly treated and it was quite obvious that quite apart from communications potential, these amateur radio satellites had educational potential of enormous proportions. In fact a "Curriculum Supplement for Classroom Use" has now been produced by the Talcott Mountain Science Centre, in collaboration with the American Amateur Radio Relay League and with AMSAT, in the form of a booklet entitled "Space Science Involvement", which sets out in great detail much of what has been said in this paper and gives a complete series of classroom activities in numerous science disciplines, making use of the facilities offered by these satellites. ■

"R.S.G.B. Lecture" on Amateur Radio Satellites

The Sayoy Place, Institution of Electrical Engineers, "R.S.G.B. Lecture", held in November, last, was on the subject of Amateur Radio Satellites, and was given by Pat Gowen, G310R, supported by members of AMSAT-UK.

Pat Gowen dealt ably with the background to the topic, illustrating with slides, the build-up from the first of the amateur radio satellites to the communication OSCARS 6 and 7. Both his tape recordings and those of Brian Bower, G3C0J, who dealt specifically with communication via the 7o cm up/ 2 metre down channel on OSCAR 7, gave those of the audience who had never had experience of OSCAR communications a good idea of the possibilities of this mode of amateur radio communiation. David Walland, gave a talk on the methods of tracking these satellites and Martin Sweeting of the University of Surrey, dealt with some of the difficulties of running a Control Station for the turning on and off of OSCAR 6.

An interesting evening, much enjoyed by the audience, and a credit to those who presented it.

A.C.G.

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Water Level Sensor

By R. Desmond

A simple circuit which gives warning if a volume of water rises above a pre-determined level.

A water level sensor can be a useful device and may be employed to warn against flooding or to ensure that water does not rise to too high a level in a pool or tank.

Pure distilled water does not conduct electricity. On the other hand, ordinary tap water or river water readily passes a current if two metal probes are immersed in it. The unit to be described takes advantage of this effect.

CIRCUIT OPERATION

The circuit diagram of the main section of the water level sensor appears in Fig. 1. Power is provided by the heater transformer T1, whose 6.3 volt secondary couples to the bridge rectifier given by D2 to D5, whereupon a rectified voltage of around 8 volts appears across the electrolytic reservoir capacitor C1. In the circuit diagram the upper supply rail is negative. The lower supply rail is positive and also connects to the chassis of the unit.

The two probes which will be used to monitor the water level connect to terminals A and B. Terminal B connects to chassis whilst terminal A couples to the base of TR1 via R2. R2 limits possible current flow in TR1 base. Also, its presence in combination with pre-set potentiometer R1 allows a control of sensitivity to be obtained.

TR1 and TR2 form a high gain switching circuit. If there is no circuit path between terminals A and B, TR1 is cut off and it passes no collector current. In consequence, no current flows to the base of emitter follower TR2, and the emitter of this transistor is at chassis potential.

If terminals A and B are bridged due to the probes being immersed in water, transistor TR1 turns hard on and its collector potential rises nearly to that of the negative supply rail. The emitter of TR2 rises to a slightly lower value, causing relay RLA to become energised. The relay contacts change over to the

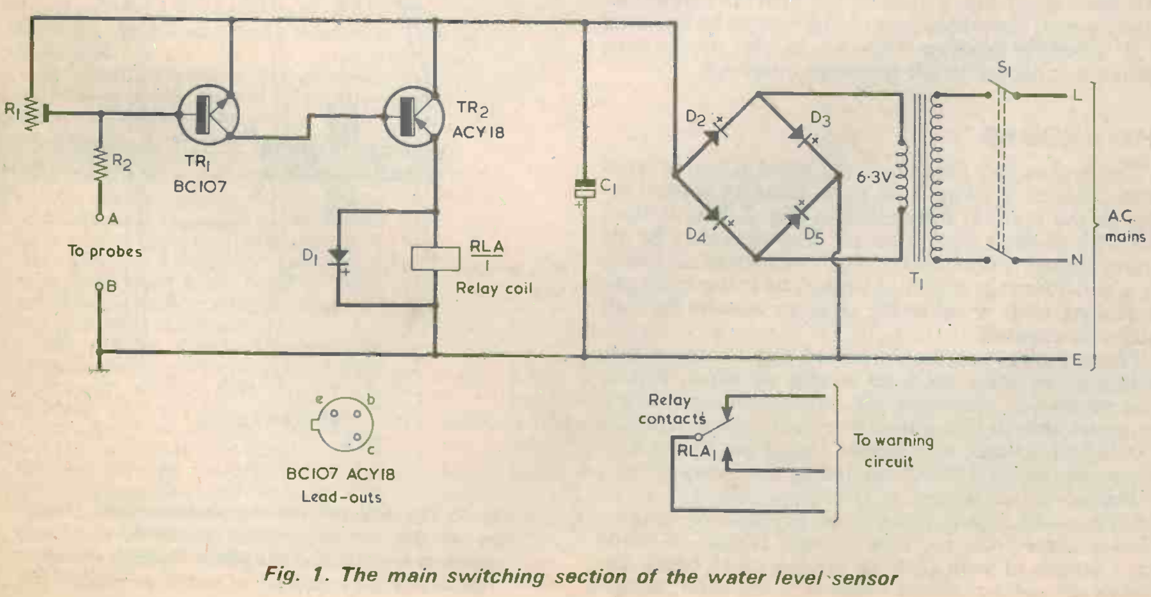

Fig. 1. The main switching section of the water level sensor

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COMPONENTS

Resistors
R1 25kΩ pre-set potentiometer, skeleton
R2 47kΩ ¼ watt 10%

Capacitor
C1 400μF electrolytic, 16V. Wkg.

Transformer
T1 Heater transformer, 6.3V secondary

Semiconductors
TR1 BC107
TR2 ACY18
D1-D5 1N4002

Relay
RLA 410Ω relay (see text)

Switch
S1 d.p.s.t. toggle

Miscellaneous
Probe, or probes, and bracket
Components for warning circuit

energised position, whereupon the warning circuit is operated. The latter may incorporate an electric bell, a warning light or any similar device.

The relay will remain in the energised state until the water level falls below the probes and the circuit between terminals A and B opens again. D1, across the relay coil, is the usual protective diode which prevents the appearance of a high back-e.m.f. in the coil when the relay releases.

The components are all standard parts. T1 may be any heater or filament transformer with a secondary voltage of 6.3 volts. The secondary current rating of a transformer of this type will be 0.5 amp or more; well in excess of requirements in the present application.

The relay is a 'Miniature Open P.C. Relay' having a 410Ω coil, available from R.S. Components or Doram Electronics. This has coil and contact tags suitable for printed circuit connections, but it may also be mounted with its tags pointing outwards by means of two 8BA bolts and nuts. The contacts are changeover, and are rated 5 amps at 250 volts a.c. or 30 volts d.c. The metal body of the relay is common with its moving contact, and so care must be taken to avoid touching it if this contact is used to switch mains voltages. In this case the relay will have to be mounted on a sheet of s.r.b.p. ('Paxolin') to provide insulation. In any event, the whole unit of Fig. 1 must be enclosed in a suitable housing with all safety precautions against accidental shock properly observed.

THE PROBES

The probes can consist of two stout p.v.c. covered wires positioned away from each other by several inches in the manner illustrated in Fig. 2. The bottom half-inch of each wire is bared. The wire may be ordinary tinned copper and this will withstand corrosion for a considerable length of time. The lower ends can be tinned with a soldering iron to ensure that all copper is covered.

The two wires may be supported about three or four inches above their ends, as is also shown in Fig. 2. This method of mounting will reduce leakage paths if the water should rise well above the probe tips before it falls below their level again. The probe tips are, of course, at the level to be reached by the water when it is desired that warning be given.

If the main unit is close to the probes, the connections to these from terminals A and B may be made via a length of twin flex. If, on the other hand, the probes are some distance away or if the interconnecting wire passes close to unscreened mains wiring, it would be preferable to employ screened wire, connected as shown in Fig. 3(a). This will ensure that there is no risk of hum voltages being applied to the base of TR1, where they might cause erratic operation of the relay. The screened wire can consist of television aerial coaxial cable or audio screened wire.

In instances where the volume of water is outdoors it will probably be at earth potential, this being the case if the water is, say, in an outside pool. In this instance one probe can be dispensed with, if desired, whereupon terminal B connects to an earth point either at or near the volume of water, as in Fig. 3(b).

R1 controls the sensitivity of the unit. Due to their damp environment there is the possibility of a high resistance leakage path existing between the probes, or between a single probe and earth, and it would be undesirable to have this operate the relay. In consequence R1 is set to give the sensitivity applicable to a particular installation.

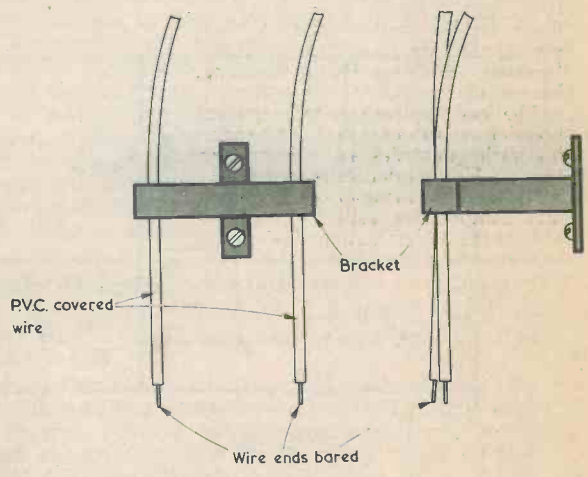

Fig. 2. The two probes are mounted with their tips at the pre-determined water level. The mounting bracket has the general shape shown here and may consist of metal or wood

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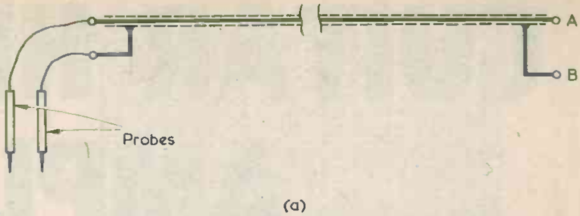


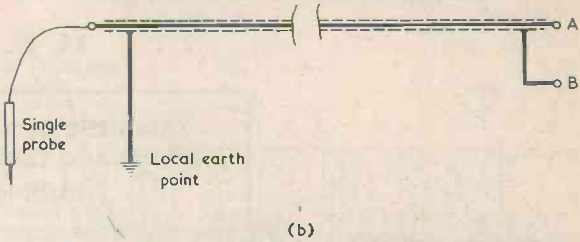


Fig. 3(a). It is desirable to use screened wire for connecting to the probes if the wire is long or passes near mains wiring

(b). For some outside applications, only one probe is required

After the unit has been completed it may be checked by immersing the probes or probe into the water with R1 at the maximum resistance setting. The relay should then operate. The resistance inserted by R1 is then reduced until the relay releases. Relay release may occur when R1 slider is quite close to the minimum resistance end of the track. After this the resistance of R1 should be increased once more until it is advanced past the point where the relay energises again by a reasonable factor.

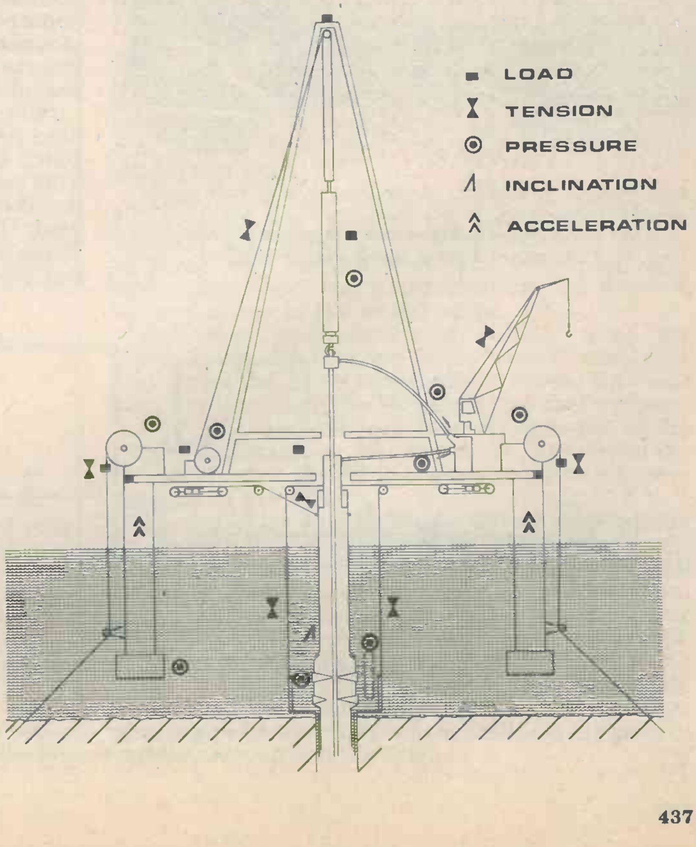
The probes or probe are then fitted in their final position, and the water level sensor is ready for use. ■

OIL RIG TRANSDUCERS

The drawing of a representative offshore oil rig illustrates the wide range of electronic sensors and transducers which are employed for static and dynamic measurement in fixed marine installations. All of these are supplied by Transducers (C.E.L.) Limited, Trafford Road, Reading, RG1 8JH.

The load applications employ compression cells and are used for measuring such quantities as anchor winch tension. The tension cells proper give indications of towing forces. There are also compression cells for weighing and for the determination of the centre of gravity of a rig. Most of these cells have ranges from zero to hundreds of thousands of kilograms. Inclination cells sense angle to the vertical whilst acceleration cells provide feedback of roll and other movement.

The general range of transducer systems employed in the current high technology offshore sites include underwater pressure sensors; hydraulic system pressure sensors, drill string weight indicator systems, mud pressure sensors, module and jacket weighing systems, and running line tension systems. A fantastic range of electronic measuring devices for an equally fascinating engineering achievement.



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GUITAR HEADPHONE AMPLIFIER

M. G. Argent

This little amplifier allows guitar practice and tuning up without disturbing others.

The component parts of the prototype amplifier fit snugly into a small plastic case

The amplifier to be described is a very useful unit which enables the electric guitar player to practice without outside disturbance. It is particularly valuable when tuning up in a dressing room while another band or group is playing live on stage. Using the guitar under such conditions would otherwise be virtually impossible.

THE CIRCUIT

The circuit, which appears in Fig. 1, employs an MC1306P integrated circuit, which will give an output in excess of the headphone requirements.

The input from the guitar passes via C1 and R1 to pin 6 of IC1. The gain and frequency response are determined by R2, C2 and C3. The output of IC1 appears at its pin 3, and this is applied to the output jack via C5. C4 and R3 form a Zobel network which counteracts the inductive properties of the headphones and aids stability.

Both the input and output jack sockets are standard ¼in. types. The output jack socket has a contact which makes when the headphone plug is inserted. This contact switches on the amplifier and saves an on-off switch. However, an ordinary jack socket can be used, if desired, and a normal on-off switch fitted. There is no volume control, as the guitar will have its own control built-in. The headphones may have any

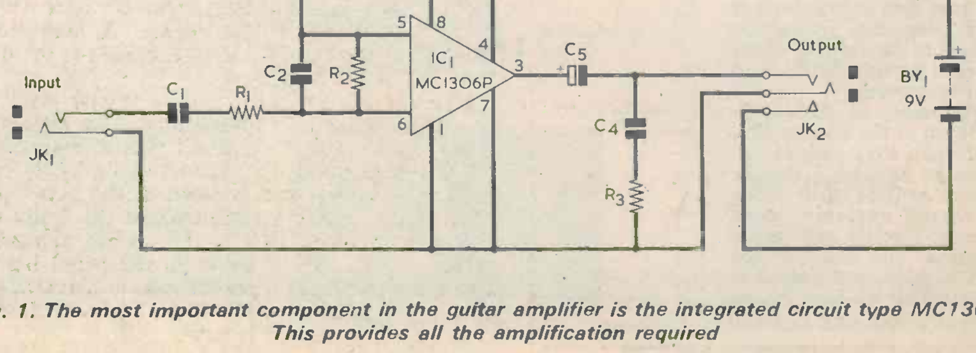

Fig. 1. The most important component in the guitar amplifier is the integrated circuit type MC1306P. This provides all the amplification required

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All parts are completely enclosed when the lid of the plastic case is fitted

impedance provided this is not lower than 8Ω. When using the amplifier for the first time keep the guitar volume low initially. With sensitive low impedance phones the volume level could be high, as the i.c. is capable of developing 500mW in an 8Ω load.

The integrated circuit is available from Chromasonic Electronics, 56 Fortis Green Road, Muswell Hill, London N10 3HN. Standard ¼in. jack sockets having two "make" contacts (of which only one is required here) may be obtained from Home Radio (Components) Ltd.

The amplifier can be powered by a PP3 or PP3-P battery, the latter having a longer life. Quiescent current consumption is approximately 4mA.

COMPONENTS

Resistors
(All ¼ watt 10%)
R1 47kΩ
R2 470kΩ
R3 10Ω

Capacitors
C1 0.1μF plastic foil
C2 47pF ceramic tubular
C3 0.047μF plastic foil
C4 0.047μF plastic foil
C5 470μF electrolytic, 10 V. Wkg.

Integrated Circuit
IC1 MC1306P

Sockets
JK1 ¼in. jack socket
JK2 ¼in. jack socket with "make" contact (see text)

Battery
BY1 9 volt battery type PP3 or PP3-P (Ever Ready)

Miscellaneous
Veroboard, 0.1in. matrix
Battery connector
Plastic or wooden case

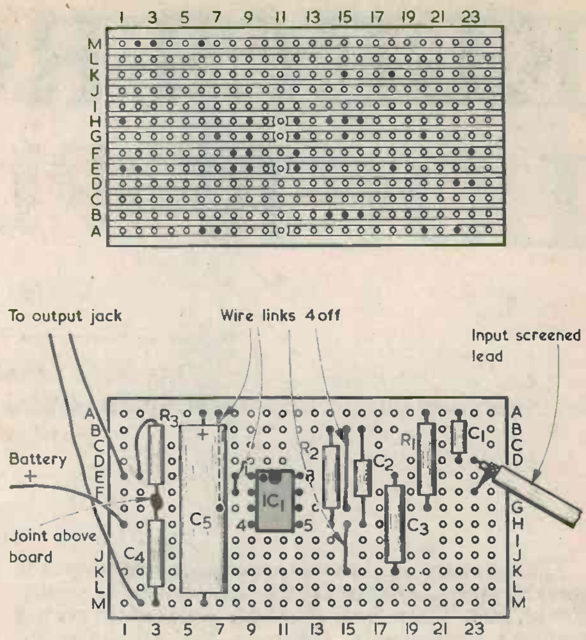

Fig. 2. The copper and component sides of the Veroboard panel on which the amplifier is assembled

VEROBOARD LAYOUT

Apart from the two jack sockets, the components are assembled on a piece of 0.1in. matrix Veroboard having 13 strips by 24 holes. The component and copper sides of this board are illustrated in Fig. 2. The strips are cut at four points, as indicated in the diagram, by means of a Vero spot face cutter or a small twist drill.

When fitting components to the board, ensure that IC1 and C5 are installed the correct way round. Assembly will be eased if C5 is the last component to be fitted. The junction of R3 and C4 consists of a solder joint above the board; this junction does not connect to any of the copper strips.

The input lead consists of screened wire, the braiding of which connects to the "sleeve" contact of JK1 whilst the centre wire connects to the "tip" contact. The lead from hole M2 connects to the "tip" contact of JK2, and the lead from E1 connects to the "sleeve" contact of this socket. A lead from the "make" contact of JK2 then connects to the negative terminal of the battery.

The amplifier may be housed in any small plastic or wooden case of suitable size. The author's unit fitted comfortably in a small plastic soap dish with lid, this measuring approximately 3½ by 2½ by 1¼in. deep. The layout can be seen in the accompanying photograph, which also illustrates the types of jack socket employed. JK2 is the socket alongside the battery connector. The Veroboard panel fits snugly across the width of the plastic case, and a piece of foam plastic glued to the inside of the lid holds the battery in place when the lid is fitted. ■

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ELECTRONIC LOCK

By Phoebus Polydorides

An ingenious circuit approach which will be of particular interest to the experimenter.

The unit described in this article is intended for the more advanced constructor who is prepared to experiment a little, since some of the parts employed are not standard components. However, the principles involved are quite simple and should not raise many problems for the experienced reader.

The device is mounted behind a hole in a panel and consists of an electronic lock which can only be opened by inserting the proper key through the hole. The key? A ferrite rod!

It is unlikely that there will be many thieves wandering around with a selection of ferrite rods in their pockets. When a ferrite rod of the correct diameter is passed into the hole a relay energises and its contacts cause a solenoid to release the lock. The unit only draws current from its battery when the ferrite rod is inserted.

THE CIRCUIT

Basically, the circuit consists of a 'transmitter' oscillator to which a 'receiver' responds when the ferrite rod is inserted into their respective coils. The ferrite rod provides inductive coupling between the coils.

As shown in Fig. 1, the 'transmitter' oscillator incorporates transistor TR1. This has C1 across its collector and emitter to maintain oscillation, the oscillator coil L1 being partly tuned by TC1. The emitter bias resistor, R3, is bypassed by C2, and R1 and R2 provide base bias. Coil L1 is tapped close to its lower end, as shown in the diagram, to give a reasonable impedance match to the transistor. However, the circuit will also operate without this tap, the upper supply rail connecting directly to the lower end of the coil. This alternative method of connection permits the use of ready-wound coils without taps.

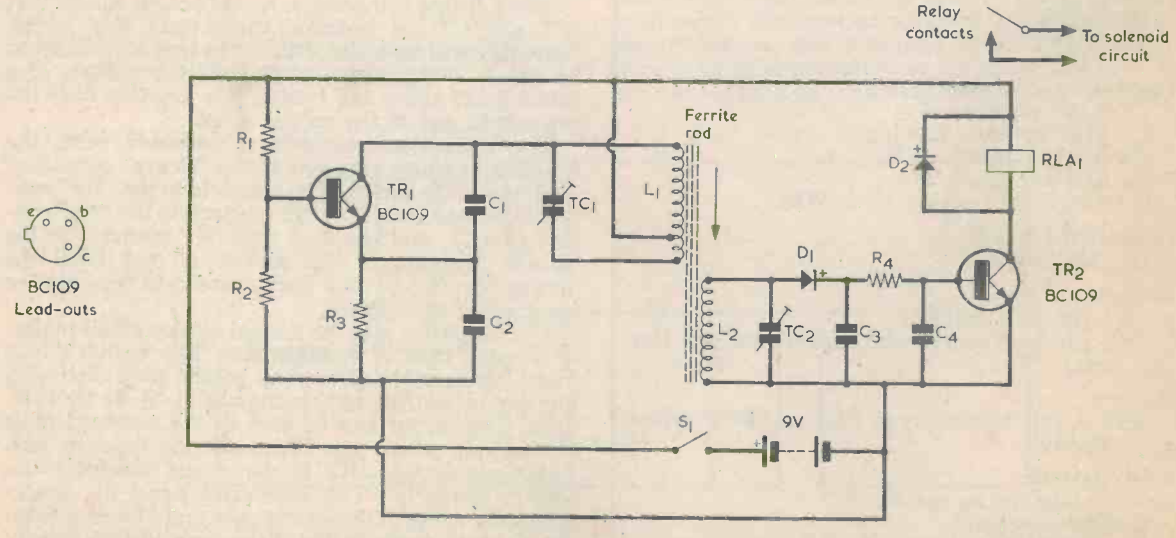

Fig. 1. The circuit of the electronic lock. It is operated by passing the ferrite rod through L1 and then L2

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The ferrite rod is inserted so that it passes through L1 and the 'receiver' coil L2, thereby closing press-button S1 and turning on the oscillator. L2 is tuned by TC2 to the oscillator frequency, and the r.f. signal induced in it is rectified by D1. The rectified signal, converted to a steady direct voltage by C3, R4 and C4, is then passed to the base of TR2 which turns on and causes the relay to energise.

It will be seen that the lock can only be opened by inserting a ferrite rod. If a rod of any other material is passed through the coils there will not be the requisite inductive coupling between them, and the lock will not operate even if S1 is closed.

THE COILS

The coils are, of course, the most important part of the assembly. To keep dimensions small a narrow diameter ferrite rod should be employed. Here, Henry's Radio list a ferrite rod with a length of 89mm. (3.5in.) and a diameter of 6.4mm. (0.25in.).

Home-wound coils may be wound on a former of approximately 8.5mm. diameter which permits the entry of the ferrite rod. Litz wire taken from an old i.f. transformer is most suitable, and both coils may consist of 200 to 250 turns, each scramble-wound to take up a length of 8mm. on the former. The tap in L1 is 40 to 50 turns from one end. It will help to wind L2 on adhesive tape, sticky side out, so that it may be moved along the former. Both the trimmers, TC1 and TC2, have high values, giving a wide range of adjustment.

Ready-made coils from an old valve i.f. transformer may also be used, if their formers allow the ferrite rod to pass through. In this case there is no tap in L1 and this is connected up as described earlier.

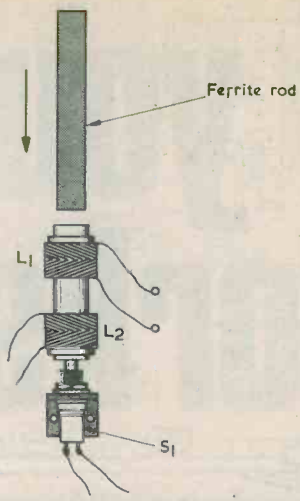

Fig. 2. When the ferrite rod has passed through the coils it presses push-button S1, thereby switching on the circuit

COMPONENTS

Resistors
(All ¼ watt 10%)
R1 3.9kΩ R3 330Ω
R2 1.2kΩ R4 22kΩ

Capacitors
C1 200pF silvered mica
C2 2,000pF disc ceramic
C3 0.05μF plastic foil
C4 1μF plastic foil
TC1 150-750pF mica trimmer
TC2 150-750pF mica trimmer

Inductors
L1, L2 (see text)

Semiconductors
TR1 BC109
TR2 BC109
D1 OA81
D2 1N4002

Switch
S1 press-button, push to make

Relay
RLA1 (see text)

Miscellaneous
Ferrite rod (see text)
9 volt battery

ADJUSTMENTS

Once the unit has been assembled insert a 0-100mA meter bypassed by a 0.1μF capacitor at its test clips between the upper supply rail and L1. Connect a second meter capable of reading currents up to 150mA in place of the relay, with an 82Ω current limiting resistor in series. Do not insert the ferrite rod at this stage.

Bypass S1 and adjust TC1 for a dip in TR1 current consumption. Similarly adjust TC2 for lowest current in TR2 collector circuit. Insert the ferrite rod into the coils. When it enters L2 the current reading in both meters will show a sharp increase. Readjust the trimmers for maximum difference in TR2 current between the states where the rod is inserted and removed, and for a reasonably low current in TR1 commensurate with this condition. If the position of L2 is adjustable, it may be moved along the former for best results.

With the author's unit it was found that, with S1 bypassed and no ferrite rod in the coils, the current in TR2 collector circuit was 20mA. This rose to 80mA when the rod was inserted. The relay should be a type which is capable of energising at the higher current and releasing at the lower current. Alternatively, a more sensitive relay, such as the Doram 'Miniature Open P.C. Relay' with 410Ω coil may be employed with a resistor connected across its coil to pass part of the collector current. The value of the resistor is found by experiment after the minimum and maximum collector currents in TR2 have been determined. To prevent excessive dissipation in TR2, the resistance in its collector circuit must never be less than 82Ω.

Fig. 2 shows the manner in which the two coils are mounted. The press-button switch is fitted at the end remote from the point where the ferrite rod 'key' is inserted. ■

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In your workshop

This month Smithy the Serviceman takes a rest from his usual servicing duties and introduces his assistant to a circuit which, at first sight, has quite unusual properties.

"Transistor circuits," boasted Dick, "I've seen them all!"

Smithy took an enormous draught from his disgraceful tin mug and surveyed his assistant dispassionately.

"Yes," vaunted Dick. "I've seen them all, every one. Common base, common emitter, common collector, the lot!"

In a virtual transport of self-aggrandisement, Smithy's assistant sprawled carelessly on his stool. The pair had just finished their lunch and Smithy was now approaching hydration equilibrium by the intake of vast quantities of tea.

"You certainly seem," he remarked musingly, "to be pretty sure of yourself."

NOVEL CIRCUIT

"Of course I am," replied Dick loftily. "Look at all the transistor circuits I've fixed since I started this servicing racket. Now I know that you're supposed to be the brains of this outfit, Smithy, but I reckon, if I think hard enough about it, I could still show you a thing or two so far as transistor circuits are concerned."

Had Dick been watching the Serviceman as he made this assertion, instead of gazing airily around the Workshop, he would have noted the thoughtful gleam that suddenly appeared in Smithy's eyes.

"I should imagine," stated Smithy artlessly, "that we older ones do have to concede that the younger generation coming up must eventually learn more than we know."

"Well," replied Dick condescendingly, "youth is bound to triumph in the end. Of course, the last thing I would *ever* do is pretend to be better than I am, and I don't want you to think that I'm doing so now. It's just that over the years I've been preparing myself."

"Preparing yourself?"

"Preparing myself," repeated Dick firmly. "I don't want to sound cruel, Smithy, but we've got to see things as they actually are. I mean, it will be only a couple of years before I'll be looking after this Workshop all on my own."

Smithy picked up his mug and raised it to his lips.

"And where," he asked caustically before he commenced drinking, "will I be?"

"Oh, I don't know," replied Dick carelessly, "probably in the local geriatric ward."

Smithy spluttered and a stream of tea ran down his chin onto his overall jacket. Hastily, he pulled out his handkerchief and mopped his face and jacket.

"Darn it," he grumbled, "that's the last of this mug of tea gone."

"Don't worry, Smithy," said Dick, getting lazily to his feet. "I'll get you some more. I suppose you can't really help it if you get a bit dithery every now and again."

Dick took the mug from the now speechless Smithy, and carried it over for replenishment to the motley collection of utensils ranged alongside the Workshop sink. Smithy glared at his retreating back, and then continued the train of thought that had commenced some moments earlier.

When Dick returned with the mug, now full of tea, he found the Serviceman had started to sketch out a circuit on his note-pad. Intrigued, Dick watched silently until Smithy had completed the circuit, then looked at it closely. (Fig. 1).

"That looks a bit unusual," he remarked. "What's it meant to be?"

"What does it look like?"

"I suppose," said Dick, "it's some sort of amplifier. I should imagine that you put in an input at the base of the BC107 you've marked as TR1 and get an output at its collector."

"Dear me," remarked Smithy mildly, "you really do give the impression of being clued up about transistor circuits. I dreamed up this particular circuit some time ago and I'm going to try it out in practice as soon as I have a little spare time."

"I'll try it out for you," offered Dick. "You've come to the right bloke if you want to find out about transistor operation."

Dick tore the sheet on which Smithy had drawn the circuit from the top of the note-pad then carried it over to his bench. He quickly found the few componets required, together with a small tagboard on which they could be assembled. As he wired up the circuit, Smithy leaned back against his own bench and sipped his tea. The suspicion of a grin hovered around his lips.

With a clatter, Dick replaced his soldering iron on its rest.

"It's all complete," he called out. "What do you want me to do next?"

"Just couple it up to a 9 volt battery," replied Smithy. "You'll also need another 47kΩ resistor and your testmeter."

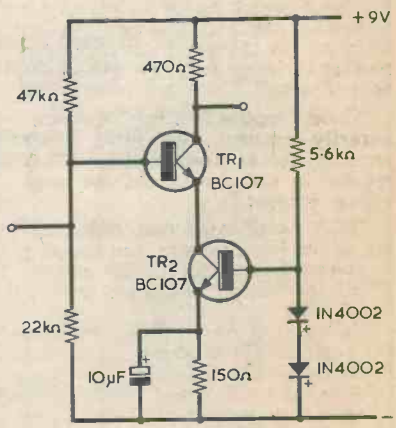

Fig. 1. The circuit which Smithy drew for his assistant

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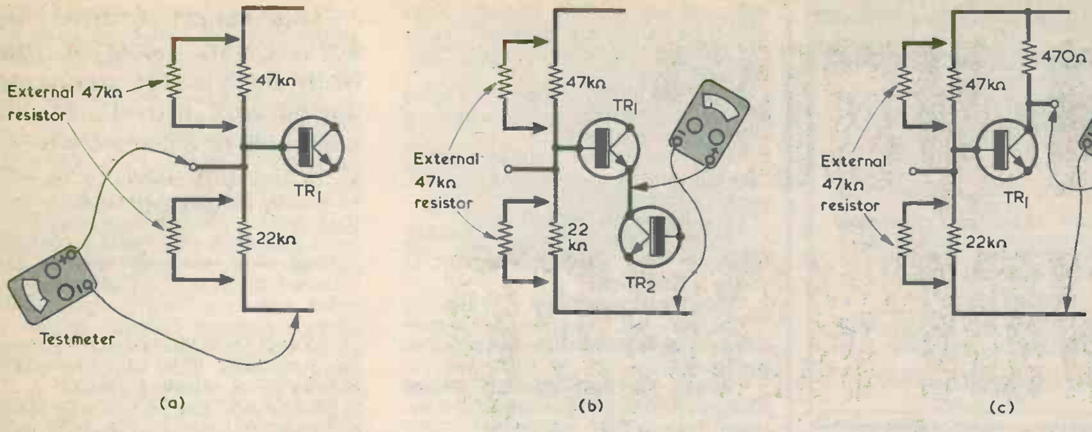

Fig. 2(a). Dick measured the voltage between TR1 base and the negative rail when an external 47k Ω resistor was first applied across the 47k Ω resistor in Smithy's circuit and then across the 22k Ω resistor (b). Next, Dick checked the voltage at TR1 emitter under the same conditions (c). When, finally, Dick measured TR1 collector voltage, with the external 47kΩ resistor applied first across the internal 47k Ω resistor and then across the 22k Ω resistor, he encountered Smithy's little paradox

Several moments passed whilst Dick fitted two crocodile clips to the supply leads for the circuit and connected these to a PP9 battery. He next found another 47kΩ resistor and pulled his testmeter towards him.

"All set," he called out.

"Right," said Smithy briskly. "Well, first of all put your testmeter to a suitable volts range and connect it between the negative supply rail and the base of TR1. Okay?" (Fig. 2(a).)

"Sure," replied Dick, as he turned the range switch on his testmeter. He picked up its test clips and applied them to the circuit. "I'm getting a reading of, let me seen now, almost exactly 2 volts."

"Good," replied Smithy, "Now temporarily connect that extra 47kΩ resistor across the existing 47kΩ resistor in the circuit and see what voltage you get."

"Righty-ho," responded Dick, picking up the 47k Ω resistor, and bridging it across the resistor in the circuit. "Well, the voltage reading has gone up to 3.6 volts."

"Now," continued Smithy, "connect the external 47k Ω resistor across the 22k Ω resistor."

"Okey-doke," called out Dick. "I'm doing that right now. The voltmeter reading has dropped to around 1.6 volts."

"That's fine," commented Smithy. "The voltage fall is less than the previous voltage rise partly because 22kΩ is lower than 47kΩ and so the effective reduction in resistance is less, and partly because there's a higher current in the 47kΩ resistor in the circuit because of the base bias current which flows in it."

SIGNAL INPUT

"I think I've got the idea of what you're doing here," remarked Dick brightly. "Altering the base voltage by temporarily applying the external 47kΩ resistor is more or less the same as applying an input signal voltage, isn't it?"

"You could say that."

"I tell you," crowed Dick triumphantly. "When it's information on transistors you need, I'm your man. What next, Smithy?"

"Connect your testmeter between the negative supply rail and the emitter of TR1," replied Smithy. "Then repeat the operation."

Smithy took up his tin mug and drank deeply of its contents whilst Dick reconnected the positive clip of his testmeter. (Fig. 2(b).)

"First reading coming up," stated Dick. "The voltage on the emitter without the external resistor applied is 1.6 volts. When I connect the external resistor across the 47kΩ resistor in the circuit the emitter voltage rises to 3.2 volts. Shouldn't it be 3 volts, to make it 0.6 volt lower than the corresponding voltage on the base? The BC107 is a silicon transistor, and there should be about 0.6 volt across its base-emitter junction."

"The reading at the base," replied Smithy, "was probably a bit lower than it should theoretically be because of the small current drawn by the testmeter itself."

"That seems reasonable enough," stated Dick. "Well, I'm putting the external 47kΩ resistor across the 22kΩ one. Whereupon the voltage on the emitter drops to — hang on a jiffy — about 1.1 volt."

"Very good."

"Where," asked Dick a little irritably, "is this getting us? All we've found out up to now is that the voltage on the emitter goes positive when the base goes positive, and it goes negative when the base goes negative. That's what's bound to happen."

"The next voltage to check," stated Smithy, ignoring his assistant's comments, "is the voltage between the negative supply rail and TR1 collector."

"Corblimey," complained Dick. "The collector voltage will change also. When the base goes positive the collector will go negative, and vice versa. Hell's teeth, Smithy, anyone could tell you that."

"Neverthelesss," remarked Smithy gently, "it would still be of interest to repeat the operation with the external resistor and see what voltages you actually get at the collector."

Grumbling, Dick connected the positive testmeter clip to the collector of TR1 (Fig. 2 (c).)

"Right," he stated. "Now, the collector voltage without the external resistor applied is 7.1 volts. I'm now applying the external resistor across the 47kΩ resistor."

Smithy picked up his mug once more and waited expectantly. For a very long time there was complete silence from Dick's bench. Smithy sipped his tea contentedly.

A low crazed monotone became audible. Smithy pricked up his ears.

"It's the strain of working in these surroundings, that's what it is," Dick mumbled to himself, "day after day, messing around with electronics. Well, it's finally happened. I've now gone

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right off my trolley. Doolally Dick they'll be calling me from now on."

"Are you," called out Smithy, "having any trouble?"

"Trouble, he says. Here am I going stark raving bonkers and he asks me if I'm having trouble!"

"It seems evident," stated Smithy, "that some little phenomenon has temporarily unnerved you."

Dick recovered his full voice.

"Some *little* phenomenon?" he repeated. "Ye gods, this circuit of yours is diabolical."

"You put it together."

"I know I did," moaned Dick regretfully. "I wish I'd never seen the horrible thing."

"What did the collector voltage change to when you connected the external resistor?"

"That's the whole thing," wailed Dick. "The collector voltage didn't change at all, it just stayed at 7.1 volts! I've repeated all the previous voltage checks at the emitter and the base just to make sure, and these voltages go up when I put the external resistor across the 47kΩ resistor in the circuit and they go down when I put the external resistor across the 22kΩ resistor. But not that collector voltage. It stays fixed at 7.1 volts all the time!"

"Well, fancy that."

"It just didn't shift at all."

"Dear me."

Smithy took a further drink of tea and gazed benevolently at his stricken assistant. Gradually, the distracted expression on Dick's face changed to one of budding suspicion.

"Why, you scheming old devil," he said accusingly. "You set this up, didn't you?"

Smithy drank a little more tea, then put down his mug.

"Didn't you?"

Smithy smiled happily.

CONSTANT CURRENT

"Go on, Smithy," persisted Dick, "you *did* set it up, didn't you?"

"Yes," replied Smithy at last. "I did set it up."

"Why?"

"Because," snorted Smithy, "I was getting fed up with your continual bragging about transistor circuits. If you'd had one-tenth of the knowledge on transistors you've been claiming, you'd have straightaway spotted something in that circuit which would have given you a clue to its performance."

"What," asked Dick, "did I miss?"

"You failed to notice the obvious fact," said Smithy, "that the BC107 in the TR2 position is connected as a constant current source."

"Blimey, is it?"

"It is indeed. Now there's been enough written about constant current sources over recent years and so I don't need to give a long explanation as to why TR2 provides a constant current. Briefly, its base is held firmly at about 1.2 volts above the negative rail by the two forward biased 1N4002 silicon rectifiers and there is an 0.6 volt drop, or thereabouts, in its base-emitter junction. Okay?"

"Yes," said Dick reluctantly. "I'm with you up to now."

"So," pronounced Smithy, "there's approximately 0.6 volt remaining across the 150Ω resistor, whereupon an emitter current of about 4mA flows in it. As the voltage and resistance are fixed that 4mA represents a constant current. Also, since the emitter and collector currents of a high gain transistor are very nearly equal, TR2 offers a constant collector current of about 4mA, too. That constant current flows through TR1 and the 470Ω resistor in its collector circuit."

Smithy rose and walked over to his assistant's bench so that he could point out the route of the constant current. (Fig. 3).

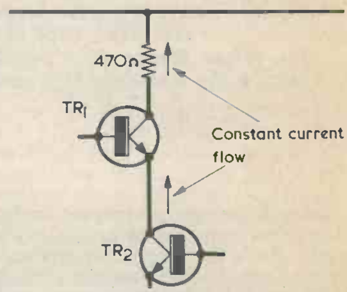

Fig. 3. The constant current from TR2 collector flows through TR1 and the 470Ω resistor in TR1 collector circuit. (Current flow from negative to positive is assumed here)

"This," said Dick, frowning, "takes a bit of absorbing. You say that the constant current of 4mA flows all the time in the 470Ω resistor?"

"I do," affirmed Smithy. "It will always flow, provided of course that there is sufficient base bias to TR1 to maintain it. Since there is a constant current of 4mA in the 470Ω resistor there must always be a constant voltage of a little less than 2 volts across it. And that's just what you found in practice."

"Let's take things a little more slowly," said Dick. "All this is a bit hard to grasp in one go. When I took the base of TR1 positive I *must* have increased the base current. Surely, by all that's sensible the collector current should have increased, too."

"It couldn't," chuckled Smithy. "TR1 is presented with two unavoidable sets of circumstances. It can only pass the 4mA constant current from TR2, and its collector current can only pass through the 470Ω resistor. So, provided the base bias current is adequate, TR1 is completely trapped between these two conditions. The only possible change that can oc-

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cur when you take the base positive is a change in the base current itself. When the base goes positive the base current increases by a tiny bit, this being the small amount needed to provide for the lower voltage between collector and emitter at the constant 4mA current. Similarly, the base current decreases very slightly if you take the base negative."

"Well," said Dick, "I'd never have believed all this if I hadn't actually seen it for myself. Gosh, I've just thought of something!"

"What's that?"

"When I started applying that external resistor to the resistors in the circuit," stated Dick, "I said at the time that this was taking the base of TR1 positive and negative in much the same way that an input signal voltage would."

"I heard you say that," confirmed Smithy. "You said it quite distinctly."

"But what all this means," wailed Dick incredulously, "is that if you actually apply an input signal voltage to the base of a transistor with a constant current source in its emitter circuit that transistor will simply not amplify. You won't be able to get *any* signal out of its collector!"

"Very succinctly put."

"But it's preposterous," exploded Dick. "Blimey, for a start the input transistors in an operational amplifier can have a constant current source in their common emitter circuit." (Fig. 4.)

"Ah," said Smithy, holding up a finger, "but there's a difference there. The two transistors in the operational amplifier are *sharing* a constant current between them. Neither of the two transistors is called upon to pass the constant current on its own. Unless, of course, the other one is cut off."

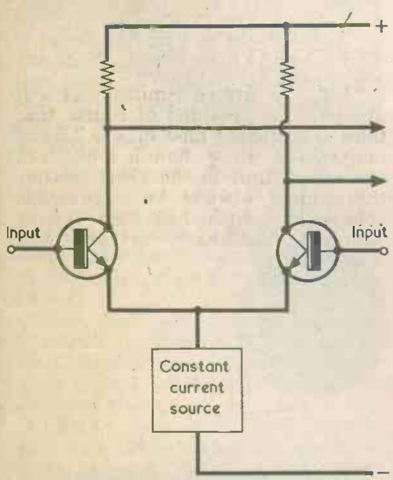

Fig. 4. Simplified diagram illustrating a differential amplifier at the inputs of an operational amplifier. The emitters connect to a single constant current source.

"Dear, oh dear me," said Dick, sighing. "Well, that's the last time I go shooting my mouth off about knowing everything on transistor circuits."

"I'm glad to hear it," replied Smithy. "Perhpas you're not so shattered as to be unable to get me a spot more tea."

"I heed your command, Master."

Whereupon the chastened Dick went once more to charge Smithy's mug with the precious life-giving fluid.

SLIGHTLY NON-CONSTANT

"Thanks," said Smithy, as Dick returned with the mug. "And, now, I have a small confession to make."

"Have you? Well, that's some small consolation at any rate."

"You see," said Smithy, "the current flowing in the collector circuit of TR1 is not a hundred per cent constant although it is very nearly so. I mentioned just now that there are very small changes in the base current of TR1 when its base is taken positive and negative. This base current flows into TR2, whereupon TR1 collector passes the 4mA constant current less the changing base current. There are also extremely small changes in collector current in TR2 as the voltage across this transistor varies. In consequence, the voltage at TR1 collector actually does change by a tiny amount when its base potential is altered. With an ordinary voltmeter having a pointer movement these changes are too small to discern. But if you'd used, say, a digital voltmeter they'd have shown up at once."

"I keep telling you," grinned Dick, "that what we need in this Workshop is a digital voltmeter, but you never listen."

It was obvious that Dick was fast recovering his normal spirits.

"One little thing that puzzles me," he continued, "is why you put a 10μF electrolytic across the 150Ω resistor."

"Ah," said Smithy, "that was partly the result of a little innate caution on my part. If you look at the circuit you'll see that there's a possible a.c. current path from the emitter of TR2 all the way up to the collector of TR1. I put the electrolytic across the 150Ω resistor just to ensure that TR2 emitter was responsive to d.c. only. Actually, the capacitor isn't really necessary with the circuit as it stands, but it *is* needed for a modification I'm going to carry out on it."

"What modification is that?"

"I'm going to apply an a.f. input to it and pass an output from TR1 collector to an a.f. amplifier."

"But," objected Dick, "we already know that the circuit doesn't amplify."

"In practice," stated Smithy, "it lets a very small amount of signal through because, as I explained just now, the current in the 470Ω resistor is marginally short of being absolutely constant."

He took out a ball-point pen, leaned forward and commenced to add some

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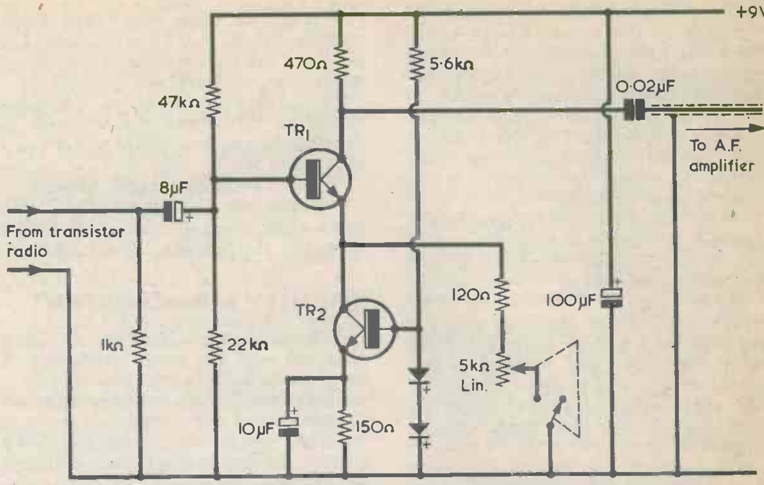

Fig. 5. An experimental circuit offering a means of low impedance volume control. The 5k Ω potentiometer and switch may be positioned remotely from the remainder of the circuit. The output capacitor value, shown here as 0.02μF, can be increased as required when the following a.f. amplifier has a low input impedance. The a.f. amplifier employed by Smithy was the signal tracer described in the last December issue

further components to his circuit. (Fig. 5.)

"Now," he went on, "this circuit will act in the way I want it to if we employ an a.f. input which is of the order of 100 millivolts r.m.s. only. For a quick experiment I can get an a.f. voltage at this level from the earphone socket of a transistor radio. So we want an input coupling electrolytic of around 8μF and, say, a 1kΩ resistor between its negative lead and the negative supply rail. A twin lead can then go to the transistor radio by way of a jack plug connected so that its sleeve is common with the negative supply rail."

"What's the 1kΩ resistor for?"

"Just to ensure that there is a d.c. path between the leads from the transistor radio," explained Smithy. "The earphone output in some radios is provided via an electrolytic capacitor. The 1kΩ resistor will ensure that this capacitor and the 8μF one I've added to my circuit are polarised properly. The output from TR1 collector can go to any a.f. amplifier having the required sensitivity and an input impedance greater than 1kΩ. That old ECL82 a.f. signal tracer of ours will do excellently here, and since it's got a high impedance input the coupling capacitor from TR1 collector need only be 0.02μF. A nice fat 100μF electrolytic across the supply rails to act as a bypass would be a good idea, too."

"This all seems reasonable enough," remarked Dick, "but what's this 5kΩ pot you've added?"

"It's a standard sized pot with a switch," said Smithy, "and its slider is wired to the switch. The added 120Ω resistor from the emitter of TR1 connects to the end of the track corresponding to full clockwise rotation of the spindle. You don't need to mount the pot for a lash-up of the type we'll have here. Just let it rest on the bench with a couple of flexible leads going to it from the rest of the circuit." (Fig. 6.)

"But what's it for?"

"You'll see in a minute," Smithy promised him. "Now get this extra bit of circuitry wired up."

Whilst Dick carried out the Serviceman's bidding, Smithy selected a small transistor radio that he had repaired during the morning. He also took the a.f. signal tracer from his side of the Workshop and carried it over to Dick's bench. After a while, Dick announced that the added wiring was completed. Smithy connected the signal tracer to the output of the circuit, then switched it on and turned its

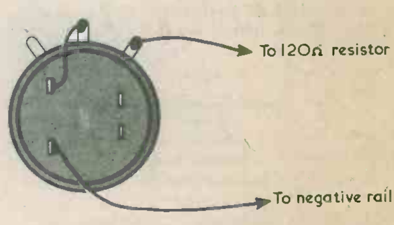

Fig. 6. Rear view of the 5k Ω potentiometer with switch, illustrating the wiring to its tags. The appropriate switch tags may be identified with the aid of an ohmmeter or continuity tester

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volume to full. He next tuned in a local station on the transistor radio, turned down its volume and inserted the jack plug from the circuit. The speaker in the radio became silent. After this, Smithy adjusted the 5kΩ potentiometer so that its switch was open, and connected the circuit to the PP9 battery.

The signal from the local station was just audible from the signal tracer speaker.

"That," remarked Smithy, "is the little bit of signal that's getting through the circuit in its constant current state."

He turned the spindle of the 5kΩ potentiometer just sufficiently far to operate its switch. The sound from the tracer speaker became noticeably louder.

"And that increase in signal level," Smithy went on, "is due to the fact that the emitter of TR1 is not connected to a constant current source any more. It's connected to a constant current source *and* a resistance of around 5kΩ. Because of this it's able to give some amplification."

He turned the potentiometer spindle clockwise. As he did so the sound from the signal tracer speaker increased continually until, when the potentiometer inserted minimum resistance, it reproduced the sound from the local station at quite a high volume level.

"There you are," said Smithy cheerfully. "As the pot offers less and less resistance the circuit changes from the constant current condition and TR1 becomes more and more like a common emitter amplifier with an unbypassed emitter resistor. The voltage gain is equal to the collector resistance divided by the emitter resistance so that, at full volume, the output voltage is about four times the input voltage. At minimum gain with the pot switch closed, the output is approximately one-tenth of the input. So the volume control has a range of 40 to 1, which is fairly extensive. Also, the volume can be further reduced by turning the pot a little more and opening the switch. The whole arrangement has the makings of a quite serviceable low impedance volume control circuit. The main thing to remember is that the input must be kept fairly low. Too high an input will break through in the constant current condition, and will overload TR1 when the pot switch is closed."

"Stap me," said Dick, supremely impressed by this exercise in electronic legerdemain. "Are there any things to look out for in a set-up like this?"

"There's just one thing," said Smithy. "And that's to guard against a general effect which is liable to occur whenever you connect the earphone output of a transistor radio to any wide bandwidth a.f. amplifier. Quite often the earphone output, particularly if the radio has a transformerless a.f. section, carries quite a bit of r.f. from the i.f. stages with it. So, if you find any instances of r.f. instability in the subsequent a.f. amplifier you can cure this by inserting a low-pass filter in the circuit. We were lucky and didn't need such a filter." (Fig. 7.)

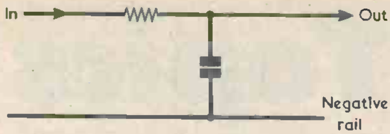


Fig. 7. The low-pass filter shown here may be inserted, if necessary, at the input or output of the circuit of Fig. 5. Suitable values when it is inserted at the input are 200 Ω and 0.05µF, although these may need to be increased if the r.f. content in the signal from the transistor radio is very high

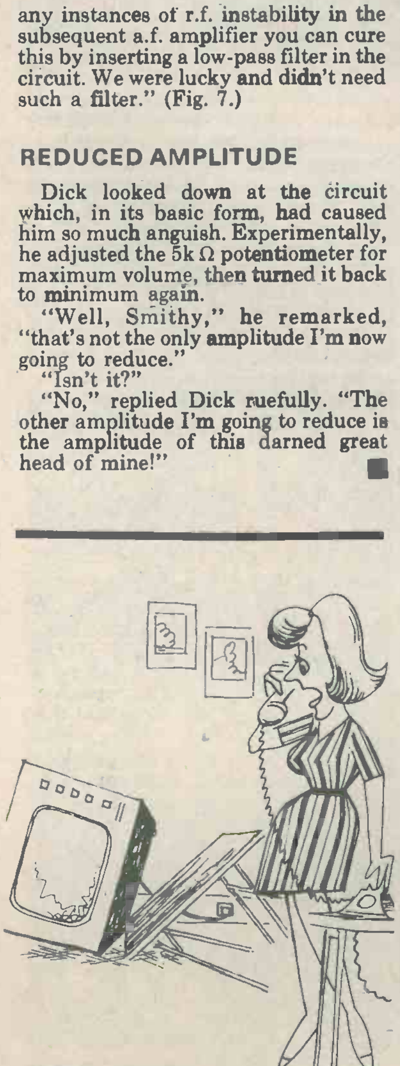
REDUCED AMPLITUDE

Dick looked down at the circuit which, in its basic form, had caused him so much anguish. Experimentally, he adjusted the 5k Ω potentiometer for maximum volume, then turned it back to minimum again.

"Well, Smithy," he remarked, "that's not the only amplitude I'm now going to reduce."

"Isn't it?"

"No," replied Dick ruefully. "The other amplitude I'm going to reduce is the amplitude of this darned great head of mine!" ■



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Radio Topics

By Recorder

My aunt's radio went wrong recently, and so I had the job of fixing it for her.

The snag? Nothing very much, just a screen-grid capacitor gone open-circuit.

Well, you say, where's the story in that? Bypass capacitors do occasionally go open. Just a moment though, *what* sort of bypass capacitor did you say?

A screen-grid capacitor, no less. What's more, it's the first component in my aunt's set to go wrong in all the 22 years she's had it in her drawing room. The only other thing I've ever had to do for it was to fit a new double-diode-triode valve some years ago.

VINTAGE PERFORMANCE

All this may sound like a candidate for a Ripley strip, or perhaps the Guinness Book of Records, but I can assure you that the set in question has been playing without a fault over all these years. It hasn't even got a name. I bought it cheap as a present for my aunt in the early 1950's from a man who manufactured nameless long, medium and short wave mains superhets in an old Nissen hut. This was during the post-war boom days when a.m. radios were selling like hot cakes and no end of clandestine manufacturers were turning them out stuffed with surplus components and any other nefarious parts they could lay their hands on.

And this brings me to my main point. If you have an old mains a.m. radio from those times that is still going strong, it's worthwhile nursing it through some more years yet if only to see how long it can be kept in working order. These sets were made in the days before printed boards and a.m.-f.m. switching, they usually have simple circuits and, in many instances, are dead easy to service. However, one important thing has always to be borne in mind. This is that their chassis are common with one side of the mains, whereupon all precautions against accidental shock, both during servicing and use, *must* be observed.

Some servicing facts concerning these old sets which do not arise with our present-day transistor receivers are worth mentioning. The first of these is that capacitors between $0.001\mu F$ and $0.1\mu F$ have paper dielectric. Unlike modern plastic foil capacitors these frequently become leaky with age, and are particularly troublesome in a.f. amplifier stages. If an old a.m. set starts to give a distorted output, replace its a.f. coupling capacitors with modern capacitors of the same value. The a.f. output valve invariably coupled to the speaker by way of an output transformer with what was euphemistically called a 'tone correction capacitor' connected across the primary. (Actually its function was to reduce the audible effect of third harmonic distortion.) If this capacitor breaks down the set will become mysteriously silent.

ELECTROLYTICS

A high hum level probably means that the h.t. smoothing electrolytic capacitors have dried out and lost some of their capacitance. New electrolytics of the same value and working voltage will solve that problem. Aged electrolytics also become intermittent if they aren't passing a ripple current to 'wet' the internal connections to the aluminium foil. If the a.f. output of the set changes intermittently from a high to a lower level without any distortion, fit new cathode bypass electrolytics in the a.f. cathode circuits.

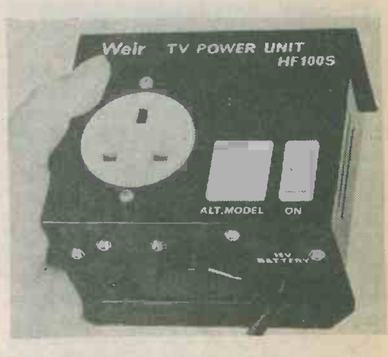
Resistors play a few unusual tricks in old valve sets. Those with resistances above about $500k\Omega$ tend to wander high in value. Old carbon composition resistors passing a current occasionally go *noisy*, and can produce a loud hiss in the output. They can't be detected by normal testmeter readings or by bridging them with other resistors; they can only be located by replacement. The stage in which they are situated may be located by using a 'silencing' technique at each grid, working back from the output valve grid. The 'silencing' is achieved by applying a $0.05\mu F$ capacitor between chassis and the grid.

Valves wear out, of course, but not as frequently as is often imagined. Some of the old octal based valves, indeed, seem to go on for ever. It isn't normally difficult to find a faulty valve by signal tracing techniques. If the set stops working on part or all of the short wave band, this is an indication that the oscillator section of the frequency changer valve is losing its emission. And, finally, it is unwise to turn on a receiver of this type without all the valves plugged in. If the heater chain is broken, the valves above the break are subjected to excessively high cathode-heater voltages.

It is possible that these hints will help in enabling you to keep one of these old a.m. radios working for many more years yet. If so, it may well enter the vintage receiver class and be something to show off to your friends.

COLOUR TV POWER UNIT

A power unit of interesting design for supplying certain classes of mains colour or monochrome television receivers from a 12 volt battery is now available from Weir Instrumentation Limited, Durban Road, Bognor Regis, Sussex. Designated the Model **HF100S**, the unit is small in size, as may be seen in the accompanying illustration.



This small power supply unit, manufactured by Weir Instrumentation Limited, will drive certain mains colour or monochrome television receivers from a 12 volt battery. The unit is intended primarily for receivers in the Sony and National Pansonic range, as well as some others having half-wave power input circuits.

The supply unit has been specially designed to drive Sony television receivers Models KV1310UB and KV1330UB, and it is also marketed for operation of the National Pansonic receiver Model TC48G. These receivers contain transformerless power supply circuits in which the incoming a.c. mains voltage is rectified directly, with resistive voltage dropping networks for the supply of individual solid-state stages. They can in consequence be operated directly from a d.c. supply voltage equal to the peak voltage of the a.c. mains supply, i.e. 350 volts on load.

By utilising this attribute of these

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television receivers Weir Instrumentation have been able to design the HF100S power unit with a high frequency inverter followed by its own internal rectifier and smoothing filter. There is a consequent large reduction in size, weight and cost as compared with a 50Hz inverter delivering an a.c. output.

The HF100S power unit has an overall efficiency of over 70% at full load and is capable of delivering an output of 100 watts maximum. Actual power consumption of the small colour television receivers for which it is designed varies from 70 to 100 watts according to picture brightness and colour. The power unit delivers adequate operating power from an input voltage ranging from 11 to 16 volts, and is fitted with an internal electronic battery protection circuit which automatically switches the inverter off in the event of the input voltage falling below 11 volts, thus preventing total exhaustion of the battery. The unit is also fully protected against overload or reversed input connections.

Some television receivers of a type suitable for operation from the HF100S are fitted with half-wave rectifiers having opposite polarity to those in the receivers just referred to. In order to cater for either polarity connection of the receiver's mains input circuit, the HS100S is fitted with a reversing switch marked 'Alt. Model'.

The HF100S unit can be used with a battery as main or standby source of power for a suitable TV receiver in cars, caravans or boats. It is a compact self-contained unit fitted with a standard 13 amp 3 pin output socket and heavy duty colour-coded battery leads 2 metres in length. It may be used as a free standing unit or mounted on a wall or bulkhead. The standard version is intended for negative earth battery supplies, the case of the unit being connected to the negative input lead. An alternative version for positive earth circuits, the Model HF100SP, is also available.

ZIP-UP SCREENING

With the certainly original sales slogan of 'Zip-up To Save Embarrassment', Walmore Electronics have introduced a new form of screening material for wiring looms. The material, known as Zip-Ex-2, prevents r.f. interference and can be fitted by the simple expedient of zipping it on to the wiring run concerned.

Zip-Ex-2 consists of four layers of 2-stranded 114 micrometre diameter Ferrex knitted wire mesh protected by a heavy duty vinyl cover. A solid brass zip is crimped directly to the wire mesh and provides the means by which the screening is secured to the wiring loom. Ferrex is a trade mark of the Metex Corporation of America, who manufacture Zip-Ex-2, and it applies to steel wire which has been clad in copper and then tin plated.

Attenuation of r.f. interference with the material is 52dB at 14kHz, 75dB at 18MHz and 55dB at 1GHz. The low frequency screening ability is superior to that of copper due to the material's magnetic characteristics.

Standard Zip-Ex-2 is available in lengths from 3 to 12.2m., in diameters ranging from 25 to 300mm. If desired, Walmore can supply the material cut to the required length and fitted with the type of termination specified by the customer. Fittings are available for coupling lengths together and for terminating at bulkheads. There are, additionally, Y-junctions and diameter transistion components.

Apart from its screening characteristics, a major advantage of Zip-Ex-2 is the ease with which access can be gained to the wiring loom for the removal or addition of cables. The screening is simply removed by undoing the zip. Further details may be obtained from Walmore Electronics Limited, 11-15 Betterton Street, London, WC2H 9BS.

TV FROM SPACE

I see that Marconi Space and Defence Systems Limited is leading a team of European contractors studying the spacecraft element of high quality colour television and sound broadcasts direct to domestic receivers. The work is being carried out under a £63,000 contract from the European Space Agency. I should add that Marconi Space and Defence System is a GEC-Marconi company.

A number of payload configurations are being considered and the European Space Agency requirement, in the first instance, is for a satellite system capable of carrying at least two television programmes and able to serve areas corresponding in size to typical European countries.

The special problems of this type of satellite payload relate to the high prime and radiated powers that must be handled. A typical payload may require as much as 2kW of prime power, and this requires special techniques for the control of thermal dissipation and protection of equipments in the various operating modes. As a result of European studies, developments in high power travelling wave tubes are well advanced, and already 1kW of radiated power in the allocated frequency band of 11.7 to 12.5GHz has been reached.

Parallel studies of domestic receivers are currently being made and the payloads being investigated by Marconi Space and Defence Systems will be compatible with such receivers. The high radiated power of the satellite will allow domestic receivers to be operated in conjunction with mass-produced 0.75 metre antennas plus amplifying and conversion circuits compatible with existing receiver techniques.

So the TV of the future may well emanate from above us as well as from ground-based transmitters. ■

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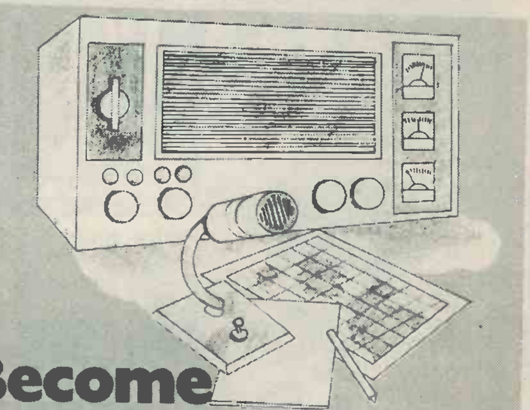

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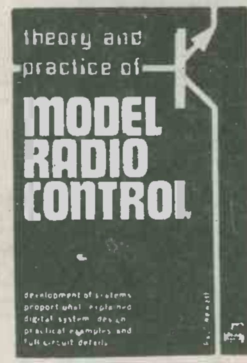

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(Continued on page 455)

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(Continued from page 454)

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FOR THE BEGINNER

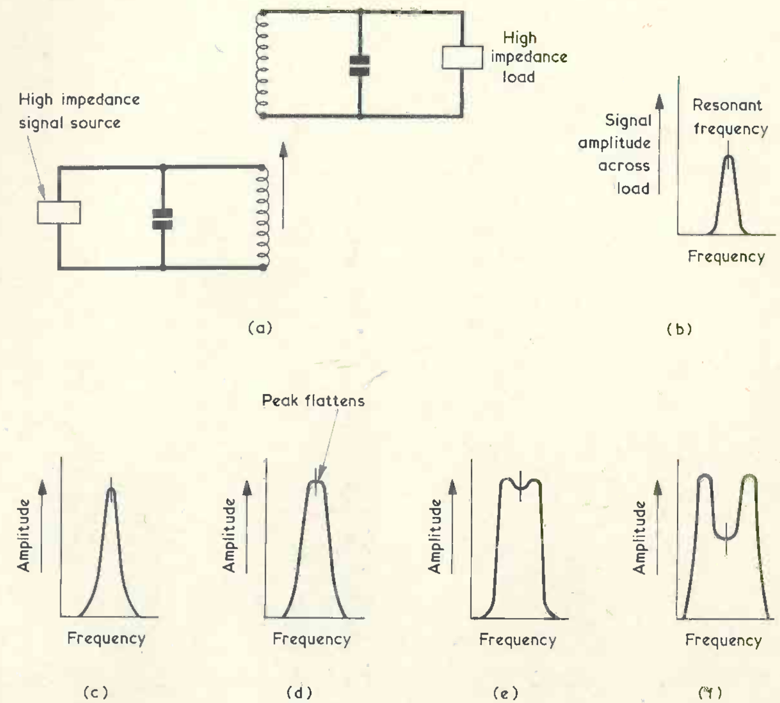
BAND-PASS FILTERS

In (a) we have two similar parallel tuned circuits, each resonant at the same frequency. The coils are widely separated to give a loose inductive coupling between them, and the overall response curve is illustrated in (b). Since there are two tuned circuits the response is sharper than the response of a single tuned circuit on its own.

We now bring the lower coil closer to the upper coil. The coupling between the coils increases, as also does the signal amplitude across the load as indicated in (c). At a certain degree of coupling the response peak commences to flatten, as in (d), although the skirts of the curve remain as steep as before. A further small increase in coupling causes the single peak to break up into two separate peaks on either side of the resonant frequency (e) and a further large increase in coupling results in the pronounced double peak response of (f).

Filters having responses of the types shown in (d) and (e) are of value in radio and television receivers as they allow the passage of a band of frequencies. The coupling at which the two separate peaks just begin to appear is referred to as 'critical coupling.' Looser coupling is 'under-coupling' and tighter coupling is 'over-coupling'.

Radio receiver i.f. transformers having two tuned circuits can have the response shown in (d) or (e). In these transformers the tuned coils are normally wound on a common former, whereupon the spacing between the coils dictates the coupling between them. Band-pass filters may also have capacitive instead of inductive coupling between the two tuned circuits, the coils being screened from each other.



(a) (b) (c) (d) (e) (f)

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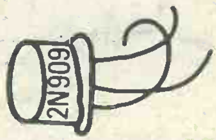

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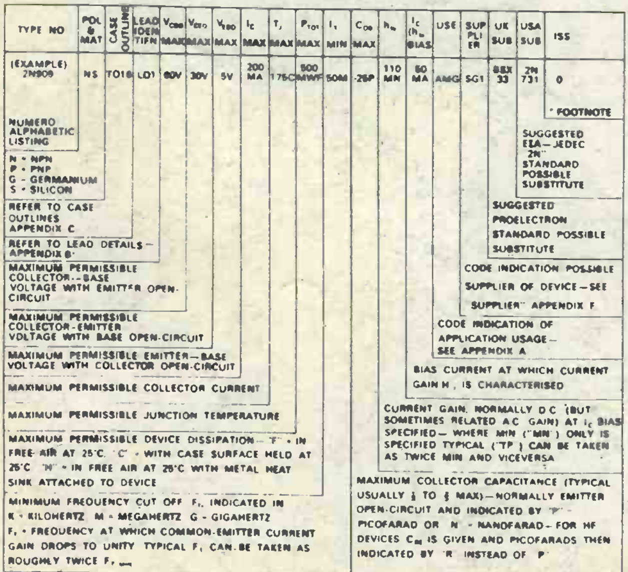

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