RADIO & ELECTRONICS CONSTRUCTOR

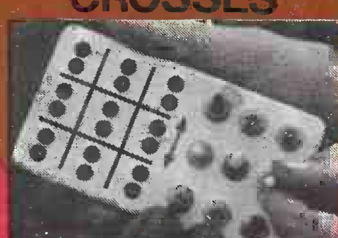
JUNE 1977

40p

SIMPLE QUADRAPHONIC AMPLIFIER

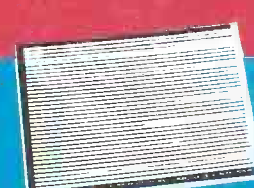
PART ONE
(3 Parts)

POCKET NOUGHTS & CROSSES



SPECIAL SERIES

Blob-a-job No. 1
VOLTAGE STABILIZER



RADIO & ELECTRONICS CONSTRUCTOR

JUNE 1977
Volume 30 No. 11

Published Monthly (1st of Month)
First Published 1947

Incorporating The Radio Amateur

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9 1SN

Telephone 01-286 6141 — *Telegrams* Databux, London

Annual Subscription: £6.00 (U.S.A. and Canada $12.00) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers please pay by cheque or International Money Order.

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

Correspondence should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers as appropriate.

Opinions expressed by contributors are not necessarily those of the Editor or proprietors.

Production.—Web Offset.

Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale, London W9 1SN

The ***Radio & Electronics Constructor*** is printed by Swale Press Ltd.

THE JULY ISSUE WILL BE PUBLISHED ON 1st JULY

SEMICONDUCTORS

F[illegible] spec. marked by Mullard etc. Many other types in stock

AC128/176	8p
ACY28	19p
AD149	40p
AF116	16½p
AF124/6/7	25p
AF139	20p
AF178/80/81	30p
AF239	30p
ASY27/73	30p
BC107/8/9 + A/B/C	6p
BC147/8/9 + A/B/C/S	6p
BC157/8/9 + A/B/C	6p
BC17BA/B, 179B	12p
BC184C/LC	9p
BC186/7	20p
BC213L/214B	10p
BC261B	8p
BC327/8, 337/8	8p
BC547/8/8A/8C	10p
BC555/6/7/8/9	9p
BCX32/36	12p
BCY40	50p
BCY70/1/2	12p
BD113	50p
BD115/6	31p
BD131/2/3	35p
BD135/6/7/9	30p
BD140/142	30p
BD201/2/3/4	80p
BD232/4/5/8	49p
BDX77	£1
BD437	50p
BF115/167/173	15p
BF178/9	20p
BF180/1/2/3/4/5	15p
BF194/5/6/7	6p
BF194A, 195C	6p
BF200, 258, 324	20p
BF202/3	30p
BF336	27p
BFS28 Dual Mosfet	£1
BFW10/11 F.E.T.	40p
BFW30	£1
BFW57/58	17p
BFX12/29/30	20p
BFX84/88/89	17p
BFY50/51/52	13p
BFY90	50p
BR101	30p
BRY39/56	26p
BSV64	30p
BSV79/80 F.E.T.s	80p
BSV91 Mosfet	90p
BSX20/21	14p
BSY40	27p
BSY95A	12p
CV7042 (OC41/44 ASY63)	5p
GET111	40p
OC35	45p
ON222	20p
TIP30/3055	45p
TIS88A F.E.T.	23p
ZTX300/341	7p
2N393 (MA393)	30p
2N456A	50p
2N929	14p
2N987	40p
2N1507/2219	15p
2N2401	30p
2N2412	70p
2N2483	23p
2N2904/5/6/7/7A	15p
2N3053	14p
2N3055 R.C.A.	50p
2N3704	8p
2N3133	20p
2N4037	34p
2N5036 (Plastic 2N3055)	30p
2SA141/2/360	31p
2SB135/6/457	20p
40250 (2N3054)	30p

BRIDGE RECTIFIERS

Amp	Volt		
½	1,600	BYX10	30p
1	140	OSH01-200	26p
1.4	42	BY164	40p
0.6	110	EC433	6p
5	400	Texas	90p

RECTIFIERS

	Amp	*Volt*	
IN4004/5/6	1	4/6/800	5p
IN4007/BYX94	1	1250	5p
BY103	1	1,500	18½p
SR100	1.5	100	7p
SR400	1.5	400	8p
REC53A	1.5	1,250	14p
LT102	2	30	10p
BYX38-300R	2.5	300	40p
BYX38-600	2.5	600	45p
BYX38-900	2.5	900	50p
BYX38-1200	2.5	1,200	55p
BYX48-300R	2.5	300	26p
BYX49-600	3	600	35p
BYX49-900	3	900	40p
BYX49-1200	3	1,200	52p
BYX48-300R	6	300	40p
BYX48-600	6	600	50p
BYX48-900	6	900	60p
BYX48-1200R	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
BYX46-300R*	15	300	£1.00
BYX46-400R*	15	400	£1.50
BYX46-500R*	15	500	£1.75
BYX46-600*	15	600	£2.00
BYX20-200	25	200	60p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.50

**Avalanche type*

TRIACS

Amp	*Volt*		
6	800	Plastic RCA	£1.20
25	900	BTX94-900	£4.00
25	1200	BTX94-1200	£6.00

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

B9A valve can .. 5p

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

OPTO ELECTRONICS

Diodes		Photo transistor	
TIL209 Red	12p	BPX29	80p
BPX40	50p	OCP71	34p
BPX42	80p		
BPY10	80p		

BIG L.E.D. 0.2" 2v 50m/A max.
ORANGE 14p
YELLOW 14p
RED 14p

(VOLTIAC)
BPY68, BPY69, BPY77 80p

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp £1.00

.3" red 7 segment L.E.D. 14 D.I.L. 0-9+D.P. display 1.9v 10m/a segment, common anode 61p

Minitron 3" 3015F filament £1.10

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

Plastic, Transistor or Diode Holder 1p
Transistor or Diode Pad 1p
Holders or pads 50p per 100

Philips Iron Thermostat ... 15p
McMurdo PP108 8 way edge plug 10p

TO3 HEATSINK

Europlec HP1 TO3B individual 'curly' power transistor type. Ready drilled 12p

Tested unmarked, or marked ample lead ex new equipment

ACY17-20	8p	OC71/2	5p
ASZ20	8p	OC200-5	8p
ASZ21	30p	TIC44	24p
BC186	11p	2G240	£1
BCY30-34	8p	2G302	5p
BCY70/1/2	8p	2G401	5p
BY126/7	4p	2N711	25p
HG1005	10p	2N2926	4p
HG5009	3p	2N598/9	6p
HG5079	3p	2N1091	8p
L78/9	3p	2N1302	8p
M3	10p	2N1907	£1
OA81	3p	Germ. diode	1p
OA47	3p	GET120 (AC128 in 1" sq. heat sink	15p
OA200-2	3p	GET872	12p
OC23	20p	2S3230	30p

NEW B.V.A. VALVES

6BW7	60p
EB91	34p
ECH81	34p
ECL80	36p
EF80	34p
EF183	34p
EY86/7	34p
PC86	53p
PC88	53p
PC97	36p
PCC84	34p
PCC89	45p
PCC189	45p
PCF80	34p
PCF82	34p
PCF801	46p
PCL82	34p
PL81	35p
PY500A	80p
PY81/800	38p
R20/U26	50p

OTHER DIODES

1N916	6p
1N4148	2p
BA145	14p
Centercel	24p
BZY61/BA148	10p
BB103/110 Varicap	15p
BB113 Triple Varicap	37p
BA182	13p
OA5/7/10	15p
BZY88 Up to 33 volt	7p
BZX61 11 volt	15p
BR100 Diac.	15p

INTEGRATED CIRCUITS

TAA700	£2.00
TBA800	£1.00
741 8 pin d.i.l. op. Amp	24p
TAD100 AMRF	£1
CA3001 R.F. Amp	50p
CD4013 CMOS	36p
TAA300 1wt Amp	£1
TAA550 Y or G	22p
TAA263 Amp	65p
7400	10p
7402/4/10/20/30	14p
7414	56p
7438/74/86	24p
7483	69p
LM300, 2-20 volt	£1
74154	90p
TBA550Q	£1.50

THYRISTORS

Amp	*Volt*		
1	240	BTX18-200	30p
1	400	BTX18-300	35p
1	240	BTX30-200	30p
15	500	BT107	£1
6.5	500	BT101-500R	90p
6.5	500	BT109-500R	£1.00
20	600	BTW92-600RM	£3.00
15	800	BTX95-800R Pulse Modulated	£8.00
30	1000	28T10 (Less Nut)	£3.00

PAPER BLOCK CONDENSER

0.25MFD	800 volt	30p
1MFD	250 volt	15p
2MFD	250 volt	20p
4MFD	250 volt	20p

I.C. extraction and insertion tool 32p

CHASSIS SOCKETS

Car Aerial **9p**, Coax **3p**, 5 pin 180° **9p**, 5 or 6 pin 240° din **6p**, speaker din switched **5p**, 3.5 mm switched **5p**, stereo ¼" jack enclosed **10p**.

CRAZY OFFERS

2200 mfd.	64v	40p
2500 mfd.	40v	30p
8 mfd.	500v	6p
400 mfd.	16v	4p
.1 mfd.	500v	1½p
.1 mfd.	1500v	2p
2200 mfd.	25v	30p
1000 mfd.	200v	25p
10000 mfd.	15v	12p
1250 mfd.	35v	10p
6800 mfd.	10v	6p
32+32 mfd.	275v	8p
16+32 mfd.	350v	12p
8+8 mfd.	350v	8p
150 mfd.	35v	4½p
100 mfd.	70v	4½p
1 mfd. non-polar	350v	3p
680 mfd.	100v	10p
15 mfd.	160v	3p
4700 pf. sub min	500v	1½p
4700 mfd.	63v	70p
300 mfd.	450v	25p

Philips electronic engineer kits add on series E1004 75p each

G.E.C. 5% Hi-stab. capacitors .013, .056, .061, .066, .069, .075, .08, .089 2p each

Push-to-Break or Push-to-Make Panel Switch 24p

ENAM. COPPER WIRE

SWG.	PER YD.
24	3p
26 to 42	2.5p

GARRARD

GCS23T Crystal Stereo Cartridge 66p
Mono (Stereo compatible). Ceramic or crystal 60p

HANDLES

Rigid light blue nylon 6½" with secret fitting screws ... 5p

Belling Lee white plastic surface coax outlet box 20p

Miniature Axial Lead Ferrite Choke formers 2p

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

Copper coated board 10" x 9" approx 25p

TIE CLIPS

Nylon self locking 7" or 3½" 2p

Geared Knob 8-1 ratio 1⅞" diam, black 70p

R.S. 2½" 35 ohm loud speaker 60p

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

MAIL ORDER CUSTOMERS ONLY ADD 8% VAT-I PAY BALANCE ON 12½% ITEMS
ALL ENQUIRIES, ETC., MUST BE ACCOMPANIED BY A STAMPED ADDRESSED ENVELOPE

BI-PAK High quality audio eq

NEW PUSH-BUTTON STEREO FM TUNER

Fitted with Phase Lock-loop Decoder

☆ FET Input Stage
☆ VARI-CAP diode tuning
☆ Switched AFC
☆ Multi turn pre-sets
☆ LED Stereo Indicator

Typical Specification:
Sensitivity 3μ volts
Stereo separation 30db
Supply required 20-30v at 90 Ma max.

OUR PRICE
£20.45

The 450 Tuner provides instant program selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.

Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T461**.

The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

STEREO PRE-AMPLIFIER PA 100

A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

Frequency response + 1dB 20Hz-20KHz
Sensitivity of inputs:
1. Tape input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms
P.U. Input equalises to R1AA curve within 1dB from 20Hz to 20KHz. Supply – 20 – 35V at 20mA.
Dimensions:
299mm x 89mm x 35mm

£13.75
P.&P. 45p

MK60 AUDIO KIT: Comprising: 2 x AL60. 1 x SPM80. 1 x PA100. 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £29.55** plus 62p postage.

TEAK 60 AUDIO KIT: Comprising: Teak veneered cabinet size 16¾" x 11½" x 3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £10.70** plus 82p postage.

AL 60

VAT ADD 12½%

25 Watts (RMS)

● Max Heat Sink temp 90C. ● Frequency response 20Hz to 100kHz ● Distortion better than 0.1 at 1kHz ● Supply voltage 15-50v. ● Thermal Feedback ● Latest Design Improvements ● Load – 3, 4, 5 or 16ohms. ● Signal to noise ratio 80db ● Overall size 63mm. 105mm. 13mm.

Especially designed to a strict specification. Only the finest components have been used and the latest solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

£4.35

STEREO 30 COMPLETE AUDIO CHASSIS

7+7 WATTS R.M.S.

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck, etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 minutes).

TRANSFORMER £2.45 plus 62p p&p

TEAK CASE £5.25 plus 62p p&p

£16.25
p. & p. 45p

Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (r.m.s.) per channel simultaneously. With the addition of the Mains Transformer **BMT80**, the unit will provide outputs of up to 1.5A at 35V. Size: 63mm. 105mm. 30mm. Incorporating short circuit protection.

Input Voltage: 33-40 V.A.C.
Output Voltage: 33V D.C. Nominal
Output Current: 10mA-1.5 amps
Overload Current: 1.7 amps approx.
Dimensions: 105mm x 63mm x 30mm
Transformer BMT80: £2.60 + 62p postage

£3.75

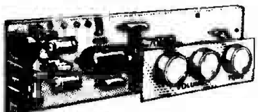
SUPERSOUND 13 HI-FI MONO AMPLIFIER

A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power out-put transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz. 30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £12·75. P. & P. £1·00.

DE LUXE STEREO AMPLIFIER

A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line-up:-2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11"w × 4"d. Overall height including valves 5". Ready built and tested to a high standard. £12·40. P. & P. £1·30.

HARVERSONIC STEREO 44



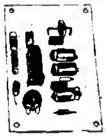
A solid state stereo amplifier chassis, with an output of 3-4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with built in short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets and 5 pin din tape rec./play socket are mounted on the printed circuit panel, size approx. 9½" × 2½" × 1" max. depth. Supplied brand new and tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically), at only £9·00 plus 50p P. & P. Mains transformer with an output of 17V a/c at 500 m/a can be supplied at £1·50 plus 40p P. & P. if required. Full connection details supplied.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240v. Secondary combinations 0-5-10-15-20-25-30-35-40-60v. half wave at 1 amp. or 10-0-10, 20-0-20, 30-0-30v. at 2 amps full wave. Size 3in. long × 3½in. wide × 3in. deep. Price £2·90. P. & P. 90p.

MAINS TRANSFORMER. For power supplies.
Pri. 200/240v. Sec. 9-0-9 at 500 mA. £1·50. P. & P. 60p.
Pri. 200/240v. Sec. 12-0-12 at 1 amp. £1·65. P. & P. 60p.
Pri. 200/240v. Sec. 10-0-10 at 2 amp. £2·35. P. & P. 90p.
Pri. 200/240v. Sec. 23v. at 1.5 amp, 6v at ·6 amp, 8v. at 50 mA. £3·00 + 65p P. & P.

ALL PURPOSE POWER SUPPLY UNIT 200/240v. A.C. input. Four switched fully smoothed D.C. outputs giving 6v. and 7½v. and 9v. and 12v. at 1 amp on load. Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case overall size 6" × 3½" × 2½". Ready built and tested. **Price £6·75. P. & P. 85p.**

STEREO-DECODER SIZE 2" × 3" × ½"



Ready built. Pre-aligned and tested. Sens. 20-560mV for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £5·62 plus 20p P. & P. Stereo beacon light if required 40p extra.

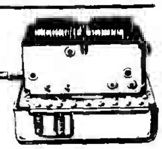
QUALITY RECORD PLAYER AMPLIFIER MK. II A top quality record player amplifier employing heavy duty double wound mains transformer. ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in wide × 3in deep × 6in high. Ready built and tested. PRICE £7·00. P. & P. 90p.
ALSO AVAILABLE mounted on board with output transformer and speaker. PRICE £8·00. P. & P. £1·00.

MAINS OPERATED SOLID STATE AM/FM STEREO TUNER

200/240V Mains operated Solid State A/M F/M Stereo Tuner. Covering M.W. A.M. 540-1605 KHZ, VHF/FM 88-108 MHZ. Built-in Ferrite rod aerial for M.W. Full AFC and AGC on AM and FM. Stereo Beacon Lamp Indicator. Built-in Pre-amps with variable output voltage adjustable by pre-set control. Max o/p Voltage 600 m/v RMS into 20K. Simulated teak finish cabinet. Will match almost any amplifier. Size 8½" w. × 4" h. × 9½" d. approx. LIMITED NUMBER ONLY at £28 + £1·30 P. & P.

SPECIAL OFFERS

Mullard LP1159 RF-IF Double Tuned Amplifier Module for nominal 470kHz. Size approx. 2¼" × 1¼" × ¾" 7·6V + earth. Brand new pre-aligned. Full specification and connection details supplied. £2·25 + P. & P. 12p.



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

PRECISION MADE Push Button Switch bank. 8 Buttons giving 16 S/P C/O interlocked switches plus 1 Cancel Button Plus 3 d/p c/o. Overall size 5" × 2½" × 1". Supplied complete with chrome finished switch buttons 2 for £1·50 + 20p, P. & P.

HI-FI LOUDSPEAKER SYSTEM MkII

Beautifully made simulated teak finish enclosure now with most attractive slatted front. Size 16½" high × 10½" wide × 9" deep (approx.). Fitted with E.M.I. Ceramic Magnet 13" × 8" bass unit, H.F. tweeter unit and crossover. AVAILABLE IN NOMINAL 4 ohm, 8 ohm or 16 ohm impedance (state which). Handling power 10 watts R.M.S.

OUR PRICE £12·80 each. Carr. £1·90

Cabinet Available Separately £7·60 each. Carr. £1·40.
Also available in 8 ohms with EMI 13" × 8" bass speaker with parasitic tweeter £11·10 each. Carr. £1·90.

LOUDSPEAKER BARGAINS
5in. 3 ohm £2·00, P. & P. 35p. 7 × 4in. 3 ohm £2·35, P. & P. 48p. 10 × 6in. 3 or 15 ohm £3·20. P. & P. 75p. 8 × 5in. 3 ohm with high flux magnet £3·00, P. & P. 50p. Tweeter. Approx. 3½". Available 3 or 8 or 15 ohms, £2·00 + 25p, P. & P.

2" PLASTIC CONE HF TWEETER 4 ohm, £8·50 per matched pair + 50p P. & P.

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

VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 54 in. wide. Our price £1·80 yd. length. P. & P. 50p per yd. (min. 1 yd.). S.A.E. for samples.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER Size 11¾" × 14¾" × 1¼" deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz-20kHz. Can be mounted on ceilings, walls, etc. and used with or without baffle. Send S.A.E. for details. Only £8·40 each. P. & P. 75p for one, 90p for two.

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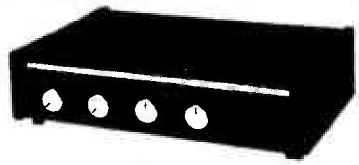

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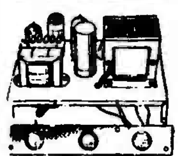

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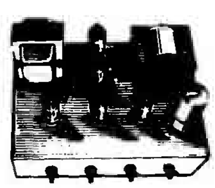

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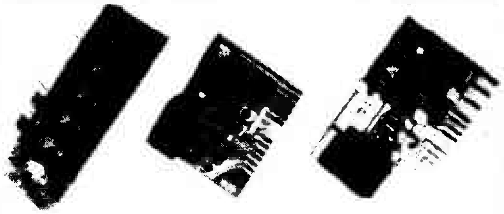

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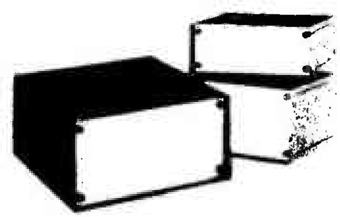

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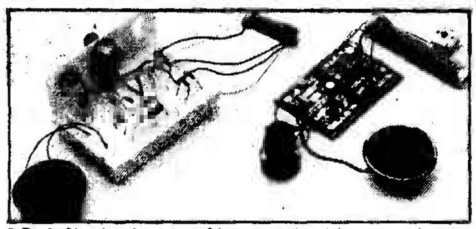

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SPECIAL SERIES . . .

Blob-a-Job No. 1

VOLTAGE STABILIZER

By I. R. Sinclair

A voltage stabilizer which can be built to provide outputs at 3 volts, 5 volts, 6 volts or 9 volts, according to the zener diode chosen.

This is the first of a series of fairly simple circuits taking advantage of the ease of construction which is possible using the new Blob Boards. With these boards, many of the tedious jobs such as drawing layouts and checking both front and back of each circuit are eliminated. Each track on a Blob Board is numbered so that we can show a track number on the circuit diagram as a guide to circuit construction. After some practice on the following circuits, you will be able to write Blob-numbers on your own circuits, so making them easy to build.

Blob Board has tinned tracks, so that soldering is very much easier than with copper, and all the construction is done on the ***track*** side of the board. In this way we can see a whole circuit at a glance, without having to keep turning the board over. In addition, having one side free of tracks or components means that Blob Boards can be simply mounted by sticking them to the surface of boxes or panels.

STABILIZER CIRCUIT

This circuit is a useful voltage stabilizer, which can be applied for t.t.l. supplies (5 volts output) or for running transistor radios (6 volts or 9 volts) or calculators (3 volts, 6 volts or 9 volts) from 12 volt batteries or other supplies. The output voltage of the stabilizer is fixed so that you must decide what output voltage you need before building the circuit. Alternatively, the circuit could be modified to provide several switched voltages.

The circuit is shown in Fig. 1. TR1 is a medium-power transistor used as a series stabilizer and is therefore wired between the unstablized d.c. supply and the circuit which is to be operated. R1 is connected between the collector and the base of TR1 and also to the collector of TR2, so that the voltage at this point controls the output voltage, since the voltage between base and emitter of a conducting silicon transistor (in this case TR1) is about 0.6 volt. TR2 is controlled by the voltage across R2, which also will be about 0.6 volt when TR2 conducts. The current flowing in R2 passes through zener diode ZD1, which decides what the output voltage will be.

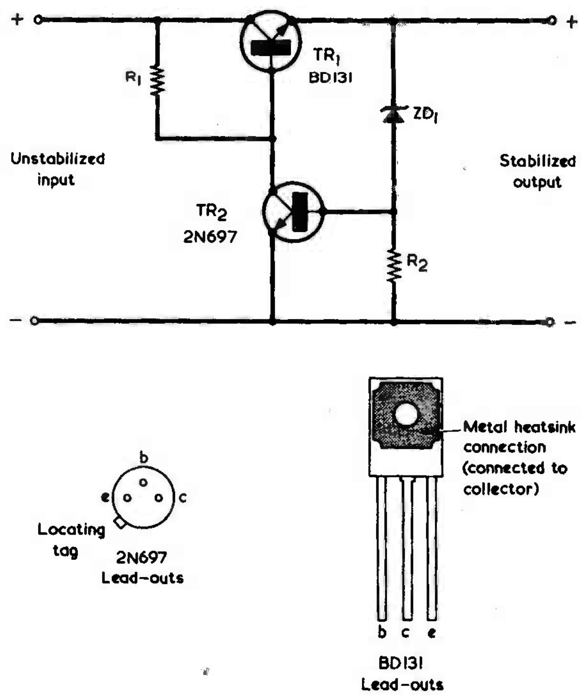


Fig. 1. The circuit of the voltage stabilizer. Output voltage is equal to zener voltage plus 0.6 volt.

If, for example, we choose ZD1 to be a 4.3 volt zener, then the voltage on the base of TR1 will be 4.3 volts less than the output voltage of the stabilizer. If this makes the voltage at the base of TR2 equal to about 0.6 volt, TR2 will conduct. Current flowing in TR2 will flow through R1, causing the voltage at the base of TR1 to drop. When the base voltage of TR1 drops the emitter voltage drops also, which in turn causes the voltage at the base of TR2 to drop by the same amount. The circuit will stabilize with TR2 just conducting, so that the stabilized voltage is equal to the zener voltage plus 0.6 volt. In our example, where we have used a 4.3 volt zener, the stabilized output voltage would be 4.9 volts, so that the circuit would be ideal for supplying t.t.l. circuits, such as those to be described later in this series.

For a 3 volt output we would need a 2.4 volt zener (or nearest), for a 6 volt output a 5.4 volt zener and for a 9 volt output an 8.4 volt zener. The nearest values obtainable are 2.7 volt, 5.1 volt and 8.2 volt, and for all practical purposes these would be satisfactory. The zener diode can be a BZY88 type for any of these voltages.

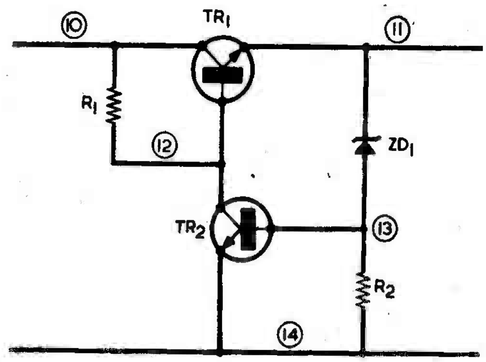


Fig. 2. Adding Blob Board track numbers to the voltage stabilizer circuit.

BUILDING THE STABILIZER

The circuit is repeated in Fig. 2, and this has numbers which indicate Blob Board tracks. The Blob Board for the circuit is specified in the Components List, and it has the track layout shown in Fig. 3. This board has much more space than we need, so that the circuit can be spread out or made in a very compact form so that the Blob Board can be cut to allow more circuits to be built on the remainder. The point of numbering the tracks is that connections shown in the drawing can be made ***anywhere*** along the track providing that each connection is made to the track number shown. You can, if you like, use any other five consecutive tracks.

COMPONENTS

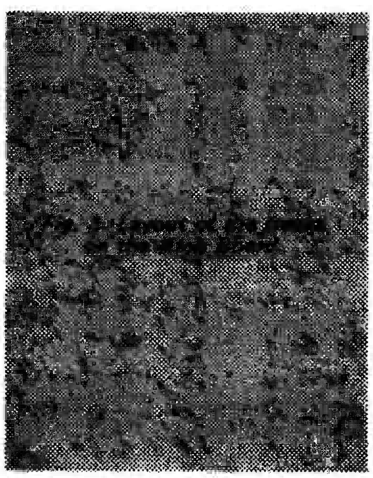
Resistors
R1 1kΩ ¼ watt 10%
R2 150Ω ¼ watt 10%

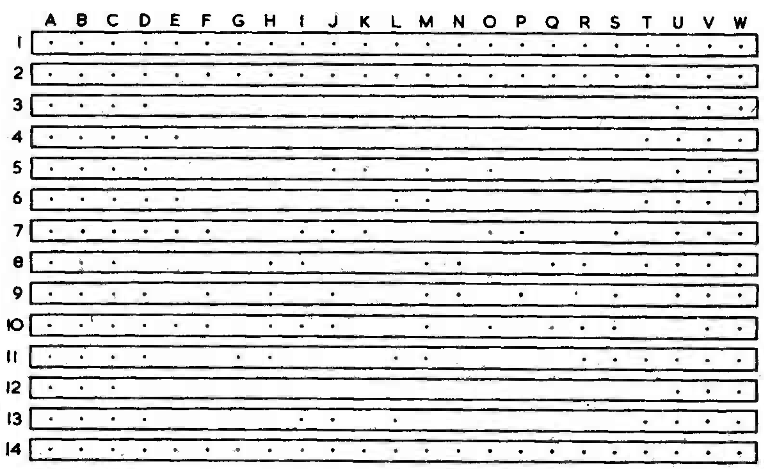
Semiconductors
TR1 BD131
TR2 2N697
ZD1 Zener diode type BZY88 (see text)

Blob Board
Blob Board type ZB2V5

Start with the resistors and cut their leads to shape and size. As is shown in Fig. 5, R2 is connected between tracks 13 and 14, next to each other, so this resistor will have to be mounted end-on as illustrated in Fig. 4(a). R1 is connected between tracks 10 and 12 so that there is room to place this horizontally, bending the wires as shown in Fig. 4(b) with the spacing between the leads equal to two Blob-tracks. Tin the ends of the leads, and then blob the components onto the board.

To do this, hold R2 with tweezers so that its lead-out wires are butted to the Blob-tracks, one on track 14 and the other on track 13. We can connect the resistor anywhere along the tracks though preferably not too near the numbered edge, since we want to be able to read the numbers. A good plan is to start ***opposite*** the numbered edge so that if we then cut the board the numbers will remain for the next project. Position V would be suitable. With the resistor lead-out wires butted against the board tracks, apply the tip of a hot iron with a little solder on it against both track and lead-out wire. A blob of solder will form very quickly round the joint, and the iron can be taken away, leaving a joint which is very strong because the Blob Board tracks are very well attached to the board. The tinning on the board plus the tinned wire of the resistor makes the job of soldering very quick. Now attach R1 in the same way, but between lines 10 and 12. We can use the same part of the board, as these resistors do not overlap.





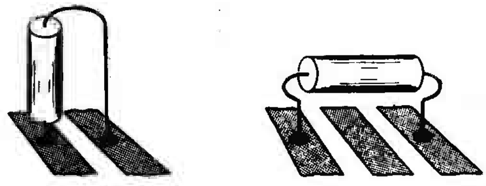


Fig. 4. Two ways of soldering a resistor to the board tracks. In (a) the resistor is end-on or vertical, whilst in (b) it is mounted horizontally.

ZENER DIODE

ZD1 should now have its leads cut to length to be connected between lines 11 and 13. It is most important that the cathode end should connect to line 11. This end is identified by a coloured band, which is usually white. Blob the zener diode in place in the same way as the resistor. No heat-shunt is required, since blobbing is such a quick operation.

Next prepare the two transistors. The leads of TR2 may have to be trimmed if they are long, but transistors with short leads can be used directly. The leads of TR1 will need to be bent slightly. Be careful to hold each lead in pliers at the body of the transistor while bending the lead, so avoiding strain on the transistor body seals. Once again, the leads are tinned and then blobbed in place on the board. The emitter of TR2 is connected to line 14, its base to line 13 and its collector to line 12. The base of TR1 is connected to line 12, its emitter to line 11 and its collector to line 10. This completes the construction.

Note that if any mistakes are made, the circuit is easily checked because of the line numbering, and corrections are easily made. In particular it is very easy to remove a transistor since each lead need only be unsoldered and lifted clear of the Blob-track; there is no need to pull the lead through a hole.

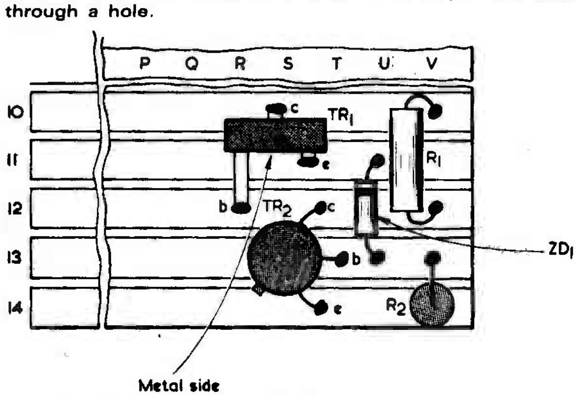


Fig. 5. The voltage stabilizer components can be assembled on the Blob Board in the manner shown here.

In use the positive side of the unstabilized input supply is connected to line 10 and the negative side to line 14. The stabilized output voltage is taken from line 11 (positive) and line 14 (negative). The unstabilized supply should preferably be at least 3 volts higher than the stabilized output, but if very much higher voltages are used some care will have to be taken over the current drawn. For example, if a 12 volt battery is used with a 3 volt stabilized output there is 9 volts across the BD131, and large currents would overheat this transistor. The current output, however, is adequate for transistor radios, calculators and small scale t.t.l. circuits. ■

THE "EPICON" CAMERA TUBE

By Michael Lorant

Dr. S. Morry Blumenfeld, Dr. William A. E. Engeler and Ernest A. Taft, staff scientists of General Electric Research and Development Center, Schenectady, New York State, have developed a new television camera pick-up tube, called "Epicon", which offers exceptionally high sensitivity and long life. Production of the new tube is already under way at General Electric's Imaging Devices Operation — part of the GE Tube Department — at Syracuse, N.Y.

An Epicon camera tube is held by Ernest A. Taft, one of its developers at the General Electric Research and Development Center, Schenectady, N.Y. Looking on are the other developers of the high sensitivity tube, Dr. William E. Engeler (left) and Dr. S. Morry Blumenfeld

An intriguing new development in the field of television camera tubes..

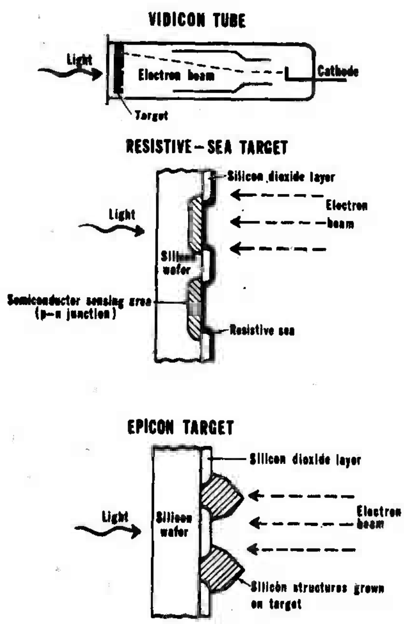
PHOTOCONDUCTIVE LAYER

The Epicon camera tube overcomes a problem which has been evident in the past with Vidicon tubes. In these, the light from the image is applied to a photoconductive target which, consisting of many semiconductor sensing devices, takes up a corresponding charge pattern. The pattern is then scanned by an electron beam.

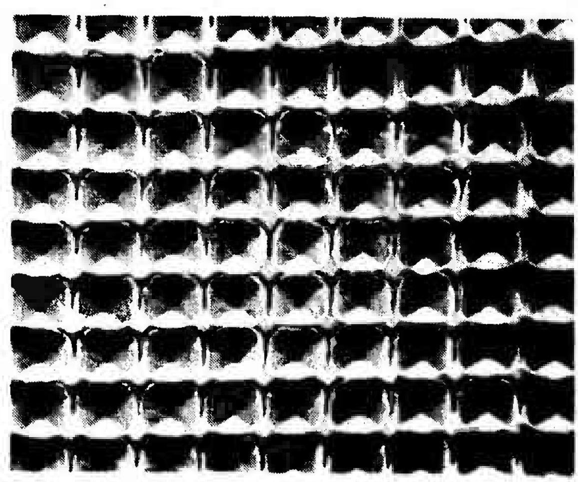
In earlier Vidicon tubes the target has consisted of a silicon wafer on which a layer of silicon dioxide has been deposited, windows in the dioxide being provided at the semiconductor sensing areas, which consist of p.n. junctions sunk below the target surface.

With this type of tube difficulties arise when electrons from the electron beam accumulate in the dioxide on the target surface. The problem has been eased by adding a thin layer of material, called a "resistive sea", over the whole surface of the target. The resistive sea permits the excess electrons to leak away but its addition introduces a further problem. This is due to the fact that the resistive sea material cannot withstand a high temperature bake-out during manufacture, with a consequent reduction in working tube life.

The Epicon target removes the necessity for a resistive sea by "growing" an array of ***millions*** of silicon structures in a few square inches of target area, these structures being in the form of pyramids which not only project above the surface of the target but also cover much of the dioxide layer around each sensing semiconductor junction. The geography of the target area is such that relatively very little of the dioxide layer is exposed to the electron beam and there is no significant storage of excess electrons.



In the basic Vidicon tube shown at the top the target has in the past consisted of semiconductor sensing areas covered by a "resistive sea" which allows excess stored electrons to leak away. With the Epicon target the dioxide is largely covered by grown silicon structures. These prevent electron storage and permit the omission of the resistive sea material



This considerably enlarged view of a small part of an Epicon target shows the regulary shaped pyramid-like silicon structures which are grown on the target surface. Covering nearly all the silicon dioxide layer, these structures prevent the absorption and retention of excess electrons and remove the necessity for a resistive layer to provide a leakage path

As a result the resistive sea is no longer required, and the target can be subjected to high bake-out temperatures during manufacture with a consequently increased tube life. Also, the tube cannot be damaged by being pointed at a bright light source, as happened on the moon when a camera with another type of tube was accidently directed at the sun. ■

NEWS . . . AND .

BBC BROADCASTS IN QUADRAPHONY

Douglas Muggeridge, Director of Programmes, BBC Radio, has said: "BBC Matrix H has many virtues. Not only is it cheap, but it is entirely compatible with stereo and mono. That is very important. We should not have decided to go ahead with experimental broadcasts if the quality of the normal signal to the listener would have been in any way impaired. So listeners with ordinary radio sets can hear the programmes in mono or stereo as they normally do, while at the same time they will be available in quadraphony to over 90% of the population of the United Kingdom.

"We are aware that very few people will be able to take full advantage of the Quadraphony transmissions at the outset of the experiment. However, by the end of the 12 month experiment we hope enough people will have been able to listen to let us have a worthwhile reaction to Quadraphonic Radio. We also hope the broadcasts will stimulate the interest of manufacturers and hi-fi enthusiasts, and that cheap decoders will soon be on the market.

"Once again BBC engineers have helped the programme makers to extend the frontiers of listening pleasure. The development of BBC Matrix H is a major achievement and because it is comparatively inexpensive it allows us to make history at a time of financial difficulty."

BBC Matrix H has the following advantages:

It is cheap for the stereo listener

By using two further loudspeakers, which can be smaller, and attaching a comparatively cheap 'black box' decoder/amplifier to his stereo equipment, he can receive BBC Quadraphony broadcasts.

It is cheap for the broadcaster

Existing stereo recording equipment, lines and transmitters can all be used without modification. The cost to the BBC of going into Quadraphony will be £10,000 to £15,000. That includes the cost of this year's experimental programmes.

Listening to mono and stereo is unimpaired

The BBC Matrix H tests have shown that balancing programmes for Quadraphony produces mono and stereo performances indistinguishable from the existing service. The listener to mono or stereo will not suffer in any way.

Enhanced listening pleasure

Listening to Quadraphony can give a worthwhile improvement over listening to stereo. The listener does not have to remain stationary in relation to the loudspeakers as he does for stereo, and with four loudspeakers he can move around without losing the effect of Quadraphony.

Programmes

<u>*Saturday, 25 June*</u>

R1 Alan Freeman (sessions only) 1430-1731

<u>*Tuesday, 28 June*</u>

R2 Radio Orchestra 2100-2200

<u>*Thursday, 30 June*</u>

R3 Verdi: Aida, live, Royal Opera House 1900-2240

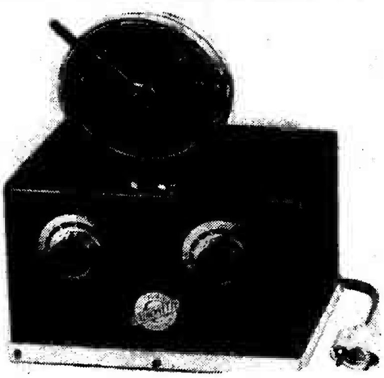
<u>*Saturday, 2 July*</u>

R3 Alison Bauld: Van Dieman's Land BBC Singers (rec. rpt.)

<u>*Friday, 22 July*</u>

R3 First Night of the Proms 1930-2140 BBC-2 taking part 1 live

FIFTY YEARS OF AC MAINS RADIO



The Radionette R3 — claimed to be the first AC mains radio in Europe, made by Jan Wessel of Norway in 1927

1977 marks the jubilee of Europe's first AC mains radio, it is claimed. This was hand-made by the Norwegian Jan Wessel in 1927.

Unlike many young people interested in crystal radio receivers in the 1920s, Jan Wessel not only spent all his pocket money on purchasing wire and crystals to listen to overseas broadcasts but carried his activities even further.

In 1926, at the age of 23, he decided self employment was the only answer and in due course registered the company 'Radionette'.

In 1927 he developed and marketed what is claimed to be the first AC mains radio in Norway and Europe — the company never looked back.

In 1968 the Norwegian Technical and Natural Science Research Council awarded him its Honours Prize for 40 years pioneering work in radio technology.

Fifty years later with a modern factory situated in 8½ acres of beautiful countryside overlooking the Oslo Fjord, Radionette, with Jan Wessel at its head, enjoy a dominant position in the Norwegian market and exports radio and t.v. products world-wide.

. . . COMMENT

'SEE IN THE DARK' CAMERA USED LIVE ON TV

BBC Pebble Mill at One, 26 April, first ever live broadcast with a Thermal Imaging Camera.

On 26 April 1977 BBC Birmingham, "Pebble Mill at One", programme featured live television pictures taken by a new low cost thermal imaging camera which can work in total darkness. The new Pyro-Electric camera, produced by the Electro-Optical Systems Division of Marconi-Elliott Avionic Systems Limited (a GEC-Marconi Electronics company), has a special Vidicon camera tube which responds only to heat radiated from a subject with no contribution whatever from light in the visible spectrum. The camera, featured in the programme because it is on display in the British Genius Exhibition, gives an output which is completely compatible with standard 625 line TV equipment. This, and its portability, is demonstrated by its use in the programme as a "roving" camera.

Hitherto thermal imaging cameras involved highly complex and expensive forward looking infra-red (FLIR) systems, based on the use of a large matrix of discrete heat sensing elements, in conjunction with a very high speed mechanical scanning system. Their cost greatly limited the application of thermal imaging techniques. Now the Marconi-Elliott Pyro-Electric Vidicon camera, whose construction and operation is similar in principle to that of a conventional TV camera, can extend the technique to a variety of industrial, medical and even domestic uses.

Working with any of the widely available TV monitors the new camera can show pictures which bear a remarkable resemblance to those taken by cameras using visible light using only the pattern of thermal energy produced by the object. This means that "hot spots" in rotating machinery, including for example vehicle tyres, can be readily located as can thermal stress in power cables and soil patterns in aerial surveys.

Calling YLs

At the Drayton Manor Rally on 17 April, a meeting of YL operators and SWLs was held, with a view to forming a British Young Ladies Association, the aims at the moment being to further YL operating in the UK, to promote friendship, and to help in any matters arising or relating to YL interests.

YLs interested should contact the following:

SWLs — Miss Brenda Tomlinson, 45 Altrincham Road, Wilmslow, Cheshire.

Transmitters — Mrs. Mary Adams, 'Little Croft', Shurdington Road, Cheltenham, Glos.

Cmos Audio Amplifier

In the components list on page 553 April issue, C3 should, of course, have been 150pF.

We regret the error which occurred during printing.

METAC ELECTRONIC AND TIME CENTRES

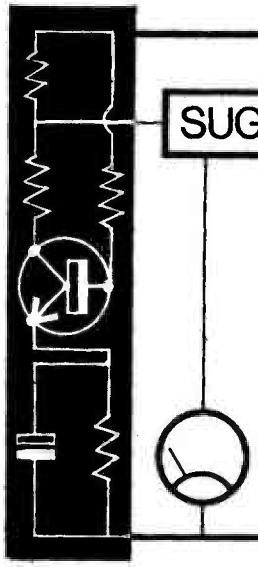
With the opening of Metac's Electronic and Time Centres — the company has introduced to the UK a new concept of specialist electronic consumer goods outlets, a trend which has proved to be very successful in the USA.

This type of retail outlet in the US is referred to as a 'Byte' shop, selling sophisticated items such as microprocessors, mini-computers, as well as the current range of electronic consumer products available on the market.

Metac Electronic and Time Centres are run by electronics engineers, offering professional expertise and advice to the High Street shopper and solutions to basic engineering problems, during and after sales.

Metac Electronic and Time Centres offer the latest state-of-the-art in electronic products, from electronic wrist-watches and clocks and time-pieces to TV games, treasure tracers and electronic car ignition systems including 'assemble it yourself' kits and later on this year — microprocessors.

Spare parts for all items, as well as 'on-the-premises' servicing are available to the customer.



SUGGESTED CIRCUIT

CD4018 TRUTH TABLES

By G. A. French

One of the more intriguing digital integrated circuits to become available to the experimenter is the presettable divide-by-N counter type CD4018. This is a CMOS device capable of functioning at supply voltages between 3 and 15 volts, and it has the unusual facility of being able to divide by 2, by 4, by 6, by 8 or by 10 as required, the divisor being selected by making the appropriate external connections between its pins. In conjunction with a CD4011 NAND gate package it will also divide by 9, 7, 5 or 3.

Many readers will be unfamiliar with the CD4018 and the writer felt that it would be of value to devote his article this month to a detailed consideration of the device, dealing in particular with its use when dividing by even numbers. The i.c. is potentially attractive for random number games and successive control systems, and so a number of truth tables have been prepared which show all the outputs given on successive counts.

PIN LAYOUT

Fig. 1 illustrates the CD4018 in its dual-in-line plastic form, this being the version normally available from component suppliers. The full RCA type number for the i.c. is CD4018A, with the suffix E added to indicate a d.i.l. plastic package. The negative supply is connected to pin 8 and the positive supply to pin 16. The device is advanced one count by each positive-going pulse applied to the clock input at pin 14, and the clock pulses are fed to five succesive counters inside the i.c., these having buffered outputs at not-Q1, not-Q2, not-Q3, not-Q4 and not-Q5 respectively. (The meaning "not" is indicated in the diagram by a bar over the letter.) If it is desired to divide the clock input by 2, the not-Q1 output is directly connected to the data input at pin 1. Division by 4, 6, 8 and 10 is carried out by similarly connecting the not-Q2, not-Q3, not-Q4 and not-Q5 outputs respectively to the data input. The divided output is normally taken from the not-Q output connecting to the data input. To give an example, Fig. 2 shows the relevant connections for division by 8. As can be seen, the input pulses are applied to pin 14 (clock), whilst pin 11 (not-Q4) is connected to pin 1 (data). The divided output is taken from pin 11.

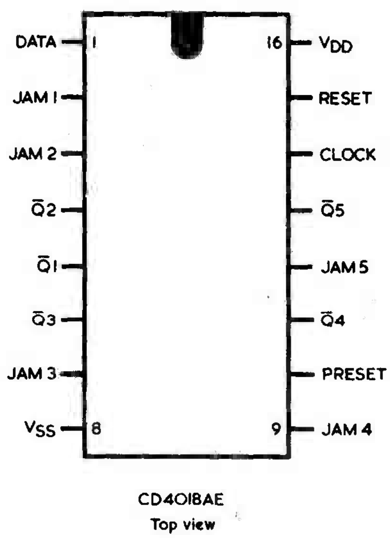


Fig. 1. Pin allocations for the CD4018AE

All the not-Q outputs are cleared to an "all-zero" state when the reset input at pin 15 is taken high (i.e. close to the positive rail). In practice, since these are "not" outputs, the outputs all go high. The reset input has no effect on operation if it is low (i.e. close to the negative rail). If the preset input at pin 10 goes high, this allows information on the "jam" inputs to preset the counter. For simple counting operations the preset and "jam" inputs can be ignored, and these are then all disabled by being connected to the negative supply rail.

Whilst simple division applications such as that shown in Fig. 2 can be readily envisaged, experimenters may also wish to take advantage of not-Q outputs other than that which governs the division factor. Such outputs can be applied to gates for the control of l.e.d. segment displays and similar functions, thereby considerably enhancing the usefulness of the counter. It is difficult to evaluate all the not-Q outputs by an examination of the manufacturer's data on the i.c., and it is for this reason that the writer decided to determine the output states by practical experiment.

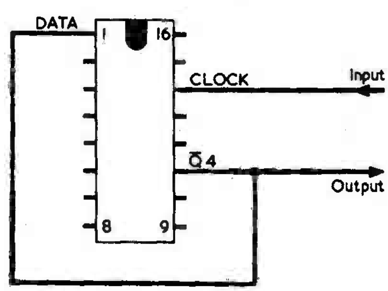


Fig. 2. For division by 8, the not-Q output is connected to the data input

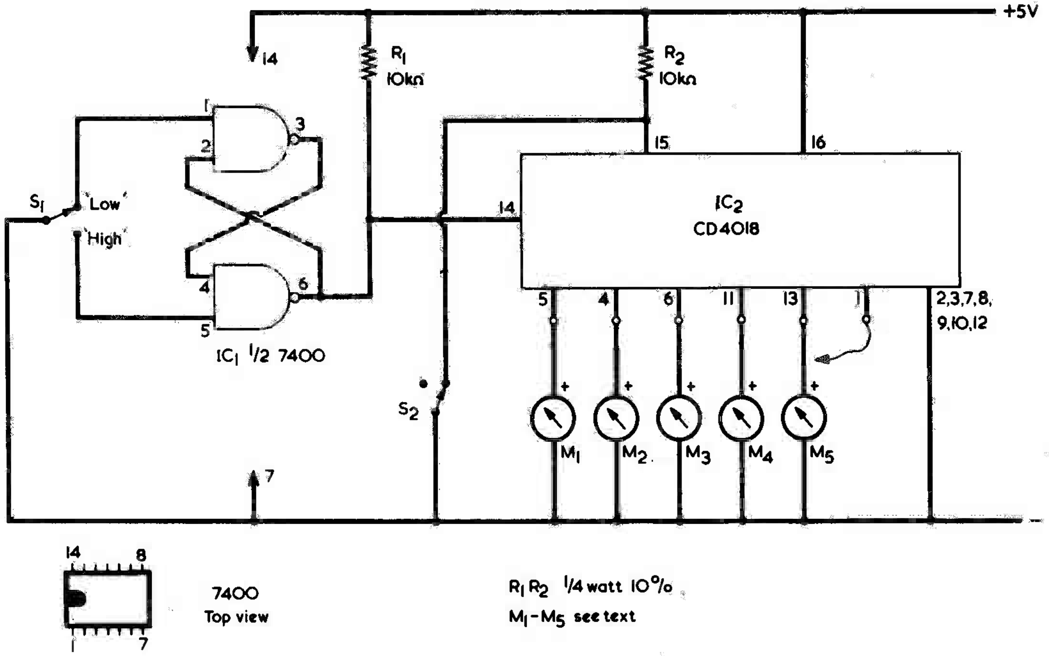


Fig. 3. The circuit employed for checking the performance of the counter

EXPERIMENTAL CIRCUIT

The experimental circuit is shown in Fig. 3. In this five voltmeters, M1 to M5, are connected to the not-Q1 to not-Q5 outputs respectively, and indicate whether each output is high or low. In practice each voltmeter should have a resistance of 100k Ω or more, as the not-Q output currents are rather limited. A suitable voltmeter would be given, for instance, by a multimeter with a resistance of 10K Ω per volt or more on its volts range switched to read 0-10 volts. A flying lead from pin 1 can connect to any of the not-Q outputs as desired, to provide the required division figure. The preset and "jam" inputs are all connected to the negative rail.

The reset input at pin 15 is normally held at a low potential by switch S2. It can be taken to a high potential by way of the 10k Ω resistor R2 when switch S2 is opened. Since the CD4018 is a CMOS device all inputs have exceptionally high internal impedances, and it is quite in order to take the reset pin high by way of a 10k Ω resistor. The object of the experiment is to initially connect pin 1 to the appropriate not-Q output, then open S2 to clear all outputs to high. S2 is next closed and successive positive-going pulses are applied to the clock input at pin 14. The not-Q outputs at each pulse are then monitored by M1 to M5.

The positive-going pulses are produced by changing S1 from the "Low" to the "High" position. Because of contact bounce the switch cannot be coupled directly to the clock input of the CD4018, and it is coupled to it instead via the RS latch given by two NAND gates of a 7400. Briefly, when S1 is set to "Low" one input of the upper NAND gate is low and so its output at pin 3 is high. Both inputs of the lower gate are high and its output at pin 6, which is fed to pin 14 of the CD4018, is low. Taking S1 to the "High" position causes pin 5 to be low and the output at pin 6 to go high. The output of the upper gate now goes low. The usefulness of the latch is that the output at pin 6 latches into the state selected by S1 as soon as the contacts of the latter close in any new position, and is not affected by subsequent contact bounce. Resistor R1 ensures that the pin 6 output, when high, is close to the potential of the positive supply rail, as is necessary for an input to a CMOS digital i.c. When pin 6 is low, the associated internal output transistor in the 7400 is turned hard on, and the output is close to the negative supply rail.

The positive supply is connected to pin 14 of the 7400 and the negative supply to pin 7. No connections are made to the other pins of this i.c. and its remaining gates are unused. Switch S1 is an s.p.d.t. toggle type.

Any regulated 5 volt supply can be employed, and that used by the author is illustrated in Fig. 4. This is quite a standard circuit, and is shown only because it was found that if S3 were closed with S1 in the "Low" position all the not-Q outputs took up a high state, irrespective of which not-Q output was coupled to pin 1 of the CD4018. This performance may be quite fortuitous and may not be repeated with other integrated circuits or with other types of power supply circuit. S2 was still of use in bringing all the outputs to high whenever a re-run of a series of readings was required.

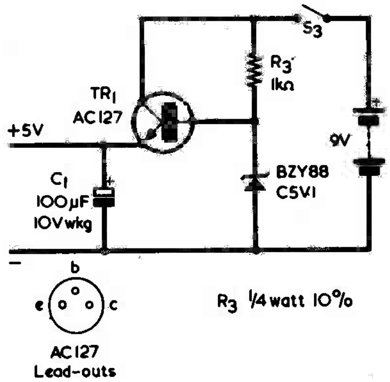


Fig. 4. A suitable 5 volt stabilized supply

TABLE 1
Not-Q5 to Data input

Step	Not-Q outputs 1	2	3	4	5
1	H	H	H	H	H
2	L	H	H	H	H
3	L	L	H	H	H
4	L	L	L	H	H
5	L	L	L	L	H
6	L	L	L	L	L
7	H	L	L	L	L
8	H	H	L	L	L
9	H	H	H	L	L
10	H	H	H	H	L
11	H	H	H	H	H

TRUTH TABLES

The first of the truth tables appears in Table 1, and applies to the case where the not-Q5 output is returned to pin 1, giving a division by 10. This particular table gives a series of readings which are quite predictable.

Step 1 is the initial step in which all outputs are high and is given by opening and closing S2 (or, in the writer's case, by switching on at S3). S1 is then taken to "High" and back to "Low", giving Step 2; subsequent steps correspond to a similar operation of this switch. As is to be expected, the output in column 5 gives the requisite division by 10. There are first five high outputs followed by five low outputs, and so on. From Step 2 to Step 6, a low output passes across the columns, a step at a time, until at Step 6 all outputs are low. At Step 7 a high output appears in column 1, and the high outputs then proceed across the columns until, at Step 11, all outputs are high again. Step 12 will then give the same result as in Step 2, and so on.

The truth table shows that, with the not-Q5 output connected to the date input, a divided by 10 output is available at any not-Q pin. There is also a phase difference between the outputs, which could be of use for some applications.

TABLE 2
Not-Q4 to Data Input

Step	Not-Q outputs 1	2	3	4	5
1	H	H	H	H	H
2	L	H	H	H	H
3	L	L	H	H	H
4	L	L	L	H	H
5	L	L	L	L	H
6	H	L	L	L	L
7	H	H	L	L	L
8	H	H	H	L	L
9	H	H	H	H	L
10	L	H	H	H	H

Table 2 is of more interest and shows the results given when the not-Q4 output is returned to pin 1. Again, the starting point is with all inputs high. A pattern emerges immediately after Step 1. Step 2 is repeated in Step 10, and the series in steps 2 to 9 inclusive is then repeated continuously. Normally, the divided by 8 output would be taken from the not-Q4 pin but (after Step 1) it can also be taken from any other not-Q output. In this table, the outputs at 1 and 5 are exactly opposite to each other for every step.

TABLE 3
Not-Q3 to Data input

Step	Not-Q outputs 1	2	3	4	5
1	H	H	H	H	H
2	L	H	H	H	H
3	L	L	H	H	H
4	L	L	L	H	H
5	H	L	L	L	H
6	H	H	L	L	L
7	H	H	H	L	L
8	L	H	H	H	L
9	L	L	H	H	H

Table 3 shows the divide by 6 state, with the not-Q3 output connected to the data input. The first three columns are predictable, and a continuous pattern taking in outputs 4 and 5 emerges after Step 2. Step 9 is the same as Step 3, with the result that Steps 3 to 8 inclusive are continually repeated. A divided by 6 output is available from any not-Q pin (after Step 2). Also, not-Q4 is directly opposite to not-Q1, and not-Q5 is directly opposite to not-Q2.

TABLE 4
Not-Q2 to Data input
Not-Q outputs

Step	1	2	3	4	5
1	H	H	H	H	H
2	L	H	H	H	H
3	L	L	H	H	H
4	H	L	L	H	H
5	H	H	L	L	H
6	L	H	H	L	L
7	L	L	H	H	L
8	H	L	L	H	H

Divide by 4 conditions are shown in Table 4, and here the pattern appears after Step 3, with Step 4 and Step 8 being identical. Steps 4 to 7 inclusive are repeated continually. Again (after Step 3) a divided by 4 output is available in all the columns, with column 3 being opposite to columns 1 and 5, and the intermediary columns 2 and 4 being opposite to each other.

TABLE 5
Not-Q1 to Data input

Step	Not-Q outputs 1	2	3	4	5
1	H	H	H	H	H
2	L	H	H	H	H
3	H	L	H	H	H
4	L	H	H	H	H

The final table, Table 5, offers no surprises. Here we have a divide by 2 function appearing in both column 1 and column 2, whilst the remaining three not-Q outputs merely remain high all the time.

It will be seen that the CD4018 is an extremely interesting digital i.c. and, even when used as a simple dividing counter, offers a surprisingly high degree of versatility. As was stated at the beginning of this article it is particularly suited for random number games and successive control systems, and the truth tables show that it is possible to take advantage of it in circuit designs employing not-Q functions which are normally ignored. Since the device is a CMOS i.c. the usual safety precautions have to be observed, and soldering to its pins should be carried out with an iron having a reliably earthed bit. If desired, the wiring can be made to an i.c. holder, the i.c. being plugged into this when all circuit connections have been completed. ■

SIMPLE QUADRAPHONIC AMPLIFIER

Taking advantage of the Motorola SQ decoder i.c. type MC1312, this quadraphonic amplifier incorporates comprehensive tone and balance controls. It is capable of taking inputs from tape, tuner or magnetic cartridge, and can operate, if desired, in two channels as well as in four channels. It can also give synthesised four channel reproduction from a standard stereo two channel input. In this article details are given of the amplifier case and power supply circuits.

Part 1

By
R. A. Penfold

Although there is now quite a wide range of four channel high fidelity equipment available, many people must be deterred from buying this by the high price of commercially produced quadraphonic equipment. There are probably many audio enthusiasts and others who are rather sceptical about the advantages of four channel audio, anyway. Even in the author's family there were some who doubted the effectiveness of quadraphonic reproduction.

The amplifier which forms the subject of this short series is a low cost unit which will handle normal two channel stereo as well as four channel SQ matrix encoded programme sources. It will also give synthesised four channel reproduction from two channel stereo sources.

An output power of about 4 watts r.m.s. per channel into 8Ω impedance speakers is available. Inputs for magnetic cartridge, tape deck and tuner are provided. If required the magnetic cartridge input can be very simply and easily modified to accept the output from a ceramic cartridge. The output quality is quite good, and the typical distortion level is less than 1% for output levels up to about 4 watts r.m.s. A brief specification for the amplifier is given in the accompanying Table.

In use the amplifier has proved to be quite successful, and has silenced the quadraphonic critics in the writer's household. The cost of the amplifier is relatively small, and it should prove to be an eminently suitable project for any experienced electronics enthusiast who is interested in building and using genuine quadraphonic equipment.

It should nevertheless be pointed out that this is not really a suitable project for beginners or relatively inexperienced constructors since a certain amount of knowledge of electronic wiring, circuit diagrams and printed circuit board production is required.

FOUR CHANNEL SYSTEMS

The design of quadraphonic equipment is complicated by the fact that there are several four channel systems of disc recording. The three main systems are CD4, QS and SQ.

The CD4 system has the disadvantage that it is rather complicated and expensive equipment is needed for reproduction. CD4 stands for Compatible Discrete Four channel, and the system was devised by the Victor Company of Japan. CD4 records are produced by RCA and several other companies.

This system is somewhat similar to the process used in stereo f.m. transmissions. One wall of the record groove carries the left front (LF) plus left back (LB) signals in the normal way. The LF-LB signal is frequency modulated onto a 30kHz carrier wave, and this signal is contained on the same wall of the record groove. At the decoder the LF+LB and LF-LB signals

SPECIFICATION

Input impedance; tape, tuner: 3MΩ typical
Input impedance; magnetic cartridge: 47kΩ
Input sensitivity; tape, tuner: 400mV
Input sensitivity; magnetic cartridge 4mV
Output power per channel, 8Ω load at 1kHz; 4-5 watts r.m.s.
Frequency response, — 3dB points; 50Hz-30kHz
Total harmonic distortion: less than 1% typical
Unweighted noise level; tape, tuner: —70dB
Unweighted noise level; magnetic cartridge: —62dB.

(Noise levels are with volume and balance controls at maximum, tone controls adjusted for flat response and inputs short-circuited.)

are recovered and mixed to produce the original LF and LB signals. The other groove wall of the record provides similar signals which contain the right front (RF) and right back (RB) signals.

The carrier signals are modulated over a frequency range of 20kHz to 45kHz, and so they are not reproduced by ordinary two channel equipment. The LF+LB and RF+RB signals are in effect an ordinary stereo signal, and will be reproduced on two channel equipment, and on mono equipment, in the usual way. CD4 has the advantage over the other two systems that it gives four independent channels.

It has the disadvantage that a special cartridge and stylus are needed to provide an adequate frequency response with sufficient channel separation. A main drawback, from the point of view of the home constructor, is the complexity of a good demodulator/decoder.

MATRIX SYSTEMS

The alternative SQ and QS matrix systems work on the same basic principle, and there are several other four channel systems which also use this principle. These include some of the very simple surround-sound systems, such as are given by adding a pair of Hafler-connected speakers to an ordinary stereo amplifier.

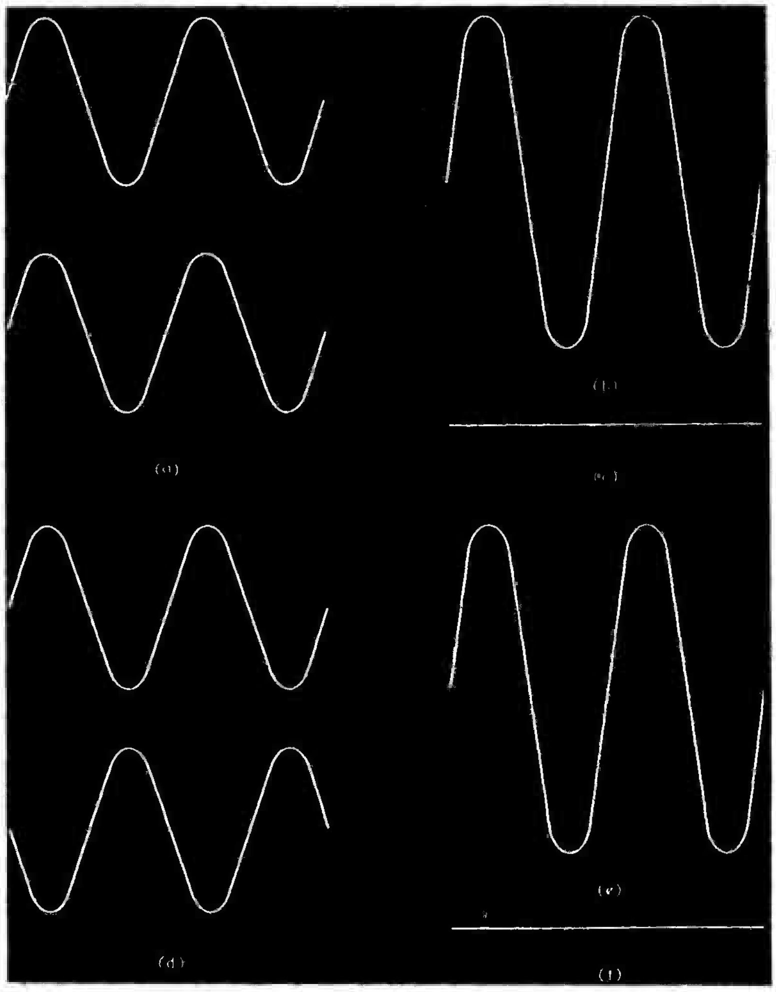
The matrix systems rely on a phasing technique which, if looked at in fairly broad terms, is reasonably easy to understand: Assume that there are two identical in-phase signals, as in Fig. 1(a). If these are fed to an electronic adding circuit they will appear as a single output having twice the amplitude of each individual input. This is illustrated in Fig. 1(b).

If, on the other hand, the in-phase signals are fed to a differential circuit, the output will be equal to the difference between the two signals. Since they are identical and in phase there is no difference and there will be no output signal, as shown in Fig. 1(c).

Should the signals be 180 degrees out of phase, as in Fig. 1(d), the opposite will occur. Feeding the signals to a differential circuit will generate an output of twice the amplitude of each input. This is obviously so, since when one signal reaches a positive peak the other reaches a negative peak and there is a large difference in their amplitudes at these points. The large amplitude signal is illustrated in Fig. 1(e).

By feeding the two out-of-phase signals to an adding circuit an output of zero is obtained. In this case the equal positive and negative going half-cycles precisely cancel one another out, as will be seen from Fig. 1(f).

In four channel matrix systems the four channels are mixed into two. However, they are not mixed in a



conventional manner but after some channels have undergone phase shifts. The resulting two channels are then cut into an ordinary stereo record groove in the usual way.

During playback the signals from the record are fed to a decoder where they are processed by phase shift networks and then passed to adding and differential circuits. The four original signals are (largely) recovered at the output. The signals in a practical system are far more complex than the sine waves used in the examples of Fig. 1, but the principle is exactly the same.

It would, perhaps, be rather idealising the system to say that the four original channels are completely recovered, since the four channels are not totally independent of each other. A signal in a rear channel will appear more loudly in that channel than it will in any other, but it will still also appear in two other channels at reduced volume. Usually, the system is arranged so that the signal appears at reduced level in the two channels adjacent to the intended one, and not at all in the diagonally opposite channel. Within the limits of the system, this will obviously give the smallest possible loss of directional accuracy to the reproduced sounds.

Compared with the overall channel separation of most stereo systems, which is of the order of 20dB to 30dB, this may not seem to be an adequate state of affairs. In practice, though, it is quite satisfactory, as a high level of separation of the four channels is not essential.

It must be borne in mind that the rear channels of the system are usually intended to reproduce the sounds that are reflected from the rear of a concert hall, and that these signals are not totally independent from those which appear from the front. They both have the same origin.

For this reason an effective four channel system can be produced with only relatively poor separation between some channels, whereupon it becomes possible to synthesise a very effective four channel signal from a two channel source.

There are several broadly similar ways of using a phasing technique to encode four channels into two and then decode them back into four channels again. This situation has led to the existence of a number of matrix systems.

The equipment to be described has been designed for use with SQ encoded material for two main reasons, both of which are eminently practical. First, a high quality i.c. matrix decoder, the Motorola MC1312, is readily available and this helps considerably in simplifying construction. Secondly, a large number of SQ encoded records are available in Britain. SQ records are produced by CBS, who are the originators of the system, and the records are available through EMI group retail outlets. Also, the Quadraphonic Record Centre, Beggars Banquet, 8 Hogarth Road, London SW5, provide a retail specialist service.

Looking down into the top of the amplifier. The power supply board is mounted above the chessis

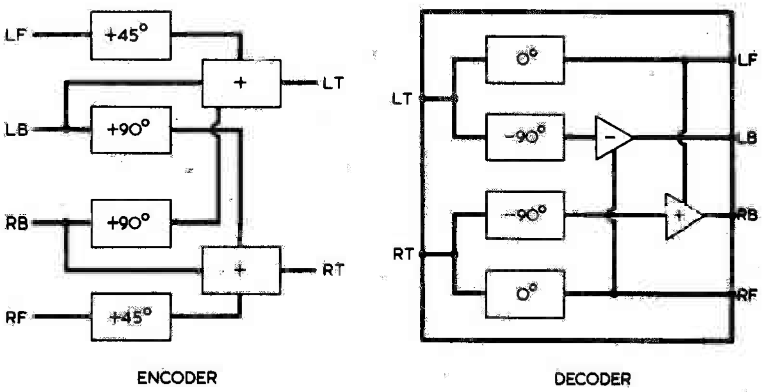
The quadraphonic amplifier does not incorporate the logic circuits which are stated to enhance front to back separation and which are encountered in some commercially produced quadraphonic amplifiers. The present design gives a completely adequate quadraphonic performance without circuit complications. The particular version of the MC1312 employed by the author is the MC1312PQ, which is in a 14 pin quad-in-line package and is available from Bi-Pak Semiconductors. The i.c. is also manufactured as a 14 pin d.i.l. package with the type number MC1312P.

A block diagram illustrating the SQ encoding and decoding processes is given in Fig. 2.

AMPLIFIER CASE

The amplifier is assembled in a home-built case, and construction commences with the making of this. The front and rear panels are cut from 18 s.w.g.

Fig. 2. Simplified block diagram illustrating the [illegible] of encoding and decoding in an SQ matrix system. The letters "LT" and "RT" stand for "Left Total" and "Right Total"



aluminium sheet, and their dimensions are shown in Fig. 3.

S1 is the main on-off switch and the type employed is a d.p.s.t. rocker switch obtainable from Doram Electronics. This requires a rectangular aperture measuring 28.2 by 22.3mm. The aperture can be cut out by means of a fretsaw or miniature file. PL1 is a neon indicator, with its own integral series resistor, suitable for operation from 240 volt a.c. mains. The hole for this should have a diameter applicable to the particular component used.

S2 is a rotary s.p.s.t. switch and it needs to be a type capable of switching mains voltages and currents. Again, the mounting hole diameter should suit the particular switch employed. S3 is a normal small 4-pole 3-way rotary switch and requires the usual ⅜ in. mounting hole. Because of the different channels handled there are two potentiometers in the VR2 position, two potentiometers in the VR3 position, and four potentiometers in the VR4 positions. These all require standard ⅜in. holes.

VR1 is a 4-gang slider potentiometer, requiring a vertical slot in the panel 64mm. long by about 3 to 4mm. wide. The fixing centres are 80mm. apart and are drilled to take M3 mounting bolts. These should be 12mm. long, and pass into M3 tapped holes in the potentiometer, with ¼in. spacers between the panel and the potentiometer. A solder tag is secured on each screw next to the potentiometer body.

To the best of the author's knowledge there is only one 4-gang potentiometer suitable for VR1 which is available to amateur electronics enthusiasts, and this is the type manufactured by Rivlin Instruments Limited, Cordwallis Street, Maidenhead, Berks. This potentiometer can be obtained direct from Rivlin Instruments Limited, complete with plain black knob. If a metal knob is preferred, this may be obtained elsewhere.

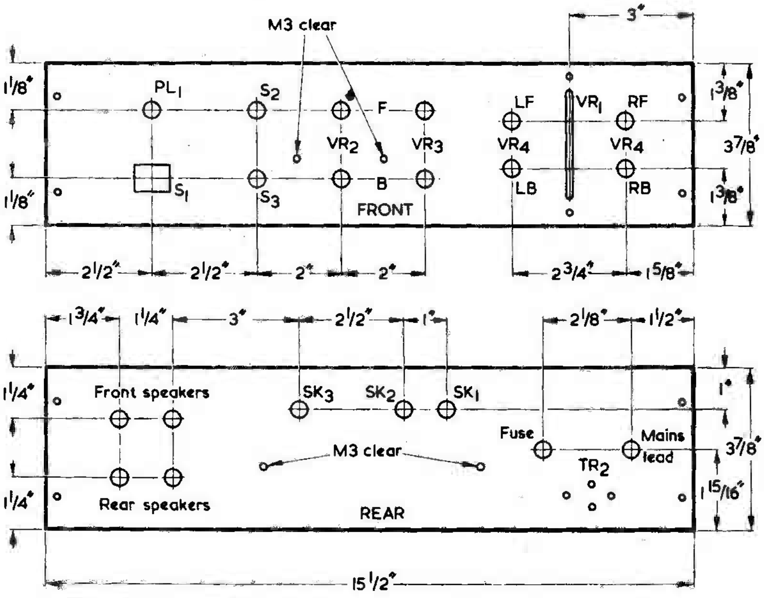
No firm dimensions for the socket mounting holes on the rear panel are given as these will depend upon the sockets employed, which will be required to match the plugs on the ancillary equipment. At the left, as shown in the diagram, are the four sockets for the speakers. SK3 is a stereo input for magnetic cartridge, SK2 for stereo tuner input and SK1 for stereo tape input. The fuseholder is a panel mounting type intended to take a 20mm. cartridge fuse. TR2 is a 2N3055 power transistor whose body is mounted, with insulating bushes and mica washer, on the outside of the rear panel. The mica washer may be employed as a template for marking out the mounting and lead-out holes. These holes must be drilled cleanly, with no burrs or rough edges which could damage the mica washer when the transistor is mounted. Also required is a hole for the grommet through which the mains lead passes.

There are two holes marked "M3 clear" on both the front and rear panels. These are drilled later to take mounting bolts for a horizontal chassis. The mounting bolts could alternatively be 4BA. There are also two small holes at the outside edges of the two panels. These are for woodscrews which pass into the sides of the case.

The case sides are of timber and their dimensions are also shown in Fig. 3. These are covered with Fablon or a similar self-adhesive plastic material having a wood grain effect. The front and rear panels are secured to them with woodscrews such that, when the case lid is fitted, its upper surface is at the same level as the panel tops.

The lid of the case consists of a piece of hardboard measuring 15½ by 8in. This is covered with the same self-adhesive material that is used for the sides and is held in place by a woodscrew at each end which passes into the case side underneath. It may be found that the lid has a tendency to sag in the middle; if this should occur two small pieces of wood about ½in. cube may be glued to the inside of the front and rear panels to provide support at the centre. On the front panel the piece of wood should be above the space

Fig. 3. The dimensions of the front and rear panels, which are cut out from 18 s.w.g. aluminium sheet. The dimensions for the sockets on the rear panel may vary slightly according to the particular socket types used by the constructor



Sides: 8" x 3 5/8" x 3/4" Top: 15 1/2" x 8" Base: 13 7/8" x 8" between the holes for the upper VR2 and VR3 potentiometers.

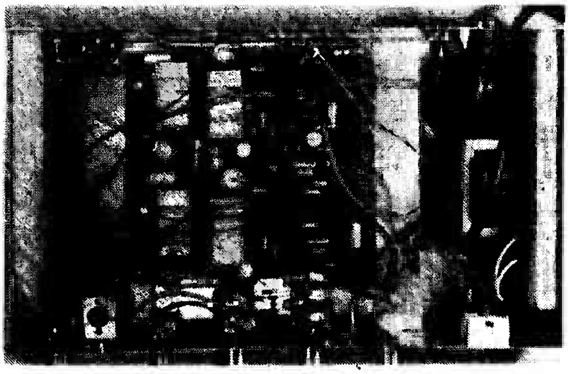
The base panel of the case is another piece of hardboard with the dimensions shown in Fig. 3. It fits inside the two side pieces, and it may be necessary to reduce its length slightly to provide the requisite clearance. Two 6in. lengths of wood, of about ¾in. square section, are nailed or screwed to the case sides just inside the bottom so that, when the base panel is fitted against them, its lower surface is at the same level as the bottoms of the panels. These wood pieces are fitted so that their rear ends butt against the rear panel, leaving about 2in. clearance behind the front panel. The base panel is secured by a woodscrew at each end passing into the supporting piece of wood above. The base has four large cabinet feet near the corners.

far to the right of the case as the presence of VR1 will permit. When the requisite position has been found the four panel holes and the corresponding holes in the chassis flanges may be marked out and drilled, and the chassis finally bolted to the front and rear panels.

The control knobs may next be fitted, as well as the grommet for the mains lead, after which the mechanical construction is virtually complete. All that remains is to carefully drill several holes for the component boards in the chassis. These holes are made later, after the boards have been prepared.

POWER SUPPLY

The power supply section of the amplifier provides



Underneath the chassis. Here are mounted the power amplifier board and the board for the magnetic cartridge pre-amplifier and SQ decoder

There is a flat chassis deck which is not shown in Fig. 3, and on which the circuit boards will be mounted. First cut out a piece of 18 s.w.g. aluminium, 9 by 8in. Bend it across its width at 90 degrees, ½in. from each end, so as to obtain a flat surface measuring 8 by 8in. with ½in. flanges along two opposite sides. Both flanges project in the same direction. This chassis deck is mounted between the front and rear panels with four bolts and nuts, the bolts passing through the "M3 clear" holes shown in Fig. 3. There is not a great deal of space for the chassis and it is advisable to fit all the sockets, potentiometers and other panel components before putting it in position. It is mounted approximately half-way up the panels with the flanges pointing downwards. It should, of course, be level and horizontal and it is mounted as

three different output voltages. These are approximately 26 volts for the power amplifiers, 20 volts for the SQ decoder and 12 volts for the magnetic cartridge pre-amplifier. The complete circuit of the supply section appears in Fig. 4.

The mains supply is fed to the primary of T1 via on-off switch S1. PL1 is a mains neon indicator with its own integral series resistor. The 30 volt secondary of the transformer feeds, via fuse FS1, the full-wave rectifier circuit given by D1 to D4. The output from the rectifier circuit is smoothed to a very high degree by the reservoir capacitor C1. The voltage across C1 provides the three output voltages by way of an electronic regulator circuit.

In this, a stabilized voltage of nominally 27 volts is developed across zener diode D5, this being applied

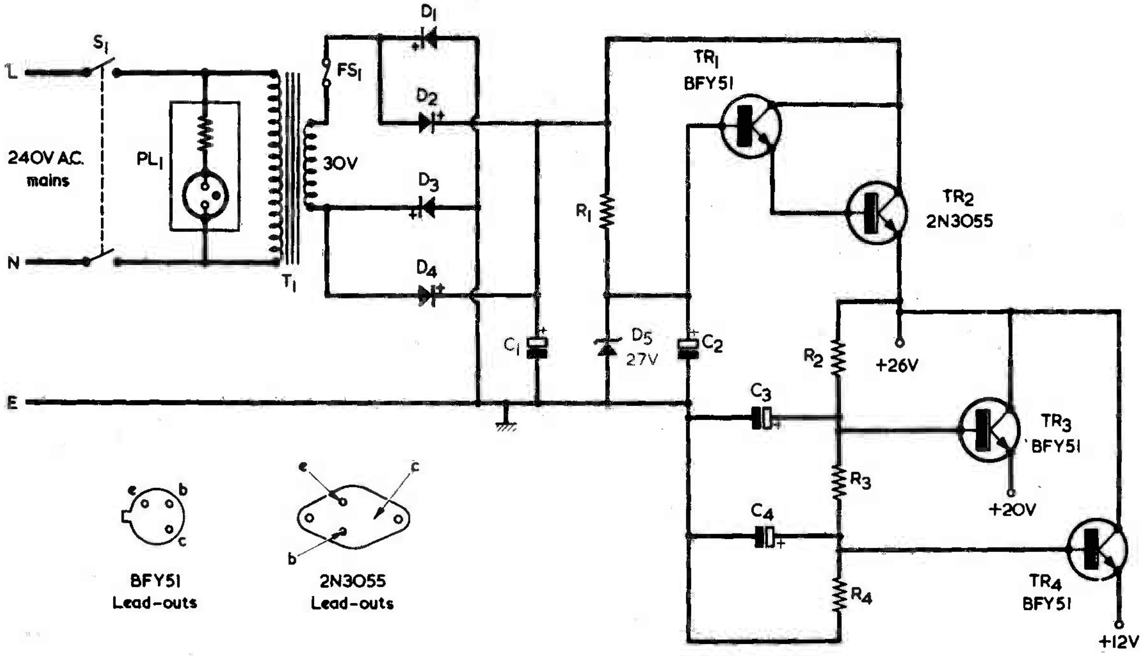
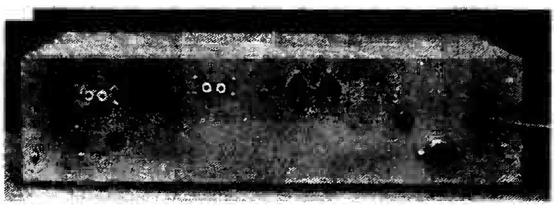


Fig. 4. The circuit of the power supply section of the amplifier. This provides outputs of 26 volts for the power amplifiers, 20 volts for the SQ decoder and 12 volts for the magnetic cartridge stereo pre-amplifier



The rear panel of the amplifier. The input and output sockets employed here may be types which are preferred by the constructor.

to the base of TR1. TR1 and TR2 form a Darlington pair and a voltage equal to the zener voltage less the voltage dropped in the base-emitter junctions of the two transistors appears at the emitter of TR2. This is the 26 volt output, with nearly all the output current flowing in TR2. C2 provides additional smoothing at the base of TR1 and there is only a very low ripple content in the 26 volt output.

This output also feeds the potential divider consisting of R2, R3 and R4. The voltages at the junctions of these resistors are applied to the bases of the emitter followers TR3 and TR4. There can be small variations in the voltage at the 26 volt output due to loading by the power amplifiers. In addition to providing extra smoothing, C3 and C4 decouple the 20 volt and 12 volt outputs from these variations.

The mains transformer is any small component having a total secondary voltage of 30 volts at 1 amp. Most transformers of this type have secondary tappings below 30 volts, and these tappings are ignored. C1 is a single ended component with tags at one end and it requires a clamp for vertical mounting.

COMPONENTS

Resistors
(All fixed values ¼ watt 10% unless otherwise stated)
R1 1-off 2.2kΩ
R2 1-off 3.3kΩ
R3 1-off 4.7kΩ
R4 1-off 5.6kΩ
R5 4-off 22kΩ.
R6 4-off 2.2kΩ
R7 4-off 15kΩ
R8 4-off 120kΩ
R9 4-off 100kΩ
R10 4-off 100 Ω 5%
R11 4-off 27k Ω 5%
R12 4-off 18Ω
R13 2-off 47kΩ
R14 2-off 120Ω 5%
R15 2-off 10kΩ 5%
R16 1-off 3.6kΩ 5%
R17 1-off 3.6kΩ 5%
R18 1-off 4.3kΩ 5%
R19 1-off 3.6kΩ 5%
R20 1-off 3.6kΩ 5%
R21 1-off 4.3kΩ 5%
R22 1-off 4.3kΩ 5%
R23 1-off 4.3kΩ 5%
R24 1-off 47kΩ
R25 1-off 7.5kΩ
VR1 1-off 100kΩ 4-gang slide potentiometer, log (see text)
VR2 2-off 100kΩ 2-gang potentiometer, log
VR3 2-off 100kΩ 2-gang potentiometer, log
VR4 4-off 47kΩ potentiometer, log

Capacitors
C1 1-off 5,000μF electrolytic, 50 V. Wkg., with clamp (see text)
C2 1-off 100μF electrolytic, 40 V. Wkg.
C3 1-off 50μF electrolytic, 25 V. Wkg.
C4 1-off 50μF electrolytic, 25 V. Wkg.
C5 1-off 100μF electrolytic, 40 V. Wkg.
C6 1-off 100μF electrolytic, 40 V. Wkg.
C7 4-off 0.47μF plastic foil
C8 4-off 0.0047μF plastic foil
C9 4-off 0.047μF plastic foil
C10 4-off 0.001μF plastic foil
C11 4-off 0.015μF plastic foil
C12 4-off 0.22μF type C280 (Mullard)
C13 4-off 470pF ceramic plate
C14 4-off 10μF electrolytic, 16 V. Wkg.
C15 4-off 100μF electrolytic, 16 V. Wkg.
C16 4-off 0.0015μF plastic foil
C17 4-off 0.001μF plastic foil
C18 4-off 0.01μF type C280 (Mullard)
C19 4-off 1,000μF electrolytic, 16 V. Wkg.
C20 4-off 0.1μF type C280 (Mullard)
C21 1-off 100μF electrolytic, 16 V. Wkg.
C22 2-off 0.47μF plastic foil
C23 2-off 220μF electrolytic, 10 V. Wkg.
C24 2-off 0.001μF plastic foil
C25 2-off 0.0082μF plastic foil 5%
C26 2-off 0.033μF plastic foil 5%
C27 1-off 0.039μF plastic foil 5%
C28 1-off 0.22μF plastic foil 5%
C29 1-off 0.047μF type C280 (Mullard)
C30 1-off 0.0068μF plastic foil 5%
C31 1-off 0.039μF plastic foil 5%
C32 1-off 0.22μF plastic foil 5%
C33 1-off 0.039μF plastic foil 5%
C34 1-off 0.0068μF plastic foil 5%
C35 1-off 0.039μF plastic foil 5%
C36 1-off 0.047μF type C280 (Mullard)
C37 1-off 100μF electrolytic, 25 V. Wkg.

Transformer
T1 mains transformer, secondary 30V at 1A

Integrated Circuits
IC1 4-off SN76023N
IC2 1-off MC1339P
IC3 1-off MC1312PQ

Semiconductors
TR1 BFY51
TR2 2N3055
TR3 BFY51
TR4 BFY51
D1 1N4003
D2 1N4003
D3 1N4003
D4 1N4003
D5 BZY88C27V

Switches
S1 d.p.s.t. rocker (Doram)
S2 s.p.s.t. rotary toggle (see text)
S3 4-pole 3-way rotary

Neon
PL1 panel mounting neon indicator with series resistor, 240V a.c.

Fuse
FS1 1.5A anti-surge cartridge fuse, 20mm.

Miscellaneous
6 large aluminium control knobs
4 small aluminium control knobs
Metal slide potentiometer control knob (see text)
Panel mounting fuseholder (for FS1)
3 stereo input sockets (see text)
4 speaker output sockets (see text)
Insulating kit (for TR2)
Clip-on heatsink (for TR4)
Materials for printed circuit boards
Materials for case (see text)
Screened wire, grommet, nuts, bolts, etc.

NEXT MONTH

In next month's issue we shall carry on to the construction of the power supply, after which we will deal with the power amplifiers and the pre-amplifier.

For completeness the full Components List accompanies the present article, and it will be evident that references to some of the components will appear in the succeeding articles. At this stage it may be mentioned that the potentiometers in the VR2, VR3 and VR4 positions should be small modern components having a body diameter of less than 1in. (25.4mm.). The 5% plastic foil capacitors will be discussed in Part 2.

(To be continued)

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

Continuing our adventures on the CW portions of the Amateur Bands, Top Band and Forty provided the usual good crop of Dx.

1.8-2.00 MHz (Top Band)

DF8FW, DJ0YD, DJ2RH, DJ6TK, DK2QL, F5AD, F8VJ, G13JEX, GM3CFS, GM3IAA, GM4AAF, GW4BCF, IK4AMO, K1PBW, N3RH, OH2BO, OH3PE/OHO, OK2BQL, OK3KFF, OL8CGB, OL9ATY, PA0HIP, VU1ITU, W1BB, W1HGT, W1HND, W2LW, WA4UPR, YU1PCF, YU2HDE, YU2RTW, YU3ZV.

Digging around among the QRM on forty metres we weeded out the following —

7.0-7.1 MHz (Forty)

CO2CM, CO5DM, CO5GV, CM7FM, EP2VW, HC1LT, HI8MOG, KP4DJE, KP4WL, KZ5EK, LU8DQ, PJ8CO, PY1NEW, PY6AVY, PZ1AH, TI2LA, TI3SPS, UD6DFF, UD6DHU, UF6FBL, UI8ADM, UJ8JCI, UL7CT, UM8BMV, VK3MR, VP2SAH, VP9HO, YS10, YV7PF, ZL2AYP, ZL2UV, ZP5AL, 5B4ZE, 7R1J, 9D5A.

Raking over twenty, the produce shown was unearthed, such as —

14.00-14.35 MHz (Twenty)

CX1AC, EL2ET, HH2EL, KG4JS, KL7HDN, KP4AR, KP4ESP, KP4MQ, KV4AA, KV4CI, KV4IL, LU8ADK, OA4EK, PZ9AB, UD6BJ, UL7GBY, VE7XM, VP2SZ, VP8AI, VP9HT, YS1ESH, YS10, ZD8TM, ZE8JJ, 5Z4LW, 5Z4NI, 8P6AU.

Little time remained for twenty-one but among the few forked out were —

21.00-21.45 MHz (Twenty-one)

HK0TU, HK5IAZ, PJ2VD and, last but not least, ZS6ME.

Till next time then, and we hope a bumper Dx harvest awaits!

CURRENT SCHEDULES

● SOUTH KOREA

"Radio Korea," Seoul, has an External Service in which English programmes to Europe are from 1130 to 1200 on **7150, 9665** and **11860**; from 1330 to 1400 on **11860** and from 2000 to 2030 on **9665** and on **9720**.

● LAOS

The Laotion Domestic Service, Vientiane, signs on at 2230 on **3900** and **6130** and continues on these channels until the 0200 sign-off. From 0400 until 0700 the frequencies in use are **6130, 6200, 7385** and **7480**. From 0900 until sign-off at 1530 the channels in use are **3900, 4645, 6130, 6200, 6240, 7310** and **7480.**

● LESOTHO

"Radio Lesotho," Maseru, presents a Domestic Service, mostly in English, from 0400 until the following sign-off times — Monday, Thursday, Friday, Saturday 2105; Tuesday 2050; Wednesday, Saturday 2145, all on **4800.**

● AUSTRIA

"Radio Austria," Vienna, features programmes in English to Europe from 0830 to 0900 on **6155, 15105, 15410** and on **17850**; from 1230 to 1300 on **6155, 9770, 11790** and on **17775**; from 1830 to 1900 on **6155, 9690, 15335** and on **17770.**

● BULGARIA

"Radio Sofia" transmits programmes in English directed to the U.K. and Eire from 1930 to 2000 on **6070** and on **9700** and from 2130 to 2200 on **7115** and **9530.**

● FINLAND

"Yleisradio," Helsinki, offers programmes in English to Europe and North Africa from 0930 to 1000 on **9550, 11755** and **15270** (Saturdays and Sundays); to Europe, Middle East and West Africa from 1900 to 1930 on **11755** and **15265** daily; to Europe and North Africa from 2000 to 2030 on **9550** and **11755** daily.

● EGYPT

"Radio Cairo" currently radiates "Voice of the Arabs" programmes, in Arabic, at various time periods throughout the day but for those interested probably the most convenient time would be from around 1500 to 1900 when they are on **15475** and **17745** or from 1900 through to 2050 sign-off on **7050** and **11630.**

AROUND THE DIAL

● BULGARIA

Radio Sofia on **11765** at 1920 when presenting a talk in English to Europe and Central Africa, programme scheduled from 1905 to 1930.

● PORTUGAL

Lisbon on **11925** at 2008, OM in Portuguese in a relay of the National Domestic Service to the Atlantic Islands, scheduled from 0700 to 2400 daily.

● **MADAGASCAR**

Radio Nederlands Relay on **11730** at 2018, musical items in the English programme directed to Western Europe from 2000 to 2120.

● **ALBANIA**

Tirana on **11985** at 0938, OM and YL alternate with a newscast in English beamed to Australia, scheduled from 0930 to 1000.

W. GERMANY

Deutche Welle on **11850** at 0942, a talk on German affairs in the English programme intended for Australia and Asia, scheduled from 0930 to 1000.

● **SPAIN**

Madrid on **11920** at 0953, talks and music in the Spanish programme for European consumption, scheduled from 0830 to 1100.

● **HUNGARY**

Budapest on **11910** at 0956, YL with announcements in the German programme for Europe, scheduled from 0900 to 1000.

● **INDIA**

AIR Delhi on **11775** at 1006, OM with a newscast in English in the daily programme directed to North East Asia and Australasia, scheduled from 1000 to 1100.

AIR Delhi on **11810** at 1403, OM with a talk about tourism in India in the General Overseas Service in English directed to South East Asia, scheduled from 1330 to 1500.

● **PHILIPPINES**

Radio Veritas, Manila, on **11780** at 1422, YL with a talk in English about the local holiday resorts and an invitation to "come to the Philippines." The afternoon English programme schedule is from 1400 to 1500 on this channel and in parallel on **9645** and **15260**. Radio Veritas is part of the Philippine Radio Educational and Information Centre.

● **SOMALIA**

Radio Hargeisa on a measured **11646** at 1516, OM in Somali announcing a programme of local Arabic-type music. This station radiates programmes for local consumption from 1100 to 1330 and from 1500 to 1630 and is subject to frequency variations.

● **BRAZIL**

Radio Nacional de Brasilia on **11780** at 2105, OM with news of local affairs in the English programme for Europe.

● **SOUTH AFRICA**

Johannesburg on **11800** at 2100, interval signal, identification and news in the English programme to Europe and West Africa, scheduled from 2100 to 2150 on this channel and in parallel on **7270, 9585** and **11900**.

● **NORTH KOREA**

Pyongyang on a measured **6338** at 1913, YL with the English programme directed to the Middle East and Africa, scheduled from 1800 to 2000 on this channel.

● **SOUTH KOREA**

Seoul on **11865** at 1356, identification by YL in the English programme intended for Europe, scheduled from 1330 to 1400 but listed on **11860**!

● **EGYPT**

Cairo on **9755** at 1543, OM with readings from the Holy Qu'ran in a transmission from the Holy Qu'ran Station, scheduled from 0230 to 0905 and from 1200 to 2100. Programmes consist entirely of readings and religious features.

Cairo on **7050** at 1910, OM in Arabic in a programme from the "Voice of Palestine, Voice of the Palestine Revolution" station, the programme schedule being from 1800 to 1930 daily.

Cairo on **17745** at 1552, OM with Arabic pop songs in a programme for the Arabic-speaking world from the "Voice of the Arabs" transmitter which operates on this channel from 0800 to 1400 and from 1500 to 1900.

● **CHINA**

Radio Peking on **6560** at 1854, OM in French with a programme for Africa and Europe, scheduled from 1830 to 1930.

Radio Peking on a measured **6933** at 1850, OM in Arabic with Africa and Europe as the target areas in a programme scheduled from 1830 to 1930.

Radio Peking on **4815** at 1901, interval signal, identification "Govorit Peking" ("Here is Peking") in the Russian programme scheduled from 1900 to 1955.

● **PAKISTAN**

Islamabad on **3330** at 1625, OM with song in Urdu, local music in the Domestic Service, scheduled on this channel from 1400 to 1810.

● **NEPAL**

Kathmandu on a measured **5006** at 1546, OM with local songs. The schedule of this 5kW transmitter is from 0020 to 0350, 0720 to 1050 and from 1150 to 1720 on this channel and in parallel on **3424** (100kW) and **7105** (100kW). Programmes in English are from 0220 to 0230 and from 1435 to 1520.

● **ECUADOR**

Emisora Progresso, Loja, on **5060** at 0350, guitar music, songs in Spanish. The schedule of this one is from 1200 to 1415 and the power is 5kW.

Radio Nacional Espejo, Quito, on a measured **4679** at 0354, OM with the local news in Spanish. Schedule is on a 24-hour basis and the power is 5kW.

Emisora Gran Colombia, Quito, on a measured **4911** at 0532, Latin American music, songs in Spanish after identification.

Radio Quito on **4920** at 0309, OM with a sports commentary in Spanish, many mentions of Quito and district.

Radio Splendit, Cuenca, on **5025** at 0437, identification and announcements with echo-effect, Latin American pop records.

Radio Zaracay, Santo Domingo, on **3390** at 0231, OM in Spanish, guitar music after station identification. Schedule is from 1000 to 0500 but has been reported by USA Dxers sometimes signing-off at 0849; the power is 10kW.

A SIMPLE AND AMUSING PROJECT . . .

POCKET NOU(AND CROSS.

By David Gibson

One of the problems with playing the popular game of Noughts and Crosses is the need for materials. Pencils are required and these get lost or points get broken. Again, volumes of paper are commonly used.

Such was the problem for the writer in keeping two lively children amused for long car journeys. The solution is an "electrical" Noughts and Crosses game where no paper or pencils are required. This saves time and temper, and ensures that the car does not look like a paper chase at the end of each journey.

LIGHT-EMITTING DIODES

The idea is basically ultra-simple. Instead of zeros and crosses, red and green light-emitting diodes are used. Thus, the game could alternatively be called "Stops and Goes" or, perhaps, "Traffic Lights".

As can be seen from the photograph, nine switches are laid out in the form of a Noughts and Crosses grid pattern. Directly alongside these switches is a pattern of l.e.d.'s. These are arranged in pairs, with one red and one green l.e.d. in each square of the grid.

The switches are changeover types with a centre "Off" position, and it is only necessary to push a switch to one side or the other to cause either a red or green l.e.d. to light. Each switch controls the pair of l.e.d.'s in the corresponding square of the grid; for example, the bottom left-hand switch controls the l.e.d.'s in the bottom left-hand square.

If a player is "Red" he will always push the switch he selects upwards (i.e. towards the operator's thumb in the photograph). The "Green" player always pushes his switch down. The idea is to get three lights of the same colour in a row to win — just like Noughts and Crosses. Obviously, once a switch has been actuated, i.e. pushed to one side, it cannot be touched by either player.

The beauty of using this simple electrical advice is that immediately a game is over it is only necessary to return all switches to their centre positions and the unit is then set up for the next game. Also, when all the switches are in their centre "Off" positions the unit draws no current at all from its batteries and so an on-off switch is superfluous.

The circuit can be assembled in almost any kind of case, this being plastic, wood or metal. The unit in the photograph is about the smallest practical size. As well as being a favourite with children it has proved to be even more popular with adults visiting the author's house!

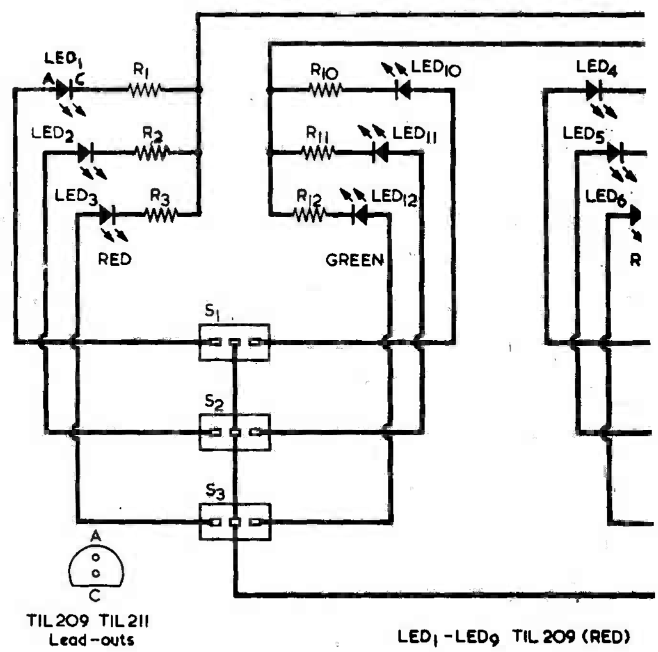


Fig. 1. The circuit of t switc

GHTS
ES

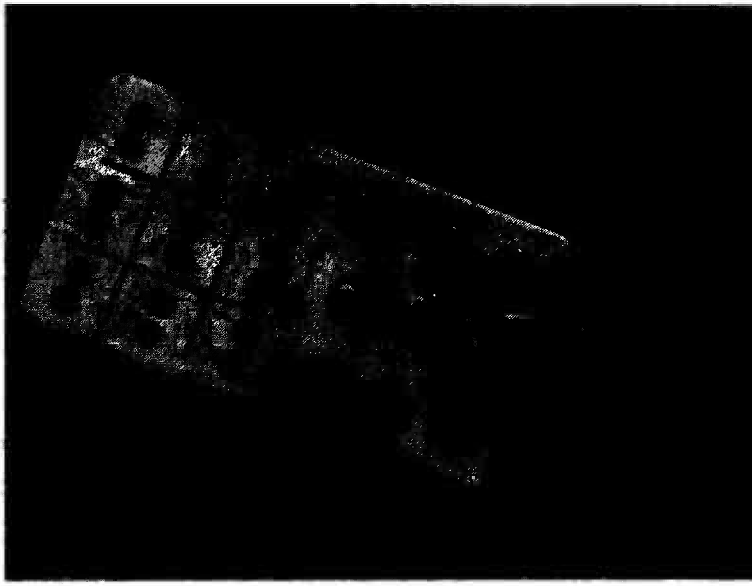
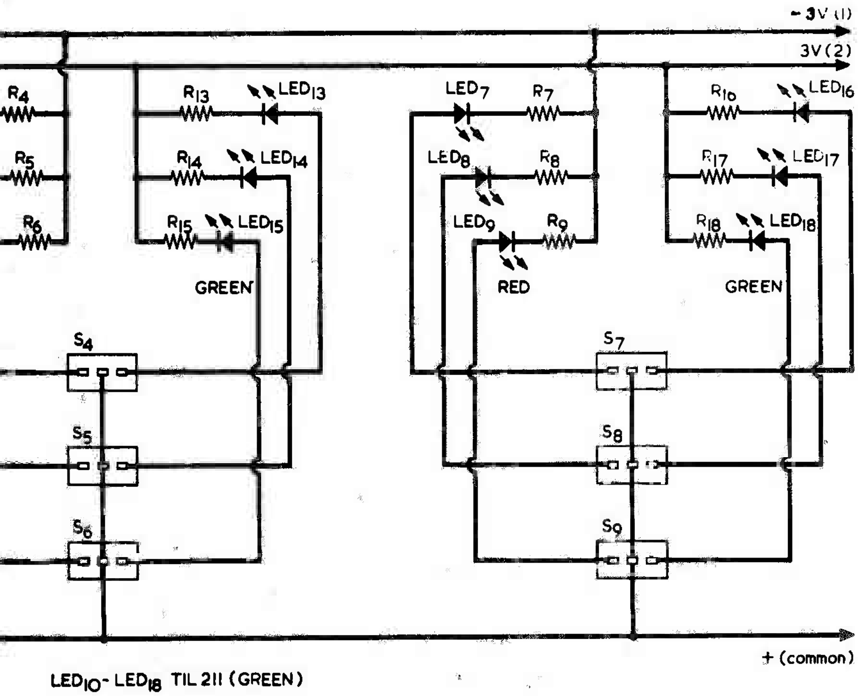


Fig. 1 gives the circuit of the unit, and here the switch and l.e.d. relative positions correspond with the positions these take up when the panel on which they are mounted is viewed from the rear. The switches are not presented in the usual circuit symbol form; instead for simplicity their physical outlines and tags are shown, also as seen from the rear. The diagram may appear a little complex for the beginner, but it is very simple. If you look at the section comprising S1 to S3, LED1 to LED3 and LED10 to LED12, you will realise how easy it really is. The common positive supply connects to the centre tag of



...e pocket Noughts and Crosses unit. All the ...es have a centre off position

COMPONENTS

Resistors
(All ¼ watt 10% — see text)
R1-R9 150 Ω
R10-R18 47 Ω

Light-Emitting Diodes
LED1-LED9 TIL209 with panel-mounting bush
LED10-LED18 TIL211 with panel-mounting bush

Switches
S1-S9 s.p.d.t. toggle with centre off, miniature

Batteries
B1-B4 1.5 volt cell type HP7 (Ever Ready)

Miscellaneous
Case (see text)
Wire, solder etc.

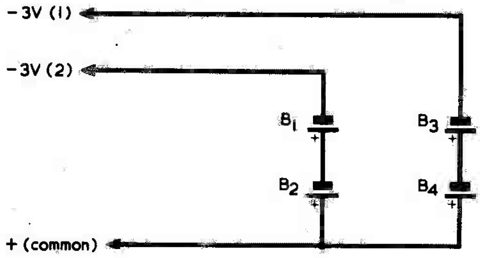


Fig. 2. Power is provided by four HP7 cells

each switch, and each outer tag connects to the corresponding l.e.d. There is a resistor in series with each l.e.d. to limit the current it passes. The section of the circuit just mentioned is simply repeated at S4 to S6, and S7 to S9.

POWER SUPPLIES

There are two 3 volt power supplies, these being numbered 1 and 2. Each supply consists of two HP7 1.5 volt cells in series, as shown in Fig. 2. Supply No. 1 feeds the red l.e.d.'s, whilst supply No. 2 feeds the green l.e.d.'s. Each red l.e.d. has a 150 Ω resistor in series and each green l.e.d. has a 47 Ω resistor in series. These values were found to roughly match up the intensities of the two colours, but the difference does mean that battery No. 2 is liable to run down before battery No. 1.

No connectors are necessary for the cells, and interconnecting wires are simply soldered to the metal case of the cell at the bottom (negative) and the brass stud (positive). It is a simple matter to solder in a pair of replacement cells when these are required. As a tip, make certain that you clean the associated area of the metal case for the negative connection before soldering, and that you obtain a good well-tinned joint here. Otherwise, the leads have a nasty habit of "falling off" in the unit case!

Each pair of cells is put in a small polythene bag to prevent short-circuits to other components or wiring, or to the case of the unit if this is metal.

The l.e.d.'s have an anode and cathode lead-out, the anode connecting to the positive side of the supply and the cathode (via the current limiting resistor) to the negative side of the supply. The TIL209 and TIL211 have a flat surface on one side to enable the cathode lead-out to be identified. These l.e.d.'s are available from a number of retailers including Bi-Pak Semiconductors, who can also supply panel-mounting bushes. The recommended diameter for the panel holes which take the bushes is 5mm., but it is always wise in matters of this nature to check with the actual components themselves before drilling the holes.

If a metal case is to be used a card should be prepared with holes matching those in the front panel for fitting inside the case behind the panel. The l.e.d.'s in their bushes then pass through the holes in the card as well as those in the panel. The card provides insulation from the inside surface of the panel and prevents short-circuits from the wiring to the l.e.d.'s. If the latter are mounted with sufficient rigidity, the series resistors may be soldered directly to the cathode lead-outs, the appropriate wires from the batteries then connecting to the free resistor lead-outs. The resistors should preferably be ⅛ watt, as the very small size of such resistors eases wiring layout. Small ¼ watt resistors can alternatively be employed, however, if these are more easy to obtain.

SWITCHES

The switches can be obtained from a number of sources, including Home Radio (Components) Ltd. Miniature types should be used. Wiring is carried out with thin flexible p.v.c. covered wire. It is a good plan to use wire of one colour for the red l.e.d. circuits and a wire of a different colour for the green l.e.d. circuits. The l.e.d. lead-outs may be splayed out so that the l.e.d. and resistor wiring is flat behind the front panel. The leads should be bent very gently, and not to close to the l.e.d. body. A piece of plastic foam may then be cut to size and placed over the l.e.d. and resistor wiring. The four HP7 cells, in their polythene bags, are then positioned side by side over the foam and are held in position when the case lid is fitted. If necessary a second piece of foam may be glued to the inside of the lid, whereupon the cells are sandwiched between the two pieces of foam.

The case employed for the unit should have dimensions which will accommodate the cells and the particular switches employed, and the latter should be obtained first. As already mentioned, the case can be metal, plastic or wood. Fig. 3 shows the front panel

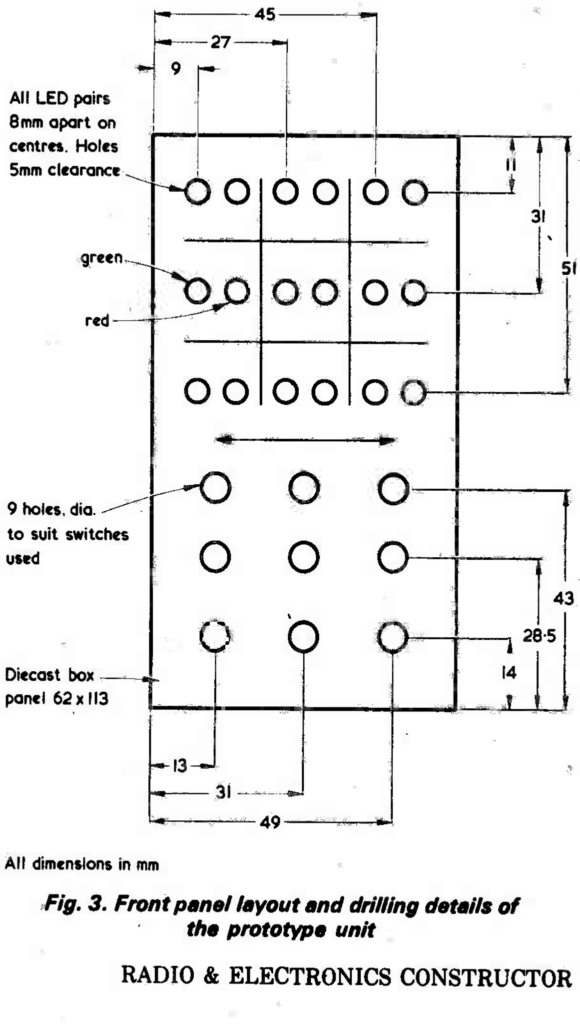


Fig. 3. Front panel layout and drilling details of the prototype unit

layout for the author's unit and gives a general idea of the l.e.d. and switch positioning. The author used a non-standard diecast box (which is strong enough to stand up to abuse by children) having the panel dimensions shown and a depth of 35mm. The bottom of the case forms the front panel and the lid is at the rear. Readers who wish to use diecast boxes may note that a conveniently sized range is listed by Maplin Electronic Supplies, the two smallest boxes in the range having dimensions of 120.65 by 60.33 by 44.04mm. and 120.65 by 95.25 by 56.74mm. respectively. However, a very wide choice of plastic and aluminium cases of around the required size is available from mail order suppliers, and the case can also be home constructed from plywood.

After drilling out the panel, the author sprayed his case matt white with the aid of an aerosol car spray. The black lines forming the grid around the l.e.d.'s were then carefully painted in. A black line between the switches and the l.e.d.'s was also painted on the panel, this having red and green arrow-heads at the ends to indicate which way the switches should be pushed. The red arrow-head indicates the direction in which the switches should be pushed to light the red l.e.d.'s and the green arrow head the direction for the green l.e.d.'s. ■

USING QUAD NORTON AMPLIFIERS

The Norton current difference amplifier is a device which has not received a great deal of attention despite its obvious advantages in some applications. This article deals with the basic theory of the amplifier and then shows how two Norton amplifiers may be employed in a practical project consisting of a meter sensitivity booster.

By A. P. Roberts

Many readers will probably be wondering what exactly a Norton amplifier is, since this type of amplifier is not often met in electronic designs for the amateur. Its infrequent use is not due to lack of possible applications, however, as the Norton amplifier is a highly versatile device.

OPERATIONAL AMPLIFIERS

A Norton amplifier is an operational amplifier but it does not have a differential voltage input, as have the commonly encountered op-amps type 741, CA3130, etc. With the latter there are two inputs, as in Fig. 1(a), one being the inverting input (−) and the other the non-inverting input (+). The output voltage is a function of the voltage difference at the inputs multiplied by the op-amp voltage gain, which is normally extremely high. Thus, only a small voltage across the inputs is needed to produce either a fully positive or fully negative output. The output goes positive when the non-inverting input is positive of the inverting input (or, put another way, when the inverting input is negative of the non-inverting input), and goes negative when the non-inverting input is negative of the inverting input. The addition of a feedback network between the output and one or both of the inputs enables a performance to be obtained which is governed by the values of the feedback components.

With the Norton amplifier the input circuits are not voltage sensitive but are current sensitive. The Norton amplifier has inverting and non-inverting inputs and it also has a very high level of gain, the output voltage being determined by the input currents.

A common emitter transistor with its emitter connected direct to earth (the negative supply rail) is used at the inverting input of a Norton circuit, and so the input voltage here is limited to about 0.6 volt positive of earth by the base-emitter junction of the input transistor. A second common emitter transistor, with the emitter also connected direct to earth, appears at the non-inverting input, giving a similar voltage limitation of about 0.6 volt positive of earth. Phase inversion is given by connecting the collector of this second transistor to the base of the first transistor. Obviously, a Norton op-amp cannot be used as a direct replacement for an ordinary voltage input op-amp.

Norton amplifiers are frequently depicted in circuits with the same symbol as an ordinary op-amp, as was shown in Fig. 1(a). Sometimes the modified symbol of Fig. 1(b) is employed instead. The Norton amplifier may also be referred to as a "current difference amplifier".

It is possible to make a Norton amplifier operate as a voltage difference device simply by adding series resistors at the inputs, as shown in Fig.1(c). The input currents are then proportional to the voltages applied to these resistors, the voltages being limited to levels which do not cause excessive input currents to flow. By using two series resistors having fairly high equal values the circuit will function in a manner very similar to that of an ordinary operational amplifier. However, there is in general little profit to be realised in using a Norton amplifier in this way because the end result will be an over-complicated circuit having a performance inferior to that of a standard op-amp.

As will be demonstrated shortly, Norton amplifiers give their best performances in circuits specifically designed for them and which take advantage of their current sensitive inputs.

It is worth noting, though, that in virtually all practical circuits incorporating Norton amplifiers resistors are employed at the inputs so that input voltages are converted to currents. Another feature is that Norton amplifiers are intended to function with a single positive and negative supply rail; they do not employ the dual supplies that are encountered with ordinary op-amps. Indeed, one of the main reasons for using Norton amplifiers is that they are capable of operating from simple single supply rail circuits.

The device which is used in the practical circuits described in this article is the CA3401E, which is available from Arrow Electronics, Ltd., Leader House, Coptfold Road, Brentwood, Essex. This contains four amplifiers, each having its own internal compensation capacitor. The device is housed in a standard 14 pin d.i.l. package and its pin functions are given in Fig. 1(d).

The CA3401E will operate over a supply voltage range of 5 to 18 volts, and it has an open loop voltage gain of typically 66dB, a typical unity gain bandwidth of 5MHz and a typical slew rate of 0.6 volt per microsecond. Other quad Norton i.c.'s are available, and the CA3401E is a direct equivalent of the MC3401P, and is pin-compatible (i.e. has the same pin allocations but a somewhat different specification and internal circuit) with the MC3301P and the LM3900N. In practice, the LM3900N will function satisfactorily in the meter sensitivity booster which forms the home constructor project in this article.

BASIC CONFIGURATIONS

One feasible method of using a Norton amplifier as an inverting amplifier is shown in Fig. 2(a). Two

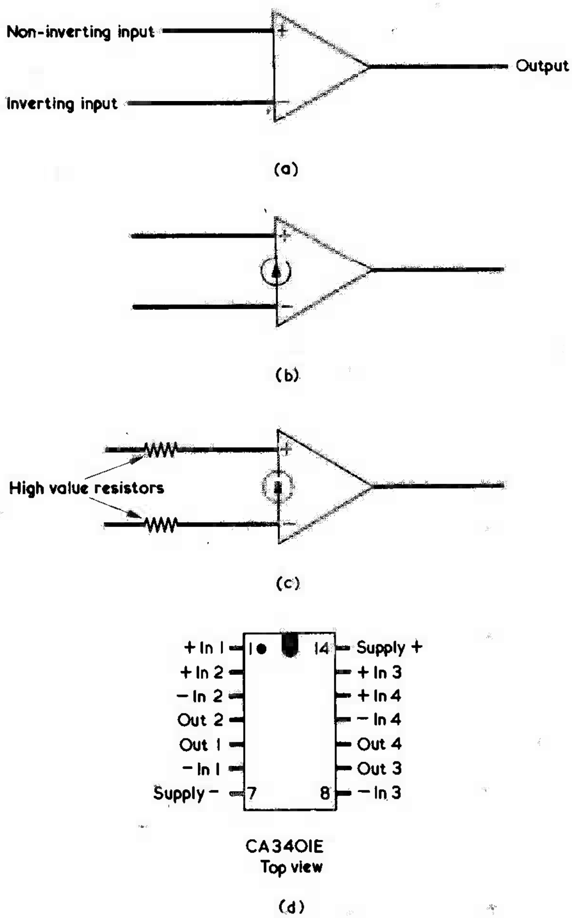


Fig. 1(a). The normal circuit symbol for an operational amplifier
(b). A Norton amplifier may have the symbol illustrated in (a) or that shown here
(c). A Norton amplifier will give a performance similar to that of a standard op-amp if high value resistors are connected to the inputs
(d). Pin diagram for the quad Norton amplifier i.c. type CA3401E

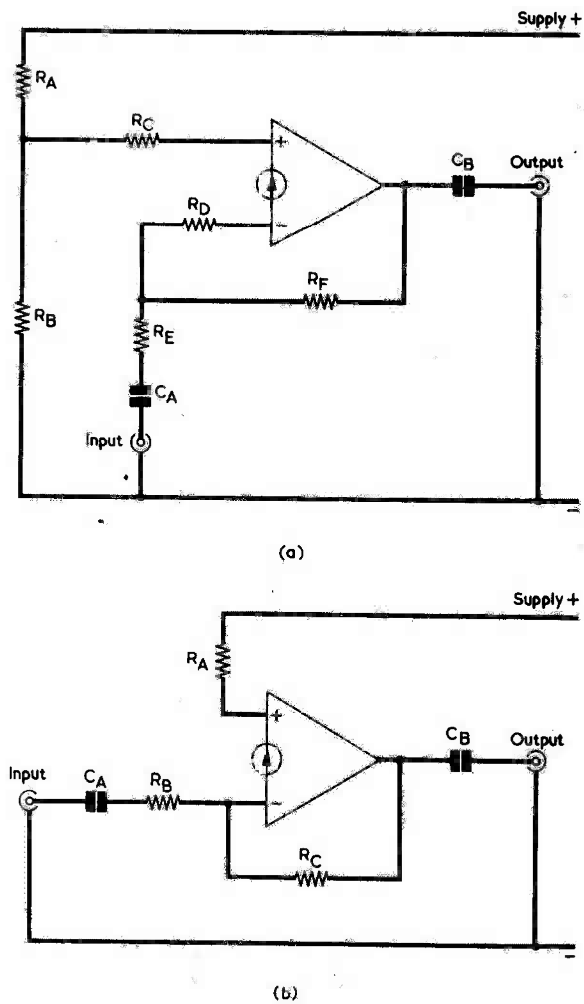


Fig. 2(a). An inverting Norton amplifier connected in a circuit of normal op-amp type
(b). An improved inverting amplifier is given with this circuit

equal high value resistors, RC and RD, are added at the inputs so that a voltage difference amplifier circuit is set up. RA and RB bias what is effectively the non-inverting input to half supply voltage, whilst RE and RF form a negative feedback loop which determines voltage gain. CA and CB provide input and output d.c. blocking respectively.

The unattractive circuit of Fig. 2(a) can be much simplified, and an increase in performance obtained, if it is developed to the configuration shown in Fig. 2(b). Here, the usefulness of a Norton amplifier becomes immediately apparent. Only three resistors are required and their values can be readily calculated for specific values of input impedance and voltage gain. RB is given a value which is equal to the desired input impedance for the circuit, and RC is then made equal to RB multiplied by the required voltage gain. Finally, RA is given a value which is approximately twice RC.

This provides a quiescent output voltage which is approximately mid-way between the supply rails because the current flowing through RC into the inverting input then balances the current flowing through RA into the non-inverting input. It is for this reason that RA and RC are given a 2 to 1 relationship.

The voltage gain is equal to RC divided by RB as a result of normal feedback action, and the inverting input can be looked upon as a virtual earth.

The values of the input and output d.c. blocking capacitors, CA and CB, are chosen to suit the input impedance and the impedance of the succeeding circuit. It should be noted that RA should not be greater than about 10MΩ as the input bias current would then be insuffficent. Also, it should not be less than a few kilohms or excessive input bias current would flow. The absolute maximum input current rating for the CA3401E is 5mA.

NON-INVERTING AMPLIFIER

A Norton amplifier can be used in the non-inverting mode, in which the input and output signals are in phase, and a suitable circuit is shown in Fig. 3.

Here, RB and RC are given the same 2 to 1 relationship as had RA and RC in Fig. 2(b), and they stabilize the quiescent d.c. condition in precisely the same way. The difference between the two circuits is merely that the input signal is fed to the non-inverting rather than the inverting input. RA sets the input impedance.

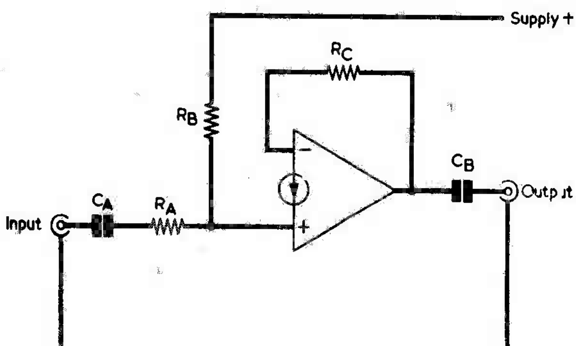


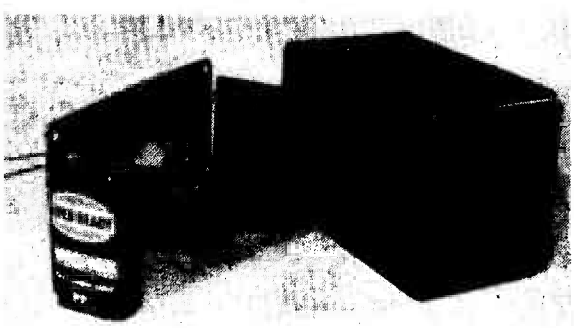
Fig. 3. A Norton amplifier connected in the non-inverting mode

The voltage gain of the circuit is equal to RC divided by RA, and this can be illustrated by simple mathematical example. Let us suppose that RC has a value which is 5 times that of RA. If a signal of 1 volt positive is applied to the input there will be an increase in the current flowing into the non-inverting input. In order to balance this the output will have to go 5 volts positive to produce a similar current flow increase at the inverting input. Thus, the ratio of these two resistors sets the voltage gain of the circuit.

PRACTICAL PROJECT

As a simple practical example of a circuit employing Norton amplifiers, a multimeter sensitivity booster will next be described. This can be used in conjunction with a multimeter switched to a 0-50μA current range, and it provides three voltage ranges of 0-0.5, 0-5 and 0-50 volts with a sensitivity of 200kΩ per volt. This is ten times the sensitivity that a normal multimeter incorporating a 0-50μA range will have, and it enables more accurate measurements to be taken from high impedance circuits.

The circuit of the sensitivity booster appears in Fig. 4, and it employs two of the four amplifiers contained in a CA3401E. The other two amplifiers are simply ignored, and no connections are made to their pins.



The Veroboard panel is fitted vertically alongside the switch

The amplifier on the left is that which handles the voltage to be measured and its output is coupled to the 0-50μA meter (which is plugged into SK1) and to R5 and R6 in series. Potentiometer R6 is coupled to the second amplifier on the right, and the function of the latter will be explained shortly. R6 is adjusted so that the resistance it inserts into circuit plus that of the meter and R5 becomes equal to 100kΩ, whereupon all three components form a voltmeter with a full-scale deflection value of 5 volts. In practice, R6 is adjusted after the unit has been completed and its input is applied to a known voltage.

The voltage gain of the left-hand amplifier is equal to R4 divided by R1, R2 or R3, according to the position of S1(a). When S1 is set to the 0-0.5 volt range the voltage gain is 10 times, whilst at the 0-5 volt range it is unity. With S1(a) put to the 0-50 volt range the voltage gain is 0.1 times, so that a voltage of 50 at the input gives an output of 5 volts. This situation is due to the fact that R4 has one-tenth the value of R1.

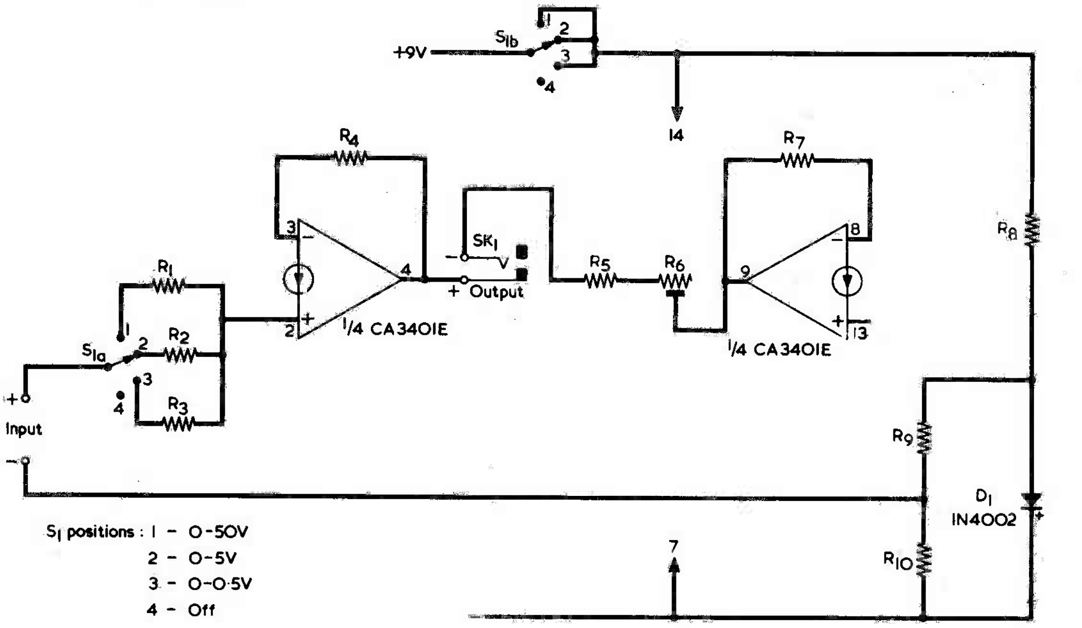


Fig. 4. Circuit diagram for the meter sensitivity booster. This employs two Norton amplifiers

COMPONENTS

Resistors
(All fixed values ¼ or ½ watt)
R1 10MΩ (see text)
R2 1MΩ 2%
R3 100kΩ 2%
R4 1MΩ 2%
R5 68kΩ 5%
R6 50kΩ or 47kΩ pre-set potentiometer, 0.1 watt miniature skeleton, horizontal
R7 1MΩ 5%
R8 10kΩ 5%
R9 100Ω 2%
R10 560Ω 2%

Semiconductors
IC1 CA3401E D1 1N4002

Switch
S1(a)(b) 2-pole 4-way rotary (see text)

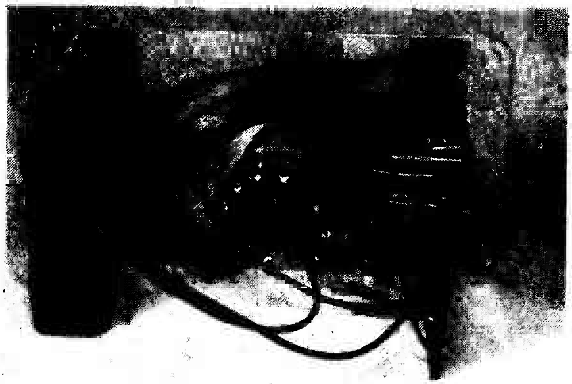
Socket
SK1 3.5mm. jack socket

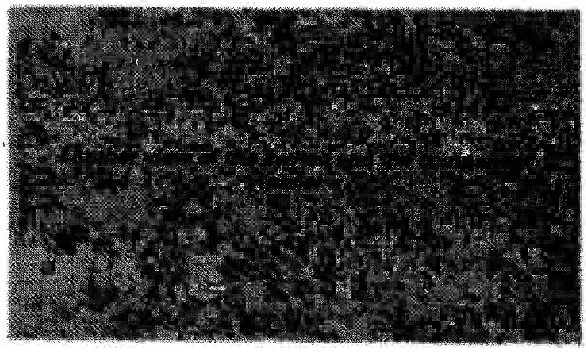
Miscellaneous
Case (see text)
Knob
9 volt battery type PP3 (Ever Ready)
Battery connector
Veroboard, 0.1in. matrix
I.C. holder, 14 pin d.i.l. (see text)
Test leads and prods
Grommet, connecting wire, etc.

There is still, nevertheless, a current gain of 10 times, since an input current of 5μA in R1 (corresponding to an input voltage of 50 volts) produces f.s.d. in the 50μA meter. By inspection of the values of R2 and R3 it will be seen that only 5μA input current is needed for f.s.d. on the other two ranges, and it is this factor which gives the circuit its tenfold increase in input resistance when compared with the multimeter on its own.

There are two complications which have to be catered for. First, about 0.5 volt is needed at the input to the amplifier before the input transistors begin to turn on, whereupon all readings would be 0.5 volt low unless some measure is taken to counteract the effect. The solution consists of returning the negative test lead to a point which is 0.5 volt positive of the negative rail, and this is given at the junction of R9 and R10. These two resistors are connected to the forward biased silicon diode, D1, across which a stabilized voltage appears.

The second complication is that the amplifier has a quiescent output of about 0.6 volt, with the result that the voltmeter given by the meter, R5 and R6 in series cannot be returned to the negative rail. R6 is, instead, connected to the output of the second amplifier on the right. This amplifier has the same value of resistor from the output to the inverting input and no connection to the non-inverting input. Its output voltage is in





consequence the same as that of the left-hand amplifier when the latter has no input, and the meter therefore reads zero.

S1(b) provides on-off switching, and S1(a) and S1(b) form a 2-pole 4-way switch. Actually, a 3-pole switch is employed, with one pole unused. The positive supply is applied to pin 14 of the CA3401E and the negative supply to pin 7. The current consumption of the circuit is approximately 4mA.

In use, the unit provides good accuracy, linearity and stability on all three ranges.

A number of the resistors are specified as 2% and no difficulty should be experienced in obtaining close tolerance components here. If desired, 1% components could be employed for R2, R3 and R4, these giving a small increase in accuracy of readings. R1 should also have a close tolerance, but close tolerance resistors with values above 1M Ω are not readily available. Either R1 may be a single 5% resistor with the possibility of consequent error on the 0-50 volt range accepted, or it may consist of several smaller 5% resistors in series. In the latter instance the overall tolerance may be significantly less than 5% as the chance exists that the lower value resistors may have positive and negative errors which tend to cancel out. In the prototype, R1 consisted of two 2.2M Ω and one 5.6M Ω resistors in series, all 5%, and these provided good accuracy.

CONSTRUCTION

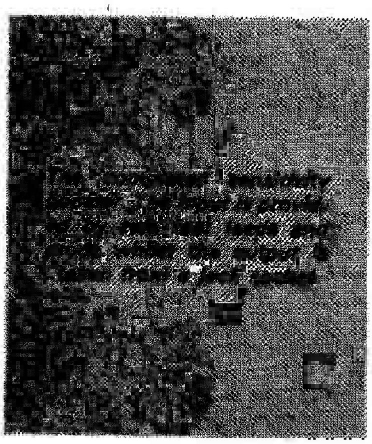
The prototype was housed in a case type M2, this being available from Doram Electronics and having dimensions of about 100 by 65 by 50mm. The M2 case is plastic with a metal front panel, and any other similarly sized small plastic case either with or without a metal panel may be employed instead. An all-metal case should not be used.

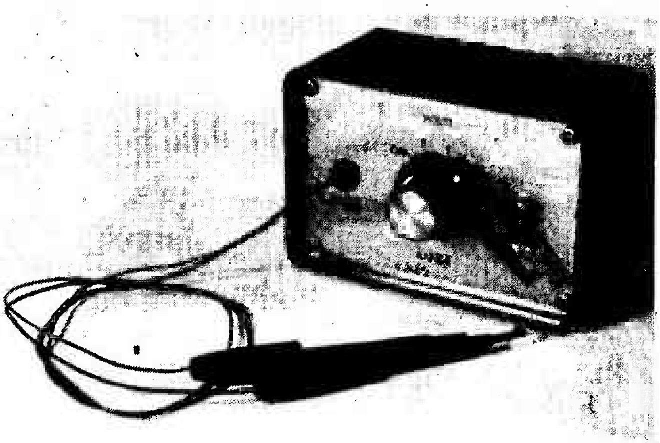
The simple front panel layout can be see in the accompanying photographs. S1 is mounted in the centre of the panel with jack socket SK1 to its right. The connection to the multimeter is made by way of a jack plug inserted in the socket. A twin flex from the jack plug is terminated in crocodile clips for quick connection to the multimeter leads, and the sleeve of the plug corresponds with the positive terminal of the multimeter. The metal panel of the prototype case is common with the positive output by way of SK1 mounting bush and nut. This should not cause any difficulties in practice, but constructors who would prefer that a metal front panel be isolated may use an insulated socket for SK1.

A small hole of about 6mm. diameter is drilled to the left of S1, and is fitted with a grommet. The two input test leads pass through this hole.

Most of the components are wired up on a Veroboard panel of 0.1in. matrix having 20 holes by 12 strips. The copper and component sides of this board are illustrated in Fig. 5, as also are the external connections.

After the board has been cut out, the breaks in the copper strips are made, and then all the components with the exception of R1, R2 and R3 are soldered in position. In the prototype an i.c. holder was soldered to the board and the CA3401E plugged into this. The





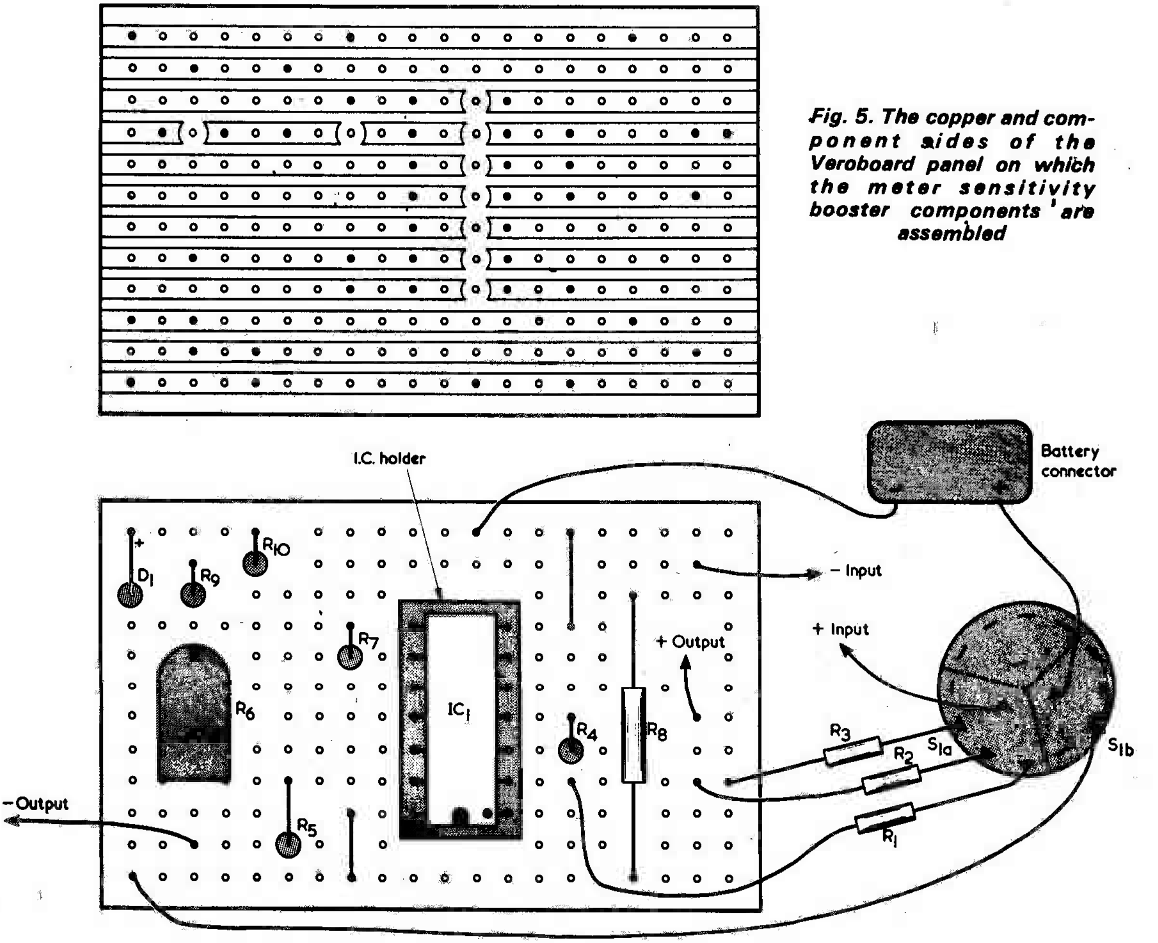


Fig. 5. The copper and component sides of the Veroboard panel on which the meter sensitivity booster components are assembled

holder is not essential and the i.c. pins can, if desired, be soldered direct to the strips of the board. Note that R6 is a miniature skeleton potentiometer having 0.2in. spacing between track tags and 0.4in. spacing between slider and track tags.

The board is secured in place by means of the resistors R1, R2 and R3, which connect to the switch tags. This gives quite an acceptable mounting as the board assembly is very light. It is positioned vertically and to the left of S1, as seen from the front. A more conventional method of securing the board in position can, of course, be adopted should the constructor so wish.

Before wiring to the switch, check the outer tags which correspond to each switch pole. With some switches, the relative positioning of inner and outer tags may vary from that shown in Fig. 5.

There is plenty of space for the PP3 battery behind the output socket. A piece of foam plastic may be inserted between the two to hold the battery in position when the front panel is screwed on.

ADJUSTMENT

The only adjustment which the finished unit requires is that of setting up R6. For this a known voltage of low source impedance is needed, and this could be a new 4.5 volt battery.

R6 is set to insert maximum resistance into circuit. As shown in Fig. 5, this is with the slider fully anticlockwise. The precise voltage of the battery is determined by the multimeter and noted. The multimeter is then disconnected from the battery, switched to its 0-50μA range and coupled to the output of the unit. S1 in the unit is next set to the 0-5 volt range and its test leads are connected to the battery. Finally, R6 is adjusted so that the meter gives a reading corresponding to the previously noted value. The unit is then set up and no further adjustments are needed.

It is not, of course, necessary to employ a 4.5 volt battery and any other reference voltage within reason can be used for setting up R6. Greater accuracy in the adjustment will, however, be given if the reference voltage provides a reading which is close to f.s.d. on the range selected, and this should preferably be the 0-5 volt range.

MEDIUM AND DUAL SHORTWAVE RADIO

Part 2

(Conclusion)

By P. R. Arthur

In last month's issue we dealt with this receiver in its basic 3-transistor form, in which it provides an a.f. output at headphone level. This concluding article describes how an optional a.f. output stage may be added and also gives details of a simple modification which permits the use of a long wire aerial.

OUTPUT STAGE

The output signal from the basic receiver is quite strong and only a single transistor output stage is required to provide loudspeaker results. Its circuit is shown in Fig. 7, and it incorporates a common emitter transistor, TR4, coupling to the loudspeaker via a step-down transformer. The connection to the speaker is made via the break contact of SK1, this cutting out the speaker when headphones are plugged in.

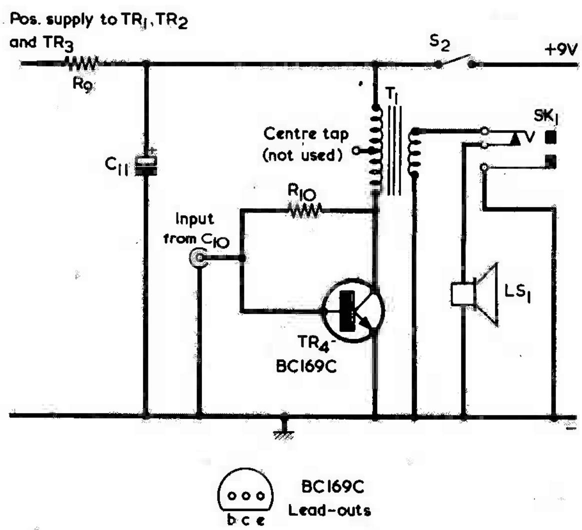
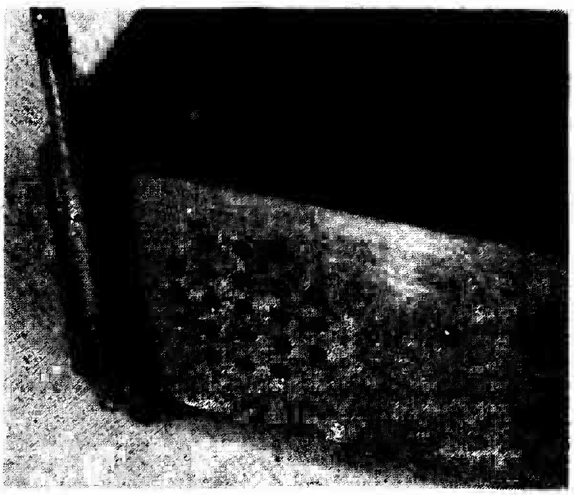


Fig. 7. The circuit of the additional a.f. output stage

R10 provides base bias for TR4, causing this to pass a quiescent current of about 9mA. The relatively low current limits the output power to some 25mW only, but this just about provides adequate volume with a miniature speaker. No d.c. blocking capacitor is required at the input since C10 of the basic receiver provides this function.

S2 is the original on-off switch, whilst R9 and C11 are additional supply decoupling components.

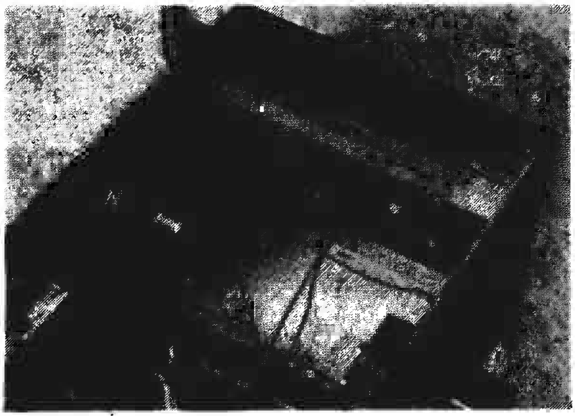
Although, ideally, low impedance headphones should be employed when the receiver has the output stage incorporated, it is found in practice that results are perfectly satisfactory using any common type of headphones.



When the a.f. output stage is fitted a small speaker is mounted on the rear panel. Small holes, rather than a single large hole, are drilled in the panel in front of the speaker

CONSTRUCTION

The loudspeaker may be any miniature type having a diameter of 3½in. or less and an impedance



The speaker seen from the inside. The a.f. output panel is secured to the right-hand side of the receiver case

in the range of 3 Ω to 8 Ω. It is fitted to the right hand side of the rear panel (as viewed from the front) and some form of aperture has to be cut out in the rear panel for it. To maintain the strength of the panel it is preferable to provide a number of small holes rather than a single large hole, and with the prototype a grid of 21 holes of ¼in. diameter was drilled over the appropriate area. These are clearly visible in the photographs of the rear of the receiver. If the speaker has mounting holes it may be secured by bolts and nuts. Alternatively it may be held in position by a good quality adhesive applied to its rim. Care should be taken to keep the adhesive away from the cone and surround.

The remaining output stage components are assembled on a piece of 0.15in. Veroboard having 15 holes by 9 copper strips. The component side of this panel is shown in Fig. 8. It is first cut to size and then the two mounting holes are drilled out. These should have a diameter suitable for small woodscrews. Next,

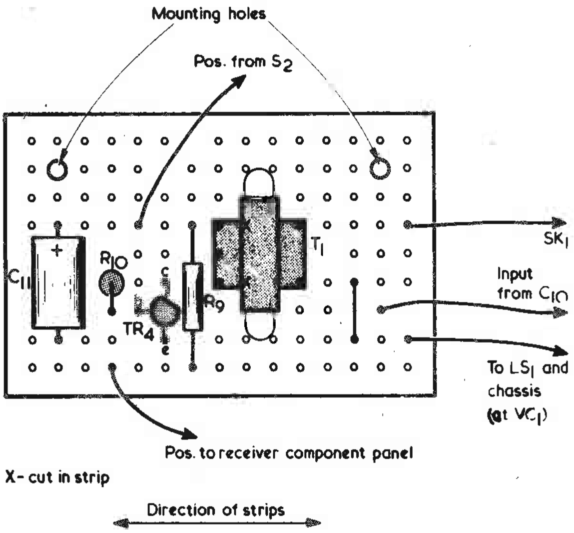


Fig. 8. The component side of the Veroboard panel on which the output stage is wired

COMPONENTS

OUTPUT STAGE

Resistors
(All ¼ watt 5%)
R9 100Ω
R10 470kΩ

Capacitor
C11 100μF electrolytic, 10 V. Wkg.

Transformer
T1 output transformer type LT700 (Eagle)

Transistor
TR4 BC169C

Loudspeaker
LS1 3-8Ω miniature speaker (see text)

Miscellaneous
Veroboard, 0.15in. matrix
0.15in. Veropins

AERIAL MODIFICATION

Capacitor
TC1 2-10pF trimmer (see text)

Sockets
SK2 insulated socket
SK3 insulated socket

the two breaks in the strips are made, after which the link wire and components are soldered in place. The mounting lugs of T1 will need to be bent out to enable it to take up its position on the panel. This component is normally supplied with flexible lead-out wires, in which case it may be secured to the board with a little adhesive. Should it be supplied with stiff wire spills these can be passed through the Veroboard holes and soldered, whereupon there is no necessity to use the adhesive. Veropins are fitted at the points where external connections will be made to the panel.

When complete, the panel is mounted on the right hand side of the case between the two 5in. battens, using two small woodscrews. It is necessary to employ spacers on the woodscrews between the panel and the case side as the panel may otherwise fracture when the screws are tightened up. Suitable spacers could consist of one or more 4BA nuts.

The a.f. output stage assembly requires only a few components in addition to the output transformer

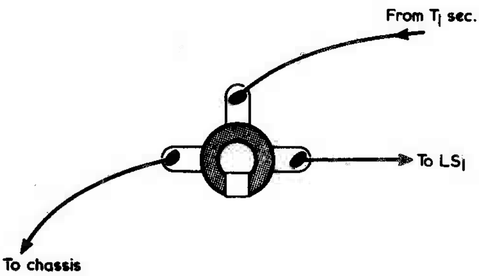


Fig. 9. Rear view of SK1, showing the new connections to its tags. The tag layout applies to normal sockets of open construction

WIRING

A few changes now have to be made in the wiring of the receiver, as so far assembled. The wire from the existing receiver component panel to S2 shown in Fig. 6 (published last month) is disconnected at the switch and reconnected to the appropriate point on the output stage panel. The wire is extended as required, a piece of sleeving being passed over the joint. Alternatively, a new wire may be fitted. This connection allows R9 to decouple the receiver circuit from the output stage. A new lead connects the a.f. output stage panel to S2. The wire from the receiver panel to the non-earthy contact of SK1 is disconnected at the socket and reconnected to the a.f. input point on the a.f. output stage panel. Again, the lead is extended or a new lead fitted.

The output stage panel obtains its negative supply by way of a lead which connects first to one tag of the speaker then continues to the moving vanes tag on the frame of VC1. The lead from the a.f. output panel to SK1 connects to its non-earthy contact, and the remaining speaker tag connects to the break contact of this socket. The appropriate socket tags are shown in Fig. 9, these being applicable to a standard 3.5mm. socket of open construction.

The receiver with the added a.f. output stage is then complete and ready for use.

The aerial and earth sockets. The aerial trimmer is soldered directly to the aerial socket

AERIAL MODIFICATION

As already stated, the receiver may be modified to allow the use of a long wire aerial. This will produce a very large improvement in results on Ranges 1 and 2, but the improvement on Range 3 is not likely to be so dramatic.

The modification simply consists of adding an insulated socket for the aerial and coupling this to the non-earthy end of the tuned circuit via a trimmer, TC1, as in Fig. 10. The trimmer has a low value and provides a very loose coupling to the tuned circuit. A tighter coupling cannot be employed as this could cause the tuned circuit to be excessively damped, with a consequent reduction in selectivity. After it has been fitted, TC1 is adjusted, with the long wire aerial to be used, for the best compromise between signal strength and selectivity.

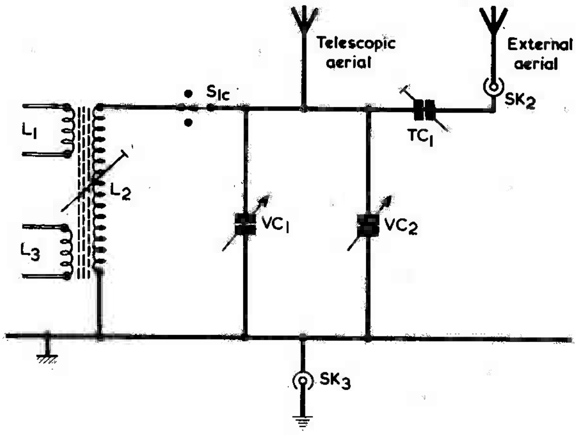


Fig. 10. The modification which enables a long wire aerial to be employed. Also added is a socket for an earth connection

TC1 may be any small air-spaced or ceramic trimmer offering a range of 2 to 10pF. A trimmer having minimum and maximum values outside these figures could of course be used, a suitable component being a Mullard concentric trimmer with a range of 0.9 to 12pF.

A further small but useful improvement will be given by adding an earth connection. This necessitates fitting a second socket which connects to the chassis of the receiver. As with the aerial modification, the earth connection will increase signal strength on Ranges 1 and 2 but will have little effect on Range 3. The earth socket is also shown in Fig. 10.

Apart from an increase to some degree in signal strength, the earth connection provides another advantage since it eliminates hand capacitance effects when the telescopic aerial is in use. These effects are to be expected with a receiver of this type and can be completely eradicated by an earth connection, even when this is of quite an inefficient nature.

The aerial and earth sockets are fitted to the rear panel of the receiver below the chassis level and rougly opposite VC2. The earth socket connects to the right-hand chassis tag in Fig. 4 (published last month). One tag of TC1 is soldered direct to the aerial socket and this should normally provide an adequate mounting. It's other tag connects to one of the fixed vanes tags of VC2.

RECENT PUBLICATIONS

RADIO COMMUNICATION HANDBOOK, Fifth Edition, Volume 1. 480 pages, 250 x 185mm. (9¾ x 7¼in.) Published by Radio Society of Great Britain. Price £7.50.

The first edition of this deservedly well known book appeared in 1938 and it has undergone many printings, involving more than 250,000 copies, in the years which have since intervened. It has also advanced through its first four editions, with each new edition being fully revised to take in the latest technology. The fourth edition appeared in 1968. In its present fifth edition it has been split into two volumes, of which Volume 1 is the subject of this review. "Radio Communication Handbook" is now the largest and most comprehensive textbook in the world on the theory and practice of amateur radio.

The subjects dealt with are basic principles, electronic tubes and valves, semiconductors, h.f. receivers, v.h.f. and u.h.f. receivers, h.f. transmitters, v.h.f. and u.h.f. transmitters, keying and break-in, modulation systems and RTTY. The text is lavishly supplemented by very many drawings, photographs, charts and tables. Great care has been taken in the preparation of the work and it would form a handsome edition to the bookshelf of the professional as well as the amateur engineer.

Volume 2, which is currently in preparation, will deal with remaining subjects, including aerials and propagation, measurements, operating technique, satellite communication and image communication.

HAM RADIO. By Kenneth Ullyet. 163 pages, 215 x 140mm.. (8½ x 5½in.) Published by David & Charles. Price £4.50.

This is an unusual book because it contains no circuit diagrams, mathematics, algebra or formulae. Instead, the book is mainly intended for general reading and, as such, offers an excellent introduction to the world of amateur radio for the person who has had no previous experience of listening or transmitting on the amateur bands.

The book still, nevertheless, deals with factualities and there is a chapter on learning the morse code and another chapter on amateur TV transmission and reception. In many instances it is not only present-day practices which are described, since the author also gives a well balanced historical survey of progress in cases where this is of interest and assists in the understanding of the subjects being dealt with.

Some technicalities appear at the end in an Appendix which deals with matters ranging from resistor and capacitor identification to ham prefixes, and which includes the Q code, international phonetic alphabets and semiconductor terminology. Distributed throughout the book are pages of photographs illustrating current and past events and personalities in the amateur radio story. One photograph, for example, depicts the L.N.E.R. radio coach employed in 1924 for experimental amateur communications from a moving train whilst another illustrates amateur television transmissions as passed via satellite OSCAR-6.

MODERN CRYSTAL SETS. By R. H. Warring. 32 pages, 185 x 245mm. (7½ x 9½in.) Published by Lutterworth Press. Price £1.95.
MODERN TRANSISTOR RADIOS. By R. H. Warring. 32 pages, 185 x 245mm. (7½ x 9½in.) Published by Lutterworth Press. Price £1.95.

These two titles are the first in a new series, ***See and Make***, which has been launched by Lutterworth Press. They are intended specifically for the newcomer and describe the assembly of simple working receivers, with every step illustrated by a diagram and/or a photograph. The complete beginner is advised to read "Modern Crystal Sets" before progressing to "Modern Transistor Radios". All constructional diagrams show the actual components, and circuit diagrams appear only in two pages at the end of "Modern Transistor Radios".

In "Modern Crystal Sets", the reader is introduced to the components which will be employed and to the techniques of soldering. A drilling diagram is given for the s.r.b.p. panel on which the sets are assembled, 6BA brass screws being passed through the holes to provide solder anchor points. The sets are a simple crystal diode set, a set using the base-emitter junction of a transistor as a diode and several sets with variations in which a transistor provides a.f. amplification.

The receivers in "Modern Transistor Radios" commence with two single transistor radios then proceed to two 2-transistor radios, two single transistor regenerative receivers, two reflex radios, two receivers with transformer output (one for a speaker) and, finally, a receiver with Class B output for a speaker.

TV SOUND ADAPTOR

By
James Kerrick

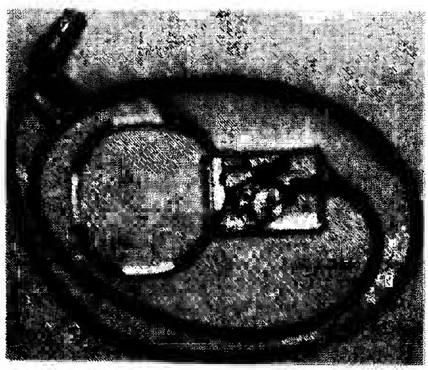
An experimental project for the more experienced constructor.

This sound adaptor picks up the 6MHz intercarrier signal from a television receiver and applies it to an MC1357 i.c. for amplification and demodulation. The resultant output can then be fed to a high fidelity sound system.

The sound reproduction offered by many television receivers leaves much to be desired, whereupon a means of improving the quality by feeding the sound signal to a separate amplifier and speaker becomes attractive. Unfortunately, it is difficult to make a satisfactory connection to the sound circuits inside most television sets since these have live chassis which are connected to one side of the mains supply. The live connection precludes direct wiring to the volume control. A mains isolating transformer could be installed between the mains supply and the TV receiver, but such a component is both costly and bulky. Coupling to the receiver a.f. output by way of an a.f. isolating transformer is also unattractive, because the signal has then been subjected to the a.f. amplification provided in the receiver and the transformer could itself introduce some distortion.

The adaptor to be described overcomes these difficulties by picking up the 6MHz intercarrier signal from the television receiver by means of a pick-up loop positioned near the back of the set. The intercarrier signal is then amplified and demodulated externally and can be applied to a high fidelity amplifier and speaker system.

It must be emphasised from the outset that this project is completely experimental in character since there is no guarantee that all television receivers will radiate a sufficiently high intercarrier signal to be picked up by the adaptor. It is probable that greatest radiation will be given by the earlier receivers employing valves in the intercarrier channel and that least radiation will be given by modern receivers having i.c.'s in the intercarrier circuits. It should be possible with such sets to couple via a low value high voltage capacitor to the intercarrier signal, but this approach has not been checked out by the author and should only be undertaken by constructors familiar with TV operation and servicing. The author's receiver is a Decca DR122 valve model and sufficient signal coupling is given with this when the pick-up loop is about 12in. from the back of the set. Because of these points, the project should be undertaken only by the experienced constructor who fully understands the principles involved and who is prepared, if necessary, to experiment. The 6MHz intercarrier signal only appears, of course, in 625 line receivers.



The pick-up loop section of the adaptor. The coaxial cable plugs into the main section incorporating the MC1357 i.c.

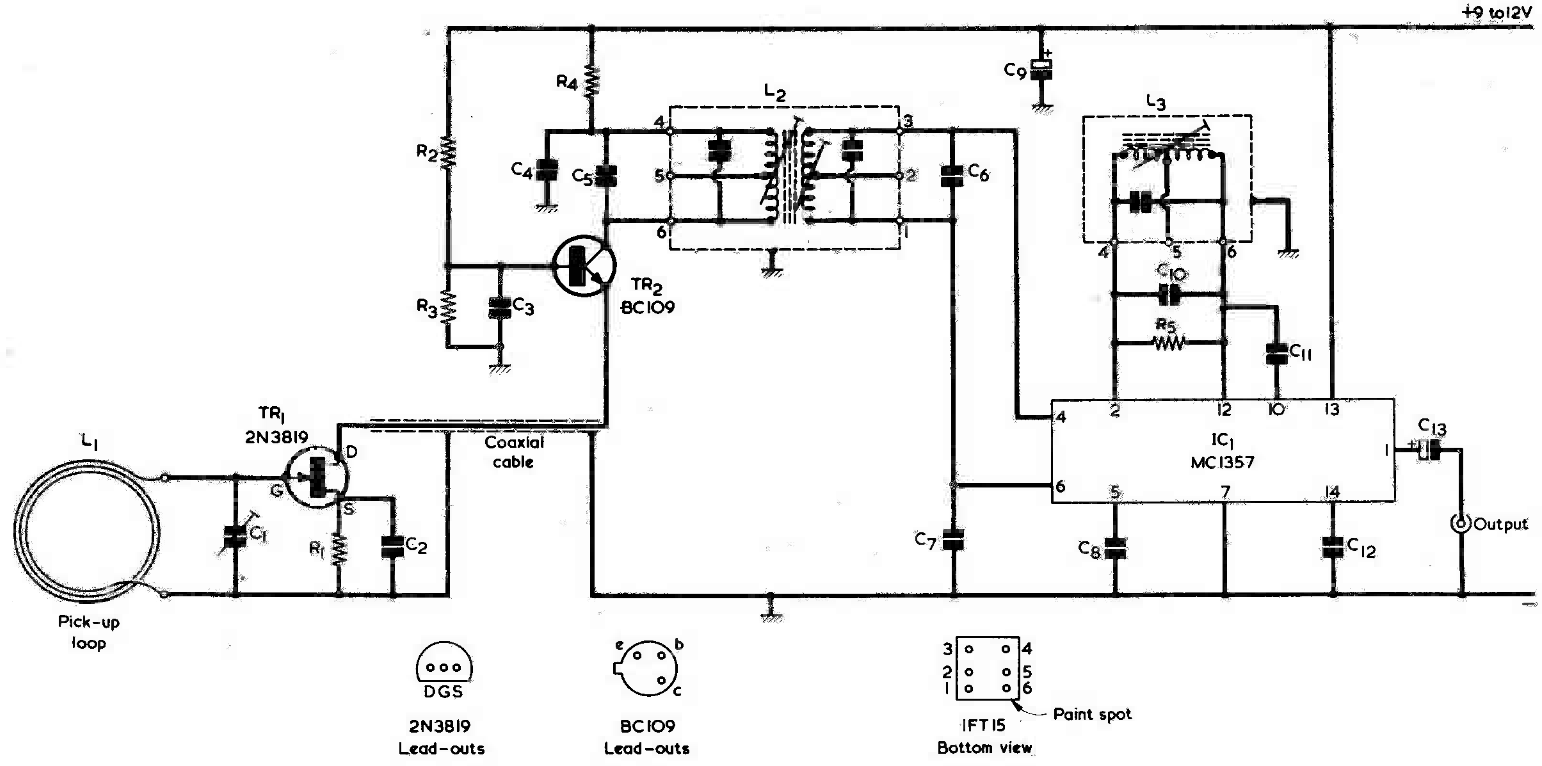


Fig. 1. The complete circuit of the TV sound adaptor. This consists of two sections which are coupled together by the coaxial cable

COMPONENTS

Resistors
(All ¼ watt 5%)
R1 See text
R2 33kΩ
R3 33kΩ
R4 100Ω
R5 15kΩ

Capacitors
C1 30pF trimmer, air-spaced
C2 0.1μF ceramic
C3 0.1μF ceramic
C4 0.1μF ceramic
C5 68pF silvered mica or polystyrene
C6 68pF silvered mica or polystyrene
C7 0.1μF ceramic
C8 0.1μF ceramic
C9 10μF electrolytic, 16 V. Wkg.
C10 68pF silvered mica or polystyrene
C11 4.7pF silvered mica
C12 0.0047μF polyester
C13 10μF electrolytic, 16 V. Wkg.

Inductors
L1 Pick-up loop (see text)
L2 10.7MHz i.f. transformer type IFT.15 (Denco)
L3 10.7MHz i.f. transformer type IFT.15, modified (Denco)

Semiconductors
TR1 2N3819
TR2 BC109
IC1 MC1357

Miscellaneous
Small plastic case (see text)
Metal case (see text)
2 coaxial sockets
Coaxial plug
Coaxial cable
Materials for printed board.

The components which form the main section can be assembled on a small printed board

CIRCUIT DETAILS

The circuit of the adaptor is given in Fig. 1. There are two sections, one being the pick-up loop section which also incorporates TR1, R1, C1 and C2, whilst the other consists of the succeeding circuitry. The pick-up loop section is intended for positioning behind the rear of the television receiver, and it is coupled to the main section by about 3ft. of coaxial cable. This is terminated in a coaxial plug (not shown in the diagram) which fits into a coaxial socket in the main section. The latter has a second coaxial socket for the a.f. output.

TR1 and TR2 form a cascode with the input signal provided by the pick-up loop. This is tuned broadly to 6MHz by trimmer C1. The collector of TR2 connects to L2, which is a Denco double-tuned 10.7MHz i.f. transformer type IFT.15. The operating frequency of the transformer is brought down to 6MHz by the external capacitors C5 and C6. Note that connection is made to the outside ends of the tuned circuits and not to the transformer taps. The secondary of L2 couples into the MC1357 i.c., and this is connected up in a standard manner. The phase shift tuned circuit is given by L3, the associated internal parallel capacitor and C10. L3 is one winding of a second IFT.15 i.f. transformer, the other winding and core having been removed. The a.f. output of the i.c. is then fed via C13 to the output socket. The bulk of the gain in the adaptor is given by the MC1357. If there is insufficient 6MHz input signal, the output of the adaptor may consist of transmitted a.m. signals at around 6MHz picked up by L1. These clear when the 6MHz input is sufficiently high to allow the MC1357 to provide full limiting.

The author's circuit does not include the 0.1μF capacitor which the manufacturers recommend be connected between pin 2 of the MC1357 and chassis, since this was not found to be necessary. Such a capacitor can be added, if desired.

CONSTRUCTION

Construction can follow normal practice with all signal-carrying wiring kept short. The pick-up loop section components in the author's prototype were housed in a small plastic case measuring 2¼ by 1¼ by ½in. The loop passes through the sides of this case, as shown in Fig. 2 and the accompanying photograph,

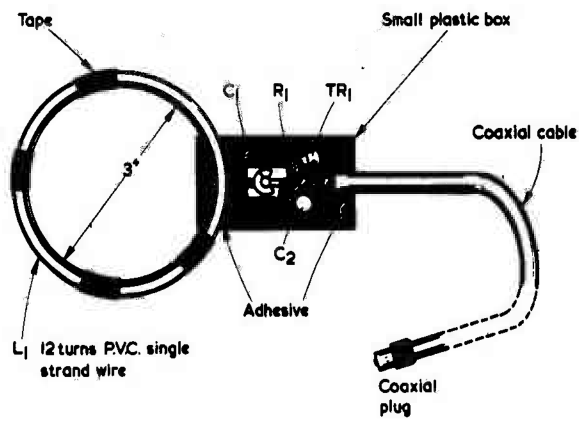
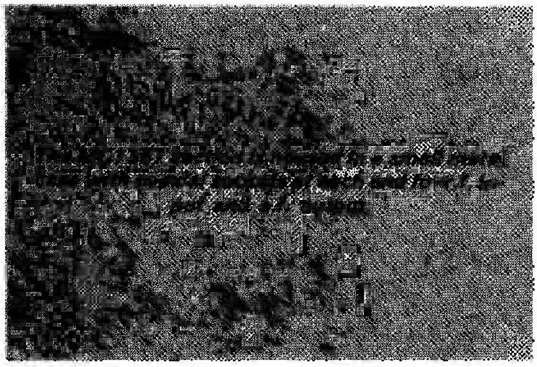
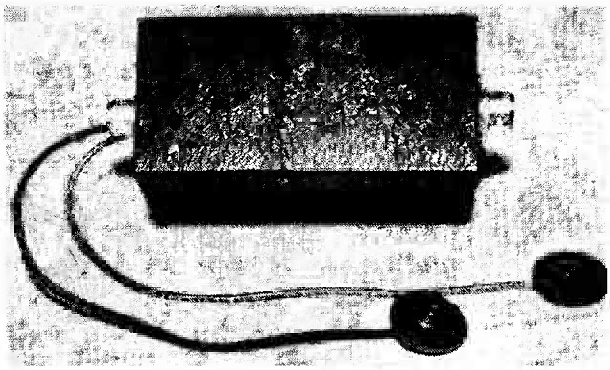


Fig. 2. Details of the pick-up loop and its associated components





and is held in position by a clear adhesive. The main circuitry is assembled on a printed board of about 3 by $1\frac{1}{2}$in., and is housed in a metal case measuring 4 by 2 by $1\frac{3}{4}$in. The battery is external to the case.

The value of R1 has to be determined by experiment and should be such that about 1 to 2mA flows in the cascode circuit. This can be checked by measuring the voltage drop across R4. The value required in R1 will probably be of the order of 2kΩ.

Assuming that it is present at sufficient strength, the circuit can be aligned from the signal radiated by the television receiver. Adjustment of L3 should provide an a.f. signal, after which L1 and L2 can be peaked by moving the pick-up coil further and further away from the set and adjusting for a limited signal in each case. The tuning of the secondary of L2 is very flat. L3 is then finally adjusted for minimum distortion.

Should it be necessary to couple directly into the receiver to obtain sufficient input, the gate of TR1 can be coupled via a low value capacitor to a suitable intercarrier point in the set, such as at a discriminator transformer. The capacitor *must* have a voltage rating suitable for 250 volts a.c., and all precautions against accidental shock to anyone using the unit must be observed. ■

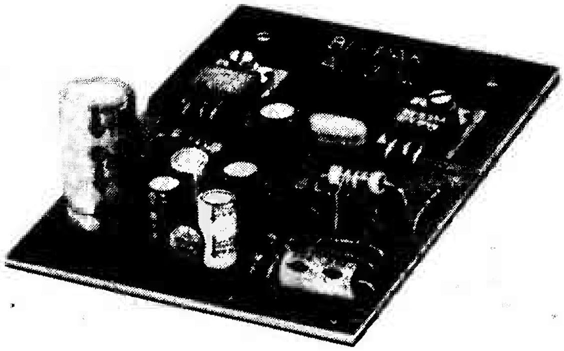
Trade News . . .

NEW AUDIO AMPLIFIER MODULE FROM BI-PAK

The AL30A is a high quality audio amplifier module providing an output power of 10w RMS. The versatility of its design makes it ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge players.

The circuit is a complementary symmetry output stage and the generous specification of the output devices ensures peak performance and reliability. The selection of these power transistors in particular determine the supply and output conditions.

A power supply is available for use with the AL30A and consists of a PS12 together with a transformer T538, also available is a stereo pre-amplifier PA12.



HEAT SINK REQUIREMENTS

In order to prevent overheating, the modules must be attached to some form of heat sink, aluminium being an ideal material for this purpose. The heat sink may take the form of a bracket on which the units are mounted. It is recommended that 18 swg aluminium or heavier is used, having a total area of 10 sq. in. when used in speech and music applications and 15 sq. in. for high power and sine wave applications. The above figures should be doubled where two units are mounted in the same heat sink.

FUSING

For domestic uses a 500mA fuse should be placed in the positive line feeding the amplifier. In cases where the module is used for high power or sine wave applications this should be increased to 1 amp.

SPECIFICATIONS

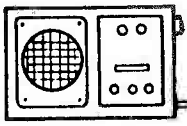
OUTPUT POWER	10w RMS
SUPPLY	22 to 32 volts
LOAD IMPEDANCE	8 to 16 ohms
INPUT IMPEDANCE	50k
SENSITIVITY	90mv for full output
TOTAL HARMONIC DISTORTION	Less than .5% (Typically .3%)
FREQUENCY RESPONSE	60Hz to 25KHz ± 2db
MAXIMUM HEAT SINK TEMPERATURE	80°c
DIMENSIONS	90 x 64 x 27mm

The output power of the amplifier is dependent on the supply voltage and load impedance. The table shows examples.

SUPPLY VOLTAGE	LOAD IMPEDANCE	OUTPUT WATTS RMS
28	8	10
28	16	5

Further details may be obtained from BI-PAK Semiconductors Ltd., of PO Box 6, Ware, Herts.

In your work-shop



This month Smithy the Serviceman demonstrates to his assistant, Dick, the unique relationship between voltage, capacitance, current and time which is given when a capacitor charges via a constant current source. Also, he used this relationship to make up a circuit which measures human reaction time following a visual stimulus.

"If," said Dick, breaking the lunch hour silence, "they installed a clock in the Leaning Tower of Pisa, what would that give you?"

Smithy lowered his tin mug to his bench and surveyed his assistant gravely.

"I don't know," he said eventually. "What would it give you?"

"The time," chuckled Dick, "*and* the inclination!"

Smithy shuddered.

"I've got another one here," continued Dick remorselessly. "What do they call the Welshman who set up the capacitor factory?"

The Serviceman concentrated.

"It's no good," he stated. "I give up. What do they call him?"

Dick grinned.

"Dai-Electric!"

CAPACITANCE

"Where on earth," groaned Smithy, "do you get all these terrible riddles?"

"I've got a bag full of them," boasted Dick. "It's the latest craze and we try them out on each other down at Joe's Caff. But at least somebody at Joe's Caff usually finds an answer; they don't give up like you do."

"It must be," confessed Smithy, "that I'm just not oriented."

"Then that's because you're old," stated Dick flatly. "We're young down at Joe's and our reactions are quicker."

"Age," protested Smithy indignantly, "has nothing to do with it. I bet my reactions are as quick as yours or any of your mates."

"Prove it."

"All right," snorted Smithy. "We'll have a contest in which each of us has to respond to a stimulus. The one who responds quicker is the one who wins."

"How the heck," responded Dick, "can we set up a contest like that?"

"Very easily," replied Smithy. "You mentioned capacitors just now and so we'll make up a human reaction timer. Now, here's a question for you. What's the basic unit of capacitance?"

"The microfarad, I suppose."

"The basic unit," pronounced Smithy, "is actually the farad, of which a microfarad is a one-millionth part. All right then, what is the definition of a farad?"

"Search me!"

"A capacitor has a value of 1 farad," stated Smithy. "If the voltage across its plates is 1 volt when it stores a charge of 1 coulomb. Taking this a stage further, the charge in coulombs is equal to capacitance in farads multiplied by the voltage across the capacitor."

"I'll take your word for it," commented Dick carelessly. "You lost me as soon as you started talking about coulombs!"

Smithy picked up his mug and drained it with one gargantuan swallow.

"Fair enough," he said equably, as he wiped his mouth with the back of his hand. "We'll leave the coulombs for a bit and come back to them later. What I want to do now is to start working out a circuit for the reaction timer, so whilst I'm doing that perhaps you could fill up my mug for me."

Obligingly, Dick rose from his stool and walked over to the cracked and battered utensils ranged alongside the Workshop sink to replenish Smithy's mug. The Serviceman pulled his note-pad towards him, took out a pen and proceeded to sketch out a small circuit. This was complete when Dick returned with Smithy's refilled mug. (Fig. 1).

"That looks pretty simple," remarked Dick, glancing at the note-pad as he placed the mug on the surface of Smithy's bench.

"It is simple," agreed Smithy. "It's just a 555 timer connected up to give one-shot operation. When the switch is closed, the 100μF electrolytic capacitor is short-circuited via the 10Ω current limiting resistor, R1. Under this condition the 555 output, at pin 3, is high and so the l.e.d. doesn't light. Opening the switch takes the short-circuit off the capacitor and it commences to charge by way of R2 and R3. When the voltage across the capacitor reaches two-thirds of the supply voltage the output at pin 3 changes state and suddenly goes low.

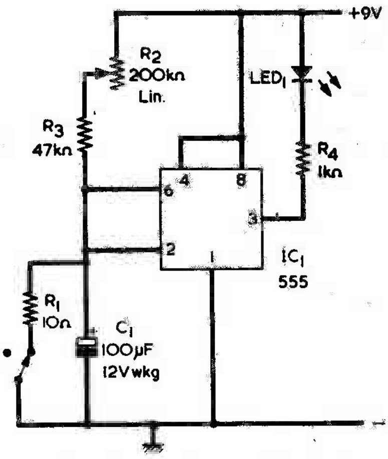


Fig. 1. The circuit of the 555 section of Smithy's human reaction timer. The l.e.d., which can be any small red or green type, lights up after a period controlled by R2

The l.e.d. is then lit up via R4. The output remains in the low state until the switch is closed again, whereupon the capacitor is discharged, the output at pin 3 goes high and the circuit is ready for another timing run. Which, of course, can be given by opening the switch once more."

TIME CONSTANT

"It appears," remarked Dick, "to be just an elementary electronic timing circuit. You could for instance replace the l.e.d. and R4 with the coil of a relay. The relay contacts would then control the circuit being timed (Fig. 2).

"True, true," confirmed Smithy. "Now, this 555 circuit is only part of the complete reaction timer, but it has its own little point of minor interest."

"What's that?"

"The length of the timing period," said Smithy, "is almost exactly the same as the time constant of the capacitor and the resistance through which it charges."

"Is it?" queried Dick. "How do you make that out?"

"Well," said Smithy, "when you have a capacitor charging up via a series resistor, the time constant is the time in seconds needed for the voltage across the capacitor to rise from zero to 63% of the supply voltage. In the 555 circuit, the output at pin 3 goes low when the voltage across the capacitor reaches two-thirds of the supply voltage. Two-thirds is the same as 67% so the length of the 555 timing run is just a little longer than the time constant. Actually, it's 1.1 times the time constant." (Fig. 3).

"Blimey," commented Dick, interestedi "that's useful to know. It makes the calculation of the capacitor and resistor values very easy."

"Exactly," confirmed Smithy. "Time constant in seconds is equal to capacitance in farads multiplied by

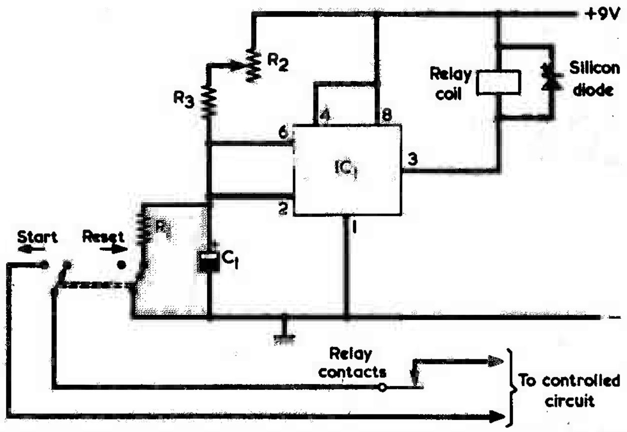


Fig. 2. As Dick pointed out, the basic 555 circuit can be adapted to form a standard electronic timer incorporating a relay. The relay coil resistance should be greater than 300Ω and the contacts shown are normally closed. The silicon diode can be a IN4002, or similar

resistance in ohms or, to simplify calculations, capacitance in microfarads multiplied by resistance in megohms. So, when R2 inserts maximum resistance into circuit, the series resistance through which the capacitor charges is about 250k Ω, or 0.25MΩ. Multiply 0.25MΩ by the 100μF in the capacitor and you get 25 seconds. Similar reasoning shows that the time constant is about 4.7 seconds when R2 inserts zero resistance into circuit."

"So," cut in Dick, "you've got a timing circuit with a range of 4.7 to 25 seconds."

"That's right," agreed Smithy. "In practice there are the tolerances in the circuit to take into account. You could say, rough check, that this 555 timing circuit has a range extending beyond 8 to 22 seconds."

Smithy leaned forward, picked up his mug and drank avidly.

"Now," he went on, "I'm going to work out the remainder of the reaction timer circuit."

The Workshop fell into an unaccustomed silence as Smithy once more worked at his note-pad. But not for long.

"Hey Smithy, I've got another little problem for you."

"Have you?" replied Smithy absently.

"Here's the situation," stated Dick. "At nightfall Anthony and Cleopatra are in a room and both are fit and well. When the morning comes, Cleopatra looks very pleased with herself, Anthony is dead and there's water on the floor. What's happened?"

"Blow me, I don't flaming well know."

"Think about it."

Reluctantly, Smithy put down his pen.

"It's beaten me," he said, his brow furrowed. "Tell me."

"The situation is easy to understand when you know about Anthony and Cleopatra."

"For goodness sake," snorted Smithy, "stop dragging it out. What's so special about Anthony and Cleopatra?"

"Anthony," replied Dick triumphantly, "is a goldfish and Cleopatra is a cat!"

"Ye gods," moaned Smithy, stricken. "And to think I was using up valuable brain power on a puzzle like that."

"I tell you," said Dick jubilantly. "If you want way-out riddles I'm the guy to come to."

"Let me," said Smithy hastily, "get back to this circuit of mine. It's nearly finished."

CONSTANT CURRENT

He was able to complete the circuit uninterrupted, after which he turned round to face his expectant assistant.

"Now," he remarked, "before I show you the complete circuit I want to say a bit more about the charging of a capacitor. What happens when a capacitor is charged via a resistor?"

"Blimey, Smithy, we've just been into that," said Dick impatiently. "The voltage across the capacitor rises."

"Yes," persisted Smithy, "but *how* does the voltage rise?"

"Oh," exclaimed Dick. "I see what you're getting at. Well, the voltage follows a curve where the rate of increase of voltage goes down with time. It's called an expectation curve!"

Smithy gazed at his assistant fondly.

"For an idiot," he remarked benevolently, "you are remarkably successful in stumbling on the right answer. The rate of increase of voltage does decrease with time, since the voltage across the series resistor reduces and the charging current goes down in proportion. But the curve, my lad, is known as an *exponential* one."

Dick beamed happily.

"I'm glad to be of help," he remarked modestly. "Just the odd word wrong now and again hardly detracts from my usefulness."

"Well, it doesn't much," qualified Smithy. "Right, tell me next what happens if, instead of using a series resistor, we charge the capacitor from a constant current source?" (Fig, 4(a).)

"Blimey," said Dick, frowning, "that's a tough one to spring on me out of the blue. If the capacitor is charged from a constant current source the charging current remains the same all the time, doesn't it?"

"It does."

"Then does the rate of increase in voltage stay the same, as well?"

"It does exactly that," confirmed Smithy. "When a capacitor is charged from a constant current source the voltage across it rises in linear form with time." (Fig. 4(b).)

"Stap me," said Dick. "I got that one right, too."

"I know you did," commended Smithy. "And now we'll get back to those coulombs I mentioned earlier on."

"I thought things were getting too easy!"

"A coulomb," said Smithy, ignoring his assistant's comments. "is simply a quantity of electricity. If a current of 1 amp flows by a certain point for 1 second we say that 1 coulomb of electricity has passed that point. In other words, a coulomb corresponds to 1 amp in 1 second. Now I said earlier that a capacitor of 1 farad has a

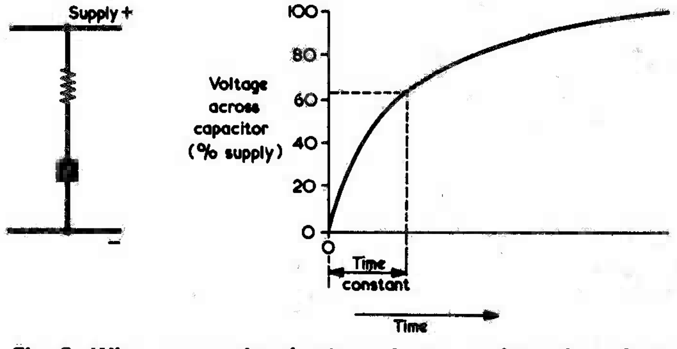


Fig. 3. When a capacitor is charged via a resistor the voltage across the capacitor rises as shown by the curve. As the voltage across the capacitor increases that across the resistor decreases, with a consequent reduction in charging current

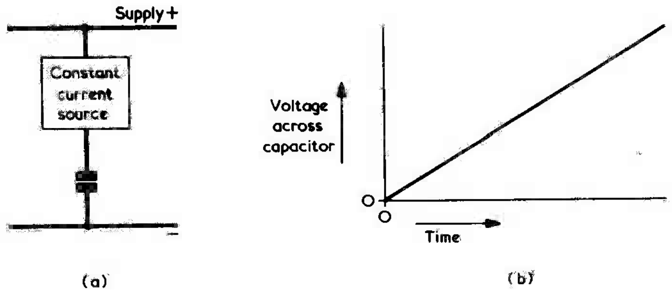


Fig. 4(a). Here, a capacitor charges via a constant current source

Fig. 4(b). The voltage across the capacitor rises in linear fashion with time

voltage of 1 volt across its plates when it stores 1 coulomb of electricity. Or, to be a little more precise, when the charge it holds is equal to 1 coulomb. Let's next say that we start off with a discharged capacitor of 1 farad and allow a charging current of 1 amp to flow into it for 1 second. What happens?"

"A voltage appears across its plates."

"How high a voltage? Remember that the charging current is 1 amp and it flows for 1 second."

"Then the capacitor," said Dick slowly, "must have taken up a charge of 1 coulomb. So the voltage across it will be 1 volt."

"Good," approved Smithy. "What happens if we let the charging current of 1 amp flow for another second?"

"The voltage will go up again," responded Dick brightly, "by another volt. It has to, because the voltage rise curve is linear with time, and we're applying a constant charging current."

"Excellent, excellent," pronounced Smithy, pleased. "And this now leads us to a delightfully neat and interlocked set of circumstances. If we apply a constant charging current of 1 amp to 1 farad we get a voltage rise across the capacitor of 1 volt per second. We will have the same result if we divide the current and the capacitance by the same figure. Thus, we get a linear voltage rise of 1 volt per second if we have a constant current of 1μA flowing into 1μF, a current of 10μA flowing into 10μF, 100μA into 100μF or 1mA into 1,000μF. The relationship ties together four separate quantities in a very simple manner, these being current, capacitance, voltage and time."

"Hey," said Dick, impressed, "that relationship really *is* something, Smithy. Isn't it funny how it works out so tidily?"

"Well, it isn't really," stated Smithy cautiously. "Actually, it's dependent upon the basic definition of the farad itself. But lots of people don't realise that the relationship exists because, like you, they get stuck at the coulomb bit. Anyway, having said all that, let me now show you this reaction timer circuit."

COMPLETE CIRCUIT

With a flourish, Smithy tore off the top sheet of his note-pad and laid it on the surface of his bench. Added to the original 555 timing circuit were a set of further components, including four transistors and a 0-100μA meter. (Fig. 5).

"Gosh, Smithy," gasped Dick. "This looks a bit complicated. I can at least recognise the 555 section, but I don't see how it fits into the rest of the circuit."

"This reaction timer," stated Smithy, "is designed to measure a person's reaction time to a stimulus. The stimulus here is the lighting of the l.e.d. which is driven by the 555. Now, there's no point in having a stimulus if you've got a good idea when it's going to appear and this is where the 555 circuit comes in. R2 should be fitted with a plain circular control knob and it is adjusted, preferably by someone other than the person taking the test, for any random setting within its range. The result is that the stimulus can appear at any time within the range of R2 after the reaction timer has been switched on. The switch which short-circuited the 100μF capacitor is now, incidentally, part of the overall on-off switch for the timer."

"What happens when the output of the 555 is high?"

"Obviously," stated Smithy, "the l.e.d. does not light. At the same time a current flows via R5 into the base of TR1, turning this transistor on and keeping capacitor C2 in the discharged condition. The 68Ω resistor, R6, is just another current limiting resistor."

"Fair enough," said Dick thoughtfully. "What occurs next is that, when the 555 output goes low the l.e.d. lights up, TR1 is turned off and capacitor C2 is able to charge."

"Youve got it," agreed Smithy. "The capacitor charges via a constant current from TR2. The base of TR2 is held at a fixed potential of about 1.2 volts negative of the positive supply rail by D1 and D2. The result is that there is about 0.6 volt between the emitter of TR2 and the positive supply rail, whereupon R8 is adjusted so that

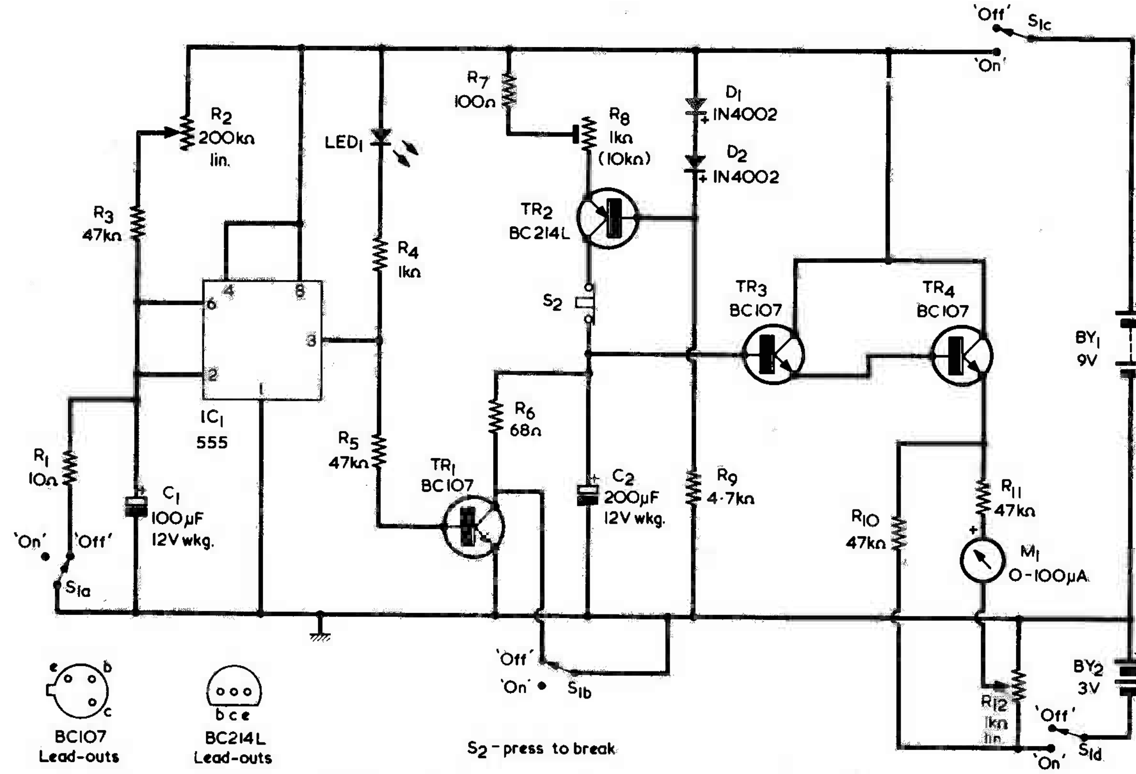


Fig. 5. The complete circuit of the reaction timer. R8, which may be a skeleton potentiometer, is given a temporary value of 10kΩ for setting-up purposes. The fixed resistors are all ¼ watt 5%, and S1 can be a 6-pole 2-way rotary switch with 2 poles unused. Current consumption from the 9 volt battery is initially 8mA, rising to 18mA when the l.e.d. is illuminated. Current drain from the 3 volt battery is 3mA

a constant current flows in TR2 emitter and, in consequence, its collector circuit."

"What is the constant current, Smithy?"

"Nominally, it's 1mA. As I said just now, 1mA into 1,000μF gives a voltage increase of 1 volt per second. What we want here, however, is an increase of about 5 volts per second, and we'll get this if we have 1mA going into one-fifth of 1,000μF, or 200μF. As you can see, C2 has that value."

"I think I'm getting the general gist of things," said Dick thoughtfully. "What are TR3 and TR4 for?"

"They're part of an electronic voltmeter circuit which is commonly used in home-constructor designs," replied Smithy. "The input impedance at the base of TR3 is in practice normally very high, higher in fact than that of a 741 i.c. used as a voltage follower. The voltage at the emitter of TR4 is 1.2 volt below that at the base of TR3, and TR4 emitter is coupled to R11 and M1, which form a voltmeter with a full-scale deflection of about 5 volts. The negative terminal of M1 is taken to the slider of R12, in order that the 1.2 volts lost in the base-emitter junctions of TR3 and TR4 can be compensated for. The result is a very high input impedance voltmeter with a range of zero to about 5 volts."

"You say about 5 volts," commented Dick. "Wouldn't it be better to have it give f.s.d. at exactly 5 volts?"

"There's no need," responded Smithy. "There are a lot of tolerances in the circuit which have to be taken up including, in particular, the wide tolerance of C2. So the circuit is set up, by adjusting R8, to take all these tolerances into account, including the tolerance in accuracy of the 0-5 voltmeter section."

"I get the idea," stated Dick. "Well, now you've explained all the bits just tell me how the complete circuit works."

"Right," said Smithy briskly. "We'll start by saying that the on-off switch is off. Both batteries are disconnected and both C1 and C2 are discharged. Turning the circuit on connects up the batteries, and takes the switch short-circuits off C1 and C2. C1 commences to charge, the output of the 555 is high and C2 is held in the discharged state by TR1. After a period depending upon the setting of R2, the 555 output goes low, causing the l.e.d. to light up and TR1 to turn off. Capacitor C2 now commences to charge with the voltage across it rising at a nominal rate of 5 volts per second. The person taking the test presses push-button S2 as soon as he can after the l.e.d. lights up. This cuts off the charging current to C2 and the voltage across this capacitor remains fixed. The voltage is read by the electronic voltmeter which then indicates, as a fraction of 1 second, the period of time which elapsed between the lighting of the l.e.d. and the pressing of S2."

A LITTLE CONSTRUCTION

"What takes place if you don't press S2? Or if you release it again after having pressed it?"

"The voltage applied to the electronic voltmeter continues to rise after f.s.d. at 1 second until it reaches about 8 volts. The meter needle is then right off scale, of course, but the overload is too small to cause any damage to it. If you switch off at S1, the circuit is ready for another go, with the two electrolytic capacitors discharged by S1(a) and S1(b)."

"Dash it all," said Dick unhappily. "I've just thought of a snag.

"What's that?"

"How in heck do you set up R8? This has got to be adjusted to take in all the tolerances you were talking about just now, but it would be impossible to adjust it by trying to time the circuit for a period of 1 second."

"There's a solution to that," said Smithy, glancing at his watch. "Look, we've still got half an hour of lunch break to go; so how do you feel about knocking up that circuit in a quick lash-up form?"

"Blimey," said Dick eagerly. "That would be a really great idea. I've got a bare old chassis knocking around with holes for the pots and the switches and I should be able to get the circuit together in no time at all."

Keenly, he snatched up Smithy's circuit and carried it over to his bench. There followed a purposeful bustle of activity as Dick collected together the components he required.

"Hey Smithy, what value should R8 have? You've shown 1kΩ for this but you've also put in 10kΩ in brackets."

"Fit a 10kΩ pot for the time being," instructed Smithy, "and keep a 1kΩ pot on one side for use later."

"Okeydoke."

Smithy relaxed as Dick worked away at his bench. Comfortably, he mused on the behaviour of his assistant and on how very obliging he could be at times.

"Hey Smithy!"

"Hello."

"There's this chap who lives in a flat on the thirteenth floor of a high-rise block. Every morning he gets into the lift on the thirteenth floor, goes down to the ground floor then proceeds to work. Every evening he gets back from work, enters the lift on the ground floor, takes it up to the tenth floor, gets out and walks up the stairs of the last three floors. Why is this?"

Smithy's mood of lazy euphoria evaporated. He glanced irritably at his assistant's back.

"Is there something wrong with the lift?"

"Nope," replied Dick, cheerfully, "it's perfectly serviceable."

Smithy grunted and drank his tea. He was now lumbered with the latest of Dick's unwelcome problems and he would not be able to settle until he knew the solution. Dick worked away happily, unaware of the discomfiture he had created behind him. The minutes passed.

"I've nearly finished," he called out. "There are only a few more parts to wire in."

Smithy could not restrain himself.

"All right," he said resignedly, "put me out of my misery. Why does this bloke only go up to the tenth floor in the evenings?"

"He's a midget," explained Dick. "He can't reach higher than the tenth floor button in the lift!"

"Dear oh dear," complained Smithy wearily. "I suppose I asked for it."

SETTING UP

"Your reaction timer's all complete," pronounced Dick a little later, as he placed his soldering iron back on its rest. "Come over and have a look."

Smithy rose and walked over to inspect his assistant's handiwork. Despite the speed with which Dick had worked the results, for a temporary assembly, were very creditable.

"Okay," said Smithy, "we'll start setting it up now. Put R8 to a central setting, connect up the batteries and switch on."

Dick proceeded to carry out Smithy's bidding. The 0-100μA meter at once gave a reverse reading. Smithy leaned forward and adjusted R12 so that the meter indicated zero. Suddenly the l.e.d. lit up and the meter needle moved relatively slowly to the right. Smithy pressed S2, and the meter needle remained frozen at a mid-scale position. He released S2, and the needle continued its movement to the right. The Serviceman switched off at S1.

"That meter needle moved rather slowly, didn't it?" queried Dick critically. "It was far too slow to correspond to a timing period of 1 second at full-scale."

"What we want to do at this stage," explained Smithy, "is to obtain full-scale deflection after 10 seconds. It will be quite easy to adjust R8 for a period of 10 seconds, as I'll show you now."

Smithy sat down and switched on the timer again. He placed his watch on the bench. After a period the l.e.d. once more lit up and Smithy judged the period taken for the meter to read f.s.d. He then picked up a length of wire and short-circuited the emitter and collector of TR1. The meter reading fell to zero and Smithy gave R8 a small adjustment. He removed the short-circuit and timed the period in which the meter needle travelled to its f.s.d. reading again. After half a dozen experimental adjustments of R8, with the emitter and collector of TR1 initially short-circuited in each case, he was finally satisfied that the timing period was as close to 10 seconds as he could make it. (Fig. 6).

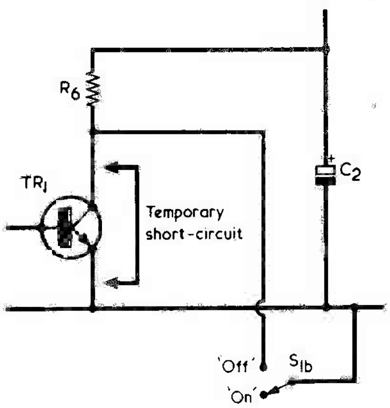


Fig. 6. Smithy adjusted R8 (with a value of 10kΩ) for a period of 10 seconds, discharging C2 before each run by placing a temporary short-circuit across the collector and emitter of TR1

"Right," he said. "The constant current source is now giving a current which, when presented to the other components in the circuit, gives a time period of 10 seconds. We'll next measure that current. Nominally, it's 0.1mA, but we'll probably find in practice that it's quite some way removed from this. Testmeter, please!"

Dick passed over the meter. Smithy switched this to an appropriate current range, switched off the timer and applied the test prods between the negative rail and the collector of TR2. He next pressed S2 and switched on again. The meter gave a reading of 0.14mA. He switched off the circuit, disconnected the meter, then released S2. (Fig. 7).

"That's it," he remarked. "With the components we have here a constant current of 0.14mA gives 10 seconds, and it follows that the current needs to be 10 times this for 1 second. So what we do now is fit the 1k pot in the R8 position and adjust this for a constant current of 1.4mA. You can do that, Dick."

Smithy watched as Dick replaced the potentiometer. Initially he adjusted the 1kΩ potentiometer to insert maximum resistance into circuit then, using the same approach as had just been employed by Smithy, Dick connected the testmeter and adjusted R8 for a current reading of 1.4mA. He switched off, disconnected the meter leads and released S2.

"Okay," said Smithy, "we're all ready to check our reaction times now. You go first, Dick."

Smithy made a random adjustment to R2 and then switched on the circuit. Dick waited expectantly for the l.e.d. to light up. As soon as it did he pressed S2. The meter indicated 26μA, corresponding to 0.26 second.

"Not bad," stated Smithy. "Try again."

On successive attempts, Dick achieved scores of 0.28, 0.29, 0.27 and, on the final attempt, a praiseworthy 0.24 seconds.

"Right," said Smithy confidently, "I'll have a go now."

To his fury, Smithy's scores averaged at 0.32 second. He obtained readings of 0.34, 0.35, 0.30 and 0.29.

FINAL RIDDLE

"There you are," jeered Dick triumphantly, "my reactions are quicker than yours and this circuit *proves* it. I'm quicker than you with problems and I'm quicker than you with actual reaction times!"

"All right, all right," said Smithy crossly. A gleam came into his eyes. "Just a minute, though. I've thought of a problem which I'll put to you for a change."

"Fire away!"

Smithy took out his pen and drew three resistors on the edge of his circuit diagram. (Fig. 8(a).)

"There are three equal value resistors here," he stated. "each with a value of R ohms. What's the total resistance between points X and Y?"

"That's easy," scoffed Dick. "It's 3R."

Smithy added a line to his diagram. (Fig. 8(b).)

"And now?"

"Well," said Dick somewhat uneasily, "the resistance between X and Y is R ohms."

Smithy added a second line. (Fig. 8(c).)

"And what," he asked, "is the resistance between X and Y now?"

Dick looked at Smithy's little circuit and scowled in anguish.

"Hey Smithy, you aren't playing fair! For the life of me I can't tell what the resistance is!"

"Then," said Smithy gently, "I'll have to tell you what it is when we have our next gen session together."

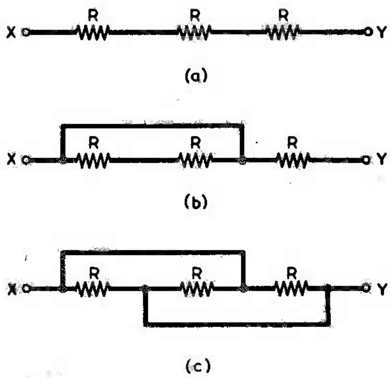


Fig. 8. Smithy's little poser. He first drew the three equal value resistors in (a), then added the circuit line in (b). Finally he added the second line in (c). What is the resistance between X and Y?

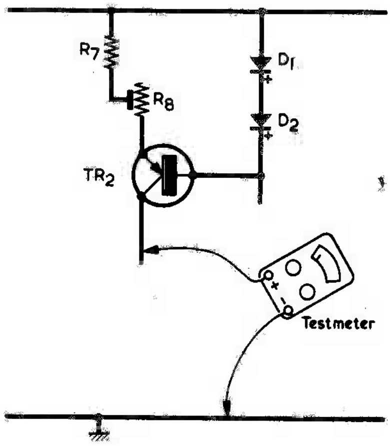


Fig. 7. Smithy next measured the constant current from TR2 corresponding to the 10 second period. R8 was then changed to 1kΩ and adjusted for a constant current 10 times greater, to give a period of 1 second. Smithy took care to ensure that the meter could not connect accidentally across C1 when the latter was charged

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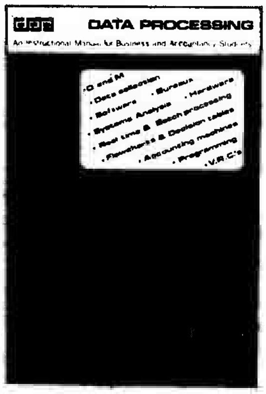

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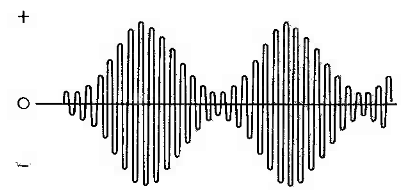
If we pick up this signal by means of the circuit in (b) and apply it to a pair of headphones we shall hear nothing. The headphones cannot reproduce (and we could not in any case hear) the high frequency r.f., but they will respond to the average content of the signal. Since the signal is symmetrical about the centre zero line the average voltage is also zero.

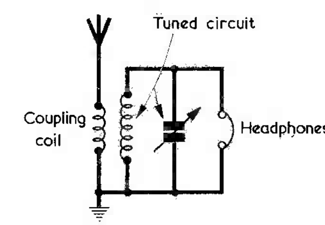
In (c) we insert a diode between the tuned circuit and the headphones. This allows only the positive half-cycles of the radio signal to be applied to the upper terminal of the headphones, as in (d). Because the signal is not now symmetrical about the centre zero line its average value, which is shown in broken line, varies. This average voltage corresponds with the modulating audio frequency and will be reproduced by the headphones.

The headphones will similarly reproduce the modulating signal if the diode is connected the other way round. This time, negative half-cycles of the radio signal would be applied to the upper terminal of the headphones, and again their average voltage would correspond with the modulating audio frequency.

When used in this manner a diode is referred to as an a.m. detector. Other devices which cause the r.f. signal waveshape to be no longer symmetrical about the centre zero line can also function as a.m. detectors.



(a)



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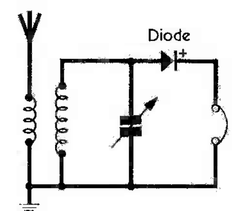

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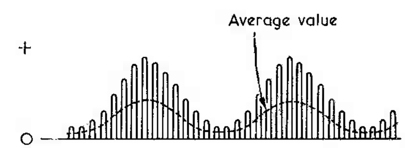

(d)

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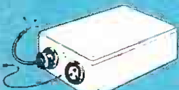
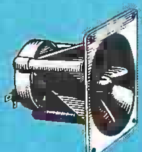
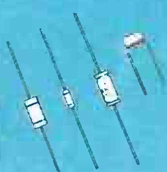

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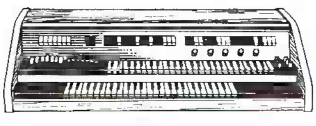

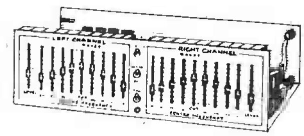

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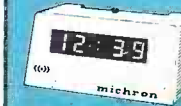
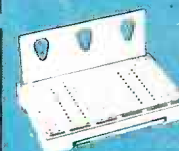

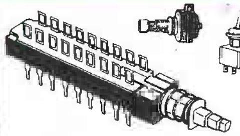

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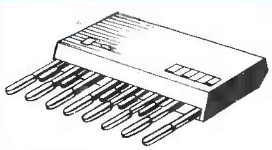

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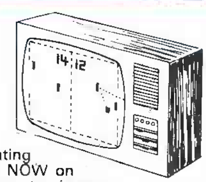

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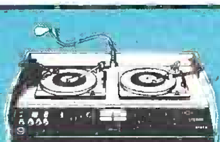

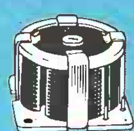




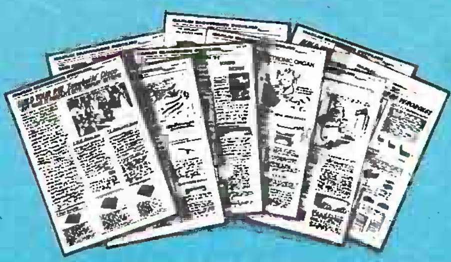

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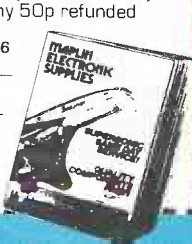

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