RADIO & ELECTRONICS CONSTRUCTOR

SEPTEMBER 1976

35p

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RADIO & ELECTRONICS CONSTRUCTOR

SEPTEMBER 1976
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Incorporating The Radio Amateur

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OCTOBER ISSUE WILL BE PUBLISHED ON 1st OCTOBER

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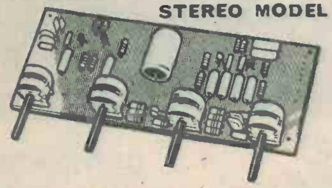

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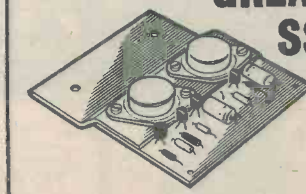

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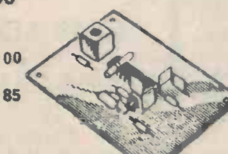

SS.202

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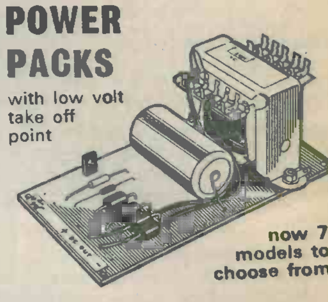
with low volt take off point



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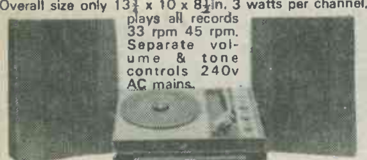

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BOXES — Grey polystyrene 61 x 112 x 31mm, top secured by 4 self tapping screws **32½p**
Clear perspex sliding lid, 46 x 39 x 24mm **10p**
ABS, ribbed inside 5mm centres for P.C.B., brass corner inserts, screw down lid, 50 x 100 x 25mm orange **48p**; 80 x 150 x 50mm black **70p**; 109 x 185 x 60mm black **£1.04**

ALUMINIUM

3" x 2" x 1"	**39p**	4" x 2½" x 2"	**44p**	8" x 6" x 3"	**£1.02**
2¾" x 5¼" x 1½"	**45p**	4" x 5¼" x 1½"	**45p**	10" x 4½" x 3"	**£1.02**
4" x 4" x 1½"	**45p**	6" x 4" x 2"	**65p**	12" x 5" x 3"	**£1.20**
4" x 2¾" x 1½"	**45p**	7" x 5" x 2½"	**79p**	10" x 7" x 3"	**£1.22**
				12" x 8" x 3"	**£1.50**

SWITCHES

Pole	*Way*	*Type*	
4	2	Sub. Min. Slide	**18p**
6	2	Slide	**20p**
4	2	Lever Slide	**15p**
2	2	Slide	**10p**
1	3	13 amp small rotary	**12p**
2	2	Locking with 2 to 3 keys	**£2.00**
2	1	2 Amp 250V A.C. rotary	**28p**

Wafer Rotary, all types **30p**
S.P.S.T. 10 amp 240v. white rocker switch with neon. 1" square flush panel fitting **65p**
S.P.S.T. dot 13 amp, oblong, push-fit, rocker **18p**

AUDIO LEADS
5 pin din plug 180° both ends 1½ Mtr., **£1.20**
3 pin din to open end, 1½ yd twin screened **35p**
Phono to Phono plug, 6ft. **35p**

COMPUTER AND AUDIO BOARDS
VARYING PANELS WITH ZENER, GOLD BOND, SILICON, GERMANIUM, LOW AND HIGH POWER TRANSISTORS AND DIODES, HI STAB RESISTORS, CAPACITORS, ELECTROLYTICS, TRIMPOTS, POT CORES, CHOKES ETC.
3lb for **85p** + **85p** post and packing
7lb for **£1.95** + **£1.20** post and packing

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

3" Tape Spools **8p**
1" Terry Clips **4p**
12 Volt Solenoid **30p**

KNOBS
SILVER METAL PUSH ON WITH POINTER, OR WHITE PLASTIC, GRUB SCREW WITH GOLD CENTRE **8p** EACH

ENM Ltd. cased 7-digit counter 2¼ x 1¾ x 1¼" approx. 12V d.c. (48 a.c.) or mains **£1.00**

ZM1162A INDICATOR TUBE
0-9 Inline End View. Rectangular Envelope 170V 2·5M/A **£2.67**

REGULATED TAPE MOTOR
9v d.c. nominal approx 1½" diameter **80p**

12v 8 amp transformer **£4.00 (p&p 85p)**

Ferric Chloride, Anhydrous mil. spec. 1lb. bag **65p**

RESISTORS

⅛–¼–½ watt .. **1p**
1 watt **3p**
Up to 5 watt wire **11p**
10 watt wire wound **12p**
15 watt **12p**
1 or 2% five times price.

Semiconductor Data Book 263 pages. Covers 2N21 through to 2N5558 plus some 3N's. Type/connection/parameter details **£1.95** No VAT

POTS
Log or Lin carbon **16p**
Switched **31p**
Dual Pots **50p**
Dual & switch .. **69p**
Lin wirewound **25p**
Slider Pot ... **43p**
Dual Slider ... **55p**
1.5m Edgetype **8p**

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

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

Boxed GEC KT88 valve **£2**

JAP 4 gang min. sealed tuning condensers New **35p**
Ex-eqpt. 2 or 4 gang **20p**

ELECTROLYTICS MFD/VOLT. Many others in stock

MFD	Up to 10V	25V	50V	70– 75V	100V	200– 250V	300– 350V	450– 500V
10	4p	5p	6p	8p	10p	12p	16p	20p
25	4p	5p	6p	8p	10p	15p	18p	20p
50	4p	5p	6p	9p	13p	18p	25p	—
100	5p	6p	10p	12p	19p	20p	—	—
250	9p	10p	11p	17p	28p	—	85p	£1
500	10p	11p	17p	24p	45p	—	—	—
1000	13p	22p	40p	75p	—	£1.50	—	—
2000	23p	37p	45p	—	—	—	—	—

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

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

INDICATORS
Bulgin D676 red, takes M.E.S. bulb **30p**
12 volt or Mains neon, red pushfit **18p**
R.S. Scale Print, pressure transfer sheet **10p**

CAPACITOR GUIDE – maximum 500V
Up to .01 ceramic **3p.** Up to .01 poly **4p.** .013 up to .1 poly etc. **5p.** .12 up to .68 poly etc. **6p.** Silver mica up to 360pF **8p**, then to 2,200pF **11p**, then to .01 mfd **18p.**
Many others and high voltage in stock.

8p. .1/600: **12p.** .01/1000, 1/350, 8/20, .1/900, .22/900, 4/16. .25/250 AC (600vDC) .1/1500 **40p.** 5/150, 9/275AC, 10/150, 15/150, 40/150.

FORDYCE DELAY UNIT
240 volt A.C./D.C. Will hold relay, etc., for approx. 15 secs after power off. Ideal for alarm circuits, etc. **£1.50**

CONNECTOR STRIP
Belling Lee L1469, 4 way polythene. **6p each**

1¼ glass fuses 250 m/a or 3 amp (box of 12) **24p**
Bulgin, 5mm Jack plug and switched socket (pair) **30p**

1" or 1¼" or 2" or ¾" CAN CLIPS 6p

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

5¼" x 2¾" Speaker, ex-equipment 3 ohm **30p**
2 Amp Suppression Choke **8p**
PAXOLINE
3 x 2½ x 1/16" .. **4p**
4⅝ x ½ x ⅛", .. **1p**
PCV or metal clip on MES bulb Holder **4p**
VALVE RETAINER CLIP, adjustable **2p**

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

12 volt 250M/A or 6 volt ½A Transformers **£1.00**
Whiteley Stentorian 3 ohm constant impedance volume control way below trade at **80p**
Drive Cord ... ... **2p per yd.**

THE RADIO SHACK

161 ST. JOHNS HILL, BATTERSEA, LONDON S.W.11
Open 10 a.m till 7 p.m. Monday to Saturday
Terms: Payment with order **Telephone: 01-223 5016**

SEMICONDUCTORS

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

AC107	16p
AC128	10p
AC176	11p
ACY28	19p
AD149	40p
AD161/2	32½p
AF116	16½p
AF124	22p
AF126	19p
AF127	26p
AF139	20p
AF178/80/81	40p
AF239	34p
ASY27/73	31p
BC107A or B	11p
BC107/8/9	6p
BC108A/B/C/109B/C	10p
BC147/8/9	6½p
BC148A/B,	8p
BC148A/B/C, 9B/C/S.	9p
BC157/8/9	6½p
BC158A/B	11p
BC159B/C. 157A	12p
BC178A/B	12p
BC179B	19p
BC184C/LC	10p
BC186	22p
BC187	24p
BC213L/214B	10p
BC216B	8p
BC327/8	12p
BC337	11p
BC338	11p
BC547/B/BA	10p
BC557/8/9	9p
BCX32/36	12p
BCY40	90p
BCY70/1/2	12p
BD112/3	50p
BD115/6	31p
BD131/2	32½p
BD133	35p
BD135	21p
BD137	24p
BD139	37p
BD142	53p
BD201/3	£1.30
BD202	79p
BD204	£1.00
BD232	60p
BD234	49p
BD235	49p
BDX77	£1.40
BF115	18½p
BF167/173	10p
BF178	24p
BF179	26p
BF180/1/2	16p
BF183	28p
BF184/5	18p
BF194/5/6/7	6½p
BF194A/195C	10p
BF200	25p
BF258	19p
BF262/3	30p
BF336	27p
BFS28 Dual Mosfet	£1.36
BFW10 F.E.T.	61p
BFW11 F.E.T.	52p
BFW30	£1.35
BFW57/58	17p
BFX12	23p
BFX29	18p
BFX30	25p
BFX84/88	17p
BFX89	40p
BFY51/2	14p
BFY90	65p
BR101	41p
BRY39	26p
BRY56	32½p
BSV64	40p
BSV79/80 F.E.T.'s	£1.00
BSV81 Mosfet	90p
BSX20/21	15p
BSY40	40p
BSY95A	12p
BU105-01	£1.60
CV7042 (OC41, OC44 ASY63)	12p
GET111	69p
OC45	48p
ON222	30p
TIP30	43p
TIP3055	46p
TIS88A F.E.T.	23p
ZTX300	5p
ZTX341	20p
2N393/MA393	30p
2N456A	60p
2N929	14p
2N987	40p
2N1507/2219	15p
2N2401	25p
2N2412	88p
2N2483	23p
2N2904/5/6/7/7A	15p
2N3053	10p
2N3055 R.C.A.	60p
2N3704	8p
2N3133	17p
2N4037	34p
2N5036	60p
2SA141/2/360	31p
2SB135/6/457	20p
40250	54p

OTHER DIODES

1N916	5p
1N4148	2p
BA145	15p
Centercel	24p
BZY61/BA148	10p
BB103/110 Varicap	23p
BB113 Triple Varicap	37p
BA182	13p
OA5/7/10	15p
BZY88 Up to 33 volt	7p
BZX61 11 volt	19p
BR100 Diac.	15p

INTEGRATED CIRCUITS

TAA700	£2.00
723 reg (TO99)	45p
741 8 pin d.i.l. op. Amp	18½p
TAD100 AMRF	£1.30
CA3001 R.F. Amp	50p
TAA300 1wt Amp	£1.20
NE555v Timer	35p
TAA550 Y or G	22p
TAA263 Amp	65p
7400/10	9p
7402/4/20/30	11p
7414	50p
7438/74/86	24p
7483	69p
LM300, 2-20 volt	£1.50
74154	£1.00

BRIDGE RECTIFIERS

Amp	Volt		
½	1,600	BYX10	30p
1	140	OSH01-200	26p
1.4	42	BY164	40p
0.6	110	EC433	15p
5	400	Texas	90p

RECTIFIERS

	Amp	Volt	
IN4004	1	400	4p
IN4005/6	1	6/800	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
BYX38-600	2.5	600	55p
BYX38-300R	2.5	300	50p
BYX38-900	2.5	900	60p
BYX38-1200	2.5	1,200	65p
BYX49-600	2.5	600	55p
BYX49-300R	2.5	300	26p
BYX49-900	2.5	900	40p
BYX49-1200	2.5	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
BYX46-300*	15	300	£1.00
BYX46-400*	15	400	£1.50
BYX46-500*	15	500	£1.75
BYX46-600*	15	600	£2.00
BYX20-200	25	200	60p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.50

Avalanche type

TRIACS

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

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

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

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

DLI Pal Delayline 50p

Relay socket 40p
Take miniature 2PCO relay

B7G or B9A valve can 9p

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

OPTO ELECTRONICS

BPX40	65p
BPX42	£1.00
BPY10	£1.00

(VOLTIAC)

BPY68, BPY69, BPY77 Diodes £1.00

Photo transistor
BPX29 £1.00
OCP71 65p

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

RED	11p
ORANGE	19p
GREEN	14p
YELLOW	14p
CLIP	2p

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp £1.00

THYRISTORS

Amp	Volt		
1	240	BTX18-200	40p
1	400	BTX18-300	50p
1	240	BTX30-200	40p
15	500	BT107	£1.60
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	2BT10 (Less Nut)	£3.00

.3" red 7 segment L.E.D. 14 D.I.L. 0-9+D.P. display 1.9v 10m/a segment, common anode 68p
DL747.6" £1.50
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
Holdersorpads 50pper100

PAPER BLOCK CONDENSER

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

I.C. extraction and insertion tool 32p

METAL CHASSIS SOCKETS

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

Multicore Solder 18SWG 3p per foot

ENAM. COPPER WIRE

SWG.	PER YD.
20-24	3p
26-42	2.5p

GARRARD

GCS23T or GP93/1 Crystal Stereo Cartridge £1.50

HANDLES

Rigid light blue nylon 6¼" with secret fitting screws 8p

Belling Lee white plastic surface coax outlet box 43p

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

TO3 HEATSINK

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

Tested unmarked, or marked ample lead ex new equipment

ACY17-20	8p	OC71/2	5p
ASZ20	8p	OC200-5	20p
ASZ21	30p	TIC44	24p
BCT86	11p	2G240	2-50
BCY30-34	10p	2G302	15p
BCY70/1/2	8p	2G401	15p
BF115	10p	2N711	25p
BY127	9p	2N2926	7p
HG1005	10p	2N598/9	6p
HG5009	3p	2N1091	8p
HG5079	3p	2N1302	8p
L78/9	3p	2N1907	2-50
M3	10p	Germ. diode	1p
OA81	3p	GET120 (AC128 in 1" sq. heat sink)	25p
OA47	3p		
OA200-2	3p	GET872	12p
OC23	20p	2S3230	30p

8 way Cinch standard 0.15 pitch edge socket 30p

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

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

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

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

3.5mm STEREO PLUG Metal screened 35p

Philips electronic engineer kits add on series E1004 £1.00 each

RS Yellow Wander Plug Box of 12, 25p

Miniature Axial Lead Ferrite Choke formers 2p

RS 10 Turn Pot 1% 250, 500 Ω; 1K, 50K 11.50

Copper coated board 10" x 9" approx 48p

TIE CLIPS

Nylon self locking 7" or 3½" 2p

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

1lb Mixed bolts, nuts, washers etc. 45p

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

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

Sparkrite mk2

Capacitive discharge electronic ignition kit

* Smoother running
* Instant all-weather starting
* Continual peak performance
* Longer coil/battery/plug life
* Improved acceleration/top speeds
* Up to 20% better fuel consumption

Sparkrite Mk. 2 is a high performance, high quality capacitive discharge, electronic ignition system in kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in 15/30 mins.
Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, old, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors or the SCR. (Most capacitive discharge ignitions are not completely foolproof in this respect). All kits fit vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISES EVERYTHING NEEDED
Ready drilled pressed steel case coated in matt black epoxy resin, ready drilled base and heat-sink, top quality 5 year guaranteed transformer and components, cables, coil connectors, printed circuit board, nuts, bolts, silicon grease, full instructions to make the kit negative or positive earth, and 10 page installation instructions.

OPTIONAL EXTRAS
Electronic/conventional ignition switch.
Gives instant changeover from "Sparkrite" ignition to conventional ignition for performance comparisons, static timing etc., and will also switch the ignition off completely as a security device, includes: switch connectors, mounting bracket and instructions. Cables excluded.
Also available RPM limiting control for dashboard mounting (fitted in case on ready built unit).

CALLERS WELCOME. For Crypton tuning and fitting service – 'phone (0922) 33008.

PRICES INCLUDE VAT, POST AND PACKING.

Improve performance & economy NOW

POST TODAY!

Quick installation *No engine modification required*

Electronics Design Associates, Dept., REC/9
82 Bath Street, Walsall, WS1 3DE. Phone: (0922) 33652

Name ....

Address ....

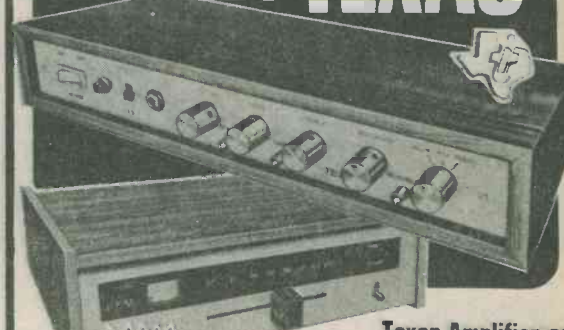
	QUANTITY REQ'D.
Mk. 2 DIY Ass. Kit @ £11.80	
Mk. 2 Ready Built Negative Earth @ £14.97	
Mk. 2 Ready Built Positive Earth @ £14.97	
Ignition Changeover switches @ £4.30	
R.P.M. Limit systems in above units @ £2.42	

I enclose cheque/PO's for £ ____________

Cheque No. ____________

Send SAE if brochure only required.

DESIGNED BY TEXAS



30,000 ALREADY SOLD

Texan Amplifier as featured by PRACTICAL WIRELESS
SOLE U.K. DISTRIBUTORS – HENRY'S

Build it yourself for only

£32 KIT PRICE INC. VAT + £1.00 p&p
Built and tested £42.00 inc. VAT + £1.00 p&p.

★ Can be built Stage by stage *Ask for leaflet 5.*
★ Everything necessary supplied. Full after sales service and guarantees.

Build the Texan stereo amplifier, then you can be doubly proud! For a start, you'll own a superb home entertainment unit. And have had all the pleasure of doing it yourself, with the Henry's kit.
Look at the Texan specification
Incorporating fully integrated stereo preamp and power amp, with 6 IC's, 10 transistors, 6 rectifiers and zener diodes. Plus stabilisied, protected circuitry, glass fib pcb; Gardeners low-field low-line mains transformer; all facilities and controls. Slim design, chassis 14½" x 6" x 2" overall. 20 watts per channel RMS, less than 0.1% distortion at 1 kHz.

TEXAN FM TUNER KIT £23.50 inc. VAT + 50p p&p
Built and tested £28.50 inc. VAT +50p p&p.
Build the matching Texan stereo tuner! Features advanced varicap tuning. Phase lock loop decoder. Professionally designed circuit. Everything you need is in the kit. From the glass fibre pcb to the cabinet itself. Excellent spec: 2.5 uV aerial sensitivity. 500 mV output (adjustable). Tuning range 87–102 MHz. Mains powered.
THE NATURAL FOLLOW-ON

VIDEO SPORT

An up-to-the-minute game.
Plugs into your own TV aerial socket. Switch on. And you're away! Choose your game – football, tennis or hole-in-the-wall. Absolutely safe. For you. Your children. And your TV. Mains powered. List Price £42.50
HENRY'S PRICE £25.00 inc. VAT + 50p p&p
★ OVER 10,000 ALREADY SOLD ★ IDEAL GIFT

DIGITAL 24 HOUR CLOCK

WITH BUILT-IN ALARM!

● SILENT RUNNING ● LARGE ILLUMINATED NUMERALS ● A.C. MAINS ● SIZE 6¾" x 2¾" x 2¾"

NORMALLY £24.00 WITH CASE

EXCLUSIVE HENRY'S PRICE **£6** — LOTS OF 3 £16.50 INC. V.A.T. and P&P

All you have to do is make a casing and you've got a £24.00 Digital Unit.

Also from Henry's MISTRAL DIGITAL CLOCK KIT £11.50 inc. VAT. 30p p&p

HENRY'S LATEST ELECTRONIC CATALOGUE **50p** + 20p carr/pack.

TRANSISTOR & VALVE DISCOUNT PRICE LIST over 2000 types SEND FOR YOUR FREE COPY

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(lower sales floor) 231 Tottenham Court Road.
Tel: 01-636 6681

PRECISION PETITE LTD

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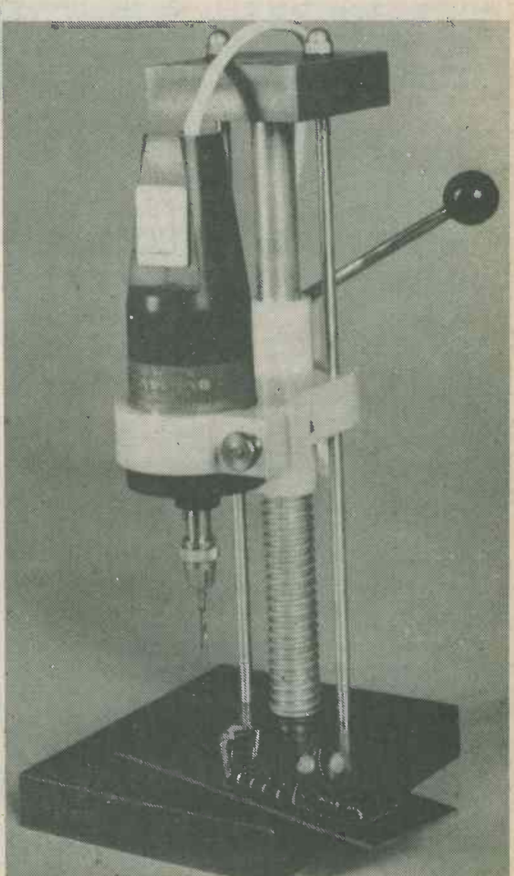
Tel: 01-977 0878

Have pleasure in introducing their Precision Tools from France for all types of electronic design and development, professional or amateur



THE ABOVE KIT IS AVAILABLE AS SEPARATES

	£ p	p&p
● Kit Complete as above	30.50	1.15
● Mk.II Drill Stand	4.00	35
● Mk.II Drill Only	8.00	35
● Flexible Shaft	5.00	25
● Transformer	5.50	70
● S.30 Kit (30 tools)	16.00	85
● S.10 Kit (10 tools)	12.50	65

(Any Quantity)

Replacement accessories	40p each	15p
Circular Saw Blade Sets (4)	£2.40	15p
Spare Collets	£0.40	15p
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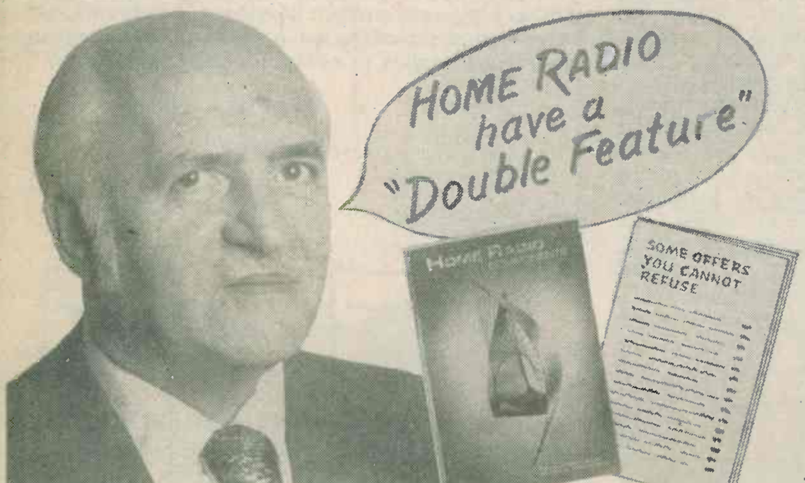

Perhaps you have to be of my vintage to know the phrase "a Double Feature," but up to a few years ago cinemas always ran a main film and a supplementary film. I was reminded of it because with their new catalogue Home Radio Components are now giving away a supplementary catalogue of bargain lines.

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TOYTOWN TRAFFIC LIGHT CONTROLLER

by J. R. Davies

By taking advantage of three 555 timer integrated circuits, this controller offers the four switching steps needed for lighting up a toy traffic light system.

The author was recently browsing through a catalogue of electronic components when he encountered a range of light-emitting diodes in red, yellow and green. It occurred to him that, as these colours correspond to the familiar red, amber and green of traffic control lights, it would be an amusing exercise to set up a switching system which automatically turned on two sets of l.e.d.'s in the standard traffic light sequence. The completed project could form an attractive gift for a youngster interested in model cars, and could also provide an entertaining and attention-catching display for the not-so-young whose professional or spare time pursuits are concerned with cars.

The sequence switching device described in this article is the outcome of the author's idea, and it employs three 555 timer i.c.'s, three transistors and a small number of other components, together with the red, yellow and green l.e.d.'s which function as the traffic lights. The circuit will accommodate any number of l.e.d.'s between one and four in each section by the choice of suitable series resistor values. For maximum realism, at least two l.e.d.'s per section will be required so that the traffic lights can face in four directions.

LIGHT SEQUENCE

Fig. 1 shows two sets of traffic lights at a crossroad junction, one set facing the North-South road and the other facing the West-East road. Starting with Red, each set will light up in the following sequence: Red, Red-and-Amber, Green, Amber, Red. Obviously, the North-South lights will be at Red when the West-East lights are at Green, and vice versa. In practice, there may be a delay after the lighting up of Red at one set before the appearance of Red-and-Amber and then Green at the other set but, at the risk of a few Toytown pile-ups, the switching can be considerably simplified by the exercise of a little judicious bending. With the present circuit it is assumed that the Amber after Green in one set of lights is coincident with the Red-and-Amber in the other set. Thus, Red (with Amber) becomes present at one set of lights when the other set changes from Green to Amber, and so a reasonable replica of actual working is achieved.

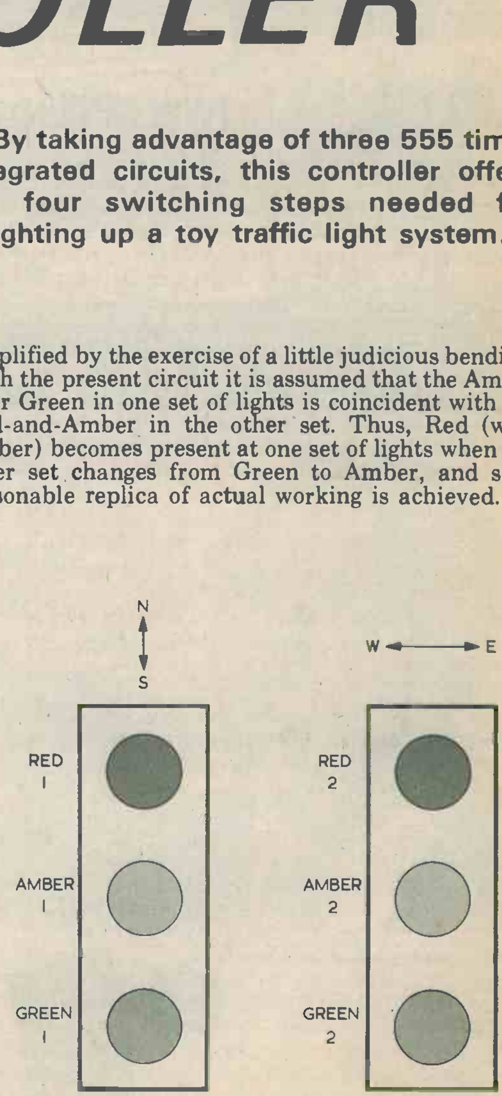


Fig. 1. Two sets of traffic lights at a crossroad junction

Toytown traffic hold up, as the cement carrier and ambulance wait for the green

Fig. 2 shows the sequences for the two sets of lights, and it will be noted that there are four switching steps in the cycle before it reverts to its initial state. From now on, we shall give the North-South lights the suffix 1, and the West-East lights the suffix 2. We shall also ascribe the colour Amber to yellow l.e.d.'s.

STEP	N-S LIGHTS	W-E LIGHTS
1	RED 1	GREEN 2
2	RED 1-AMBER 1	AMBER 2
3	GREEN 1	RED 2
4	AMBER 1	RED 2-AMBER 2
1	RED 1	GREEN 2

Fig. 2. Suitable switching steps for the two sets of lights

BASIC CIRCUIT

Fig. 3 shows a simplified circuit of the sequence switcher. Here, the blocks identified as "Red 2", "Grn 1", etc., represent the l.e.d. or l.e.d.'s in each set, together with their series resistors. IC1 is in a standard 555 multivibrator circuit and produces a near-square wave at its pin 3 which changes state at relatively long intervals. IC2 and IC3 are also 555 i.c.'s, and are employed without their discharge function. Pins 2 and 6 connect to the internal comparators and all that has to be remembered here is that when these two pins are taken lower than one-third of VCC the output at pin 3 goes high (i.e. close to the positive rail), and that when the two pins are taken above two-thirds of VCC the output at pin 3 goes low (i.e. close to the negative rail).

Let us commence examination at an instant when the output of IC1 goes high. This at once causes Red 1 to light up. Green 2 also lights up since TR2 is conductive. TR2 is conductive because, prior to the change at IC1 output, capacitor C3 had been held discharged via D1 and the output at pin 3 of IC3 is consequently high, causing base current to flow into TR2. As IC1 output goes high, a base current flows into TR3 and this turns on, discharging C2 and causing IC2 output to go high.

The circuit is now at Step 1 of Fig. 2, with Red 1 and Green 2 alight.

Since IC1 output is high, diode D1 is reverse biased and C3 commences to charge via VR3. VR3 has been previously set up such that the voltage across C3 reaches two-thirds of VCC a short time before the output of IC1 goes low. When the voltage across C3 has risen to two-thirds of VCC, the output of IC3 goes low, removing the base bias from TR2 and causing this transistor to become cut off. Green 2 extinguishes. The output of IC3 also causes both Amber 1 and Amber 2 to light up via D3, with D2 being reverse biased.

We have now reached Step 2 of the sequence. Red 1 and Amber 1 are lit up, as also is Amber 2.

The circuit remains in this state until the output of IC1 changes and goes low. At once Red 1 extinguishes and Red 2 lights up. C3 is rapidly discharged by way of D1, which is now forward biased, and the output of IC3 goes high. This causes a base current to flow into TR2, but Green 2 cannot be illuminated because its upper terminal is low. Since IC3 output goes high, Amber 1 and Amber 2 extinguish. Before the change in IC1 output, the output at pin 3 of IC2 was high. TR1 now becomes turned on, and Green 1 lights up.

We are now at Step 3 of the sequence, with Green 1 and Red 2 illuminated.

The charging of C2 was previously inhibited because TR3 was turned on. But TR3 is now turned off, allowing C2 to charge via VR2 (which has been previously set up in the same manner as VR3). A short time before the next change in output from IC1, the voltage across C2 reaches two-thirds of VCC and the output of IC2 goes low. Base bias for TR1 ceases and Green 1 extinguishes in consequence. Also,

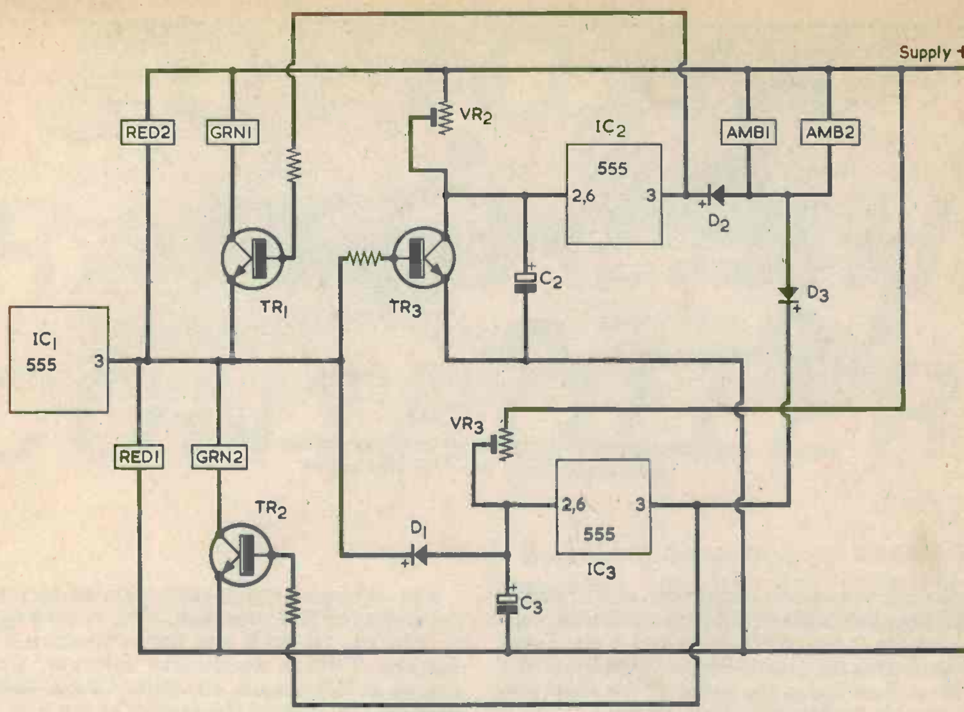


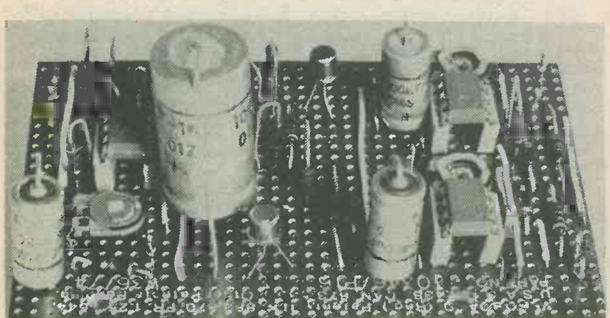
Fig. 3. Simplified circuit demonstrating the operation of the traffic light controller

Amber 1 and Amber 2 are lit up via D2, with D3 reverse biased.

Thus we now have Amber 1 lit up, together with Red 2 and Amber 2, this constituting Step 4 of the switching cycle.

The circuit stays in this state until the output from IC1 goes high again. Red 1 lights up, Red 2 extinguishes and TR3 is turned on. C2 discharges rapidly and the output of IC2 goes high with Amber 1 and Amber 2 extinguishing as a result. Green 2 also lights up because, with C3 previously inhibited via D1, the output of IC3 is high and TR2 is turned on.

Which is where we came in.



The controller components are assembled on a standard size Veroboard panel. The traffic lights are switched by three 555 timers and three transistors

FULL CIRCUIT

The full circuit diagram appears in Fig. 4. This is the same as Fig. 3 with components added for practical operation.

IC1 appears in an astable multivibrator circuit, with C1 charging via R1, R2 and VR1, and discharging via R2 and VR1. Since R1 is much lower in value than R2 and VR1 the output approaches a 50:50 square wave, this being particularly the case when VR1 inserts a high resistance into circuit. The cycle length can be adjusted by VR1 from roughly 7 seconds to 70 seconds. The shorter time periods are useful for circuit testing, and in practice a cycle length of about 30 to 40 seconds is adequate to demonstrate the changing of the lights without excessive waiting.

The blocks of Fig. 3 which represented the lights are now replaced by the actual l.e.d.'s. Two are shown at each position but, as already mentioned, there may be any number from one to four. The l.e.d.'s at each position are connected in series as indicated. The diagram also shows the series resistor values for different numbers of l.e.d.'s. These resistor values assume a forward voltage per l.e.d. of around 2.2 volts with a forward current of the order of 20mA.

TR1, TR2 and TR3 are switched in the same manner as in Fig. 3, but an extra 1k Ω resistor is added across each base and emitter. These extra resistors ensure that each transistor is fully cut off when the associated 555 output goes low, and guards against the (admittedly unlikely) possibility of an i.c. output not being adequately negative when in the nominal low state.

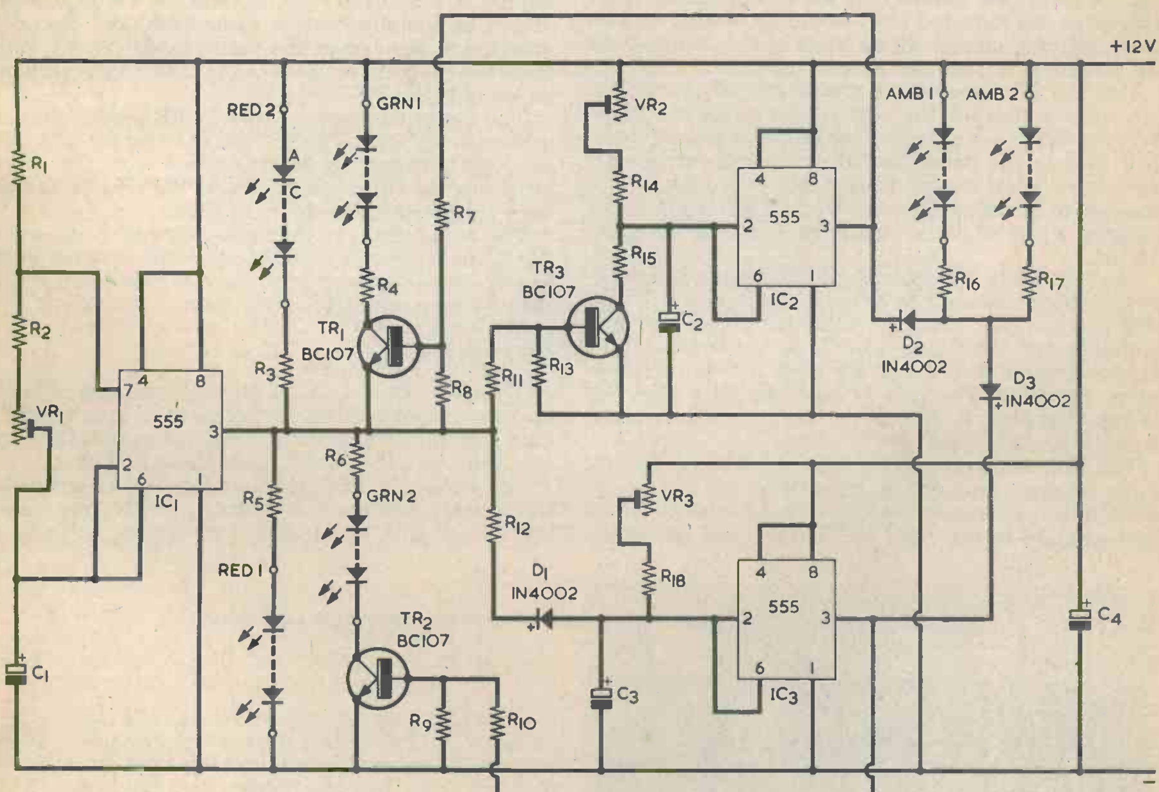
COMPONENTS

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)
- R1 4.7kΩ
- R2 47kΩ
- R3-R6 See Fig. 4
- R7 4.7kΩ
- R8 1kΩ
- R9 1kΩ
- R10 4.7kΩ
- R11 4.7kΩ
- R12 100Ω
- R13 1kΩ
- R14 22kΩ
- R15 100Ω
- R16 See Fig. 4
- R17 See Fig. 4
- R18 22kΩ
- VR1 470kΩ pre-set potentiometer, 0.1 watt, miniature horizontal
- VR2 220kΩ pre-set potentiometer, 0.1 watt, miniature horizontal
- VR3 220kΩ pre-set potentiometer, 0.1 watt, miniature horizontal

Capacitors
- C1 100μF subminiature electrolytic, 25V Wkg. (Mullard)
- C2 100μF subminiature electrolytic, 25V Wkg (Mullard)
- C3 100μF subminiature electrolytic, 25V Wkg. (Mullard)
- C4 1,000μF subminiature electrolytic, 16V Wkg. (Mullard)

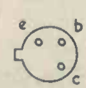
Semiconductors
- IC1 555
- IC2 555
- IC3 555
- TR1 BC107
- TR2 BC107
- TR3 BC107
- D1 1N4002
- D2 1N4002
- D3 1N4002
- Light-emitting diodes, red, yellow and green (see text)

Miscellaneous
- Veroboard, 0.1in. matrix, 2.5 x 3.75in.
- Veropins, 0.1in. (9 required)
- Hardware for light standards (see text)
- Wire, solder, etc.



R3, R4 / R5, R6 / R16, R17	1 L.E.D.	470Ω ½ watt
	2 L.E.D.'s	390Ω ¼ watt
	3 L.E.D.'s	270Ω ¼ watt
	4 L.E.D.'s	150Ω ¼ watt

Fig. 4. The full working circuit of the controller



BC107 Lead-outs

Resistors R12 and R15 are surge limiting resistors. R12 ensures that the maximum surge current which flows when C3 is discharged is about 110mA. Similarly, R15 limits discharge current to about the same value when TR3 discharges C2. VR2 and VR3 now have R14 and R18 in series to limit their range and to prevent excessive current flow in their tracks if they are set to insert a low resistance into circuit. R2, incidentally, performs a similar function in relation to VR1.

A low supply source impedance is essential, as a number of switching operations occur simultaneously, or nearly simultaneously, during the cycle. The low impedance is provided by C4. Constructors who like to build projects in stages, checking each stage when it is complete, are advised to ensure that C4 is in circuit at the outset.

No connections are made to any of the i.c. pins which do not appear in the circuit of Fig. 4.

VEROBOARD ASSEMBLY

The complete circuit fits comfortably on a piece of 0.1in. matrix Veroboard measuring 2.5 by 3.75in. This is a standard size and does not need to be cut from a larger piece. It should have 24 strips by 37 holes.

The component and copper sides of the board appear in Fig. 5. Since large sections of the circuit change from one polarity to the other, rather more link wires are required than would be needed in, say, an amplifying circuit where most of the components are straddled across two supply rails.

The two 6BA clear holes should initially be drilled out, after which all the cuts in the strips are made with the aid of a Vero spot face cutter or a small twist drill held in the hand. Visually check the cuts after they have been made. With 0.1in. Veroboard it is possible to occasionally miss a small sliver of copper bridging a cut which is fondly imagined to be open-circuit.

Next fit 0.1in. Veropins at all the points where external connections are to be made to the board. These pins are virtually essential with this project, as it is probable that the flying leads from the board will be moved around to a relatively large extent in subsequent handling. The copper could be torn from the s.r.b.p. backing if the flying leads were soldered directly to the strips.

The link wires are fitted after the Veropins. Link wires bridging more than three holes should be insulated, but shorter wires can be bare tinned copper. Immediately to the right of VR3 are two link wires which lie alongside each other. These two wires must both be insulated.

The three diodes, the three potentiometers and all the resistors and capacitors are next soldered in. Note that the potentiometers are miniature types having 0.2in. spacing between track tags and 0.4in. spacing between track and slider tags. After these, the three transistors are connected to the board. Finally to be mounted are the integrated circuits. The author fitted these to short 4-way lengths of 0.1in. connection strip in the prototype, these effectively forming i.c. holders, but the integrated circuits can alternatively be soldered directly to the board.

When assembly has been completed, check for short-circuits between the supply rails by connecting an ohmmeter across the supply rail pins. After an initial charging surge in C4, the resistance reading should rise well above 1k Ω if the ohmmeter test prods are applied with a polarity that agrees with that of C4. In other words, check with the test leads connected one way round and then transpose them; the higher reading is the correct one. A careful visual examination should also be made, looking in particular for short-circuits between strips.

The completed board may be housed in any convenient plastic or home-made wooden case. If it is to be powered by a battery, an on-off s.p.s.t. toggle switch may be inserted in series with the positive supply lead. Should it be desired that a mains power supply be employed both this and the Veroboard panel can be installed in the same case, and the on-off switch will then be in the mains input circuit. Wires from the case will connect to the traffic light standard or standards.

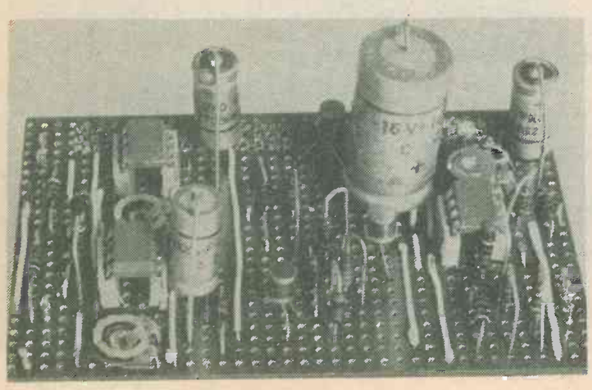
The board can be mounted by 6BA bolts and nuts at the two 6BA clear holes. It is in order for 6BA nuts, used for spacing, to be in contact with the copper strips, as the three strips around the 6BA clear holes have no connections made to them.

The connections to the light-emitting diodes are as illustrated in Fig. 5. Four connections external to the board are taken from a positive supply point, and a fifth from a negative supply point.

SETTING UP

To check the circuit the requisite number of l.e.d.'s may be temporarily connected up to it. It is helpful to have the l.e.d.'s soldered to tagstrips so that they take up positions approximating to those in Fig. 1.

The three pre-set potentiometers are all connected into circuit such that the timing periods they control increase as they are adjusted clockwise. Initially set



The Veroboard panel, as seen from the other side

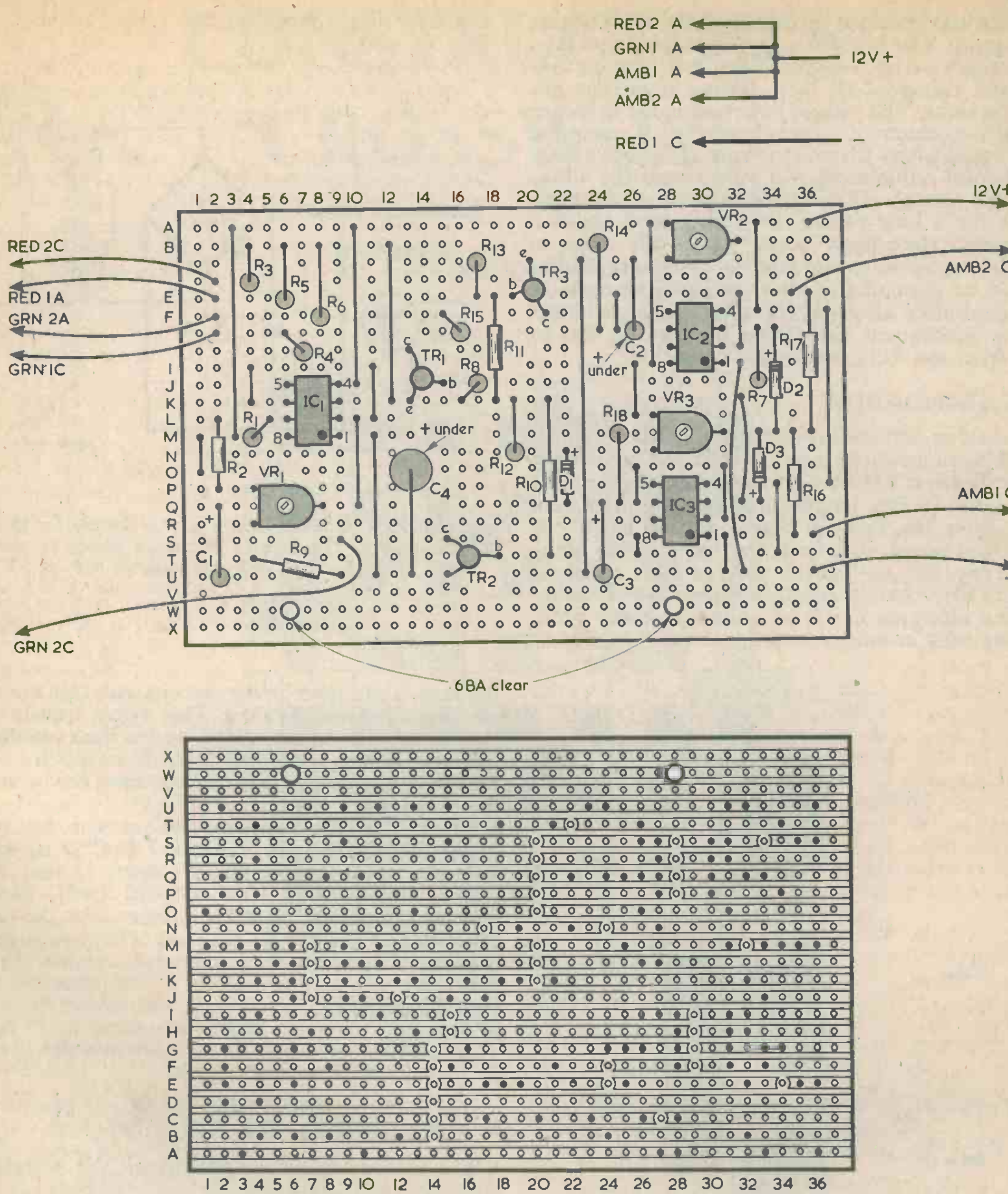


Fig. 5. The controller is assembled on a Veroboard panel as shown here

VR1 nearly fully anti-clockwise and set VR2 and VR3 to approximately mid-travel, then switch on. After an initial charging period for C1, during which Red 1 and Green 2 will light up, the circuit will settle down to alternate illumination of Red and Green l.e.d.'s.

VR2 is next adjusted. This controls the start of illumination in Amber 1 and Amber 2 after Green 1. As this control is adjusted anti-clockwise, Green 1 will be followed by Amber 1 and Amber 2, and a final setting is needed in VR2 which gives the Amber period the correct length.

VR3 may next be adjusted, and this controls the lighting of Amber 1 and Amber 2 after Green 2. It is adjusted in the same manner, and for the same length of Amber period, as VR2.

These adjustments will check that the circuit is working satisfactorily. As the switching will now be relatively rapid, VR1 may be adjusted for the final cycle period, after which VR2 and VR3 are adjusted for the corresponding Amber periods.

To take up variations within tolerance of the timing capacitances, VR1 is given a slightly larger value than would otherwise be required. Should it happen that the actual values of all three timing capacitors are about the same, VR1 should not be adjusted to higher than three-quarters of its maximum value, since the Amber periods may then be too long. However, a little experimental adjustment will soon reveal the situation in this respect. If the timing capacitors have been in stock for a long period, they may need about a dozen runs before they "form" and settle down to their final capacitance and internal resistance values. It should be remembered that the first half-cycle in IC1 immediately after switching on is always longer than the subsequent half-cycles because C1 has to charge from the fully discharged condition.

LIGHT STANDARDS

The making and scaling of the standards on which the l.e.d.'s are mounted is left to the constructor's ingenuity. "Lantex" (s.r.b.p.) tubing is available from Home Radio in 6in. lengths with outside diameters ranging from ¼in. to more than 1in., and lengths of such tubing could well form the basis of the standards. They will need to be painted with alternate white and black bands. Another approach can consist of putting alternate bands of white and black p.v.c. insulating tape around the standards. The wiring to the l.e.d.'s can then be carried out with thin enamelled wire of around 30 s.w.g. This wiring travels down the *outside* of each standard, and is then covered by the tape. Wiring in this manner will be much simpler than is given by passing the wires down the centres of the standards.

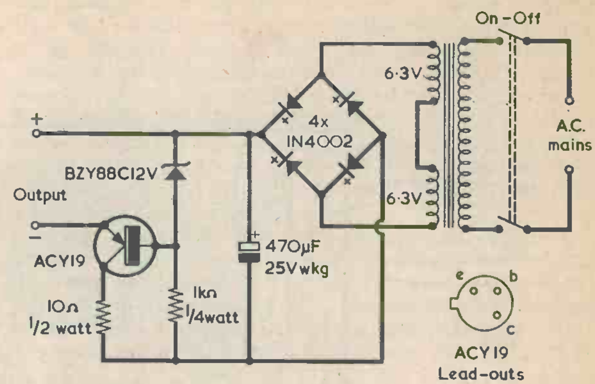


Fig. 7. A suitable mains power supply for the controller. The output connects direct to the positive and negative rails of Fig. 4

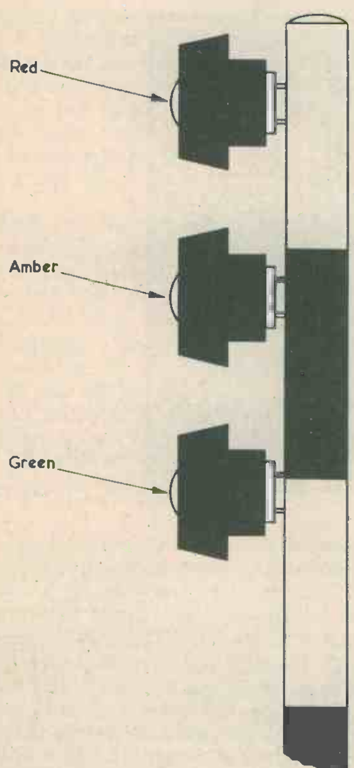


Fig. 6. As is explained in the text, l.e.d.'s with panel mounting bushes offer a fair approximation to actual traffic lights

The l.e.d.'s may be of any size considered suitable. A possible choice here is the "L.E.D.4" types with a diameter of 5.1mm. available from Doram Electronics under Code Nos. 586-475 (red), 586-481 (green) and 586-497 (yellow), These have the anode connected to the shorter lead-out. They are supplied with panel mounting bush assemblies which, if fitted over the l.e.d.'s, approximate to the appearance of traffic light hoods, as in Fig. 6. As mentioned earlier, all the l.e.d.'s in each section are wired up in series. Thus, all the North-South l.e.d.'s are in series circuits, as are all the West-East l.e.d.'s.

POWER SUPPLY

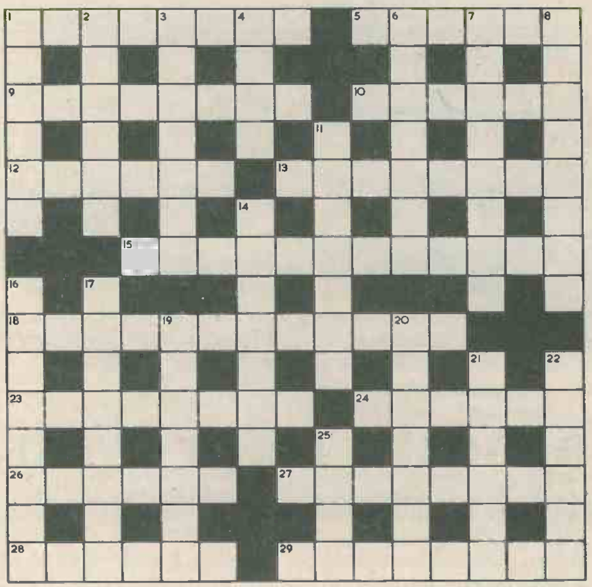
The current drawn by the circuit varies between approximately 50mA and 70mA during the cycle, and this is rather high for continuous operation from dry batteries, although the use of dry batteries for initial checking may be found convenient.

Any small mains power supply offering 12 volts at the current required may be used, and a suitable circuit is given in Fig. 7, in which the pass transistor is an inexpensive germanium type having a high collector current rating. Other transistors in the ACY19 "family" of ACY17 to ACY22 will function equally well. The 10Ω resistor in the collector circuit limits surge current after switch-on when C4 on the Veroboard panel charges.

The mains transformer is a small heater transormer having two 6.3 volt secondaries. These are connected in series to produce a total voltage of 12.6 volts.

CONSTRUCTOR'S CROSSWORD

Compiled by J. R. Davies



Clues Across

1. Southern coven can turn things on. (8)
5. Acid and alcohol form these compounds. (6)
9. Emission of brilliance. (8)
10. Hustler which soaks up valve gas. (6)
12. This clock now governs the six radio pips. (6)
13. Descriptive of ion emitted by positive plate. (5, 3)
15. Muddled voter and American anode put metal on metal. (12)
18. The Ancient Mariner could have found a use for this. (5, 7)
23. NOR gate plus pole produces particle. (8)
24. In chalk a litmus paper turns blue. (6)
26. What TO5 has and TO1 has not. (6)
27. Keeping ganged tuned circuits in tune. (8)
28. Shoran spells out these Indian trees. (6)
29. SN7400 enabled in the countryside? (4, 4)

Clues Down

1. Cliff-hanging transfer of computer bits. (6)
2. Not the aerial for stereo f.m. (6)
3. Encourage one, Capone, along this cable. (7)
4. Confused ache, 1-off. (4)
6. These flip-flop capacitors get things moving. (5-2)
7. Feedback quite opposite to 2. (8)
8. Atomiser output and what produces it. (5,3)
11. Physics term for available energy. (7)
14. Resonant radar testing device. (4, 3)
16. These parameters relate output to input. (8)
17. Electronic map tracer fitted in a vehicle. (8)
19. Go on, act out this eight-sided piece! (7)
20. Son of germanium. (7)
21. Singular laminae. (6)
22. This sideband takes up less space. (6)
25. Excess voltage could cause an excursion. (4)

For Solution see page 109

Dust-off air blast cleaner

Immediately available from importers Pelling & Cross Ltd., 104 Baker Street, London W1., a very useful cleaning device for the hi-fi and electronics enthusiast. Dust-Off is a 14 oz. can containing a liquified gas (freon) which emerges as a pressurised, super dry but inert gas, capable of dislodging even well engrained dust and oxide from delicate tape recorder mechanisms, tape heads, and record stylus without the danger of creating static by conventional forms of wiping or brushing.

Do it yourself enthusiasts will also find it invaluable for cleaning printed circuit boards, switches and relays as well as those awkward places where no brush has access. With suitable care the can can be inverted and liquid freon made to emerge from the nozzle causing instant freezing where sprayed. This can be utilized to check faulty circuit boards and other soldered connections for 'dry joints.' Poor joints will either 'make' or 'break' under this treatment making the task of fault finding easier.

A flexible hose and extension nozzle is available so that the jet may be most precisely directed where required.

The cost of the initial Dust-Off can and trigger nozzle is £8.57 inclusive of VAT, plus post and packing at 65p. Flexible extension nozzle £1.49 plus post and packing 35p.

Scotch cassette improvements

Compact cassettes, like cars, are continually being refined to improve their performance, although the detail improvements are seldom noticeable on cursory examination; indeed, some are visually undetectable.

3M, which is top of the sales league in the U.K. with its range of cassettes, has recently put into full-scale operation its new tape manufacturing facility at Gorseinon, near Swansea. The £3½m. scheme includes an automatic cassette assembler known as the 'Snowflake,' and an impressive number of cassette winders known as 'Raindrops.' These, coupled with what is probably the world's most sophisticated tape coating machine, are now producing a range of cassettes which exhibit marked improvements over the previous hand-assembled models.

Scotch Dynarange, New High Energy, Chrome and dual-layer Classic cassettes are now all manufactured on 3M's automatic assembly lines. The mechanics are common to each range within the Scotch family, and have been designed with reliability and consistent performance in mind. In fact, 3M's Recording Materials Division is so confident about the trouble-free operation of its cassettes that it is currently calling them 'The Jambusters' in a national retail campaign which highlights their jam-free properties.

Detailed improvements in Scotch cassette design include the following:

(1) Larger, permanently fixed one-piece pressure pad for better head-to-tape contact and signal uniformity; (2) Posi-Track backing — a tape back-coating process for a smooth wind and reduction of static-induced dust attraction which can lead to annoying drop-outs; (3) Fixed polished metal guideposts which eliminate the mechanical movement associated with nylon wheels and so reduce wow and flutter.

Improvements have also been made to tape formulations: the popular Scotch Dynarange tapes, for example, have a new oxide formulation, which gives an improvement of some 4dB over the tape previously used in Dynarange cassettes.

Taking the "lid" off a new Scotch High Energy cassette reveals the large one-piece pressure pad and polished metal guideposts which contribute towards good wow and flutter performance.

. . . COMMENT

International Broadcasting Convention 1976

The Sixth International Broadcasting Convention will be held at Grosvenor House, London, from 20-24 September 1976 and will be opened by the Admiral of the Fleet the Earl Mountbatten of Burma, Chairman of the National Electronics Council.

Lord Mountbatten has taken a keen active interest in the art and science of radio and television for many years. He is a Past-President of the Institution of Electronic and Radio Engineers, one of the IBC sponsors.

The aims of IBC, since it was launched in 1967 have been to provide an international forum for people with interests in the wide field of broadcast engineering, to discuss developments and to exhibit and demonstrate their latest equipment and to assist the all important objective of exporting UK products and expertise. With the support of world broadcasting organisations and equipment manufacturers, these aims have been achieved and IBC is now firmly established in the international broadcasters calendar.

IBC 76, to be held at Grosvenor House, London, from 20-24 September is the sixth of the biennial conventions, each one of which has attracted an increasing number of participants from all over the world. At IBC74 more than 2,000 delegates from 44 countries attended. Today the indications are that the number will again increase with an even higher percentage from overseas.

All available exhibition space has been sold. Most of the leading world manufacturers are represented.

Running concurrently with the Exhibition will be a Technical Programme consisting of 60 papers written by leading international experts.

Earl Mountbatten at the HEDA Exhibition

Earl Mountbatten listens to the new Hacker portable stereo radio at the HEDA Exhibition, at NEC Birmingham. On the left are Mr. R. H. Hacker, Managing Director, and Mr. H. A. McGhee, Chairman.

Earl Mountbatten of Burma visited the all British Stand of Hacker Radio Ltd., at the HEDA Exhibition held in the New Exhibition Centre, Birmingham.

On his whistle stop show tour, the Earl was able to listen to the third programme 'Stereo Style' on Hacker's new stereo portable radio.

One of the highlights at HEDA, it incorporates acoustic principles not previously used in portable radios. In genuine Rio Rosewood, it has a black leather and matt silver finish.

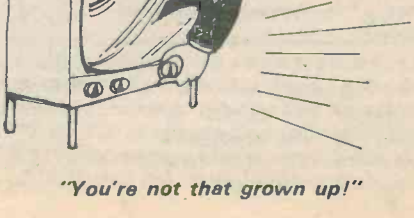
Growing up with television

Children aged between five and 15 in Britain watch an average of 24 hours of television a week, a recent survey reported.

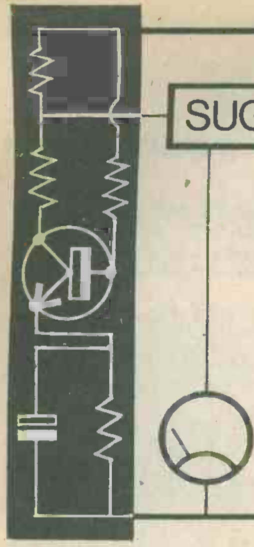
It is not surprising, therefore, that they in turn are constantly watched by psychologists, whose findings are read by anxious parents. A book by Grant Noble, a specialist in this field, was recently published in London and reviewed on BBC World Service. The book, called *Children in Front of the Small Screen,* is based on original research carried out with children in Britain, Ireland and Canada.

Central to the author's theme is the idea that television satisfied those needs of children which were met long ago by the village community. It was as a member of that community that the child saw enacted before him the whole pattern of social relationships which he was likely to encounter later. Through television he can learn, for example, what it is like to be a policeman or a butcher, a painter or an artisan, and to recognise people he might never otherwise have a chance to meet.

On the thorny problem of television and violence, Grant Noble's view is that in nine cases out of ten televised violence has no effect on the normal child. His studies show that when children watch programmes in which violence is shown in a stylised way, as in Westerns, they do not subsequently behave in an anti-social way.



"You're not that grown up!"



SUGGESTED CIRCUIT

RELAY TRIGGER CIRCUIT

By G. A. French

In some electronic devices it is desirable to have a very short closure of a circuit when a push-button is pressed. Typical applications are given by the starting of a timer cycle and the testing of power supplies having instant short-circuit shut-down. A very simple means of obtaining the short closure of the circuit is by means of a relay, and this offers the advantage that the contacts which provide the closure are completely isolated from the circuit which energises the relay coil. Incidentally, the technique to be discussed in this article plays an important part in a more complex device on which the author is currently working, and which he hopes to describe in a future article in the "Suggested Circuit" series.

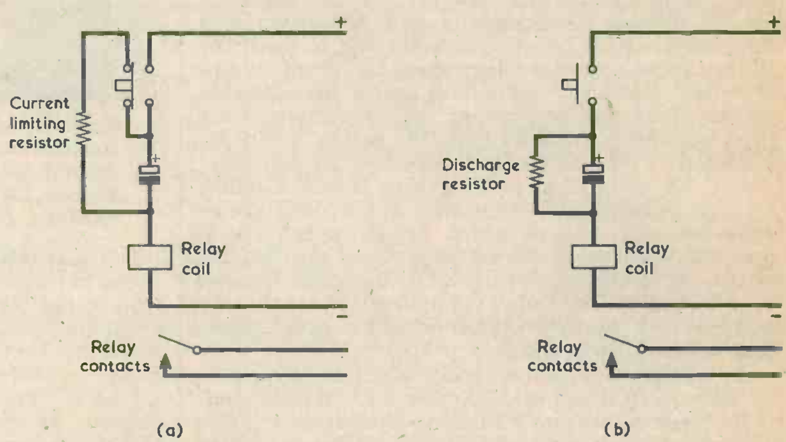


Fig. 2 (a). A development from Fig. 1 which allows the capacitor to discharge between operations (b) An alternative capacitor discharge circuit

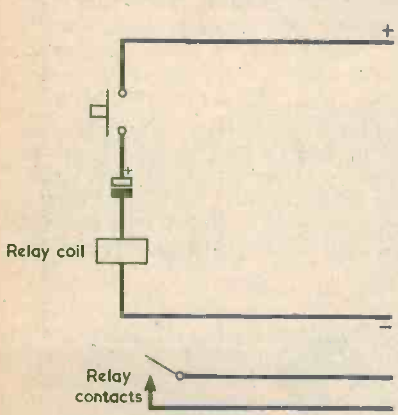


Fig. 1. The basic relay circuit. When the button is pressed the relay energises momentarily as the capacitor charges

BASIC CIRCUIT

The basic relay trigger circuit appears in Fig. 1. Here, a discharged electrolytic capacitor is connected in series with a push-button and the coil of a relay. The relay contacts, which are normally open, couple to the circuit requiring the short closure. On pressing the button a charging current for the capacitor flows through the relay coil, causing the relay to energise and its contacts to close. If the capacitor has a low value it charges very quickly, whereupon the voltage available for the relay coil falls below the release level and the relay de-energises. Thus, pressing the button causes a very short closing of the relay contacts, the period during which they remain closed being independent of the time the push-button is pressed. The series capacitor is shown as an electrolytic component because it is found in practice that the capacitance required is higher than can be economically provided by a non-polarised capacitor.

It is necessary to have the capacitor discharge after the push-button is opened, so that the relay will again energise when the button is pressed. One method of discharging the capacitor is shown in Fig. 2 (a). Here, the push-button is made a double-throw component, and has two extra contacts which close when pressure on the button is removed. The capacitor then discharges by way of these two contacts and the current limiting resistor. The latter may have a value of 10Ω and, under the circuit conditions to be described, can be a ½ watt component.

An alternative means of discharging the capacitor is shown in Fig. 2 (b). In this circuit the push-button is the same as in Fig. 1, and the capacitor discharges, when the push-button is opened, by way of a parallel resistor permanently connected across it. This resistor must have a value significantly higher than that which would allow the relay to remain energised with the capacitor out of circuit.

If the current limiting resistor of Fig. 2 (a) or the parallel discharge resistor of Fig. 2 (b) is given a high value which does not permit quick discharge of the capacitor, relay energising after one operation is inhibited until the capacitor has discharged to the level at which a sufficiently high voltage is available for the relay coil when the push-button is pressed a second time. This effect has the result that, after the circuit has been operated once, it cannot be operated again until a pre-determined period of time has elapsed.

The relay type employed is of considerable importance, and it is necessary that it has a light mechanical action. An excellent choice here is the popular 'Miniature Open P.C. Relay' with 410Ω coil which is available from Doram Electronics Ltd. This has a single pole changeover contact set, and the armature is integral with the moving contact. Also, the armature retaining spring imparts only a small amount of tension. Relays of more common construction, in which the armature is L-shaped and pivots on a knife-edge or hinge, would be much too sluggish for use in the present application. The Doram Electronics relay was employed in all the tests next to be discussed.

TEST CIRCUIT

The relay was initially connected in the test circuit shown in Fig. 3 (a). The relay contacts were coupled to a thyristor gate circuit, which monitored their closure. The thyristor, TH1, fired even when contact closure was virtually instantaneous, causing a forward reading to be given in the voltmeter connected across the thyristor anode load. This technique was particularly helpful during the later timing experiments, when it would otherwise have been difficult to observe the actuation of the relay as well as the second hand of a watch. After it had fired, the thyristor was returned to the non-conductive state by momentarily opening the switch S1. The push-button circuit in Fig. 3 (a) is the same as that of Fig. 2 (a). The push-button is shown as S2, the series electrolytic capacitor as C1 and the current limiting resistor as R3.

The first task was to find the minimum value required in C1 for reliable operation of the relay. Obviously, the lower the value of C1 the shorter the period of closure of the relay contacts. Various values were checked and the requisite capacitance was found to be 20μF.

The test circuit was then changed to that in Fig. 3 (b), in which the capacitor has a parallel resistor across it, as in Fig. 2 (b). This resistor is now shown as R4, and the push-button as S3.

R4 was at first given a value of 2.2kΩ and it was found that the capacitor discharged almost immediately after the push-button was opened, resulting in a performance which was virtually the same as that of Fig. 3 (a). Higher values were then checked. With R4 at 100kΩ it was necessary to wait for 5.5 seconds after opening the push-button before the relay could be made to operate again. As is to be expected, the time delay was proportional to the value of the resistance. With R4 at 200kΩ the delay was approximately 11 secs., and with R4 at 47kΩ the delay was between 2.5 and 3 seconds. These delays would also be given with the circuit of Fig. 3 (a) if R3 were given similarly high values. Note that the delay starts after the last release of the push-button: if the button is pressed during a delay period the electrolytic capacitor becomes charged and another delay period commences.

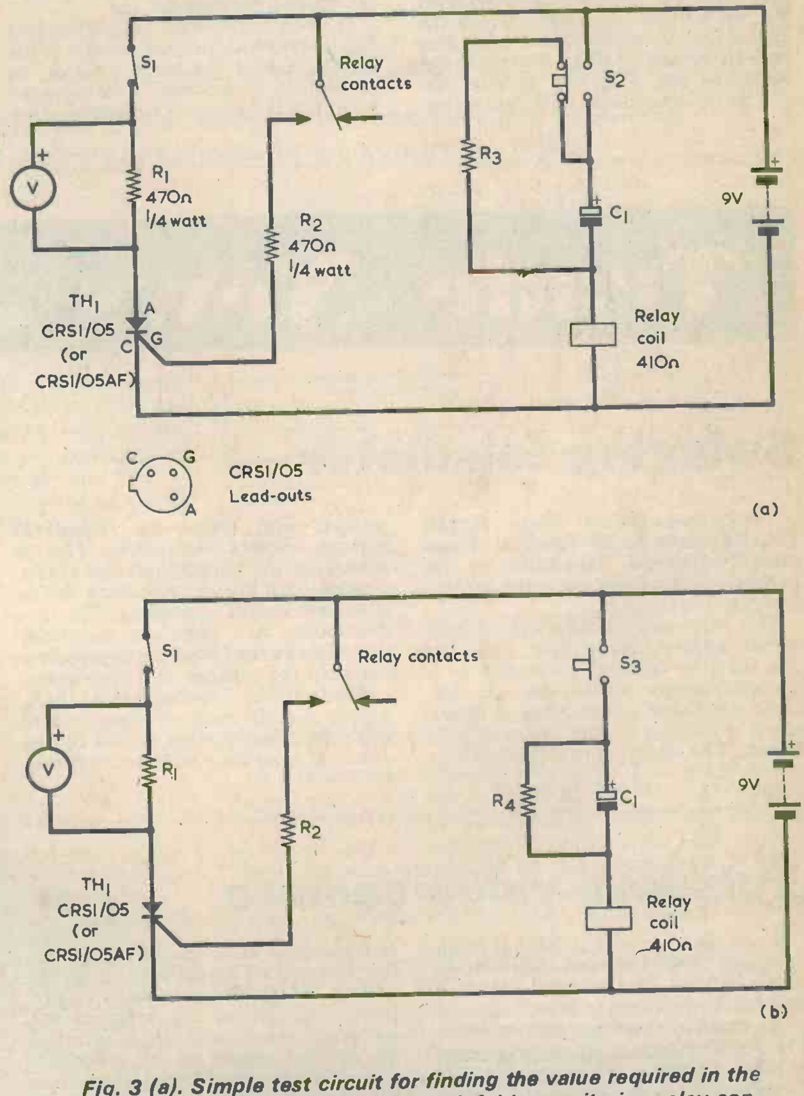


Fig. 3 (a). Simple test circuit for finding the value required in the capacitor. The thyristor circuit is helpful in monitoring relay contact operation since the thyristor turns on with even a momentary closure of the relay contacts. The voltmeter is a multi-testmeter switched to an appropriate volts range (b) The circuit of Fig. 2 (b) with thyristor monitor

COMPONENT VALUES

The component values just mentioned were those obtained with the particular relay employed by the author. There are bound to be variances between one relay of the type specified and the next, whereupon the constructor who wishes to use the circuit has to find the value required in the electrolytic capacitor by experiment. The value required will also vary with supply voltage, which can lie in the range of 9 to 12 volts. If delays are to be incorporated the value of the discharge resistor is also found experimentally.

The constructor should first decide whether he is to use the push-button circuit of Fig. 2 (a) or that of Fig. 2 (b). The circuit is then wired up without the electrolytic capacitor. With the Fig. 2 (a) circuit the current limiting resistor should be 10Ω ½ watt; with the circuit of Fig. 2 (b) the parallel discharge resistor should be 2.2kΩ ½ watt. Starting at around 100μF, various values of electrolytic capacitor are then tried, reducing these until a value is reached at which the relay fails to energise when the push-button is pressed. A capacitance value slightly higher is installed. There is no necessity for a thyristor monitor circuit with this procedure as the operation of the relay can be observed visually. If a capacitor with too low a value of capacitance has been in stock for a considerable period it may initially cause the relay to energise. Such capacitors should be allowed to "form" by keeping the push-button pressed for several seconds, after which their functioning can be more accurately assessed. When no delay periods are needed, the circuit is then set up and is ready for use.

If delay periods are required either the 10Ω current limiting resistor or the 2.2kΩ parallel discharge resistor, as applicable, is removed, to be replaced by a 100kΩ resistor. The length of the discharge period offered by this is then found with the aid of a watch having a sweep second hand or digital second display. The discharge period is the shortest time after the push-button is released at which the relay energises when the button is pressed again. When this period has been found the resistance value finally required may be calculated and the resistor installed. Thus, if the 100kΩ resistor gives a delay of four seconds when a delay of six seconds is required, the resistor finally installed may have a value of 150kΩ. Resistor values greater than 470kΩ are best avoided. The thyristor monitor circuit in Figs. 3 (a) and (b) is not essential for finding delay periods but it will in practice ease the process considerably.

For consistent performance the supply voltage for the push-button and relay circuit should be reasonably well stabilized, and regulation should be no worse than, say, plus or minus 0.5 volt of the nominal value. ■

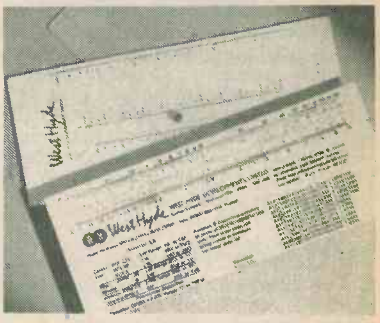
Trade News . . .

Swinging calculator

Introduced by West Hyde Developments Ltd., Ryefield Crescent, Northwood, Middlesex, is the pocket calculator shown in the accompanying photograph.

This has a card sliding inside a plastic sheath approximately 6½in. long. On one side the calculator operates as a straightforward slide rule. On the other side it has a cursor free to rotate about an eyelet at the centre of the sheath. The sliding card underneath is printed with scales for resistance, voltage, current and power. This is moved in the sheath and the cursor rotated until the cursor centre line is over two known quantities. The corresponding two unknown quantities may then be read from the appropriate scales in the manner of a nomogram.

West Hyde Developments, Ltd., supply a wide range of resistors and capacitors, and further details can be obtained from their address, as above.



The West Hyde Developments calculator.

Tubeless video camera

A new development by RCA is given by their TC1155 tubeless video camera. This uses a c.c.d. (charge coupled device) image sensor instead of the traditional vidicon pick-up tube. The silicon image radiation sensor uses 163,840 elements which enable the camera to provide sharp clear highlights with anti-blooming characteristics. Image retention due to trace persistence in electron beam tubes is thereby eliminated.

The image sensor incorporates a self-scanning technique in which electric charges are transferred along the surface of the silicon wafer which forms the heart of the image sensor. Varying intensities of visible or infrared light impinging on the wafer surface produce proportional changes in the charge in discrete silicon elements. These changes are digitised and encoded with timing data for transmission to the receiver.

The light-weight (2.5lb.) TC1155 camera takes advantage of the reliability and operation benefit of solid-state technology and operates over a range of –12°C to +50°C. The camera is suited to uses such as industrial process control or scientific instrumentation where non-contact measurement based on precision image geometry is advantageous.

Additional information may be obtained by writing to RCA Electro-optics and Devices, Sunbury-on-Thames, Middlesex.

AUDIO CONTROL CIRCUITS — 3

AUTOMATIC FADER

By P. R. Arthur

This concluding article in our 3-part series describes how the MC3340P integrated circuit may be employed in an automatic fader.

In the preceding two articles of this series, circuits have been described which incorporate the Motoroloa MC3340P electronic attenuator, these circuits consisting of a compression amplier, an audio squelch unit and a dynamic noise limiter. As was stated in the first article of the series, the MC3340P is a new device which supersedes the MFC6040. Both these i.c.'s are electrically identical and are different only in the number of pins and pin spacing. The pin connections for both types were given in the first article.

We now proceed to the final audio control circuit to be dealt with, this being an automatic fader.

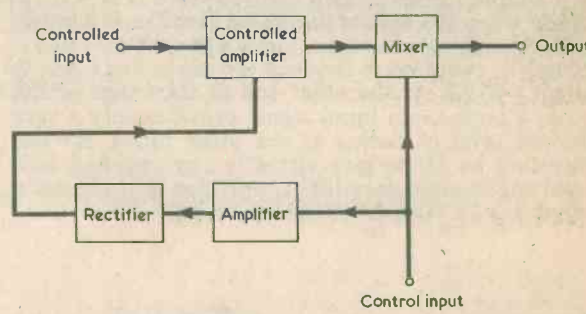
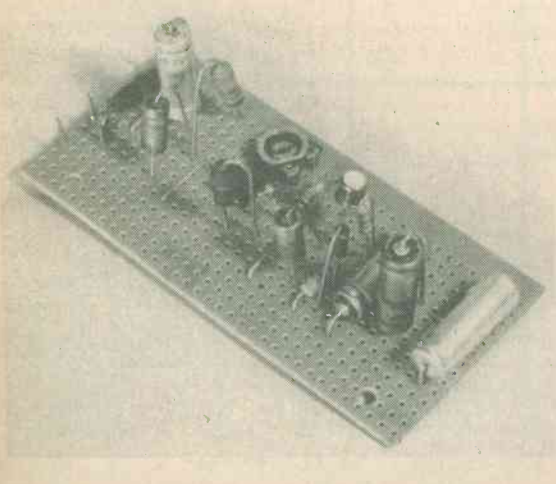


Fig. 14. Block diagram illustrating the operation of the automatic fader



The componets of the automatic fader are wired up on a Veroboard panel

AUTOMATIC FADER

An automatic fader is a type of 2-channel audio mixer, but it has the additional facility that when a signal is fed to the main input the secondary input is automatically attenuated or faded out. This type of circuit can be employed in the production of electronic music, in home movie equipment and at discotheques. There are, no doubt, other uses to which it may be put.

Fig. 14 shows the stages of the fader in block diagram form. The main, or control, input is fed straight to the mixer, whilst the secondary controlled input is fed to the mixer via a controlled amplifier (the MC3340P). Part of the main input signal is amplified, rectified and smoothed, and the d.c. potential thus produced is applied as a control voltage to the controlled amplifier. The circuit is arranged such that the greater the control voltage, the lower the gain of the controlled amplifier. Feeding an input signal to the main input thus fades out the secondary input.

THE CIRCUIT

As can be seen from the circuit of Fig. 15, only a single active device is needed in addition to the MC3340P.

R5 and R6 form a simple passive mixer which combines the control input and the output from the controlled amplifier. The controlled input is fed to the input terminal (pin 1) of the i.c. via C5. R4 sets the gain of the device at about unity, and C6 is the roll-off capacitor.

The control input signal is also fed via C2 to the base of TR1. TR1 is used as a common emitter amplifier with R1 as the collector load resistor and R2 as the base bias resistor. A pre-set variable resistor, R3, is connected in the emitter circuit of TR1 and is unbypassed.

The amplified signal appearing at the collector of TR1 is fed to a voltage doubling rectifier and smoothing circuit consisting of C3, D2, D1 and C1. The positive bias produced at the positive terminal of C1 is then applied to the control terminal (pin 2) of the MC3340P. Thus, a signal input at the control input produces a positive bias of proportional value at pin 2 of the i.c., and fades out the secondary input accordingly.

The voltage gain of TR1 is controlled by R3, which is a simple feedback gain control. Gain is at a maximum when R3 inserts minimum resistance into circuit. At this gain level an input signal of only about 100mV is required to fade out the controlled input to about −40dB. At the other end of the range of R3, quite a large main input signal provides only a very limited level of fading at the other input. R3 can therefore be set to give virtually any required fade level to the secondary input, provided that the main input is at a level of 100mV or more.

COMPONENTS

Resistors
(All fixed values ¼ watt 5 or 10%)
R1 4.7k Ω R2 2.2M Ω
R3 2.2k Ω skeleton potentiometer, 0.1 watt, horizontal mounting (see text)
R4 6.8k Ω
R5 10k Ω
R6 10k Ω

Capacitors
C1 100μF electrolytic, 10 V Wkg.
C2 1μF electrolytic, 25 V Wkg.
C3 10μF electrolytic, 16 V Wkg.
C4 25μF electrolytic, 16 V Wkg.
C5 10μF electrolytic, 16 V Wkg.
C6 560pF polystyrene
C7 10μF electrolytic, 16 V Wkg.

Semiconductors
IC1 MC3340P
TR1 BC108C
D1 OA91
D2 OA91

Switch
S1 s.p.s.t. toggle

Miscellaneous
Veroboard, 0.1in. matrix, 34 holes x 14 strips
Veropins (as required)
Wire, etc.

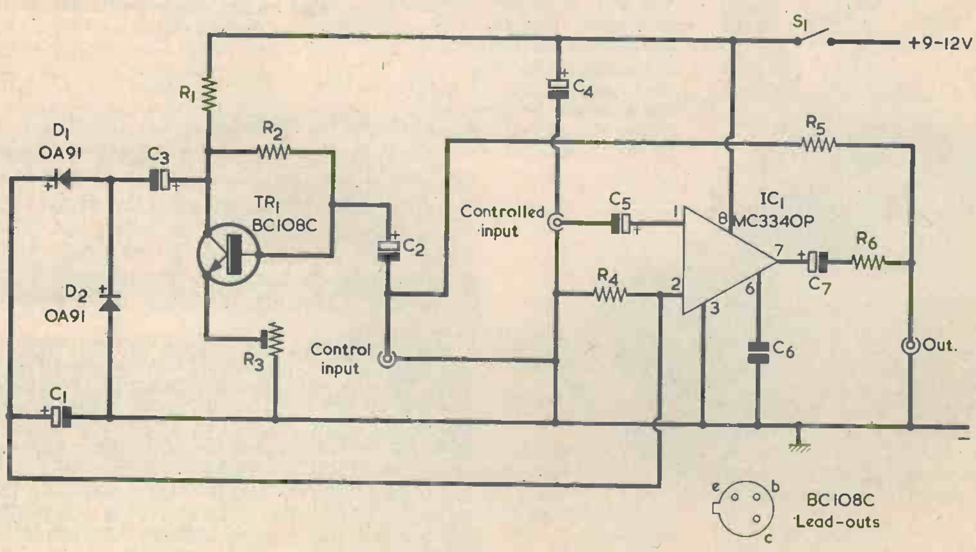


Fig. 15. Full circuit diagram for the automatic fader

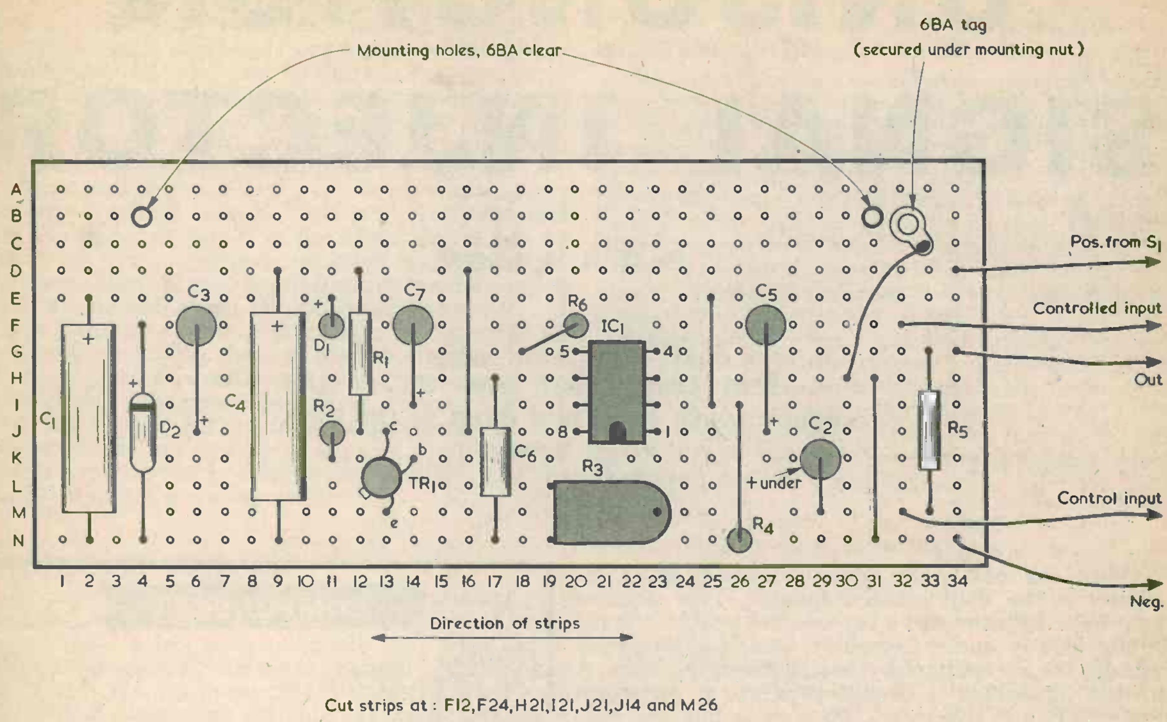
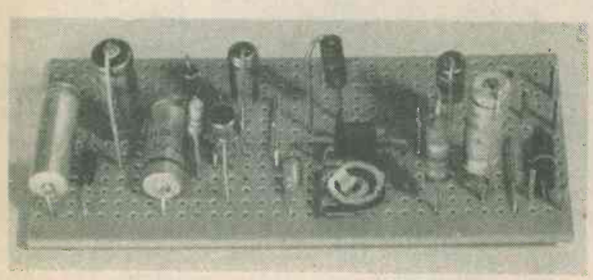


Fig. 16. Component side of the Veroboard assembly. (Pins 4 and 5 of the integrated circuit are 'NC' pins.)

The input impedance at the control input is dependent upon the setting of R3 and the input impedance of the circuit into which the output couples. A low input impedance would be given if R3 inserted zero resistance into circuit, but in practice this resistor will probably insert a few ohms at its minimum resistance setting. The control signal input impedance may therefore be looked upon as ranging between some 1kΩ to 10kΩ or more. The input impedance at the secondary input is of the order of 50kΩ.

The current consumption is approximately 8mA from a 9 volt supply and 12mA from a 12 volt supply.



Another view of the Veroboard assembly

CONSTRUCTION

The automatic fader components are assembled on a 0.1in. matrix Veroboard panel having 34 holes by 14 copper strips. Fig. 16 gives full details of this panel.

First, cut out the panel to the correct size with a small hacksaw, then drill out the 6BA clear mounting holes. Next cut the copper strips at the points specified, using a Vero spot face cutter or a small twist drill held in the hand. Then fit and solder the components to the panel as illustrated. Note that R3 is a pre-set potentiometer having its two track tags spaced at 0.2in. and its slider tag spaced 0.4in. from the track tags. Fit 0.1in. Veropins to the circuit points where external connections to the supply, etc., are made.

The panel can be fitted in a small metal case which is connected to the negative rail by a solder tag under one of the securing nuts. The input and output sockets may be phono or coaxial types, or jacks, according to preference, and they take up their chassis connection by way of the metal case. The leads from the panel to their non-earthy contacts need not be screened but should be kept reasonably short. If a battery is used for the supply this may also be housed in the metal case.

(Concluded)

UNIJUNCTION SIGNAL INJECTOR

By N. R. WILSON

A low cost instrument which offers a modulated test signal over all of the medium wave band and most of the long wave band.

One of the most useful devices for use as an a.f. oscillator is the unijunction transistor. This requires only three resistors and a capacitor to enable it to oscillate at any audio frequency, and it can operate without the necessity of bypassing the supply rails. A further advantage is that it produces a waveform which is rich in harmonics, these extending well over 2MHz.

SIGNAL INJECTOR

A unijunction transistor, TR1, appears in Fig. 1 and in conjunction with R1, R2, R3 and C4 functions as an oscillator running at around 800Hz. Oscillation takes place in conventional manner; after on-off switch S2 is closed C4 charges by way of R3 until the potential on its upper plate reaches triggering level, whereupon it discharges abruptly via the emitter and base 1 of the transistor into R2. The capacitor then charges again by way of R3 until the triggering level is once more reached, and so the cycles proceed.

A series of abrupt pulses at oscillator frequency is present at the base 1 of the transistor. In Fig. 1 these are loosely coupled via C3 to the tuned circuit given by L1 and VC1(a)(b), together with C1 or C2 when range switch S1 is adjusted accordingly. The pulses passed via C3 shock-excite the tuned circuit and cause

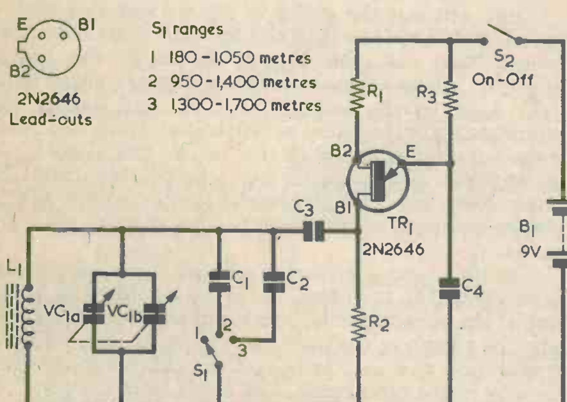


Fig. 1. The circuit of the unijunction signal injector. This produces a modulated r.f. signal over the ranges indicated

COMPONENTS

Resistors
(All ¼ watt 10%)
R1 470 Ω
R2 150 Ω
R3 22k Ω

Capacitors
C1 750pF polystyrene or silvered mica (see text)
C2 1,500pF polystyrene or silvered mica
C3 See text
C4 0.047μF plastic foil
VC1(a)(b) 500+500pF variable air-spaced, 2-gang.

Coil
L1 Home-wound on ferrite rod (see text)

Transistor
TR1 2N2646

Switches
S1 Single pole 3-way, rotary
S2 S.P.S.T., toggle

Battery
B1 9 volt battery

damped oscillations to be produced at its resonant frequency. If the coupling provided by C3 is loose enough, and if the tuned circuit has a reasonably high Q, the frequency range over which the damped oscillations appear is nearly as sharply defined as occurs with a conventional r.f. oscillator having positive feedback. Since the damped oscillations are produced by the pulses from the unijunction transistor, the r.f. signal at the tuned circuit is effectively amplitude modulated at unijunction oscillator frequency.

L1 can be a coil wound on a ferrite rod whereupon a further advantage accrues. This is given by the fact that the signal produced in the tuned circuit can be picked up on a transistor superhet receiver whose ferrite rod aerial is held parallel with the rod on which L1 is wound and about six inches away from it.

The purpose of the signal injector is to provide an amplitude modulated signal of known frequency which can be coupled to a medium and long wave superhet without any interconnecting wires. It may then be used for tuning and padding adjustments in the receiver aerial and oscillator circuits, for frequency calibration of a newly constructed receiver, and for general receiver servicing work.

FREQUENCY RANGES

In order to obtain a wide frequency range, the capacitance in the tuned circuit is capable of being varied from a low to a relatively very high value. When range switch S1 is set to position 1, L1 is tuned by VC1(a) and (b) in parallel. VC1(a)(b) is a 2-gang 500+500pF air-spaced variable capacitor, offering a maximum capacitance of 1,000pF. Variable 2-gang capacitors of this type were commonly used in the earlier valve radio receivers, and they are still available in several styles from many of the mail order houses. They tend to be somewhat more bulky in size than the variable capacitors encountered in modern transistor receivers.

With the prototype, the coverage given by VC1(a)(b) on its own is 180 to 1,050 metres. When S1 is set to Range 2, C1 is connected across the 2-gang capacitor, and the range given by adjusting the capacitor then becomes 950 to 1,400 metres. Setting S1 to position 3 gives a range of 1,300 to 1,700 metres. C1 and C2 should be polystyrene or silvered mica capacitors. C1 in the prototype is 750pF but this value may be a little difficult to obtain from retailers, and if necessary the more readily available value of 680pF may be employed instead. Should it be found that this value does not give an overlap with the low wavelength end of Range 3, a further capacitor of around 68pF may be connected in parallel. Since L1 is home-wound, the actual ranges obtained may vary slightly from those shown in Fig. 1, but they should agree in general and have a small amount of overlap between them.

Coil L1 consists of 75 turns of 30 s.w.g. enamelled wire close-wound at the centre of a ferrite rod having a length of 7in. and a diameter of ⅜in. Shorter rods down to a length of 5in. may also be employed and these will require proportionately more turns. It is a simple matter to find the number of turns required with such rods. First wind on too many turns (say 90) then remove these, as required, until the tuned circuit resonates at 200 metres with VC1(a)(b) vanes nearly fully out of mesh and S1 at position 1.

The current consumption of the circuit is only 1.4mA, and B1 may be a small battery such as the Ever Ready PP3.

CONSTRUCTION

The circuit can be assembled in any small wooden or plastic case with L1 mounted on the outside. The rod should be several inches clear of the battery and the metal frame of the 2-gang capacitor. The leads to L1 should be kept reasonably short, as these will also radiate r.f. energy and it is desired to have as much as possible of the radiation given by L1 only. The 2-gang capacitor needs to be fitted with a pointer knob or cursor and a scale which can be calibrated over the three ranges. There is no necessity for a slow motion drive if a reasonably large knob is fitted.

Capacitor C3 is not a physical capacitor but consists of the capacitance between a short insulated wire and the lead of R2 which connects to the base 1 of the transistor. The arrangement is shown in Fig. 2. The degree of coupling can be varied by moving the wire and it should be sufficiently loose to ensure that a sharp well-defined signal is given.

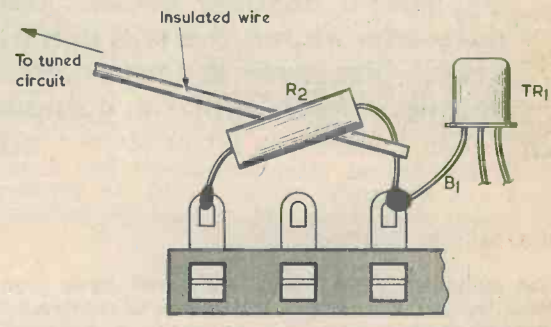
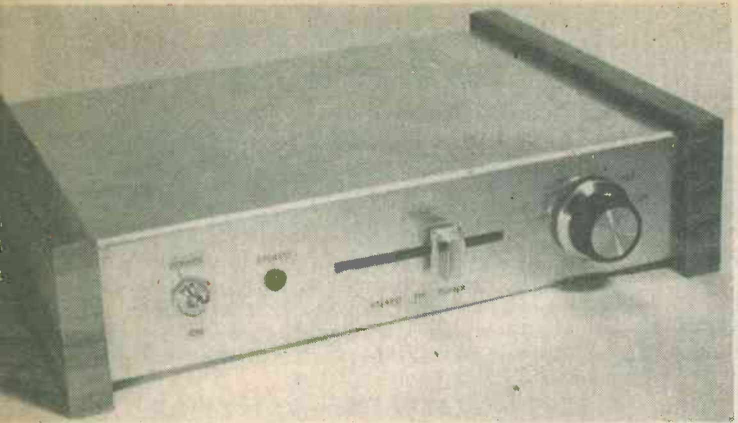


Fig. 2. C3 is given by positioning an insulated wire from the tuned circuit against or near to the non-earthy lead-out of R2

After the circuit has been assembled it may be checked out with a standard medium and long wave superhet. The latter is positioned with its ferrite rod parallel with L1, and VC1(a)(b) is adjusted until the modulating tone is picked up. The tone may be heard weakly at frequencies other than the resonant frequency but the presence of the latter will be obvious when it is tuned in. The tone tunes in about as sharply as a broadcast station on both medium and long waves. It is a little weaker on long waves due to the high tuning capacitance in the unit. The optimum spacing between the receiver ferrite aerial rod and L1 will soon become apparent after a little experience.

The unit is then calibrated in terms of wavelength with the aid of a receiver having a reliably calibrated tuning scale, checking against stations of known wavelength when these appear. There will, of coue, e, be a gap in the calibration between about 600 metres on the medium wave band and about 1,000 metres on the long wave band. ■



The 'A

Part 1

By R. A. Penfold

Incorporating two integrated circuits and a pre-aligned front-end module, this f.m. tuner is far simpler to construct than would be one employing discrete components throughout. If desired, the stereo decoder section may be omitted or added at a later date whereupon the unit can then function as a mono tuner. This article discusses the tuner circuit and commences constructional details, which will be completed in next month's concluding article.

Not so many years ago it may well have been beyond the scope of many constructors to complete a stereo f.m. tuner project. This was not necessarily due to the complexity of the circuitry involved, but was mainly because of the complications incurred in aligning the finished tuner.

The setting up problem can be overcome these days by the use of modern circuitry which, although originally developed to reduce and simplify the test and alignment procedure for commercially made tuners, also has the effect of enabling the home constructor to carry out a successful alignment even when no test equipment is available.

TUNER STAGES

Fig. 1 gives a block diagram of the various stages which comprise the tuner to be described. The front end is based on a ready made module, the Mullard LP1186. This is pre-aligned by the manufacturer and needs no further adjustment. The module is coupled aperiodically to a single transistor i.f. amplifier, which is in turn coupled to an integrated circuit i.f. amplifier and quadrature detector via a ceramic filter. The only conventional L-C tuned circuit used in this combination is the quadrature detector coil, and this can be given the correct adjustment very simply without the need for any test equipment.

The stereo decoder is based on a modern integrated circuit employing a phase locked loop (p.l.l.). This requires only the adjustment of a single pre-set potentiometer for alignment, and again no test equipment is required for this. All stages are supplied by a stabilized and well smoothed mains power supply unit.

The tuner has been designed primarily as a relatively simple unit and is not quite as sensitive as

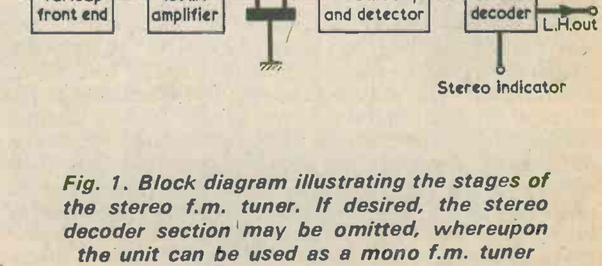


Fig. 1. Block diagram illustrating the stages of the stereo f.m. tuner. If desired, the stereo decoder section may be omitted, whereupon the unit can be used as a mono f.m. tuner

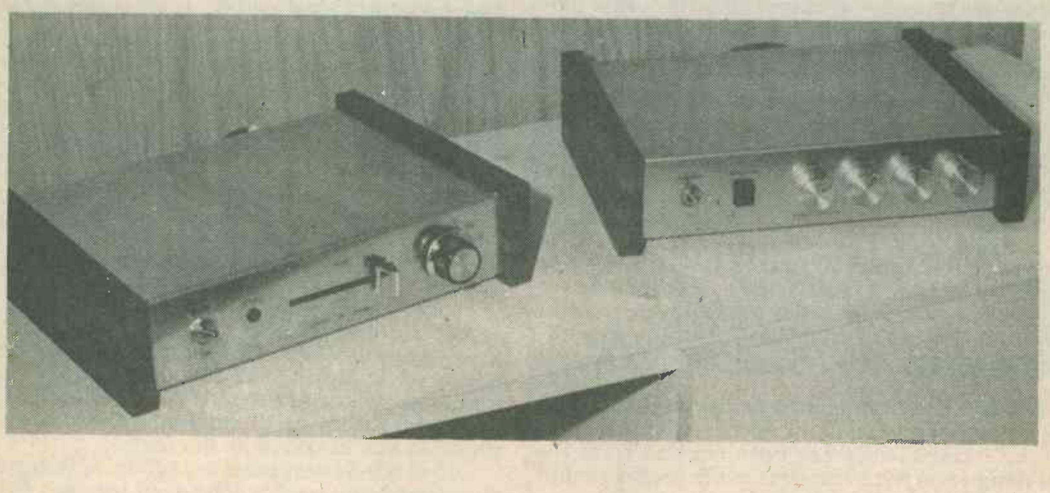
...cademy' Stereo F.M. Tuner

some of the more elaborate modern tuners. It does, however, have enough sensitivity to provide good reception of the ordinary national v.h.f. B.B.C. transmissions in most areas, as well as reception of B.B.C. and commercial local radio stations where these are in operation.

The use of integrated circuits enables a high quality output to be given despite the relative simplicity of the overall circuit. The i.f. amplifier-detector i.c. gives a typical distortion level of only 0.5% at an i.f. of 10.7MHz, and the stereo decoder has an even lower distortion figure of typically 0.3% at the maximum permissable input level.

The building of the tuner should not prove to be too troublesome provided the constructor has some experience in etching his own printed circuit boards. Most of the circuitry is contained on three printed boards, one for the power supply, one for the tuner and one for the stereo decoder.

The unit is housed in an attractive case of the "book-ends" type, which is made by slightly modifying a ready-made chassis. Switch tuning is employed, giving five pre-set tuning positions together with a sixth position which enables variable tuning to be accomplished by means of a slider potentiometer on the front panel. Frequency coverage is from approximately 87 to 104MHz. The output level is about 250mV r.m.s., and should preferably be fed into an impedance of about 100k Ω Virtually any stereo amplifier will have at least one suitable input.



The tuner employed in conjunction with the Stereo I.C. Amplifier described in our March 1976 issue

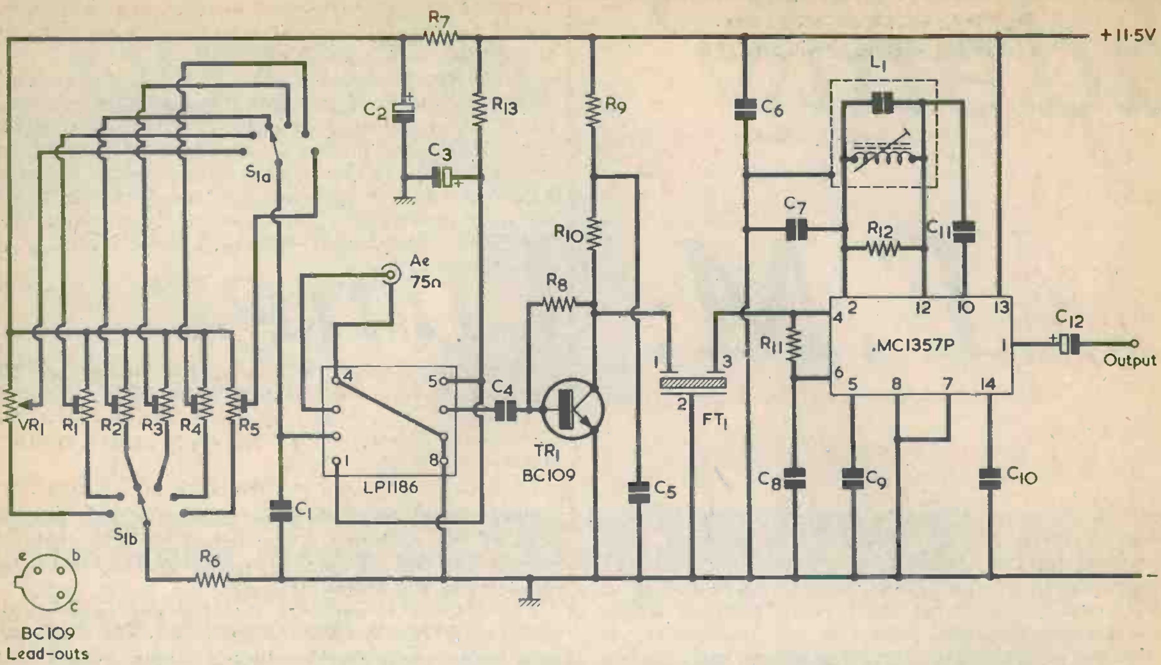


Fig. 2. The basic tuner section of the unit. This provides a mono output via C12 and incorporates a Mullard voltage controlled f.m. module type LP1186

THE CIRCUIT

The circuit diagram of the tuner, less the power supply and stereo decoder sections, is shown in Fig. 2.

S1(a)(b) is the tuning switch and selects one of six potentiometers, according to its position. VR1 is a front panel manual tuning potentiometer, whilst R1 to R5 are pre-set tuning potentiometers. R6 forms part of the potential divider at all settings of S1 (a)(b), and limits the minimum voltage which can be fed to pin 2 of the LP1186 module.

This module incorporates variable capacitance diodes for tuning and requires only a single tuning voltage. The aerial couples to pin 3, and pins 4, 7 and 8 are the aerial earthy input, i.f. earthy output and negative supply connections respectively. These are all connected to chassis. Pin 5 is the positive supply input, and the basic 11.5 volt supply is reduced to about the required level of 8 volts by R13. C3 provides decoupling. The tuning voltage must obviously be extremely well smoothed in order to ensure that mains hum is not introduced by modulation of the local oscillator, and so extra smoothing is provided by R7 and C2.

Pin 1 is the a.f.c. connection to the module. Since frequency stability was found to be quite adequate without a.f.c this facility has been omitted from the present design and pin 1 connects to the positive supply.

The i.f. output from the module is coupled via C4 to the base of TR1, the first i.f. amplifier. This is connected in the common emitter mode, and is fed from the positive supply via the decoupling components R9 and C5. The value of R10 is chosen to match the input impedance of the ceramic filter, FT1.

Pin 4 of the Motorola MC1357P i.c. connects to the other side of the ceramic filter. This i.c. comprises an i.f. amplifier and quadrature detector. R11 completes part of the bias circuit of the i.c. and also largely determines the input impedance, which matches the output impedance of the filter. It is important that the impedances of the circuits at the input and output of the filter provide a good match, as otherwise the shape of the i.f. passband will deteriorate.

C6 to C9 are all decoupling capacitors. There are relatively few decoupling capacitors required here when compared with discrete component amplifiers. This is due to the use of three long-tailed pairs coupled via emitter followers to form the i.f. amplifier inside the i.c., these being fed from an internal voltage regulator. The long-tailed pairs, at 53dB, provide the bulk of the gain of the tuner, although the LP1186 front-end adds a useful further gain of 30dB. The i.f. transistor, TR1, does little more than make up for the 6dB loss in the ceramic filter.

L1, C11 and R12 are in the tuning circuit for the quadrature detector. The capacitor shown connected across L1 is an integral part of the ready-made coil unit. The output of the quadrature detector connects to pin 1 of the i.c. via an internal emitter follower. C12 provides d.c. blocking at the output.

C10 is the de-emphasis capacitor, as is required for mono reception, and is connected between the output of the quadrature detector and chassis. It has the effect of reducing the treble content of the audio output signal. This is necessary because the signal is given a degree of pre-emphasis (treble boost) at the transmitter, and a compensatory reduction in the treble response is required in the receiver. The overall

COMPONENTS

Resistors
(All fixed values $\frac{1}{4}$ watt 5%)
R1-R5 100kΩ pre-set potentiometer, horizontal skeleton, standard size
R6 15kΩ
R7 270Ω
R8 220kΩ
R9 100Ω
R10 330Ω
R11 390Ω
R12 3.9kΩ
R13 680Ω
R14 4.7kΩ
VR1 100kΩ potentiometer, linear, slider (see text)

Capacitors
C1 0.1μF type C280 (Mullard)
C2 10μF electrolytic, 16 V Wkg.
C3 50μF electrolytic, 16 V Wkg.
C4 0.01μF type C280 (Mullard)
C5 0.022μF plastic foil
C6 0.022μF plastic foil
C7 0.1μF plastic foil
C8 0.1μF plastic foil
C9 0.1μF plastic foil
C10 5,600pF polystyrene (see text)
C11 4.7pF silvered mica or ceramic
C12 10μF electrolytic, 16 V Wkg.
C13 100μF electrolytic, 16 V Wkg.
C14 220μF electrolytic, 16 V Wkg.
C15 1,500μF or 1,600μF electrolytic, 30 V Wkg.

Inductors
L1 Coil assembly type KACS K586 HM (see text)
T1 Mains transformer, miniature, secondary 9-0-9 V at 100mA (see text)

Semiconductors
IC1 MC1357P
TR1 BC109
TR2 BC238
TR3 AD162 (with insulating kit)
D1-D4 1N4001
D5 BZY88C12 V

Module
Voltage controlled f.m. tuner module type LP1186 (Mullard)

Filter
FT1 Ceramic filter type CFSA 10.7. no colour (see text)

Switches
S1 (a) (b) 2-pole 6-way rotary
S2 (a) (b) D.P.S.T. toggle

Miscellaneous
Control knob
Coaxial socket
3-way DIN socket
Mains lead
16 s.w.g. aluminium chassis with base plate, 9 x 7 x 2in. (see text)
Chipboard (see text)
Materials for printed boards
Nuts, bolts, etc.

effect of pre-emphasis and de-emphasis is to give a small but worthwhile improvement in the signal-to-noise ratio of the received signal.

It is important to note that C10 is only needed for mono reception. The tuner can easily be built as a mono unit by simply omitting the stereo decoder, connecting the output from C12 to the output socket, and including C10 on the printed circuit board. When the stereo decoder is included C10 must be omitted, as stereo reception will otherwise not be possible. With the stereo decoder, de-emphasis is provided at the decoder outputs.

POWER SUPPLY SECTION

Since any changes in the supply voltage will alter the frequency to which the unit is tuned, it is absolutely essential that a well stabilized power supply be employed. The circuit of the power supply section is shown in Fig. 3.

The output from the secondary of T1 is fed to a bridge rectifier consisting of D1 to D4. T1 is a transformer having a 9-0-9 volt secondary with the 0 volt centre-tap ignored. The output from the bridge rectifier is smoothed by C15.

A stabilized potential of 12 volts is provided by the simple shunt regulator formed by R14 and zener diode D5. C13 smooths out any mains hum or noise present across D5.

TR2 and TR3 are wired as common emitter amplifiers, with a 100% negative feedback loop between the collector of TR3 and the emitter of TR2. This combination gives a voltage gain of almost exactly unity. Therefore the voltage at the collector of TR3 is virtually fixed relative to that at the base of TR2. About 0.5 volt is dropped between the base and emitter of TR2, and so the output stabilizes at about 11.5 volts.

Since the combined current gain of TR2 and TR3 is very high a low output impedance is achieved, and the supply is easily able to handle the necessary output current of about 35 to 40mA. C14 provides final smoothing of the supply, and S2 is the on-off switch.

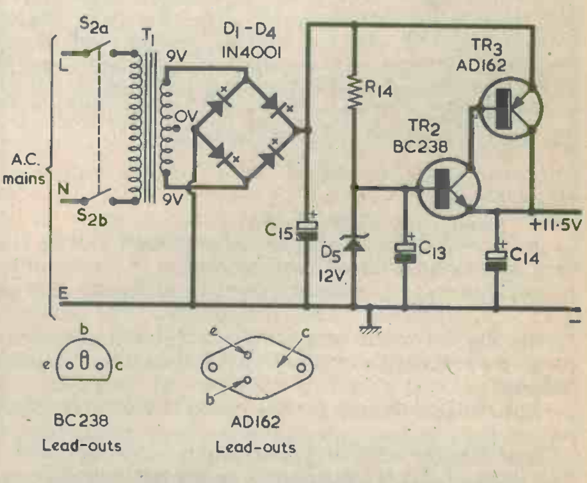
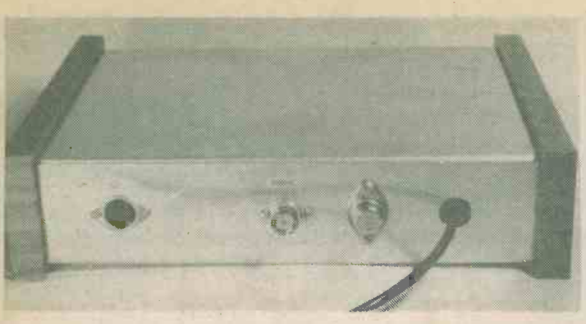


Fig. 3. The power supply section. This gives a well stabilized output voltage, thereby ensuring that there are no shifts in tuning due to supply voltage changes



Mounted on the rear panel are the aerial and output sockets, together with the power transistor incorporated in the stabilized mains power supply

The circuit of Fig. 3 gives an extremely well smoothed and stabilized output, and quite large variations in the output load current and mains input voltage have no significant effect on the output voltage. This assumes, of course, that D5 is a good-quality component.

COMPONENTS

Some notes on the components so far encountered will be helpful. The MC1357P integrated circuit is listed by Chromasonic Electronics, 56 Fortis Green Road, Muswell Hill, London, N10 3HN. The coil assembly specified for L1 is available from Ambit International, 25 High Street, Brentwood, Essex, CM14 4RH, as also is the ceramic i.f. filter type CFSA 10.7. These filters have five frequency groupings around 10.7MHz identified by a colour code, and filters centred on 10.7MHz are identified by no colour. A filter of this type is to be preferred. R1 to R5 are standard sized horizontal skeleton pre-set potentiometers, and not miniature types.

The mains transformer must be a miniature type, and the component employed in the prototype was obtained from M. Dziubas, 158 Bradshawgate, Bolton, BL2 1BA. The slider potentiometer has an overall length of 87mm. and can be obtained from several suppliers including Electrovalue Ltd., 28 St. Judes Road, Englefield Green, Egham, Surrey, TW20 0HB. Its knob has to be ordered separately.

THE CASE

A 16 s.w.g. aluminium chassis measuring 9 by 7 by 2in. and fitted with a baseplate forms the basis of the case. This can be obtained from H. L. Smith and Co. Ltd., 287 Edgware Road, London W2. The baseplate forms the lid of the unit and, when this is completed, may be secured in place with small self-tapping screws.

The drilling details for the case are shown in Fig. 4, where the front and rear panels and the two sides are shown flat for ease of presentation.

The cut-out for VR1 can be made by first drilling a $\frac{1}{8}$in. diameter hole, and then using a miniature round file to lengthen this to the dimensions shown. A miniature flat file can finally be used to square up the ends of the cut-out, and to remove any irregularities which may be evident. The easiest method of mounting VR1 is to glue it in position with an epoxy adhesive. Great care must be taken to ensure that no adhesive gets onto the track. The component must be aligned accurately behind its cut-out.

The hole for D6 will take a panel mounting light-emitting diode functioning as a stereo beacon with the stereo decoder. D6 can be any l.e.d. offering a reasonably bright light at a forward current of around 10mA, and a relatively large l.e.d. will give a good appearance to the front panel. If the unit is to be constructed as a mono tuner, the l.e.d. may be powered from the 11.5 volt supply via a 1k Ω resistor and employed as an on-off indicator.

The aerial and output sockets are mounted on the rear panel, the former being a standard coaxial socket and the latter a 3-way DIN socket. There is also a hole which takes a $\frac{1}{2}$in. grommet for the mains lead. Further required are four holes for TR3, the body of which is on the outside of the chassis. TR3 is insulated from the chassis by means of the usual mica washer and insulating bushes, and the washer may be used as a template for marking out the holes required. The holes must be free of burrs and, when the transistor is mounted, a solder tag inside the chassis under the upper securing nut provides the collector connection. A continuity tester or ohmmeter is employed to make quite certain that the transistor is fully insulated from the chassis.

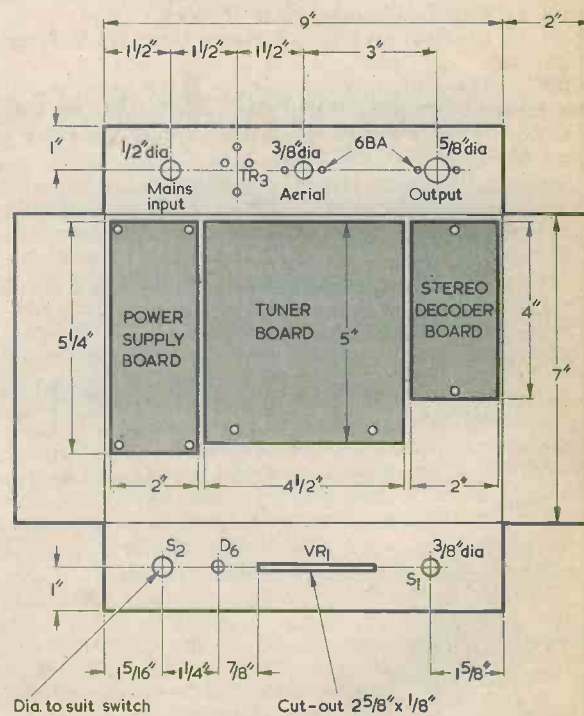
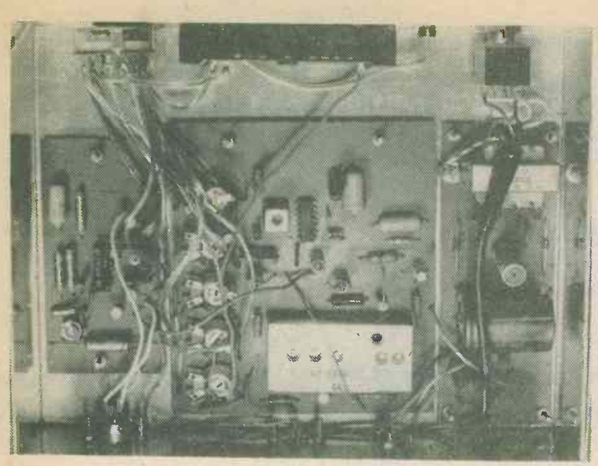


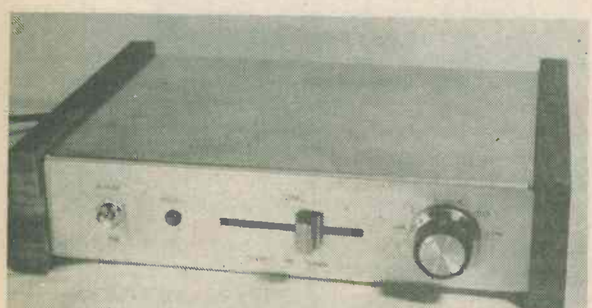
Fig. 4. Drilling details for the tuner chassis. The sides, and the front and rear panels are shown opened out to simplify presentation. Also illustrated are the positions taken up by the three printed circuit boards



The tuner circuitry is carried on three separate printed circuit boards

The mounting holes on the chassis bottom for the printed circuit boards can be marked out with the aid of the boards themselves after they have been made up. Their positions and outside dimensions are shown in Fig. 4.

Two pieces of chipboard, each measuring $2\frac{1}{2}$ by $7\frac{1}{2}$ by $\frac{1}{2}$in. are glued to the ends of the chassis to give a case having a "book-ends" appearance. The chipboard is first covered with a self-adhesive material, such as Fablon or Contact, over its surface apart from most of the inside area which will be against the aluminium. Material having a woodgrain pattern offers what is probably the most attractive finish. The two pieces of chipboard are then glued to the ends of the chassis by means of epoxy resin applied to the uncovered sections of the chipboard.



A further look at the front panel of the tuner, showing its neat and simple finish

NEXT MONTH

In next month's concluding article constructional details will be given for the power supply and tuner printed boards, after which the stereo decoder circuit and its assembly will be described. The accompanying Components List specifies the parts required for the power supply and tuner sections. A further Components List for the decoder section will appear in Part 2.

(To be concluded)

THE NOR GATE

by C. F. Edwards

A swift sojourn with a neglected member of the t.t.l. family.

For some reason, NOR gates do not appear to have the popularity that is enjoyed by NAND gates and the more complex t.t.l. (transistor-transistor logic) i.c.'s which are so readily available these days. Perhaps this is because they don't fit so readily into quickly designed logic systems. In consequence, it will do no harm to briefly examine a commonly encountered NOR gate, such as that which is incorporated in the SN7402 integrated circuit.

SN7402 GATE

The SN7402 has the internal circuitry shown in block form in Fig. 1, and it contains four 2-input NOR

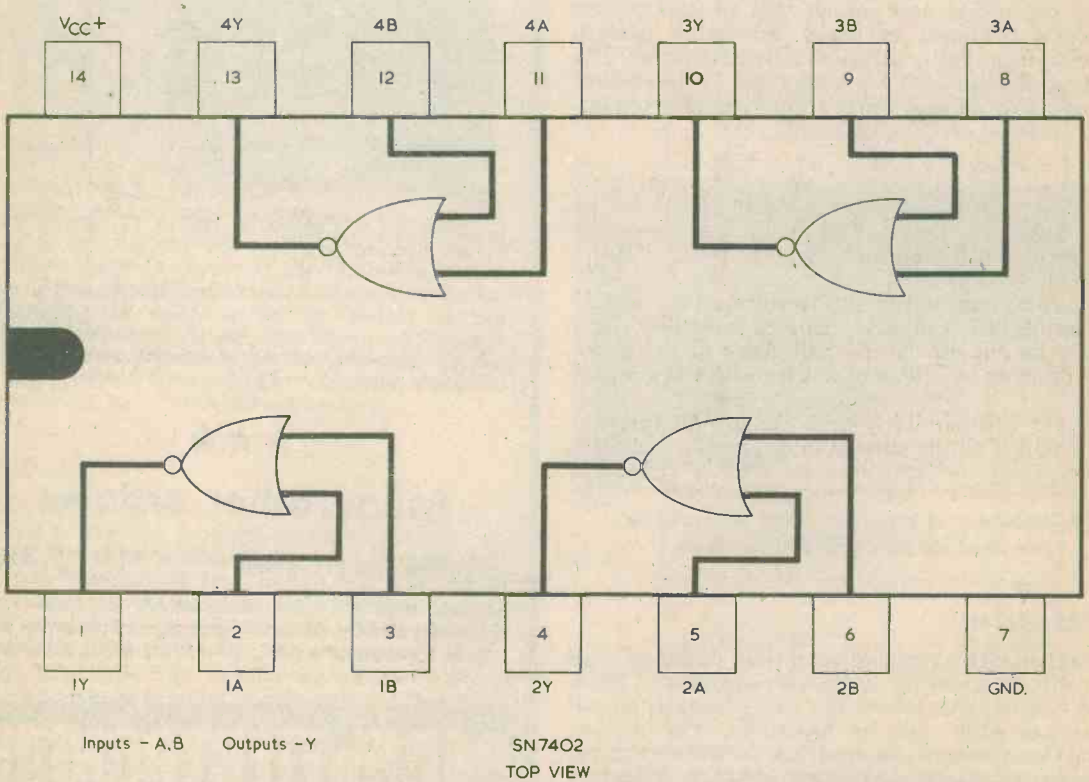


Fig. 1. Block diagram illustrating pin allocation and internal functions of the SN7402. As is common with integrated circuit pin layout diagrams, the pins point away from the reader

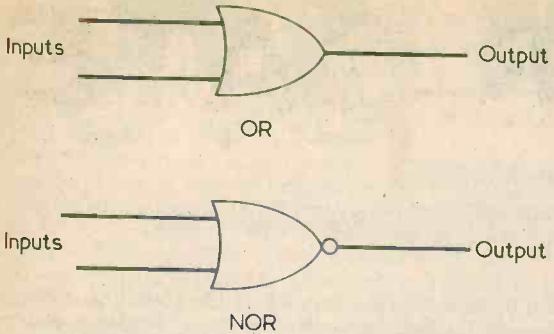


Fig. 2. Adding a circle at the output of an OR gate symbol changes it to a NOR gate symbol

gates. The gates are shown as OR gates (in which the input lines pass to a curved concave outline) having a circle at the output to indicate inversion. See Fig. 2. With t.t.l. positive logic, in which 1 is represented by a high positive voltage with respect to ground or earth and 0 by a low positive voltage, an OR gate will give an output 1 when any one or more of its inputs is raised from 0 to 1. With a NOR gate the output is inverted. The NOR gate output falls from 1 to 0 when any one or more of its inputs rises from 0 to 1.

Fig. 3 shows the truth table for a 2-input NOR gate. The input columns are headed A and B and the output column is headed Y. When both the inputs are at 0, as occurs in the first line, the output is at 1. As is shown in the second, third and fourth lines, the output falls to 0 when A is 1, when B is 1 and when both A and B are 1.

The circuit of one of the SN7402 NOR gates appears in Fig. 4. If both inputs A and B are at 0 they are only slightly positive of ground potential, and transistors TR1 and TR4 are turned hard on. Resistors R1 and R3 allow the bases of TR1 and TR4 to be about 0.6 volt positive of the emitters. The collectors of the two transistors will be just slightly positive of the emitters.

These collectors, with their low voltages, connect to the bases of TR2 and TR3, causing these two transistors to be cut off. No current flows in the base-emitter junction of TR6, and this transistor is also cut off.

TR2 and TR3 similarly draw no current through R2, whereupon all the current in this resistor flows to the base of TR5, which turns on. The voltage at its emitter and, hence, that at the gate output is high, representing 1.

A	B	Y
0	0	1
1	0	0
0	1	0
1	1	0

Fig. 3. Truth table for a 2-input NOR gate

INPUT CHANGE

If input A goes up to 1, the emitter of TR1 is taken positive of its base and it cuts off. A current now flows through R1 and the forward biased base-collector junction of TR1 to the base of TR2, turning TR2 on. The emitter current of TR2 flows into the base-emitter junction of TR6 whereupon this transistor also turns on. At the same time, the collector of TR2 falls to a voltage which is only slightly positive of its emitter and consequently takes the base of TR5 negative. Thus the output goes low, representing 0.

Transistor TR3 takes no part in this process because it remains cut off.

If it had been input B instead of input A which changed from 0 to 1 the same process would have occurred, with TR4 and TR3 performing the same functions as TR1 and TR2 respectively. If both inputs rise to 1 the output again falls to 0, as TR2 and TR3 merely duplicate each other's function.

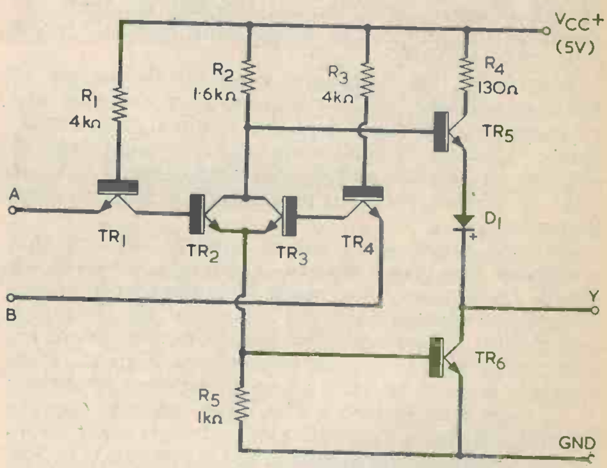


Fig. 4. The internal circuit of one of the 7402 NOR gates. The resistor values shown are nominal

The purpose of diode D1 is to ensure that TR5 is fully cut off when TR6 is hard on. Under this condition, the collector of TR6 is about 0.2 to 0.3 volt positive of its emitter. TR5 can then only pass current if the voltage at its base is about 1.2 volts positive of TR6 collector, the 1.2 volts being made up of an 0.6 volt drop in D1 and a further 0.6 volt drop in the base-emitter junction of TR5. The voltage delay given by D1 takes up the border-line case, which can occur during transition from one state to the other, where TR2 (or TR3) is not turned fully on and its emitter-collector voltage approaches some 0.8 to 0.9 volt. ■

SHORT WAVE NEWS

FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

Scanning the higher frequency bands recently we noted a few stations of interest to the S. W. Listener. The Holy Qur'an Station at Riyad, Saudi Arabia on **15245** at 2000 signing-off with the National Anthem after readings from the Qur'an (westernised incorrectly as Koran) and station identification in Arabic. The schedule of this programme, which consists entirely of readings from the Holy Qur'an is from 1700 to 2000.

Another Arabic transmitter is that of Radio Kuwait, which was logged at 2010 on **9715** when radiating the Domestic Service on this channel, the schedule being from 1830 to 2215.

A further Arabic station, Radio Baghdad, was logged at 1803 on **9745** with a talk in Arabic in the "Voice of the Masses" programme directed to Arab expatriates in Europe, the programme schedule being from 1500 to 1930.

Also for S. W. Listeners, we noted Jerusalem at 2025 on **15100**, OM with identification and announcements at the end of the English programme; Radio Grenada at 2032 with cricket commentary in English on **15105**, and W1NB Red Lion, U.S.A., at 2035 on **15185**, religious programme in English after identification.

For the Dxer, the item of possible interest this month is Voz del Caqueta, Colombia, at 0445 on **5035**. Local music and songs then the identification with three chimes followed by chord on Hawaiian guitar both before and after identification which, incidentally, has an added echo-effect. Sign-off after trumpet fanfare at 0457 without National Anthem.

In very general terms, the Dxer tends to operate from **6000** down to **2200** kHz although often resorting to the HF bands in search of Dx stations. The SW Listener mostly uses bands from **6000** kHz upwards to **21750** or so, hence the division of schedules listed under China — see Current Schedules.

CURRENT SCHEDULES

Readers are reminded that all short wave schedules are liable to be altered at short notice, those published here are correct at the time of writing.

● U.S.S.R.

From the regional centre of Kiev, "Radio Kiev" operates an External Service in English to Europe from 1930 to 2000 on **7205, 7390** and on **11890**. The service is transmitted via the technical facilities of Radio Moscow.

"Radio Vilnius" presents a programme in English on Saturdays and Sundays directed to North America and Europe from 2230 to 2300 on **9655, 9720** and on **11900**. This service is also transmitted by the technical facilities of Radio Moscow.

Dxers may be interested in listening for the "Pacific Ocean Radio Station", Vladivostock which, according to the BBC Monitoring Service, operates from 0700 to 0800 in Russian to the Pacific and North America on Sundays, Wednesdays, Fridays and on Saturdays and daily to the Far East, Middle East and South Asia on **5015, 9520, 9600, 9645, 9770, 9810, 11740, 15100, 15130, 15190, 17745, 17765, 17805** and **17835**. The above transmission is relayed by Magadan on **4030, 5940** and **12240**, Petropavlovsk-Kamchatka on **4485**, Yuzhno-Sakhalinsk on **4050** and by Kharbarovsk on **7210**. From 1430 to 1530 in Russian to the Pacific and the Middle East on Sundays, Wednesdays, Fridays and Saturdays and daily to the Far East and South Asia on **7245, 7290, 9590, 9690, 9735, 11795, 11820, 11835** and on **12010**. From 1900 to 2000 in Russian to the Pacific and North America on Sundays, Wednesdays and Fridays, to the Far East and South Asia on Saturdays on **5015, 6060, 6150, 6200, 7100, 7160, 7170, 7280, 7295, 7315, 9710, 9735** and on **12010**.

"Radio Tashkent" has an External Service in English for South Asia from 1200 to 1230 and from 1400 to 1430 on **11730, 11925, 15115** and on **15460**.

● CZECHOSLAVAKIA

"Radio Prague" radiates an External Service in English for Africa, South East Asia and Europe from 1530 to 1630 on **6055, 7345, 9605, 11990, 15110, 17840** and on **21670**. To the U.K. and Eire from 1630 to 1700 on **5930** and **7345**; from 1900 to 1930 on **5930, 7245** and on **7345**; from 2000 to 2030 on **5930** and **7345** and from 2130 to 2200 on **5930, 7345, 9540, 11990** and **17840**. "Radio Prague" also operates an "Inter-Programme" to Europe in English as follows — from 0745 to 0800, 0845 to 0900, 0945 to 1000, 1045 to 1100, 1145 to 1200 on **6055** and on **9505**, transmissions consisting of either a news bulletin or a commentary or a short feature programme.

● CUBA

"Radio Havana" offers an English programme directed to Europe from 2010 to 2140 on **17885**.

● SPAIN

"Radiotelevision Espanola", Madrid, has an External Service in which is featured an English transmission to Europe from 2130 to 2230 (not Sundays) on **6075** and on **9505**.

● CHINA (FOR S.W. LISTENERS)

"Radio Peking" schedules English programmes to Europe from 2030 to 2130 on **6590, 6860, 7590, 9030** and on **9880**; from 2130 to 2230 on **5090, 6590, 6860, 9030** and on **9840**.

The Domestic Service (First Programme) in Standard Chinese can be heard on **7935** from **1518** to

1735, 2000 to 2300; **10245** from 1100 to 1230, 2202 to 0100; **12120** from 2300 to 0800 (except Wednesdays and Friday's when 0500 to 0800); **12420** from 0829 to 1735, 2203 to 0415; **15230** from 2338 to 1130; **15550** from 0103 to 1040; **15590** from 2303 to 1515 and on **17605** from 0418 to 0828.

The Domestic Service (Second Programme) in Standard Chinese may be logged on **7770** from 1203 to 1600, 2100 to 2330; **9670** from 0700 to 1200; **9745** from 0700 to 1428; **11040** from 2333 to 1400 (on Tuesdays 0600 to 0800 only); **11505** from 2333 to 1200 (on Tuesdays 0600 to 0900 only); **12200** from 0003 to 1100 and on **15030** from 2300 to 0800.

"Radio Peking" also operates an External Service in Standard Chinese, Amoy and Hakka directed to Taiwan as follows — on **9170** and **11100** from 0830 to 1900 and from 2000 to 0610 (Sundays to 0655); on **15710** from 0830 to 1429 and from 2316 to 0610; on **15880** from 0830 to 1225 and from 0016 to 0610. This service (to Taiwan) is also relayed by the PLA Fukien Front Station from 1200 to 1215, 2100 to 2130 and from 0400 to 0415 (also see below).

● CHINA (FOR THE DXER)

The Domestic Service (First Programme) in Standard Chinese on **3450** from 1233 to 1735, 2000 to 2200; **4460** from 1133 to 1735, 2000 to 2335; **4800** from 1100 to 1735, 2000 to 0100; **4905** from 2000 to 2200; **5320** from 1043 to 1735, 2000 to 0100; **5860** from 100 to 1735, 2000 to 0100 and on **6665** from 1100 to 1735 and 2000 to 0100.

The Second Programme in Standard Chinese may be located on **4250** from 1333 to 1500, 2100 to 2240; **4850** from 1403 to 1600, 2100 to 2400; **5075** from 1103 to 1600, 2100 to 2400; **5163** from 1203 to 1600, 2100 to 2400; **6345** 1403 to 1600, 2100 to 2330 and on **7190** from 2243 to 1330.

To Taiwan in Standard Chinese, Amoy and Hakka ("Radio Peking") on **5125** from 1430 to 1900, 2000 to 2315 and on **6890** from 1226 to 1900 and from 2000 to 0015.

The PLA (People's Liberation Army) Fukien Front Station operates its own schedule in Standard Chinese and Amoy in addition to the relays shown above. Transmissions may be tuned in on the following channels — **2490** from 1000 to 0025; **3000** from 1201 to 2400; **3535** from 1413 to 2241; **3640** from 1415 to 2241; **4045** from 1000 to 0530; **4330** from 1000 to 0144; **5240** from 1000 to 1412, 2242 to 0530; **5265** from 1000 to 1414, 2242 to 0530; **5900** from 1000 to 1200, 0001 to 0530; **6765** from 0026 to 0530 and on **7850** from 0145 to 0530.

● CHINA (FOR ALL LISTENERS)

"Radio Peking" operates an extensive round-the-clock service in Russian, a convenient time to log these would be from 2130 to 2225 on **6545, 6645, 6900, 6930, 6990, 7035, 9340, 9370, 9390, 9440** and on **9696.** However, a word of warning, to avoid interference some channels may vary by as much as 10kHz. Or why not listen to a reversed tape transmission on **5220** and **8260** which may be logged from 0900 to 0955, or even a reversed tape single-sideband signal on **6550** from 1830 to 1925! (All this information according to the BBC Monitoring Service).

● BANGLADESH

"Radio Bangladesh", Dacca, transmits an External Service in English to Europe from 1230 to 1300 on **15270**; from 1815 to 1915 on **9550** and **11970.**

● PAKISTAN

"Radio Pakistan", Karachi, features a newscast in English at slow speed directed to Europe from 1100 to 1155 on **15110** and **17665** and transmissions in the World Service directed to the U.K. as follows — in Urdu from 0830 to 1100 on **15110** and on **17665**; from 1915 to 2145 on **9445** and **11672** (1915 to 2045 in Urdu; 2045 to 2100 in Sylheti; 2100 to 2145 in English).

● GERMANY (EAST)

"Radio Berlin International" schedules a service in English to Europe from 1830 to 1915 on **6080, 6115, 7185, 7300** and on **9730**; from 2115 to 2200 on **7260.**

● PORTUGAL

"Radiodifusao Portuguesa", Lisbon, currently lists a broadcast in English to Europe from 2030 to 2100 on **6025** and on **9740.**

● CLANDESTINE

"Voice of the Malayan Revolution", in Malay "Inilah Suara Revolusi Malaya", is a pro-communist transmitter attacking the governments of both Malaysia and Singapore and is thought to be located near Changsha in Hunan Province of China. The schedule commences at 0430 and ends at 0005 in various time-periods throughout the day, probably the best chances of logging this one would be from 2200 to 2245 in Malay, 2245 to 2320 in Standard Chinese and from 2330 to 0005 in Tamil on **7305** and on **15790**, at which times this month the short signal path will be mostly in darkness. Transmissions in English are made from 0930 to 1015 and from 1450 to 1530 on **11830** and on **15790**, the latter period being best for U.K. reception.

"Voice of the People of Thailand", in Thai "Thi Ni Sathani Vithayu Sieng Prachachon Heang Prathet Thai", is controlled by the Communist Party of Thailand and the transmitters are thought to be located in the Kunming area of Yunnan Province in China. The transmissions are in Thai, Laotian and White Meo and may be located on **6033** and on **9423**. Try for the 1530 to 1610 or the 2300 to 2340 transmissions in Thai.

"Voice of the People of Burma", in Burmese "Myama-pye Pey-thu Ah-than" in Chinese "Mien-tien Jen-min Chih Sheng Kuang-po Tien-tai", is pro-Burmese Communist Party and is thought to be located on, or very near, the Burma/China border. The frequency is **5110** and the transmissions are as follows — from 0030 to 0130 in Burmese (Tuesdays, Thursdays, Fridays, Sundays), Standard Chinese (Saturdays), Shan (Wednesdays), Jingpaw (Mondays); from 1200 to 1300 in Burmese (Tuesdays, Thursdays, Fridays, Saturdays), Standard Chinese (Saturdays), Shan (Wednesdays) and Jingpaw (Mondays). All according to the BBC Monitoring Service.

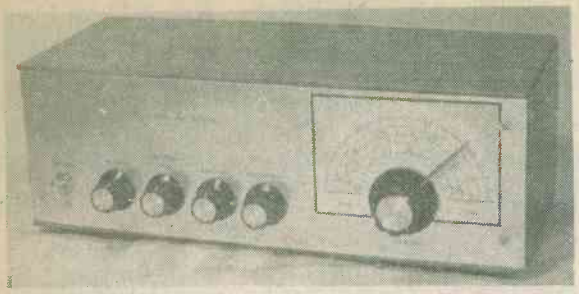
AROUND THE DIAL

● INDIA

Air Delhi on **3365** at 1730, local music, OM in vernacular then suddenly off without National Anthem.

● COLOMBIA

Ecos del Atrato, Quibdo, on **5020** at 0335, YL with songs in Spanish, local music under some commercial interference. The schedule of this one is reportedly from 0100 to 0515 variable — as is the frequency, it can be sometimes be logged on, or near, **5016!**



3-BAND SHORT WAVE RADIO

Part 2 By A. P. Roberts

In the article which appeared last month the circuit and construction of this t.r.f. design were described. Notes on operation are given in this concluding article, together with details of the a.f. output stage which enables the receiver to drive a loudspeaker.

In last month's issue a description was given of the circuit and construction of this receiver with the exception of the optional a.f. output stage. The latter is covered in the present concluding article, but details will be given first of the aerial and earth required, and of receiver operation.

AERIAL AND EARTH

The receiver is intended for use with an external long wire aerial. As it has good sensitivity, a short indoor aerial will provide reception of a large number of transmissions, including many quite distant ones. However, for best results a long outdoor aerial is required. This should preferably be about 20 metres or more long and set up as high as possible. It will be more efficient if it is positioned well clear of any buildings or similar obstructions. It should be insulated from its supports and from anything else with which it comes into physical contact.

An earth connection is not essential, and is only likely to add significantly to signal strength when the Range 3 coil is in use. An earth merely consists of a metal plate or pipe buried in moist soil, this being connected to the receiver by way of a wire which should be as short as is reasonably possible. In general, the larger the surface area of the metal plate or pipe the more efficient the earth will be.

In the receiver circuit (published last month) the aerial has a d.c. coupling to the gate of TR1, the r.f. amplifier, by way of the r.f. gain control VR1. Unless suitable precautions are taken a very long wire aerial is capable of picking up a static voltage under certain conditions, but the relatively low resistance to earth offered by VR1 should be more than adequate to discharge any static voltages which might appear when the receiver is used in the U.K. If the receiver is employed overseas with a long aerial in areas where static may be produced, an isolating plastic foil capacitor of $0.01\mu F$ may be inserted between socket SK1 and the slider of VR1, and a $22k\Omega$ $\frac{1}{4}$ watt resistor connected between SK1 and SK2. Under these conditions an earth connection must be provided.

USING THE RECEIVER

A little practice will probably need to be gained with the receiver before optimum results are obtained.

S1 is an ordinary on-off switch, The aerial connects to SK1, the earth (if used) to SK2, and the headphones to SK3. It is best to use the Range 4 coil when initially testing the receiver, as this will provide a large number of very strong signals.

Start with VR1 fully advanced, VR2 about two-thirds advanced, and VC3 at minimum capacitance. As supplied, the cores of the coils are fully screwed into the formers. The core of each coil should be unscrewed so that about 10mm. of the brass thread protrudes from the top of the former.

VC1 is used to search the band for signals, fine tuning being carried out by VC2. If a whistle of varying pitch is heard as the receiver is tuned across a station, this means that too much regeneration is being applied and VR2 should be backed off slightly. The set is most sensitive when the regeneration is adjusted to just below the point at which the circuit breaks into oscillation (causing the characteristic whistle in the headphones).

It will usually be necessary to advance the regeneration control VC3 (i.e. increase its capacitance) in order to bring the receiver to just below the threshold of oscillation. For best results VR2 should always be well advanced, with VC3 advanced as far as is necessary to produce an output of good volume. If the set oscillates even with VC3 at minimum capacitance, then VR2 is backed off a little to bring the circuit just below the point of oscillation.

S.S.B. (single sideband) and c.w. (morse) signals are the main modes of transmission in use on the amateur bands, and these can be resolved by adjusting the circuit so that it is just beyond oscillation point and, for s.s.b., adjusting VC2 to produce an intelligible output. Strong s.s.b. signals may overload the detector, resulting in a very distorted audio signal. Advancing VC3 further, or backing off VR1, should prevent this. For c.w. signals, VC2 is adjusted for a tone of the required frequency.

Very strong a.m. signals may also overload the detector. The effect given is a high level of background noise accompanied by several stations which cannot be tuned out and which occupy an excessively large part of the band. For correct reception under these circumstances it is necessary for VR1 to be turned back slightly.

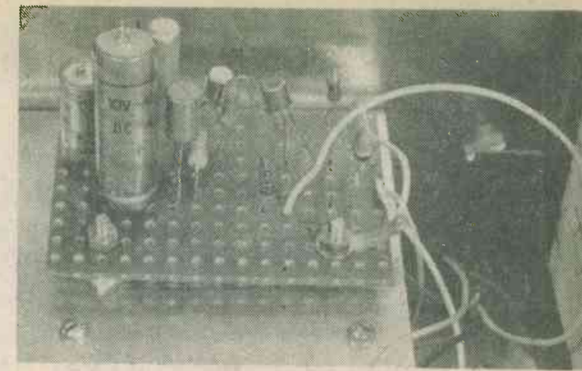
OUTPUT STAGE

The optional a.f. output stage is added if it is required that the receiver drive a loudspeaker. The circuit of the stage is given in Fig. 7, and it provides an output of up to about 200mW into a 25Ω speaker. Speakers with impedances below 25Ω must not be used, but it is in order to employ speakers with higher impedances. However, these will cause the maximum available output power to be reduced. The speaker is installed in its own case, external to the receiver.

The circuit of Fig. 7 is fairly conventional, and comprises a common emitter Darlington pair (TR5 and TR6) driving two complementary emitter follower output transistors (TR7 and TR8). R13 provides the usual base bias for the output transistors, the bias voltage being a little lower than would normally be employed. This does not result in any noticeable crossover distortion as a high level of negative feedback is provided over the amplifier as a whole. The second a.f. amplifier in the receiver, TR4, provides quite a high level of drive, and so the output stage is called upon to offer only a very low voltage gain. The prototype uses the high gain BC109C for TR5 and TR6. Standard BC109's could alternatively be used, but there might be a slight loss of performance with these.

C13 and C14 have values which prevent problems with low frequency instability. C12 is the output d.c. blocking capacitor. The quiescent current drawn by the output stage is about 5mA, whereupon the quiescent current taken by the complete receiver with output stage is approximately 11mA.

The parts required for the output stage appear in the accompanying Components List.



The Veroboard panel on which are assembled the a.f. output stage components

CONSTRUCTION

The output stage components are assembled on a piece of 0.15in. matrix Veroboard having 15 by 10 holes. The layout is given in Fig. 8.

First cut out a board of the required size and drill out the two 6BA clear mounting holes. Next cut the strips at the two points indicated with crosses, using a small twist drill or the special Vero spot face cutter tool. Next fit and solder the components. Take care to ensure that the connections to TR7 and TR8 are made fairly quickly. These are germanium transistors and are more liable to be damaged by heat than are the other silicon transistors.

The output stage panel is fitted above the chassis in the position indicated in Fig. 4 (published last month). Using the panel as a template mark out, and then drill, the two 6BA clear holes required in the

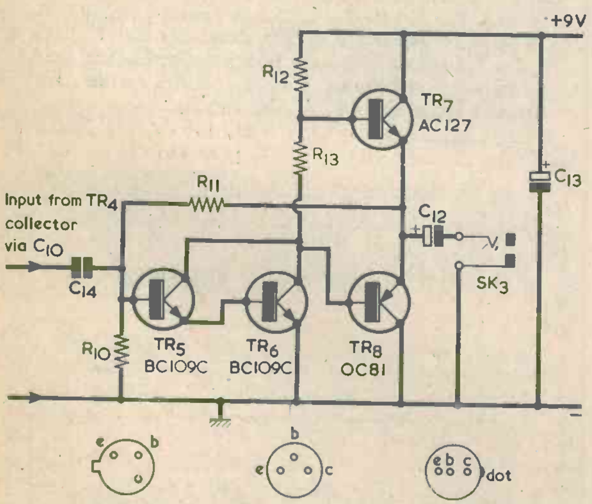


Fig. 7. The circuit of the a.f. output stage

COMPONENTS

Resistors
(All ¼ watt 10%)
R10 10kΩ
R11 33kΩ
R12 1.8kΩ
R13 180Ω

Capacitors
C12 100μF electrolytic, 10 V. Wkg.
C13 470μF electrolytic, 10 V. Wkg.
C14 0.022μF type C280 (Mullard)

Semiconductors
TR5 BC109C
TR6 BC109C
TR7 AC127
TR8 OC81

Miscellaneous
Veroboard, 0.15in. matrix
Speaker, 25Ω impedance

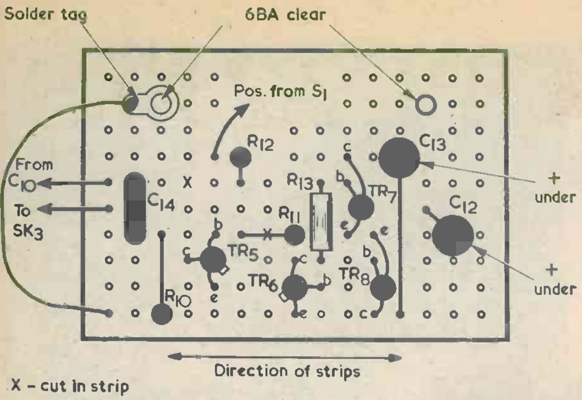
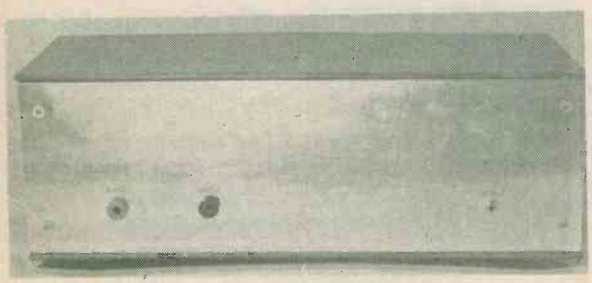


Fig. 8. Component layout and wiring on the output stage Veroboard panel. The solder tag is secured under one of the mounting nuts and provides the chassis connection for the panel

chassis. After it has been wired to the other sections of the receiver the panel is mounted, with spacing washers, in the same way as was the receiver panel.

The lead which now connects C10 of the receiver panel to SK3 is removed from SK3 and connected to C14 on the output stage panel. A lead from the output stage panel now connects to SK3, whilst a third lead connects to the tag of S1 which is remote from the battery. (If desired, the input lead to C14 may be connected direct to the collector of TR4 on the receiver panel, whereupon C10 is not required and can be removed.)

It should be noted that the receiver will still feed medium to high impedance headphones with the output stage fitted. These are plugged into SK3, just as before, and a little more gain and volume will be available.



The output jack socket, together with the aerial and earth sockets, is mounted on the rear panel of the receiver

FINAL POINTS

A finishing touch consists of adding a wire pointer to the tuning knob for VC1 by means of a suitable adhesive, and of fitting a tuning scale to the panel behind it. The tuning scale visible in the photograph of the prototype front panel is taken from "Panel Signs" Set No. 5. The controls were marked with legends indicating their functions, these being taken from "Panel Signs" Set No. 4. "Panel Signs" are available from the publishers of this journal.

If a calibrated signal generator is to hand, the scale can be marked up in terms of frequency. Should no calibration source be available the scale is marked with the position of the amateur and broadcast bands, as received. ■

SOME

By R. River

1. Charlie comes into the workshop with a box containing resistors.

He says to Jack, Fred, Jim and Joe: "I have no further use for these resistors, take what you want."

Jack takes half the total number of resistors plus half a resistor.

Fred takes half the remainder plus half a resistor.

Jim takes a quarter of the remainder plus half a resistor.

Joe takes the remaining resistor.

What is the lowest number of resistors that Charlie gave away? (No resistors were broken in two.)

2. A computer is made up with integrated circuits. There are 100 different types of i.c. in the computer, the types being numbered from 1 to 100 inclusive.

The whole circuit requires 100 of type 1, 99 of type 2, and so on to 1 of type 100.

What is the total number of i.c.'s used in the computer?

3. A service manager is hard pressed and his two best repair men are off work due to illness. There are 32 colour sets which must be repaired as soon as possible.

A free-lance service engineer offers to repair the 32 sets at the following rates: ½p for the first set, 1p for the second set, and so on, doubling the charge for each set. The service manager agrees to this.

Why did the service manager faint when he received the repair bill?

4. In an electronic calculation a certain parameter, x, is equal to the cube root of the sum of the cubes of the other circuit quantities, L, R and C. The relationship is shown in Fig. 1.

If L is 3, R is 4 and C is 5, what is the value of x?

$$X = \sqrt[3]{L^3 + R^3 + C^3}$$

Fig. 1. The equation encountered in problem 4

ELECTRONIC PUZZLES

Here are some problems which merit a period away from the work bench. The puzzles are mainly of a mathematical nature and include an acknowledged oldie together with one or two minor stinkers. Solutions are given on page 115.

5. You have seven precision resistors with values respectively of 1Ω, 2Ω, 4Ω, 8Ω, 16Ω, 32Ω and 64Ω. How many values of resistance in 1Ω steps between 1Ω and 100Ω can be produced by single resistors or series combinations of two or more of these resistors?

6. The first line in Fig. 2 illustrates that ¼MHz is equal to 250,000Hz. The square roots must also be equal, as shown in the second line, but this leads to the obviously untrue third line. What has gone wrong?

$$1/4\,\text{MHz} = 250{,}000\,\text{Hz}$$

$$\sqrt{1/4\,\text{MHz}} = \sqrt{250{,}000\,\text{Hz}}$$

$$1/2\,\text{MHz} = 500\,\text{Hz}$$

Fig. 2. The first equation is obviously true, as also is the second equation which follows from it. But we then arrive at the very peculiar relationship which appears on the third line

7. Fig. 3 illustrates a venerable puzzle which continues, nevertheless, to have traumatic effects amongst those who have not yet encountered it. The cube is made up of 12 resistors, and each resistor has a value of 1Ω. What is the resistance between the opposite corners X and Y?

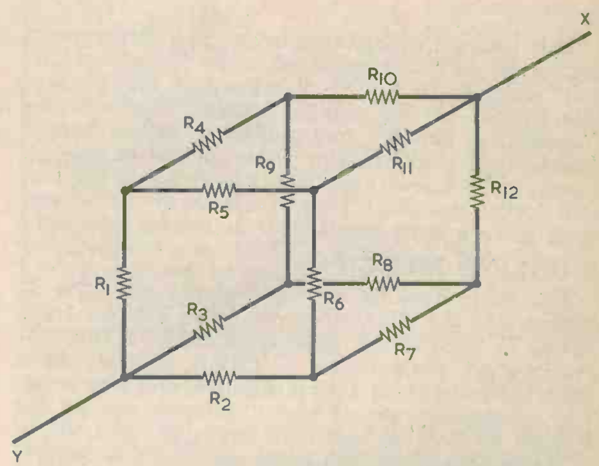


Fig. 3. A cube is made up of equal value resistors

8. A resistor and a capacitor cost 11p. The capacitor costs 10p more than the resistor.
How much does the resistor cost?

9. A serviceman in a radio controlled van is out on a call. After travelling at 15 m.p.h. he is 1 mile from base when he is redirected to go to the home of the service manager's mother-in-law, which is 2 miles from base in the same direction.
How fast must he drive the extra 1 mile to average 30 m.p.h. for the total 2 mile trip? ■

For solutions see page 115.

Constructor's Crossword Solution

Across

1, Switches. 5, Esters. 9, Radiance. 10, Getter. 12, Atomic. 13, Anode Ray. 15, Electroplate. 18, Radio Compass. 23, Negatron. 24, Alkali. 26, Flange. 27, Tracking. 28,Rohans. 29,Open Gate.

Down

1, Serial. 2, Indoor. 3, Coaxial. 4, Each. 6, Speed-Up. 7, External. 8, Spray Jet. 11, Entropy. 14, Echo Box. 16, Transfer. 17, Odograph. 19, Octagon. 20, Silicon. 21, Lamina. 22, Single. 25, Trip.

TONE-CANCELLING CAPACITANCE BRIDGE

by
W. R. Jenkins

A novel design in which the capacitance to be measured is balanced against another of equal value.

This unusual capacitance bridge is a development from a design which appeared in the "Suggested Circuit" series by G. A. French in the July 1974 issue of this journal. In the original article, "Multivibrator Capacitance Bridge", two opposing outputs from a symmetrical multivibrator were applied to the unknown and a known capacitance in series. In the present design, two amplifying transistors are added and these allow a more identifiable null to be achieved.

WORKING PRINCIPLE

The basic working principle of the circuit is illustrated in Fig. 1(a), where TR1 and TR2 are transistors in a 50:50 a.f. multivibrator. At a first approximation, the collector of TR1 is always positve when the collector of TR2 is negative, and vice versa. The consequent out of phase collector signals are applied to CX, the unknown capacitor, and VC, a calibrated capacitor. When the values of CX and VC are equal, there should theoretically be zero signal at the junction of the two capacitors. A pair of high resistance headphones is connected between this junction and the lower supply rail, whereupon VC can be adjusted for a null signal in the phones and the value of CX read from the VC calibration.

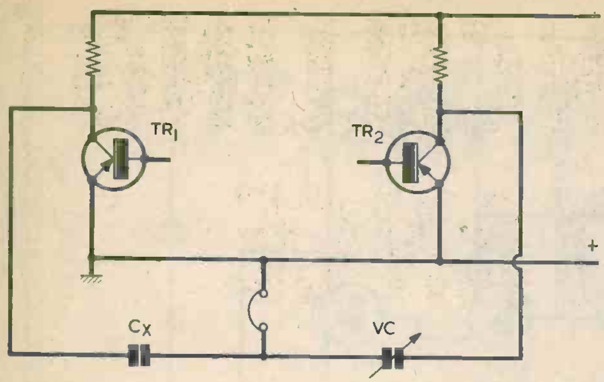
In practice, the signals at the collectors of TR1 and TR2 are not always out of phase with each other. For instance, at the period in the multivibrator cycle when TR1 turns off its collector potential does not rise immediately to that of the upper supply rail. Instead, it rises relatively slowly as the cross-coupling capacitor connected to the collector charges. Similarly, the collector potential of TR2 rises relatively slowly after the instant in the cycle when this transistor turns off. In consequence, the signal voltages applied to CX and VC are not exactly opposite to each other and the null given when these two capacitances are equal consists of a change in the character of the tone in the headphones rather than a marked diminution of its amplitude.

The null given by the arrangement of Fig. 1(a) is still quite detectable, but an improvement can be obtained by adding two transistors in the manner shown in Fig. 1(b). Here, TR3 and TR4 have their base-emitter junctions inserted in the emitter circuits of TR1 and TR2. Since these base-emitter junctions are connected to be forward biased they have no effect on multivibrator operation apart from a slight lowering in frequency. At the same time, the circuit allows TR3 to turn on and off at the same times as does TR1, and allows TR4 to turn off at the same times as does TR3. There are no cross-coupling capacitors to the collectors of TR3 and TR4 and so the collector potentials of these two transistors rise almost immediately to that of the upper supply rail after the instants of changeover which turn off TR1 or TR2. As a result, the signals obtained at the collectors of TR3 and TR4 are more truly opposite to each other throughout the multivibrator cycle than are those at the collectors of TR1 and TR2.

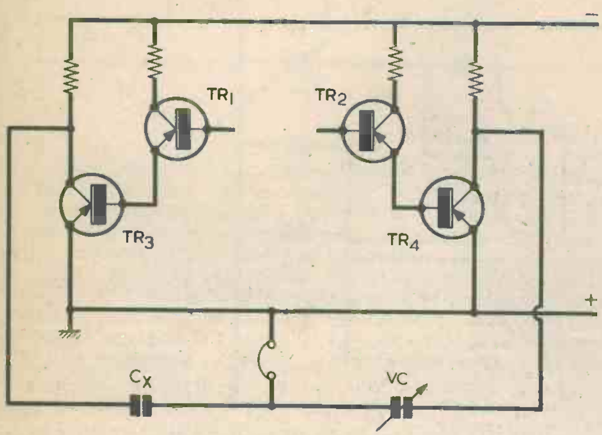
In Fig. 1(b) the collectors of TR3 and TR4 are applied to CX and VC, and VC is once again adjusted for a null in the headphones. Even with this circuit there is not a complete cancellation of the multivibrator tone at balance, but the reduction in amplitude and change in tone character are significantly more evident than occurs with the circuit of Fig. 1(a).

There are several advantages in the circuit of Fig. 1(b) when compared with a more conventional type of bridge of simple design. The first of these is that one of the headphone leads is at chassis potential, with the result that bridge readings are not affected by changing capacitances between the headphone leads and earth. Second, the collector resistors of TR3 and TR4 can be given low values, whereupon one terminal of CX and one terminal of VC connect to low impedance points in the circuit.

There is one disadvantage in the circuit, this being that the maximum capacitance which can be



(a)



(b)

Fig. 1(a). Basic circuit illustrating the functioning of the capacitance bridge
(b). An improvement in performance is given by adding the transistors TR3 and TR4

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
R1 470Ω
R2 2kΩ
R3 15kΩ
R4 10kΩ
R5 2kΩ
R6 1kΩ
R7 100Ω
VR1 1kΩ pre-set potentiometer, skeleton
VR2 10kΩ pre-set potentiometer, skeleton
VR3 25kΩ potentiometer, log

Capacitors
C1 0.047μF plastic foil
C2 0.047μF plastic foil
C3 50pF silvered mica or polystyrene
C4 1,000pF silvered mica or polystyrene
C5 100μF electrolytic, 10 V. Wkg.
VC1(a)(b)(c) 500+500+500pF variable, 3-gang (see text)

Transistors
TR1 ACY19
TR2 ACY19
TR3 BC214L
TR4 BC214L

Switches
S1 3-pole 4-way, rotary
S2 s.p.s.t., toggle

Battery
B1 9 volt battery

Miscellaneous
Headphones, 4,000Ω
2 insulated terminals
2 control knobs.

measured is limited to the maximum capacitance which can be given to VC, whilst the minimum capacitance is limited by circuit strays and the reactance at a.f. of the two capacitances. In the author's circuit the total range of measurements is from 20pF to 2,300pF. In mitigation, it can be stated that this range takes in very many of the capacitances that need to be measured in the amateur workshop, including variable capacitors and small silvered mica and ceramic capacitors whose markings have become smudged or erased.

FULL CIRCUIT

The full circuit of the bridge appears in Fig. 2. Here, TR1 and TR2 appear in a standard multivibrator circuit which runs at approximately 1.3kHz. A pre-set potentiometer is inserted in the base circuit of TR2 to enable the multivibrator to be set up for 50:50 operation. TR3 and TR4 couple to TR1 and TR2 in the same manner as in Fig. 1(b), and a second pre-set potentiometer in the collector circuit of TR3 enables the outputs of TR3 and TR4 to be balanced.

VC of Fig. 1(b) can consist of any variable capacitance offering the required range, and constructors can use whatever components they may have on hand here. The metal frame of the variable capacitor should be connected to the low impedance output at TR4 collector, and should also, of course, be insulated from chassis. The author employed a 3-gang capacitor with a nominal value of 500pF in each section in conjunction with the range switching circuit shown. When range switch S1 is in position 1, it selects C3 in series with one section of the capacitor. In position 2, the single section of the capacitor is switched into circuit on its own. At position 3 all the sections of the capacitor are in circuit in parallel, and in position 4 C4 is added to this parallel combination. If this circuit is employed, care is needed in the wiring to keep stray capacitances low, and it helps if fairly thin connecting wire is used.

A testmeter having a resistance on its voltage ranges of 10,000 ohms per volt or more is required for setting up the multivibrator. The meter is switched to a low d.c. volts range (say 0-10 volts) and is connected across the collectors of TR1 and TR2. The meter may

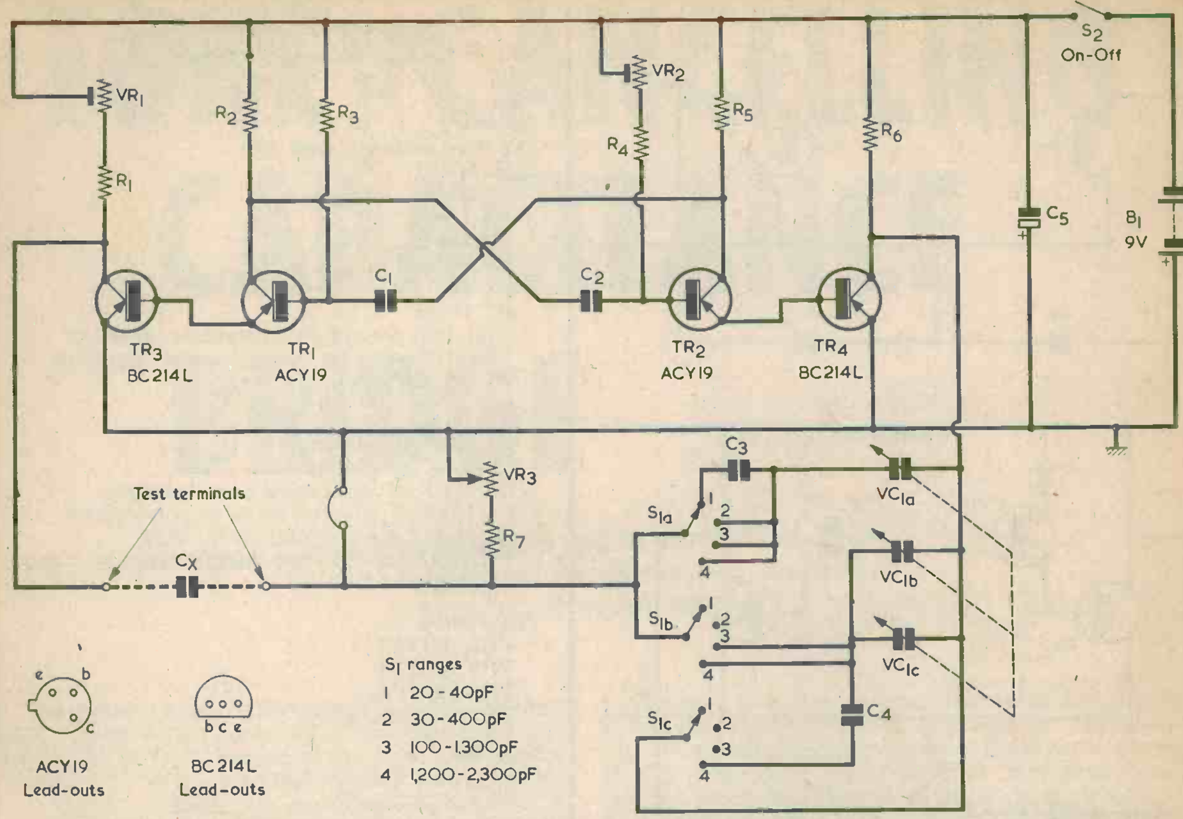


Fig. 2. Complete circuit of the tone-cancelling capacitance bridge. Alternative means of providing the VC arm may be employed if desired

give a forward or a reverse reading, and VR2 is then adjusted for a zero reading. This reading indicates that the transistors are turned on for equal periods during the cycle. The voltmeter is then removed and is connected across the collectors of TR3 and TR4. This time, VR1 is adjusted for a zero reading, and it will probably be necessary to finally switch the meter to a lower volts range than was needed with TR1 and TR2.

VR3 is included to vary the amplitude of the tone heard in the headphones. When measuring high values of capacitance it may be adjusted to reduce the volume level of the tone. With low values of capacitance it is adjusted to insert maximum resistance into circuit. It is wired such that the resistance it inserts increases as its spindle is turned clockwise. The headphones are standard magnetic types with a resistance of 2,000Ω in each phone.

The null given when the variable capacitor is adjusted is quite noticeable. The amplitude of the tone in the headphones decreases and changes from a "full" sound to one having a thin and reedy character. There is also the impression of a rise in pitch.

The bridge is calibrated with the aid of known values of capacitance connected to the test terminals. The current drawn from the 9 volt battery is 14mA.

Radio Topics

By Recorder

★★★★★★★★★★

I live and learn.

Until recently I had assumed in my innocence that, for an oscillator to work, it required positive feedback in phase from an amplifier output back to its input. But I find you can also have a perfectly respectable oscillator in which the amplifier output is out of phase with the input. And how is this magic wrought?

By hysteresis.

SCHMITT TRIGGER

If you couple the output of a t.t.l. Schmitt trigger back to its input via resistor, and add a capacitor between the input and ground, the set-up will oscillate away quite happily. A suitable Schmitt trigger is one of the two triggers in the SN7413. This actually has four inputs going to an AND gate so in practice the four inputs are joined together to form a single input.

When this input is at ground level the Schmitt trigger output is high. If the input is taken slowly positive and reaches a voltage of typically 1.7 volts above ground the output suddenly goes negative and stays negative for all further positive excursions of the input. If now we start to take the input negative towards ground the output suddenly goes high again when the input reaches a level of, typically, 0.9 volt. Thus, the Schmitt trigger exhibits a hysteresis effect which, with the SN7413, occupies a range of approximately 0.8 volt.

It is now fairly easy to see how oscillation may be obtained. Let's say that at an instant in the oscillatory cycle the input has been negative-going, has just reached 0.9 volt, and the output has in consequence just gone high. The output at once forces the input to go high via the resistor coupling them together, but the rise of voltage at the input is delayed by the capacitor between the input and ground. After a period it reaches 1.7 volts above ground whereupon the output at once goes low. The output draws the input low too, but there is again the delay resulting from the capacitor between the input and ground. When the input does reach 0.9 volt the output goes high once more; which is where we came in.

Neat, isn't it?

The resistor coupling the output back to the input needs a fairly low value because of the relatively heavy current needed to hold a t.t.l. input down, and a suitable value is of the order of 360Ω The capacitor between input and ground can be 0.1μF to 1μF.

The time constant of 360Ω and 1μF is 360 microseconds, and the capacitor is swinging between 1.7 and 0.9 volts. A very rough guess at the time taken to drop from 1.7 to 0.9 volts would be about 300 microseconds, arguing a frequency, with 360Ω and 1μF, of around 1.6kHz. But the situation is complicated by the current drawn by the Schmitt trigger input when it is taken negative and so the actual frequency of oscillation may vary quite a bit from any easily calculated figure.

STEERING BY A STAR

Marconi Space and Defence Systems Limited, one of the GEC-Marconi Electronics Companies, continue to report 100% success for their star-pointing systems which are incorporated in upper-atmosphere research rockets. The star-pointing system complements the Marconi sun-pointing control system which has already made more than 50 successful flights.

The fifth Skylark research rocket carrying the star-pointing equipment was successfully launched from Woomera Rocket Range recently. The 330kg. (720lb.) payload was carried to a peak altitude of 250km. (154 miles). During the flight the rocket acquired the target star Zeta Taurus (visual magnitude 3.0) and remained "locked on" to this star with an accuracy of six arcseconds for a period of four minutes.

The mission objective of this, a Leicester University experiment, was to measure the abundance of oxygen, helium and neon in the vicinity of the Crab Nebula by observing the absorption of low energy X-rays.

LINE OUTPUT SNAG

Coming down to earth with rather a bump I must next recount the sad plight of an acquaintance who has to switch his television set off every time he goes to the toilet.

He lives on his own and has used for many years a beat-up old valve monochrome television receiver which, he insists, he is going to hang on to until it finally breaks down. Which may occur in the fairly near future, as it has now developed an intermittent fault in the line output stage.

What happens is that every now and again the picture suddenly disappears and a quite frightening sizzling noise becomes audible from the inside of the set. My acquaintance switches it off and then leaves it for about five minutes before turning it on again. Amazingly enough, the set then resumes normal working and continues to do so until the fault appears once more. The shortest time between the occurrence of the fault has been two days and the longest time a fortnight.

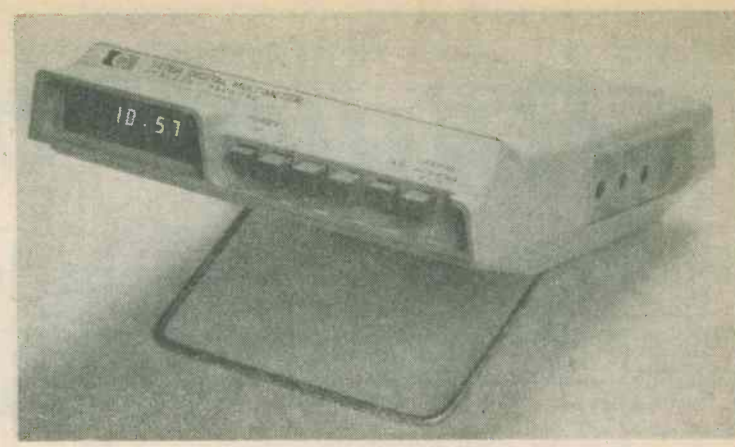
As he complains, my acquaintance is scared of leaving the TV set for any period of time whilst it is switched on in case the fault comes on whilst he is away, so that he would return to a receiver with a completely burnt-out line output stage. I must say that this is the hardest hard-luck TV story I've heard yet.

DIGITAL MULTIMETER

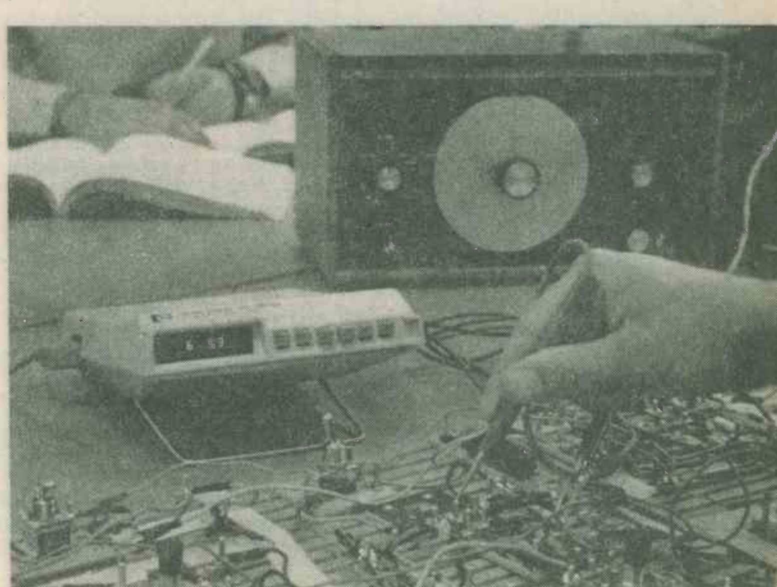
I also have photographs this month of the recently introduced Hewlett-Packard fully autoranging digital multimeter type 3476A, which is available from Hewlett-Packard Limited, King Street Lane, Winnersh, Wokingham, Berkshire. Claimed to offer comprehensive facilities at very competitive cost, this multimeter is a.c. mains operated and has dimensions of 2.3in. high, 6.6in. wide and 8.1in. deep. There is also a model 3476B which can be powered by the mains or by its own rechargable nickel cadmium batteries.

Readout is by way of a 3½ digit l.e.d., and voltages can be measured from 0.0001 to 1,000 volts d.c., and 0.0003 to 700 volts a.c. Resistance measurements are from 1Ω to 1MΩ. D.C. current range is 0.0001 to 1.1 amp, and a.c. current range is 0.0003 to 1.1 amp. Autozero and autopolarity are built in.

The manufacturers state that the low price of the digital multimeter has been achieved through a major technological advance. Development of fine-line tantalum nitride technology has eliminated the use of more costly discrete precision resistors. The tantalum nitride resistors are contained in a small pack and are matched to 0.02% by means of a laser-trim process.



The Hewlett-Packard digital multimeter type 3476A. This features autoranging, autozero and autopolarity selection.



Sorting out the voltages in a complex experimental breadboard layout with the aid of the Hewlett-Packard digital multimeter

FIRE SURPRISE

And finally a rather disturbing little incident which happened to me personally and which has to do with quite simple electricity.

In my workroom I have a standard 2-bar portable electric fire, each bar consisting of a ceramic rod having a spiral groove in which is wound the element resistance wire. Two terminals at the ends enable the bars to be quickly fitted or removed, as required.

I switched on one bar of this fire one chilly morning and noticed several minutes later that there was a bright, almost white-hot, glow at one point of the element. Thinking that a spot of dust had fallen onto the wire I dismissed the effect from my mind and started work. When I turned round several minutes later the excessive glow was still there.

This was beginning to become interesting. It was evident that there must be a thin point in the wire at the bright glow, and that the element was on the verge of expiry. I assumed that the wire would soon melt at the weak spot whereupon, since an alternating current breaks its own arc, the element would simply become open-circuit and that would be that. But I was mistaken.

Shortly afterwards the glow increased in intensity *and* size. What was more, the ceramic itself now seemed to be cooking up. And then not only did the glow get even wider and brighter but the bar started throwing out sparks onto the floor, crackling away like a miniature fireworks display. Enough is enough and I switched off. When I examined the offending rod later I found that the ceramic had actually melted and re-set at the area of the glow.

Now, this was completely unexpected. That element had a fair amount of grime on its surface and so I presume that this broke down to some form of conductive material when the wire finally became open-circuit. Molten glass, believe it or not, passes electricity so, alternatively, could the ceramic material become conductive if it was hot enough? There was no change in the brightness of the glow from the rest of the bar so about the same current was still flowing after the wire parted. The element, incidentally, registered as an open-circuit when I checked it with a testmeter after it had cooled.

Quite a mystery. But, at any event, that little episode is going to make me think very carefully before I leave a fire of this nature unattended anywhere in the future. ■

SOME ELECTRONIC PUZZLES

Solutions to the puzzles set on page 108.

1. 27 resistors.
2. 5,050 integrated circuits.
3. The repair bill was for:
   £21,474,836.47½ plus VAT.

Disregarding the initial ½p, the series 1, 2, 4p ... has 31 terms and its sum is equal to 2 to the 31st power minus 1. (Try this with shorter series: the sum of 1 and 2 is 2 squared minus 1, the sum of 1, 2 and 4 is 2 cubed minus 1.)

2 to the 31st power is:
2,147,483,648.
Subtracting 1, dividing by 100 to produce pounds and pence, and then adding the initial ½p gives the solution above.

4. 6.
5. All the values can be made up, and also values up to 127Ω. This is a use of the binary system.
6. The error is that the square root of a MHz should also be taken. The square root of a MHz is a kHz, so that the third line should read:
   ½kHz = 500Hz.
7. The resistance between X and Y is five-sixths of an ohm.

The easiest way of solving the problem consists of first assuming that a voltage is applied across X and Y and then finding points of equal potential in the cube. The cube can be redrawn in the manner illustrated in Fig. 4, whereupon inspection shows that points A, B and C are at the same potential. Since no current can flow between points having equal potential, A, B and C may be joined together without altering the overall resistance of the cube. Points D, E and F are similarly at the same potential and can also be joined. The cube may then be redrawn as in Fig. 5. (The circular presentation of Fig. 4 was first suggested to us by D. Graves, and appeared on page 640 of our April 1964 issue. — Ed.)

8. The resistor costs ½p.
9. It is impossible for the serviceman to average 30 m.p.h. for the 2 mile trip. To do this he would have to cover the 2 miles in 4 minutes, but he has already spent 4 minutes on the first mile.

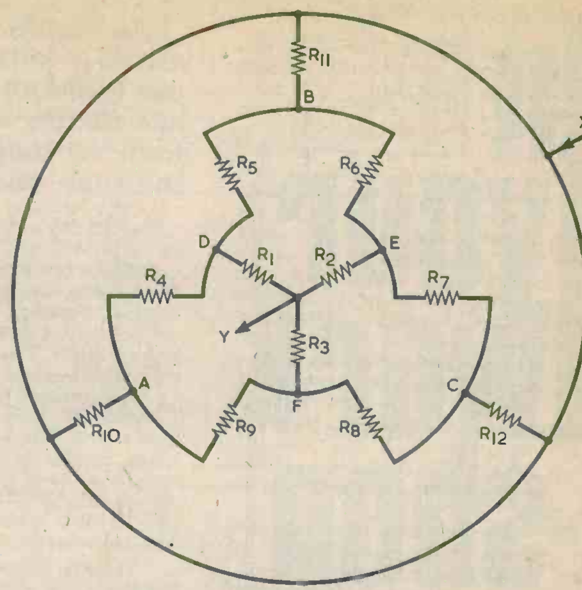


Fig. 4. The cube of resistors can be redrawn in the manner shown here

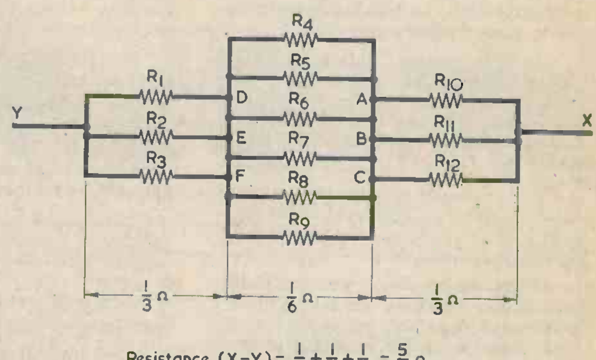


Fig. 5. If equal potential points in the cube are joined together it becomes possible to arrive at this simplification

In your workshop

As Smithy says, there must be many old valve radios stored in lofts and attics which can be brought back into use again after a few simple repairs. This month, Dick and Smithy stumble on a medium and long wave radio from the early 1950's, and Smithy demonstrates some of the basic faults liable to occur in the sets of this era.

"Cardboard boxes," complained Smithy. "Nothing else but cardboard boxes!"

"Dash it all," protested Dick. "I've got to keep things somewhere."

"Normal people," stated Smithy, "keep things in cupboards and drawers. But not you. *You* keep things in cardboard boxes. It baffles me how you can get your legs under your bench even."

The Serviceman glared at the heterogeneous collection of dusty cardboard boxes ranged on the floor underneath his assistant's bench.

"What you must do," went on Smithy accusingly, "is wait until you find a cardboard box that takes your fancy and then use it for hoarding junk. A fetish for cardboard boxes, that's what you've got."

"Hey," said Dick indignantly. "There's no call for remarks like that."

"Well," responded Smithy, "we can't have all these boxes of yours cluttering up the Workshop. Let's see what's in this one."

CARDBOARD BOXES

Smithy pulled out the box nearest him, placed it on Dick's bench and opened it up.

"Blimey," he remarked, surprised. "This is full of nothing else but control knobs. I don't think I've ever seen so many different types of control knob all together in my life."

"I never," stated Dick proudly, "throw away a control knob. Whenever we dispose of a set I always keep the knobs. You never know when you'll need one with a particular style and colour."

But Smithy's curiosity was now fully aroused and he ignored his assistant's comments as he pulled out more of the boxes and placed them on Dick's bench. These contained, respectively, a quantity of loose mains transformer laminations, resistors with short leads, a selection of 465kHz i.f. transformers, a further quantity of transformer laminations, capacitors with short leads, four small reels of 36 s.w.g. enamelled wire, several loose coils of unused electric fire element wire, a large package of six inch nails, and a third quantity of transformer laminations.

"Ye gods," snorted Smithy, surveying the boxes which now covered most of Dick's bench. "What d'you want all these laminations for?'

"I never know if I might not want to make up a special transformer for myself some day," responded Dick quickly. "Have you ever tried to *buy* laminations?"

"Well, what's the electric fire element wire for?"

"For making up very low values of resistance," replied Dick. "You can easily make up temporary resistors with the wire if you want values below about half an ohm or so."

"I suppose," conceded Smithy, "that you have a point there. There's only two more boxes left now. What's in them?"

"Search me," said Dick. "They've been here as long as I can remember."

Smithy reached down, pulled out the box which was further from the wall and placed it on Dick's bench. He opened it, gave a startled gasp and commenced searching feverishly through its contents.

"There just seems to be a lot of old mags in it," commented Dick dispassionately.

"Old mags?" repeated Smithy incredulously. "Do you know that all the issues of *The Radio Constructor* from January 1955 to December 1956 are in here? I thought I'd lost them for ever."

He looked happily at the magazines.

"This makes my collection complete all the way back to 1950 now. Blow me, that's the best find I've had for ages. This brings us to the last box of all. I wonder what we'll find in that."

Purposefully, Smithy reached down, picked up the remaining box and placed it on the bench. He wiped the dust from its surface with a rag then opened it up. His face took on a puzzled expression as he peered inside and drew out an object which he placed on the surface of Dick's bench.

It was a medium and long wave valve radio in a neat and relatively small two-tone plastic case. Its mains lead, terminated in an old-fashioned 2-pin 2-amp mains plug, was held in a neat bundle with an elastic band.

VALVE RADIO

"Stap me," breathed Dick. "Where on earth did that come from?"

"What is more to the point," stated Smithy, "is how long has it been there?"

"Well,' said Dick. "I've never ever looked inside either of those last two boxes. When did you lose the 1955 and 1956 issues of *The Radio Constructor?*"

"I don't even remember keeping them," replied Smithy, scratching his head. "They must have found their way into that box after I'd read them, and they've been there ever since."

"That means," said Dick slowly, "that the mags have been down there for around twenty years. And if the box with the radio in it was behind the one with the mags in . . ."

"That means," broke in Smithy, "that the radio has been there for at least as long as the magazines have been."

Dick gazed at the set with reluctant respect.

"If that set originally came in for a repair," he remarked, "it's certainly had to wait a long time for it! What do we do with it now Smithy, chuck it out?'

"Certainly not," retorted Smithy. "If it's got a fault, we'll fix it. The cabinet has got a few scratches on it so it wasn't brand-new when it came in. Funnily enough, this situation is much the same as occurs in quite a few households. I bet there are no end of old mains radios stored away in lofts and attics which require only a little work to get them going again. The trouble these days is that everybody is so preoccupied with solid state equipment that they've completely forgotten that you can still get an excellent performance from a valve radio. Hello, what's this?"

Smithy looked into the cardboard box and took out a folded piece of paper.

"Stone me," he remarked. "The service sheet for the radio was put in the box with it. Well, that makes our job a lot easier. There's a bit more space on my bench, so let's take the radio over there."

Dick picked up the radio and the pair walked over to Smithy's bench, on which Smithy laid out the service sheet with the circuit diagram uppermost. (Fig. 1.)

"The set's got a ferrite aerial," remarked Smithy, "and so it must have been made after about 1952, which is when ferrite aerials first started appearing. The circuit itself is dead standard. The first valve is a UCH81 triode-heptode frequency changer and the second valve is a UBF89 double-diode-pentode, with the pentode section acting as i.f. amplifier and the diodes acting as the signal and a.g.c. detector. These are followed by a UCL82 triode-pentode. This has the triode acting as an a.f. voltage amplifier and the pentode as the output amplifier. Add to that the UY85 rectifier, and that's all the valves in the set complete."

"Why do the valve type numbers all start with the letter U?"

"The letter U means that their heaters are rated at 0.1 amp. In consequence the heaters can all be connected in series with 0.1 amp passing through them. If the first letter of the type numbers had been P, they could have been used in an 0.3 amp series string. When the first letter is E the heater is rated at 6.3 volts. Many valves whose first letter in the type number is E are also rated at 0.3 amp so that they could be used in an 0.3 amp string too."

"The circuit seems pretty simple," remarked Dick. "The signal is picked up on the ferrite aerial and is applied to the bottom grid of the heptode section of the UCH81. The triode section must be the oscillator."

"That's right," confirmed Smithy, "and the oscillator signal is coupled into the third grid of the heptode. The i.f. signal is taken off the anode of the heptode and passed by the first i.f. transformer to the signal grid of the pentode section of the UBF89. This gives further amplification and the i.f. signal is then detected by the diodes and appears across the 100kΩ resistor and volume control in series. The voltage at the top of the 100kΩ resistor goes more negative as signal strength increases and this voltage is fed back to the signal grids of V1 and V2 to give automatic gain control. The a.f. signal tapped off by the volume control slider is passed to the a.f. amplifier incorporating the UCL82."

"All the cathodes except that for the output pentode," commented Dick, "connect direct to chassis. Shouldn't they have a cathode bias resistor and a bypass capacitor like the output pentode has?"

"The UCH81 and UBF89 are quite happy with their cathodes connected to chassis," replied Smithy. "Even if the set isn't tuned in to a signal there's a small negative voltage on the a.g.c. line due to detected noise and other effects, and this gives them sufficient bias.

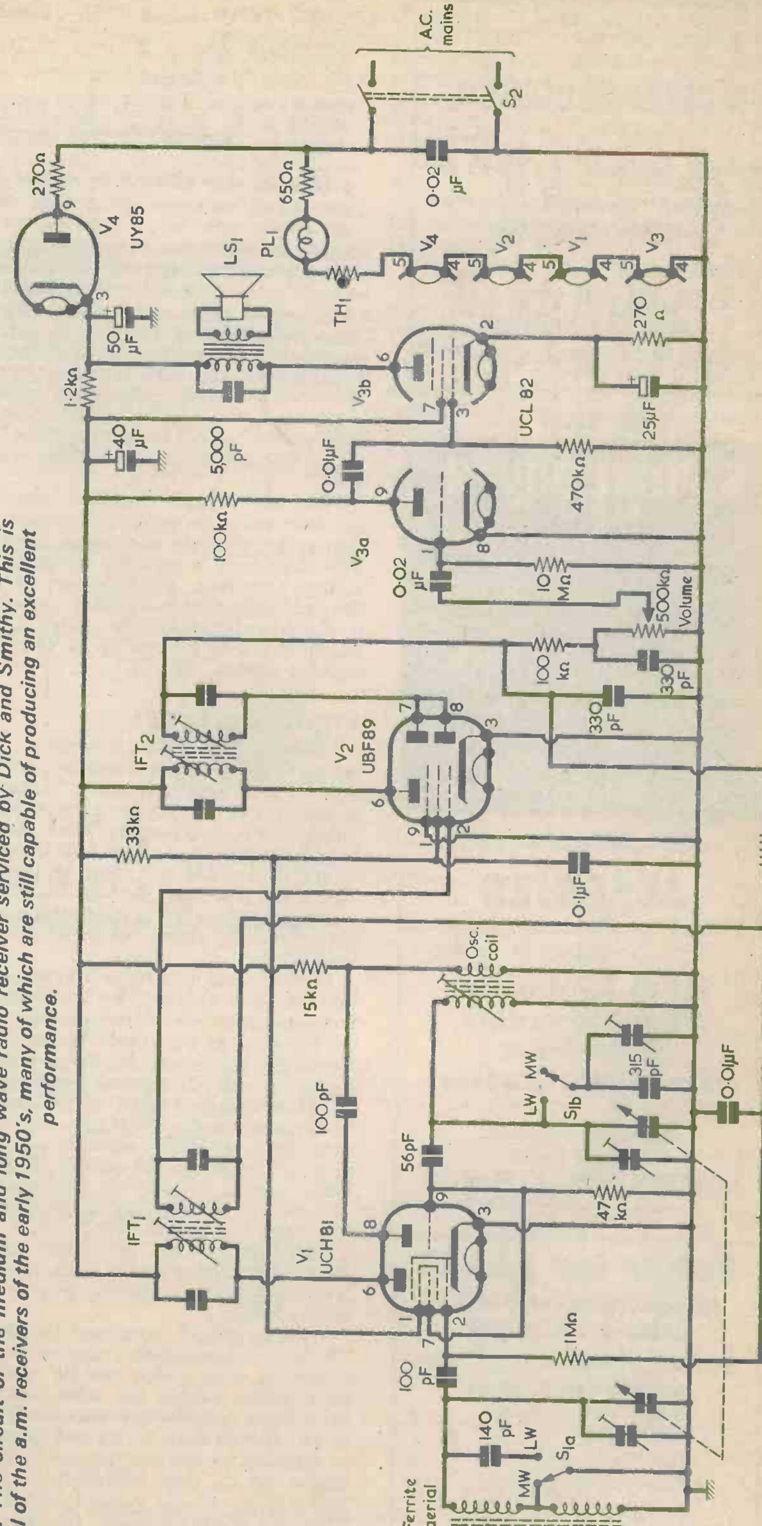


Fig. 1. The circuit of the medium and long wave radio receiver serviced by Dick and Smithy. This is typical of the a.m. receivers of the early 1950's, many of which are still capable of producing an excellent performance.

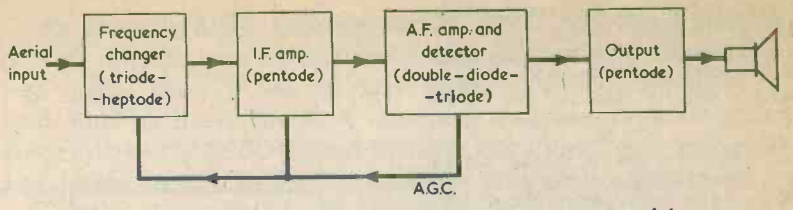


Fig. 2. An alternative signal stage line-up encountered in a.m. radios.

And, of course, the bias increases considerably when a signal is being received because of the a.g.c. action. So far as the triode section of the UCL82 is concerned you'll see that the grid resistor has the high value of 10MΩ. This allows an effect which was described as 'grid current bias' to take place and the triode works quite satisfactorily under these conditions."

"Is the valve line-up here a standard one?"

"Oh yes," stated Smithy. "About the only variation you'll find is when the output pentode is a single valve. You then have a separate triode a.f. voltage amplifier, and this will have the two signal diodes with it to make it a double-diode-triode. The i.f. amplifier is a simple pentode on its own without diodes." (Fig. 2.)

STARTING TESTS

"Shall I," asked Dick, "connect this set up to the mains and switch it on?"

"Not yet," replied Smithy. "I want to check first that it hasn't got an h.t. short down to chassis. That may have been what was wrong with the set in the first place, but there is also a very slight possibility that the h.t. electrolytics have gone low resistance over the last twenty years. Better to be safe than sorry."

Dick applied himself to the receiver and was soon able to draw the chassis from its case.

"Blimey," he remarked, "there isn't even a printed circuit. All the parts are wired up on a chassis with tagstrips."

"That seems reasonable enough," commented Smithy. "Many receiver manufacturers hadn't changed over to printed circuits in the earlier 1950's. Okay, Dick, check the resistance between the positive tag of the reservoir capacitor and chassis."

Dick applied his test prods and watched the meter needle. This moved fairly swiftly to a reading of around 20kΩ. (Fig. 3.)

"Not so good," remarked Smithy. "If the h.t. electrolytics were in good condition, that meter needle would have swung over a lot more slowly. Still, there isn't by any mean a dead short between the h.t. line and chassis so it should be safe to apply the mains. Before we do that, however, fit the knobs back on the control spindles. This will make it easier to operate them. And also, of course, don't forget that the chassis is connected to one side of the mains and that you can get a dangerous shock from it if you aren't careful."

"Hey Smithy," grumbled Dick, "take it easy. I *have* been fixing live-chassis TV's for quite a time now, you know."

"Sorry," chuckled Smithy. "This radio is taking me back over the years so much that I got carried away for the moment! I should set your testmeter to a high voltage range now and connect it between chassis and the positive tag of the reservoir electrolytic again. This will enable us to monitor the h.t. voltage."

Dick connected the receiver to the mains. He then adjusted the range switch of the testmeter, clipped its negative lead to the receiver chassis and applied its positive prod to the reservoir capacitor tag. He put his hand out towards the combined volume control and switch.

"Don't have your face too close to the chassis for the first few minutes," stated Smithy. "After twenty years out of service there is just a very slight risk

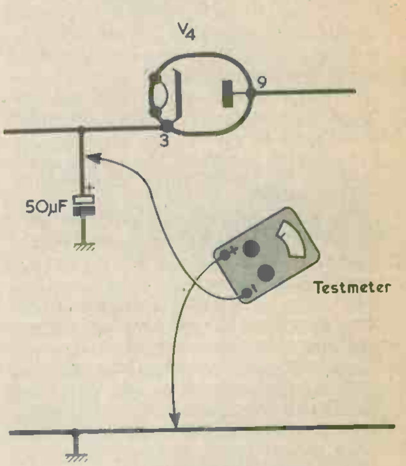


Fig. 3. Checking for h.t. short-circuits to chassis at the reservoir capacitor by means of a testmeter switched to read ohms. With normal testmeters, connecting the test leads in the manner shown causes the testmeter battery to have the same polarity as the electrolytic capacitor.

of the reservoir capacitor going pop when the rectified voltage gets to it. I know I'm a bit of a fuddy-duddy so far as things like this are concerned but I believe in safety first. Okay, switch on now."

There was a click as Dick turned on the switch. The dial lamp lit up weakly, then rose to full brightness as the resistance of the series thermistor in the heater chain dropped. The valve heaters began to glow cheerfully.

Dick glanced at the meter.

"Hey, Smithy," he called out, "there's no voltage across the electrolytic. The rectifier must be duffy."

"Give it a chance," retorted Smithy. "It's got an indirectly heated cathode and that cathode has got to warm up just the same as all the other cathodes. Hello, the meter needle's starting to move now."

Slowly, the meter needle rose to indicate a reading of 190 volts. It stayed at this level for a short moment then continued to a steady reading of 210 volts. Dick removed the positive test prod.

"That's beautiful," said Smithy. "Now we'll just leave it like that for a few moments to give the electrolytics a chance to form and start working properly. All we've got to do for the moment is keep a visual check to ensure that no resistors are cooking up. So far, we've discovered two good things."

"What are those?"

"First," said Smithy, "the heater chain is all right. Second, so is the rectifier. Well, I think we've given those h.t. electrolytics enough time now to get back into working order. See what happens when you turn up the wick."

NO OUTPUT

Dick advanced the volume control and the pair listened.

"It's dead," stated Dick shortly. "There's no background noise, no hum, no nothing."

"Fair enough," commented Smithy. "We've got h.t. at the reservoir capacitor. Check if there's h.t. at the smoothing capacitor."

Obligingly, Dick applied his testmeter prod to the positive tag of the smoothing capacitor. (Fig. 4 (a).)

"I'm getting about 180 volts here," he called out.

"That seems all right," said Smithy. "Try the anode of the UCL82 triode. It's pin 9."

"Okey-doke," replied Dick. "I'm putting the prod on pin 9 now. And the voltage is 100 volts." (Fig. 4(b).)

"There doesn't seem to be anything wrong there, either," said Smithy. "But there's certainly a fault in the circuit following that triode anode."

"Why's that?"

"Because there should have been a crackle from the speaker when you put the test prod on the anode pin. Try the voltage on the pentode anode. It's pin 6."

Dick placed the test prod on the anode pin. (Fig. 4(c).)

"The meter says 210 volts," he called out.

"Does it now?" said Smithy. "That's the same reading as we got at the reservoir capacitor. Normally, there's about 20 volts dropped across the primary of these valve output transformers, so either the primary is short-circuit or the pentode isn't drawing any anode current through it. We can see if the pentode is passing cathode current at any event by measuring the voltage across its cathode bias resistor. So check the voltage at pin 2, Dick."

Once more Dick took up the test prod and, this time, he applied it to pin 2 of the UCL82 valveholder. He glanced at the meter then selected a lower voltage range. (Fig. 4(d).)

"There's 18 volts there," he announced.

"18 volts?" repeated Smithy. "That seems a bit high. These output pentodes usually run with a cathode bias of around 12 volts. At any rate, the voltage shows that the pentode is passing current so it looks as though there's a short across the output transformer primary. Switch the set off, Dick, and measure the resistance of the primary."

Dick carried out Smithy's instructions. After setting his testmeter to an ohms range and zeroing it, he applied his test prods to the transformer tags. (Fig. 5(a).)

"You were right," he announced cheerfully, "there seems to be a dead short here. There's certainly a zero resistance reading in the meter."

"Good show," commented Smithy. "My guess is that the 5,000pF capacitor across the primary has broken down. Snip one of its leads and check it."

The capacitor was mounted on the transformer tags and it took Dick no

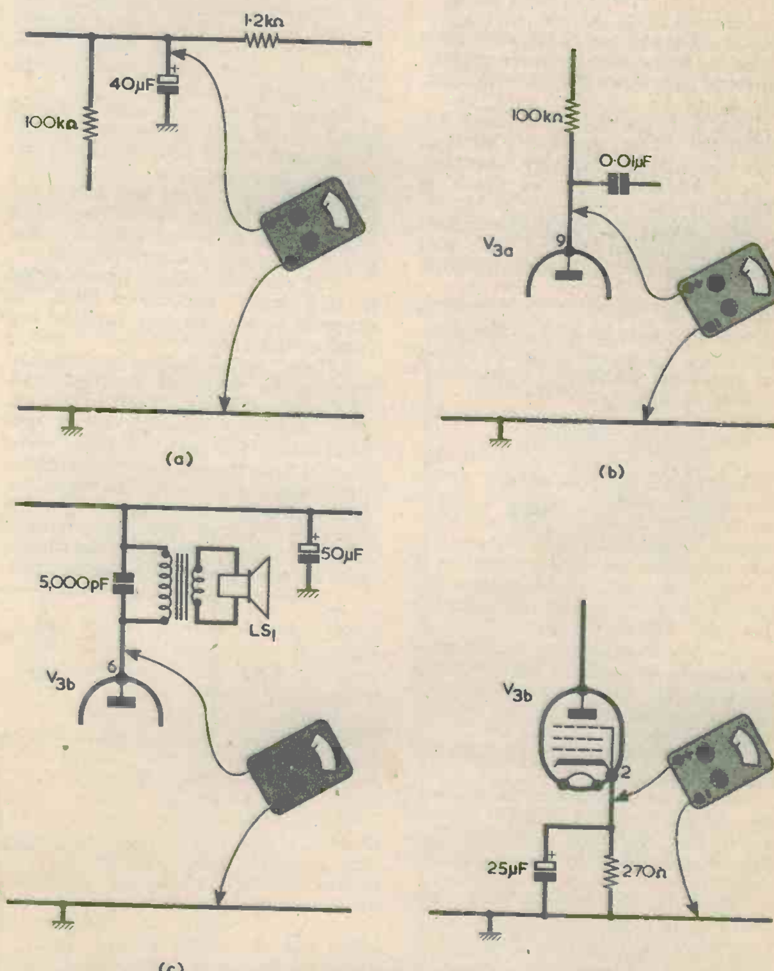


Fig. 4. Successive steps in tracing a fault in the radio. Dick checked the voltage at (a) the smoothing capacitor, (b) the a.f. triode anode, (c) the output pentode anode and (d) the output pentode cathode.

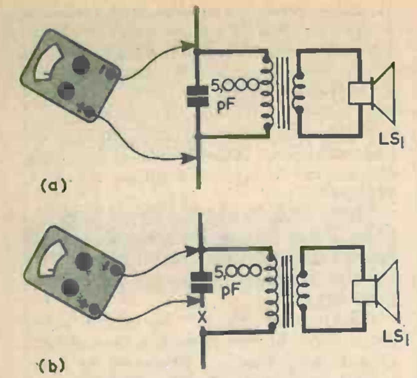


Fig. 5 (a). Checking the resistance at the output transformer primary. (b) One lead of the capacitor has to be disconnected before its condition can be checked.

time at all to cut one of its leads close to the tag it connected to. He applied his testmeter leads to the capacitor. (Fig. 5(b).)

"That's it, Smithy," he called out jubilantly. "The capacitor's shorted. Let's see what the primary resistance is now. Blow me, it's as much as 300Ω!"

"That would be about the correct value," confirmed Smithy. "So your next job is to fit a new 5,000pF capacitor."

"Righty-ho, Smithy," said Dick, as he rose and made his way to the spares cupboard. "I suppose a modern plastic foil capacitor will be all right. What working voltage — 250?"

"750 volts would be nearer the mark."

"Hey?"

"I'm quite serious," said Smithy. "The alternating a.f. voltage across that transformer primary can rise to nearly 200 volts peak if the receiver volume is turned up high. Believe it or not, but some set makers used to fit 1,000 volt capacitors across the speaker primary in output circuits like this one."

After a little searching, Dick located a suitable capacitor. He returned, removed the faulty component and commenced to solder in the replacement.

"What," he asked, "is this capacitor supposed to do, anyway?"

"It's simply a brute-force treble-cut component," replied Smithy. "It cuts down the shrillness resulting from third harmonic distortion in the pentode."

"Stap me," exclaimed Dick, as he absorbed this information. "Couldn't they have used negative feedback instead?"

"Negative feedback?" repeated Smithy. "You've got to be joking, Dick. Feedback was only appearing in hi-fi amplifiers in the days when that set was made. Set-makers would have had kittens at the thought of losing gain by introducing negative feedback!"

"Well, I've got the new capacitor soldered in," announced Dick. "So let's try out this set again."

Once more he turned the volume control switch. There was silence for some moments as the valves warmed up then a quiet hiss became audible from the speaker. Dick turned the tuning control experimentally. Almost immediately he found a station and tuned it in carefully. A voice from the speaker announced a record by Carol Gibbons and the Savoy Orpheans, to be followed by the record itself. Both the voice and the record were noticeably distorted.

"I think," remarked Smithy, "that we have what is a very common snag in these old radios."

"What's that?"

"I think that the 0.01μF coupling capacitor between the triode and pentode sections of the UCL82 has gone leaky and is causing the signal grid of the pentode to go positive. This would explain the unusually high cathode bias voltage, too. Well, we can soon check this. Put that meter on the cathode again, Dick."

Smithy picked up a spare test lead and held the plug at one end against the chassis. Whilst Dick measured the cathod voltage, the Serviceman applied the prod of the test lead to the signal grid of the pentode. There was a loud crackle from the speaker, after which it remained silent. (Fig. 6).

"The cathode voltage has dropped to 12.5 volts," announced Dick. "It dropped as soon as you put that test prod on the grid."

"Then," stated Smithy in a satisfied tone as he removed the test lead, "we've found another fault in this set. That coupling capacitor *must* have been leaky. The fact that there was a crackle from the speaker also confirms that there's leakiness in the capacitor. If the capacitor had been all right the signal grid would have been held at chassis potential by way of the 470kΩ grid resistor, whereupon connecting it directly to chassis would merely have stopped the sound without causing any crackle. So you've got another capacitor to change now, Dick."

"As you wish," said Dick obligingly, making his second trip to the spares cupboard. "What working voltage does this one need?"

"350 volts will be more than adequate," stated Smithy. "Incidentally, you have to keep an eye on the working voltage of replacement capacitors for these old valve sets. We've got used to plastic foil capacitors having working voltages below 200 volts in transistor equipment, and these could well break down in some of the circuits in a valve set."

NEW CAPACITOR

Dick had no trouble in locating a new 0.01μF 350 volt capacitor. He sat down at Smithy's bench and removed the faulty component so that it could be replaced by its much less bulky modern equivalent.

"Are these capacitors always liable to give trouble in old sets, Smithy?"

"Oh definitely," confirmed Smithy. "All the tubular capacitors from around 0.001μF to 0.1μF had paper dielectric with wax impregnation, and it is very common for these to become leaky after some ten to twenty years simply due to the ingress of moisture. If they're used as cathode bypass capacitors they don't usually cause much trouble until their leakage resistance becomes very low, because they're connected across low value resistors. But they only need to have a leakage resistance of 10MΩ or less to cause trouble when they connect an anode to a following grid. So whenever you want to refurbish an old valve radio the components you want to check are firstly, h.t. electrolytics and secondly, paper dielectric capacitors. After that the next components to suspect are fixed resistors of 1MΩ or more. These have a tendency to go high in value."

"Apart from the faults we've

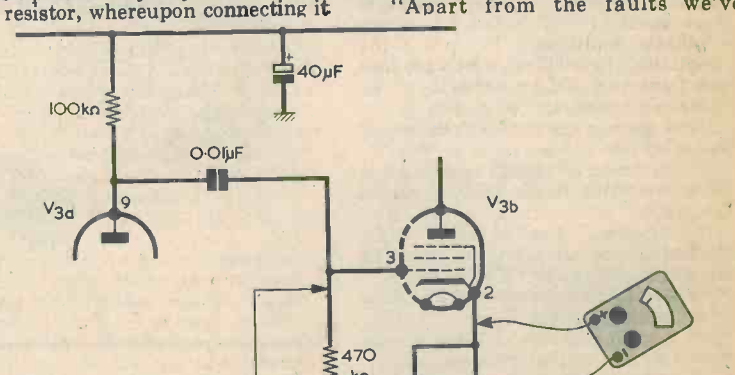


Fig. 6. Checking the voltage at V3(b) cathode with the grid resistor short-circuited.

bumped into today," said Dick, "what are the main troubles you are likely to encounter?"

"Instability is the most common one," replied Smithy. "If you look at the circuit of the set we've got here you'll see that the absolute bare minimum of decoupling components is used. For instance, the 40μF smoothing capacitor is the h.t. bypass component for the anode circuits of the frequency changer, the i.f. amplifier and the a.f. triode. In some sets it may also be the anode bypass component for the output pentode as well. The capacitor only needs to develop a very small impedance for all these circuits to couple together, whereupon you get instability. This can happen even when the capacitor still seems to be working all right as a smoothing component."

"Are there any other forms of instability?"

"A very common one is given when the bypass capacitor at the screen-grid of the frequency changer or the i.f. amplifier goes open. The screen-grid prevents capacitive coupling between the anode and the signal grid and, if it isn't reliably held at chassis potential for r.f. by its bypass capacitor, the stage simply oscillates. Usually, you get a heterodyne beat with stations as you tune them in. In the set we have here, both the frequency changer *and* the i.f. amplifier screen-grids are bypassed to chassis by one capacitor and, once again, it only needs a little unwanted impedance in the bypass circuit for the whole receiver to become unstable." (Fig. 7.)

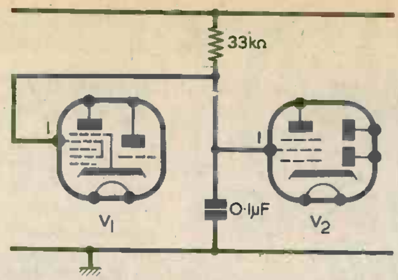


Fig. 7. A common bypass capacitor couples the screen-grids of both the frequency changer heptode and the i.f. amplifier pentode to chassis.

"D'you know, Smithy," said Dick, as he put Smithy's soldering iron back on its rest, "going back to valves is like entering a new world again."

"You can have a lot of fun with these old valve radios," agreed Smithy. "One would hardly suggest that somebody *constructed* a valve radio in these present times. On the other hand there can be a lot of pleasure in *servicing* an old valve radio and getting it to go again."

"Well," said Dick. "I've put in the new 0.01μF capacitor, so let's see how this particular old set works."

He switched it on again. They waited once more for the valves to warm up. As the set came to life, the same voice was heard announcing Henry Hall and his B.B.C. Dance Orchestra. This was followed by "The Teddy Bears' Picnic".

"There's something fishy going on here," remarked Dick a little uneasily. "We've repaired an old radio and all it plays is old records."

"I must confess that it's a bit odd," commented Smithy. "Still that distortion has cleared up. There's no noticeable hum either, so we'll assume that the reservoir and smoothing electrolytics are all right. Indeed, the set sounds jolly good."

"It isn't bad at all," agreed Dick. "In fact the quality is a darned sight better than the noises we've got used to with present-day transistor radios. For a start, there's a bit of bass to it."

"True," confirmed Smithy.

They listened critically as "The Teddy Bears' Picnic" came to a close. Then followed an interview with a civic dignitary in what was obviously a repeat of "Down Your Way". The dignitary chose a comfortingly modern recording.

"Well," said Dick, his brow clearing, "that clears up the old records mystery. The previous people in the programme must have been elderly geysers."

"Let's put this set through its paces," suggested Smithy.

Dick rotated the tuning control, to be rewarded by a good selection of stations, both on medium and long waves.

UNEXPECTED PRESENT

"Seeing," remarked Smithy, "that we found this set under your bench, you might as well keep it for yourself. I can't see anyone coming to claim it after all these years."

"Gosh Smithy, thanks. This will be just the job for my bedroom. I must say that I've really enjoyed the repair job we've done on it. Are there any other hints you can pass on about fixing old sets?"

"Only the obvious ones. For instance there's not much point in tackling an old set if the cabinet is broken beyond repair or if the set has been stored in a damp place. Also, the job is probably not worth the trouble if there's a mechanical snag in the wavechange switching arrangements or in the tuning drive which is difficult to clear. Again, I'd think twice about tackling some of the earlier sets with printed circuits as there's a fairly high risk of leakage between copper sections on the board. The best sets to play with are those where the parts are assembled on a chassis."

Dick looked fondly at the radio which he had now so unexpectedly acquired, then glanced over at the cardboard boxes on the surface of his bench.

"If," he remarked cheerfully, "this is what happens when we have a clear-out of my junk, then I'm all for having a clear-out every day!" ■

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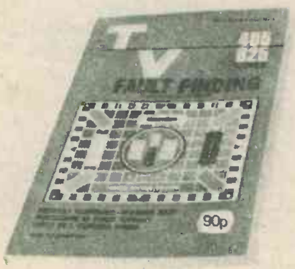

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