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

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THE JANUARY ISSUE
WILL BE PUBLISHED ON
2nd DECEMBER

THE 'NUTS & BOLTS' OF THOSE PROJECTS!

TRANSFORMERS

MINIATURE MAINS Pri240V
with two independent secondary windings.

No.		Type	Price
2024	MT280	0-6v. 0-6v RMS	£1.30*
2025	MT150	0-12v. 0-12v RMS	£1.30*

MINIATURE MAINS Pri 240v

No.	Secondary	Price
2021	6v-0-6v 100mA	90p*
2022	9v-0-9v 100mA	90p*
2023	12v-0-12v 100mA	90p*

1 amp MAINS Pri 240v

No.	Secondary	Price	
2026	6v-0-6v 1 amp	£2.70*	p&p 30p
2027	9v-0-9v 1 amp	£2.20*	p&p 30p
2028	12v-0-12v 1 amp	£2.60*	p&p 30p
2029	15v-0-15v 1 amp	£2.75*	p&p 30p
2030	30v-0-30v 1 amp	£3.45*	p&p 30p

STANDARD MAINS Pri 240v
Multi-tappad secondary mains transformers available in ½ amp 1 amp and 2 amp current rating. Secondary taps are 0-19-25-33-40-50v.
Voltages available by use of taps;
4. 7. 8. 10. 14. 15. 17. 19. 25. 31. 33. 40. 50, 25-0-25 volts.

No.	Rating	Price	
2031	½ amp	£3.42*	p&p 30p
2032	1 amp	£4.40*	p&p 50p
2033	2 amp	£5.45*	p&p 85p

AUDIO LEADS

S127	5 pin DIN plug to 4 phono plugs length 1·5m	£1·30*
S128	5 pin DIN plug to 5 pin DIN socket length 1·5m	£1·05*
S129	5 pin DIN plug to 5 pin DIN plug mirror image length 1·5m	£1·05*
S130	2 pin DIN plug to 2 pin DIN socket length 5m	68p*
S131	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5 length 1·5m	83p*
S132	2 pin DIN plug to 2 pin DIN socket length 10m	98p*
S133	5 pin DIN plug to 2 phone plugs connected to pins 3 & 5 length 1·5m	75p*
S134	5 pin DIN plug to 2 phono sockets connected to pins 3 & 5 length 23cm	68p*
S135	5 pin DIN socket to 2 phono plugs connected to pin 3 & 5 length 23cm	68p*
S136	Coiled stereo headphones extension cord extends to 7m	£1·75*
S124	3 pin DIN plug to 3 pin DIN plug length 1·5m	75p*
S125	5 In DIN plug to 5 pin DIN plug length 1·5m	75p*
S113	3·5mm Jack to 3·5mm Jack length 1·5m	75p*
S114	5 pin DIN plug to 3·5mm Jack connected to pins 3 & 5 length 1·5m	85p*
S115	5 pin DIN plug to 3·5 Jack connected to pins 1 & 4 length 1·5m	85p*

G.P. SWITCHING TRANS.

TO18 SIM. TO 2N706/8

BSY27/28/95A. All usable devices. No open and shorts.

ALSO AVAILABLE IN PNP similar to 2N2906. BCY 70.
20 for 50p, 50 for £1, 100 for £1·80, 500 for £8, 1,000 for £14.

When ordering please state NPN or PNP

SIL G.P. DIODES

300 mW 40 PIV (min) SUB-MIN
FULLY TESTED
Ideal for Organ builders
30 for 50p, 100 for £1·50, 500 for £5, 1,000 for £9

L.E.D.'s

Type	Size	Order no	Colour	Price
TIL209	.125"	1501	RED	.12p
TIL211	.125"	1502	GREEN	.25p
TIL213	.125"	1503	YELLOW	.25p
FLV115	.2"	1504	RED	.12p
FLV310	.2"	1505	GREEN	.25p
FLV410	.2"	1506	YELLOW	.25p

2nd Grade L.E.D.'s

A pack of standard sizes and colours which fail to perform to their very rigid specification, but which are ideal for experiments.
Order no. 1507 £0.90

L.E.D. CLIPS

	Size	Order no.	Price
Pack of 5	.125"	1508/.125	.15p
Pack of 5	.2"	1508/.2	.18p

NUTS & BOLTS

BA BOLTS — packs of B.A. Threaded cadmium plated screws, slotted cheese head. Supplied in multiples of 100.

Type	No.	Price	Type	No.	Price
1"OBA	839	£1.50	1"4BA	845	£0.51
½"OBA	840	£0.83	½"4BA	846	£0.38
1"2BA	842	£0.69	¼"4BA	847	£0.33
½"2BA	843	£0.54	1"6BA	848	£0.50
¼"2BA	844	£0.63	½"6BA	849	£0.30
			¼"6BA	850	£0.33

BA NUTS — Packs of cadmium plated full nuts in multiples of 100.

Type	No.	Price	Type	No.	Price
0BA	855	£0.90	4BA	857	£0.42
2BA	856	£0.60	6BA	858	£0.36

BA WASHERS — flat cadmium plated plain stamped washers supplied in multiples of 100.

Type	No.	Price	Type	No.	Price
0BA	859	£0.20	4BA	861	£0.15
2BA	860	£0.15	6BA	862	£0.12

SOLDER TAGS — hot tinned supplied in multiples of 100.

Type	No.	Price	Type	No.	Price
0BA	851	£0.42	4BA	853	£0.30
2BA	852	£0.36	6BA	854	£0.30

INSTRUMENT CASES. In two sections, black vinyl covered top and sides and bezel.

No.	Length	Width	Height	Price
155	8"	5¼"	2"	£1.52*
156	11"	6"	3"	£2.12*
157	6"	4¾"	1½"	£1.30*
158	9"	5¼"	2½"	£1.76*

ALUMINIUM BOXES. Made from bright ali., folded construction each box complete with half inch deep lid and screws.

No.	Length	Width	Height	Price
159	5¼"	2¼"	1½"	£0.62*
160	4"	4"	1½"	£0.62*
161	4"	2¼"	1½"	£0.62*
162	5¼"	4"	1½"	£0.70*
163	4"	2½"	2"	£0.64*
164	3"	2"	1"	£0.44*
165	7"	5"	2½"	£1.04*
166	3"	6"	3"	£1.32*
167	6"	4"	2"	£0.86*

BRIDGE RECTIFIERS

SILICON 1 AMP

Type	Order No.	Price
50vRMS	BR1/50	£0.28
100vRMS	BR1/100	£0.30
200vRMS	BR1/200	£0.32
400vRMS	BR1/400	£0.36

SILICON 2 AMP

Type	Order No.	Price
50v	BR2/50	£0.45
100v	BR2/100	£0.48
200v	BR2/200	£0.52
400v	BR2/400	£0.58
1000v	BR2/1000	£0.68

FUSE HOLDERS & FUSES

Description	Order No.	Price
20mm x 5mm chassis mounting	506	£0.07*
1¼" x ¼" chassis mounting	507	£0.10*
1¼" car inline type	508	£0.20*
Panel mounting 20mm	509	£0.22
Panel mounting 1¼"	510	£0.24

QUICK BLOW 20mm

Type	No.	Type	No.	Type	No.
150mA	611	1A	615	3A	619
250mA	612	1.5A	616	4A	620
500mA	613	2A	617	5A	621
800mA	614	2.5A	618	ALL 5p EACH	

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2.5A	628
250mA	623	2A	626	3.15A	629
500mA	624	1.6A	627	5A	630

ALL 7p EACH

QUICK BLOW 1¼"

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

ALL 7p EACH

Type	No.	Type	No.	Type	No.
1A	635	2.5A	638	4A	641
1.6A	636	3A	639	5A	642
2A	637				

ALL 6p EACH

SWITCHES

Description	No.	Price
D.P.D.T. miniature slide	1973	£0.10*
D.P.D.T. standard slide	1974	£0.12*
Toggle switch S.P.S.T. 1½ amp 250v AC	1975	£0.33*
Toggle switch D.P.D.T. 1 amp 250v AC	1976	£0.36*
Rotary ON-OFF mains switch	1977	£0.42*
Push switch – Push to make	1978	£0.13*
Push switch – Push to break	1979	£0.18*

ROCKER SWITCH	Colour	No.	Price
A range of rocker switches SPST — moulded in high insulation. Material available in a choice of colours ideal for small apparatus	RED	1980	£0.22*
	BLACK	1981	£0.22*
	WHITE	1982	£0.22*
	BLUE	1983	£0.22*
	YELLOW	1984	£0.22*
	LUMINOUS	1985	£0.22*

Description	No.	Price
Miniature S.P.S.T. toggle 2 amp 250v AC	1958	£0.50*
Miniature S.P.S.T. toggle 2 amp 250v AC	1959	£0.55*
Miniature D.P.D.T. toggle 2 amp 250v AC	1960	£0.65*
Miniature D.P.D.T. toggle centre off – 2 amp 250v AC	1961	£0.85*
Push button S.P.S.T. 2 amp 250v AC	1962	£0.65*
Push button S.P.S.T. 2 amp 250v AC	1963	£0.68*
Push button D.P.D.T. 2 amp 250v AC	1964	£0.80*

MIDGET WAFER SWITCHES

Single-bank wafer type – suitable for switching at 250v AC 100mA or 150v DC in non-reactiver loads make-before-break contacts. These switches have a *spindle* 0.25" dia and 30° indexing.

Description	Order No.	Price
, pole 12 way	1965	£0.48*
2 pole 6 way	1966	£0.48*
3 pole 4 way	1967	£0.48*
4 pole 3 way	1968	£0.48*

MICRO SWITCHES	Order No.	Price
Plastic button gives simple on-off action Rating 10 amps 250v AC	1969	£0.20
Button gives 1 pole change over action Rating 10 amp 250v AC	1970	£0.25

DISPLAYS

LED Type	Order No.	Price
BDL707 .3" single	1510	£0.80
BDL747 .6" single	1511	£1.50
BDL727 .5" double	1512	£1.80

COLD CATHODE ITT 5087 ST

Side viewing indicator tubes. Displays 0-9 and decimal points. Wide viewing angle – operates from 180v with 16k series anode resistors – character height 16.5mm pin connections supplied.

Order No. 1513 Price £0.60

VOLTAGE REGULATORS

Positive Regulators TO220 case

MVR 7805 5v	£1.25	MVR 7815 15v	£1.25
MVR 7812 12v	£1.25	MVR 7824 24v	£1.25

Negative Regulators TO220 case

MVR 7905 5v	£1.85	MVR 7915 15v	£1.85
MVR 7912 12v	£1.85	MVR 7924 24v	£1.85

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223	50 Projects Using IC CA3130	95p
224	50 CMOS IC Projects	95p
225	A Practical Introduction to Digital IC's	95p
226	How to Build Advanced Short Wave Receivers	1·20
RCC	Resistor Colour Code Disc Calculator	10p

THYRISTORS

600mA TO18 CASE

Volts	No.	Price
10	THY600/10	£0.15
20	THY600/20	£0.16
30	THY600/30	£0.20
50	THY600/50	£0.22
100	THY600/100	£0.25
200	THY600/200	£0.38
400	THY600/400	£0.44

1 AMP TO5 CASE

Volts	No.	Price
50	THY1A/50	£0.26
100	THY1A/100	£0.28
200	THY1A/200	£0.32
400	THY1A/400	£0.38
600	THY1A/600	£0.45
800	THY1A/800	£0.58

3 AMP TO66 CASE

Volts	No.	Price
50	THY3A/50	£0.28
100	THY3A/100	£0.30
200	THY3A/200	£0.33
400	THY3A/400	£0.42
600	THY3A/600	£0.50
800	THY3A/800	£0.65

5 AMP TO66 CASE

Volts	No.	Price
50	THY5A/50	£0.36
100	THY5A/100	£0.46
200	THY5A/200	£0.50
400	THY5A/400	£0.57
600	THY5A600	£0.69
800	THY5A/800	£0.81

5 AMP TO220 CASE

Volts	No.	Price
400	THY5A/400P	£0.57
600	THY5A/600P	£0.69
800	THY5A/800P	£0.81

7 AMP TO48 CASE

Volts	No.	Price
50	THY7A/50	£0.48
100	THY7A/100	£0.51
200	THY7A/200	£0.57
400	THY7A/400	£0.62
600	THY7A/600	£0.78
600	THY7A/800	£0.92

10 AMP TO48 CASE

Volts	No.	Price
50	THY10A/50	£0.51
100	THY10A/100	£0.57
200	THY10A/200	£0.62
400	THY10A/400	£0.71
600	THY10A/600	£0.99
800	THY10A/800	£1.22

16 AMP TO48 CASE

Volts	No.	Price
50	THY16A/50	£0.64
100	THY16A/100	£0.58
200	THY16A/200	£0.62
400	THY16A/400	£0.77
600	THY16A/600	£0.90
800	THY16A/800	£1.39

30 AMP TO94 CASE

Volts	No.	Price
50	THY30A/50	£1.18
100	THY30A/100	£1.43
200	THY30A/200	£1.63
400	THY30A/400	£1.79
600	THY30A/600	£3.50

No.	Price
BT101/500R	£0.80
BT102/500R	£0.80
BT106	£1.25
BT107	£0.93
BT108	£0.98
2N3228	£0.70
2N3525	£0.77
BTX30/50L	£0.33
BTX30/400L	£0.46
C106/4	£0.60

SUPER UNTESTED PAKS

Pak No.	Qty.		Order No.	Price
U50	100	Germ. gold bonded OA47 diode	16130	£0.60
U51	150	Germ. OA70/81 diode	16131	£0.60
U52	100	Silicon diodes 200mA OA200	16132	£0.60
U53	150	Diodes 75mA 1N4148	16133	£0.60
U54	50	Sil rect top hat 750mA	16134	£0.60
U55	20	Sil rect stud type 3 amp	16135	£0.60
U56	50	400mW zeners DO7 case	16136	£0.60
U57	30	NPN trans BC107/8 plastic	16137	*£0.60
U58	30	PNP trans BC177/178 plastic	16138	*£0.60
U59	25	NPN TO39 2N697/2N1711 silicon	16139	£0.60
U60	25	PNP TO59 2N2905 silicon	16140	£0.60
U61	30	NPN TO18 2N706 silicon	16141	£0.60
U62	25	NPN BFY50/51	16142	£0.60
U63	30	NPN plastic 2N3906 silicon	16143	*£0.60
U64	30	PNP plastic 2N3905 silicon	16144	*£0.60
U65	30	Germ. 0071 PNP.	16145	£0.60
U66	15	Plastic power 2N3055 NPN	16146	£1.20
U67	10	TO3 metal 2N3055 NPN	16147	£1.20
U68	20	Unijunction trans IIS43	16148	£0.60
U69	10	1 amp SCR TO39	16149	£1.20
U70	8	3 amp SCR TO66 case	16150	£1.20

■ Code Nos. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

COMPONENT PAKS

Pak No.	Qty.		Order No.	Price
C1	200	Resistor mixed value approx (count by weight)	16164	*£0.60
C2	150	Capacitors mixed value approx. (count by weight)	16165	*£0.60
C3	50	Precision resistors. Mixed values	16166	£0.60
C4	80	'W resistors mixed preferred values	16167	*£0.60
C5	5	Pieces assorted ferrite rods	16168	*£0.60
C6	2	Tuning gangs. MW/LW VHF	16169	*£0.60
C7	1	Pack wire 50 m ters assorted colours single strand	16170	£0.60
C8	10	Reed switches	16171	*£0.60
C9	3	Micro switches	16172	*£0.60
C10	15	Assorted pots	16173	*£0.60
C11	5	Metal jack sockets 3 x 3.5mm 2 x standard switch types	16174	*£0.60
C12	30	Paper condensers preferred types mixed values	16175	*£0.60
C13	20	Electolytics trans. types	16176	£0.60
14	1	Pak assorted hardware nuts/bolts, gromets, etc.	16177	£0.60
C15	5	Mains slide switches assorted	16178	*£0.60
C16	20	Assorted tag strips and panels	16179	£0.60
C17	15	Assorted control knobs	16180	*£0.60
C18	4	Rotary wave change switches	16181	*£0.60
19	2	Relays 6-24V operating	16182	*£0.60
C20	1	Pak. copper laminate approx 200 sq. in.	16183	£0.60
C21	15	Assorted fuses 100mA-5 amp	16184	£0.60
C22	50	Metres PVC sleeving assorted size AND COLOUR	16185	£0.60
c23	60	¼ watt resistors mixed preferred values	16188	*£0.60
C24	25	Presets assorted type and value	16186	*£0.60
C25	30	Metres stranded wire assorted colours	16187	£0.60

SLIDER PAKS

Pak No.	Qty.		Order No.	Price
S1	6	Slider potentiometers, mixed values	16190	*£0.60
S2	6	Slider potentiometers, all 470 ohms	16191	*£0.60
S3	6	Slider potentiometers, all 10k lin	16192	*£0.60
S4	6	Slider potentiometers, all 22k lin	16193	*£0.60
S5	6	Slider potentiometers, all 47k lin	16194	*£0.60
S6	6	Slider potentiometers, all 47k log	16195	*£0.60

CERAMIC PAKS

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Pak No	Qty		Order No.	Price
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MC2	24	miniature ceramic capacitors, 3 of each value 100pF 120pF 150pF, 180pF, 220pF, 270pF, 330pF and 390F	16161	*£0.60
MC3	24	miniature ceramic capacitors, 3 3 of each value — 470pF, 560pF, 680pF, 820pF, 1,000pF, 1,500pF, 2,200pF and 3,300pF	16162	*£0·60
MCA	21	miniature ceramic capacitors, 3 of each value — 4,700pF, 6,800pF 0·01μF 0·015μF, 0·022μF 0·033μF, 0·047μF	16163	*£0.60

LINEAR PAKS

Manufacturer's "Fall Outs" which include Functional and part-Functional Units. These are classed as "out of spec" from the maker's very rigid specifications, but are ideal for learning about ICs and experimental work.

U721–30 Assorted Linear Types, 709, 741, 747, 748, 710, 588, etc.
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U76SD FM STEREO DECODER

5 ICs 76110 equivalent to MC1310P-MA767. Data supplied with pak.
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U76A AUDIO POWER OUTPUT AMPLIFIERS

8 assorted types. SL403, 76013, 76003, etc. Data supplied with pak.
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74F–50 Flip-Flops assorted 7470-72-73-74-76-104-109, etc.
ORDER No. 16225 £1.20

74M–30 MSI, Assorted Types. 7441-47-90-154, etc.
ORDER No. 16226 £1.20

VEROBOARDS PAKS

VB1–Approx. 30sq.in. various sizes. All 0.1in matrix.
ORDER No. 16199 60p

VB2–Approx. 30sq.in various sizes. 0.15in matrix.
ORDER No. 16200 60p

ELECTROLYTIC PAKS

A range of paks each containing 18 first quality, mixed value miniature electrolytics.

EC1 Values from 0.47uF to 10uF.
ORDER No. 16201 *60p

EC2 Values from 10uF to 100uF.
ORDER No. 16202 *60p

EC3–Values from 100uF to 680uF.
ORDER No. 16203 *60p

C280 CAPACITOR PAK

75 Mullard C280 capacitors, mixed values ranging from 0.01uF to 2.2uF complete with identification sheet.
ORDER No. 16204 *£1.20

CARBON RESISTOR PAKS

These paks contain a range of Carbon Resistors, assorted into the following groups:

R1–60 mixed ¼W 100-820 ohms.
ORDER No. 16213 *60p

R2 60 mixed ¼W 1-8.2k
ORDER N9. 16214 /60p

R3–60 mixed ¼W 10-82k
ORDER No. 16215 *60p

R4–60 mixed ½W 100-8205
ORDER No 16216 *60p

R5–40 mixed ½W 100-820
ORDER No. 16217 *60p

R6 40 mixed ½W 1-8.2k
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R7 40 mixed ½W 10-82k
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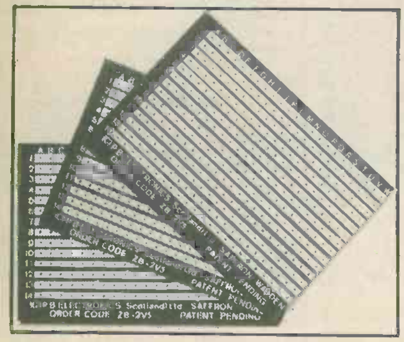

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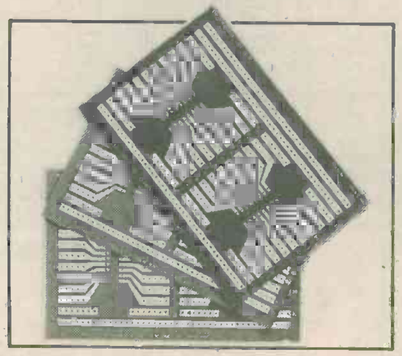

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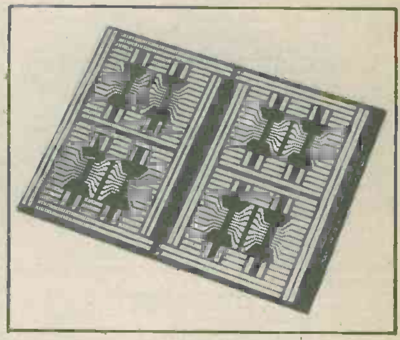

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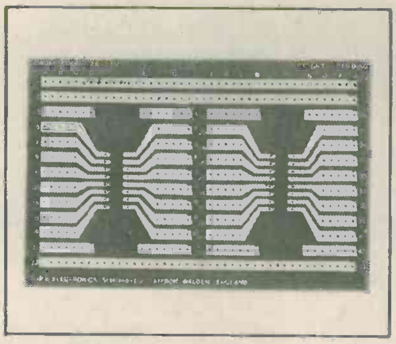

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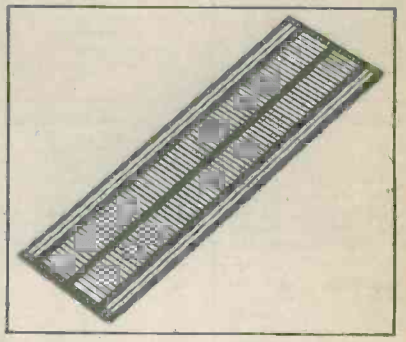

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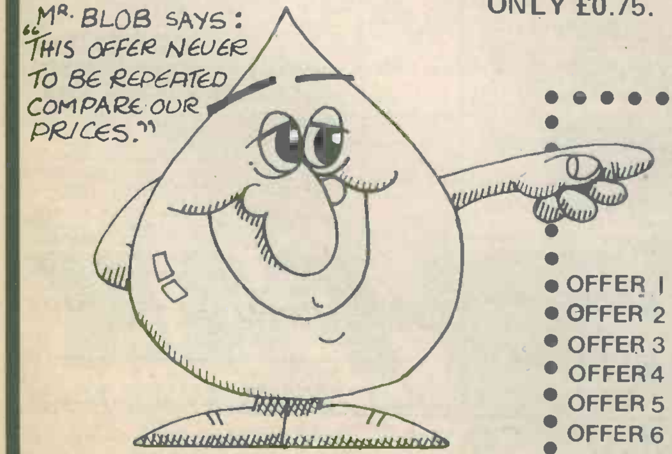

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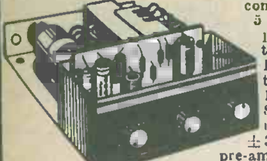
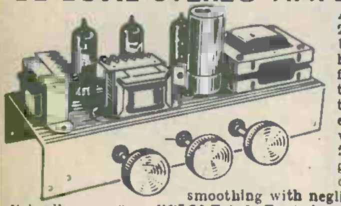


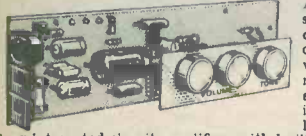
A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power out-put transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz. 30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £15.00. P. & P. £1.20.

DE LUXE STEREO AMPLIFIER



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

HARVERSONIC STEREO 44



A solid state stereo amplifier chassis, with an output of 3-4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with built in short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets and 5 pin din tape rec./play socket are mounted on the printed circuit panel, size approx. 9¾" × 2¾" × 1" max. depth, Supplied brand new and tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically), at only £9·00 plus 50p P. & P. Mains transformer with an output of 17V a/c at 500 m/a can be supplied at £1·50 plus 40p P. & P. if required. Full connection details supplied,

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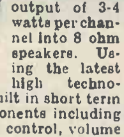

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Stereo beacon light if required 40p extra.

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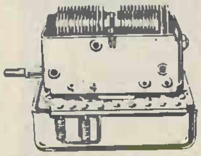

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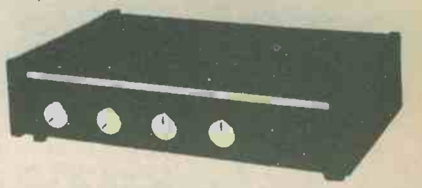
HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



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

AMPLIFIER KIT	£13·50	P. & P. 80p
(Magnetic input components 33p extra)		
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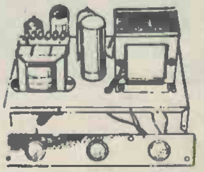

3-VALVE AUDIO AMPLIFIER HA34 MK II.
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½"w. × 4"d. × 4¾"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £8.50. P. & P. £1.40.

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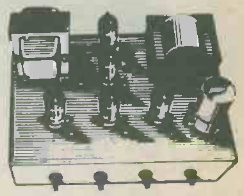
10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15 Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p × SAE (Free with parts). All parts sold separately. ONLY £13.50. P. & P. £1.40. Also available ready built and tested £18.00. P. & P. £1.40.

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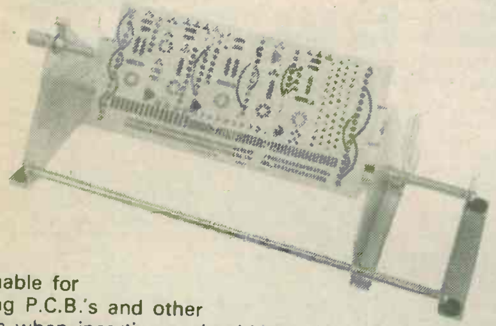

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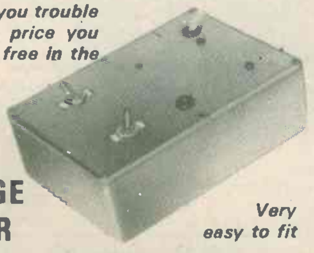

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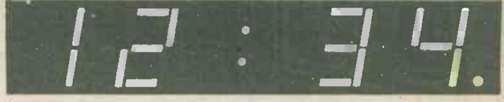

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Special announcement. The Bionic Radiometer metal locator is at last to be released. A full VLF discriminator, with simultaneous display of ferrous, non-ferrous and foil objects. With a little practise, you can actually find objects obscured by junk. Outperforms units costing £150+. Digital control. Demo available at Brentwood, on sale soon for less than £75.SAE info:

COMPONENTS

Herewith the list of first quality parts and modules for wireless, inc. Europe's largest range of signal coils and inductors. ½m in stock !

CA3089E	FM IF	1.94
KB4402	FM IF	1.94
HA1137W	FM IF	2.20
TBA120	FM IF	0.75
TBA120S	FM IF	1.00
sn76660n	FM IF	0.75
ua720	AM rad	1.40
CA3123E	AM rad	1.40
HA1197	AM rad	1.40
TBA651	AM rad	1.81
MC1350	agc gain	1.00
ua753	fm gain	1.80
LM1496	Bal mix	1.25
MC1310P	mpx dec	2.20
KB4400	as above	2.20
ca3090aq	mpx dec	4.35
HA1196	mpx dec	4.20
LM380	2w AF	1.00
LM381	preamp	1.81
tda2020	15w AF	2.99
tca940E	10w AF	1.80
tba810as	7w AF	1.08
LM301an	op amp	0.39*
ua741	op amp	0.34*
LM3900	op amp	0.68*
7805uc	5v/1amp	1.55*
tda1412	12v/½A	0.95*
78M20	20v/½A	1.20*
78M24	24v/½A	1.20*
ua723cn	variable	0.80*
NE550a	as above	0.80*
taa550b	32v ref	0.50*
icl8038cc	sig gen	4.50*
NE555v	timer	0.70*
NE566v	vco	2.50*
NE567v	tone dc	2.50*
NE560B	hf pll	3.50*
NE561B	hf pll	3.50*
NE565K	lf pll	2.50*
MC1312	quad	1.50
11C90	650mhz	14.00*
ZTX107	50v/.3w	0.14
ZTX108	30v/.3w	0.14
ZTX109	30v/.3w	0.14

BC413	lo noise	0.18
40238	shld RF	0.25*
BF224	.6ghz RF	0.22
BF274	.7ghz RF	0.18
ZTX212	50v/.3w	0.17
ZTX213	30v/.3w	0.16
ZTX214	30v/.3w	0.17
ZTX451	60v/1w	0.18
ZTX551	60v/1w	0.18
BD515	45v/10w	0.27
BD516	45v/10w	0.30
BD535	60v/50w	0.52
BD536	60v/50w	0.53
BD609	80v/90w	0.70
BD610	80v/90w	1.20
BF256	1ghz fet	0.34
E176	p ch swt	0.38
MEM614	(40822)	0.38*
MEM616	(40673)	0.67*
MEM680	lo noise	0.75*
BA102	vhf varic	0.30
BA121	vhf varic	0.30
BB104	dual var.	0.45
BB105	uhf varic	0.40
mvam2	dual AM	1.48
mvam115	15v/AM	1.05
mvam125	25v/AM	0.90

TOKO Coils & Filters

10mm & 7mm (rad cont)

AM IFts with cap		0.30
FM IFts with cap		0.33
eg		
YHCS11098AC2		0.30
YHCS12374AC2		0.30
YHCS11100AC2		0.30
KALS4520A		0.33
KACSK586HM		0.33
LLC238	7mm	0.33
LLC4827	7mm	0.33
LLC4828	7mm	0.33
CFS10.7	ceramic	0.50
BLR3107N	mpx	1.90
BBR3132	6pole fm	2.25

MFL 2.4 kHz ssb mech. filter for ssb gen/IF 455kHz with matching transf's. 9.95
MFH series 4/5/7kHz band-width @ 455kHz 1.95
MFK series 7/9kHz bw 1.65

Modules/tunerheads etc.

EC3302 3cct v/cap fm 7.50
EF5600 5cct v/cap fm 12.95
EF5800 6cct v/cap fm 15.25
EF5801 (5800+osc op) 17.45
8319 4 v/c, mos mixer 11.45
7252 complete fm mono tunerset.afc,agc,mute 26.50
7253 complete fm stereo tunerset. afc, agc, mute 26.50
7020 10.7MHz fm if 6.95
7030 linear phase fm if 10.95
93090 ca3090aq dec 8.36
92310 1310 decoder 6.95
91196 ha1196 decoder 12.99
91197 mw/lw v/cap tun.11.35
7122 3 v/c mw (OR lw) tuner KIT 15v tuning 9.00
810k 7w af kit comp. £3
940k 10w af kit 3.95
tda2020k pr. tda2020 ics, pcb, heatsinks for pa 9.35
All mpx decoders feature TOKO pilot tone filters.

Tuners: complete

Larsholt signalmaster Mk 8
Best fm tuner kit under £100
Looks as good as it sounds.
Full instructions 86.95
Audiomaster amp. Matching 25+25w rms amp. 79.00
carriage on above £3 extra ea.

Misc.

FX1115 beads 10/0.25
MW/LW ferrite rod ant 0.90
min. foil trimmers (see pl)
22t 100k pots for tuning..45
RFchokes: 1uH to 120mH

VAT is extra at 12½%, except where otherwise shown (*8%). PP now 25p per order. Catalogue 45p (inc). Pse send A5 or larger SAE with enquiries. Price lists free with an SAE. Full range of components etc available to callers at our new easy-to-get-to premises.

ambit INTERNATIONAL

Number 2, Gresham Road, Brentwood, Essex. CM14 4HN
telephone (0277) 216029
Our new premises are only 200 yards from Brentwood station - with parking facilities outside the door !!

TRADE COMPONENTS

JUST A FEW BARGAINS ARE LISTED - SEND STAMPED ADDRESSED ENVELOPE FOR A QUOTE ON OTHER REQUIREMENTS. PAY A VISIT. OVER 90% OF STOCK BELOW QUANTITY WHOLESALE PRICE. ALL PRICES INCLUDE THE ADDITIONAL DISCOUNT IN LIEU OF GUARANTEE. MINIMUM ORDER GOODS VALUE £1.00.

Goods sent at customer s risk, unless suficient payment for registration (1st class letter post),or compensation fee (parcel post) included.

VALVE BASES

Printed circuit B9A–B7G	5p
Chassis B7–B7G	9p
Shrouded chassis B7G–B8A	10p
B12A tube	10p

Speaker 6″ x 4″ 5 ohm ideal for car radio **70p**

TAG STRIP – 6 way **3p** 9 way **5p** Single **1p**

5 x **50pF** or 2 x 220pF trimmers 20p

Car type panel lock and key **40p**

18 volt 4 amp charger, bridge rectifier **79p**

GC10/4B **£3.00**

Aluminium Knobs for ¼″ shaft. Approx. ⅝″ x ⅞″ with indicator Pack of 5. **50p**

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 **£1.10**

Used 999 ALARM UNIT. 12 volt includes loop cassette tape player, 2 x d.p.t.d., 1 x 4 p.d.t. miniature relay. Reed relay, solenoid, 35 marked semiconductors, caps, resistors, pots, terminal strip etc.

£2.00 plus £1.40 p&p

SWITCHES

Pole	*Way*	*Type*	
1	2	Sub. Min. Slide	**12p**
6	2	Slide	**20p**
2	1	Rotary Mains	**20p**
2	1 (or 1p 2W)	Micro with roller	**20p**
2	3	Miniature Slide	**16p**
1	2	Toggle	**12p**

S.P.S.T. 10 amp 240v. white rocker switch with neon. 1″ square flush panel fitting **30p**

S.P.S.T. dot 13 amp, oblong, push-fit, rocker**15p**

Sidleen/AFA Very High Security barrel Key Switch. 2 tubular keys **£1.50**

AUDIO LEADS

3 pin din to open end, 1½ yd twin screened **35p**

Twin phono—open end, 4ft., twin screened **35p**

COMPUTER & AUDIO BOARDS/ASSEMBLIES

VARYING CONTENTS INCLUDE 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** + **£1.00** post and packing

7lb for **£1.95** + **£1.40** post and packing

1k horizontal preset with knob **3p**

3″ Tape Spools **3p**

1″ Terry Clips **4p**

12 Volt Solenoid **30p**

TV KNOB

Dark grey plastic for recessed shaft (quarter inch) with free shaft extension **5p**

ENM Ltd. cased 7-digit counter 2¼ x 1¾ x 1¼″ approx. 12V d.c. (48 a.c.) or mains **75p**

ZM1162A INDICATOR TUBE

0-9 Inline End View. Rectangular Envelope 170V 2·5M/A **£1**

REGULATED TAPE MOTOR

9v d.c. nominal approx 1½″ diameter **60p**

3.5mm metal stereo plug **20p**

Ferric Chloride, Anhydrous mil. spec. 1lb bag **40p**

RESISTORS

⅛–¼–½ watt	**1p**
1 watt	**2p**
Up to 15 watt wire wound	**8p**

1 or 2% five times price.

Cinch 8 way std 0.15 pitch edge connector**20p**

Diode Equivalent Book, 172 pages, AA111 to ZY200, 1N34 to 1S3200, also outline and connection data.

£1.50 **NO VAT**

POTS

Log or Lin, single or dual, switched carbon or wire-wound, rotary or slider. All types **20p**

1.5m Edgetype **3p**

Skeleton Presets

Slider, horizontal or vertical standard or submin. **6p**

THERMISTORS

VA1008, VA1034, VA1039, VA1040, VA1055, VA1066, VA1082, VA1100 **10p**

VA1077, VA1005, **15p**

RELAYS

12 volt S.P.C.O octal mercury wetted high speed **40p**

P.O. 3000 type, 1,000 OHM coil, 4 pole c/o **40p**

Mains or 12v d.p.c.o heavy duty octal **50p**

700 ohm 11-31 volt miniature sealed d.p.d.t. **80p**

JAP 4 gang min. sealed tuning condensers **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, 22/50 Tubular tantalum **20p each** 16-32/275V. 100-100/150V. 100-100/275V **30p**; 50-50/385V. 12,000/12V, 32-32-50/300V, 20-20-20/350V **60p**; 700 mfd/200V **£1.00**; 100-100-100-150-150/320V **£2.00.**

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**.

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

Many others and high voltage in stock.

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**

CONNECTOR STRIP

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

1¼ glass fuses 250 m/a or 3 amp (box of 12)	6p
Bulgin, 5mm Jack plug and switched socket (pair)	30p
Reed Switch 28mm. body length	5p

Aluminium circuit tape, ⅛″ x 36 yards—self adhesive. For window alarms, circuits, etc.**60p**

MAINS DROPPERS

66+66+158 ohm, 66+66+137 ohm

17+14+6 ohm, 266+14+193 ohm **5p**

285+575+148+35 ohm

25+35+97+59+30 ohm **5p**

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

OUTPUT TRANSFORMERS

Sub-miniature Transistor Type	25p
Valve type,	40p

KEY EDIT and display boards with up to 132* 12V bulbs, 38 d.t.l. and t.t.l. i.c.'s and other components. (*A few bulbs may be broken).

£2.00 plus 75p p&p

Crouzet 30-minute timer-programmer, multi-variable contacts

£6.00 plus £1.00 p&p

ACOS DUST JOCKEY Automatic record cleaner **£1.00**

Wood cased 8-12V buzzer

£1.50 plus 80p p&p

McMurdo 8 or 12 or 18-way plug and socket, ex-equipment **36p**

Miniature 0 to 5mA d.c. meter approx. ⅞″ diameter	**£1**
RS Yellow Wander Plub Box of 12	**25p**
18 SWG multicore solder	**2½p foot**

STYLII 15p

ER5SB/5MX/HC1/HC2/ER2. Compact X2/X/C/SX. Garrard GCM21T/22T/GKM24T/GKS25/GP59. B.S.R. C1/FX1M/ST3/CS80/TC8/OP and T. and many other sapphire types.

Send sample required with payment and s.a.e if in doubt.

THE RADIO SHACK

161 ST. JOHNS HILL, BATTERSEA, LONDON S.W.11

Open 10 a.m. till 7 p.m. Tuesday to Saturday. VAT receipts on request.

Terms: Payment with order   Telephone: 01-223 5016

POSTAL ORDERS means quicker service — unless a fee is paid for special clearance it is 15 days* to ensure cheques are not returned 'unpaid'. Postal order poundage charge is offset by it now costing up to 16p bank charges on every cheque written out. * Timed from banking at Barclays till G.P.O. deliver returned cheque.

Greenpar 50 ohm BNC line plug, round or flanged chassis socket or t.n.c. or u.h.f. plug, all 50p each

SEMICONDUCTORS

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

AC128/176	8p
ACY28	19p
AD149	40p
AF116	16½p
AF124/6/7	25p
AF139	20p
AF178/80/81	30p
AF239	30p
ASY27/73	30p
BC107/8/9 + A/B/C	6p
BC147/8/9 + A/B/C/S	6p
BC157/8/9 + A/B/C	6p
BC178A/B, 179B	12p
BC184C/LC	9p
BC186/7	20p
BC213L/214B	10p
BC261B	8p
BC327/8, 337/8	8p
BC547/8/8A/8C	10p
BC555/6/7/8/9	9p
BCX32/36	12p
BCY40	50p
BCY70/1/2	12p
BCZ11	28p
BD113	50p
BD115/6	31p
BD131/2/3	35p
BD135/6/7/9	30p
BD140/142	30p
BD201/2/3/4	80p
BD232/4/5/8	49p
BDX77	£1
BD437	50p
BF115/167/173	15p
BF178/9	20p
BF180/1/2/3/4/5	15p
BF194/5/6/7	6p
BF194A, 195C	6p
BF200, 258, 324	20p
BF202/3	30p
BF336	27p
BFS28 Dual Mosfet	£1
BFW10/11 F.E.T.	40p
BFW30	£1
BFW57/58	17p
BFX12/29/30	20p
BFX84/88/89	17p
BFY50/51/52	13p
BFY90	50p
BR101	30p
BRY39/56	26p
BSV64	30p
BSV79/80 F.E.T.s	80p
BSV81 Mosfet	90p
BSX20/21	14p
BSY40	27p
BSY95A	12p
CV7042 (OC41/44 ASY63)	5p
GET111	40p
ON222	20p
TIP30/3055	45p
TIS88A F.E.T.	23p
ZTX300/341	7p
2N393 (MA393)	30p
2N456A	50p
2N929	14p
2N987	40p
2N1507/2219	15p
2N2401	30p
2N2412	70p
2N2483	23p
2N2904/5/6/7/7A	15p
2N3053	14p
2N3055 R.C.A.	50p
2N3704	8p
2N3133	20p
2N3553	50p
2N4037	34p
2N5036 (Plastic 2N3055)	30p
2SA141/2/360	31p
2SB135/6/457	20p
40250 (2N3054)	30p

BRIDGE RECTIFIERS

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

RECTIFIERS

	Amp	Volt	
IN4004/5/6	1	4/6/800	5p
IN4007/BYX94	1	1250	5p
BY103	1	1,500	18½p
SR100	1.5	100	7p
SR400	1.5	400	8p
REC53A	1.5	1,250	14p
LT102	2	30	10p
BYX38-300R	2.5	300	40p
BYX38-600	2.5	600	45p
BYX38-900	2.5	900	50p
BYX38-1200	2.5	1,200	55p
BYX48-300R	2.5	300	26p
BYX49-600	3	600	35p
BYX49-900	3	900	40p
BYX49-1200	3	1,200	52p
BYX48-300R	6	300	40p
BYX48-600	6	600	50p
BYX48-900	6	900	60p
BYX48-1200R	6	1.200	80p
BYX72-150R	10	150	35p
BYX72-300R	10	300	45p
BYX72-500R	10	500	55p
BYX42-300	10	300	30p
BYX42-600	10	600	65p
BYX42-900	10	900	80p
BYX42-1200	10	1,200	95p
BYX46-300R*	15	300	£1.00
BYX46-400R*	15	400	£1.50
BYX46-500R*	15	500	£1.75
BYX46-600*	15	600	£2.00
BYX20-200	25	200	60p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.50
RAS310AF*	1.25	1,250	40p

Avalanche type

TRIACS

Amp	Volt		
6	800	Plastic RCA	£1:20
25	900	BTX94-900	£4.00
25	1200	BTX94-1200	£6.00

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

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

DLI Pal Delayline 50p

Relay socket 10p
Take miniature 2PCO relay

B9A valve can ... 5p

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

OPTO ELECTRONICS

Diodes	
TIL209 Red	12p
BPX40	50p
BPX42	80p
BPY10 (VOLTIAC)	80p
BPY68 BPY69 BPY77	80p

Photo transistor	
BPX29	80p
OCP71	34p

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

YELLOW	14p
RED	14p

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp **£1.00**

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

Minitron 3" 3015F filament £1.10

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

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

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

TO3 HEATSINK

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

Tested unmarked, or marked ample lead ex new equipment

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

KLAXON 12-24v 2-tone transistorized Alarm Sounder. Note, pitch and duration variable. Weatherproof alloy case. **£10.00 p&p £1.30**

NEW B.V.A. VALVES

EB91	34p
ECL80	34p
PCC84	34p
6SN7	50p
6AT6	50p
EZ81	40p

TRANSFORMER

Ferromag C core. Screen-95-105-115-125-200-220-240v Input: output 17v ¾A x 2 + 24-0-24v 1.04A + 20v 1mA. These current ratings can be safely exceeded by 50%. £3.50 + £1.00 p&p.

WOODS 240V A.C. Approx. 2,500 r.p.m. continuous rated 5 or 6in. **FAN** (ex-computer) **£3.60 plus £1 p&p**

OTHER DIODES

1N916	6p
1N4148	2p
BA145 ...	14p
Centercel	24p
BZY61/BA148 ...	10p
BB103/110 Varicap	20p
BB113 Triple Varicap ...	37p
BA182	13p
OA5/7/10 ...	15p
BZY88 Up to 33 volt	8p
BZX61 11 volt	15p
BR100 Diac.	15p

INTEGRATED CIRCUITS

TAA700	£2.00
TBA800	£1.00
741 8 pin d.i.l. op.	24p
SN76013N	£1.20
TAD100 AMRF	£1
CA3001 R.F. Amp	50p
CD4013 CMOS	36p
TAA300 1wt Amp	£1
TAA550 Y or G	22p
TAA263 Amp ...	65p
7400	10p
7402/4/10/20/30	14p
7414 ...	56p
7438/74/86	24p
7483 ...	69p
LM300, 2-20 volt	£1
74154	90p
TBA550Q	£1.50

THYRISTORS

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

PAPER BLOCK CONDENSER

0.25MFD	800 volt	60p
1MFD	250 volt	30p
2MFD	250 volt	40p
4MFD	250 volt	40p

I.C. extraction and insertion tool 32p

CHASSIS SOCKETS

Car Aerial **9p**, Coax **6p**, 5 pin 180° **9p**, 5 or 6 pin 240° din **6p**, speaker din switched **10p**, 3.5 mm switched **5p**, stereo ¼" jack enclosed **15p**.

CRAZY OFFERS

2000 mfd.	50v	16p
2500 mfd.	40v	30p
8 mfd.	500v	6p
400 mfd.	16v	4p
.1 mfd.	350/500v	1½p
.1 mfd.	1500v	2p
2200 mfd.	25v	30p
1000 mfd.	200v	25p
10000 mfd.	15v	12p
1250 mfd.	35v	10p
6800 mfd.	10v	6p
32+32 mfd.	275v	8p
16+32 mfd.	350v	12p
8+8 mfd.	350v	8p
150 mfd.	35v	4½p
100 mfd.	70v	4½p
1 mfd. non-polar	350v	3p
680 mfd.	100v	10p
15 mfd.	160v	3p
4700 pf. sub min	500v	1½p
4700 mfd.	63v	70p
250 mfd.	300v	18p
4700 mfd.	40v	35p
25000 mfd.	25v	20p
1000 mfd.	63v	30p
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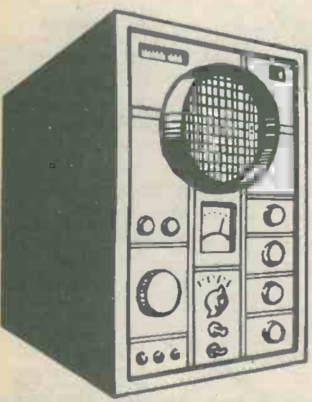

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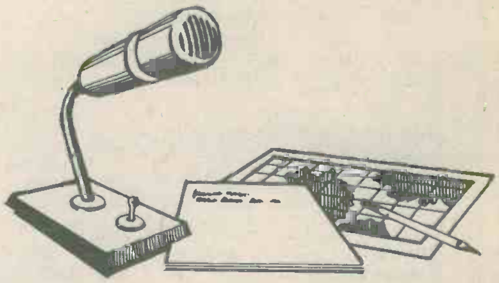

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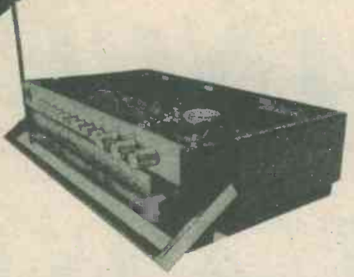

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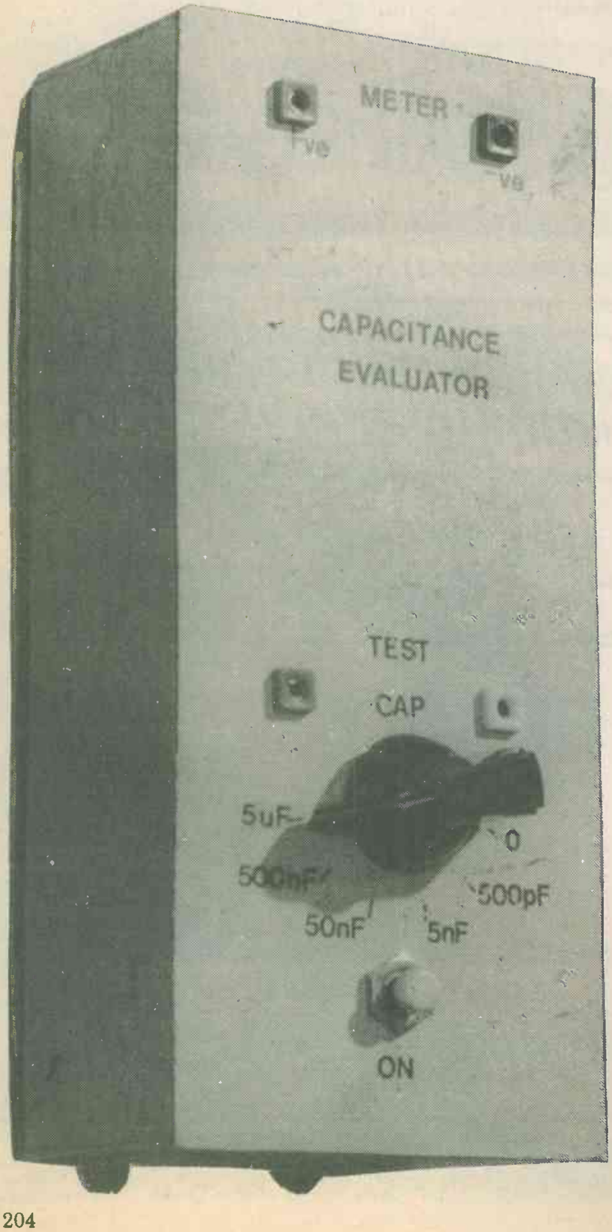
CMOS CAPACITANCE EVALUATOR

By Bruce Woodland



This low cost instrument incorporates a quad 2-input CMOS NAND gate and is capable of measuring capacitance from 50pF to 5μF. Capacitance is indicated by a moving-coil meter which can be plugged in as required, thereby conferring a significant economic advantage.

The high input impedance of CMOS logic integrated circuits permits quite sophisticated circuit elements to be developed from just a few gates. The unit described here exploits this versatility. An oscillator and a "single shot" monostable are built around four NAND gates form a linear scale capacitance meter. This can be used to determine the value of any non-polarised capacitor between 50pF and 5μF.

As only two active devices, the CMOS package and a p.n.p. transistor, are needed and since the meter movement need not be an integral part of the unit its cost is minimal.

PRINCIPLE OF OPERATION

The CMOS i.c. has four NAND gates and two of these, G1 and G2, appear with associated components in a rectangular wave oscillator. See Fig. 1. The falling edge of its output waveform triggers a monostable incorporating the remaining two gates, G3 and G4. The period of time during which the monostable is on after triggering is directly related to the value of the capacitance being measured and the associated timing resistor, R5, R6 or R7. The monostable output is low when it is on and this output is coupled to the meter via the buffer emitter

COMPONENTS

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)
R1 68Ω
R2 270kΩ
R3 27kΩ
R4 27kΩ
R5 10kΩ 2%
R6 100kΩ 2%
R7 1MΩ 2%
R8 see text
VR1 100kΩ pre-set potentiometer, 0.1 watt, horizontal skelton

Capacitors
C1 20μF or 22μF electrolytic, 10V Wkg.
C2 0.33μF (see text)
C3 3,300pF (See text)
C4 100pF polystyrene

Semiconductors
IC1 CD4011
TR1 2N4062K (see text)
D1 BZY88C7V5

Switches
S1 (a) (b) 2-pole 6-way, miniature rotary
S2 push-button, miniature, press to make

Sockets
SK1-SK4 insulated sockets (see text)

Battery
BY1 9 volt battery type PP3 (Ever Ready)

Meter
M1 external meter (see text)

Miscellaneous
Materials for case (see text)
Battery connector
4 plugs
2 crocodile clips
Pointer knob
14 way i.c. holder
Materials for printed circuit board
Nuts, bolts, etc.

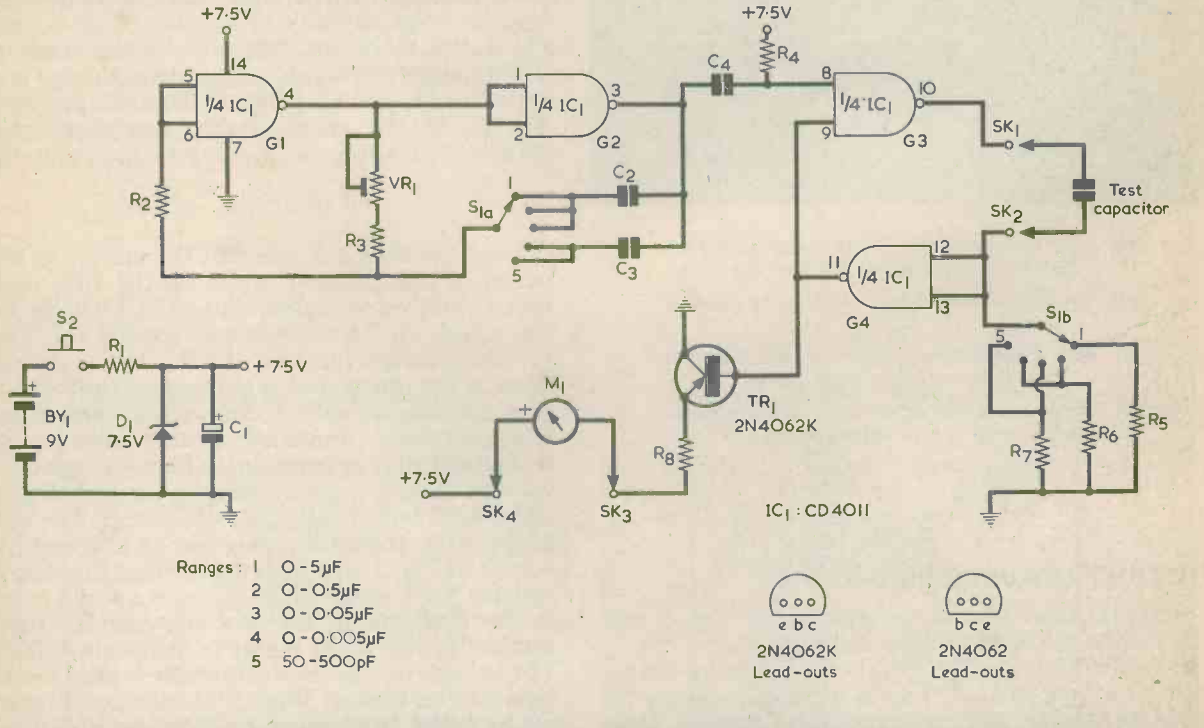


Fig. 1. The circuit of the CMOS capacitance evaluator. Meter M1 is an external meter, and can consist of a multimeter switched to a low current range

follower, TR1, allowing a relatively insensitive meter movement to be used without loading the output of the monostable. The magnitude of the meter reading is proportional to the length of the on period and hence a linear scale of capacitance results.

The oscillator repetition time is arranged to be fractionally longer than the monostable on period when maximum test capacitance for a range is connected. This results in a slight overload if the test capacitance is out of range. With the component values specified the monostable on period for maximum test capacitance should approximate to 90% of the oscillator repetition time, ensuring that meter overload can never exceed some 10%.

On ranges 1, 2 and 3, oscillator frequency is controlled by C2 and the monostable on period by R5, R6 or R7. Ranges 4 and 5 have oscillator frequency controlled by C3 and the monostable by R6 and R7.

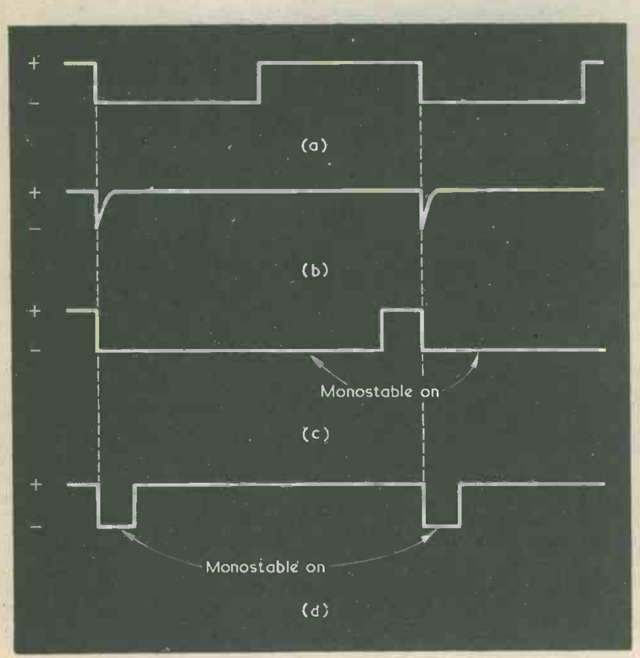


Fig. 2(a). The waveform at the output of the oscillator incorporating G1 and G2

(b). The differentiated pulse applied to pin 8 of G3

(c). The monostable output when the test capacitance has a high value

(d). The monostable is on for a much shorter period with a low test capacitance

OUTPUT WAVEFORMS

Examination of the waveforms in Fig. 2 will clarify the principle of the instrument.

The waveform in Fig. 2(a) is the output of the oscillator at pin 3 of G2. This is differentiated by C4 and R4 giving the negative-going trigger pulse shown in Fig. 2(b). (Fig. 2(b) omits the small positive-going differentiated pulse given when the oscillator output goes high.)

If the test capacitor has a value near the maximum value of a range the monostable output, at pins 9 and 11 of C3 and G4, has the waveform illustrated in Fig. 2(c). Note the extended time in which the monostable is on and its output is low. The monostable output waveform for a fairly small value of test capacitance is shown in Fig. 2(d). The output is low for only a short period.

PRACTICAL CONSIDERATIONS

Unfortunately, transfer voltages of CMOS gates are subject to considerable variation, ranging from about 30% to 70% of supply voltage. Whilst this makes little difference to the oscillator, the on time of the monostable is only predictable within fairly wide limits. The oscillator frequency thus needs to be adjustable, hence the pre-set variable resistor VR1, which is adjusted to the required value as described later.

A test capacitance of 50pF is about the lower limit for reliable results with this circuit. Indeed, the monostable will refuse to trigger if a test on less than about 20pF is attempted.

To ensure that the accuracy of the capacitance meter is not compromised by falling battery voltage, the simple zener stabilizing circuit incorporating R1 and D1 is utilised. C1 is a bypass capacitor for the stabilized voltage. The unit is powered by a 9 volt battery type PP3, this being quite suitable as current is only drawn from it when S2 is pressed to take a capacitance reading.

SUITABLE METERS

M1 is an external meter which is connected to the circuit at sockets SK3 and SK4. Any moving-coil meter movement having an f.s.d. of 5mA or less can be used, and it is preferable if this has a scale graduated 0-5 so that capacitance indications can be read directly. Naturally, the larger the meter the more accurate will be the readings. A multimeter switched to a low current range is quite suitable. The value of R8 will depend upon the sensitivity of the meter to be used and can be calculated from

$$0.9\ (6.9 \text{ volts} - V_m)$$

divided by the f.s.d. value of the meter. In the expression, the 0.9 term caters for the 10% overload factor referred to earlier whilst the 6.9 volts term is the supply of 7.5 volts minus the 0.6 volt drop in the base-emitter junction of TR1. Vm is the voltage drop in the meter and is only significant when this is a multimeter switched to a low current range. Due to their universal shunt circuits, many testmeters drop a suprisingly high voltage on their current ranges, a quite common figure being of the order of 1 volt at full-scale deflection. The voltage dropped by the multimeter can be checked by the circuit of Fig. 3, in which the current limiting fixed resistor has a value which permits a slight overload in the multimeter, thereby allowing the variable resistor to adjust the meter to full-scale deflection. The voltage across the multimeter is then read by a separate voltmeter. With a panel-mounting single range meter movement the Vm term can be ignored.

If a panel-mounting 0-1mA meter having negligible Vm is to be used, R8 is equal to 0.9 times 6.9 volts divided by 1mA, which calculates as 6.2kΩ. However, to allow for component tolerances the next lowest preferred value should be selected,

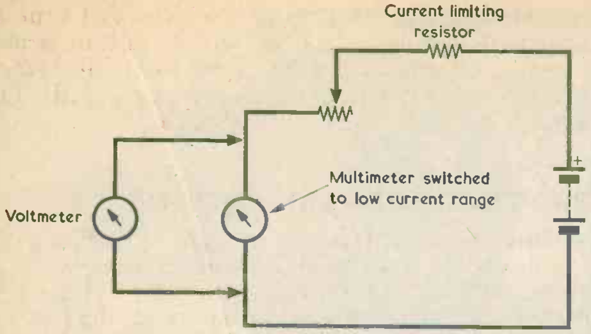


Fig. 3. The voltage dropped across many multimeters when these are switched to a low current range can be surprisingly high. This circuit enables the voltage dropped by a particular multimeter to be checked. The current limiting resistor must have a value which ensures that an excessive current cannot flow through the multimeter

whereupon R8 may be 5.6k Ω. The value of R8 can be similarly calculated for other meters.

COMPONENTS

The three resistors in the monostable circuit, R5, R6 and R7, are close tolerance components and are shown in the Components List as 2% types. No problems should be experienced in obtaining the values required in 2%; indeed, the values are fairly widely available in the closer tolerence of 1%. C2 and C3 should also be close tolerance. The 3,300pF capacitor required for C3 is listed by Maplin Electronic Supplies in 1% polystyrene, and such a capacitor would be an excellent choice here. It is a little more difficult to find a source of a close tolerance 0.33μF capacitor for C2, but a 5% carbonate component, again listed by Maplin Electronic Supplies, will be adequate in practice.

The transistor employed in the TR1 position in the prototype is a 2N4062K, which is not as readily available as the normal 2N4062 and which has the rather unusual lead-out layout shown in the inset in Fig. 1. For convenience, Fig. 1 also shows the lead-out layout for the standard 2N4062, which may alternatively be used. If a 2N4062 is fitted to the author's printed circuit layout its leads are liable to cross each other and so should be covered with lengths of sleeving to prevent short-circuits. However, the choice of transistor for TR1 is not very critical and most small signal p.n.p. silicon transistors would be suitable.

VR1 is an 0.1 watt horizontal skelton potentiometer having 0.2 in. spacing between track tags and 0.4 in. spacing between track and slider tags. S1(a) (b) is a 2-pole 6-way rotary switch with no connections made to the sixth position. A 14 way i.c. holder is specified, and the CD4011 is fitted into this after wiring has been completed and checked out. In the prototype, SK1 to SK4 were insulated sockets suitable for 2mm. banana plugs.

CONSTRUCTION

The layout of the capacitance meter is by no means critical, and construction can proceed in any reasonable manner. However, the following details of the prototype instrument may be helpful.

The unit is housed in a home-made plywood case having internal dimensions of 5½in. long by 2¼in. wide by 1½in. deep. Its front panel and four sides are covered by Formica. The back is cut from a sheet of aluminium and has flanges bent down at the ends to facilitate a push fit.

The printed circuit board, which is reproduced full size in Fig. 4, is mounted behind the front panel by means of four countersunk 6BA bolts and nuts, the bolt heads being covered by the Formica. Brass ¼in. spacing washers are fitted over the bolts between the board and the front panel. The board is oriented such that R8 is at the top. The two switches and four sockets are also mounted on the front panel, in the position shown in the photograph. SK3 and SK4 are at the top, whilst SK1 and SK2 are just above S1 (a) (b). A simple

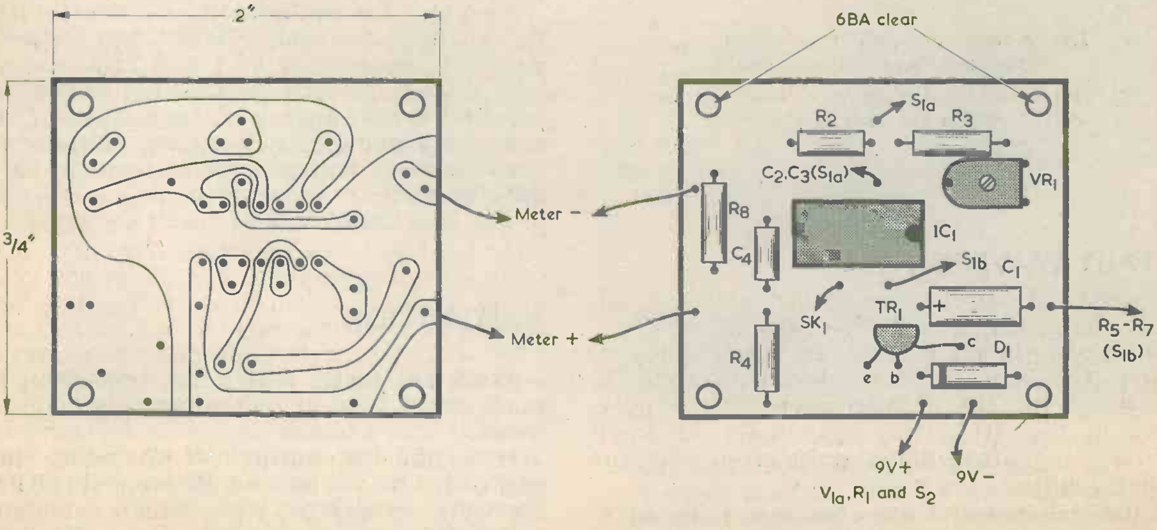


Fig. 4. The printed board layout employed in the prototype. This is reproduced full size for tracing

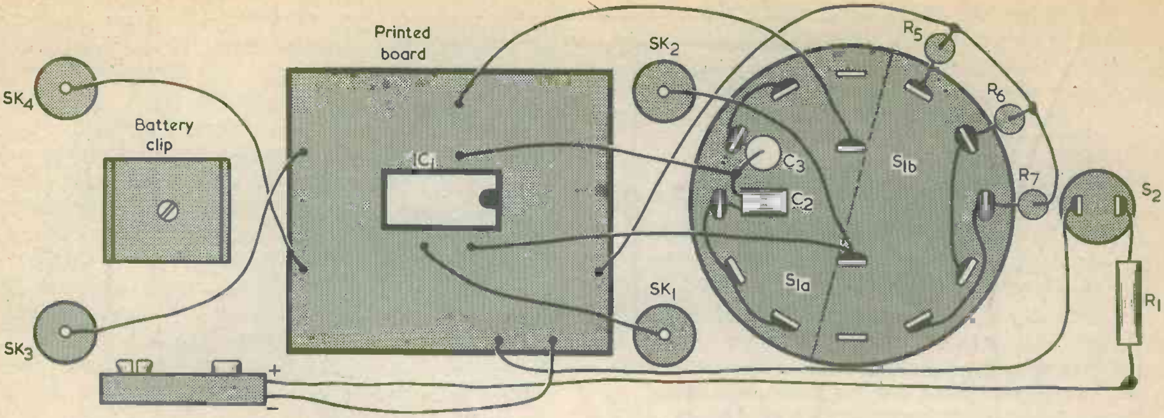
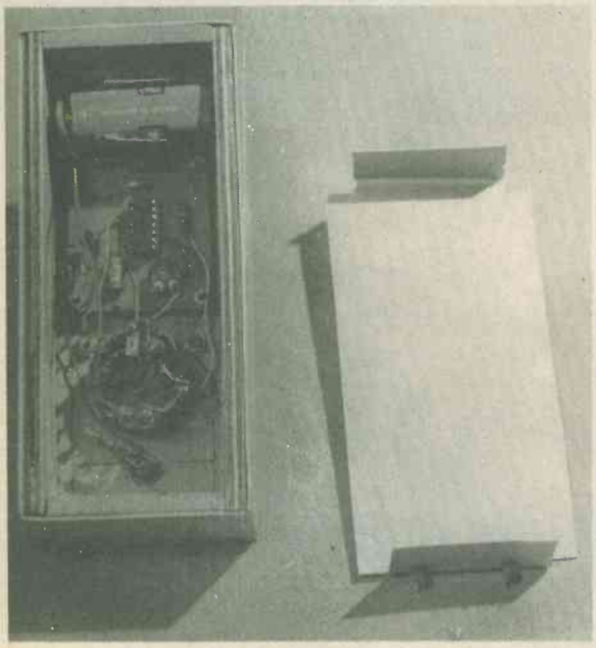


Fig. 5. Illustrating how the printed board connects to S1 (a) (b) and to the four sockets. Capacitors C2 and C3 and resistors R5 to R7 are soldered to the tags of S1 (a) (b)

home-made metal U-clamp to secure the battery is mounted to the back of the front panel above the printed board.

Resistor R1 is soldered to one tag of S2, with the positive battery lead connected to its free end. C2, C3 and R5 to R7 are soldered to the tags of S1 (a) (b), as illustrated in Fig. 5. The leads to S1 (a) (b) and to SK1 and SK2 must be kept as short as is reasonably possible and should not be twisted together. The most suitable test probe leads consist of 4in. lengths of insulated flexible wire terminating in crocodile clips at one end and plugs suitable for SK1 and SK2 at the other end.



The components and battery inside the evaluator case. The case bottom is simply a piece of aluminium sheet with flanges which fit inside the top and bottom of the case to provide a push fit

SETTING-UP

A close tolerance capacitor is required for setting-up the instrument, this having a value which is near the maximum of any range. The better this component, the more accurate will be the results obtained. Only one range has to be set up, the adjustment holding good for all the other ranges.

First plug the meter into SK3 and SK4, then set S1 (a) (b) to the appropriate range. Connect the standard capacitor to SK1 and SK2, and adjust VR1 so that it inserts maximum resistance into circuit (this is fully anti-clockwise in Fig. 4). Press S2 and slowly reduce the resistance inserted by VR1 until the meter reads the correct value for the standard capacitor.

The instrument is then ready for use.

PRECAUTION

Since the meter reading is dependent on the mark-space ratio of the monostable output, it is possible that a totally erroneous indication can be given if the test capacitance is greater than the maximum for the range selected. It is important, therefore, to always start with the highest range selected and then work down as required through the lower ranges. ■

BRR,BRR - - -
BRR,BRR - - -
TELEPHONE BELL SIMULATOR

By G. A. French

"A USEFUL STAGE PROP" (Suggested circuit)

In both amateur and professional theatrical work, the action of a play frequently requires that a telephone be caused to apparently ring on stage. It is, of course, quite an easy matter to make an electric bell ring by means of a simple circuit incorporating a battery and a push-button, but it is surprisingly difficult to operate the push-button so that the ringing of the bell takes place realistically with the familiar "brr, brr ... brr, brr" rhythm of the standard Post Office ringing cycle.

This difficulty can be readily eased if an electronic circuit is employed to control the bell. All that is then required is that the electronic unit be switched on, whereupon the bell will ring in the normal telephone manner until the unit is switched off again. A circuit capable of meeting this requirement is described in the present article.

OPERATING PRINCIPLE

There are many ways of designing an electronic device which will provide the necessary ringing pattern, and one of the simpler approaches consists of employing two 555 timer i.c.'s, one of these controlling the bell directly whilst the second inhibits and enables the first i.c. to produce the requisite gaps between each pair of ringing periods. However, before turning to electronic details it is first desirable to examine the Post Office ringing cycle itself.

This is illustrated in Fig. 1, in which the ringing of the bell is indicated by the waveform rising to the "On" level. The bell rings for a period of 0.4 second, is silent for 0.2 second, rings again for 0.4 second and is then silent for 2 seconds. After that the cycle commences once more, with a second pair of 0.4 second ringing periods which have a gap of 0.2 second between them. The total cycle length is 3 seconds.

Fig. 2 shows a standard circuit for a 555 timer i.c. when it is used as a continually running astable multivibrator. At the instant of switch-on capacitor C is discharged and it then commences to charge via RA and RB in series. Under this condition the output voltage at pin 3 is high. When the voltage across the capacitor is equal to two-thirds of the supply voltage the comparator connected to pin 6 of the i.c. triggers the internal flip-flop, causing both the output at pin 3 to go low and the internal discharge transistor connected to pin 7 to turn on. The capacitor now discharges via RB on its own until the voltage across it falls to one-third of the supply voltage.. A second comparator, at pin 2, returns the flip-flop to its previous state, the output at pin 3 goes high again and the discharge transistor connected to pin 7 turns off. The capacitor once more charges via RA and RB in series until the voltage across it reaches two-thirds of the supply voltage. Thus the cycles proceed.

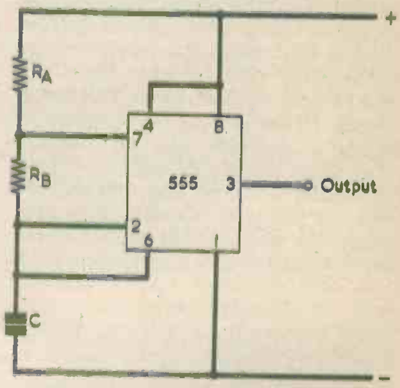


Fig. 2. A standard 555 astable multivibrator circuit. Points in this which are applicable to the telephone bell simulator are discussed in the text

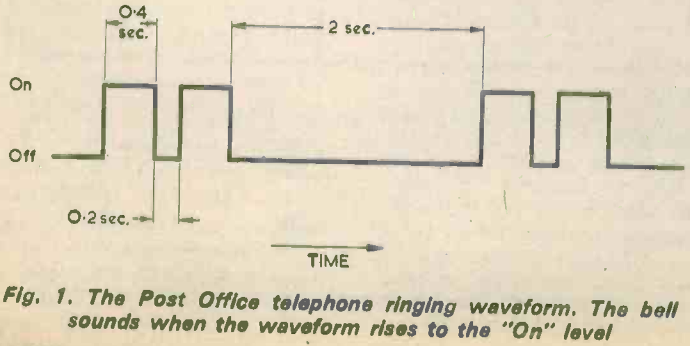


Fig. 1. The Post Office telephone ringing waveform. The bell sounds when the waveform rises to the "On" level

The length of time in a cycle during which the capacitor charges and the output is high is equal to 0.7 times the product of C and the sum of RA and RB, where time is in seconds, capacitance is in microfarads and resistance is in megohms. The period during which the capacitor discharges is equal to 0.7 times the product of C and RB.

We can use a 555 timer to generate a series of pulses having an on period of 0.4 second and an off period of 0.2 second. Another 555 i.c. can then control the pulse generator so that it is only allowed to produce two pulses at a time and is then inhibited such that 2 seconds elapse before it is allowed to produce a further two pulses. The period during which the pulse generator is enabled, or is allowed to produce pulses, can be given either when the output of the controlling 555 is high or when it is low. Of these two choices the second is more desirable. If the enable period corresponds to the output of the controlling 555 being high, the first enable period immediately after switching on will be longer than all the subsequent enable periods because, during this initial period, the capacitor voltage has to rise from zero to two-thirds of the supply voltage instead of rising from one-third of the supply voltage. If we make the enable period correspond to that when the output of the controlling 555 is low then all enable periods will be of the same length. It then becomes feasible to design a circuit with no control other than an on-off switch. When the switch is closed there is a short wait (in practice about 3 seconds) before the first enable period starts and the bell commences to ring with the standard "brr, brr . . . brr, brr" rhythm.

CIRCUIT DIAGRAM

The full circuit of the telephone bell simulator appears in Fig. 3. Here, IC1 is the controlling 555 whilst IC2 is the pulse generator. Let us assume for the moment that diode D1 and resistor R3 are not coupled to capacitor C3, whereupon IC2 is always enabled and is capable of oscillating continuously.

The period during which C3 charges and the i.c. output is high is equal to 0.7 times the product of the value of C3 and the sum of the values of R4 and R5. This calculates as 0.38 second. The time in each cycle when C3 discharges is given by 0.7 times the product of the value of C3 and that of R5, which is equal to 0.19 second. Thus, the output at pin 3 of IC2 is high for 0.38 second and is low for 0.19 second. The i.c. output drives a relay which is energised when the i.c. output is high, causing the electric bell to sound for about 0.38 second and to be silent for about 0.19 second. These periods are more than adequately close to the Post Office ringing and silent times of 0.4 and 0.2 second.

If we now take into account diode D1 and resistor R3 we can see that IC2 is enabled and is allowed to generate ringing pulses when the output of IC1 is low. Under this condition, diode D1 is reverse biased and capacitor C3 is free to charge via R4 and R5 and to discharge via R5. When the output of IC1 goes high, IC2 is inhibited. This is because D1 is now forward biased and it causes the voltage across C3 to be taken to a level higher than two-thirds of the supply voltage. IC2 cannot then oscillate, its output is in the low voltage state and the relay is de-energised.

The upper waveform of Fig. 4 shows the voltage on the upper terminal of C3 with respect to the negative supply rail, whilst the lower waveform is the corresponding ringing waveform. In passing it should be mentioned that the output of a 555 does not go fully to the positive supply rail when it is in the high condition, but to a voltage of around 1 volt or more below it. In Fig. 4 it is assumed that this voltage is 0.8 volt and that a further forward voltage of 0.6 volt is dropped across D1, causing a voltage of 10.6 to appear across C3 during the inhibit period. (Resistor R3 has little effect on circuit operation and merely limits the initial charging current in C3 when IC1 output goes high).

During the inhibit period the upper terminal of C3 is in consequence at 10.6 volts and the output of IC2 is low. Also, the internal discharge transistor connected to pin 7 of IC2 is turned on. At the end of the inhibit period the output of IC1 suddenly goes low, allowing C3 to discharge into R5. The discharge continues until C3 voltage reaches one-third of the supply voltage at 4 volts, whereupon the IC2 flip-flop changes state, C3 commences to charge via R4 and R5, and the first

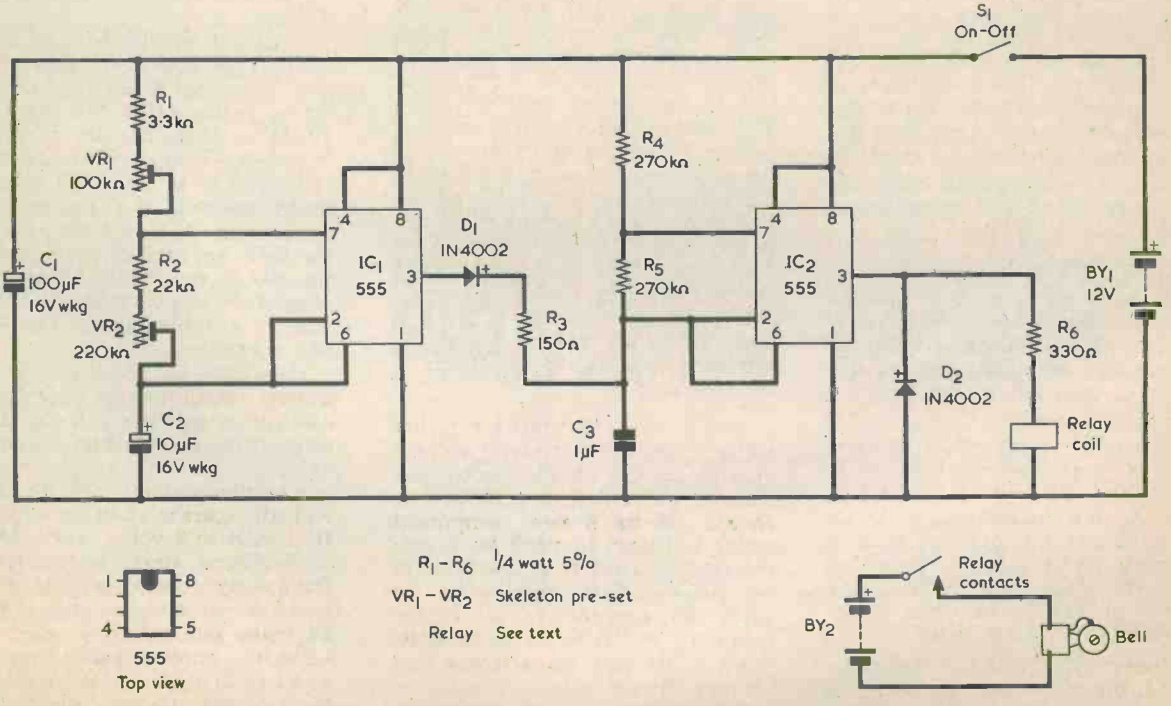


Fig. 3. The complete circuit of the telephone bell simulator. The relay contacts cause the bell to ring with the standard Post Office rhythm

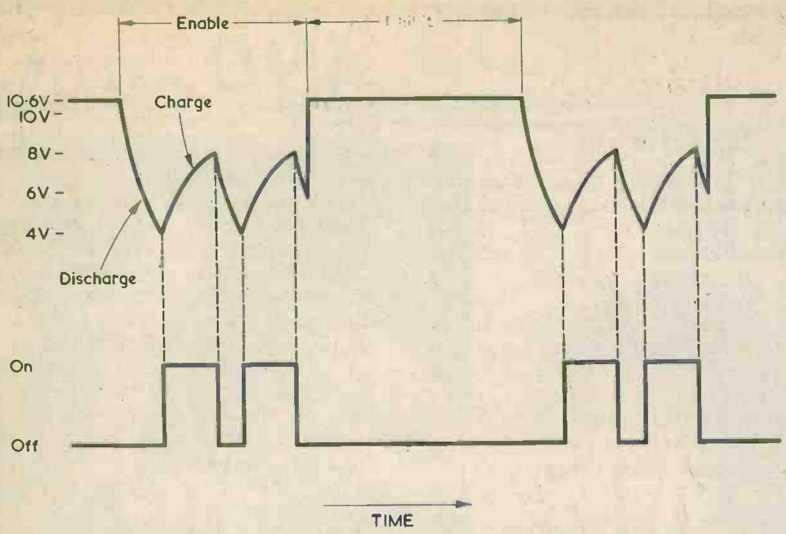


Fig. 4. The upper waveform illustrates the voltage on the upper terminal of C3 whilst the lower waveform is the corresponding ringing waveform. The length of the enable period is controlled by VR2 and that of the inhibit period by VR1

ringing pulse starts. The pulse continues until C3 voltage reaches two-thirds of the supply potential at 8 volts and then commences to discharge again. At 4 volts, the next ringing pulse starts, to terminate with the C3 voltage at 8 volts. C3 starts to discharge once more, but the enable period comes to an end before the capacitor voltage reaches 4 volts. The voltage is abruptly taken up to 10.6 volts, with IC2 consequently inhibited.

The sum of the enable and inhibit periods is 3 seconds. In practice the enable period (IC1 output low) is equal to about 1.4 seconds and the inhibit period (IC1 output high) is equal to about 1.6 seconds.

CONTROL PERIODS

The enable and inhibit periods produced by IC1 are controlled by C2, R1, VR1, R2 and VR2. If C2 had a value of 10μF exactly an enable time of 1.4 seconds (when C2 discharges) would be given by a total value in R2 and VR2 of 200kΩ and an inhibit time of 1.6 seconds (C2 charging) when the total value of R1, VR1, R2 and VR2 is 230kΩ. However, it is necessary to make C2 an electrolytic capacitor, with a tolerance on its value of, typically, -10% to +50%. As a result a wide degree of adjustment has to be provided in VR1 and VR2.

After construction has been completed, the adjustment procedure is carried out in the following manner. VR1 is initially set to insert about 25kΩ and VR2 to insert about 100kΩ into circuit, after which the unit is switched on by means of S1. The relay should now commence to operate. If VR2 is adjusted it will be found that as its resistance increases the relay operates more than twice during the enable periods and that, as its resistance decreases, the relay operates twice with the second energising period being shorter than the first. The correct setting of VR2 is between that which just allows two full relay energising periods and that which just allows a very short third energising period to take place. The setting should be somewhat closer to the first state of affairs than to the second condition, but it is not at all critical. If the capacitor employed for C2 has an exceptionally low value within its tolerance it may not be possible for VR2 to insert enough resistance to cause the relay to operate three times. Should this occur, the value of R2 can be increased to 47kΩ or 68kΩ as required. The possibility of this happening is, however, quite low.

If VR2 is set to insert a very low value of resistance the relay will not operate, as the enable periods are then too short. A final point is that, should C2 be a new component which has been in stock for a considerable period, it is desirable to let IC1 oscillate unadjusted for some 30 seconds to allow the capacitor to "form" and to settle down to its final capacitance and leakage current values.

After VR2 has been adjusted, VR1 is set up for a ringing cycle length of 3 seconds. The easiest way of determining the cycle length is to count the number of cycles in a 30 second period whilst observing a watch having a sweep second hand or an l.c.d. digital second read-out. Since the inhibit period is only a little longer than the enable period the final setting in VR1 may be fairly close to that which gives zero resistance. Again the setting is not critical.

FURTHER POINTS

A few further points need to be dealt with. A supply voltage of 12 volts at BY1 rather than the usual 9 volts is recommended for two reasons. The first of these is that, during the inhibit period, the upper terminal of C3 is about 1.4 volts below the potential on the upper supply rail and this voltage difference could be significantly higher with some specimens of the 555 or when high temperature conditions prevail. A supply voltage of 12 volts nominal ensures that the upper terminal of the capacitor is taken well above two-thirds of the supply voltage even when the latter has dropped, due to an aging battery, to as low as 9 volts. The second reason is that the higher voltage ensures reliable relay operation when the relay coil has the resistor, R6, in series with it. To prevent the appearance of a high back-e.m.f. across the relay coil on de-energising it is necessary to connect a reverse diode across it, the diode in Fig. 3 being D2. However, such a diode, when connected directly across a relay coil, can cause contact release on de-energising to be sluggish. This effect is reduced to a negligible order in the present circuit by the inclusion of R6.

The relay should be a light quick-acting type and a suitable component here is the 6 volt nominal Open Relay with 410Ω coil which is available from Maplin Electronic Supplies. The operate voltage range of this relay is 4.8 to 35 volts. Its make contacts are connected in series with BY2 and the bell, and the bell can, of course, be wired to the rest of the circuit by way of a long length of 2-core flex. BY2 has a voltage suitable for the particular bell employed.

Capacitor C2 should be a good quality modern component. The author employed a Mullard miniature electrolytic capacitor here.

As already mentioned, the circuit will still operate when the voltage of BY1 falls to 9 volts. Since the 555 i.c.'s change states at fractions of the supply voltage, settings in VR1 and VR2 which have been made at 12 volts will still hold good at 9 volts. The current drawn from BY1 at 12 volts is about 12mA with the relay de-energised and about 25mA with the relay energised. ■

NEWS . . . AND .

ELECTRONIC KITS AT THE INTERNATIONAL HANDICRAFTS EXHIBITION — OLYMPIA

The Philips range of electronic kits were shown for the first time at the International Handicrafts and D.I.Y. Exhibition, at Olympia, by SST Distributors (Electronic Components) Ltd. — part of the Philips group of UK companies.

Philips electronic kits are already well established in Europe. Now they are available by post in Britain from S.S.T. Distributors (Electronic Components) Ltd., West Green Road, Tottenham, London, N17 0RN.

The kits enable the electronics hobbyist to tackle a wide variety of constructional projects from a small multipurpose amplifier to a studio-quality mixer unit.

Every kit contains all the components needed to complete a project, and all kits are sold with a money-back guarantee. Prompt postal delivery from S.S.T. is ensured.

In addition to the complete range of Philips kits, S.S.T. also supply the unique Breadboard and Blob-Board range from P.B. Electronics Ltd. These boards, as most readers will know, enable the constructor to prove his circuit design and then construct it in the simplest possible way.

Putting together a hifi-stereo amplifier. This is one of the many projects offered by the Philips range of electronic kits.

NEW MANUFACTURING FACILITIES FOR MINIATURISED PORTABLE RADIO TELEPHONES

A complete new production line for manufacturing and testing miniaturised CQP 800 portable radio telephones is now fully operational at Storno Limited's manufacturing facilities at Camberley, Surrey.

The Storno CQP 800, it is claimed, represents a new concept in the field of personal radios as its performance and reliability exceed many of the most advanced and larger sized mobiles. It is constructed from expandable modular thick film hybrid integrated circuits which permits the user to alter the facilities originally provided, or incorporate additional modules to increase the number of channels available.

The modular components are currently produced by Storno's parent company in Copenhagen. However, a company spokesman emphasised that the new CQP 800 production facilities embrace much more than assembling modules produced in Denmark.

Test technician aligns the CQP 800 and checks transmit watts and receiver sensitivity across the complete frequency band.

Substantial amounts of new, test and quality control equipment, including infrared soldering systems; a hot and cold environmental test chamber; radio-telephony test sets; multi-frequency vibrator and a 'burn-in' test facilities have been installed at Camberley.

Initially, the mother board is fixed to the side panels, and then wired to the head module. A Q.C. inspector visually checks each stage of production before the various modules are pushed into the pins on the mother board. A function test is made of the complete unit.

At this stage the equipment is put through a series of environmental tests, the first of which is a 'burn-in' on the customer's transmitter and receiver cycle for any given length of time, depending on contract requirements. After the 'burn-in' the equipment is checked for transmit watts and receiver sensitivity across the complete frequency band.

A compressor unit and vibration table working with a programmer unit is used to test the sets under varying forces on all planes; much more severe than would be encountered in normal use.

The equipment is checked once again to ensure it conforms to its specification limits, and then air tested after the parameter has been recorded on a test certificate. A final Q.C. inspection prior to the sets being despatched completes the manufacturing process.

Storno CQP 800's are being increasingly used in the UK. Earlier this year several thousand personal sets and associated CQF 800 base stations were ordered by the Metropolitan Police and the Royal Air Force.

. . . COMMENT

AN ARTIFICIAL EAR?

Scientists and Doctors in Cambridge and London have taken a first step towards the creation of an artificial ear to enable completely deaf people to hear, the science and industry unit of BBC World Service recently reported.

Over the past year, six completely deaf patients in Britain have been fitted with a thin wire electrode temporarily and painlessly implanted in their inner ears. Linked to a microphone the electrode has enabled them to hear parts of the speech of someone speaking nearby.

This is far from being an artificial ear, it produces only a crude sensation of sound in the user's brain, but patients are already finding that the device adds considerably to the effectiveness of lip reading.

A thin wire is implanted on to a membrane-covered opening to the cochlea, the inner ear. Depending on the wavelength of the sound, these shake different areas of sensory hairs in the walls of the cochlea, which in turn create the sensation of sound by stimulating the auditory nerve.

We regret that, as notified in our last issue, it has become necessary to increase to 45p the cover price of 'R. & E.C.'; to meet increased costs of production.

A glance at the 17 articles in this issue shows an impressive list of practical articles for the constructor, plus much useful information and general news of benefit to readers whether technically advanced or just commencing to enjoy our hobby.

Incidentally, we shall be very interested to learn of any unusual finds by readers who construct and use the Simple Metal Locator.

We have not previously commented on the Government's Central Policy Review Staff (the 'Think Tank') proposals for an eight hour cut in the present 24 hour cycle of the BBC's World Service.

Among other programme reductions, the proposals include:

- no transmissions to North America, Australia, New Zealand, Western and Southern Europe
- no broadcasting at all between 2000 and 0400 GMT and therefore no service for the large evening audiences in Europe, Middle East, Africa, Western Hemisphere.
- no breakfast listening in S.E. Asia, Australia, Indian Subcontinent, USSR East of Moscow, Iran, the Gulf, East Africa

To withdraw from a dominant role in world broadcasting seems very foolish. To quote the *Sunday Times:* "... Even the Tankers admit that 'External broadcasting can justifiably be claimed to be one of the UK's success stories.' Why then seek to limit it?"

EXHIBITED AT THE INTERNATIONAL RADIO AND TV EXHIBITION BERLIN

The Heinrich Hertz Institute for Communications Technology Berlin GmbH exhibiting and demonstrating a future communications system (Two-way Cable TV) at the International Radio and TV Exhibition 1977 Berlin, as shown in the photograph.

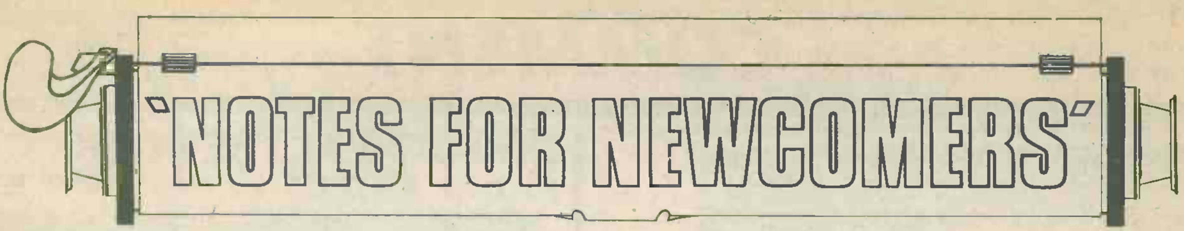
This technical system is intended as a communications aid (programme transmissions) and partner (computer dialogue) for private subscribers.

I.E.A. 78

IEA 78 — The 12th Instruments, Electronics and Automation Exhibition — will be staged at the National Exhibition Centre, Birmingham, from 13 to 17 March 1978, occupying the largest hall there, Hall 5, with three impressive sections for Electronic Components, Process Control Instrumentation and a General classification.

Products will include professional and industrial electronics, active and passive components, process control and scientific instrumentation, machine tool control and automation, computer techniques and data handling. IEA 78 will be the only internationally recognised trade fair in 1978 covering the electronic and instruments industries in the United Kingdom.

Danger, High Vaultage.



'NOTES FOR NEWCOMERS'

THE EMITTER FOLLOWER

by F. T. Jones

Examines one of the basic transistor configurations.

The emitter follower (or common collector, because the collector is common to both the input and output circuits) configuration is one of the most useful in transistor circuit design. Fig. 1(a) shows a basic emitter follower circuit with an n.p.n. transistor whilst Fig. 1(b) illustrates the circuit with a p.n.p. transistor. A bias resistor for the base is assumed.

VOLTAGE GAIN

An input signal may be applied to the base of the emitter follower via a coupling capacitor. If the signal takes the base negative the emitter goes negative by virtually the same amount; taking the base positive causes the emitter to go similarly positive. In consequence the voltage gain of the emitter follower is almost exactly equal to unity, which is another way of saying that the output signal voltage at the emitter is the same as the input signal voltage at the base. The voltage drop inside the transistor between the base and the emitter stays at very nearly the same figure for all emitter currents within the range which the transistor can handle. With germanium transistors the voltage drop is typically 0.1 to 0.2 volt, whilst with silicon transistors it is of the order of 0.6 volt. The voltage drop increases slightly with increasing emitter current, with the result that the voltage gain is not precisely unity but is very slightly lower than this. For most practical applications it can be considered as being unity.

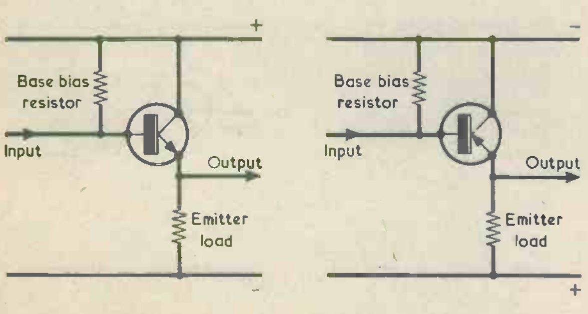


Fig. 1. The emitter follower or common collector configuration with (a) an n.p.n. transistor and (b) a p.n.p. transistor

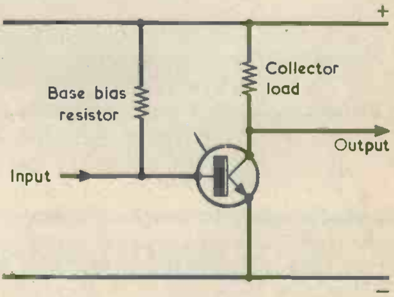


Fig. 2. An n.p.n. transistor in the common emitter mode

From the point of view of voltage the emitter "follows" the base. This explains the term "emitter follower".

CURRENT GAIN

In a transistor connected in the common emitter mode, as in Fig. 2, an increase in base current causes an amplified increase in collector current. This is the current gain of the transistor and under d.c. conditions can be defined by the term hFE. If a transistor passes a collector current of 10mA when the base current is 0.1mA we say that the transistor has an hFE of 100 (at the collector current concerned).

In an emitter follower an increase in base current similarly causes the collector current to increase, and both the collector and the base current in the transistor flow through the emitter. Under d.c. conditions the emitter current is the collector current of hFE times the base current plus the base current itself, whereupon static current gain becomes equal to hFE + 1. In most instances the error involved in stating that the emitter follower gain is equal to hFE is negligibly small.

The fact that the emitter follower provides current gain makes it suitable for driving a relatively heavy current through its emitter load when only a small current is available at its base. The input impedance at the base is approximately equal to the emitter load impedance, or resistance, multiplied by the hFE of the transistor.

EMITTER FOLLOWER CIRCUITS

The emitter follower features extensively in Class B a.f. amplifier output stages, which have the basic circuit shown in Fig. 3(a). Two emitter followers, one n.p.n. and one p.n.p., have their bases coupled to the collector of a driver transistor. As the collector voltage of this transistor goes positive and negative with signal voltage so also do the bases of the two output transistors. When the driver transistor collector goes positive the p.n.p. transistor cuts off and the n.p.n. emitter follower causes an equal signal voltage to be applied across the speaker. The p.n.p. transistor similarly feeds negative-going signal voltages to the speakers. The diode between the two output transistors bases ensures that both the transistors are passing emitter current when there is either no signal or only a low signal voltage from the driver transistor, thereby obviating crossover distortion. Components other than diodes may be connected between the two bases to perform a similar function. There is no necessity to return the speaker to a mid-voltage point between the two batteries, as is done in Fig. 3(a), and it is normally more convenient to use one battery and couple the speaker to the output emitters via a large value electrolytic capacitor, as in Fig. 3(b).

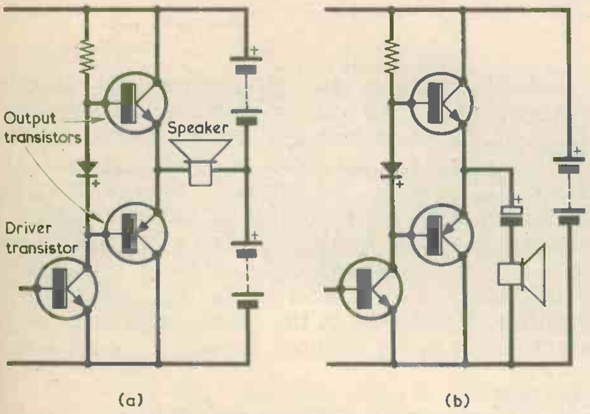


Fig. 3(a). A Class B a.f. amplifier output stage. The two batteries have equal voltages (b). In practice a single battery can be used, the speaker being connected to either the positive or negative rail and coupled to the output emitters via a high value electrolytic capacitor

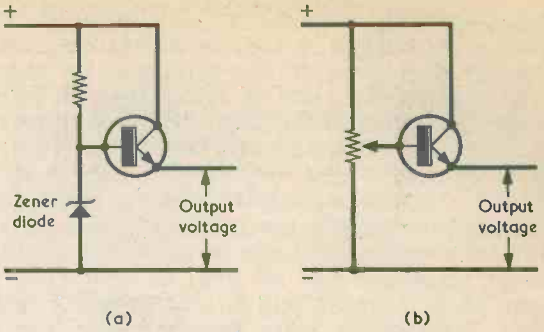


Fig. 4(a). A voltage stabilizing circuit incorporating an emitter follower (b). A very simple variable voltage supply. The output current can be considerably higher than the current flowing in the potentiometer

The emitter follower performs many useful services in power supply circuits. In Fig. 4(a) it provides a relatively steady voltage for varying output currents, the output voltage being equal to the zener diode voltage less the voltage drop inside the transistor between its base and emitter. The advantage of the circuit is that the output voltage remains reasonably steady for widely varying output currents, whilst only a small current needs to flow in the resistor coupling to the zener diode and in the zener diode itself. A very simple variable voltage supply is given by the circuit of Fig. 4(b). The output voltage can be varied by adjusting the potentiometer and the advantage is that the current in the potentiometer can be much lower than the output current of the circuit. The emitter follower plays a similar role in more complicated power supplies having a much higher performance than the simple circuits of Fig. 4.

DARLINGTON PAIR

Two emitter followers in tandem form a "Darlington pair" and this is shown in Fig. 5(a) for

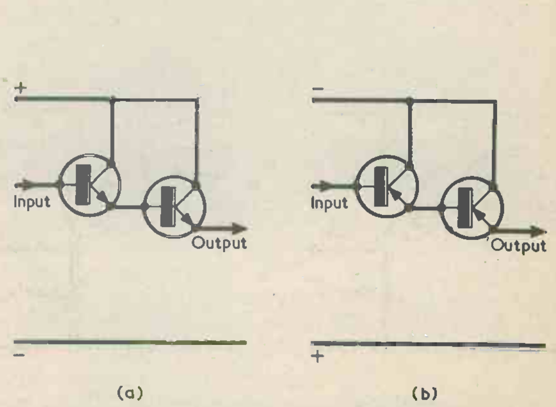


Fig. 5. The Darlington pair. In (a) this consists of two n.p.n. emitter followers whilst in (b) it is given by two p.n.p. emitter followers

n.p.n. transistors and in Fig. 5(b) for p.n.p. transistors. The voltage at the emitter of the second transistor now "follows" the voltage at the base of the first transistor, and is lower than it by the voltage drop between the base of the first transistor and the emitter of the second transistor. With two silicon transistors this drop is of the order of 1.2 volts (i.e. 0.6 volt in each transistor). The current gain is approximately the product of the gains of the two transistors, and can be exceptionally high. If each transistor has an hFE of 300 times the overall static current gain is about 90,000 times.

The Darlington pair configuration is encountered in high output current applications such as those given in a.f. output stages. If only a small output current is required from the Darlington pair the input current, with modern small signal silicon transistors, can be extremely low. Fig. 6 shows a Darlington pair employed in an electronic voltmeter where the main load is an ordinary moving coil voltmeter having a resistance of, say, 10,000Ω per volt. Both transistors are small silicon types. The input resistance at the base of the first transistor is, in practice, of the order of tens or even hundreds of megohms (although this assumes leakage currents in the transistors which are lower than manufacturers' specifications).

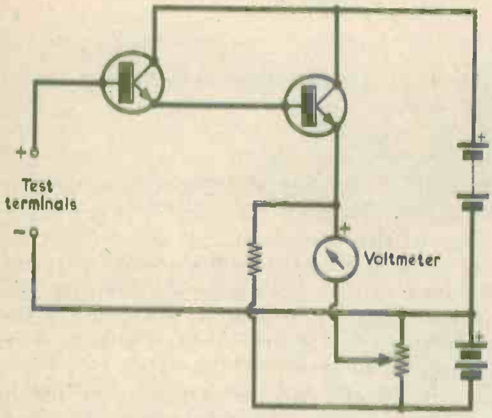


Fig. 6. An electronic voltmeter having a very high input resistance can be made up with two small silicon transistors in a Darlington pair. The lower battery has a voltage of 3 volts and the potentiometer a value of 1kΩ

This input resistance is higher than that encountered in bipolar operational amplifiers such as the 741, although it is not as high, of course, as that at the input of a CMOS op-amp such as the CA3130. In Fig. 6 the negative terminal of the moving coil meter is taken to the slider of a potentiometer. This is adjusted to cancel the base-emitter voltage drop in the Darlington pair and is set up such that the moving coil meter reads zero when there is zero voltage across the test terminals. The resistor between the emitter of the second transistor and the negative end of the potentiometer linearises low voltage readings and eases zero-setting by the potentiometer. It can have a value equal to about one quarter of the resistance of the voltmeter, and it also provides part of the Darlington pair output load. ■

HI-FI in the 1920's

by H. Ross McDonald

Drawing back the veil from over half a century ago

The photograph accompanying this article shows one of the few quality amplifiers of the early 1920's. It was manufactured by the Western Electric Company around 1923 to 1924, and was intended to provide loudspeaker results from a crystal set with an economy of battery power. I understand that a 2-valve version was used by the early British Broadcasting Company (not yet a Corporation) as a portable studio microphone pre-amplifier. The model in the photograph employs 3 valves, these being "Weco" types.

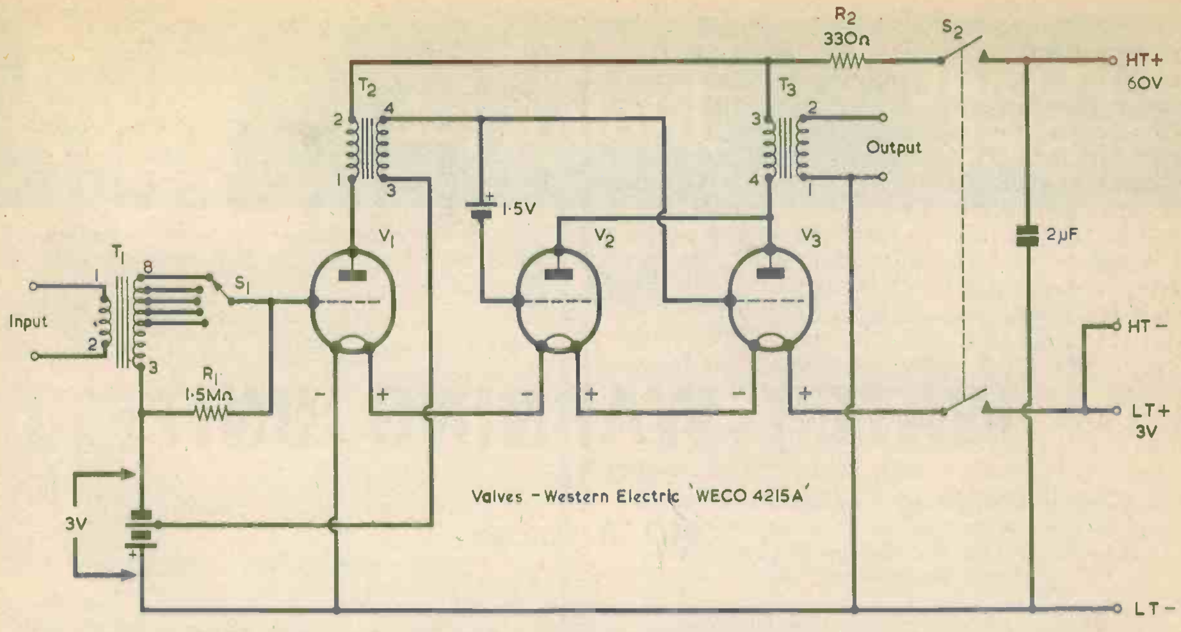
VALVES

The "Weco" valve originated in America and cost about £1. 12s. in the U.K. (in 1977 that equals about £7.50). They are about 2in. long by ½in. in diameter and do not have socket pins like the majority of valves; they are instead bayonet fitting like an electric light bulb. They were intended for dry cell working and had a filament consumption of 1 volt at 0.25 amp. The maximum anode voltage was 80 volts.

I have made some quick measurements with the three valves in the set but, as I have no access to the original curves and do not know how many hours the valves have run, the figures may not be representative. I found that, at 70 volts h.t. and −1 volt grid bias, anode current is 4 to 5 mA, amplification factor is 6 to 7, mutual conductance is 0.45 mA per volt and anode impedance is about 15kΩ.

CONSTRUCTION

The amplifier is very well made, and is enclosed in a neat French-polished mahogany box measuring 5 by 5 by 10in. The lid has three small circular windows which allow the user to see if the valves are alight. Every surface that can be plated or polished has been so treated. The grid bias batteries made by Ever Ready are "specials" with unusual terminations, so obviously a fairly long production run was envisaged.



The circuit of the amplifier, S1 is a 5-position switch which functions as a volume control, whilst S2 is the on-off switch. Note that the 2µF capacitor, a paper dielectric component, is connected across the h.t. supply before the on-off switch

CIRCUIT

The circuit requires little comment. Since V2 and V3 are in parallel it is really a 2-valve amplifier. Because of the different filament potentials, a separate 1.5 volt cell is used to bias V2. This is rather an unusual arrangement as the 1.5 volt cell is floating at signal potential. Volume control is given by S1, which selects different taps in the secondary of transformer T1. The secondary circuit is damped by R1.

PERFORMANCE

I checked the amplifier with a 250mV input from a good sine wave source, assuming 2kΩ to be a reasonable output load and examining the results on an oscilloscope. At 1kHz the amplifier gave an output of 14 volts. There was very little output at 100Hz (1.3 volts) or at 10kHz (0.8 volt) but the output is sensibly uniform from 300Hz to 8.5kHz — certainly better than any loudspeaker of the period.

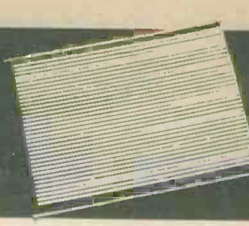
So, between 300Hz and 8.5kHz output power is 72 to 98 milliwatts with minimum sine wave distortion. I did not try a square wave source — *too* much copper and iron! The total d.c. power consumption, including filaments, was 1.3 watts.

Trying to simulate contemporary conditions I connected up to a 1924 horn loudspeaker and to my fine B.T.H. crystal set which, if one can find the right spot on the galena detector, will give 350mV on Radio 4. The results were quite gratifying, considering the basic simplicity of the equipment. Even now the amplifier really does what it was intended to do by the makers — "Give good clear loudspeaker volume from a simple crystal set". ■

Now considerably more than 50 years old, this beautifully preserved a.f. amplifier is still working and can drive a 1924 horn loudspeaker with an input from a crystal receiver of the same period.

SPECIAL SERIES

Blob-a-job



No. 6

WATER WARNING UNIT

By I. R. Sinclair

A circuit which offers audible warning when the presence of water is sensed by a detector strip.

This is a circuit which sounds a warning when a drop of water bridges two adjacent tracks on a piece of Blob Board. It can be used as a "wash-day alarm" to sound a warning of rain on the clothes line, a "drip alarm" to warn of leaks from washing machines, or a container alarm to warn of boiling-over pots or too vigorous fermentation of beer or wine.

CIRCUIT ACTION

The action of the circuit is simple. TR1 and TR2 in Fig. 1 are connected as a high gain current amplifier with the base of TR1 connected to one track of a spare piece of Blob Board which acts as the water detector. See Fig. 2. The adjacent track on the detector strip connects through a 100kΩ resistor, R1, to the positive supply.

The emitter of TR1 is connected to the base of TR2 so that any base current in TR1 will be greatly amplified by the two transistors. In turn, TR2 emitter supplies bias to the bases of TR3 and TR4.

These last two transistors are connected as a multivibrator where output frequency is decided by the values of coupling capacitors and base resistors that are used. The ideal frequency for our purpose is around 500Hz, since this gives a penetrating note that can be heard over other sounds at a distance. The effect of a drop of water bridging the two tracks of the detector strip is to allow some current to flow into the base of TR1, whereupon the multivibrator is biased on. The effect of varying resistance at the detector strip will be to alter the pitch of the note, making it more noticeable. The circuit is very sensitive, and even breathing on the detector is enough to sound the alarm.

For an indoor alarm the use of a small high-resistance speaker of 75Ω or more as a load for TR4 is quite adequate, and the circuit then has a battery consumption of 8mA. when the alarm

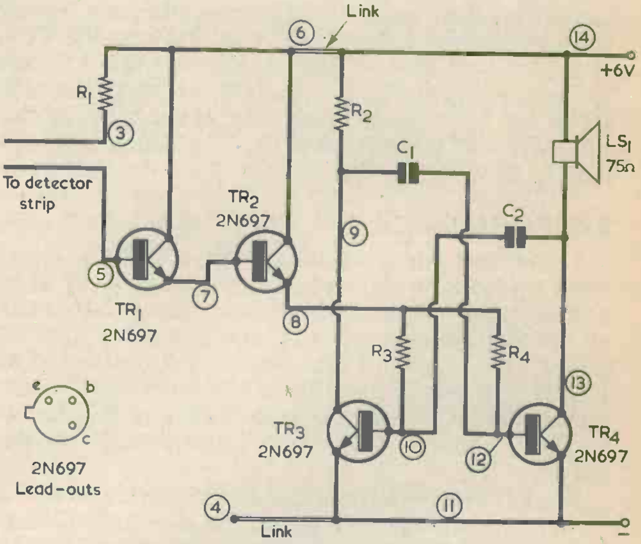


Fig. 1. The circuit of the water warning unit. The circled numbers indicate the Blob Board tracks at which connections are made.

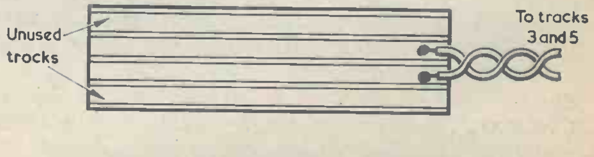


Fig. 2. The detector strip. This consists of a small piece of Blob Board and causes the main circuit to be activated when the two centre tracks are bridged by moisture.

COMPONENTS

Resistors
(All ¼ watt 10%)
R1 100kΩ
R2 2.2kΩ
R3 68kΩ
R4 68kΩ

Capacitors
C1 0.02 or 0.022µF polyester
C2 0.02 or 0.022µF polyester

Semiconductors
TR1 2N697
TR2 2N697
TR3 2N697
TR4 2N697

Speaker
LS1 Moving-coil, 75Ω or 80Ω

Blob Board
Blob Board type ZB-2V5

Miscellaneous
6 volt battery
On-off switch
Small piece Blob Board (for detector strip)

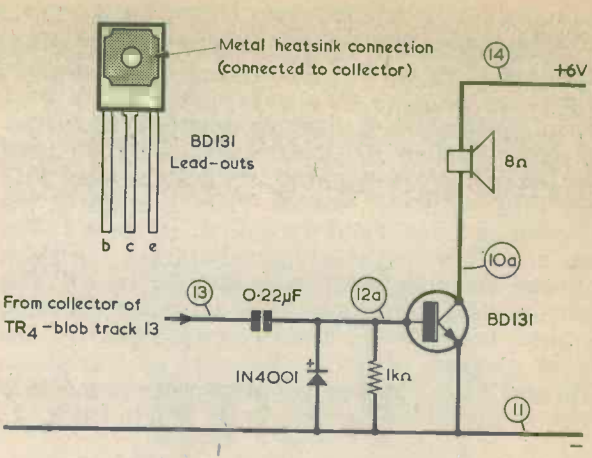


Fig. 3. An add-on output stage which gives a higher volume of warning tone. This is optional and the parts required are not included in the components list.

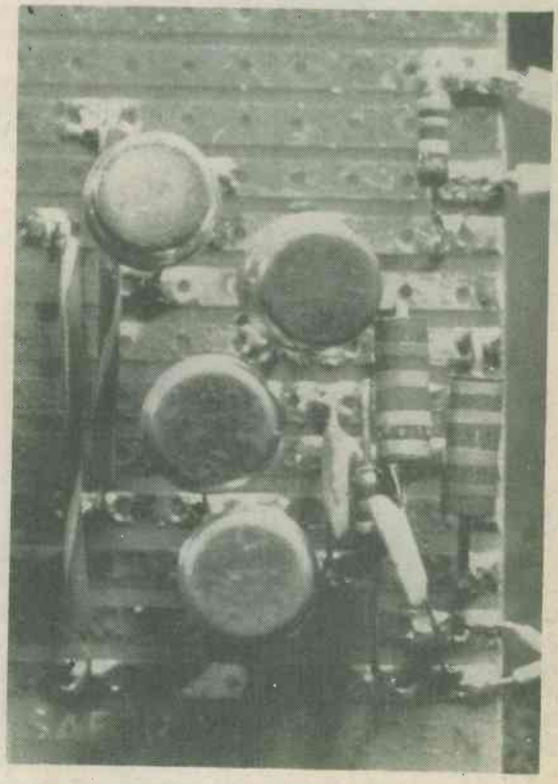
sounds. For outdoor use more power may be needed. This is easily provided by the additional stage shown in Fig. 3, but the current when the alarm sounds will rise considerably, to some 100mA or so, the actual current depending on the hFE value of the BD131. Only the simple indoor version is described in detail here, but the add-on power stage is outlined so that this stage can be added later or built right away, as may be required. The add-on power stage consists of a small power transistor coupled to the output of the multivibrator and having no bias so that it only passes collector current when the multivibrator operates. Its collector load consists of an 8Ω speaker rated at not less than 3 watts.

Returning to Fig. 1 it may be thought that R4 in the base circuit of TR4 has rather a high value when the collector load for this transistor is a 75Ω speaker. The circuit has, however, been checked in practice with a wide range of transistors in the TR4 position and has functioned satisfactorily in all cases. The high value of R4 keeps supply current consumption to a low level.

CONSTRUCTION

The most suitable Blob Board for this circuit is the ZB-2V5 board with its fourteen lines of tracks, and the circuit diagram of Fig. 1 shows the track numbering for each part of the circuit. Note that two tracks are used for the positive line, and these must be connected as shown. Having two positive supply tracks makes it easier to use transistors with short leads.

Start in the usual Blob Board way by measuring out your components against the tracks on the Blob Board to which they will connect, cutting leads to length as needed and shaping the leads so that the components can be mounted either horizontally or end-on. The author used disc ceramic capacitors for C1 and C2. This type of capacitor has a relatively wide tolerance on value and constructors who prefer closer tolerance components may employ polyester capacitors instead. Polyester capacitors are shown in the Components List. Remember that components can be placed anywhere on the board as long as they connect to the correct tracks. Once the leads have been cut and shaped the ends can be tinned, ready to blob on the board.

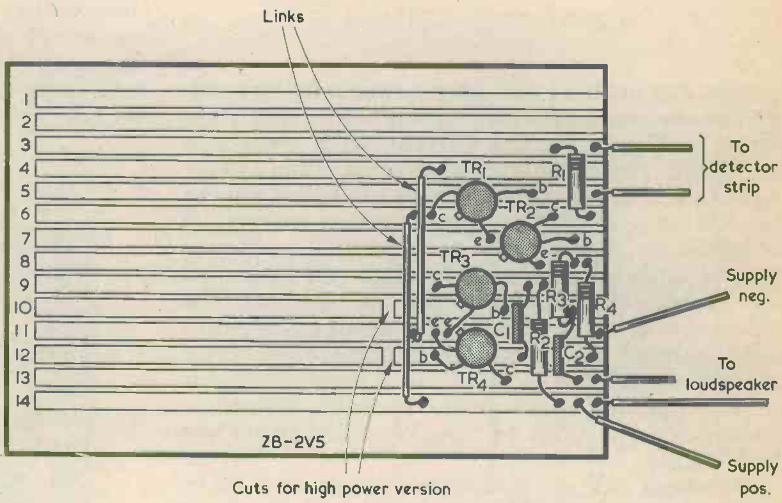


The components for the water warning unit are readily assembled on the Blob Board. The tinned tracks allow soldered connections to be made quickly and reliably.

As usual with this type of board, it is an advantage to start at the end opposite the track numbers so that the numbers are always visible. Leave some room for attaching the insulated wires to the detector strip, which may be several metres away if need be. Commence by blobbing on the transistors TR1 and TR2, with the base of TR1 on track 5, the collector on track 6 and the emitter on track 7. The base of TR2 is then also blobbed to track 7, with its collector on track 6 and its emitter on track 8. The resistors and capacitors can be mounted next, blobbed between the tracks as indicated in the layout diagram of Fig. 4, followed by transistors TR3 and TR4. The positive supply line connects to track 14 and the negative supply line to track 11.

A link wire connects track 4 to the negative supply and this prevents moisture on the board itself from setting off the alarm. Track 4 acts as a guard and ensures that any leakage from track 3 is to the negative supply rail, so that TR1 cannot be turned on.

Fig. 4. The circuit of Fig. 1 assembled on the Blob Board. The two cuts in the tracks are required if the output stage of Fig. 3 is to be incorporated.



POSITIONING

The main problem is to suitably position the loudspeaker and the detector strip, and this depends on how the circuit is to be used. It is possible to build all the parts into one unit which can be hung on a clothes line; alternatively the detector can be placed under a washing machine, with the main unit on the wall and the loudspeaker in the hall. If the unit is being used to detect spillage of liquid, it is obviously better to have the main unit separated from the detector strip to avoid damage to the unit if spillage is too great. For a clothes line water detector, a neat solution is to mount the detector strip on the back of the Blob Board on which the circuit is assembled. The loudspeaker can be mounted using thick tinned copper wire connecting to tracks 13 and 14 and the speaker tags. A case can then be made, large enough to hold the battery as well, the Blob Board with the detector strip on the top acting as a lid. An on-off switch in series with the positive supply can be mounted on one side of the case. The bottom of the case should not be boxed in but fitted with a coarse wire mesh or speaker grille and four short legs. There is then no risk of damage to the speaker if the box is placed on a wet surface, as is most likely. To hang the box on a clothes line, two wire hooks can be attached to the top of the case to hold it correct way up.

These are only suggestions and, doubtless, the keen constructor will devise alternative means of housing the unit and of positioning the detector strip and the speaker. Since the current drawn is very small until the alarm sounds, battery life is good. A suitable battery for the circuit of Fig. 1 would consist of four HP7 cells in series.

ADD-ON STAGE

The circuit of the add-on power stage is given in Fig. 3. The loudspeaker of Fig. 1 is replaced by a 2.2kΩ resistor connected between tracks 13 and 14, and the collector of TR4 couples to the base of the BD131 via a $0.22\mu F$ capacitor. There is ample room on the Blob Board for the additional transistor and components, though the tracks have to be cut as shown in Fig. 4. The new tracks which are now isolated from the existing ones, are referred to by the numbers 10a and 12a. The circuit with the add-on stage may be powered by two Ever Ready 3 volt No. 800 batteries connected in series.

■

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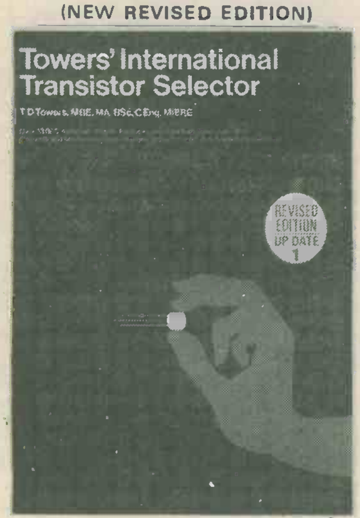

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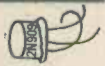

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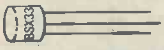

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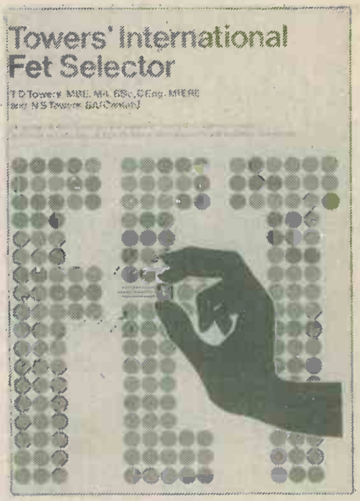

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SHORT WAVE NEWS

FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT   *Frequencies* = kHz

The 90 metre band (3200 to 3400kHz) can offer a varied diet of Dx for those who are prepared to dig amongst the QRM, who are patient and who are incurable insomniacs — well, we all have our failings!

As a guide to what may be heard, a few recent loggings on this band are featured below.

● BRAZIL

Radio Olinda, Pernambuco, on **3285** at 0043, OM with songs in Portuguese, announcements with echo-effect, identification at 0045. The schedule on a 24-hour basis and the power is 1kW.

● ECUADOR

Radio Iris, Esmeraldas, on **3380** at 0047, orchestral music with announcements in Spanish. The schedule is from 1100 to 0500 and the power is 10kW.

Radio Zaracay, Santo Domingo, on **3390** at 0053, OM in Spanish with a talk about music. The schedule is from 1000 to 0500 (but sign-off sometimes varies to 0845) and the power is 10kW.

● VENEZUELA

Radio Barcelona, Barcelona, on **3385** at 0050, Latin American dance music, OM in Spanish. Schedule is from 1000 to 1200 and from 2100 to 0400 and the power is 1kW.

Radio Universidad, Merida, on **3395** at 0058, OM in Spanish, local-style pops. The schedule is from 1000 to 0400 and the power is 1kW.

● GUATEMALA

La Voz de Nahuala, Nahuala, on **3360** at 0344, OM in Spanish, local pops. The schedule is from 1100 to 1300 and from 2230 to 0430 and the power is 1kW.

The saga will be continued next month.

CURRENT SCHEDULES

Whilst the schedules published here are correct at the time of writing, they may be subject to change at short notice.

● BANGLADESH

"Radio Bangladesh", Dacca, has an External Service in which a programme in English is directed to Europe from 1230 to 1300 consisting of a newscast and news commentary on **15520** and on **17890**. A further programme in English may be heard from 1815 to 1915 on **9495** and on **11620**.

● TAIWAN

The "Voice of Free China", Taipeh, presents a programme in English to Africa, the Middle East and Europe from 2130 to 2230 daily on **9510**, **9600**, **11860**, **15225** and on **17720**.

● ITALY

"RAI — Italian Radio and Television", Rome, in the current schedule, lists a programme in English for the U.K. from 1935 to 1955 on **7275**, **9710** and on **11800**. For insomniacs, "Nocturne from Italy" is on the air from 2230 through to 0500 on **6060**, the programme consisting of musical items with newscasts in Italian and English every hour on the hour.

● INDONESIA

"The Voice of Indonesia", Jakarta, radiates programmes in English intended for South East Asia and the Pacific from 0100 to 0200, 0800 to 0900 and from 1400 to 1500 on **9585** and **11790**.

● SAUDI ARABIA

The "Broadcasting Service of the Kingdom of Saudi Arabia", Jiddah, has a programme in English for North Africa from 1900 to 2200 on **11855**.

● PORTUGAL

"Radiodifusao Portuguesa", Lisbon, transmits a programme in English to Europe from 2030 to 2100 on **6025** and on **9740**.

AROUND THE DIAL

● NIGERIA

Lagos on a measured **15118** at 0628, African drums interval signal, identification and Nigerian news in English at 0630 then a religious programme until 0700 identification and "Weekend Magazine" with a further newscast at 0730. **15120** is the listed frequency, the above programme also in parallel on **7275** but not heard. Some interference at times from the Vatican transmitter on **15120**.

● VATICAN

Vatican City on **9645** at 0640, light music with announcements in Italian, French and English. Also on **7250** at 1345 with news of the Catholic world in English.

● PORTUGAL

Lisbon on **9670** at 0646, YL with a religious talk in English.

● TANGIER

UN Tangier on **9630** at 0630, news of United Nations proceedings in English; into a programme in Hebrew at 0635.

● CAPE VERDE

Voz de Sao Vicente on a measured **3931** at 2128, OM in Portuguese, light music Portuguese style.

● SAO TOME

Radio Nacional de Sao Tome on a measured **4807** at 2020, YL's with songs, local music in typical style.

● CANADA

Sackville on **17760** at 1945, OM with "Saturday Magazine" which included a talk on Canadian pops in the English programme scheduled for Europe from 1930 to 2000 on this channel and in parallel on **5995, 9530, 11855** and on **15325**.

● ECUADOR—2

HCJB Quito on **17755** at 2000, identification, 4 pips time-check then "DX Party Line", a programme for Dxers. Also in parallel on **15310**.

● SOUTH AFRICA

RSA Johannesburg on **17780** at 0600, identification followed by news of African affairs in English. This transmission is intended for West Africa and is scheduled from 0600 to 0700 on this channel and in parallel on **11900** and **15220**.

● AUSTRALIA

Melbourne on **17870** at 0617, OM with horse racing commentary in English, the programme presumably intended for African consumption.

● PAKISTAN

Karachi on **15115** at 1047, local songs and music in the World Service programme directed to the U.K. in Urdu, scheduled from 0830 to 1100. A newscast in English read at slow-speed followed at 1100 after station identification. Also heard in parallel on **17665**.

Karachi on **21590** at 1115, OM and YL alternate in the Burmese programme for Burma (where else!) scheduled from 1100 to 1200. Identification in English and sign-off at 1200.

● MALAYSIA

Tebrau (BBC Relay) on **3915** at 1824, OM with a commentary on world affairs in English. This transmitter relays programmes in Burmese, Chinese, Indonesian and Vietnamese in addition to English. The schedule is from 1000 to 1100, 1130 to 1445, 2230 to 2345; the English programmes being from 1500 to 1830.

● WEST GERMANY

"Radio Deutsche Welle — the Voice of Germany", Cologne, on **15150** at 1945, OM with the history of Morocco in English in a programme for African consumption. Station identification and sign-off (English programme) at 2000. This transmission can also be heard in parallel on **9765** and **11905** and is scheduled from 1930 to 2000.

VOA Munich on **3980** at 0300, station identification and a newscast in English.

● BULGARIA

Sofia on **9700** at 1938, OM with local news in the English programme directed to the U.K. from 1930 to 2000; also in parallel on **11720**.

● CONGO

RTV Congolaise, Brazzaville, on **4765** at 2130, identification and announcements in English by OM, local newscast in English until 2145.

● CHINA

PLA Fukien Front on **4330** at 2049, YL in Chinese in the Network 1 programme intended for Taiwan and Offshore Islands scheduled from 1058 to 0155.

PLA Fukien Front on **4380** at 2250, Chinese orchestral music in the Amoy Network 2 programme to Taiwan and Offshore Islands scheduled from 0230 to 1900.

Radio Peking on **3920** at 2104, OM in Chinese in the Home Service 1 programme, scheduled on this channel from 1100 to 1735 and from 2000 to 0100.

Radio Peking on **4460** at 2104, YL in Chinese in the Home Service 1 programme, scheduled here from 2000 to 2315.

Radio Peking on **9860** at 1751, Chinese orchestral music in the English programme for East and South Africa, scheduled from 1700 to 1800.

● CAMEROON

Yaounde on **4925** at 2051, local music and songs, identification in French at 2100. Also in parallel on **4750**. Listed **4972** but no trace of this channel at the time the foregoing transmissions were logged.

● LIBYA

Mebo II (a ship anchored off the Libyan coast) on **6206** at 2031, U.K. pop records with announcements in English. Test transmission announced until 2300.

● NORTH KOREA

Radio Pyongyang on **6575** at 2115, YL in the English programme to Europe, scheduled from 2000 to 2150.

Radio Pyongyang on a measured **11533** at 1820, OM in the Arabic programme intended for Africa and the Middle East, scheduled from 1700 to 1900. Also logged in parallel on a measured **6338**.

● VENEZUELA—2

Radio Tachira, San Christobal, on **4830** at 0005, a programme of pops in the local style, OM announcer in Spanish. The schedule is from 1000 to 0500 and the power is 10kW.

Radio Popular, Maracaibo, on **4810** at 0305, YL with love song (they also have their troubles apparently!) in Spanish, guitar music, identification 0315. Schedule is from 1000 to 0500 and the power is just 2kW.

● NOW HEAR THIS

Radio Alfonso Padilla Vega, Padilla, Bolivia, on a measured **3481** at 0150, YL with songs in Spanish, OM announcer. The schedule is from 2215 to 0245 (Sundays until 0200) and the power is 0.3kW.

Back garden treasure hunting. Wielding the metal locator is the author's brother, photographer J. W. Penfold

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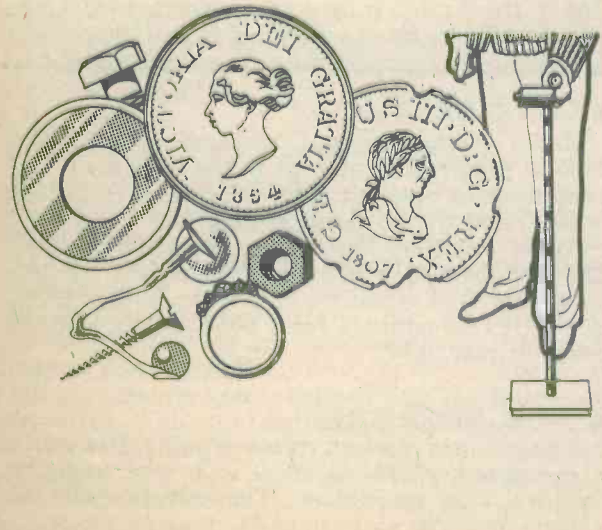


The metal locator which forms the subject of this article has been designed to incorporate a minimum of components and to be as simple to use as possible. It has only two active components: a field-effect transistor and an operational amplifier. The presence of a metal object in the vicinity of the search coil is indicated by an increase in the deflection of the meter which is fitted to the unit. Power is obtained from an internal 9 volt (PP3) battery, and the detector is thus completely self-contained.

When one considers the simplicity of its circuit the detector performs quite well, but it would be naive to expect it to have a performance equal to that of a multi-transistor unit costing several times as much. Small objects, about the size of a 5p piece, can be detected at depths of up to about 1in. or so. Larger objects can be detected at greater depths, with the absolute maximum being about 1ft. for a fairly large and thick sheet of metal. It should be pointed out that although metal detectors having a meter to monitor the output are easier to use than the more common b.f.o. types, with which the presence of a metal object is indicated by a change in the pitch of an audio output tone, a certain amount of skill is still needed in order to obtain optimum results. This is really just a matter of practising sufficiently with the detector.

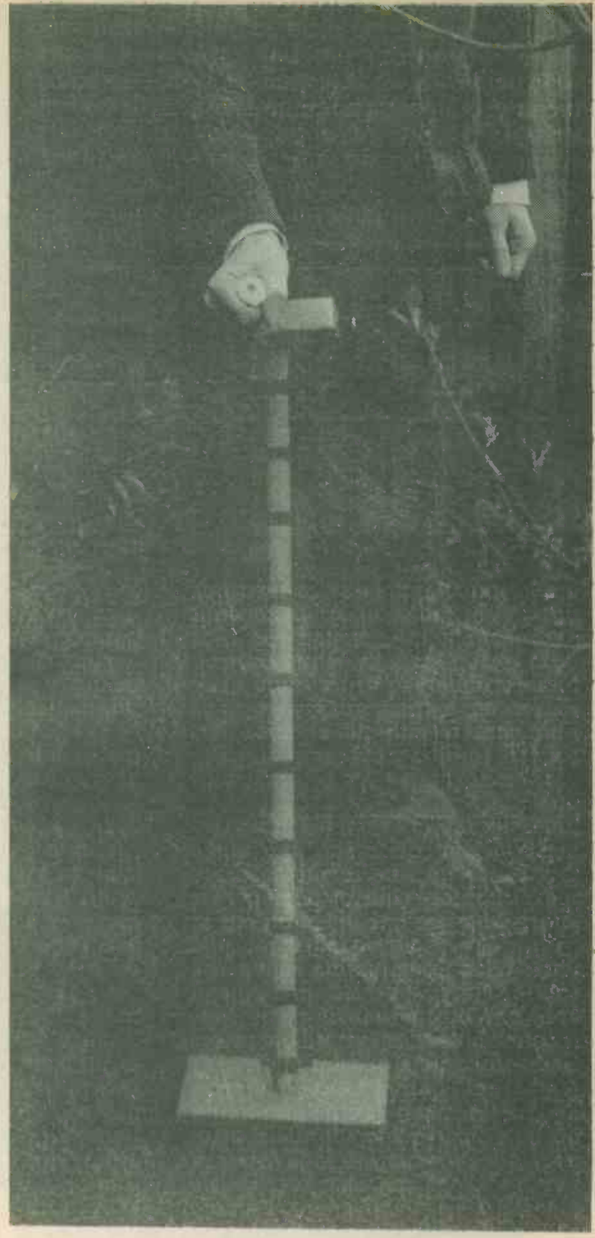
METAL ATOR

By

Penfold

quate sensitivity for general pur-

ces in the circuit, these being a
MOS operational amplifier.



The simple metal locator in use. Its neat design enables it to be easily carried whilst observing the meter, and yet the requirements for constructing the wood and hardboard framework are minimal

OPERATING PRINCIPLE

If a piece of metal is placed near an unscreened coil, there will be a small change in the inductance of that coil. It is on this basic principle that most metal detectors operate.

Probably the most common method of detecting the change in inductance is to use the search coil in an r.f. oscillator whose output is heterodyned with a second, reference frequency, oscillator. The resultant beat note is at an audio frequency which alters as the search coil inductance changes.

A different and even simpler method is to once more use the search coil in an r.f. oscillator circuit but, this time, to monitor the d.c. bias level in the oscillator by means of a sensitive voltmeter. It may not be appreciated by some readers that the biasing of an oscillator is not completely controlled by the values of the bias components. For example, an oscillator circuit which has the feedback path open and is therefore not oscillating may draw a supply current of say, 2mA; if the feedback path is closed so that oscillation takes place the consumption may decrease or increase considerably according to the type of circuit used. Similarly, changes in operating frequency may alter current consumption and also vary the circuit potentials. This is the system which is employed in the present design.

LICENCE

It is necessary to obtain a Pipe Finder/Metal Detector Licence before the metal locator may be used, and an application form for this can be obtained from The Home Office, R1 Division, Radio Regulatory Department, Waterloo Bridge House, Waterloo Road, London SE1 8UA. The expression "Home Built" should be entered in Section 3(ii) of the application form and the equipment may be described as "Metal Locator, R. & E. Constructor, December 1977". The operating frequency should be entered in the application form as "75kHz". As was mentioned earlier, the operating frequency must not exceed this figure. The licence fee at the time of writing is £1.20, and the licence is valid for 5 years from the date of issue.

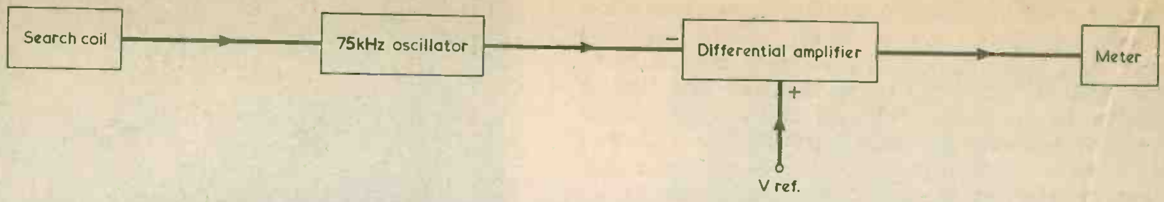


Fig. 1. Block diagram illustrating the sequence of operation of the metal locator. As the search coil approaches a piece of metal its inductance changes, causing a fall in oscillator bias voltage. This fall in voltage is amplified by the differential amplifier to give a corresponding deflection in the meter

A block diagram of the metal locator is shown in Fig. 1. The oscillator has to operate at a frequency within the range of 16 to 150kHz, accept for the band 90 to 110kHz, as otherwise the unit cannot be licensed in the U.K. and it would be illegal to use it. In the present metal locator the oscillator operates at a frequency of 75kHz. The operating frequency must not exceed 75kHz, and this fact will be assured by carefully following the coil winding details which are given later.

At a suitable take-off point a potential from the oscillator is fed to the inverting input of a high gain differential amplifier. The non-inverting input of the differential amplifier is connected to a reference voltage which is very slightly higher (i.e. more positive) than the normal output voltage from the oscillator. The output voltage of the differential amplifier is equal to its voltage gain multiplied by the voltage difference at its inputs. If the inverting input voltage is fractionally lower than that at the non-inverting input there is a small output voltage from the differential amplifier, this causing a slight deflection of the meter connected to that output. It should be noted that the gain of the differential amplifier is extremely high and that the voltage across its inputs is extremely small.

When a piece of metal is placed near the search coil the operating frequency of the oscillator is slightly increased, giving a corresponding reduction in the output voltage passed to the differential amplifier. The voltage difference at the inputs of the differential amplifier increases, resulting in an increase in the deflection of the meter. In general the changes in the output potential of the oscillator are of a very small order, but they are greatly amplified by the differential amplifier and therefore produce a significant meter deflection.

THE CIRCUIT

As can be seen from the circuit diagram in Fig. 2, few components are required for the metal locator.

TR1 is the oscillator transistor, and this field-effect device is connected in the common drain

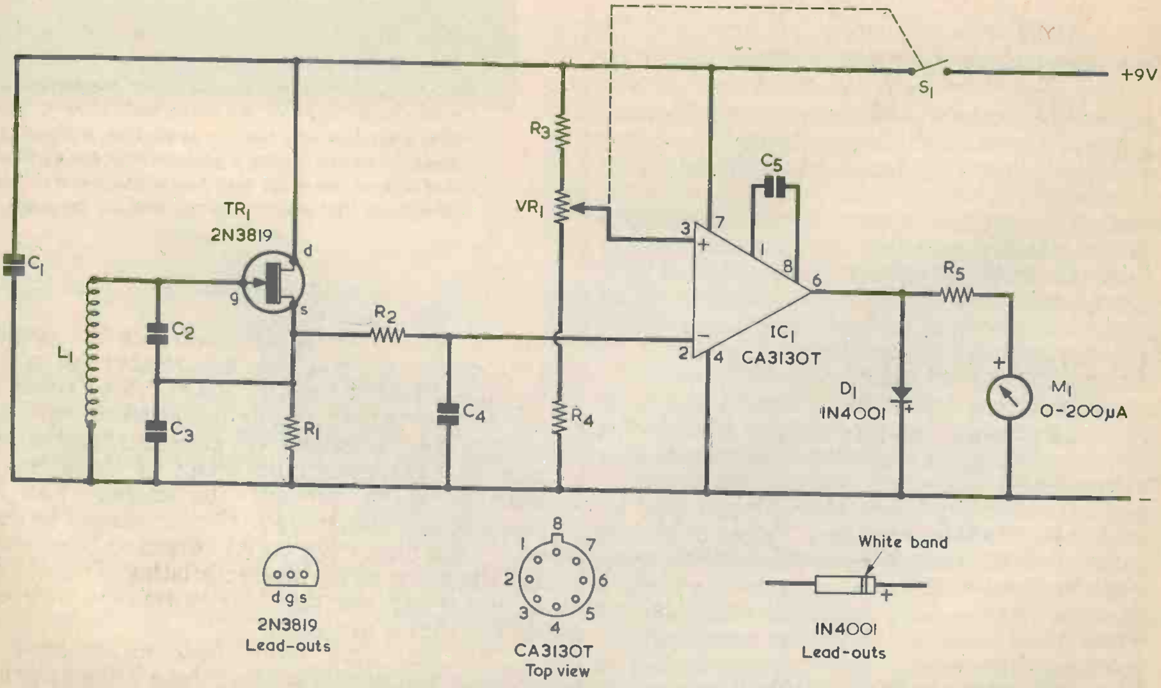


Fig. 2. Few components are required for the metal locator, as is evident from this circuit diagram. In the inset showing the 2N3819 lead-outs, the lead-outs point towards the reader. On the other hand, the CA3130T lead-outs point away from the reader

mode, or source follower configuration as it is often termed. R1 is the source load resistor and the search coil, L1, provides a bias path for the transistor gate. C2 and C3 in series form the tuning capacitance for the search coil and also provide a capacitive tap into the tuned circuit. The source of TR1 connects to this tap, which provides the necessary positive feedback for the circuit to oscillate.

The output voltage from the oscillator is taken from TR1 source and is connected to the inverting input of the differential amplifier by way of R2, which forms an r.f. filter in conjunction with C4. The differential amplifier is an i.c. operational amplifier type CA3130T. The reference voltage at its non-inverting input is obtained from a potential divider consisting of R3, VR1 and R4. VR1 is adjusted to provide a small deflection of the output meter. C5 is the compensation capacitor for the CA3130T.

It is not desirable to feed the meter direct from the i.c. output without some means of overload protection since the i.c. can provide quite a high output current which could easily damage the meter. Silicon diode D1 provides the protection required because it becomes conductive when the voltage across it reaches about 0.5 volt and limits any further significant positive excursion of the i.c. output. Series resistor R5 provides further protection and the combined effect of these two components is to prevent the meter from being dangerously overloaded. The i.c. cannot be damaged by the limitation on its output voltage given by D1 since one of the characteristics of the CA3130T is that it can withstand an output short-circuit for an indefinite period.

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
R1 4.7kΩ
R2 100kΩ
R3 3.3kΩ
R4 560Ω
R5 470Ω
VR1 5kΩ potentiometer, linear, with switch S1

Capacitors
C1 0.1μF type C280 (Mullard)
C2 0.001μF ceramic plate
C3 0.0068μF polyester or polystyrene
C4 0.015μF type C280 (Mullard)
C5 220pF ceramic plate

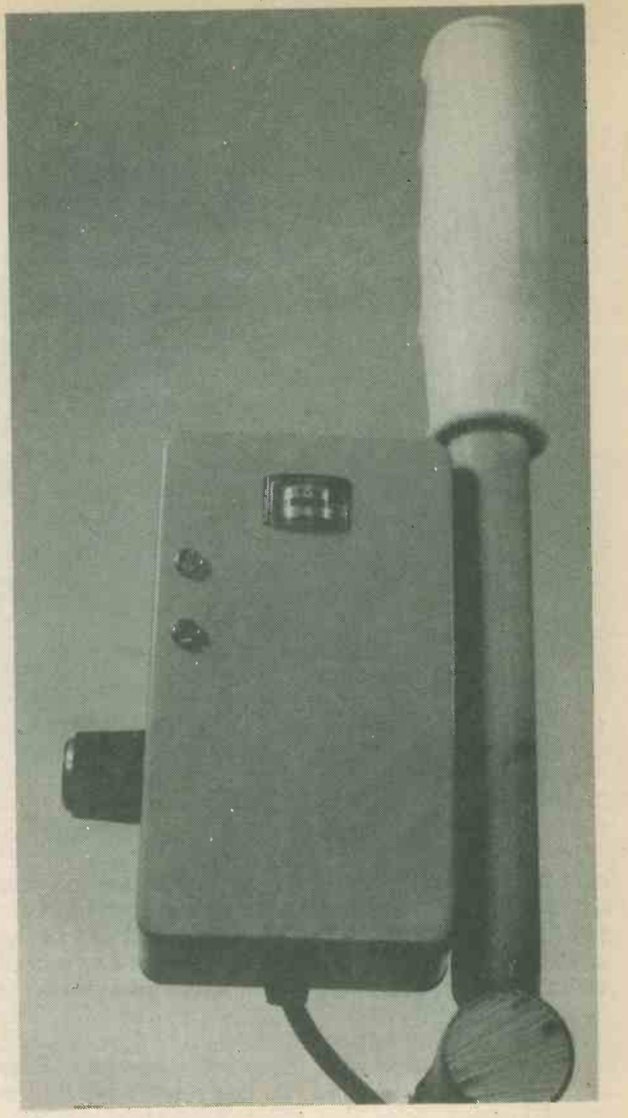
Inductor
L1 search coil (see text)

Semiconductors
IC1 CA3130T
TR1 2N3819
D1 1N4001

Meter
M1 0-200μA level meter (see text)

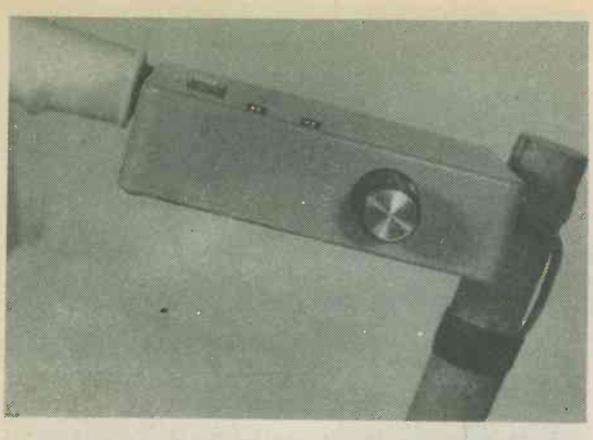
Switch
S1 s.p.s.t. toggle, part of VR1

Miscellaneous
Plastic case type DC2 (see text)
38 s.w.g. enamelled copper wire (for L1)
9 volt battery type PP3 (Ever Ready)
Battery connector
Control knob
Veroboard, 0.1in. matrix
Veropins (see text)
Wood, hardboard, etc., for frame
2-core flex (see text)
Solder, wire, etc.



The metal locator electronics are housed in a small plastic case screwed to one side of the handle. At the top can be seen the indicating meter. The two screw heads which are visible are those of the 6BA screws which secure the Veroboard component panel inside the case

Readers who have had experience with operational amplifiers may be a little surprised at the fact that it is possible to resolve a near-zero output from the open-loop CA3130T by means of a simple standard potentiometer at the non-



Potentiometer VR1, which provides the reference voltage for the differential amplifier, is mounted on the side of the plastic case

inverting input. However, the comparator circuit is a little less critical than would be expected at first sight because the voltage from the oscillator at the inverting input is not pure d.c. but has a small amount of residual a.c. on it. This tends to "broaden out" the adjustment settings in VR1. The setting of this potentiometer is still rather critical, however, and more experienced readers may, after they have become used to the operation of the metal locator, ease this effect by experimentally increasing the value(s) of R3 and/or R4 as required with their particular unit. The values specified for R3 and R4 in the Components List nevertheless allow satisfactory operation to be achieved.

S1 is the on-off switch and is ganged with VR1. C1 provides the only supply decoupling which is required. The circuit has a current consumption from the 9 volt battery of approximately 3mA only.

COMPONENTS

Most of the components are standard types, but a few require additional comment. The meter employed for M1 is a 0-200μA level meter, and a suitable type here is the miniature level meter available from Maplin Electronic Supplies. This has dimensions of 23 by 22 by 26mm. and an internal resistance of 1,200Ω. The metal locator components are housed in a plastic case with approximate dimensions of 111 by 60 by 27mm. The plastic case type DC2, also available from Maplin Electronic Supplies, will be satisfactory here. The search coil connects to the remainder of the electronics by a length of 2-core flex. Although the self-capacitance of this flex is largely swamped by C2 and C3, it would be preferable to employ the same type as that used in the prototype. This is twin p.v.c. covered flexible cable with a "figure 8" section, normally recommended for loudspeaker connections and having a current rating of 2 amps.

WOODWORK

Details of the wooden structure for the metal locator are shown in Fig. 3. Commence by cutting out the three pieces of hardboard which form the basis of the search coil. 3mm. thick plywood may alternatively be employed. The 7 by 5in. piece is positioned centrally between the two 8 by 6in. pieces, so that the latter overlap by ½in. all round. These three parts are glued together using a generous amount of a good adhesive. The pole section is a length of 1in. diameter timber such as a piece of broom handle. This is cut to length and the lower end is cut to the specified angle before it is screwed to the search coil former.

The handle consists of a piece of round dowel about 10in. long overall. This is filed down to about ⅜in. diameter at one end so that it will fit into a hole of the same diameter drilled in the upper part of the pole. The handle is glued to the pole.

The search coil consists of 100 turns of 38 s.w.g. enamelled copper wire wound around the middle of the three hardboard pieces which make up the former. A small hole is drilled at the centre and towards the rear of the upper one of the three pieces, and two short lead-out wires are passed through this. The wooden framework and the coil are then varnished. It should be noted that the coil will not give its final correct performance until the varnish has dried and set.

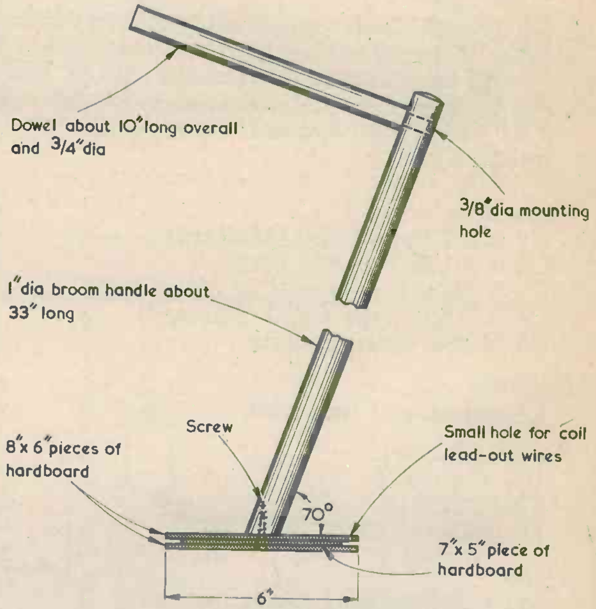


Fig. 3. The wood and hardboard sections of the metal locator

CONSTRUCTION

Most of the components are assembled on a piece of Veroboard of 0.1in. matrix having 21 holes by 9 copper strips. This panel is illustrated in Fig. 4, which also shows details of the other wiring. A panel of the appropriate size is cut out with a hacksaw, after which the two 6BA clear holes are drilled out. Next the 9 breaks in the copper strips

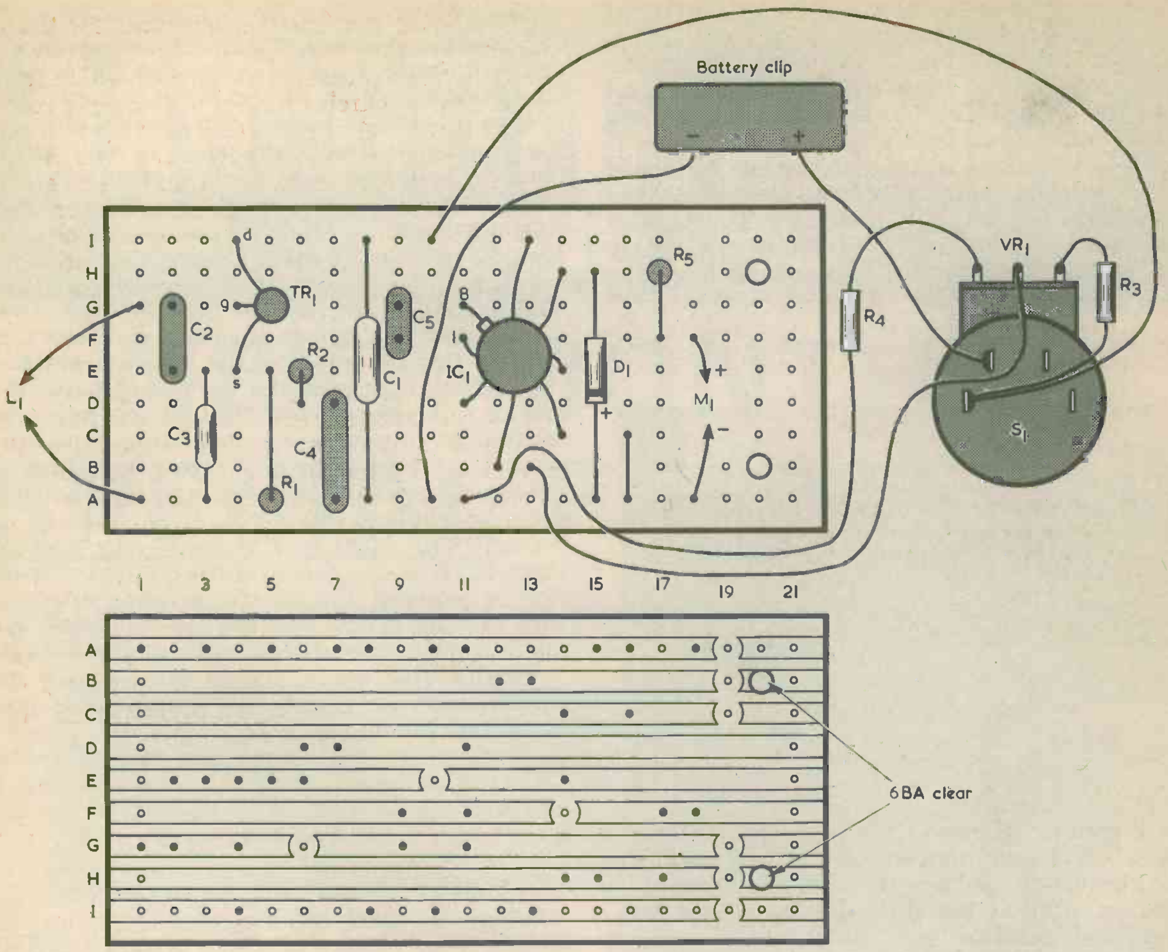
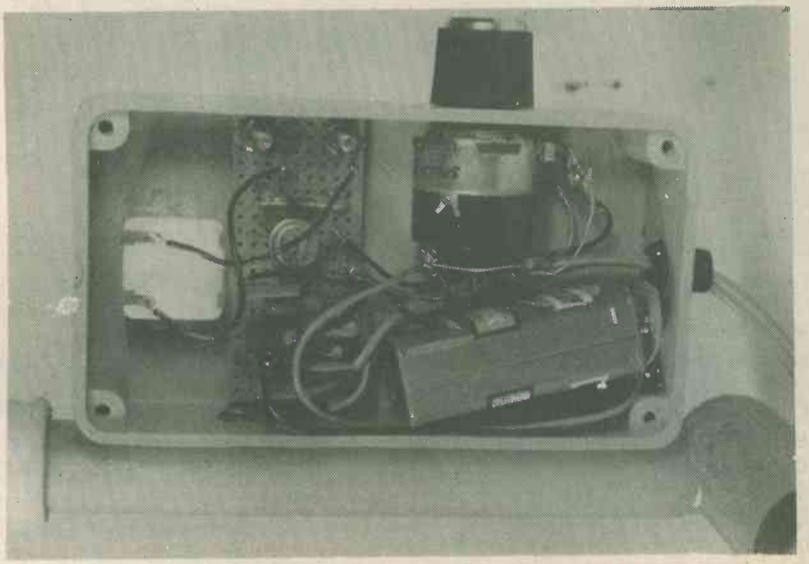
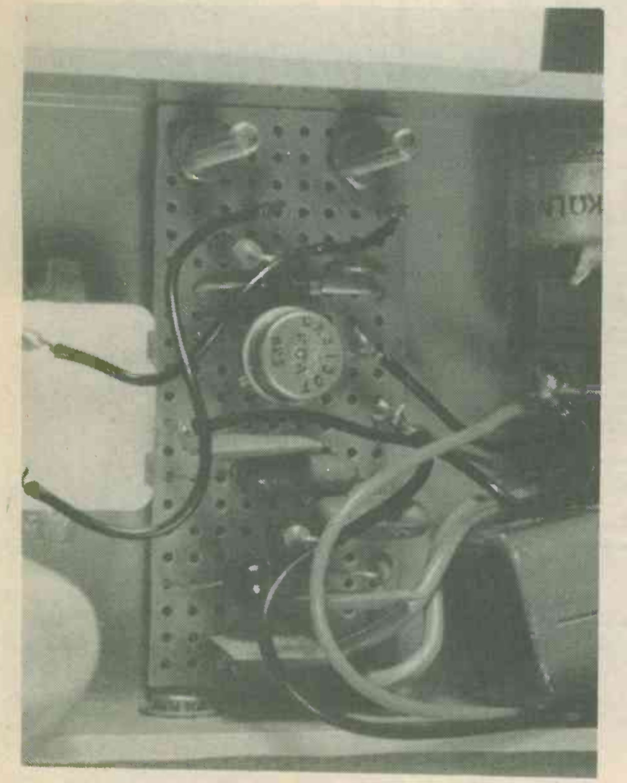


Fig. 4. Most of the components are assembled on a Veroboard panel. This diagram shows the component and copper sides of the panel



The plastic case with cover removed. There is ample space for the meter, the component panel, the potentiometer and switch, and the battery are made after which the components are soldered in position. Although not essential it helps considerably to solder in Veropins suitable for 0.1in. Veroboard at the points where external connections are made. Since IC1 is a CMOS device it is essential that all soldering be carried out with an iron having a reliably earthed bit.

The plastic case is secured on the left hand side of the handle by means of two woodscrews passed through holes drilled in the case side. The relative positions of the case and the handle are clearly shown in the photographs. The case lid is on the underside, so that the meter is mounted in what would conventionally be considered the bottom surface of the case. The meter requires a small rectangular mounting hole which can be made with a fretsaw or a miniature file. The meter can be held in place as a tight push fit or it can be secured with adhesive. Two 6BA clear holes for mounting the Veroboard panel are also required in this surface of the case. The meter is positioned near the top end of the case (i.e. furthest away from the wooden pole) with the board immediately below it. VR1/S1 is positioned with its body below the Veroboard panel on the side opposite that which is secured to the handle, and the battery fits into the remaining space below the panel. The layout can be clearly seen from the photographs of the case. A hole of about $\frac{5}{16}$in./ diameter is drilled at the bottom of the case and is fitted with a rubber or plastic grommet. The wire to the search coil passes through this.



A closer look at the component panel. Most of the few components which are required for the metal locator are assembled on this

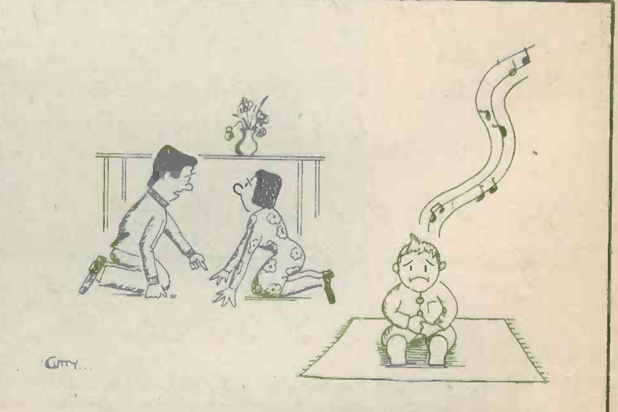
The easiest method of assembly consists of making all the holes required in the case and of then fitting the meter. VR1/S1 and the grommet. The case is then screwed to the wooden handle, after which the assembled Veroboard panel is mounted with two 6BA bolts and nuts. Short spacing washers are fitted over the bolts between the panel and the inside case surface. The final wiring is then completed. It will be observed that R4 is wired between the panel and VR1, and that R3 is wired between VR1 and S1. When the case lid is secured in place, a piece of foam rubber or plastic between the lid and the battery will hold the latter in place.

The twin wire from the Veroboard panel to the search coil passes down the wooden pole and is secured at intervals by insulating tape wound around the two. A piece of tape also secures it to the top of the coil former at the point where it connects to the coil lead-outs. This piece of tape protects the joints and prevents any accidental short-circuits. If a more robust method of connection is required the junctions may be insulated with tape and held down with a soft plastic home-made clamp secured with two small woodscrews.

Finally, the metal locator will be very much easier to use and control if a handlebar grip is fitted to the handle. Such a grip should be available at any cycle shop. The grip will probably be found to be an extremely loose fit, and this situation can be rectified by wrapping a few layers of insulating tape over the handle.

TESTING

When the unit has been switched on, there should be no deflection of the meter until VR1 is sufficiently advanced clockwise. There is only a very limited range of adjustment in VR1 between the positions which give nil deflection and full-scale deflection of the meter needle, and VR1 needs careful setting up in order to produce an intermediate reading. The meter can be set up for approximately half f.s.d. or less, and a positive meter deflection should be produced when the search coil is placed near a metal object. The metal locator is then ready for use.



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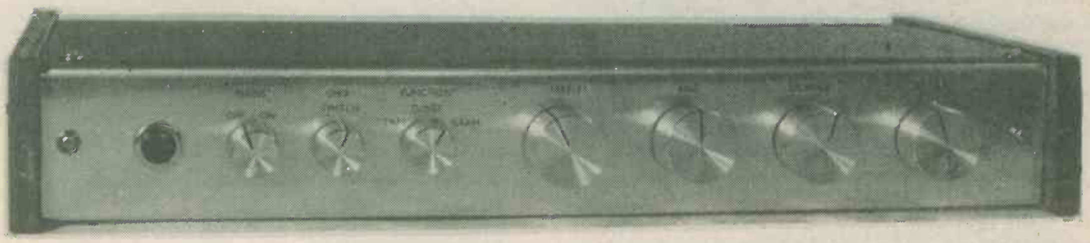

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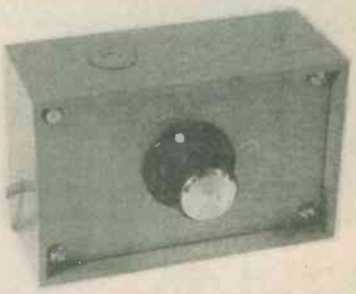

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OP-AMP TRANSISTOR TESTER

By
D. V. Henderson

A low cost circuit which enables the current gain of small-signal silicon transistors to be measured with a high degree of accuracy.

The transistor tester whose circuit is described in this article employs no meter yet gives accurate indications of current gain for small-signal silicon bipolar transistors. Equally accurate indications are possible with germanium small-signal transistors when these have low leakage currents. Gain measurement is made at a collector current of about 4mA with about 4 volts between the collector and emitter of the transistor being tested. Germanium and silicon power transistors may also be checked, bearing in mind that the test is being carried out at a relatively low collector current.

OPERATING PRINCIPLE

The principle of operation of the tester can be introduced by means of the circuit shown in Fig. 1(a). Here, a 9 volt supply is coupled to an n.p.n. transistor under test, which is connected as an emitter follower. The emitter load resistor, R1, has a value of 1kΩ and the base connects to the positive rail via a 1MΩ variable resistor, VR1. If we assume that there is zero voltage drop in the base-emitter junction of the transistor then it becomes possible to adjust VR1 such that 4.5 volts is dropped across R1, with a further 4.5 volts dropped across VR1.

The current flowing in VR1 is equal to the current in R1 divided by the current gain of the transistor in the emitter follower mode. Since equal voltages are dropped across the two resistors it follows that the current gain becomes equal to the resistance inserted into circuit by VR1 divided by the resistance of R1. This last resistor has the round figure value of 1kΩ, whereupon the current gain of the transistor is equal to the number of kilohms inserted into circuit by VR1. If VR1 inserts 100kΩ the transistor has a current gain of 100 times, should VR1 insert 200kΩ the gain is 200 times, and so on.

A simple example will illustrate this relationship. The current flow in R1 when there is 4.5 volts across it is 4.5mA. If the transistor has a current gain of 100 times the base current flowing via VR1 is 0.045mA. The resistance inserted into

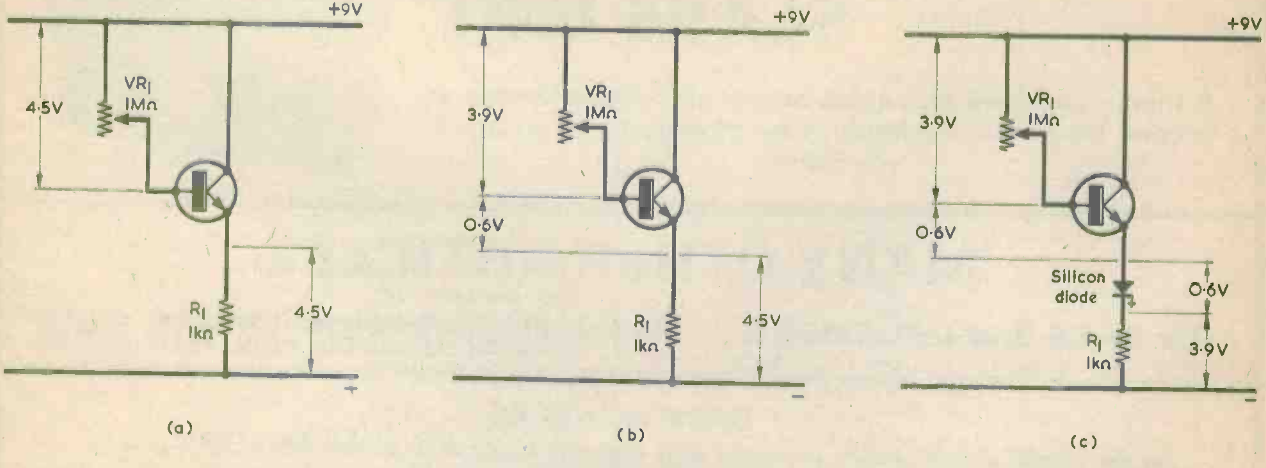


Fig. 1(a). Assuming zero voltage drop across the base-emitter junction of the transistor, VR1 can be set up to give the voltages shown here
(b). In practice there is a significant voltage drop across the base-emitter junction of a silicon transistor
(c). The voltage drop can be compensated for by inserting a silicon diode in series with the emitter. VR1 may now be adjusted for a symmetrical voltage pattern

circuit by VR1 has 4.5 volts dropped across it and must therefore, from Ohm's Law, be equal to 4.5 volts divided by 0.045mA. This works out as 100kΩ. If the transistor has a current gain of 200 times the voltage conditions in Fig. 1(a) are given when VR1 inserts 200kΩ because, obviously, the base current now required is half that for the previous example.

To sum up, we can find the current gain of the transistor in Fig. 1(a) by adjusting VR1 so that 4.5 volts appears across R1. The current gain of the transistor is then equal to the number of kilohms inserted by VR1. If this variable resistor has a scale which has been previously calibrated with the aid of an ohmmeter, we can read off the transistor current gain directly from the scale.

For the circuit of Fig. 1(a) to be of use it is necessary to monitor the voltage across R1. This can be done by connecting a voltage comparator to the emitter of the transistor. If we have the voltage comparator give an indication when the voltage at the emitter is precisely *half* that of the supply then the same relationship between the resistance inserted by VR1, the resistance of R1 and the current gain of the transistor will hold good at supply voltages other than 9 volts. The supply will not then need to be stabilized and can consist of a 9 volt battery which is discarded when its voltage falls to, say, 7 volts. For the time being, however, we shall continue our explanation with a supply of 9 volts.

A further point is that we are talking in terms of the current gain of the transistor when used as an emitter follower. This can be considered as being virtually equal to hFE, the static base to collector current gain of the transistor. Actually, it is equal to hFE + 1 because both the collector and base currents flow in the emitter. For transistor gains above 50 or so, the + 1 factor can be ignored.

SILICON TRANSISTORS

In Fig. 1(a) we assumed that there is zero volts drop across the base-emitter junction of the test transistor. With germanium transistors there is, in practice, a voltage drop of about 0.15 volt. This is sufficiently small when compared with the other voltages in the circuit to be considered negligible, whereupon the circuit as it stands is suitable for finding the current gain of germanium transistors. Some small-signal germanium transistors have leakage currents which could cause inaccurate gain readings to be given, although the later production of these devices seems to be relatively free from this shortcoming. In any event, germanium transistors are largely disappearing from the electronic scene, and silicon transistors do not give any serious difficulties so far as leakage currents are concerned.

On the other hand, silicon transistors exhibit a relatively high forward voltage drop across the base-emitter junction, and this is large enough to be a significant factor here. Typically, the voltage drop is about 0.6 volt. If we put a silicon transistor in the circuit of Fig. 1(a) and set up VR1 for 4.5 volts at the emitter we will obtain voltage figures similar to those shown in Fig. 1(b). There will now be 0.6 volt across the base-emitter junction of the transistor and only 3.9 volts across VR1. The voltages across R1 and VR1 are manifestly dissimilar and their previous relationship with transistor current gain no longer holds good.

A solution is shown in Fig. 1(c), in which a forward biased silicon diode is inserted between the transistor emitter and R1. This diode will give a voltage drop of around 0.6 volt whereupon, when VR1 is adjusted for 4.5 volts at the transistor emitter, the voltages in the circuit will be those shown in the diagram. Both VR1 and R1 have equal voltages across them, with the result that the resistance inserted by VR1 once more becomes equal to R1 multiplied by the current gain of the transistor. In practice the voltage across the diode will be slightly higher, by about 0.1 volt, than the voltage drop in the base-emitter junction, but the error introduced will be much less than if the diode were omitted. An advantage given by the inclusion of the diode is that the voltages around the central voltage point now become symmetrical, and a voltage comparator working to half supply voltage can be coupled to the transistor emitter. The circuit will then allow accurate gain measurements to be made at supply voltages other than 9 volts, and no inaccuracies will result due to falling battery voltage.

FULL CIRCUIT

The full circuit of the op-amp transistor tester appears in Fig. 2, where it will be seen that the voltage comparator is a 741 operational amplifier. This has its non-inverting input connected to the emitter of the test transistor, and its inverting input to the junction of the two equal value resistors R3 and R4. Thus, when the non-inverting input goes positive of the half-supply voltage the i.c. output goes highly positive, and when the non-inverting input goes negative of half-supply voltage the output goes highly negative. In the first state the red light-emitting diode, LED2, is illuminated, and in the second state the green l.e.d., LED1, is lit

COMPONENTS

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)
R1 1kΩ 2%
R2 18kΩ
R3 10kΩ 2%
R4 10kΩ 2%
R5 470Ω
R6 470Ω
VR1 1MΩ potentiometer, linear

Semiconductors
IC1 741 in 14 pin d.i.l.
D1-D4 1N4002
LED 1 light-emitting diode, green
LED 2 light-emitting diode, red

Switches
S1 s.p.s.t., toggle
S2(a)(b)(c) 3-pole 3-way, rotary

Battery
BY1 9 volt battery

Miscellaneous
3 terminals
2 pointer control knobs
Suitable plastic case

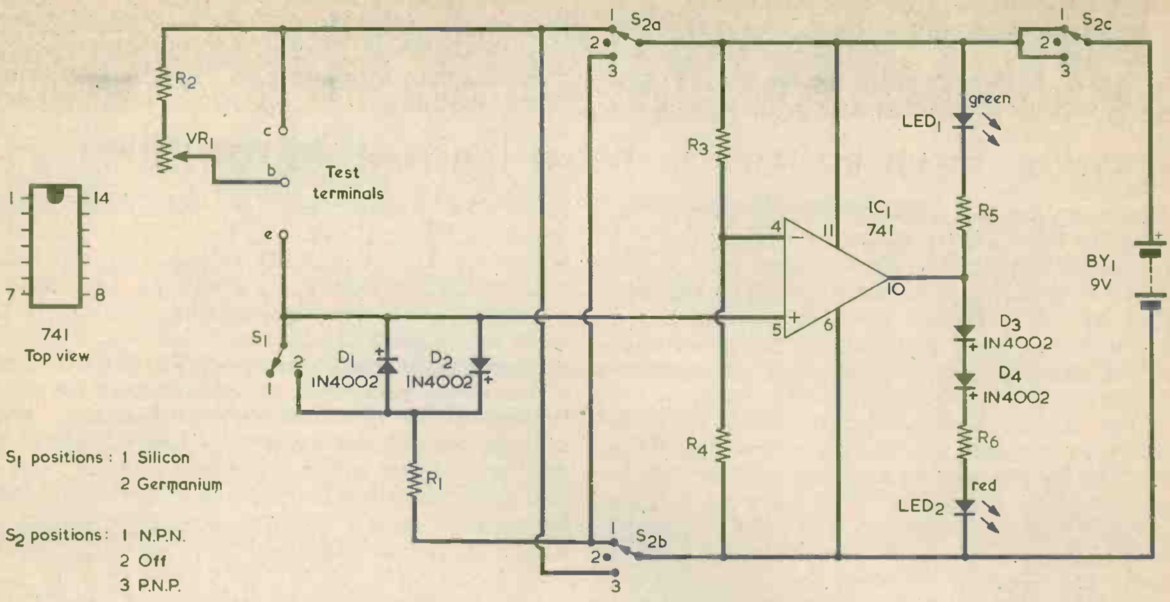


Fig. 2. The circuit of the op-amp transistor tester. This can be assembled in any convenient plastic box large enough to take the 9 volt battery and the components

up. Silicon diodes D3 and D4 are inserted in series with the feed to LED2 because, in its low state, the 741 output is still about 2 volts positive of the negative supply rail. Without the two diodes and their forward voltage drop the red l.e.d. would be partly illuminated when the 741 output is low.

VR1 and R1 carry out the same function as they did in Fig. 1. R2 is now, however, inserted in series with VR1 to limit the maximum current which can flow in the potentiometer to 0.5mA. This protects the potentiometer and the transistor under test. The diode in series with the emitter in Fig. 1(c) now appears as D2. D1, connected across it with reverse polarity, caters for the situation when p.n.p. transistors are being tested. When S1 is in position 1, the two diodes are in circuit and the tester can be used to check silicon transistors. Putting S1 to position 2 short-circuits the diodes and the tester may then be employed for germanium transistors.

S2(a) and S2(b) give supply polarity reversal. In position 1 the upper test transistor rail is positive and the lower rail is negative. Setting the switch to position 3 reverses the polarities. On-off switching is achieved with S2(c). It is necessary to have a central "Off" position because most rotary switches have a make-before-break action. If the polarity reversing switch employed adjacent fixed contacts on a rotary switch the battery would be momentarily short-circuited each time the switch was operated.

VR1 has a scale calibrated in terms of transistor gain. This is marked up by connecting an ohmmeter between the slider of VR1 and the upper end of R2, so that the resistance of R2 as well as that inserted by VR1 is taken into account. The scale is marked "100" at 100kΩ, "200" at 200kΩ and so on. Intermediary markings at "150", "250", etc., may also be entered on the scale, if desired. VR1 should be wired up to insert zero resistance into circuit when its spindle is turned fully anti-clockwise. The numbers on the scale will then increase with clockwise rotation.

All the components are readily available. VR1 is a standard carbon potentiometer and could, with advantage, be a moulded track type. Switch S2(a)(b)(c) is specified as 3-pole 3-way. A 4-pole 3-way switch can be used here, with no connections made to one of the poles. The current consumption of the tester is about 10mA with a test transistor connected and VR1 adjusted; in consequence the 9 volt battery may be a PP6 or a larger type, such as the PP9. The 741 is shown in the 14 pin d.i.l. form. The 8 pin d.i.l. version may alternatively be employed. This has its inverting input at pin 2, its non-inverting input at pin 3 and its output at pin 6. Positive and negative supplies connect to pins 7 and 4 respectively.

To check the gain of a transistor this is connected to the test terminals with VR1 set to insert maximum resistance. S1 and S2 are then set to the appropriate positions. With an n.p.n. transistor the green l.e.d. will light up. VR1 is then turned slowly anti-clockwise until a setting is reached where the green l.e.d. extinguishes and the red l.e.d. lights up. The current gain of the transistor is then read off from the scale of the potentiometer. With a p.n.p. transistor the red l.e.d. will be initially lit, giving way to the green l.e.d. when VR1 slider reaches the appropriate point along its track. Due to the very high gain of the 741 op-amp it will be virtually impossible for VR1 to resolve a setting at which both l.e.d.'s are alight. VR1 need only be adjusted to the position at which changeover takes place.

No harm will result if VR1 is adjusted to a low resistance, if the test terminals are short-circuited or if the test transistor is connected incorrectly. All the currents which can flow are limited to safe values by R1 and R2. ■

Trade News . . .

MINIATURE WELDING TORCH FROM BRITISH ROTOTHERM

This precision engineered miniature welding torch — believed to be one of the smallest units of its type commercially available — is now being marketed in this country by The British Rototherm Company Limited, the sole U.K. agents.

A precision engineered welding torch, which is expected to find wide application in electronics, is now being marketed in this country by The British Rototherm Company Limited, the sole U.K. agents.

Manufactured by the Tescom Corporation of the U.S.A. and aptly named "The Little Torch" it is not much larger than a fountain pen yet boasts the capabilities of more conventional welding and soldering equipment whilst having a considerably higher degree of accuracy.

Its ability to solder, weld or braze components as fine as .001 in. wire makes it particularly suitable for many applications in electronics. In the United States it is currently used for such tasks as repairing vacuum tubes, soft soldering silver wire in diodes and 'balling' 0.001 in. gold wire. In many applications of this type "The Little Torch" has replaced a more expensive process such as electric welding or is operating at a faster rate than a conventional soldering iron.

With tip orifice sizes as small as 0.003 in., which are jewelled for precise flame control, and flame temperatures up to 6300 deg. F. it can weld, solder and braze to such tolerances that it can be safely used in areas where in the past the risk of heat damage to adjacent components would have precluded the use of a torch.

From the operator's point of view its compact size, lightweight aluminium alloy body and interchangeable tips, which swivel through 360 deg., allow it to be handled very precisely in confined situations.

It operates on oxygen and a range of fuel gases including acetylene, hydrogen, l.g.p. and natural gas at pressures from 2 to 4 lbs./sq. in. Gas consumption ranges from 0.023 to 2.54 cub. ft.hr.

Surprisingly, "The Little Torch" is not expensive. British Rototherm expect to sell it complete with case, five tip sizes and 6 ft. of twin hose for less than £30.00.

Further information on "The Little Torch" can be obtained direct from The British Rototherm Co. Ltd.., Margam, Port Talbot, West Glamorgan, South Wales, SA13 2PW.

WIRE STRIPPING HAND TOOL

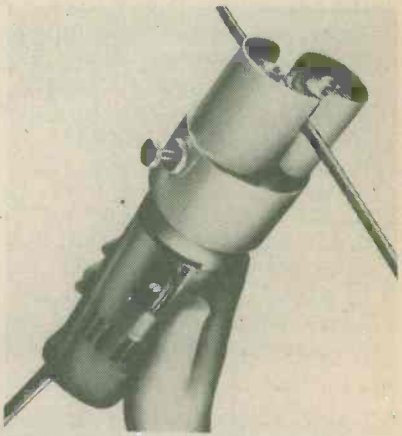
Eraser International have available from stock in London, the Rush model PD2 wire stripping hand tool.

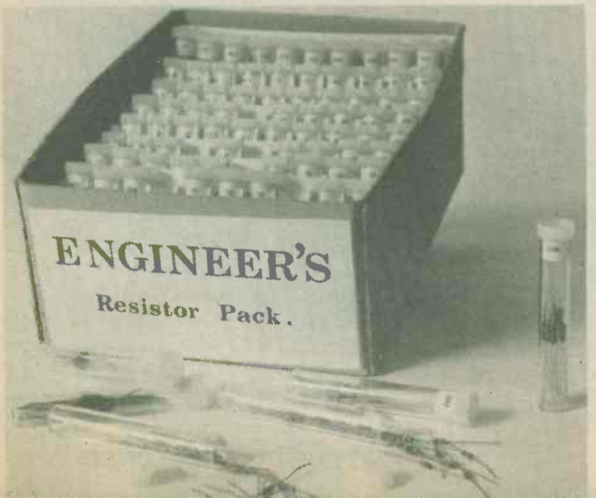
The Rush model PD2 wire stripper is designed to strip round, square and rectangular wire up to guages of 2 SWG.

The PD2 is designed for stripping film type insulations from wires commonly used in transformers and electric motors. It will also strip wires insulated with asbestos and glass type coverings. Wires are stripped by a brushing action generated by two counter rotating wire brush wheels.

The machine is fully adjustable for different wire sizes and is ideally suited for production use.

Further information is available from Eraser International Ltd., 213 Hampton Court Parade, East Molesey, Surrey, KT8 9HB.





ENGINEER'S RESISTOR PACK

The home constructor or service engineer can now buy his resistors in quantity from Home Radio in the form of an Engineer's Resistor Pack. Values from 4.7Ω to 1.5 MΩ (20 of each) are separately packed in individual clear plastic tubes. There are additional resistors of the more popular values making a grand total of 1600 in all. The resistors are mostly 5% tolerance and either $\frac{1}{8}$ or $\frac{1}{4}$W rating. Each tube is clearly marked and the backing cards can be left in the original box supplied to give quick access to any value of resistor required. The Pack costs £17.50 plus $12\frac{1}{2}$% VAT plus 85p post, packing and insurance. Available from Home Radio (Components) Ltd., 234 London Road, Mitcham, Surrey CR4 6HD.

MODIFIED MAINS CURRENT MONITOR

by T. K. Wong

There is no risk of leaving mains operated bench equipment switched on if this current monitor is inserted in the bench supply. Its l.e.d. warning lamp lights up for even very small mains currents.

A mains current monitor which causes an l.e.d. to be lit whenever any current is drawn from the a.c. mains was described in the "Suggested Circuit" which appeared in *Radio and Electronics Constructor* for December 1976. The present article describes an improved current monitor which has been developed from the previous circuit.

ORIGINAL CIRCUIT

For convenience, the earlier circuit is reproduced in Fig. 1. The mains transformer primary in this is connected permanently across the mains supply and the two output leads at the right connect to the supplied equipment, which could for instance be the equipment on a service engineer's or experimenter's work bench. The current being monitored flows through rectifier D4 on half-cycles when the live side of the mains is negative and through rectifiers D2 and D3 in series on half-cycles when the live side of the mains is positive. The rectifiers are all silicon types, with the result that there is a voltage drop of about 0.6 volt when D4 conducts and a drop of about 1.2 volts when D2 and D3 conduct. These small voltage drops should have no effect on standard mains powered equipment.

The mains transformer has a 6.3 volt secondary and is so wired that the upper end of this secondary is positive when the live side of the mains is positive. On half-cycles when the live side is negative, rectifier D1 is non-conductive and the circuit is inoperative. The only effect given then is that 0.6 volts is dropped across D4 when the supplied equipment draws current.

If when the live side is positive no current is drawn, there is no voltage drop across D2 and D3 and, therefore, no base bias current for TR1. This transistor does not conduct and LED1 is extinguished. If, on the other hand, a current is drawn, there is a 1.2 volt drop in D2 and D3, causing current to flow into TR1 base via R3. TR1 passes collector current and the l.e.d. becomes illuminated. The l.e.d. is only alight on half-cycles when the live input is positive but persistence of vision gives the impression of continual illumination.

The circuit is very sensitive, and the l.e.d. will light up for load resistances across the monitored supply which are as high as 1MΩ. In consequence, in addition to the circuit indicating that equipment is switched on and is drawing current it will also detect insulation leakage in the monitored supply.

The diodes D2, D3 and D4 should have ade-

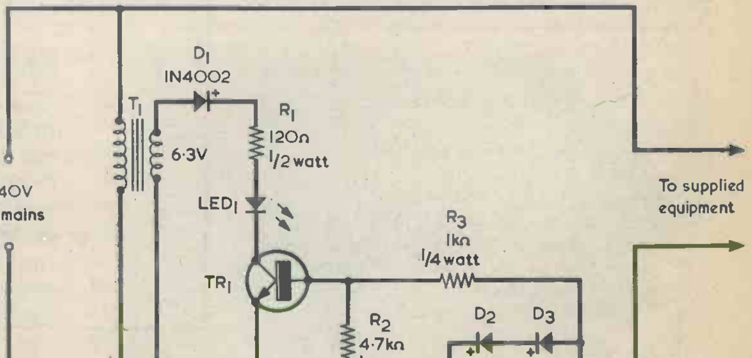


Fig. 1. The circuit of the mains current monitor which appeared in the December 1976 issue. TR1 is a BC107, but any other similar small signal n.p.n. transistor would be satisfactory

quate forward current ratings. Rectifiers rated at 3 amps will, for instance, be satisfactory for loads up to 720 watts. They can have low reverse voltage ratings as the reverse voltages applied across them are very small.

MODIFIED VERSION

The modified version of the circuit now to be described introduces several advantages. Firstly, it is more economical as it dispenses with the mains transformer, which is rather an expensive item nowadays. Secondly, it is physically smaller in size and, thirdly, it eliminates a possible source of induced hum which could be given by the transformer.

The modified circuit is shown in Fig. 2. and it functions in the same manner as the previous circuit insofar that a voltage is dropped across D2 and D3, causing the transistor to be biased on, on positive live half-cycles when the monitored equipment draws current. Instead of using a step-down transformer to power the circuit, a half-wave rectifier, D1, is employed. This conducts on positive (live) half-cycles and supplies current to ZD1 and the transistor-l.e.d. circuit. If no current is drawn by the supplied equipment TR1 will not conduct, and all the current from D1 will flow into the zener diode. When the supplied equipment draws current, TR1 turns on and, except for very low load currents, will divert all the current passed by D1 away from the zener diode. The l.e.d. will then be fully illuminated.

On negative (live) half-cycles D1 will not be conductive. Any voltage from this rectifier due to leakage current cannot be applied to the transistor-l.e.d. circuit because ZD1 then acts as a normal forward biased silicon diode.

DESIGN NOTES

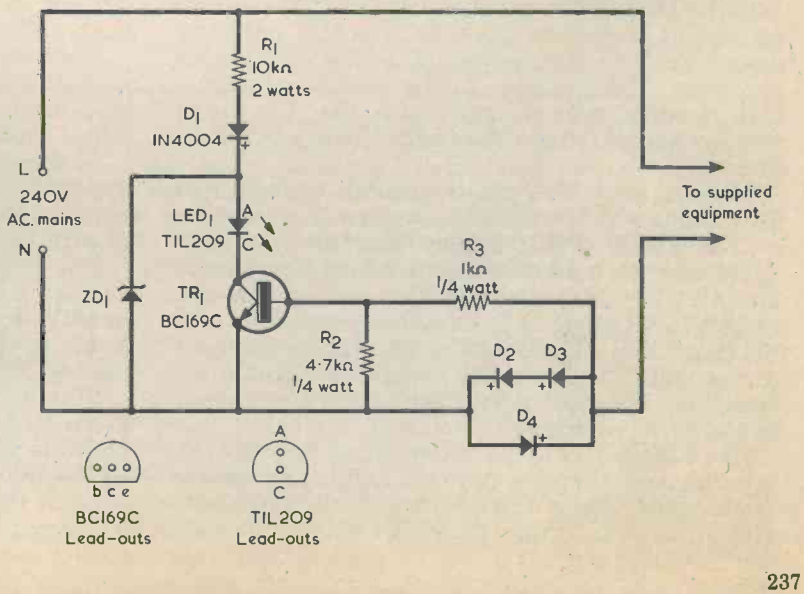
At first sight it may seem rather difficult trying to design a zener regulator with peak voltage of up to 340 volts! However, there is one point to note: the circuit operates from a half-way rectifier circuit feeding a "resistive" load. The average d.c. level will therefore be 0.45 times the r.m.s. value of the mains voltage, or 108 volts in this case. If we know the current we wish to pass through the l.e.d. we can find the value of R1 by working to these figures, ignoring voltage drop in the l.e.d. and the transistor when conducting. A suitable l.e.d. current will be 10mA, and 108 volts divided by 10mA gives a resistance for R1 of 10.8k Ω. In practice a value of 10k Ω will be satisfactory. The average power dissipated in R1 will be around 1 watt and, to conform to good practice, a resistor with a larger power rating should be used.

D1 will have to withstand a peak inverse voltage of 340 volts, thus a diode in the 1N4004 to 1N4007 range could be used.

The zener voltage was found to be of secondary importance and zener diode voltages between 5.6 and 20 were tested in the circuit without any significant effect on its performance. In general, the zener diode mainly ensures that the voltage across the l.e.d. and the transistor does not rise to an excessive value on positive half-cycles when the transistor is turned off. The zener diode power rating can be modest and 400mW diodes will be quite satisfactory, particularly for zener voltages below 10. A peak current approaching 34mA will flow through the diode for a short while in each cycle but such a current is well within maximum zener current ratings for diodes in the BZY88 series. Readers who prefer firmer specifications can employ a BZY88 having a voltage of 7.5, 8.2, 9.1 or 10 volts in the ZD1 position.

The l.e.d. used was a TIL209 and, with an average current of 10mA flowing through it, the brightness was found to be sufficient. Some constructors may prefer larger diodes. Again, the maximum current rating of the diode should not be exceeded (40mA for a TIL209) which it is not in this circuit. Transistor TR1 was a BC169C but most common small-signal n.p.n. silicon transistors would be suitable here.

Fig. 2. The modified mains current monitor. This offers economies in components and takes up a smaller space. The resistors may have a tolerance on value of 10%.



ASSEMBLY

Assembly of the circuit should follow usual construction and safety practice. Since some of the circuit points are at live mains potential it is essential that the components be contained in a housing which ensures that there is no risk of accidental shock. If the case is metal it must be reliably earthed. A small amount of heat will be generated as there will be a continual dissipation of approximately 1 watt.

For interest, a comparison was made between this power figure and the power consumption of a small 6 volt transformer. The power consumed by the transformer off load measured at 1.7 watts, although the power figure will vary according to the quality of the transformer used. This finite power consumption of a transformer off load may come as a surprise to some readers, but it is to be expected of practical non-ideal components. ■

BETTER TV SOUND

by J. P. Macaulay

How to obtain improved television sound quality, simply and safely, from many portable TV receivers.

Those who have had the good fortune to hear and see the stereo-TV joint broadcasts will appreciate the extra dimension that stereo adds. However, it is not so widely appreciated that the sound channel of the normal TV broadcast, although in mono, is of the same order of quality as the Band II f.m. radio broadcasts.

This fact is certainly not exploited by TV manufacturers, judging by the inferior size and quality of the speaker provided in the average set. It was the author's enjoyment of these joint programmes that promoted this short article, and it is aimed at those who possess a portable TV having an earphone socket.

TAKE-OFF POINT

Many currently available portable TV's feature an output socket on the side which is normally meant for the connection of a low impedance earphone. This facility can be used to provide a high quality take-off point for the TV sound without having to modify or add circuitry to the existing set.

Modern portables are invariably transistor or i.c. designs which, unlike the larger sets, do not use a live-chassis power supply and are therefore operated from a more or less standard transformer and rectifier arrangement. This means that the chassis is not likely to be at mains potential as with the larger sets. In any case, a set with an earphone socket will not have a live chassis or it would not satisfy the stringent safety regulations which apply to electrical equipment on sale in the U.K.

The easiest way to get better sound from the TV is to run a pair of wires from the earphone socket to the auxiliary input of a hi-fi amplifier. The sleeve of the jack plug fitting into the TV earphone socket will normally connect to the TV chassis. The other end of the wire connecting to the plug sleeve should connect to the chassis of the amplifier. With a stereo amplifier, the two non-earthy input points should be paralleled.

When the input impedance at the auxiliary input is fairly high, say above 10kΩ, the output emitter followers of the internal TV amplifier will work virtually in Class A. The reason for this is simple. With a low impedance load like the internal speaker the output transistors operate in Class B; however, the low quiescent current which flows in all Class B amplifiers is sufficient, when working into a high impedance, for no extra current to be taken from the TV power supply. Thus, the current which flows in the high impedance load is sufficiently small to be provided by the quiescent current in the output pair and these operate in push-pull Class A.

Further, the output capacitor in the TV set has negligible effect on the low frequency response, thus improving the overall quality of the output signal available from the earphone socket.

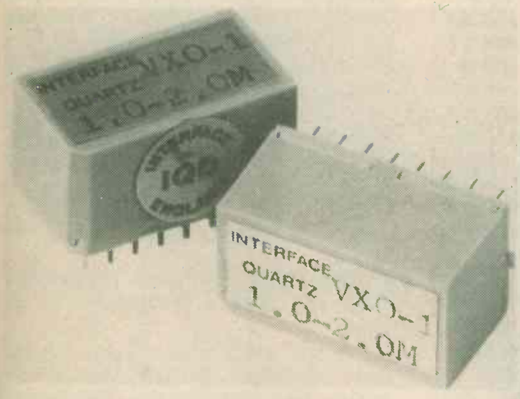
As the output from the earphone socket is at low impedance it is not necessary to use screened wire for the connection to the hi-fi amplifier. Any kind of wire including thin 2-core flex is suitable.

It is difficult to describe the enhancement of TV viewing which results from a satisfactory sound quality, but the scheme can be safely said to be a good investment, especially when watching musical programmes.

Finally, it must be stressed that the connection to the hi-fi amplifier must only be carried out with portable television sets which have an earphone socket fitted by the receiver manufacturer. On no account should any attempt be made to obtain an a.f. signal from a TV receiver which does not have such a socket installed. ■

New Products

COMPATIBLE CRYSTAL OSCILLATOR

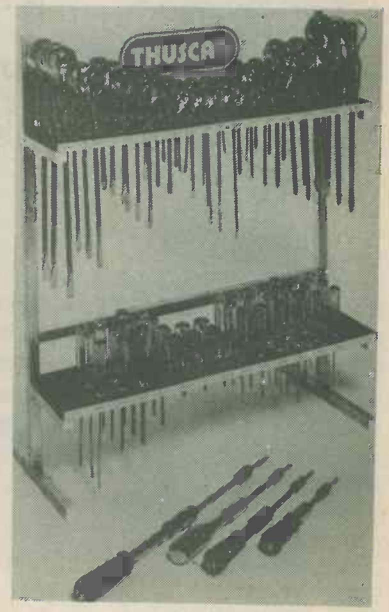


Introduced in the Autumn Verospeed Catalogue is a TTL Compatible Crystal Oscillator with both normal and complementary outputs at 1 MHz and 2 MHz mounted in dual line configuration. The device operates from a supply voltage of 5v (± 0.25V) and draws 35 mA max. The temperature coefficient is 1ppm/° C max or less than ± 50 ppm drift over the operating temperature range (0-70° C). Rise and fall time 20 nS max. Available to order code 90-6287H price £9.36 on a guaranteed ex-stock basis from Verospeed, 10 Barton Park Industrial Estate, Eastleigh, Hants. SO5 5RR.

RANGE OF SCREWDRIVERS

Thunder Screw Anchors Ltd. announce the introduction of a range of cabinet handled and 'continental' handled screwdrivers together with a mains tester and a selection of spiral ratchet screwdrivers. The cabinet handle range includes screwdrivers of electricians, engineers and crosspoint types with blade sizes from $\frac{3}{16}$" x 3" to $\frac{3}{8}$" x 10", a total of 15. The continental range includes chubby, pozidriv, crosspoint and electricians patterns. Spiral ratchets are available with or without locking device, and with or without a magazine to hold bits.

The screwdrivers, as shown in photograph, are made from high quality steel and are extremely competitively priced. Further details from Thunder Screw Anchors Ltd., Industrial Estate, Southwater, Horsham, Sussex. RH13 7HQ.



CAR REAR SCREEN HEATER

The Rainbow Rear Screen Heater, an Italian invention from the 1976 Turin Motor Show, is an entirely new concept in rear screen heating employing a new revolutionary method of fixing which gives "Total Visibility" to the driver and is indistinguishable from a standard fitting.

Carrying an Italian patent, No. 165006 with U.K. patent pending, the Rainbow finishes, once and for all, the unsightly small square stuck to a window which clears only a portion of the screen and which ceases to function if a single filament, which carries a weak resistance, should break. The Rainbow will continue to operate even in the unlikely event of 2 filaments breaking.

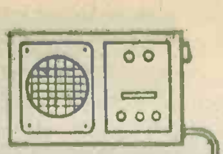
Fixing time is approximately 20 minutes — a grooved adhesive plastic strip, 30cm long, is cut to length (rule provided) and placed at each end of the screen. The filaments are run horizontally across the whole width of the screen, thin metal strips slot into the grooves giving electrical contact — all that remains is to connect up with the plugs, cable and illuminated warning switch!

When fitted, the Rainbow gives the same heat as a standard fitting and breakage of filaments is nullified by their high-tack adhesion. Should a filament be accidentally damaged it is easily replaced as 13 metres of filament are supplied — ample for the largest rear screen.

The Rainbow comes in an attractive bubble-pack containing everything, including a switch with warning lamp, electrical contacts and cable etc. Full fitting instructions are printed on the reverse of the pack.

The recommended retail price is only £4.95 plus V.A.T., and is available from all leading accessory shops, or in case of difficulty, from Macgilwood Ltd., 39/41 High Street, Gt. Dunmow, Essex.

In your workshop



This month Dick sets out on the repair of a television receiver having a faulty contrast control circuit. As always Smithy offers assistance, but events do not turn out quite as he had anticipated.

Cheerfully, Dick selected a 14 inch black and white television receiver from the "For Repair" rack and carried it over to his bench. It had its own loop aerial at the back and he decided to check its performance with this, rather than use the Workshop aerial. He connected the set to the mains and switched on. Almost immediately the sound channel of one of the local TV transmissions became audible from the speaker. As he waited for the picture tube to warm up he adjusted the volume control of the receiver. Both the sound quality and output power available were completely acceptable.

Shortly afterwards, a pale raster appeared on the screen. Dick looked at it closely and was just able to make out a weak picture which was firmly synchronised both for line and frame. He put his hand out to the brightness control but all that this could do was to increase the brightness of the raster and make the weak picture even less discernible.

Dick next tried the contrast control. He rotated it experimentally to find that it had no effect whatsoever on picture amplitude. The picture remained at its same weak level for all settings of the control.

Frowning, he checked the type number of the receiver, switched it off, then made his way to the filing cabinet in which the service manuals were kept.

CONTRAST FAULT

At his own bench Smithy, working at a backlog of paperwork, permitted himself a quick grin as he heard his assistant's footsteps pass behind him, followed by the sound of the filing cabinet drawer being opened. This little scene represented what, to him, amounted to a major victory in the constant battle of wills with his assistant. For years Dick had looked upon the consultation of a service manual as the last resort in the tracking down of a snag. As a result he would sometimes, to Smithy's mind, needlessly waste time by ploughing on guided only by instinct in search of a fault, instead of taking out the service sheet and finding the trouble by logical reasoning. To be honest, Smithy had to admit that, in compensation, his assistant possessed an abundance of the two necessary prerequisites of a successful service engineer: a nose for faulty components and good luck.

But now,as a result of Smithy's continued admonitions, Dick had completely changed his servicing approach. If the service manual was available he consulted it as soon as he started on a repair job.

Smithy returned contentedly to his paperwork. He was ordering new components to stock the spares cupboard, employing a technique which would have sent the average stores accountant into a shivering decline. Smithy's dictum was simply to get in plenty of everything: not only did this mean that there was less risk of a spare part not being immediately to hand when it was needed but it also meant that Smithy had to do his paperwork much less frequently.

As he added a dozen 0.1μF capacitors type C280 to his list he was aware of a quiet moan from the other side of the Workshop. He paused, then returned to his task. A dozen 0.47μF C280's mightn't be a bad idea, either. He entered them in his list.

Once more there was the low moan.

Alarmed, Smithy turned round, to see his assistant slumped despondently on his stool staring down at something on his bench. Smithy rose hurriedly and walked over to Dick's side, noticing that the object of Dick's gaze was the service manual he had just selected, which was now opened out at its circuit diagram. Once again the moan issued from Dick's lips.

"For goodness' sake," said Smithy irately, "I thought you were having a seizure or something."

Dick gazed up mournfully at the Serviceman.

"I reckon I should have one, too," he grumbled, "after seeing the contrast circuit in this set. I can't even begin to understand it."

Smithy glanced briefly at the circuit. (Fig. 1.)

"There's nothing very complicated there," he stated. "It's just a 470Ω pot in the emitter circuit of the video output transistor."

"That's not all there is to it," retorted Dick. "What about that pre-set contrast control? There's a 4.7kΩ pre-set pot there and for the life of me I can't fathom out what it does in the circuit."

"Dash it all," snorted Smithy, "that pot is just in a gated a.g.c. circuit. And a pretty simple gated a.g.c. circuit, at that."

He looked at his assistant's downcast face then sighed helplessly.

"All right," he said resignedly, "tell me what's happened up to now."

"Well," said Dick, "I got this set onto my bench, plugged it in to the mains and switched on. The sound came on right away but when the picture came up it was locked but very weak. What's more, it stayed at the same weak level at all settings of the contrast control. So I did what you're always telling me to do. I went and got the service manual."

Smithy nodded his approval.

"Very good. A few minutes with the manual can often save you ages in finding a fault."

"Can it? If I hadn't got that manual out I would by now have been happily poking around inside this set looking for the fault."

"What good would that do if you didn't know where to look?"

"Instead of which," continued Dick, ignoring the Serviceman's remark, "I'm sitting here like a lemon gazing at a circuit which I simply cannot understand. What does that pre-set contrast control do, Smithy?"

"It sets up the gated a.g.c. contrast level," replied Smithy. "And it's very doubtful whether it has anything to do with the fault you've got in that set."

"Still," persisted Dick, "how does it work?"

GATED A.G.C.

"Well," said Smithy reluctantly, "if we're going to talk about gated a.g.c. we want to clear up a few background details first. To start off with, why do we use gated a.g.c.?"

"Search me," said Dick cheerfully. Now that the Serviceman was beside him to offer assistance his spirits were rising visibly.

"You need gated a.g.c.," said Smithy, "to ensure that any impulsive interference which is picked up by a TV receiver doesn't generate an excessively high a.g.c. voltage. We're talking about 625 line television reception, and in the 625 line video signal the line sync

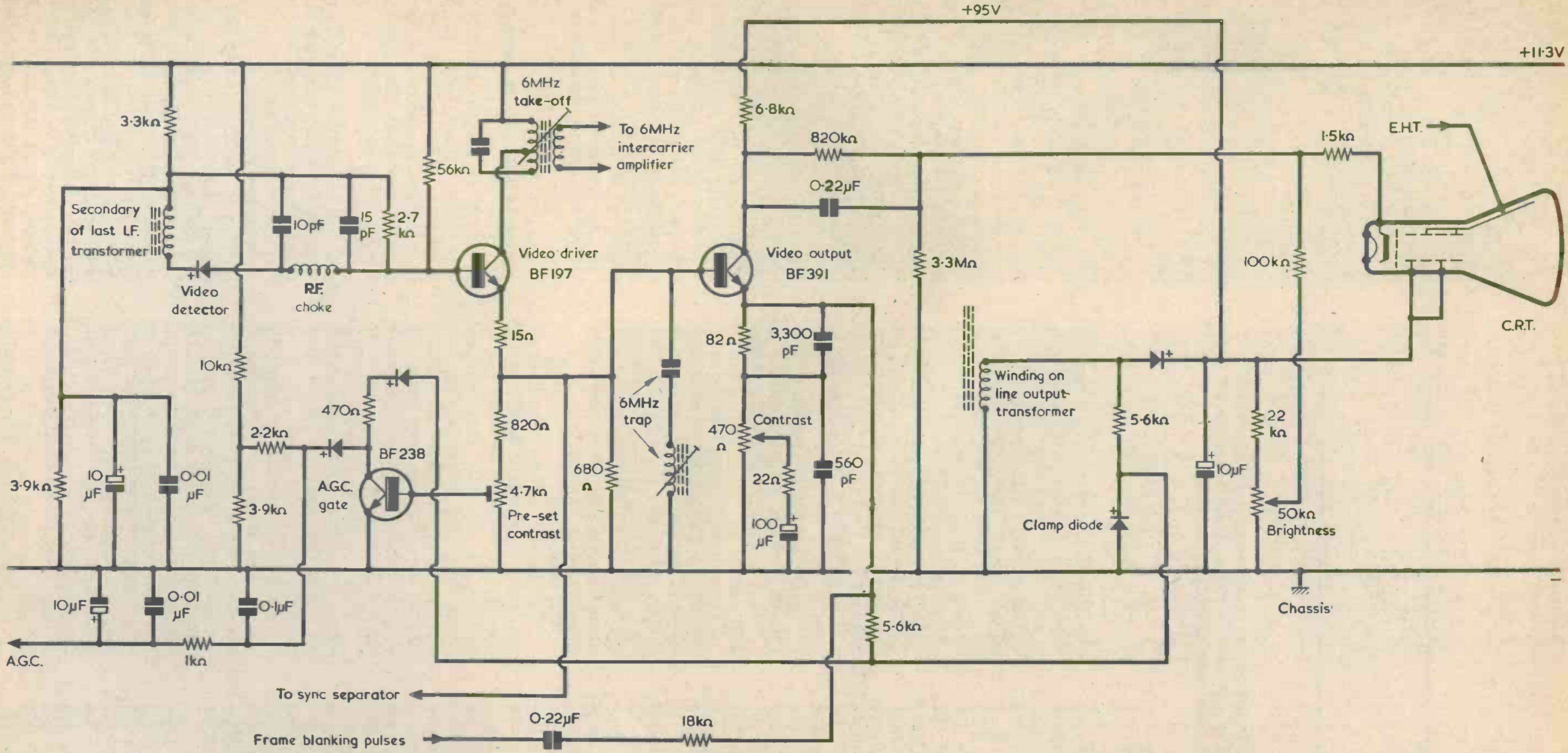


Fig. 1: Video detector, video driver, video output and a.g.c. gate stages in the television receiver selected by [illegible]

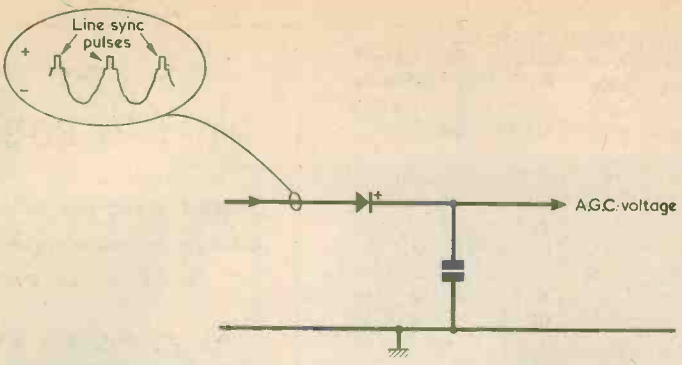


Fig. 2. Theoretically, a simple circuit of this nature, in which the detected 625 line signal is applied to a diode, could be employed to produce an automatic gain control voltage

pulse tips correspond to maximum signal amplitude. It would be quite possible in theory to have an a.g.c. circuit in which the detected video signal was simply applied via a series diode to a capacitor. The capacitor would charge up to the line sync pulse tip level and the voltage across it would correspond to signal voltage. That voltage could be used as an a.g.c. voltage controlling the gain of one or more of the preceding stages in the receiver. If the signal amplitude at the diode increased so would the a.g.c. voltage, and this would cause the gain of the preceding stage or stages to be reduced and bring the signal level down again." (Fig. 2.)

"That sounds fine by me. What's wrong with a system like that?"

"It's no use in practice," replied Smithy, "because it's wide open to impulsive interference. If impulsive interference of sufficient strength got into the system the interference pulses would also be rectified by the diode and the a.g.c. voltage would go up, reducing the gain of the receiver. Gated a.g.c. gets over this snag very largely by employing an a.g.c. voltage producing circuit which is only operative when line sync pulses are present. Unless interference pulses appear at the same time as the line sync pulses, which is unlikely, the a.g.c. voltage producing circuit ignores them completely."

"Well," commented Dick, "that makes sense. But the gating circuit required for producing the gated a.g.c. voltage seems to me to have a lot more in it than just a simple diode and capacitor."

"That's fair comment," admitted Smithy. "Anyway, let's have a look at what goes on in the particular gated a.g.c. circuit you've got here. If we go back to the video detector, we see that this is connected so that the detected video signal appearing after it has negative-going line sync pulses. This signal is applied to the base of the video driver transistor which, so far as the video signal is concerned, is an emitter follower. The output at the emitter will therefore be a signal which also has negative-going line sync pulses, and this is passed on to the base of the video output transistor. It is also applied, via a 15Ω and 820Ω resistor, to that 4.7kΩ pre-set contrast pot which has been causing you so much anguish."

"Now, don't be like that, Smithy."

"Stap me," snorted Smithy. "It's you who makes me like that."

"You've been taking those niggle pills again!"

"I have *not* been taking any niggle pills. For goodness' sake stop interrupting and let me get on with this explanation. As you can see, the slider of that pre-set pot goes to the base of the BF238 gated a.g.c. transistor, the emitter of which goes straight down to deck."

"To deck?"

"To chassis. If you next look at the line output transformer you'll see that there's a winding on it which, by flyback rectification, gives 95 volts positive for the brightness control and the focus electrodes of the picture tube, as well as for the video output transistor collector load."

"That's a funny way of setting about things, isn't it? Couldn't the 95 volts be derived from the mains?"

"This," pronounced Smithy, "is one of the many small portable black and white TV's which are being produced these days for operation from the mains or from a 12 volt accumulator. The mains supply line in the set is at about 11 volts stabilized and any higher voltages that are required are taken from windings on the line output transformer."

"Oh, I see. Well, that seems fair enough."

"Darned right it's fair enough! Now that line output transformer winding also connects, via a 5.6kΩ resistor, to a clamp diode. This does not conduct during flyback pulses when the upper end of the winding goes positive, but it does conduct between pulses when the winding upper end goes negative. The result is that you get a nice series of positive-going pulses, synchronised with the picture line sync pulses, at the upper end of the diode, with the waveform staying at chassis potential between pulses. This waveform is applied via a 5.6kΩ resistor to the emitter of the video output transistor and also, via another diode and a 470Ω load resistor, to the collector of the BF238 transistor." (Fig.3.)

"This," remarked Dick, looking more closely at the circuit, "is beginning to get more interesting. Things are beginning to slot into place."

"Good," said Smithy, pleased now with his assistant's attention. "From what we have seen, the BF238 can only act as a transistor during the periods when the positive-going pulses from the line output transformer winding are present because that's the only time when it has a positive collector supply. When these pulses are present so also are the negative-going signal line sync pulses from the video driver transistor emitter. In consequence, the current flowing into the base of the BF238 during these periods depends upon the amplitude of the signal. If the amplitude increases, the line sync pulse tips go further negative and less current flows into the base. The collector current decreases and the collecter voltage goes positive. If the signal amplitude decreases, the signal line sync pulses go less negative and more current flows into the transistor base. Its collector voltage then goes negative."

FORWARD A.G.C. BIAS

"Hey," said Dick excitedly, "just let's hold things here for a few moments. What you're saying is that if signal amplitude at the video emitter increases the collector of the BF238 goes positive."

"That's it."

"And if signal amplitude at the video emitter decreases the BF 238 collector goes negative?"

"You've got it."

"Humph!"

"But," Smithy reminded him, "these voltages at the collector of the BF238 only appear when line sync pulses are present. Between the pulses the collector drops down to around chassis level. Now, the collector connects to another diode which in turn connects to a 2.2kΩ resistor coupled to a potential divider consisting of a 10kΩ and a 3.9kΩ resistor across the supply lines, and the a.g.c. voltage is taken from the junction of the diode and the 2.2kΩ resistor. In the absence of signal, when there are no line sync pulses at all, this potential divider provides a standing a.g.c. bias. When a signal comes along the collector of the BF238 goes positive during line sync pulses and the diode conducts, causing the a.g.c. line to go positive as well. The positive voltage from the diode is in the form of pulses, and these are smoothed out in the a.g.c. line by a 0.1μF capacitor, a 1kΩ resistor and a 0.01μF and 10μF capacitor in parallel. And so you get an a.g.c. output which goes smoothly positive as signal strength increases. The amount by which it goes positive is controlled by the pre-set contrast control pot, which can be adjusted such that useful a.g.c. control is given over the normal range of signal strengths likely to be received. What the pot does is to adjust the current which flows into the base of the BF238 when signal line sync pulses are present."

"What happens," asked Dick, "at the base of the BF238 between sync pulses?"

"The base-emitter junction of the BF238 merely acts as a forward biased silicon diode," explained Smithy. "The voltage at the emitter of the video driver transistor goes more positive during the periods between line sync pulses, which merely means that a larger current flows into the base. This has no effect on a.g.c. operation because the BF238 cannot act as a transistor until it gets a positive supply for its collector, and this positive supply only appears when line sync pulses are present."

"Humph!"

Dick absorbed this information, then turned his attention to the i.f. amplifier stages in the circuit.

"There's something else here," he remarked. "You said just now that the a.g.c. voltage goes positive as signal strength increases."

"I did."

"But," said Dick triumphantly, "That *can't* be true! The controlled i.f. transistors are n.p.n. types, which means that their gain *increases* when the a.g.c. line goes positive. The a.g.c. line would have to go *negative* and not positive to reduce the gain of those transistors."

He pointed to the transistors in question. (Fig.4.)

"Ah," said Smithy imperturbably. "Now what you're saying would be true if we were talking about a.g.c. control in a transistor radio. In present-day TV sets i.f. gain is controlled by what is known as 'forward a.g.c.', with which i.f. gain is reduced by *increasing* the base current of the controlled transistors. What this does, roughly, is to reduce the impedance of the base-emitter junction inside the transistor and thus reduce the signal voltage which appears across that junction. This only works with transistors which are specially designed for forward a.g.c. operation, and the BF196's used in this circuit are forward a.g.c. types. The system has the advantage that a high a.g.c. voltage reduces transistor gain without reducing its linearity of operation, with the result that strong signals don't cause cross-modulation."

"Humph!"

"I wish," said Smithy irritably, "you'd stop saying 'humph' every time I impart a bit of information to you. It's even more annoying than those ghastly jokes you keep

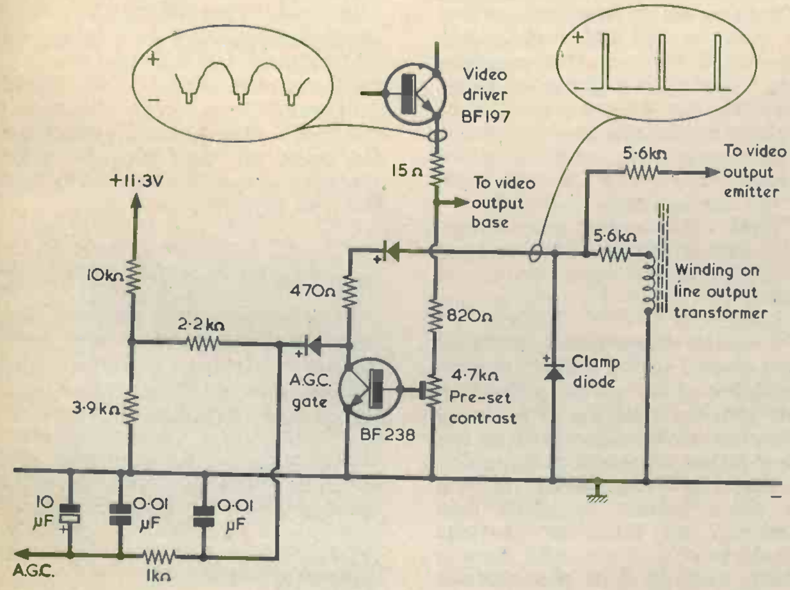


Fig. 3. The gated a.g.c. section of the circuit, illustrating the waveforms which are applied to the BF238 transistor

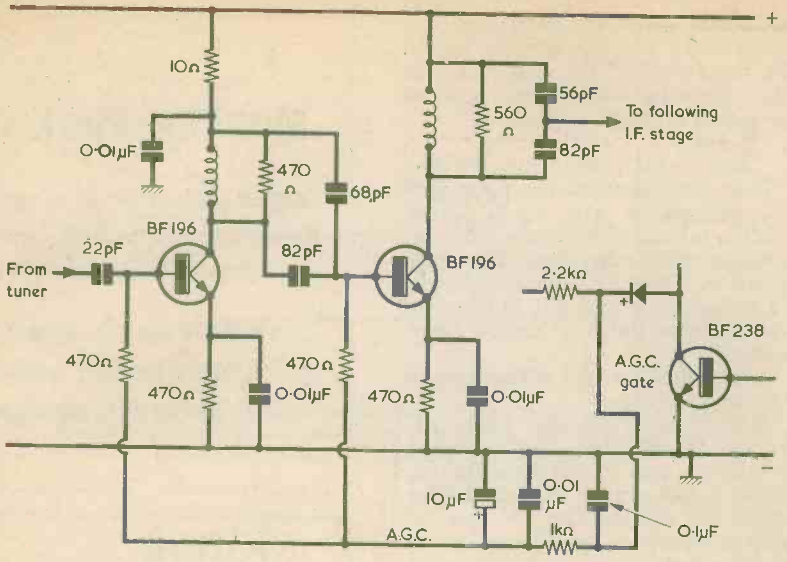


Fig. 4. The first two i.f. transistors in the television receiver are those whose gain is controlled by the a.g.c. voltage. Their gain decreases as the a.g.c. voltage goes positive

coming out with."

"I haven't heard any new jokes recently," confessed Dick. "Apart, that is, from those I've heard on B.B.C. sound radio."

"I would remind you," said Smithy hastily, "that this is a respectable establishment. You certainly aren't going to repeat any of *those* jokes here."

BLANKING PULSES

"Okeydoke," said Dick equably. "Let's get back to the circuit. There's another thing here that's puzzling me."

"What's that?"

"You inferred just now that those positive pulses from the line output transformer winding had a value of 95 volts. Isn't that rather a high voltage to apply to the collector of the BF238 a.g.c. transistor?"

"The pulses are reduced in voltage by the time they get to the collector," said Smithy. "There is a 5.6kΩ resistor in series between the winding and the clamp diode, and a further 5.6kΩ resistor from the clamp diode to the emitter of the video output transistor. On their own these resistors cause a sizeable drop in pulse amplitude. Then there is a further drop due to the collector current drawn by the BF238. As a result, the pulse voltage at the BF238 collector is at quite a low level, and is well within the collector voltage rating of the transistor."

Dick turned his attention to the video output section of the circuit. (Fig.5.)

"I hadn't thought about that 5.6kΩ resistor connecting to the video output transistor emitter," he remarked thoughtfully. "Why are the positive flyback pulses from the line output transistor applied there?"

"To give line blanking," replied Smithy. "The pulses drive the emitter positive during line flyback, whereupon the video output transistor collector goes positive as well. This causes the picture tube cathode to go positive too, so that the tube is cut off during line flyback. There are also positive-going flyback pulses from the frame timebase, and these are applied to the video output emitter by way of a 0.22μF capacitor and an 18kΩ resistor. They cause the tube to be cut off during frame flyback."

"That video output emitter circuit," said Dick musingly, "has got the 470 Ω customer operated contrast control pot in it. How does that work, Smithy?"

"It varies the amount of signal degeneration in the emitter circuit. When the slider of the 470 Ω contrast pot is at the top of its track nearly all the emitter load of the video output transistor is bypassed by the 100μF electrolytic, and so the video output transistor has maximum gain. When the pot slider is at the bottom of the track there is hardly any bypass capacitance across the emitter load at all, and the video output transistor has minimum gain. Correct contrast is given at some setting between these two extremes. Don't worry about the 3,300pF and the 560pF capacitors in the emitter circuit. They're merely there to increase the video output transistor gain at the higher video frequencies so that it has a flatter response over the video frequency range. Any more questions?"

Dick pondered for a moment.

"Nope," he said finally, "there's nothing else I can think of."

"Good," said Smithy briskly. "Well now, we can next observe the usefulness of getting out the service manual at an early stage during a repair. For a start we can tell from the service manual circuit that the video signal is getting up to the video driver stage at good strength and that it is certainly appearing at the collector of the video driver transistor."

"How do we know that?"

"Because we're hearing the sound channel. The 6MHz intercarrier sound signal must therefore be appearing at the 6MHz sound take-off transformer in the video driver collector circuit. From this it's fairly safe to assume that the emitter circuit of the video driver transistor is also all right, particularly as we're getting frame and line sync. So we'll look for a snag in the video output stage."

Smithy smiled smugly at his assistant.

"It's all," he remarked condescendingly, "a process of logical deduction. You take a look at the service manual, consider the known facts and then proceed to make your diagnosis. A few minutes' time is all that's needed and then, my boy, it's nothing more than logical deduction."

"A few minutes?" repeated Dick incredulously. "Blimey, we've been nattering away here for nearly an hour."

"Ah yes," conceded Smithy, "but that's because you let yourself be side-tracked by that pre-set contrast control circuit."

"Humph!"

"Just," said Smithy icily, "get the back off that set and start checking around. You'll soon find that I'm right."

CONTRAST CONTROL FAULT

Dick removed the receiver plug from the mains and then unscrewed the back of the set. He put it to one side and peered in.

"Ye gods," he breathed.

Surprised at his assistant's reaction, Smithy pushed him to one side and looked into the recesses of the receiver. He blanched.

"Well," he stuttered weakly, "you *are* supposed to look for obvious faults first."

"You mean," scoffed Dick, "use logicial deduction?"

"Well, yes."

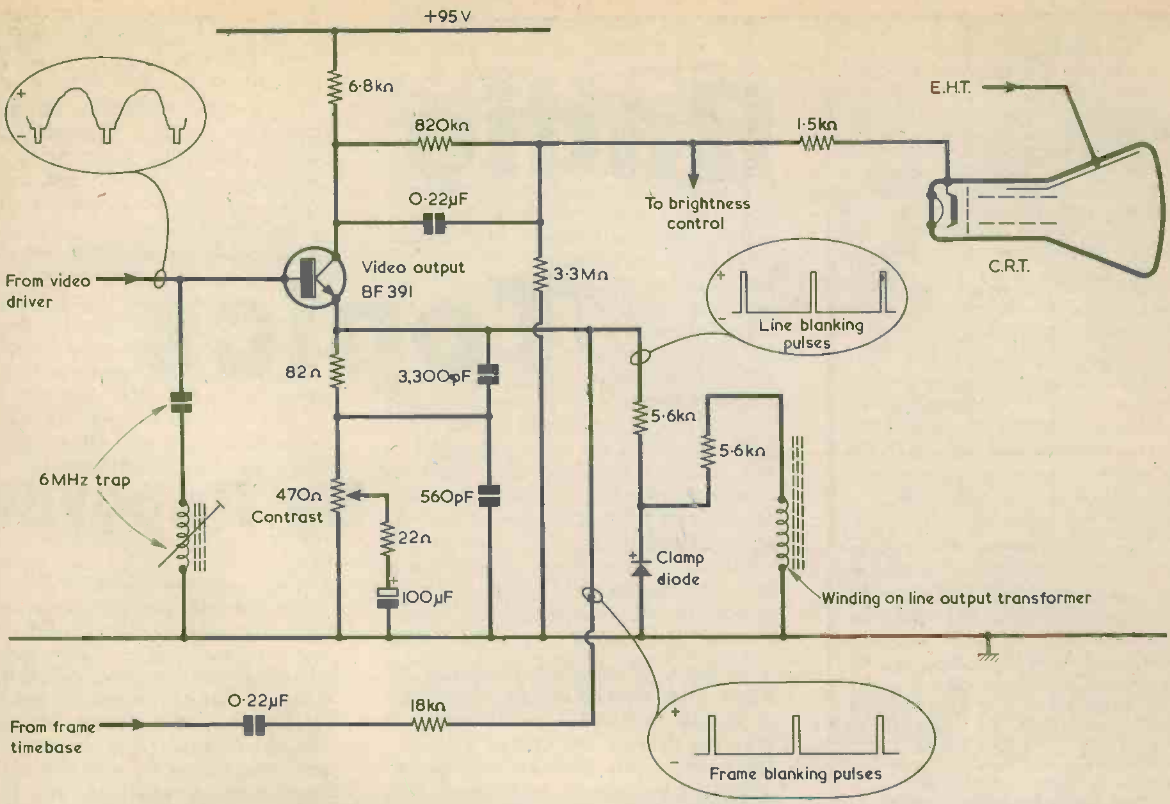


Fig. 5. Blanking pulses from the line output transformer winding and from the frame timebase are applied to the emitter of the video output transistor

"Logical deduction my Aunt Fanny!" snorted Dick. "All that's wrong with this set is that the wire has come off the slider tag of the contrast control! If I'd been working in my old way I'd have seen that the contrast control wasn't working and the very first thing I'd have done would have been to check the wiring to it without thinking any further. No service manual, no worries about pre-set contrast controls and sync pulses, no nothing. And certainly not no flaming logical deduction!" (Fig.6.)

Even this parade of double negatives did little to diminish Smithy's embarrassment. Dick picked up his soldering iron and quickly resoldered the offending wire to the tag of the contrast potentiometer. He then reconnected the receiver to the mains, switched it on and waited for the tube to warm up. It now reproduced a perfectly respectable picture and Dick was able to adjust the control so that it gave an impeccable contrast level.

"From now on," he pronounced resolutely, "I'm going to do servicing *my* way. And that means digging around quietly and following my nose until I've run the snag down to earth. In future I'll get out the service manual only when I'm good and ready for it!"

For once, Smithy had no comment to make. Shot down, verily, irretrievably, in flames, he returned crestfallen to his bench and listlessly resumed the task of completing his components order. He heard Dick return the now serviceable television receiver to the "Repaired" rack and, glancing round surreptitiously, saw him pick up a record player from the "For Repair" rack. Cheerlessly, he proceeded with his list, and the Workshop fell into a despondent stillness.

"Hey, Smithy!"

Smithy's heart leaped. He forced his voice into its usual unexpressive tone: "Hello!"

"Could you come over here for a moment, please?"

■

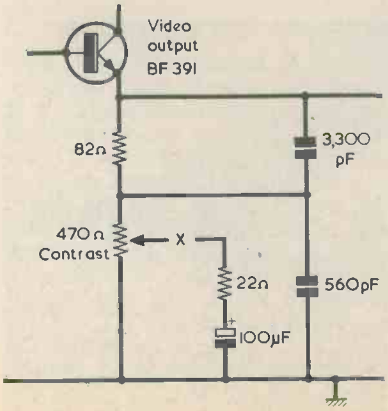


Fig. 6. If the connection to the contrast control potentiometer slider is interrupted the video output transistor operates at minimum gain for all settings of the control

EDITOR'S NOTE

The diagrams accompanying this feature are slightly simplified versions of the appropriate sections of the circuit employed in the Thorn Consumer Electronics 1691 series of monochrome television receivers. The contrast control "fault" was devised for the feature.

Radio Topics

By Recorder

It isn't, of course, necessary to know what goes on inside a machine to be able to operate it. For instance you can drive a car armed with little more than the knowledge of what the pedals do and where the petrol goes. The chap at the garage will be able to fix most of the faults the car may have but he will not be fully aware of the many facets which went into that car's production: the choice of the precise metal formulations to be used, the design of the presses which turn out the bodywork, the specifications for the paints with which the body is covered, the choice of wire enamel or other insulation in the dynamo or alternator windings, the moulds from which any plastic components are made, and so on.

All the products of our continually developing technology appear at the ends of long chains of knowledge and experience. If you consider an item made of aluminium you first go back to the designer who selected the grade and hardness of the metal, then further to the smelter at which the aluminium was produced and, eventually, work right back to the people who dig the bauxite out of the ground.

INTEGRATED CIRCUITS

So it is, increasingly, with electronic components these days, including in particular digital i.c.'s. It is relatively easy to comprehend the internal circuit of a NAND gate or a NOR gate, but when we get to the more complex i.c.'s the profusion of the devices inside the chip make it impossible to determine precisely what goes on without a prolonged study. I've just opened my Texas Instruments T.T.L. Data Book at random, to encounter the 74192 and its associated family. This is a 16 pin d.i.l. integrated circuit described as a Synchronous 4-bit Up/Down Counter (Dual Clock With Clear). Don't let the Up/Down term throw you; this merely means that if you feed positive-going pulses to the Up pin the counter counts up, and if you feed them to the Down pin the counter counts down.

The internal circuitry of the device is also shown. There aren't any individual transistors, diodes or resistors to be seen as the circuit would then assume enormous proportions; the parts are instead "condensed" into the symbol outlines for NAND gates, inverters and so on, with interconnecting lines between them. The circuit shows ten NAND gates, six AND gates, four OR gates, four OR gates with inverting inputs, four inverters and four flip-flops. Confronted with an array like that, the best plan unless you have the time to linger is simply to accept the fact that the i.c. gives the outputs it is intended to do and leave it at that. And yet the 74192 is relatively a simple logic i.c., at least several orders of complication below the circuitry to be found in a microprocessor chip.

So with electronics we are now well into the stage where a logic circuit designer does not have to bother his head overmuch with what goes on inside the i.c.'s he uses. He can simply leave that to the people one step back in the chain: those who design and develop the integrated circuits. A further step has been added in the series from raw materials to final product.

Incidentally, if you are used to digital integrated circuits which draw relatively low currents, these more complicated t.t.l. types are liable to occasion a little surprise. The current drawn by the 74192 at a supply voltage of 5 volts is 65mA typical and 102mA maximum. A powerful i.c. in terms of logic, but it requires quite a lot of power in terms of electricity.

CURRENT FLOW

Turning to much simpler matters we have received several letters recently from newcomers to the hobby who, understandably, are puzzled by the direction in which electric current is supposed to flow. Does it flow from negative to positive or does it flow from positive to negative?

There is a story here, and I hope that I won't introduce any glaring historical inaccuracies if I make this as simple as possible.

In the early days of electricity when cells and batteries were starting to appear and it became possible to detect and then measure the current which flowed from them, decisions had to be made. It was obvious that the two terminals of a cell or battery had an opposite electrical effect and so one terminal was described as the positive terminal and the other as the negative terminal. So far so good. The next question which had to be answered was: in what direction does the current from a battery flow? and that was when the whole mix-up began, because it was decided that electric current flows from positive to negative. A whole engineering science was built up on this assumption, introducing laws which determined such things as the polarity of the magnetic field around a coil through which an electric current flows. In the early 1900's thermionic diodes appeared on the scene and it became evident that electric current consisted of a movement of electrons. And, oh dear, these electrons went from negative to positive!

It was virtually impossible to revise the existing framework of electrical science which was based on the concept of electricity flowing from positive to negative, and so the idea of electricity flowing in this direction continued, and has continued right up to the present day. nearly all electrical engineering calculations are based on the convention that electricity flows from positive to negative. When it is necessary to discriminate between the conceptual flow of current from positive to negative and the true flow from negative to positive we refer to the former as "conventional current flow" and to the latter as "electron current flow". Nearly all the references to current flow in *Radio & Electronics Constructor* apply to conventional current flow; where the reference is to electron current flow this is stated explicitly.

Although it's a bit mind-bending at first, you soon get used to the anomaly. Indeed, it's a lot easier to do so when dealing with transistors where everything is hidden away in a solid-state block than it was with valves where you could *see* the space across which the electrons travelled! Don't forget that current does just the same amount of work regardless of the direction in which it is assumed to flow.

LOGIC PROBE

A new low cost circuit-powered logic probe suitable for digital applications in both d.t.l./t.t.l. and CMOS modes is being introduced into the U.K. by Continental Specialities Corporation of New Haven, Connecticut, U.S.A.

This probe, the LP-1, appears in the second photograph and is the size of a fountain pen. It combines the functions of pulse detector, pulse stretcher and memory circuit, allowing those employing it to obtain an instant picture of static and dynamic circuit conditions. The ability of the probe to detect pulses as short as 50 nanoseconds, coupled with its stretching and latching ability, means that single-shot, low repetitive rate, narrow pulses are readily detectable and visible. Such pulses can be nearly impossible to see, even with a fast oscilloscope.

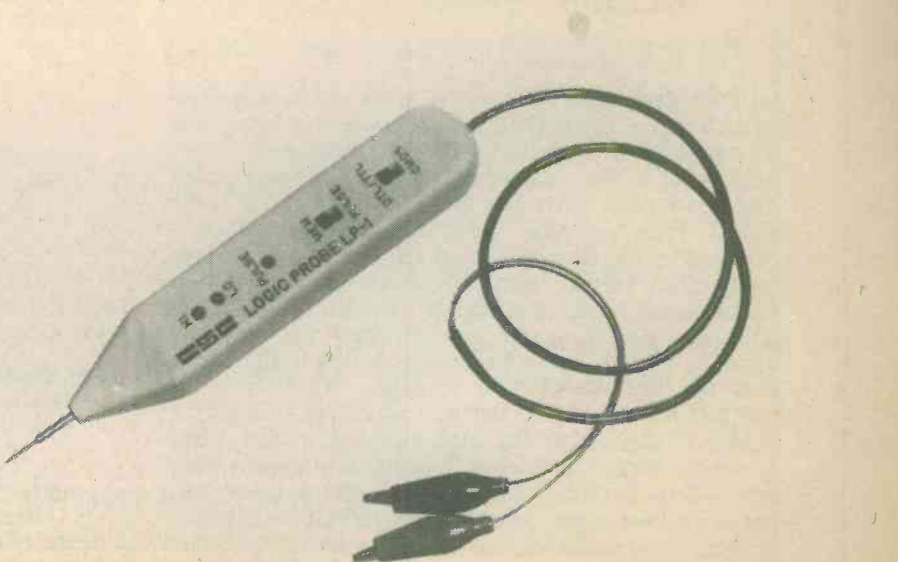
The user simply connects the clip leads to the circuit's power supply, sets the Logic Family switch to the proper position ("TTL/DTL" or "CMOS"), thereby establishing the correct logic level for the family under test, and then touches the probe tip to the circuit point. Two level detector l.e.d.'s — "HI" (logic 1) and 'LO" (logic 0) — plus a blinking pulse detector l.e.d. indicate the activity at the point being checked. By using the Pulse/Memory switch the user can select indication of pulse transitions, or storage of low-rep-rate or single-shot events.

In operation, logic 1 levels trigger the "HI" l.e.d., logic 0 levels trigger the "LO" l.e.d., and in the "PULSE" position of the Pulse/Memory switch, the "PULSE" l.e.d. blinks three times a second to indicate pulse transitions. This pulse-stretching feature allows high-rep-rate transitions to be observed. At high frequencies the LP-1 probe simultaneously indicates whether or not signals are symmetrical. Pulse trains with duty cycles less than 30% will activate the "LO" l.e.d., while duty cycles of more than 70% will activate the "HI" l.e.d.

The input impedance on both d.t.l./t.t.l. and CMOS modes of 100kΩ virtually eliminates loading problems in the circuit under test, and input impedance is constant for both high and low states in both logic families.

The LP-1 probe is housed in a rugged moulded plastic case with built-in strain-relieved power cables and protection against reverse polarity and overvoltage. Further information is available from Continental Specialities Corporation, 44 Kendall Street, Box 1942, New Haven, Connecticut 06509, U.S.A. ■

The Continental Specialities digital probe type LP-1. This provides the functions of pulse detector, pulse stretcher and memory circuit, and indicates both static and dynamic conditions at the circuit point being monitored



THE STORY OF THE DETECTOR

By D. P. Newton

Before the advent of the valve, radio equipment was awe-inspiringly primitive both in its assembly and in its operation.

The problem of detecting radio signals has been solved in many complex and ingenious ways but one device, in essence very simple, is especially surprising in that it could actually be made to work at all! It consisted of a short insulated tube with two metal plugs separated by a few millimetres. As is shown in Fig. 1, the gap was loosely filled with filings of a metal such as nickel. In this state the resistance between the two plugs was relatively high but, when a radio signal was applied to it, the resistance became suddenly small and continued to be low after the end of the radio signal. This "coherer", as it was known, was largely due to a gentleman called Branly in 1890, three years after Hertz's demonstration of radio waves. In a series circuit with a 1.5 volt cell and a galvanometer it can be used to show the presence of radio waves, the galvanometer being deflected as the waves affect the filings. However, its limitations as a detector are obvious; it needs a shake to reset it to the high resistance state after the radio wave has ceased. Mechanical means were devised to do this, and although the coherer was employed for many years in the reception of spark transmitters there was an obvious need for a detector in the more modern sense of the word.

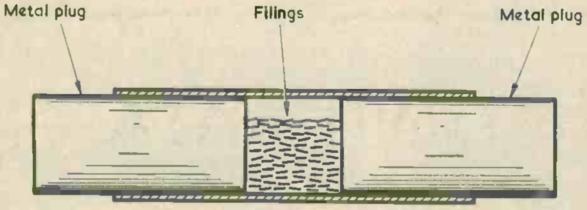


Fig. 1. The basic construction of the coherer, employed as a detector with the early spark transmitters. The metal filings "cohered" to present a low resistance when a radio signal was applied

CRYSTAL DETECTOR

A true detector needs to do a lot more than the coherer. In the early days of radio there was no amplification, and the detector had to extract the useful information from the carrier wave by rectifying the current it produced in the aerial circuit. Some crystals, either in contact with a fine wire "cat's whisker" or in contact with another crystal, have this ability. These were the most delicate, and often perverse, parts of the "crystal sets" in which they were used. Crystals of galena, silicon, zincite or bornite were employed, the cat's whisker being scraped over the surface until a sensitive part was located. Fig. 2 shows the general idea.

Of course the first device we would really call a valve was invented by Sir John Ambrose Fleming and patented in 1904. In 1883, Edison had discovered that an extra electrode in a light bulb would give a current if it was connected to the positive terminal of the filament battery but not if connected to the negative terminal. See Fig. 3. The effect was enhanced when the electrode was made more positive with respect to the filament. Fleming was quick to see the use of such a device as a detec-

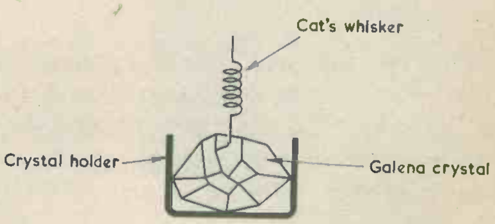


Fig. 2. The crystal detector. This functions as an inefficient and temperamental rectifier, with connections being made to the cat's whisker and the metal crystal holder

tor of radio waves. With a circuit like that of Fig. 4 he fed radio waves to his special "light bulb" and was able to obtain a direct current through a sensitive mirror galvanometer. It was then a short, but no less ingenious, step for the American Lee de Forest to later add another electrode, the grid to make the triode amplifier.

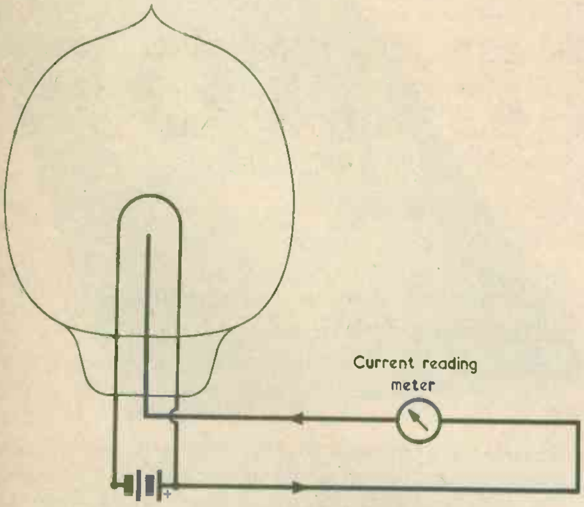


Fig. 3. The "Edison Effect". If a second electrode was placed in a filament bulb, current flowed when it was coupled to the positive terminal of the filament battery

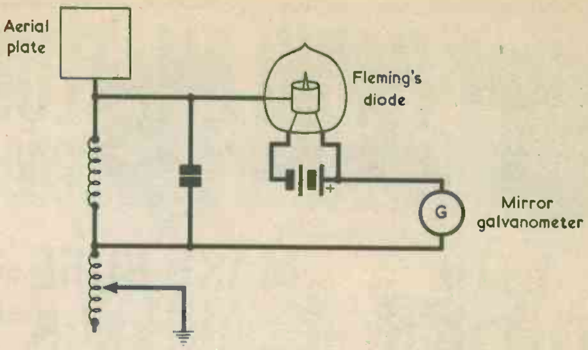
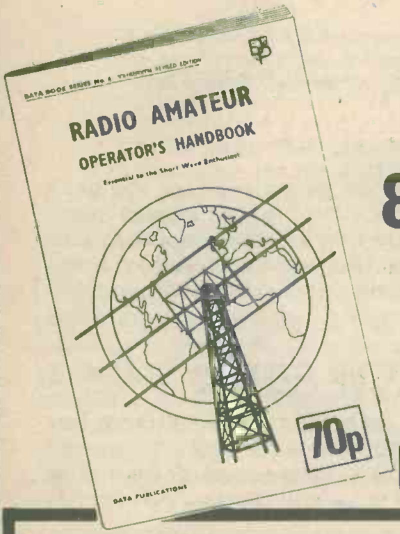


Fig. 4. Fleming developed the "Edison Effect" to produce a thermionic diode capable of rectifying, and thereby detecting, radio waves

With the advent of the reliable valve, the cat's whisker and crystal fell out of favour except as an object of scientific study. While thermionic valves became more complex, the peculiar action of these crystals was analysed and a new material developed: the semiconductor. Three years after Fleming's death, Barden and Brattain, in 1948, produced the first practical transistor. By placing two cat's whiskers near one another on a piece of germanium, a semiconductor, the amplifying action of a triode was achieved and the early crystal set, albeit in a new guise, had come of age. ■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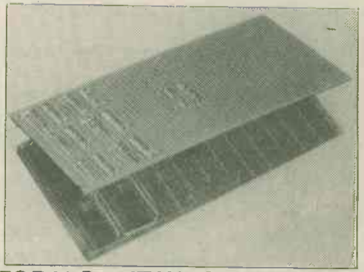

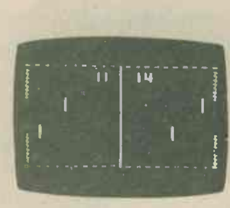

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