Easy to build projects for everyone

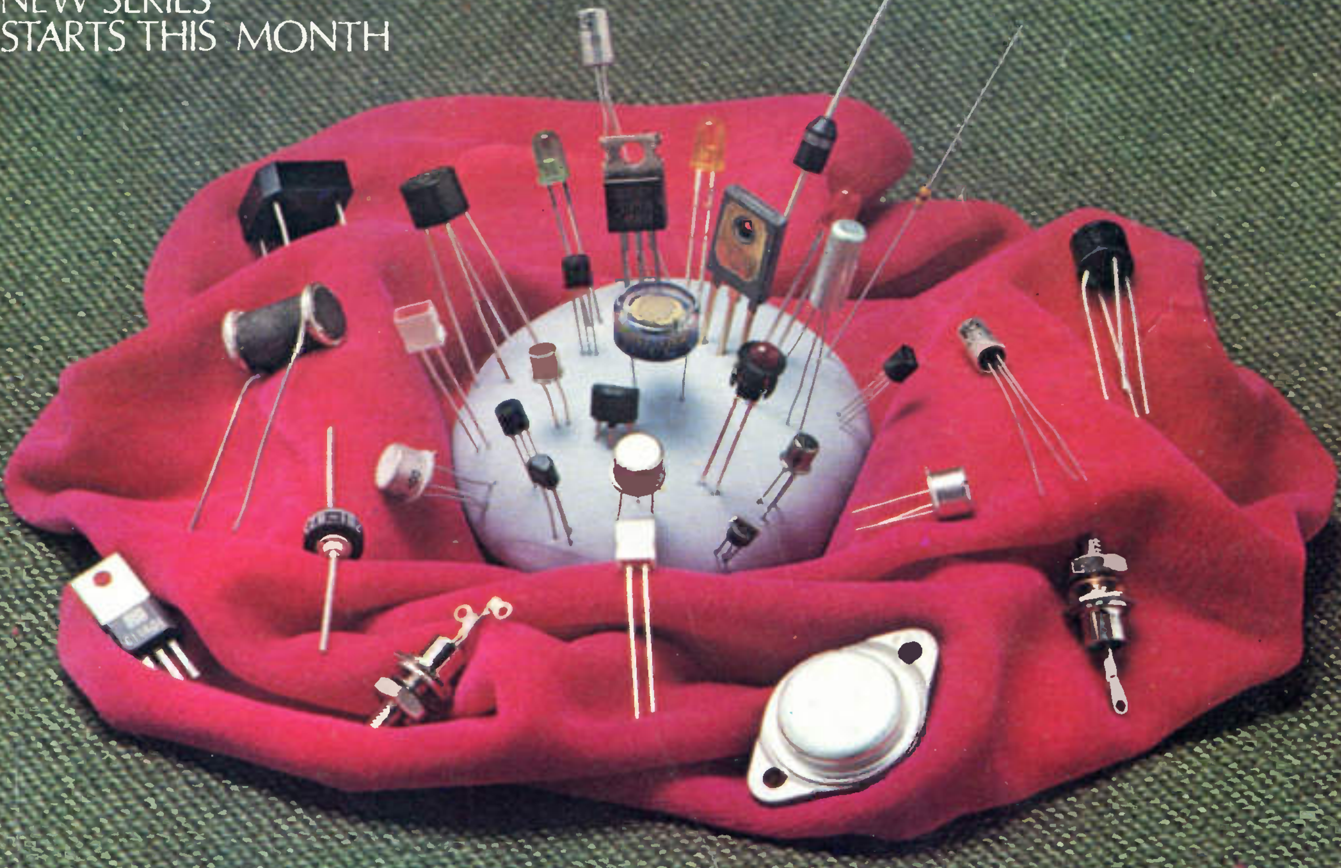
Everyday ELECTRONICS

JUNE 81

60p

DISCRETE SEMICONDUCTORS

NEW SERIES
STARTS THIS MONTH



DARKROOM TIMER

TAPE AUTO START

BURGLAR ALARM

TREMOLO UNIT

Australia $1·20 New Zealand $1·30 Malaysia $4·50

BI-PAK NEW EXTENDED 1981 RANGE

AERIALS

105	Adjustable Aerial Gutter Mount	£3·00
106	C.B. Mobile Antenna	£9·50
107	FM Indoor Ribbon Aerial	£0·50
108	4 Section Car Aerial (Stainless)	£2·16
109	4 Section Car Aerial (Chrome)	£1·83
110	8 Section 1200mm Telescopic Aerial	£2·00
111	8 Section 750mm Telescopic Aerial	£2·60
112	5 Section 570mm Telescopic Aerial	£2·64
113	Roof Mounting Aerial	£3·80

AUDIO LEADS

114	5 pin—3·5mm 3 & 5 connected	£0·65
115	5 pin—3·5mm 1 & 4 connected	£0·65
116	Car Aerial Ext Lead	£1·00
117	Mains Cassette Lead	£0·48
119	2 × 2 pin Plug to In Line Stereo Jack Socket	£0·74
120	Universal Car Adaptor Plug	£0·52
123	20ft. Coiled Guitar Lead	£1·50
125	5 pin to 5 pin DIN	£0·65
126	5 pin to DIN to open ends	£0·65
127	5 pin to DIN to 4 Phono Plugs	£1·00
128	5 pin Plug to 5 pin Socket	£0·75
129	5 pin to 5 pin Plug (Mirror Image)	£0·72
130	2 pin Plug to 2 pin Line Socket 5 metres	£0·55
132	2 pin Plug to 2 pin Line Socket 10 metres	£0·85
133	5 pin Plug to 2 Phono Plug	£0·65
136	Headphone Ext Lead 7 metres	£1·50

A.B.S. PLASTIC BOXES

141	4" × 1" × 2"	£1·08
142	4·4" × 1·22" × 2·44"	£1·24
143	4·75" × 1·56" × 2·56"	£1·30
144	6·00" × 2·00" × 3·15"	£1·50
145	7·5" × 2·38" × 4·33"	£2·64
146	2·8" × 4·37" × 1·63"	£1·40
147	3·78" × 6·33" × 2·06"	£1·92
148	5·63" × 4·14" × 2·19"	£2·14
149	5·63" × 6·7" × 2·19"	£2·62
150	6·65" × 4·98" × 2·76"	£3·84
151	9·57" × 7·36" × 4·06"	£5·82

VERO CASES

152	23/16" × 2" × 1" Black	£0·47
153	23/16" × 2" × 1" White	£0·47
154	Vero Plastic Case Box	£4·82

INSTRUMENT CASES

155	8" × 5¼" × 2"	£1·70
156	11" × 6" × 3"	£2·63
157	6" × 4½" × 1¾"	£1·64
158	9" × 5¼" × 2¼"	£2·20

ALUM BOXES

159	5¼" × 2¼" × 1½"	£0·83
160	4" × 4" × 1½"	£0·83
161	4" × 2¼" × 1½"	£0·83
162	5¼" × 4" × 1½"	£0·93
163	4" × 2¼" × 2"	£0·83
164	3" × 2" × 1"	£0·57
165	7" × 5" × 2½"	£1·30
166	8" × 6" × 3"	£1·68
167	6" × 4" × 2"	£1·12
168	Sloping Box—Large	£6·97
169	Sloping Box—Small	£4·63

CASSETTES

301	Low Cost C60	£0·36
302	Low Cost C90	£0·45
303	Low Cost C120	£0·65
304	30 Min Letter Tape	£0·38
305	Empty Library Case	£0·12

CAPS, CHOKES, TRIMMERS

327	Jackson Coupling	£0·74
328	Jackson Slow Motion Drive	£1·38
329	Jackson 300PF Dilecon	£2·64
330	Jackson 500PF Dilecon	£3·10
331	Jackson 01-365PF	£2·86
332	Jackson 02-365PF Dual	£4·34
333	Jackson 804 10PF	£2·62
334	Jackson 804 25PF	£2·88
335	Jackson 804 50PF	£2·88
336	Jackson 804 100PF	£3·42
337	Trimmer Cap 40PF	£0·20
338	Trimmer Cap 250PF	£0·25
339	Trimmer Cap 450PF	£0·30
340	Trimmer Cap 750PF	£0·34
357	Repanco CH1 2·5MH	£0·44
358	Repanco CH2 5·0MH	£0·50
359	Repanco CH3 7·5MH	£0·50
360	Repanco CH4 10·0MH	£0·56
361	Repanco CH5 1·5MH	£0·44
362	Repanco CH6 5UH	£0·38
363	Repanco DRX1 Coil	£0·60
364	Repanco DRR2 Coil	£1·00

ELECTROLYTIC CAPACITORS

430	470µF	50v	£0·30
431	1000µF	25v	£0·40
432	1000µF	63v	£1·00
433	1000µF	100v	£1·25
435	2000µF	25v	£0·70
436	2200µF	40v	£1·20
437	2200µF	100v	£2·00
438	3300µF	100v	£2·40
439	4700µF	25v	£0·90
440	4700µF	63v	£2·30

BATTERY HOLDERS

200	Battery Holder 2 × HP7 Short	£0·18
201	Battery Holder 4 × HP7 Short	£0·19
202	Battery Holder 6 × HP7 Short	£0·20
203	Battery Holder 4 × HP7 Long	£0·19
204	PP3 Battery Clips	£0·07
205	PP9 Battery Clips	£0·12
206	Battery Holder 4 × HP11 Long	£0·23
207	Battery Holder 4 × HP11 Short	£0·25
208	Battery Holder 4 × HP2 Long	£0·30

ETCHANT AND PENS

1610	Dalo Etch Resist Pen	£0·90
1611	Ferric Chloride ½lb pack	£0·95
1612	Pentel Etch Resist Pen	£0·65

ENAM. COPPER WIRE 2oz

365	40 swg	£1·00
366	38 swg	£0·88
367	36 swg	£0·90
368	34 swg	£0·82
369	32 swg	£0·80
370	30 swg	£0·80
371	28 swg	£0·76
372	26 swg	£0·74
373	24 swg	£0·66
374	22 swg	£0·62
375	20 swg	£0·60
376	18 swg	£0·60
377	16 swg	£0·52
378	14 swg	£0·52

TINNED COP. WIRE 4oz

379	24 swg	£0·94
380	22 swg	£0·88
381	20 swg	£0·86
382	18 swg	£0·90
383	16 swg	£0·78

HARDWARE IN PACKS OF 25

839	0BA 1" Bolt	£0·70
840	0BA ½" Bolt	£0·40
842	2BA 1" Bolt	£0·35
843	2BA ½" Bolt	£0·30
844	2BA ¼" Bolt	£0·32
845	4BA 1" Bolt	£0·28
846	4BA ½" Bolt	£0·20
847	4BA ¼" Bolt	£0·18
848	6BA 1" Bolt	£0·24
849	6BA ½" Bolt	£0·18
850	6BA ¼" Bolt	£0·20
851	0BA Solder Tags	£0·20
852	2BA Solder Tags	£0·16
853	4BA Solder Tags	£0·14
854	6BA Solder Tags	£0·12
855	0BA Full Nut	£0·42
856	2BA Full Nut	£0·26
857	4BA Full Nut	£0·18
858	6BA Full Nut	£0·18
859	0BA Washer	£0·12
860	2BA Washer	£0·09
861	4BA Washer	£0·09
862	6BA Washer	£0·09

FUSE HOLDERS

506	20mm Chassis Fuse Holder	£0·14
507	1¼" Chassis Fuse Holder	£0·14
508	1¼" Car in line Fuse Holder	£0·12
509	20mm Panel Fuse Holder	£0·26
510	1¼" Panel Fuse Holder	£0·32

FUSES

Quick Blow 20mm:

611	150mA	£0·06
612	250mA	£0·06
613	500mA	£0·06
614	800mA	£0·07
615	1 Amp	£0·06
616	1·5 Amp	£0·07
617	2·0 Amp	£0·06
618	2·5 Amp	£0·06
619	3·0 Amp	£0·06
620	3·15 Amp	£0·07
621	5·0 Amp	£0·06

Semi Delay: 20mm

622	100mA	£0·07
623	250mA	£0·07
624	500mA	£0·07
625	1 Amp	£0·07
626	1·6 Amp	£0·07
627	2 Amp	£0·07
628	2·5 Amp	£0·07
629	3·15 Amp	£0·07
630	5·0 Amp	£0·07

Quick Blow 1¼":

631	250mA	£0·06
632	500mA	£0·06
634	800mA	£0·06
635	1 Amp	£0·06
636	1·5 Amp	£0·06
637	2·0 Amp	£0·06
638	2·5 Amp	£0·06
639	3 Amp	£0·06
641	4 Amp	£0·06
642	5 Amp	£0·06

KNOBS

1101	Black/Silver Knob	£0·28
1102	Large Calibrated Knob	£0·30
1103	Alli PA100 Knob	£0·46
1104	Heavy Brushed Alli Knob 15mm	£0·32
1105	Heavy Brushed Alli Knob 22mm	£0·40
1106	Heavy Brushed Alli Knob 28mm	£0·52
1107	Matt Black Knob 17mm	£0·40
1108	Matt Black Knob 24mm	£0·46
1109	Matt Black Knob 28mm	£0·56
1110	All Metal Serated Edge Knob 15mm	£0·34
1111	All Metal Serated Edge Knob 24mm	£0·48
1112	All Metal Serated Edge Knob 30mm	£0·60
1113	Black Plastic Metal Skirt	£0·24
1114	Black Pointer Knob	£0·22
1115	Black/Chrome Instrument Knob 22mm	£0·32
1116	Alli Push Button Knob 11mm	£0·14
1117	Black Plastic Slider Knob	£0·12
1118	Chrome Slider Knob	£0·14
1119	Chrome/Black Slider Knob	£0·22

MICROPHONES etc.

1325	Crystal Desk Mike	£3·30
1326	Cassette Mike 2·4mm + 3·5mm Plugs	£1·46
1327	Dynamic Cassette Mike	£1·86
1328	Dual Imp Dynamic Mike	£10·50
1329	Dual Imp Condenser Mike	£13·20
1330	Plastic Mike Holder	£0·66
1331	Windshield Medium (Pair)	£1·38
1332	Windshield, Large (Pair)	£1·92
1333	Gooseneck 320mm (Chrome)	£2·60
1334	Gooseneck 515mm (Chrome)	£3·50
1335	Mike Floor Stand	£10·70
1336	Cassette Deck Mike 5K ohm	£5·30
1337	Mike Boom Arm	£8·80
1338	Crystal Mike Insert	£0·52
1339	Two-Station Intercom	£6·60
1340	Mobile or CB Mike 600 ohms	£5·98
1341	Mobile or CB Mike 250 ohms	£6·00

SEMICONDUCTOR HARDWARE

Insulating kits in packs of 5

867	TO220	£0·20
868	TO3	£0·20
869	SO55	£0·20
870	TO66	£0·20
871	TO64	£0·20
872	TO48	£0·20
873	TO3 Single Heat Sink	£0·26
874	TO3 Double Heat Sink	£1·35
875	Double Sided Heat Sink	£2·65
876	TO5/39 Heat Sink	£0·15
877	TO18 Heat Sink	£0·15
878	TO1 Heat Sink	£0·10
879	TO220 Heat Sink	£0·15
880	TO66 Transistor Cover	£0·14
881	TO3 Transistor Cover	£0·14

METERS

1304	Illuminating Kit 2" Meters	£0·80
1305	2" Meter 2 Amps	£4·60
1306	2" Meter 30 volts	£4·60
1307	2" Meter 50UA	£4·60
1308	2" Meter 100UA	£4·60
1309	2" Meter 500UA	£4·60
1310	2" Meter 1mA	£4·60
1311	2" Meter 50 volts	£4·60
1312	SWR and FS Meter	£9·50
1313	SWR and Power Meter	£11·90
1315	Test Meter 20,000 OPV	£24·75
1316	Multi Tester RE185M	£45·00
1317	Double VU Meter	£3·25
1319	100-0-100 UA Meter 45mm	£1·90
1320	Min Level Meter 23mm	£0·95
1321	VU Meter 40mm	£1·96
1322	Test Meter 1000 PV	£6·50
1323	Test Meter 20,000 OPV	£11·40
1324	Test Meter 50,000 OPV	£19·75

SWITCHES

1958	Min SPST Toggle Switch	£0·70
1959	Min SPDT Toggle Switch	£0·75
1960	Min DPDT Toggle Switch	£0·80
1961	Min DPDT Centre Off Switch	£0·95
1962	Push Button SPST	£0·90
1963	Push Button SPDT	£0·95
1964	Push Button DPDT	£0·98
1965	1P 12W Rotary Switch	£0·60
1966	2P 6W Rotary Switch	£0·60
1967	3P 4W Rotary Switch	£0·60
1968	4P 3W Rotary Switch	£0·60
1973	Min DPDT Slide Switch	£0·15
1974	Std Slide Switch	£0·16
1975	SPST Toggle Switch	£0·33
1976	DPDT Toggle Switch	£0·46
1977	Rotary On-Off Switch	£0·56
1978	Push to Make Switch	£0·15
1979	Push to Break Switch	£0·19
1986	Sub Min SPST Toggle Switch	£0·54
1987	Sub Min SPDT Toggle Switch	£0·58
1988	Sub Min DPDT Toggle Switch	£0·62
1989	Keyboard 24-way	£1·50
1990	Keyboard 40-way	£1·60
1991	Keyboard Switch	£0·20
1992	Push to Make Switch (metal body)	£0·32

TOOLS, CROC CLIPS ETC

2001	Insulated Croc Clips (Red)	£0·06
2002	Insulated Croc Clips (Black)	£0·06
2003	1½ Insulated Croc Clips (Red)	£0·07
2004	1% Insulated Croc Clips (Black)	£0·07
2005	30 Amp Croc Clips 100mm	£0·74 per pair
2006	Test Leads	£0·55
2007	Test Lead Kit	£1·70
2008	4mm Test Lead Set	£1·36
2009	4mm Test Prods Set	£0·52
2010	Pincer Action Prod Set	£1·40
2011	Cutters	£5·50
2012	Pliers	£5·20
2013	Croc Clip Test Set	£1·00
2014	Resistance Sub Box	£4·30
2015	IC Extraction Tool	£0·64
2016	Neon Mains Tester/Screwdr.	£0·52

SOLDERING EQUIPMENT

1925	12 volt Soldering Iron MLX	£5·46
1927	Multicore solder 22swg tube	£1·00
1928	Multicore solder 22swg reel	£3·50
1929	Multicore solder 18swg reel	£3·50
1930	Desolder braid	£0·75
1931	X25 Soldering Iron	£4·20
1932	X25 1/8" Replacement Bit	£0·50
1933	X25 3/16" Replacement Bit	£0·50
1934	X25 3/32" Replacement Bit	£0·50
1935	X25 Replacement Element	£1·80
1936	Desolder Pump	£5·56
1937	Desolder Pump Nozzles	£0·64
1938	SK1 Soldering Kit	£7·00
1939	ST3 Iron Stand	£1·60
1940	Horizontal IC Desoldering Bit	£1·95
1941	Vertical IC Desoldering Bit	£1·95
1942	Antex Heat Shunt	£0·15
1943	CCN240 Soldering Iron	£4·20
1944	CCN240 3/32" Replacement Bit	£0·50
1945	CCN240 2/8" Replacement Bit	£0·50
1946	CCN240 3/16" Replacement Bit	£0·50
1947	CCN240 Replacement Element	£1·90
1948	C240 Soldering Iron	£4·20
1949	C240 3/32" Replacement Bit	£0·50
1950	C240 1/8" Replacement Bit	£0·50
1951	C240 3/16" Replacement Bit	£0·50
1952	C240 Replacement Element	£1·70
1953	G Soldering Iron	£4·20
1954	Model G 3/32" Replacement Bit	£0·50
1955	Model G 1/8" Replacement Bit	£0·50
1956	Model G 3/16" Replacement Bit	£0·50
1957	Model G Replacement Element	£1·90

MAINS PLUGS AND SOCKETS

1916	13 Amp Rubber Plug	£0·52
1619	13 Amp Plastic Plug	£0·46
1620	13 Amp Free Socket	£0·50
1621	13 Amp 2-way Free Socket	£1·50
1622	13 Amp 4-way Free Socket	£4·20

POTS

1831	1K	Lin. Single Pots.	29p
1832	2K2	Lin. Single Pots.	29p
1833	4K7	Lin. Single Pots.	29p
1834	10K	Lin. Single Pots.	29p
1835	22K	Lin. Single Pots.	29p
1836	47K	Lin. Single Pots.	29p
1837	100K	Lin. Single Pots.	29p
1838	220K	Lin. Single Pots.	29p
1839	470K	Lin. Single Pots.	29p
1840	1M	Lin. Single Pots.	29p
1841	2M2	Lin. Single Pots.	29p
1842	4K7	Log. Single Pots.	29p
1843	10K	Log. Single Pots.	29p
1844	22K	Log. Single Pots.	29p
1845	47K	Log. Single Pots.	29p
1846	100K	Log. Single Pots.	29p
1847	220K	Log. Single Pots.	29p
1848	470K	Log. Single Pots.	29p
1849	1M	Log. Single Pots.	29p
1850	2M2	Log. Single Pots.	29p
1851	4K7	Lin. Dual Pots.	88p
1852	10K	Lin. Dual Pots.	88p
1853	22K	Lin. Dual Pots.	88p
1854	47K	Lin. Dual Pots.	88p
1855	100K	Lin. Dual Pots.	88p
1856	220K	Lin. Dual Pots.	88p
1857	470K	Lin. Dual Pots.	88p
1858	1M	Lin. Dual Pots.	88p
1859	2M2	Lin. Dual Pots.	88p
1860	4K7	Log. Dual Pots.	88p
1861	10K	Log. Dual Pots.	88p
1862	22K	Log. Dual Pots.	88p
1863	47K	Log. Dual Pots.	88p
1864	100K	Log. Dual Pots.	88p
1865	220K	Log. Dual Pots.	83p
1866	470K	Log. Dual Pots.	88p
1867	1M	Log. Dual Pots.	88p
1868	2M2	Log. Dual Pots.	88p
1870	4K7	Lin. Switched Pots.	68p
1871	10K	Lin. Switched Pots.	68p
1872	22K	Lin. Switched Pots.	68p
1873	47K	Lin. Switched Pots.	68p
1874	100K	Lin. Switched Pots.	68p
1875	220K	Lin. Switched Pots.	68p
1876	470K	Lin. Switched Pots.	68p
1877	1M	Lin. Switched Pots.	68p
1878	2M2	Lin. Switched Pots.	68p
1879	4K7	Log. Switched Pots.	68p
1880	10K	Log. Switched Pots.	68p
1881	22K	Log. Switched Pots.	68p
1882	47K	Log. Switched Pots.	68p
1883	100K	Log. Switched Pots.	68p
1884	220K	Log. Switched Pots.	68p
1885	470K	Log. Switched Pots.	68p
1886	1M	Log. Switched Pots.	68p
1887	2M2	Log. Switched Pots.	68p
1888	100K	Log.-Anti Log. Dual Pot.	88p
1889	5K	Log. Pot. 16mm Switched	36p
1890	5K	Log. Pot. 17mm Switched	48p
1891	10 ohm	Wire Wound Pots.	85p
1892	22 ohm	Wire Wound Pots.	85p
1893	47 ohm	Wire Wound Pots.	85p
1894	100 ohm	Wire Wound Pots.	85p
1895	220 ohm	Wire Wound Pots.	85p
1896	470 ohm	Wire Wound Pots.	85p
1897	1K ohm	Wire Wound Pots.	85p
1898	2K ohm	Wire Wound Pots.	85p
1899	4K7 ohm	Wire Wound Pots.	85p

CABLE (per metre)

390	Light Mic Cable	£0·10
391	Twin Mic Cable	£0·15
392	Fig. 8 Stereo Cable	£0·12
393	4 Way SCR Cable	£0·35
394	4 Way Ind. Screened Cable	£0·18
395	Heavy Mic Cable	£0·25
396	3 Amp 3 Core Mains Cable	£0·16
397	Twin Oval Mains	£0·10
398	Fig. 8 Speaker Cable	£0·07
399	Low Loss Coax 75 ohms	£0·20
400	Uniradio 76-50 ohms Coax	£0·30

MIN PRESETS 9p EACH

1801	100 ohm	Horizontal
1802	220 ohm	"
1803	470 ohm	"
1804	1K	"
1805	2K2	"
1806	4K7	"
1807	10K	"
1808	22K	"
1809	47K	"
1810	100K	"
1811	220K	"
1812	470K	"
1813	1M	"
1814	2M2	"
1815	4M7	"
1816	100 ohm	Vertical
1817	220 ohm	"
1818	470 ohm	"
1819	1K	"
1820	2K2	"
1821	4K7	"
1822	10K	"
1823	22K	"
1824	47K	"
1825	100K	"
1826	220K	"
1827	470K	"
1828	1M	"
1829	2M2	"
1830	4M7	"

TRANSFORMERS

2021	6-0-6v 100mA	£0·90
2022	9-0-9v 74mA	£0·90
2023	12-0-12v 100mA	£1·15
2024	0-6v 0-6v 280mA	£1·60
2025	0-12v 0-12v 150mA	£1·60
2026	6-0-6v 1 Amp	£2·40
2027	9-0-9v 1 Amp	£2·00
2028	12-0-12v 1 Amp	£2·50
2029	15-0-15v 1 Amp	£2·75
2030		
2031	Multi tap ½ Amp	£3·40
2032	Multi tap 1 Amp	£4·80
2033	Multi tap 2 Amp	£6·40
2034	0-35v 1·7 Amp	£4·90
2035	0-55v 2 Amp	£6·65
2036	0-17v 750mA	£2·85
2037	Min audio output	£0·25
2038	Min audio driver	£0·36
2040	0-45-55v 1·5 Amps	£6·45
2041	0-55-65v 2 Amps	£8·46
2042	0-25v 2 Amps	£4·50
2043	15-0-15 150mA	£2·40

2017
PICK UP FOR ACOUSTIC GUITAR
£5·50

2018
TELEPHONE PICK-UP COIL
£0·66

170
QUICK TEST BLOCK "KEYNECTOR"
£6·50

1617
TO3 TRANSISTOR SOCKET

MAINS FUSES 13A PLUG TYPE

643	1A	£0·12 each
644	2A	
645	3A	
646	5A	
647	13A	

BI-PAK

Send your orders to Dept. EE6 BI-PAK PO BOX 6 WARE HERTS
SHOP AT 3 BALDOCK ST., WARE, HERTS.
TERMS CASH WITH ORDER. SAME DAY DESPATCH. ACCESS, BARCLAYCARD ALSO ACCEPTED. TEL: (0920) 3182. GIRO 388 7006.
ADD 15% VAT AND 50p PER ORDER POSTAGE AND PACKING.

Get a great deal from Marshall's

CRIMSON ELEKTRIK HI FI MODULES

CE 608	Power Amp	£20·09
CE 1004	,, ,,	£23·43
CE 1008	,, ,,	£26·30
CE 1704	,, ,,	£33·48
CE 1708	,, ,,	£33·48
CPS 1	Power Unit	£19·52
CPS 3	,, ,,	£23·52
CPS 6	,, ,,	£30·00
CPR 1	Pre Amp	£32·17
CPR 1S	,, ,,	£42·52

SINCLAIR INSTRUMENTS

Digital Multimeter

PDM35	£34·50
,, ,, DM235	£52·50
,, ,, DM350	£72·50
,, ,, DM450	£99·00

Digital Frequency Meter PFM200 £49·80

Low Power Oscilloscope SC110 £139·00

TF200 Frequency Meter £145·00

TGF 105 Pulse Generator £85·00

NEW

LCD Multimeter TM351 £99·00

LCD Multimeter TM352 £49·95

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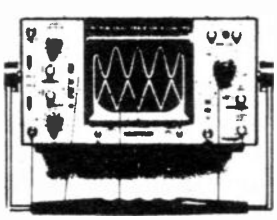

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Subminiature toggle.
SPST 55p SPDT 60p DPDT 75p
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1P12W, 2P6W, 3P4W or 4P3W 55p each.
Push to make 15p Push to break 22p

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Jack	Plug	skt.
2·5mm	10p	10p
3·5mm	10p	9p
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An extremely versatile sound processing unit capable of producing, for example, flanging, vibrato, reverb, fuzz and tremolo as well as other fascinating sounds. May be used with most electronic instruments. Some SW's not incl. in kit—see list for selection.
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Sophisticated versatile fuzz unit incl. variable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering.
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A 3 watt mains powered amplifier suitable for instrument practise or as a test gear monitor. Drives 8 or 15 ohm speakers (not incl. in kit).
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Maintains the natural attack whilst extending note duration.
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An automatically controlled 6 stage phasing unit with internal oscillator. Depth can be increased with extension.
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PHASING & VIBRATO
Includes manual and automatic control over the rate of phasing & vibrato. Capable of superb full sounds. A separate power supply is included.
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As the name implies! Order code SET 91 £11·68

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The output of the internal generator is phase-split and modulated by an input signal. Output amplitudes, depth & rate are panel controlled. The effect is similar to a rotary cabinet.
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SWITCHED TONE TREBLE BOOST
Provides switched selection of 4 preset tonal responses.
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A variable siren generator that can produce British & American police sirens, Star-Trek red alert, heart beat monitor sounds, etc.
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FUNNY TALKER
Incorporates a ring modulator, chopper & frequency modulator to produce fascinating sounds when used with speech & music.
Kit order code SET 99 £15·43

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As the name says! Order code SET 28 £8·94

DISCOSTROBE
A 4-channel 200-watt light controller giving a choice of sequential, random or full strobe mode of operation.
Kit order code SET 57 £36·52

LIST
Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBS, kits and other components. Overseas enquiries for list—Europe send 50p, other countries send £1·00.

BARCLAYCARD VISA AMERICAN EXPRESS

TERMS: C.W.O., Mail Order or Collection by appointment. Tel. 01-302-8184 (Mon-Fri).

KIMBER-ALLEN KEYBOARDS
Claimed by the manufacturers to be the finest moulded plastic keyboards available. All octaves are C-C, the keys are plastic, slope fronted, spring loaded, fitted with actuators and mounted on a robust aluminium frame.
3-Octave £25·50, 4-Oct £32·25, 5-Oct £38·50, Gold-clad contacts (1 needed for each note) type GJ (SPCO) 33p each. Type GB (2-PR n/o) 38p each.

CHOROSYNTH
A standard keyboard version of the published Elektor 30-note chorus synthesiser with an amazing variety of sounds ranging from violin to cello and flute to clarinet amongst many others.
Kit plus keyboard & contacts SET 100 £114·12

FORMANT SYNTHESISER
For the more advanced constructor who puts performance first, this is a very sophisticated 3-octave synthesiser with a wealth of facilities, including 6 oscillators, 3 waveform converters, voltage controlled filter, 2 envelope shapers and voltage controlled amplifier. Case and hardware not included—see our lists for further details.
Kit plus keyboard & contacts SET 66 £323·35

P.E. MINISONIC SYNTHESISER
A very versatile 3-octave portable mains operated synthesiser, with 2 oscillators, voltage controlled filter, 2 envelope shapers, ring modulator, noise generator, mixer, power supply and sub-min toggle switches to select the functions. A case is excluded, but the text gives comprehensive constructional details.
Kit plus keyboard & contacts SET 38 £188·68

PRICES INCLUDE VAT @ 15% & U.K. P. & P.

NEW KIT MAKE-UP —SEE BELOW

128—NOTE SEQUENCER
Enables a voltage controlled synthesiser, such as the P.E. Minisonic, to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are initiated from the 4-octave keyboard and note length and rhythmic patter are externally variable.
Kit plus keyboard & contacts SET 76 £114·89

16—NOTE SEQUENCER
Sequences of up to 16 notes long may be pre-programmed by the panel controls and fed into most voltage controlled synthesisers. The notes and rhythms may be changed whilst playing, making it more versatile than the name would suggest.
Kit order code SET 86 £60·13

DIGITAL REVERB UNIT
A very advanced unit using sophisticated I.C. techniques instead of noise-prone mechanical spring lines. The basic delay range of 24 to 90MS can be extended up to 450MS using the extension unit. Further delays can be obtained using more extensions.
Main kit order code SET 78 £67·22
Extension kit EXT 78 £45·94

RING MODULATOR
Compatible with the Formant and most other synthe sisers.
Kit order code SET 87 £11·69

WAVEFORM CONVERTER
Converts saw-tooth waveform into sinewave, mark-space sawtooth, regular triangle, or squarewave with variable mark-space. Ideally one should be used with each synthesiser oscillator.
Kit order code SET 67 £20·13

BASIC COMPONENT SETS
Include specially designed drilled & tinned fibreglass printed circuit boards, all necessary resistors, capacitors, semiconductors, potentiometers, and transformers. They also include basic hardware such as knobs, sockets, switches, a nominal amount of wire and solder, a photocopy of the original published text, and unless otherwise stated, a robust aluminium box. Most parts may be bought separately. For fuller kit and component details see our current lists.

Kits originate from projects published in PE, EE, and Elektor.

RHYTHM GENERATORS
Two different kits—The control units are designed around the M252 and M253 rhythm-gen chips which produce pre-programmed switch-selectable rhythms driving 10 effects instrument generators feeding into a mixer.
12-Rhythm unit SET 103-253 £64·10
15-Rhythm unit SET 103-252 £57·26

6—CHANNEL MIXER
A high specification stereo mixer with variable input impedances. Specs given in our lists. The kit excludes some SW's—see lists for selection. The extension gives two extra channels.
Main kit code SET 90 £88·99
Extension kit EXT 90 £11·74

3—CHANNEL STEREO MIXER
Full level control on left and right or each channel, and with master output control and headphone monitor.
Kit order code SET 107 £18·68

3—MICROPHONE STEREO MIXER
Enables stereo live recordings to be made without the 'hole in the middle' effect. Independent control of each microphone.
Kit order code SET 108 £12·31

HEADPHONE AMPLIFIER
For use with magnetic, ceramic or crystal pick-ups tapedeck, or tuner, and for most headphones. Designed with RIAA equalisation.
Kit order code SET 104 £18·18

VOICE OPERATED FADER
For automatically reducing music volume during disco talk-over.
Kit order code SET 30 £7·80

DYNAMIC NOISE LIMITER
Very effective stereo circuit for reducing noise found in most tape recordings.
Kit order code SET 97 £12·87

DYNAMIC RANGE LIMITER
Automatically controls sound output levels.
Kit order code SET 62 £8·51

TUNING FORK
Produces 84 switch-selectable frequency-accurate tones with led monitor displaying beat-note adjustments.
Kit order code SET 46 £34·56

TUNING INDICATOR
A simple octave frequency comparitor for use with synthesisers where the full versatility of KIT46 is not needed.
Kit order code SET 69 £14·41

PULSE GENERATOR
Produces controllable pulse widths from 100NS to 2Sec. Variable frequency range of 0·1Hz to 100KHz.
Kit order code SET 115 £21·45

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Allows audio signals to be injected into circuits under test, and for tracing their continuity. Includes frequency & level controls.
Kit order code SET 109 £15·31

WAVEFORM GENERATOR
Provides sine, square and triangular wave outputs variable between 1Hz & 100KHz up to 10V P-P.
Kit order code SET 112 £21·58

SPEECH PROCESSOR
Improves the inteligibility of noisy or fluctuating speech signals, and ideal for inserting into P.A. or C.B. radio systems.
Kit order code SET 110 £8·21

FREQUENCY COUNTER
A 4-digit counter for 1Hz to 99KHz with 1Hz sampling rate.
Kit order code SET 79 £43·30

EXPOSURE TIMER
Controls up to 750 watts in 0·5sec steps up to 10 minutes, with built-in audio alarm.
Kit order code SET 93 £36·44

EXPORT ORDERS ARE WELCOME
Postage rates are shown in our lists. All payments must be cash-with-order, in sterling by international money order or through an english bank. We do not offer a C.O.D. service. To obtain list—Europe send 50p, other countries send £1·00.

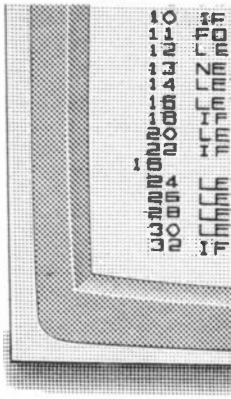
MORE KITS AND COMPONENTS ARE ON OUR LISTS

Prices are correct at time of press. E. & O.E. subject to availability.

PHONOSONICS • DEPT EE16 • 22 HIGH STREET • SIDCUP • KENT DA14 6EH

New! Sinclair ZX81 Personal Computer.

Kit: £49.95 complete



Built: £69.95 complete

Reach advanced computer comprehension in a few absorbing hours

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. At £99.95, the ZX80 offered a specification unchallenged at the price.

Over 50,000 were sold, and the ZX80 won virtually universal praise from computer professionals.

Now the Sinclair lead is increased: for just £69.95, the new Sinclair ZX81 offers even more advanced computer facilities at an even lower price. And the ZX81 kit means an even bigger saving. At £49.95 it costs almost 40% less than the ZX80 kit!

Lower price: higher capability
With the ZX81, it's just as simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, or to select a program off a cassette through the keyboard.

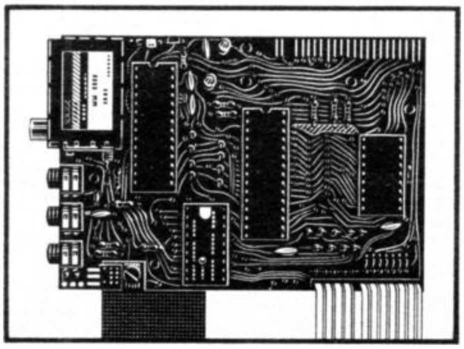
Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

Kit or built – it's up to you!

The picture shows dramatically how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

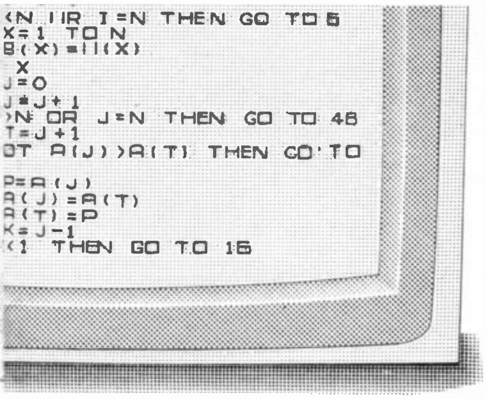
Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.



Proven micro-processor, new 8K BASIC ROM, RAM – and unique new master chip.

New Sinclair teach-yourself BASIC manual

Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs. You need no prior knowledge – children from 12 upwards soon become familiar with computer operation.



If you own a Sinclair ZX80...

The new 8K BASIC ROM used in the Sinclair ZX81 is available to ZX80 owners as a drop-in replacement chip. (Complete with new keyboard template and operating manual.)

With the exception of animated graphics, all the advanced features of the ZX81 are now available on your ZX80 – including the ability to drive the Sinclair ZX Printer.

16K-BYTE RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

New, improved specification

- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
- Graph-drawing and animated-display facilities.
- Multi-dimensional string and numerical arrays.
- Up to 26 FOR/NEXT loops.
- Randomise function – useful for games as well as serious applications.
- Cassette LOAD and SAVE with named programs.
- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
- Able to drive the new Sinclair printer (not available yet – but coming soon!)
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

Coming soon – the ZX Printer.

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics across 32 columns, *and* highly sophisticated graphics. Special features include COPY, which prints out exactly what is on the whole TV screen without the need for further instructions. The ZX Printer will be available in Summer 1981, at around £50 – watch this space!

How to order your ZX81

BY PHONE – Access or Barclaycard holders can call 01-200 0200 for personal attention 24 hours a day, every day.

BY FREEPOST – use the no-stamp-needed coupon below. You can pay by cheque, postal order, Access or Barclaycard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research Ltd, FREEPOST 7, Cambridge, CB2 1YY. **Order**

Qty	Item	Code	Item price £	Total £
	Sinclair ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.	12	49.95	
	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack(s).	18	49.95	
	8K BASIC ROM to fit ZX80.	17	19.95	
	Post and Packing.			2.95

Please tick if you require a VAT receipt ☐ TOTAL £ ______

*I enclose a cheque/postal order payable to Sinclair Research Ltd, for £ ______

*Please charge to my Access/Barclaycard account no. ______

*Please delete/complete as applicable. Please print.

Name: Mr/Mrs/Miss ______

Address ______

FREEPOST – no stamp needed. EVE06

sinclair ZX81

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Projects... Theory...

and Popular Features...

HOME AND SAFE

One of the most sensible and valuable tasks the constructor can apply himself to (if he has not already done so) is the making of a burglar alarm system. The need for such a form of protection for our homes is all too clear.

In presenting this *Burglar Alarm System* we believe the whole range of possibilities has been examined and a system devised that should give maximum security with minimum likelihood of false alarms. The electronics are but part of the story of course and the handyman will have plenty of scope to exercise his capabilities in the installation of sensors and wiring.

TWO NEW SERIES

The more you know about the subject the more fun and reward you can extract from it. And this certainly applies to the commonplace "discretes". Our four-part series, *Discrete Semiconductors Explained* takes a thorough look into these devices, ranging from diodes to triacs. It will provide useful data for all constructors regardless of level of experience.

We welcome the newcomers to electronics who are constantly joining the ranks of EVERYDAY ELECTRONICS regular readers. To give them a helping hand we introduce a strictly down to earth treatment of the subject in the short series *Back To Basics*.

MICROS IN SCHOOLS

The government is funding a scheme to put a microcomputer into every secondary school by the end of 1982. The extra £4 million of public expenditure incurred is a welcome and necessary investment for the future.

The decision to restrict the choice to British made microcomputers is understandable. Whether the Department of Industry was wise in limiting its choice to just two computers is more debatable, particularly since they have not included the cheapest of all British microcomputers, the Sinclair ZX81.

Some schools will not be able to afford the £130 or £425 to meet the half-cost of the selected models, from Acorn and Research Machines respectively. The ZX81 costs half the price of the cheaper of these two, and even less in kit form.

The Department of Industry could have been more imaginative. A microcomputer in kit form would offer certain advantages, over and above mere cost, even if not fully meeting the official specification. Though not essential in order to punch a computer keyboard the practical work in assembling a micro would be a worthwhile experience for any young person.

Fred Bennett

Our July issue will be published on Friday, June 19. *See page 395 for details.*

Readers' Enquiries

We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.

We cannot undertake to engage in discussions on the telephone.

Component Supplies

Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

Everyday
ELECTRONICS

VOL. 10 NO. 6 JUNE 1981

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

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Certain back issues* of EVERYDAY ELECTRONICS are available worldwide price 80p inclusive of postage and packing per copy. Enquiries with remittance should be sent to Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF. In the event of non-availability remittances will be returned.
* *Not available*: October 1978 to May 1979.

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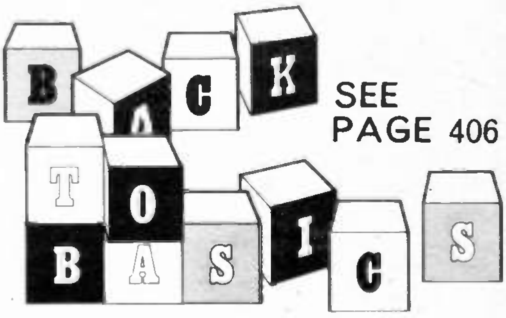


SEE PAGE 406

AT HOME OR AWAY YOU HAVE TRIPLE PROTECTION WHEN YOU BUILD THIS

BURGLAR ALARM SYSTEM

BY H.G. FIELD

STATISTICS show that burglary and housebreaking are increasing at an alarming rate, so it is the wise householder who takes precautions and protects his home and its contents.

The obvious first step is to fit locks and bolts to all possible points of entry, such as doors and windows. These will, if in the locked position, make it difficult for the would-be intruder to gain access to the premises. In many instances their attempts, whether successful or not, are unnoticed by the occupants or their neighbours. What is required therefore is a means of drawing attention to the fact that someone may be making a forced entry, and certainly if they have succeeded.

The Burglar Alarm System featured here provides many of these requirements when all possible means of access are made part of one of the three security loops incorporated in the design.

PRINCIPLE OF OPERATION

The system requires the fitting of a switch of some sort (see later) to doors and windows to be guarded. The switch can be either an open or a closed type that changes its state (from closed to open or vice versa) when the door or window is opened. A switch change for only a brief instant is enough to cause the alarm to latch on.

The closed loop is ideal for doors and windows, whereas the parallel loop is suitable for pressure mat type switches. These are normally open switches which close when pressure is applied, such as results when a person stands on the "mat". These are convenient if one does not wish to become involved in embedding switches in the woodwork.

AUDIO LOOP

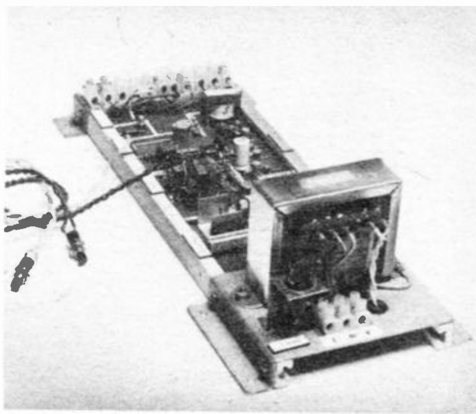
These features are common to other loop alarm systems published and available commercially, but the third loop we believe is original. This is an "audio loop". Here, microphones are used as sensors, and these are glued to window panes. These will sense any disturbance of the pane/frame that would be produced by a person attempting to break-in by breaking the glass or forcing the frame. The disturbance will cause the alarm to latch on. Microphone amplifier sensitivity can be adjusted to suit the environment by means of a single control on board the main unit.

When the alarm is triggered it remains on until reset by a switch on the front panel. An internal local alarm in the form of a solid-state bleeper is included as well as an outlet for a power bell. The latter can be sited in the eaves of the building. d.c. power supplies for the circuitry and alarms are derived from the a.c. mains.

Short term exit and entry alarm-inhibit switches are included to enable the user to leave or enter the premises through a "protected" door without triggering the alarm but leaving it in a ready condition after a delay of about 23 seconds. This should be ample time for anyone entering or leaving the premises.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Burglar Alarm System is shown in Fig. 1. It consists of three distinct sections: (1) microphone amplifier channel, (2) alarm control/latch, (3)



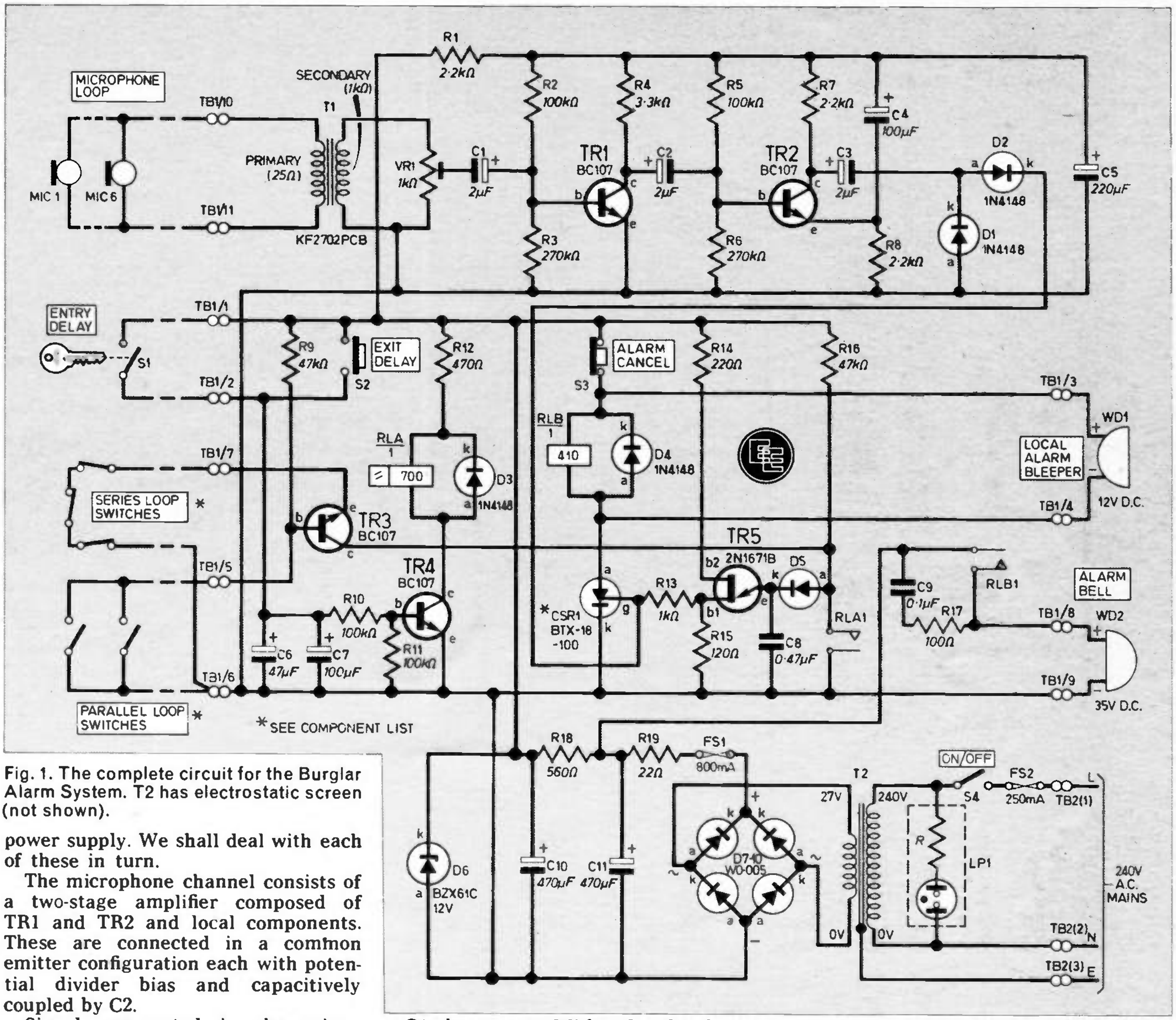


Fig. 1. The complete circuit for the Burglar Alarm System. T2 has electrostatic screen (not shown).

power supply. We shall deal with each of these in turn.

The microphone channel consists of a two-stage amplifier composed of TR1 and TR2 and local components. These are connected in a common emitter configuration each with potential divider bias and capacitively coupled by C2.

Signals generated in the microphones are inductively coupled through T1 to the amplifier. VR1 across T1 secondary acts as a gain control, the output being from the wiper which is coupled to the first stage via d.c. blocking capacitor C1. The amplified a.c. signal appears at TR2 collector where it is capacitively coupled (C3) to D1 and D2.

The arrangement of these diodes is two-fold, to rectify the signal from TR2 collector and to reference it to 0V. Thus for no microphone signal the output is 0V. A disturbance in the vicinity of the microphone will cause the output at D2 cathode to rise; this reaches the trigger input, the gate of CSR1 to trigger the alarm.

R8 and C4 ensure that the alarm is not triggered when the a.c. mains is first switched on. Before switch on, C4 will be discharged so TR2 emitter potential will at switch on be close to the positive supply rail—and so be off, dropping towards the 0V rail as C4 charges up. With value for C4 and R8 as shown, TR2 turns on approximately 1 to 2 seconds after a.c. mains is switched on. R1 and C5 decouple the amplifier positive supply from the +12V rail.

The alarm control which includes exit and entry delay is seen in the middle tier of Fig. 1.

The device which is responsible for turning on the bleeper and alarm bell is thyristor CSR1. The path between anode and cathode in CSR1 is effectively open circuit until it receives a positive voltage at its gate terminal, whereupon anode to cathode becomes a short circuit. This acts therefore like a switch causing power to be applied to WD1 and RLB. The latter through its contacts supplies a d.c. voltage to the bell connected at TB1/8 and TB1/9.

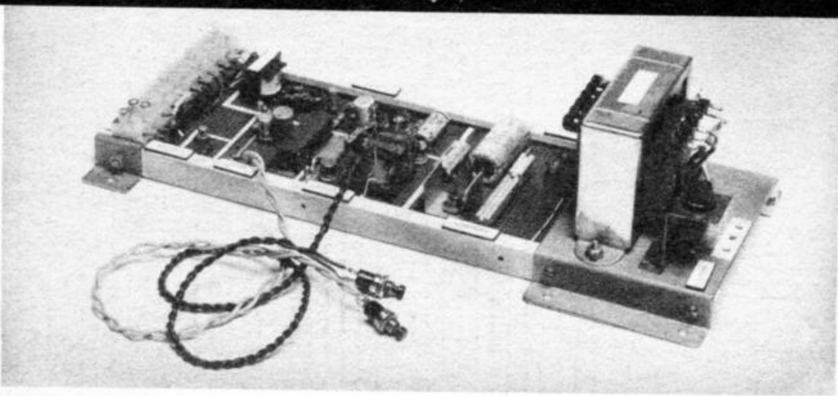
Only a brief pulse is required at CSR1 gate to cause this "switch" to latch on. It may be turned off by briefly interrupting the current flow through the device and this is the function of S3 which cancels the alarm.

A positive potential can reach CSR1 gate from the microphone amplifier output described above, and from the output of unijunction TR5.

An output pulse from TR5 will result if the emitter reaches a certain threshold potential. This can be achieved by C8 charging up through R16 and D5. With loop switches in the closed and open positions as shown, TR3 is turned fully on and therefore its collector potential is close to 0V. This prevents C8 from charging through D5.

If a series loop switch is opened or a parallel loop switch is closed (as would result from a door or window being opened), TR3 is turned off, effectively being out of circuit. C8 is then able to charge up through D5, causing the unijunction to emit a pulse from b1 resulting in CSR1 being triggered on.

COMPONENTS



COMPONENTS approximate cost £27 excluding bell, loop switches, microphones

Resistors

R1	2·2kΩ	R8	2·2kΩ	R15	120Ω
R2	100kΩ	R9	47kΩ	R16	47kΩ
R3	270kΩ	R10	100kΩ	R17	100Ω
R4	3·3kΩ	R11	100kΩ	R18	560Ω 2W
R5	100kΩ	R12	470Ω	R19	22Ω 2W
R6	270kΩ	R13	1kΩ		
R7	2·2kΩ	R14	220Ω		

All ¼W carbon ±5% except where stated otherwise

Capacitors

C1	2μF 16V elect.	C7	100μF 16V elect.
C2	2μF 16V elect.	C8	0·47μF polyester
C3	2μF 16V elect.	C9	0·1μF polyester
C4	100μF 16V elect.	C10	470μF 25V elect.
C5	220μF 16V elect.	C11	470μF 50V elect.
C6	47μF 16V elect.		

Semiconductors

D1-D5	1N4148 silicon (5 off)
D6	BZX61 or similar 12V 1·3W Zener diode
TR1-TR4	BC107 silicon *npn* (4 off)
TR5	2N1671B unijunction
CSR1	BTX18-100 or any thyristor rated in excess of 30mA 12V

Miscellaneous

S1	single-pole key operated type
S2	push-to-make momentary action
S3	push-to-break momentary action
S4	mains on-off toggle
RLA	700 ohm reed operating coil and combined magnetic reed switch with normally open contact
RLB	miniature open 6V relay, 410 ohm coil resistance with at least one set or normally open contacts
T1	audio type KF2702PCB, 6·3:1, 25 ohm primary/1 kilohm secondary
T2	mains primary/27 volt 1 amp secondary with screen (KF2700)
LP1	panel mounting mains neon
TB1	2A screw terminal block 11-way
TB2	2A screw terminal block 3-way
WD1	miniature solid state 12V d.c. bleeper
WD2	35V d.c. bell (main alarm) 6in diameter
FS1	800mA 20mm
FS2	250mA 20mm
VR1	1 kilohm standard horizontal preset
MIC1-MIC6	Post Office earpieces, moving armature type 4T (6 off)

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Stripboard: 0·1 inch matrix, 38 strips (including 4 unpunched) × 91 holes; chassis mounting fuseholder or clips for FS1; panel mounting fuseholder for FS2; aluminium or mild steel for chassis; plastic guides—Swish curtain track, 310mm (2 off); double-sided Veropins; 4BA fixings and solder tag; rubber grommets (2 off); sufficient length of bell wire for loop switches and microphones; sufficient length of cable for alarm bell; case.

Series loop switches: these should be normally open types which are in the closed position when the guarded entrance is shut. Suitable switches are micro switches and reed/magnet. Quantity as required.

Parallel loop switches: these should be normally open types if not fitted to doors or windows but normally closed types if they are, where when the entrance is "closed", they would be held open. Suitable switches are pressure mats, microswitches, and reed/magnet where the reed is a changeover type. Quantity as required.

C8 can also be inhibited by the closure of RLA1, which is part of the exit/entry delay circuitry. TR4 is normally off, so RLA is not energised. When S1 or S2 is pressed, TR4 is turned on and capacitors C6 and C7 charge up to +12V. This results in RLA1 contacts closing, holding D5 anode at 0V.

TR4 is held on after the switch is released due to the charge on C6 and C7. This charge leaks away through R10, R11 and the base of TR4 and is sufficiently discharged after about 23 seconds resulting in TR4 switching off and RLA being de-energised. During this period the opening and closing of the loop switches is ineffective. The microphone loop, however, remains active.

The d.c. power supply is derived from the a.c. mains via step down transformer T2, full-wave rectified by diode bridge D7 to D10 to provide a 40V peak. Quiescent current voltage drop across R19 leaves about 35V d.c. smoothed by C11. R18 and Zener D6 provide a stabilised +12V for the alarm control circuitry.

CONSTRUCTION starts here

COMPONENT BOARD

Most of the components are mounted on a piece of 0·1in matrix stripboard size 34 strips × 91 holes. This is fitted into two plastic guides (Swish curtain rail in fact) and held together by two metal chassis. One chassis accommodates the mains transformer and the other a length of screw terminal block for connection to the alarms and remote switches, see photographs.

This arrangement is by no means essential and constructors may alter this to suit their requirements.

Prepare the board by making the necessary breaks on the underside and the four fixing holes according to Fig. 2.

Relay RLB is mounted somewhat unconventionally, being upside down. Fixings on the usual top of the relay are used to bolt RLA to a small square of Paxolin (any insulating material will do) and this in turn is bolted to the board. Connection tags are now uppermost.

A metal heatsink for D6 is shown in the drawing and photographs which is bolted to the board via the stud fixing on this device. Connection to the cathode is through a solder tag fitted beneath the fixing nut. The

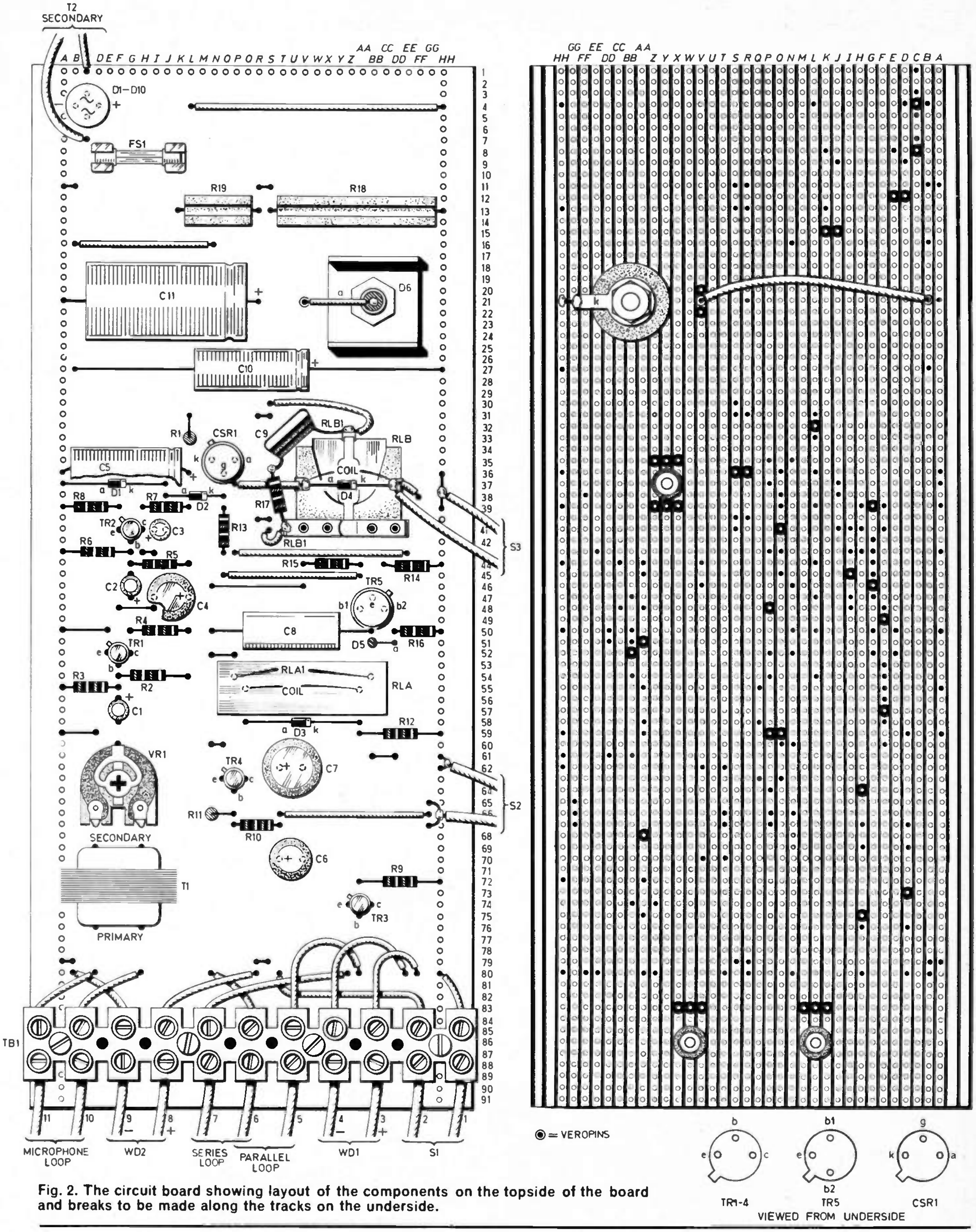
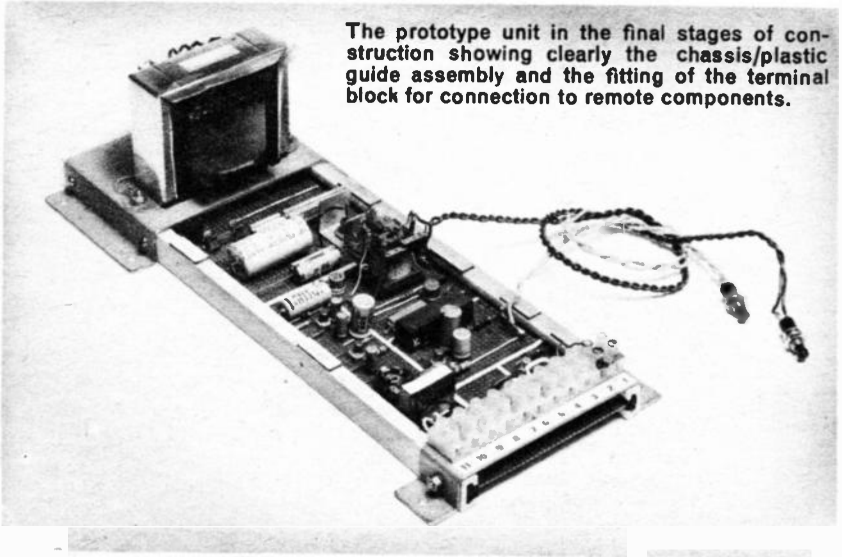


Fig. 2. The circuit board showing layout of the components on the topside of the board and breaks to be made along the tracks on the underside.



The prototype unit in the final stages of construction showing clearly the chassis/plastic guide assembly and the fitting of the terminal block for connection to remote components.

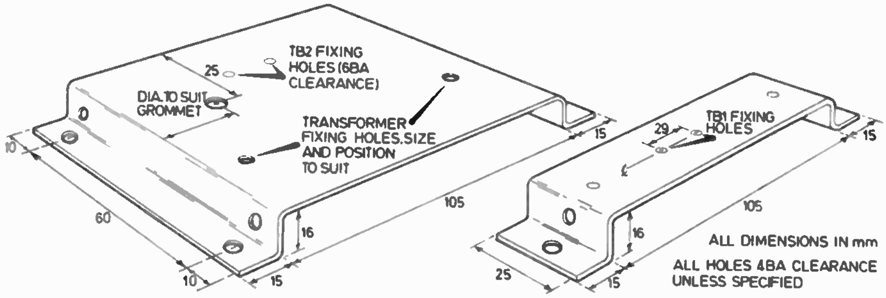


Fig. 3. Construction details for the two chassis pieces required in the prototype.

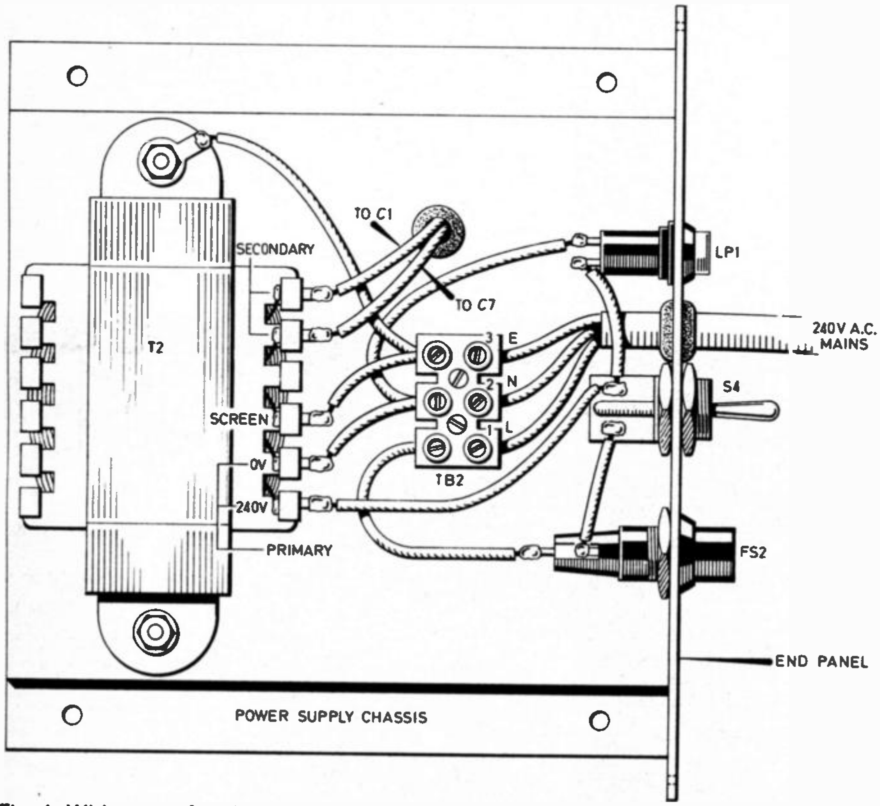


Fig. 4. Wiring up of mains input components on the larger chassis. Note that the two wires feeding through the grommet go to stripboard locations C1 and C7.

device used by the designer is rated at 20 watts, but a lower rating as specified in the component list is sufficient and much cheaper.

There are two connections from the underside of the board to off-board tags on RLB and D4. Double sided Veropins are ideal for this type of connection.

The author used thin strips of white tape to segregate the various sections on the component board. This we feel is a good idea as it allows construction within these areas to be checked more easily. They will also prove to be an aid during assembly.

Resistors R18 and R19 should be mounted so that their bodies are about 5mm above the board to aid ventilation. Short ceramic pillars were used to protect the leads of these components on the prototype.

The wattage ratings of R18 and R19 as used by the author are 7W and 2W respectively and these have been drawn as such in Fig. 2, but 2W for each should be adequate and are specified in the component list.

One component requiring care when positioning and soldering is the bridge rectifier. The four leads of this device are connected to adjacent tracks so this area especially should be viewed closely for solder bridges.

Order of construction is unimportant apart from the general rule of leaving semiconductors until last. Construction in five sections on the board would seem to be a good idea.

Wiring from S2 and S3 to the board has been drawn as built using wire bridges, but the leads could be soldered directly to the board, or Veropins used instead. Attach short lengths of lead to reach each of the 11 terminal block positions.

CHASSIS

Details of the chassis are given in Fig. 3. These are dimensioned to suit the component board size specified and plastic guides. Several pieces of channelled rubber were used to hold and support the board in the plastic track. The two bolts holding the terminal strip to the chassis should be long enough to pass through the board as well. Spacers between board and chassis produce a very secure fixture.

An end panel to hold some of the power supply components is required, but its size will be determined by the dimensions of the chosen housing for the unit. The wiring of the a.c. mains side of this section on its chassis with end panel is shown in Fig. 4.

One other panel of some description may be required to hold S2, S3 and the bleeper. The latter is useful in setting up and testing when you would not want the main alarm to sound. The connection to this external alarm bell must be made using heavy gauge wiring to reduce the voltage drop along this d.c. line.

BURGLAR
ALARM SYSTEM

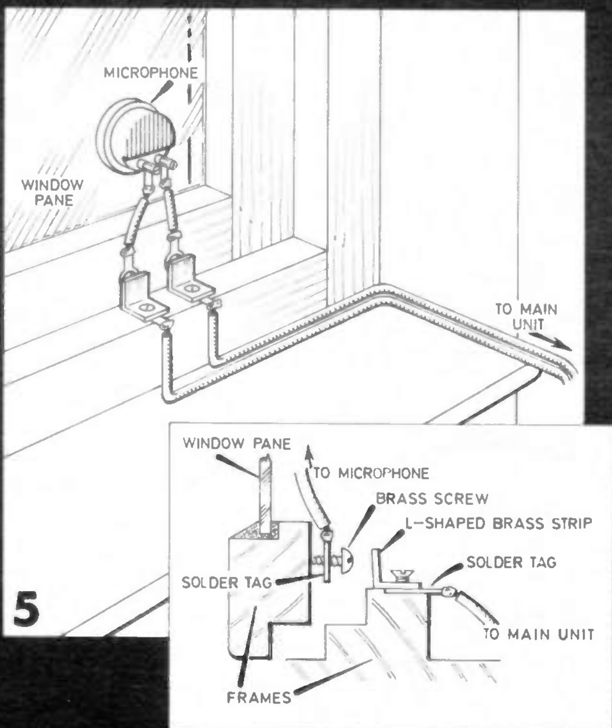
Fig. 5. One method of wiring to a microphone in the audio loop fitted to a swing window.

Fig. 6. Fitting a lever type microswitch to a door frame.

Fig. 7. Using a microswitch with a sash window.

Fig. 8. Cross section of a casement window fitted with a microswitch.

Fig. 9. A reed switch and magnet fitted in place on a door frame and door.



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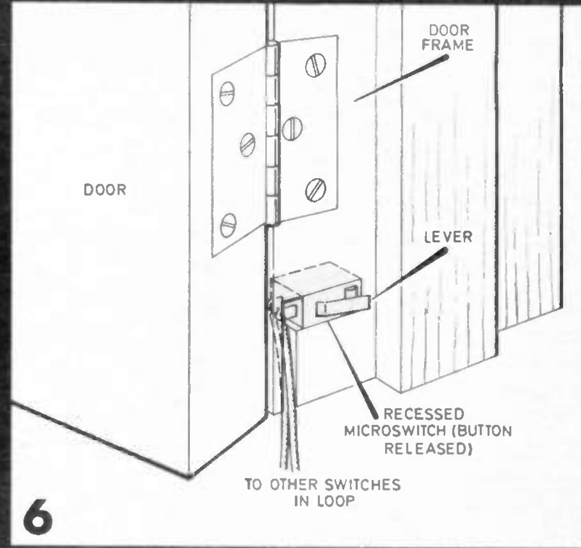

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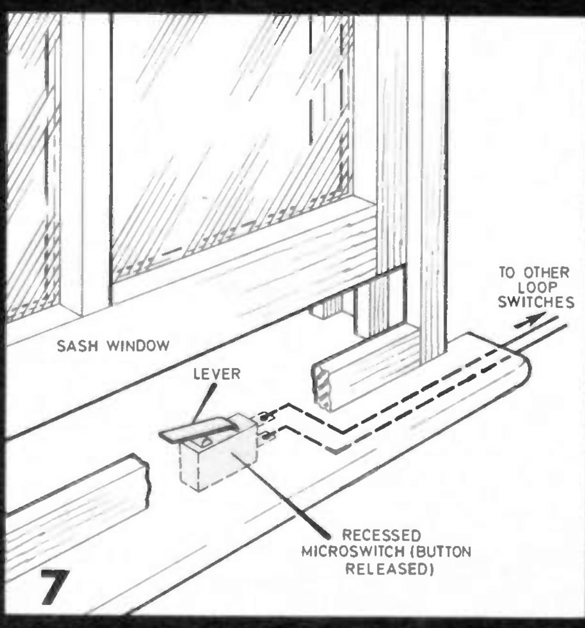

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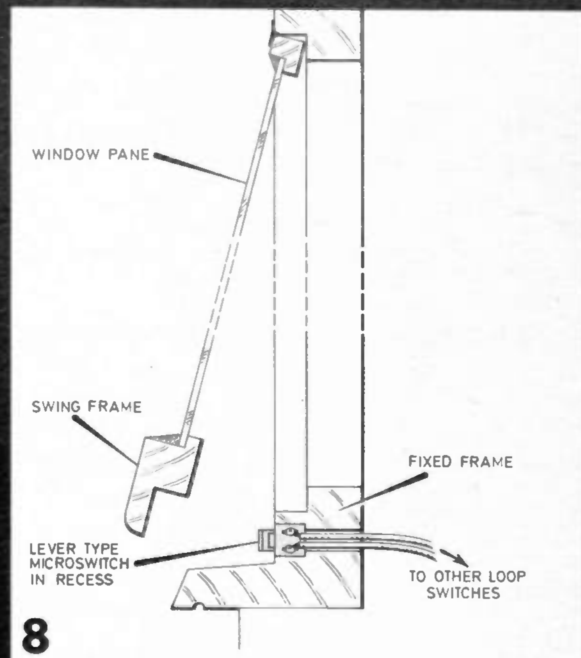

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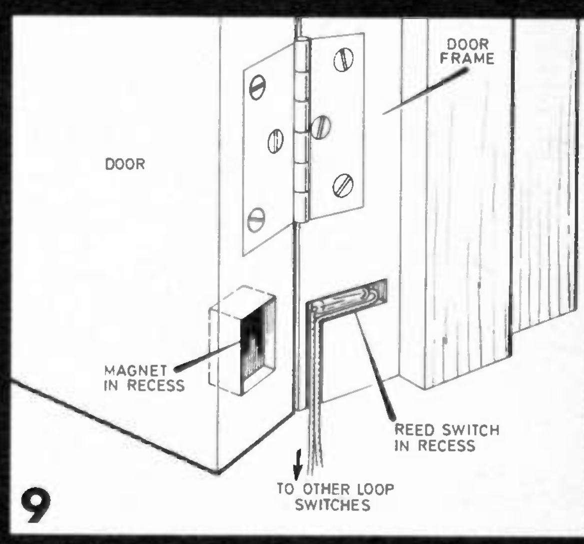

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TESTING

With the unit completed according to Figs. 2 and 3, the circuitry should be checked out before proceeding with the installation of the loop switches and microphones.

Connect a normally closed push-button switch across TB1/6 and TB1/7 to simulate the series loop and a normally open switch across TB1/5 and TB1/6 to simulate the parallel loop. Connect WD1 (TB1/1 and TB1/2) but not WD2 at this stage.

Connect a single microphone across TB1/10 and TB1/11 with VR1 set fully anticlockwise. The EXIT DELAY and ALARM CANCEL should already be connected. Plug in to the mains and switch on at S4. Nothing should happen, apart from the neon lighting up. Tap the microphone as VR1 is turned clockwise until WD1 is heard. Press ALARM CANCEL to mute WD1.

Now connect a voltmeter across TB1/8 and TB1/9 (alarm bell position) and tap the microphone again to turn on WD1 again. About 35 volts d.c. should be read on the voltmeter. Press the ALARM CANCEL switch to mute WD1 and read 0V on the meter.

The voltmeter can now be replaced by the bell and the test repeated. Remove the bell and microphone after this test.

Press the switch across TB1/6 and TB1/7 (series loop) to cause WD1 to sound. Release the switch and the bleeper should continue to sound until S3 is pressed. Repeat with the switch across TB1/5 and TB1/6 (parallel loop).

DELAY SWITCHES

Now press the EXIT DELAY switch followed by either the series or parallel loop switch being repeatedly pressed. No sound should be heard from WD1 until after about 23 seconds when operation of either of the loop switches should cause the alarm to trigger on and the bleeper to sound. This verifies correct operation of the EXIT DELAY facility.

Connect a wire to TB1/1 and after touching the other end briefly on TB1/2 repeatedly press the series or parallel switch. Once again no sound from WD1 should be produced until after about 23 seconds when operation of either loop switch will trigger the alarm on. This verifies correct operation of the ENTRY DELAY facility.

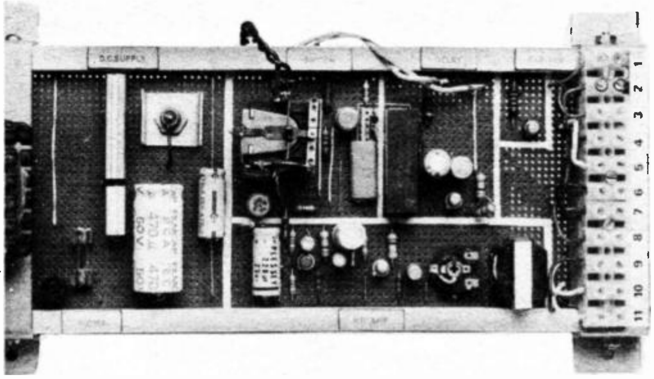
It only remains to install the loop switches and microphones in the house and connect these to the main unit, and successfully repeat the above tests with these in place to complete the alarm system.

MICROPHONES

The "microphones" used by the author were in fact Post Office telephone earpieces type 4T. These are moving iron transducers having an impedance of 150 ohms at 1000Hz (25 ohms d.c. resistance). It was envisaged that six of these will be required in a typical house. This gives a total parallel impedance of 25 ohms and T1 has been chosen to suit. The number of microphones used is not critical.

These need to be fitted to the window pane, see Fig. 5. The easiest method is to use double-sided Sellotape although this may not stand up to situations where there is heavy condensation. In these cases an epoxy type adhesive should be used. It is not thought that self-adhesive pads will be suitable as these will help to cushion the disturbance.

A problem arises with microphones fitted to swing (or sash) windows. Ample spare lead will need to be made available to allow the windows to be opened. Alternatively, a pair of contacts will need to be made such as those seen in Fig. 5. These are shown with a casement window. Strips and screw head contacts should be transposed for sash windows.



Plan view of the component board. White tape has been used to segregate circuit functions which could prove useful in construction.

LOOP SWITCHES

The criteria for any of the loop switches is that they can be made to open (or close) when a door or window is opened. Almost any type can be used including toggle, push button, rocker, microswitch, reed/magnet, and even home made versions.

The most suitable switches however are the microswitch and reed/magnet combination. We shall take a closer look at installation of these two types.

The microswitch is operated by pushing down a small button on one of its faces, being flush when fully depressed. Operation of the button can be direct or by an incorporated lever or roller. The lever type is most suitable.

These should be fitted below the lower hinge on a door frame and embedded into the frame as shown in Fig. 6. When the door closes, its edge bears down on the lever which depresses the button to operate the switch contacts.

Usually, microswitches have a single pole changeover contact arrangement, which allows it to be connected in either the series or parallel loop.

Microswitches are also suitable for fitting to sash windows where they are embedded in the frame, see Fig. 7.

With casement windows, the microswitch should be embedded in the fixed framework directly opposite and furthest from the hinged side of the frame, see Fig. 8.

Reed switches are turned on and off by means of a magnetic field, in this case by the field from a small bar magnet. A typical arrangement for a door is seen in Fig. 9. The reed switch is embedded in the frame below the lower hinge, and a magnet fitted in the door edge in a position so that when the door is fully closed the magnet causes the reed contacts to close.

This type of reed is suitable for including in the series loop only. Reeds can be obtained with a single-pole changeover contact arrangement which would then allow the switch to be used in the parallel loop if desired.

The advantage of reed switches over the microswitch is its much smaller size and that both reed and magnet can be embedded below the surface of the frame and door, filled in and painted to be invisible. The reed/magnet can be used to replace the microswitches shown in Figs. 7 and 8.

Finally, for windows, the home made contacts shown in Fig. 5 can be used as switches for the series loop by simply putting a link wire or strip across the two screws on the swinging frame.

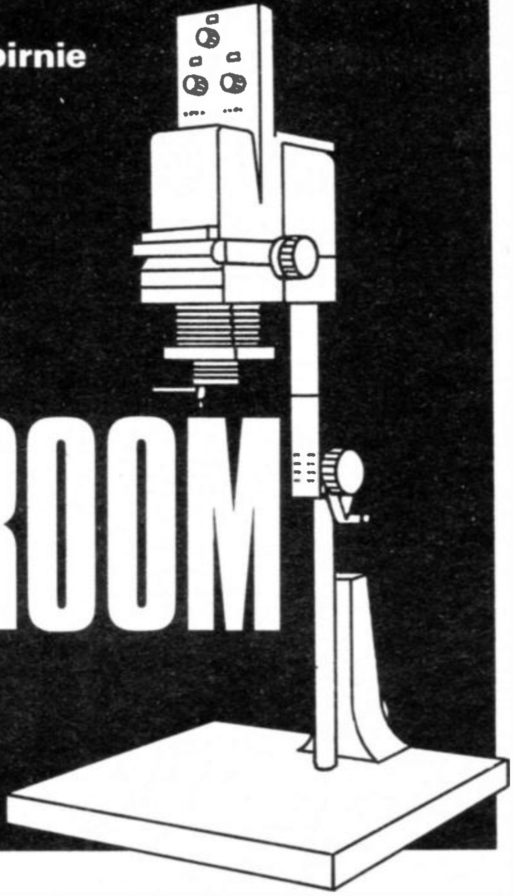
No doubt there are countless other ways and means of fitting and realising these switches both with commercially available and home made versions that the constructor will employ to suit individual requirements. The above details, however, should serve as a guide to what is required.

The ENTRY DELAY switch for obvious reasons needs to be situated outside the house, on the front door for example. This therefore should be a key operated switch.

Pressure mats have normally open contacts until pressure is applied and therefore are suitable for the parallel loop.

By T. R. de Vaux-Balbirnie

DARKROOM TIMER



SEVERAL DESIGNS for darkroom timers have been published in the past. These enable the user to select a given exposure time so that, when a button is pressed, the enlarger lamp is illuminated for the correct time interval.

Some sophisticated circuits also measure the light arriving at the enlarger baseboard through the negative and lens thus giving the correct exposure automatically.

For the professional and serious amateur photographer these are fine, but the present project is far simpler and should appeal to those amateurs who only require a timer occasionally.

This timer takes the form of a simple lamp flasher circuit operated from the mains. A relaxation oscillator sets a neon lamp flashing once per second. The user simply counts the correct number of flashes (which have previously been determined by trial and error) out of the corner of his eye.

With very little practice this may be done almost subconsciously so that the user is free to attend to "dodging" and other darkroom techniques which need concentration. This method of timing is certainly more relaxing than trying to see a dimly-illuminated clock and far more accurate than counting seconds by guesswork. The author can see that there could be numerous other uses for the circuit apart from darkroom work.

ACCURACY

The accuracy of timing is not particularly high and this must be borne in mind at the outset. In trials on the prototype, however, it was found perfectly acceptable for black and white photography at least. Over the short term, that is, during the same darkroom session, the rate of flashing kept accurate to one flash per minute. Over the long term it was found to be acceptably accurate providing the mains voltage did not alter appreciably.

The circuit is also sensitive to changes in mains voltage but the effect is not large. In trials, voltage changes of plus or minus 10 per cent were used and the rate of flashing kept accurate to within about 3 flashes per minute. This was considered acceptable as mains voltage changes of 10 per cent are rare. In any case the short term accuracy is more important, and during the same darkroom session it is unlikely that the mains voltage will change much. Changes in temperature likewise have a small effect on the timings.

CIRCUIT DESCRIPTION

The circuit for the Darkroom Timer is shown in Fig. 1. Mains current flows through the fixed resistor R1 then through the preset variable resistor VR1. From here it flows through the diode D1 which rectifies the a.c. current. This small d.c. current then charges the capacitor C1.

A miniature neon lamp is connected across C1 in series with a limiting resistor R2. The voltage across the capacitor rises slowly and when about 80 volts is reached the gas in the tube "strikes" giving a red glow. The voltage soon falls below a certain threshhold value as C1 discharges and the neon extinguishes. The whole cycle then repeats indefinitely.

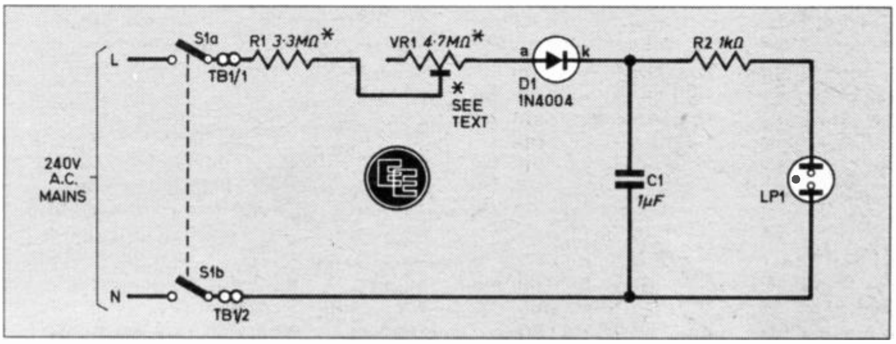
The time between flashes depends chiefly on the values of R1, VR1 and C1. The larger these values then the greater will be the time constant. With the values given, the time will be about one second. To allow for tolerances in the values of individual components, VR1 gives some measure of control and will be set for the correct rate.

It will be noted that although the time *between* flashes is relatively long, the duration of the flash itself is short. This is because R2 has a small value so C1 discharges rapidly. A graph showing the voltage across C1 against time is shown in Fig. 2. It is called a "sawtooth" waveform for obvious reasons.

COMPONENTS

The choice of some of the components is important. It will be seen that R1 and VR1 have much higher values than are normally encountered in electronic circuits. They are easily available, however. Although R1 was

Fig. 1. Full circuit diagram of the Darkroom Timer.

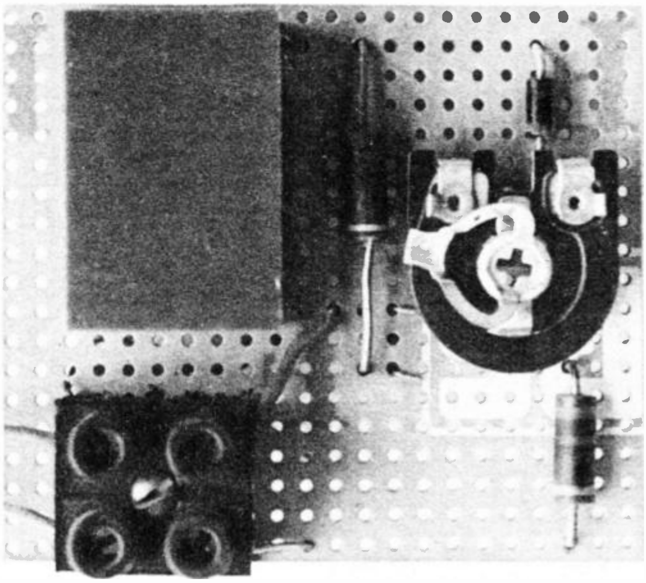


an ordinary carbon resistor in the prototype, some readers may wish to use a high stability type here with a view to perhaps improving the long term stability of the circuit.

The preset, VR1 is a standard size type. It was thought that the miniature type was not up to the job—mechanically at any rate. Diode D1 is a silicon diode capable of withstanding the mains peak reverse voltage that is, the maximum voltage across it in the non-conducting half cycles. This is about 350 volts. It must be remembered that, although the mains voltage is generally considered to be 240 volts, this is only an *average* figure. The peak of the a.c. waveform reaches approximately 350 volts and it is this figure which must be withstood.

Capacitor C1 must *not* be an electrolytic type. A good quality non-electrolytic capacitor must be used. It would seem that a working voltage of 80 volts would be sufficient for C1 as this is the maximum voltage developed across it before the neon strikes. This may be correct in theory but if a fault should develop preventing the neon tube from operating then C1 will charge up to peak mains voltage. This means that, once again, a component with a working voltage of at least 350 volts should be used.

Photograph right shows top view of prototype circuit board. The mains switch is not shown in this photo but connects to the terminal block at the bottom left of the picture.



COMPONENTS

Resistors
R1 3·3MΩ*
R2 1kΩ
Both ¼W carbon ±5%

Capacitor
C1 1μF 350V d.c. paper

Semiconductor
D1 1N4004 1A 400V silicon diode

Miscellaneous
VR1 4·7MΩ standard horizontal preset*
LP1 wire ended 80V neon
S1 d.p.d.t. toggle
Stripboard, 0·1 inch matrix, 19 strips × 22 holes; plastics case, size as required; two rubber grommets; 2-way screw terminal block; plastics sleeving; connecting wire.

* See text.

See Shop Talk page 425

Approx. cost Guidance only £2

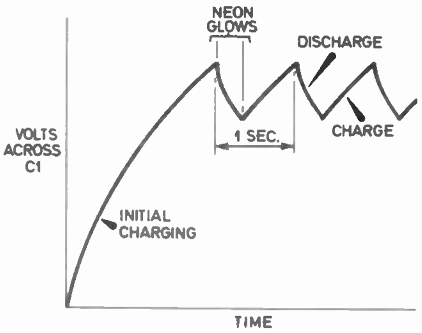


Fig. 2. Graph showing charge/discharge cycle of C1 connected in parallel with the neon tube, LP1.

MAINS SWITCH

A mains switch must be incorporated in the circuit and this should be of the double-pole type. This will ensure total isolation from the mains when the unit is switched off. Although the contacts for this switch must be rated for mains use, their current carrying capacity need only be small. A rating of 1 amp will be quite sufficient.

Take care when selecting the neon tube, LP1. This is not the usual mains panel indicator which incorporates a series resistor but the more simple miniature wide ended type without the resistor.

It is advisable to include a fuse in the circuit. If connections are made to an ordinary fused plug then a low value of fuse should be fitted. A 13 amp fuse should not be used. Despite what the man in the corner shop may tell you, it *is* possible to buy 1 amp plug fuses. You may have to settle for the more common 3 amp type, however. If the unit is not to be wired to a fused plug then a separate fuseholder must be wired in series with the mains live cable before the switch.

STRIPBOARD

The prototype was built on a small piece of 0·1 inch matrix stripboard 22 holes by 19 strips, and full details are shown in Fig. 3. Soldering must be carried out with care to avoid bridging between adjacent copper tracks. The strips should be broken in the places indicated using either the special tool or a small twist drill.

The neon tube is mounted on the opposite side of the circuit panel to the other components, that is, on the copper track side. When finally mounted in its case, the neon may then protrude slightly through a hole with a rubber grommet inserted in it. The grommet grips the neon and gives a neat appearance. In this way, with the back of the case removed, VR1 is accessible for adjustment. The wire ends of the neon should be cut off to a convenient length and fitted with short lengths of scrap insulation removed from connecting wire.

External connections are made to the circuit by means of a 2-way plastic screw terminal block mounted on the panel. The Live and Neutral connections should not be interchanged.

CASE

The finished project may be very small so a suitable plastics box should be chosen in which to house it. The choice of box has been left to the constructor. One hole should be drilled for the neon as mentioned previously. Another hole should be drilled in the side of the box for the mains lead. This should also be fitted with a grommet.

It will be noted that no provision for an earth connection has been made. This is not necessary as the unit is mounted in a non-conducting case. For this reason a metal case must not be used. The circuit panel must be securely mounted inside. The leads to the neon are not sufficient to support it.

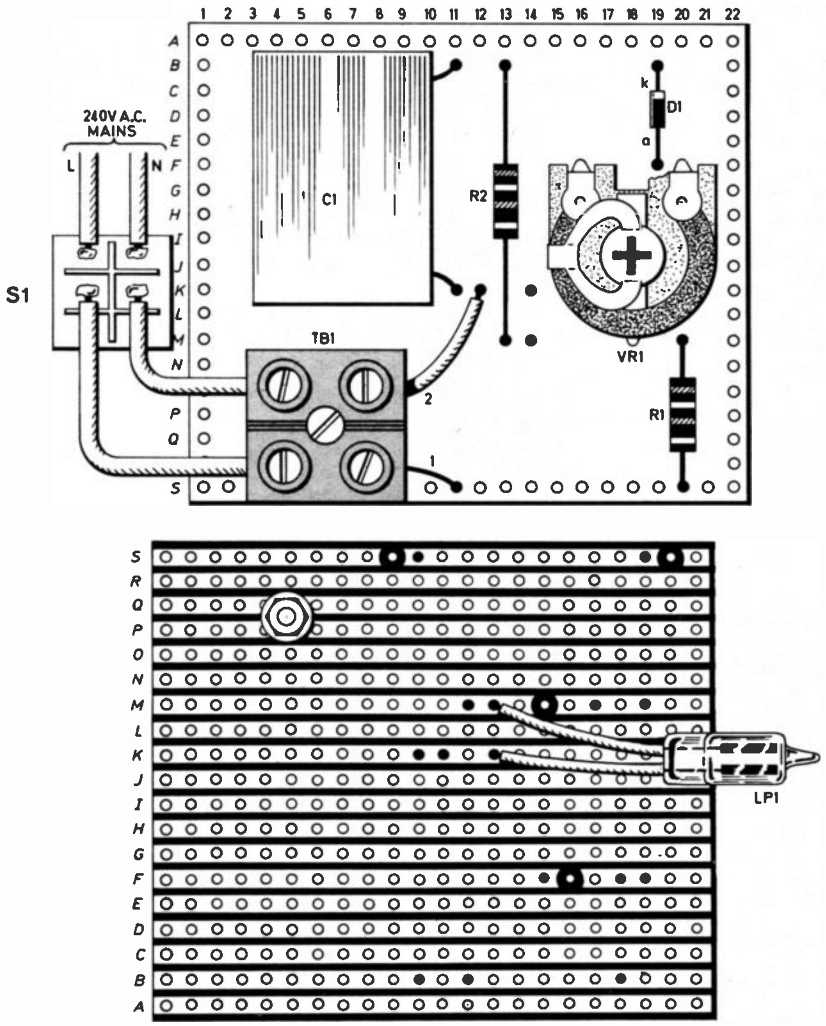
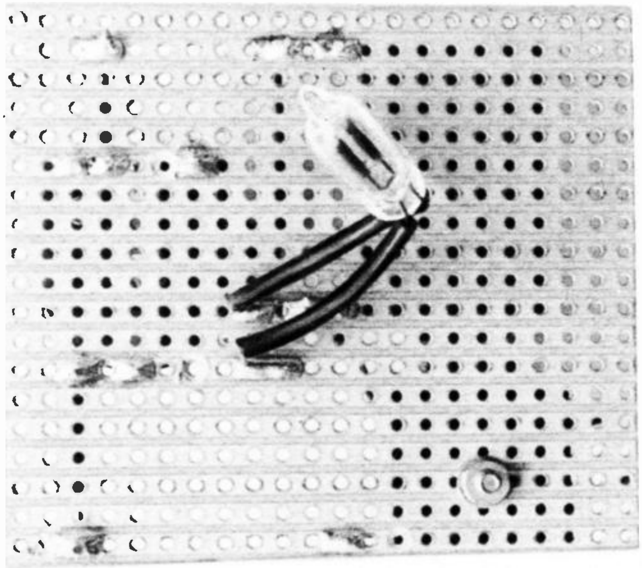


Fig. 3. Stripboard layout. The mains switch, S1 may be located at any convenient position in the case. Note that the neon tube, LP1, is connected to the reverse of the board.



Underside view of the circuit board showing the neon lamp and its connections.

SETTING UP

Before connecting the unit to the mains, VR1 should be set to approximately mid position. It should then be plugged in and switched on. From this point it must be remembered that the circuit panel is "live" and must not be touched. After a few seconds the neon should begin to flash regularly. The number of flashes in, say, 20 seconds may then be counted and after switching off, VR1 can be adjusted as necessary. Anticlockwise rotation will reduce its value, the flashing rate will increase.

After a while it will be found that VR1 can be set to give 60 flashes per minute accurate to within one flash. It may appear that the brightness of the neon is too low under normal room lighting. Taking the unit into the darkness under normal safelight conditions will dispel any doubts. When the timing has been set to satisfaction, the back of the case should be fitted. It will probably be found necessary to adjust VR1 every now and again.

DARKROOM USE

The light from the flashing neon is not, in fact safe to bromide paper. Tests on the prototype, however, showed that no trouble would be experienced when the unit is used at normal working distances, say, more than 3 or 4 feet away. Anyone really worried about this point may do their own tests and fit a red plastic dome over the neon tube if necessary.

In exceptional cases the constructor may find that the correct timing is impossible to obtain even with VR1 set to its limit. This could happen if the true value of C1 is somewhat different to its nominal value. In this case a higher or lower value for R1 will need to be used. The higher value of R1 will produce fewer flashes per minute and vice versa.

ELECTRODES

Users will notice that only one of the electrodes flashes within the neon. This is correct as it is being used under d.c. rather than a.c. conditions. Another practical point is that, on first switching on, C1 must charge up from zero. After that it only charges from the threshold value. This means that the unit takes three or four seconds to start flashing. It is better to leave it switched on for the entire darkroom session to avoid this inconvenience. It remains cool and consumes next to no power. ⌑

DISCRETE SEMICONDUCTORS EXPLAINED

PART ONE

BY J.B.DANCE

THIS is the first of a series of articles covering discrete semiconductor components. This first part examines common types of semiconductor diodes available for many purposes. Subsequent parts of this series will cover transistors, Darlington devices, field effect and unijunction transistors, thyristors, diacs, triacs, varistors and various types of optoelectronic device.

DISCRETE COMPONENTS

What is a discrete component? As its name suggests, it is a single individual component contained in its own separate package. Discrete components are therefore essentially simple devices with only a few connections (usually two, three or four connections). Discrete components are easy to use, easy to solder into a circuit and are generally easy to test.

It is convenient to regard some components which actually contain more than a single device in each package as discrete components. For this reason this series will cover a few products of this type, such as bridge rectifiers which contain four separate diodes, and Darlington transistors which contain two transistors connected together to provide a higher gain than is provided by either of the transistors alone.

DIODES

Semiconductor diodes are one of the simplest types of semiconductor device, which, as their name implies, have only two electrodes or connections. Many diodes are specifically designed for applications in which they are required to pass appreciable current only in one direction (known as the "forward" direction), but some types of diode are used in applications in which they pass a current in the reverse direction.

The conventional symbols for a simple diode are shown in Fig. 1.1, either a full arrow or a half arrow being equally acceptable. Sometimes the arrow or half arrow is placed in a circle to imply that the diode is encapsulated in a package, but often the circle is omitted.

FORWARD DIRECTION

The arrow in the circuit symbol for a diode shows the direction in which it will pass a **conventional** current easily, this direction being known as **the forward direction,** that is from the positive to the negative line.

A drawing of a typical small-signal glass-encapsulated diode is shown in Fig. 1.2. A coloured band or indentation or sometimes a red spot is placed near the end out of which the current flows when the diode is biased in the forward direction. Thus the arrow of the circuit symbol points towards the end carrying this coloured band or spot.

P AND N-TYPE MATERIALS

In order to understand why a semiconductor diode conducts easily only in one direction, we must consider the nature of the semiconductor materials employed in its construction. Most modern semiconductor diodes employ silicon as the semiconductor material, but germanium is used in some types, whilst other materials such as gallium arsenide are found in some diodes.

A pure or **intrinsic** semiconductor material is of extremely high purity. It contains relatively few charge carriers which are able to move and thus carry a current; such intrinsic semiconductor materials therefore pass little current and have a high resistivity. Many charges are present as the electrons and positive nucleii in such a material, but few are free to move unless the temperature is quite high.

If such an intrinsic material is **doped** by the addition of a very small percentage of an element such as arsenic, the arsenic atoms provide negative charge carriers (electrons) so that the conductivity of the material is greatly increased. Such a doped material is known as an ***n*-type** material, since conduction occurs by means of the movement of the negative electrons.

In an *n*-type material, the mobile electrons can be shown as in Fig. 1.3, whereas the positive charges associated with them are encircled to show that these positive charges cannot move. Any material must contain roughly equal numbers of positive and negative charges or very high voltages would be developed.

If, however, an intrinsic material is doped with an element such as boron whose atoms readily accept an electron, an electron from a neighbouring atom can easily jump into the

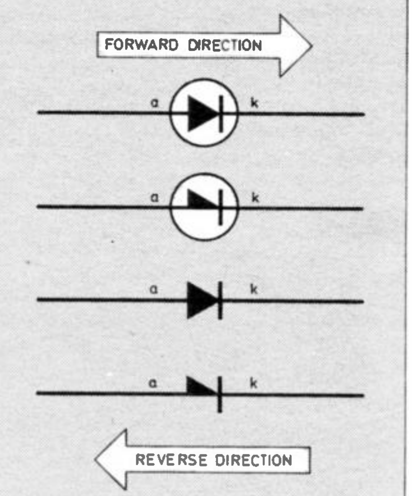


Fig. 1.1. The symbols which can be used to represent a semiconductor diode.

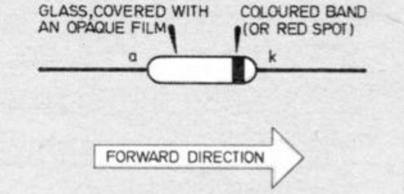


Fig. 1.2. A small signal diode with polarity marking.

boron atom. This creates a vacancy or a hole in the neighbouring atom which can in turn be filled by an electron from its neighbour. Thus a number of electrons actually move in succession, but it is convenient to think of the movement of the hole rather than of many electrons.

The hole moves in the opposite direction to the electrons and therefore behaves as a positive charge carrier. Such a doped material can be represented as in Fig. 1.4 where the mobile positive holes move amongst the associated fixed negatively charged atoms which must be present for the material as a whole to be electrically neutral.

In such a material conduction occurs by the movement of the positively charged holes (or, at least, this is the most convenient way of thinking about it), and it is known as a *p*-type material.

JUNCTION DIODE

A **junction diode** consists of a piece of *p*-type material and a piece of *n*-type material brought together in a single crystal of the semiconductor material.

When such a junction is formed, some of the mobile (**free**) electrons of the *n*-type material diffuse across the junction into the *p*-type material whilst mobile holes from the *p*-type material move into the *n*-type section. This movement of charge results in the *p*-type material becoming negatively charged with respect to the *n*-type material.

Holes in the *p*-type material are therefore drawn away from the junction region under the influence of the negative potential. Similarly electrons in the *n*-type material are drawn away from the junction deeper into the *n*-type material.

The junction region itself is therefore depleted of both types of mobile charge carriers (holes and electrons) and is known as the **depletion region**. Such a junction diode without any voltage applied as a bias can be represented as in Fig. 1.5. The voltage between the *p*- and *n*-type material is the natural junction potential.

FORWARD BIAS

When a bias is applied in the forward direction across the diode of Fig. 1.5, the *p*-type material is made more positive relative to the *n*-type. Little current will flow until the applied voltage exceeds the natural junction potential of the unbiased diode. As soon as the applied voltage exceeds the latter, holes from the *p*-type material are attracted across the junction and electrons from the *n*-type are attracted in the opposite direction. Both of these movements constitute a flow of conventional current from the *p*-type to the *n*-type material in the forward direction.

As the applied forward bias voltage is increased, the current which flows increases very rapidly and the diode would soon be damaged if the current were not limited by the effective resistance of the voltage source.

In a germanium diode the natural junction potential is only about 0·2V, so such a diode will pass a forward current even when the applied voltage is quite small. Silicon diodes have at natural junction potential of about 0·65V, so a somewhat higher voltage is needed to cause a silicon diode to conduct, see Fig. 1.6.

REVERSE BIAS

If a reverse bias is now applied to the junction diode in Fig. 1.5 so that the *p*-type material is made negative with respect to the *n*-type material, the positive holes will be attracted away from the junction deeper into the *p*-type material. Similarly the negative electrons in the *n*-type material will be pulled away from the junction deeper into the *n*-type material on the right hand side of Fig. 1.5.

The application of such a reverse bias therefore increases the width of the depletion region and makes it more difficult for any current to flow through the diode. This is why the diode does not show appreciable conduction in the reverse direction.

Any doped semiconductor material contains not only the large numbers of charge carriers of the wanted polarity (the **majority carriers**), but also far smaller number of mobile charges of the opposite polarity (the **minority carriers**). Thus the *p*-type material of Fig. 1.5 contains a relatively small number of free electrons and the *n*-type material contains a small number of mobile holes.

The application of a reverse bias voltage to the junction will cause these minority carriers to be attracted through the junction. This constitutes a reverse current in the opposite direction to the flow expected from the arrow of the diode symbol. However, the numbers of the minority carriers are so small that the reverse current which flows is far smaller

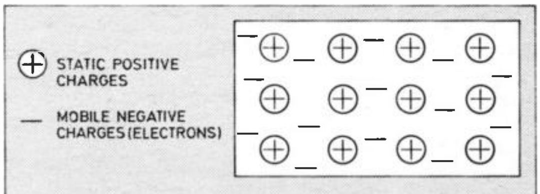


Fig. 1.3. N-type material has fixed positive charges and mobile negative electrons.

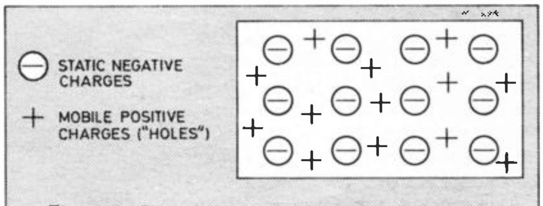
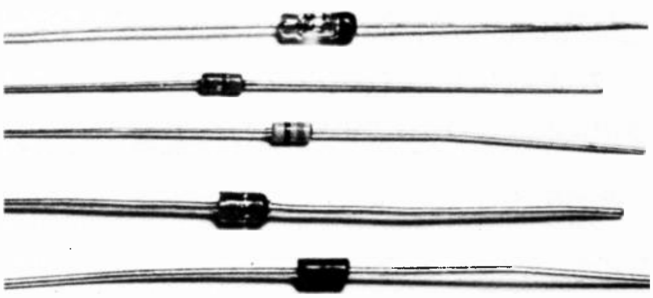


Fig. 1.4. P-type material has fixed negative charges and mobile positive holes.



A selection of small signal glass encapsulated diodes.

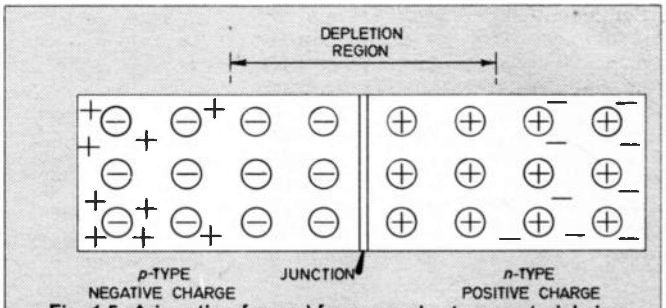


Fig. 1.5. A junction formed from *p* and *n*-type materials in a single crystal. The p-type material becomes negative with respect to the n-type owing to diffusion of the mobile charges.

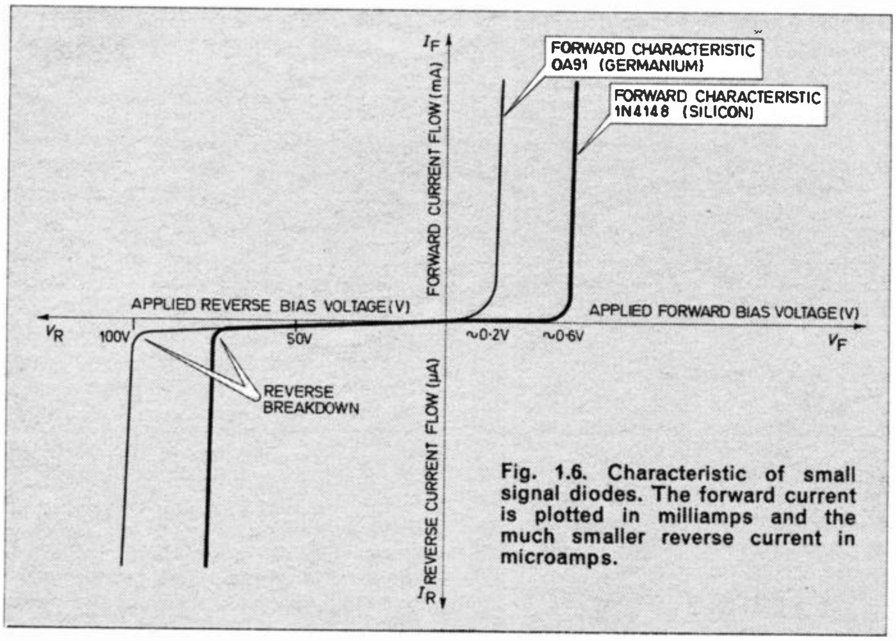


Fig. 1.6. Characteristic of small signal diodes. The forward current is plotted in milliamps and the much smaller reverse current in microamps.

than the forward current. The flow of reverse current is one way in which a semiconductor diode falls short of being a perfect rectifying device—which would allow current to flow in one direction only.

A typical small germanium diode will pass a reverse current of the order of a few hundred microamps, whereas a typical small silicon diode will pass a reverse current measured in nanoamps. The difference in these values is due to the fact that there are far fewer minority charge carriers present in silicon than are present in germanium. Reverse currents are sometimes known as **leakage currents.**

Reverse currents increase rapidly with temperature, since a rise of temperature causes a great increase in the number of minority carriers present.

REVERSE BREAKDOWN

If the reverse voltage applied to a diode is increased, a point is reached at which the reverse current increases very rapidly with the applied voltage. This is known as **reverse breakdown** and must be avoided in many rectifier circuits or damage will occur.

A maximum voltage is therefore quoted for diodes in the reverse direction which should never be exceeded; it is known as the **peak inverse voltage** (p.i.v.) or as the V_{RRM} value. The diode manufacturers state that the diode will not breakdown at an applied reverse voltage less than this value.

CHARACTERISTIC

The characteristic of a diode is of the form shown in Fig. 1.6. As the applied forward voltage V_F, is increased, little current passes at first, but then the forward current, I_F, increases very rapidly with V_F. In the reverse biased mode, little reverse current, I_R, flows before the breakdown point is reached and then the reverse current increases very rapidly with the applied reverse voltage, V_R.

Power diodes are intended for higher currents and therefore have junctions with a greater cross sectional area than small-signal diodes. They are normally supplied in stud-mounting cases (Fig. 1.7) which can be screwed to a heat sink, the size of the heat sink required depending on the forward current. Power diodes have a larger reverse leakage current than small-signal types, owing to their greater junction area.

POINT CONTACT DIODES

A **point contact diode** consists of a fine coiled spring of tungsten wire

Fig. 1.7. A stud-mounted power diode.

which presses lightly against a crystal of the semiconductor material (normally germanium) as shown in Fig. 1.8. During manufacture a current passed through the wire causes a small amount of *p*-type material to be formed at the point of contact with the *n*-type crystal.

A point contact diode is therefore basically a junction diode of small area. Diodes of this type have a low capacitance, although the forward voltage is generally higher than that of the junction types. Point contact diodes are used mainly as radio frequency detectors and mixers.

GOLD BONDED DIODES

A **gold bonded diode** has a similar construction to the point contact diode except that the tungsten wire is replaced by a fine gold wire. Gold bonded diodes have a low capacitance, but will pass a higher forward current at a given forward voltage than a point contact diode.

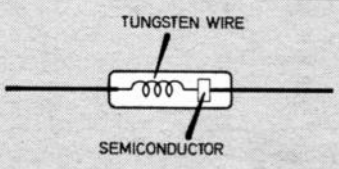


Fig. 1.8. A point-contact diode.

HALF-WAVE RECTIFIER

One of the most common applications of a junction diode is in a simple half-wave rectifier circuit like that of Fig. 1.9. Although a mains transformer and an electrolytic capacitor are shown, a similar circuit can be used at radio frequencies as a simple amplitude modulation detector.

Let us consider the case where the voltage across the transformer secondary winding is V_{ac} volts r.m.s. It follows from theory that the peak voltage across this winding is $\sqrt{2} \times V_{ac}$. When the upper end is positive with respect to the lower end of the winding, a current will flow through the diode *D1* to charge the capacitor to a voltage which is equal to this peak voltage if the output current taken is small.

When the output voltage from the secondary winding changes in phase so that the lower end is positive, very little current will flow through the reverse biased diode. However, what is the peak voltage across this diode while it is non-conducting? The voltage across the transformer secondary winding has a peak value of $\sqrt{2} \times V_a$ with the lower end positive, but this lower end is connected to the negative side of *C1*. Thus the total voltage across the reverse biased diode is $\sqrt{2} \times V_{ac} + \sqrt{2} \times V_{ac} = 2\sqrt{2} \times V_{ac} = 2{\cdot}828 V_{ac}$.

Thus to ensure there is no danger of the diode breaking down, it should have a p.i.v. or V_{RRM} rating of not less than 2·828 times the r.m.s. value of the transformer secondary voltage. If the secondary voltage is 50V r.m.s., one requires a diode rated at not less than 142V breakdown. In practice, it should be still higher to allow for any increases in the mains supply voltage!

FULL-WAVE CIRCUIT

The rectifier circuit of Fig. 1.10 is somewhat similar to that of Fig. 1.9 except that the secondary winding of the transformer has a centre tap and two diodes are used instead of one to obtain full-wave rectification. When the upper output from the secondary winding in Fig. 1.10 is positive, *D1* conducts and charges *C1*. When the lower output is positive relative to the centre tap, *D2* conducts and charges *C1*; thus charging occurs in both parts of the input waveform.

In this circuit both *D1* and *D2* should have a reverse breakdown voltage of no less than 2·828 V_{ac} where V_{ac} is the r.m.s. voltage of *each half* of the transformer secondary winding. The output voltage is 1·414V a.c. under no load conditions.

The transformer required for the circuit in Fig. 1.10 must provide the same secondary voltage across each half secondary as that in Fig. 1.9 for a given output voltage. However, the full wave rectification in Fig. 1.10 ensures that any output current taken from the circuit will produce a smaller fall in the output voltage than in the circuit of Fig. 1.9. Mains hum will also normally be less.

FULL-WAVE BRIDGE

Another much used full-wave rectifier diode circuit in which the need for a centre-tapped secondary winding is obviated by the use of four diodes in a bridge circuit is shown in Fig. 1.11. When the output from the upper end of the secondary winding is positive relative to the lower end, a current flows through *D2* to charge *C1* and returns from the lower end of *C1* through *D3*. Similarly when the lower end of the winding is positive, a current flows through *D4* to charge *C1* and back via *D1*.

The output voltage is therefore 1.414 times the r.m.s. output from the transformer secondary winding under no load conditions.

The diode bridge circuit of Fig. 1.11 is widely used, so bridge rectifier modules are available which contain all of the four diodes required mounted in a single package (see Fig. 1.12). Low current bridge rectifiers (up to a few amps output current) need not be mounted on a heatsink, but a heatsink should always be used in high current circuits. The connections to diode bridges are marked on the devices, the two alternating input voltage connections being interchangeable.

VARICAP DIODES

Varicap (variable capacitor) diodes are silicon diodes especially designed for use in applications where the reverse voltage applied alters the width of the depletion region (refer to Fig. 1.5) and hence the capacitance across the diode.

Varicap diodes have been much used for tuning f.m. receivers and television receivers; such tuning systems are especially convenient when one requires remote "electronic" tuning using a potentiometer or push-buttons. However, it is also possible to tune a.m. reecivers using the high capacitance varicap diodes now available which can have values up to at least 500pF. A number of matched diodes are required for the signal frequency tuned circuits and the oscillator circuit in the case of a.m. receivers. No selection of the varicap diodes is necessary for f.m. receiver tuning.

ZENER DIODES

Zener diodes are silicon junction diodes which have been specially made so as to have a particular breakdown voltage with a very sharp "knee" in their reverse characteristic (refer to Fig. 1.6). They are used to provide an output voltage which shows little variation with output load current or with the input voltage.

A simple Zener diode circuit is shown in Fig. 1.13. The breakdown

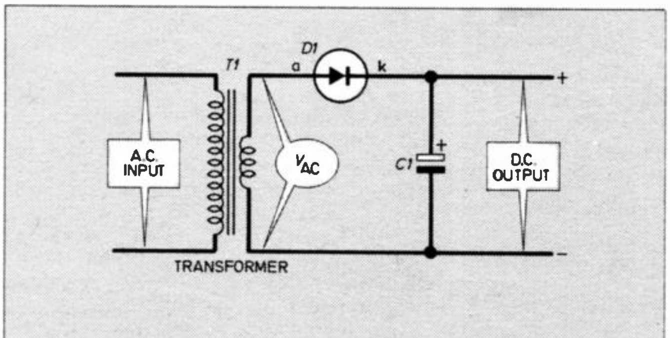


Fig. 1.9. A simple half-wave rectifier circuit.

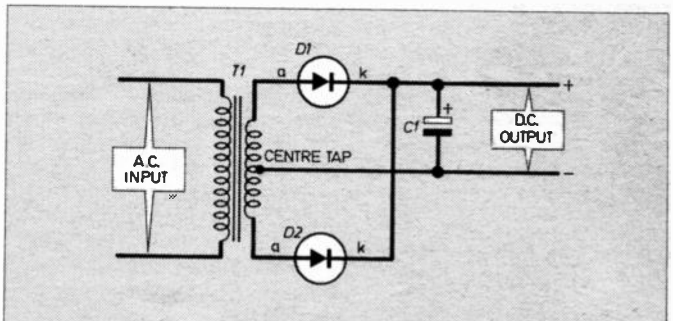


Fig. 1.10. A full-wave rectifier circuit using two diodes and a centre-tapped transformer winding.

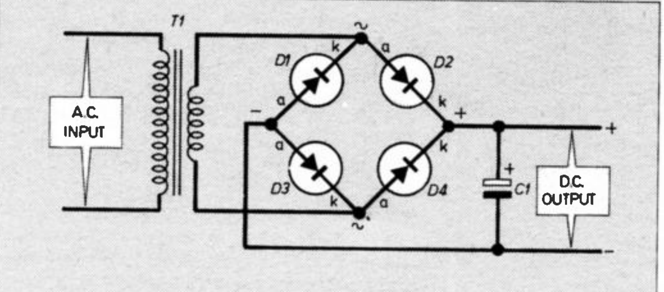
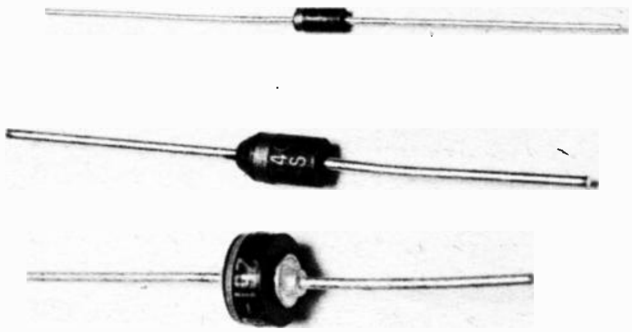


Fig. 1.11. A full-wave bridge rectifier circuit.



Three plastic encapsulated rectifier diodes (top) 1N4001, 1A (middle) IN5401, 3A (bottom) high power, 6A.

Table 1.1. Commonly used small diodes with some high current and high voltage units.

Diode type	V_{RRM} (V)	Max. mean I_F (mA)	Typical V_F (V)	at I_F (mA)	Typical I_R (µA)	at V_R (V)	Package	Remarks
Germanium Point contact								
AA119	45	35	2·6	30	170	45	DO-7	Detector diode
OA90	30	10	2·0	30	400	30	DO-7	High frequency detector
OA91	115	50	2·1	30	57	100	DO-7	General purpose diode
OA95	115	50	1·85	30	80	100	DO-7	General purpose diode
Germanium Gold Bonded								
AAY30	30	—	0·88	150	8	30	DO-7	High speed switching diode
AAZ13	8	20	0·6	10	30	8	DO-7	Fast switching diode
AAZ15	100	140	0·8	250	25	70	DO-7	High voltage type
OA47	30	48	0·54	30	10	30	DO-7	General purpose diode
Silicon junction types								
1N914	75	75	1·0	10	0·025	20	DO-35	Fast computer diode
1N3890 series	100–400	12 A	1·4	12 A	3 mA	V_{RRM}	DO-4	Power rectifier, stud fitting
1N4148	75	75	1·0	10	0·025	20	DO-35	Fast computer diode
1N4001 to 1N4007	50–1000	1 A	1·1	1 A	10	V_{RRM}	DO-15	General purpose 1 A diodes
1N5401 to 1N5408	100–1000	3 A	1·0	3 A	15	V_{RRM}	SO-78	General purpose 3A diode
BY170	15 kV	2·5	35	100	7	15 kV	Plastic	E.H.T. rectifier
BYX38 series	300–1200	6 A	1·7	20 A	200	V_{RRM}	DO-4	Power rectifier, stud fitting
BYX42 series	300–1200	12 A	1·4	15 A	200	V_{RRM}	DO-4	Power rectifier, stud fitting
BYX91 series	90 kV–180 kV	200	225–450	2 A	10	V_{RRM}	Special	Silicon rectifier for X-ray equipment
BYX97 series	300–1600	47 A	1·05	40 A	4 mA	V_{RRM}	DO-5	Power rectifier, stud fitting
OA200	50	80	1·15	30	0·01	35	DO-35	General purpose diode
OA202	150	160	1·15	30	0·01	150	DO-35	High voltage small diode
OSS9410	30 kV	10 A–30 A	5·4	150 A	16 mA	30 kV	Special	High voltage rectifier unit

voltage of the Zener diode should be equal to the output voltage required; Zener diodes are available for voltages from 2·7V to over 200V. The current flowing through *R1* is equal to the difference between the input voltage and the Zener voltage divided by *R1*. This current must exceed the output current required, since it also has to supply the Zener current. Note that the Zener is reverse biased.

As the output current falls in Fig. 1.13 the Zener current increases by the same amount and the circuit designer must ensure that this will not cause the Zener to become too hot. High current power Zener diodes are available. Alternatively a low-current Zener may be used with a following transistor current amplifier.

The output voltage from the Zener circuit varies somewhat with temperature, but this variation is smallest for Zener diodes with a breakdown of about 5·6V. Very stable temperature compensated Zener devices can be obtained in which the Zener is placed in series with one or more internal forward biased silicon diodes.

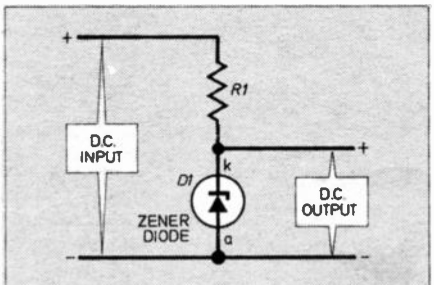


Fig. 1.13. A basic Zener diode circuit.

SCHOTTKY DIODES

Schottky rectifier diodes contain a metal-semiconductor junction instead of a *pn* juction. They are used where fast switching is needed (especially in switched mode power supplies) in order to obtain maximum power conversion efficiency.

TESTING DIODES

Ordinary silicon and germanium diodes including Zener and varicap diodes can readily be given a rough test of their ability to function by checking that they show a much higher resistance in one direction than the other when the probes of a multimeter switched to a resistance range are connected across the diode. For the testing of Zener diodes with a breakdown of less than 15V, the meter range(s) designed for the higher resistance values should not be used or the applied voltage may be adequate to cause reverse conduction.

The use of a meter switched to a resistance range has the advantage that the current is limited to a safe value by the meter circuit. However, one should remember that the terminal of the meter which is marked positive is actually the negative when the meter is switched to a resistance range. Never use a megger instrument to test a diode.

Next month: transistors.

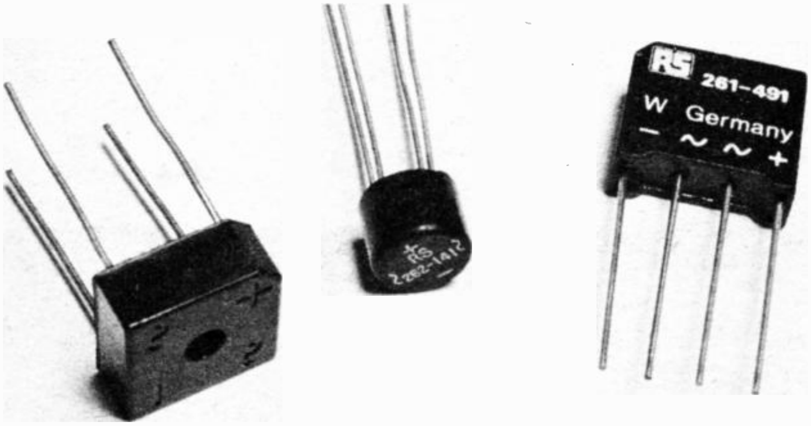


Fig. 1.12. Three types of diode bridge module.

Made to Measure Just FOR YOU

ELECTRONIC MULTIMETER

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Everyday ELECTRONICS

JULY 1981
ISSUE ON SALE
FRIDAY, JUNE 19

tape AUTO START

BY F.G.RAYER

THIS Tape Auto Start operates in conjunction with a battery tape recorder with a remote stop-start control switch socket so that the recorder starts automatically when speech or other sounds to be recorded arise. Details are also given on how to modify other tape recorders to suit later on.

There is adjustable delay in switching off, to avoid interruption of recording between words. Current in the stand-by condition is only 1mA to 2mA or so, from an internal 6 volt battery.

The Auto Start may be used for dictation where there will be delay between sentences or sections, or to start recording automatically for home musical efforts. Changing from auto to manual control does not require any disconnection of the unit.

CONTROL CIRCUIT

The full circuit of the unit is shown in Fig. 1. The microphone is plugged into the MIC socket SK1. The signal is split and one path goes to a screened output lead to the audio input socket of the recorder. The other path is into the control circuit of the unit. The microphone control switch cable is plugged into the socket marked MIC SWITCH SK2.

The CONTROL OUTPUT cable is plugged into the control switch socket on the tape recorder.

If S1 is set to MANUAL, the switch on the microphone is connected directly to the CONTROL OUTPUT cable, which is plugged into the tape recorder control socket. The Auto Start is then by-passed, and operation of the switch on the microphone starts and stops the recorder as usual.

With S1 set at AUTO the remote switch on the microphone is connected up to the Auto Start and turns this on and off. Components R1 and C1 couple the audio input from the microphone to the very high impedance input of TR1, an f.e.t. This is followed by IC1, with a gain control VR1 which allows adjustment of the audio level at which the Auto Start switches in the recorder.

Audio output from pin 6 of IC1 provides negative bias for the base of TR2, due to rectification by D1. Audio signals thus produce a voltage drop in R9/VR2. This causes the base of

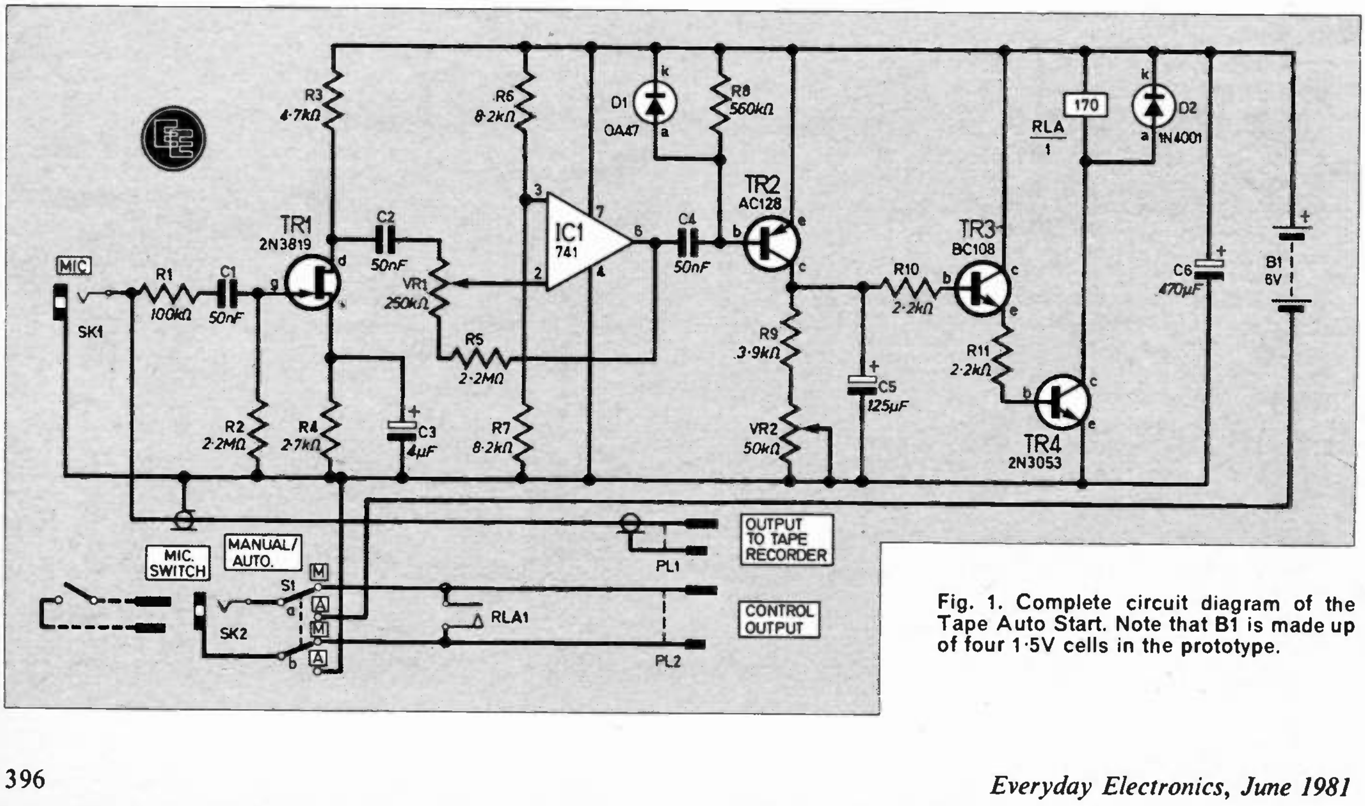


Fig. 1. Complete circuit diagram of the Tape Auto Start. Note that B1 is made up of four 1·5V cells in the prototype.

TR3 to go positive, and TR4 follows, so that current flows in the relay coil. When the relay contacts close, the CONTROL OUTPUT circuit is completed, and this switches on the recorder.

Charging of C5 produces a delay in switching off. The pre-set VR2 allows this to be adjusted from almost immediate operation, to a delay of many seconds.

PLUGS AND JACK SOCKETS

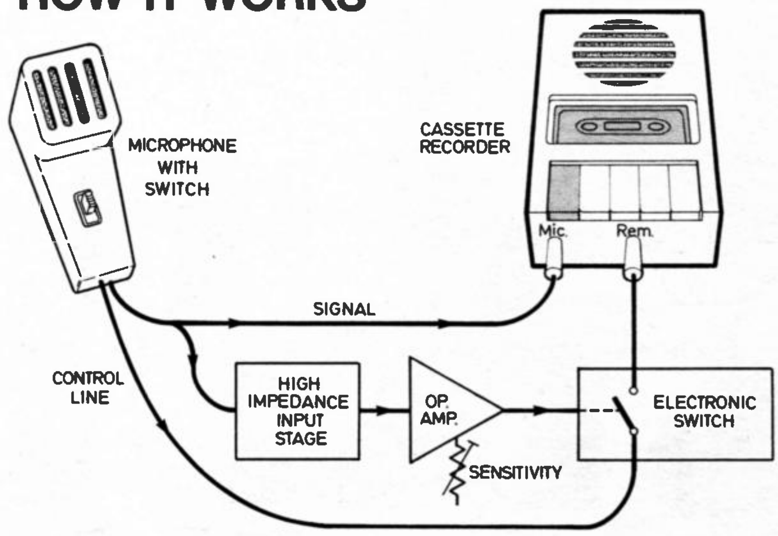
The microphone used had a dual plug, with 3·5mm for audio and 2·5mm control plugs side by side. This is the usual arrangement with this sort of recorder. At the Auto Start, separate 3·5mm and 2·5mm sockets were fitted, correctly separated.

The Auto Start has a screened a.f. lead with 3·5mm plug, and twin flex control lead with 2·5mm plug. These are simply inserted in the appropriate recorder sockets.

A dual plug could be used, but it was found a second recorder had different plug spacing, so the individual plugs were best.

Where a multiple-contact plug is present, a socket will need to be chosen to match.

HOW IT WORKS



The signal and control lines from the remote control microphone are fed into the unit. The signal line is split, one half going straight to the audio input of the tape recorder, the other into the unit.

When a signal is picked up by the microphone, it is amplified in the unit and operates an electronic switch placed in the control line to the tape recorder.

The minimum sound level that triggers the unit can be set by altering the gain of the amplifier.

CONSTRUCTION starts here

CIRCUIT BOARD

The full circuit board layout is shown in Fig. 2. This board consists of 0·15 inch matrix stripboard size 22 strips by 25 holes and the strips run in the long dimension. Pins 1, 5 and 8 of IC1 are unused and should be cut short.

Breaks in the strips are necessary and are indicated in the diagram. These should be made before fitting the components, with a cutter or small drill.

Check that the breaks actually do go right through the strips and that copper fragments do not bridge over to adjacent strips. Note the breaks near the fixing bolts, to avoid short circuiting to the metal panel.

RELAY

The relay is also mounted directly onto the board. It will be necessary to drill holes for the coil connection pins and a larger cutout for the contact connections. This can be seen clearly in Fig. 2. Make sure that there is sufficient clearance around the connections so that short-circuits are impossible.

The diode for reverse voltage protection, D2, is also mounted on the underside of the board in the position shown. Obviously if you are using a different relay to the one specified, then these cutouts will have to be in different positions and different sizes.

You should start assembly with the resistors, then capacitors, finally ending up with the semiconductors.

Solder on leads for positive and negative battery connections, and to those relay contacts which close when the relay is energised. These can be made up of light gauge stranded cable. Power is provided by four HP7 batteries connected in series in a special holder.

Exterior view of the completed prototype. The microphone and control sockets can be seen top right with manual/ auto switch below and in the foreground is a suitable interconnecting lead.

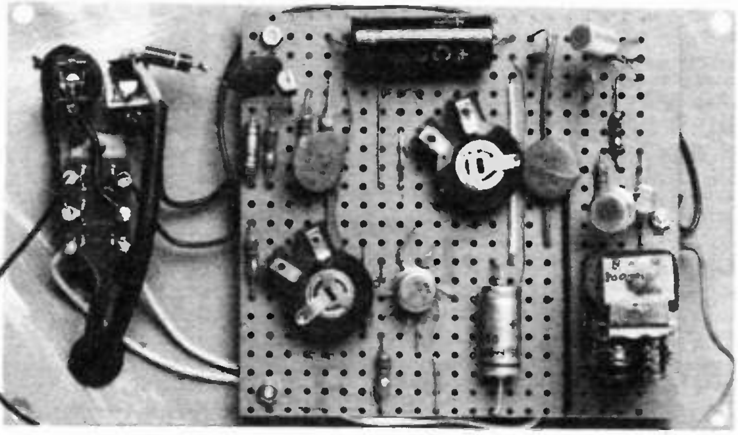
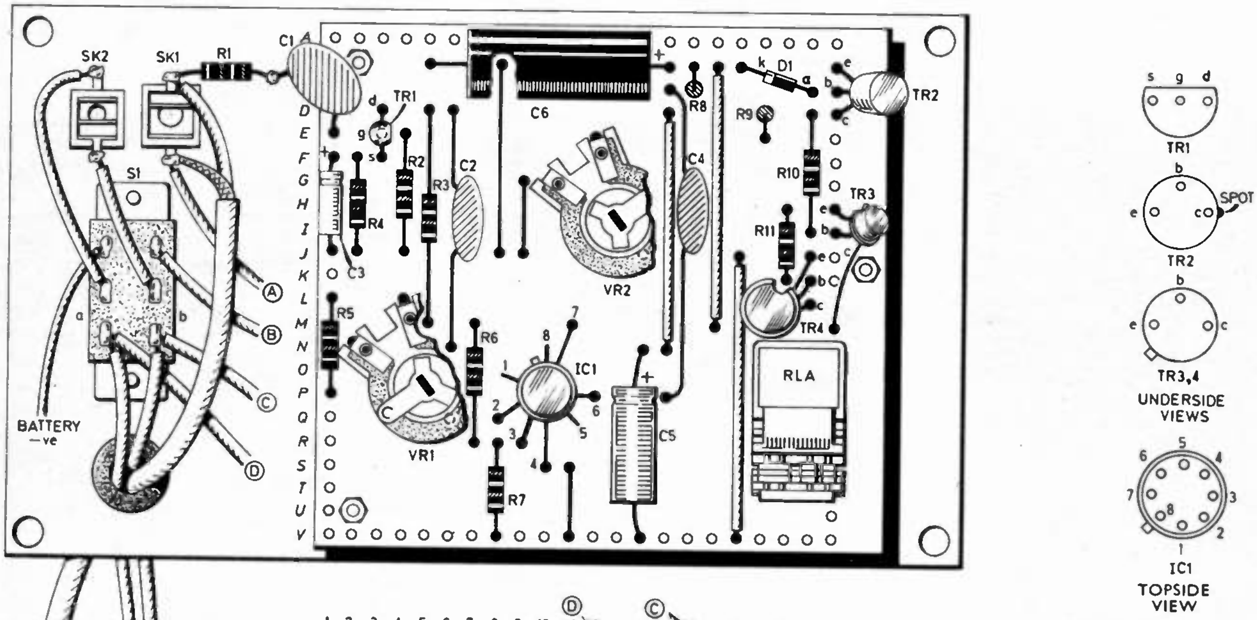


Photo right shows the completed front panel. Compare this with the layout drawing below.



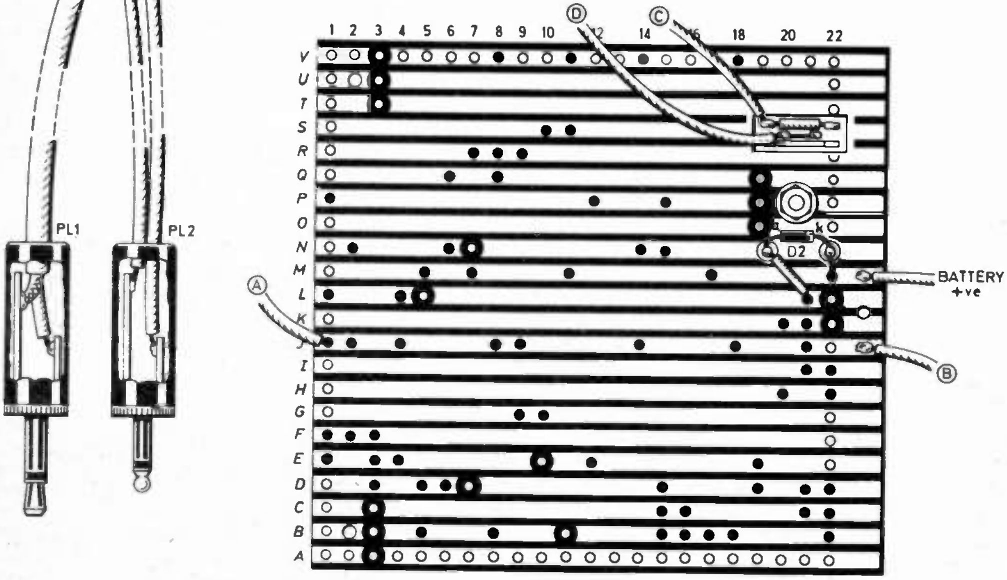


Fig. 2. Full construction and circuit board layout. The circuit board is mounted on the rear of the front panel and all major controls and sockets are mounted alongside. Note that C1 is mounted such that one of its leads is wired directly to the board and the other is butt-jointed to R1 which is then wired to SK1. On the underside of the board, you can see the cutouts for the relay mounting bolt, coil contacts and other contacts. These are hard-wired into the rest of the circuit and are not soldered to the copper strips.

PANEL ASSEMBLY

Full details of the case and front panel are also shown in Fig. 2. These consist of a plastic box 155×95×50mm and a matching aluminium front panel. The board is mounted by means of three 8BA bolts and spacers, with extra nuts. A tag completes the negative circuit to the panel.

Resistor R1 is connected directly to the tip connection of the microphone socket. The sleeve is grounded to the panel and negative line. Switch S1 is connected to the socket taking the microphone switch plug, and it was found necessary to isolate this socket from the panel. This can be done with insulated washers, or a fully insulated socket could be used instead.

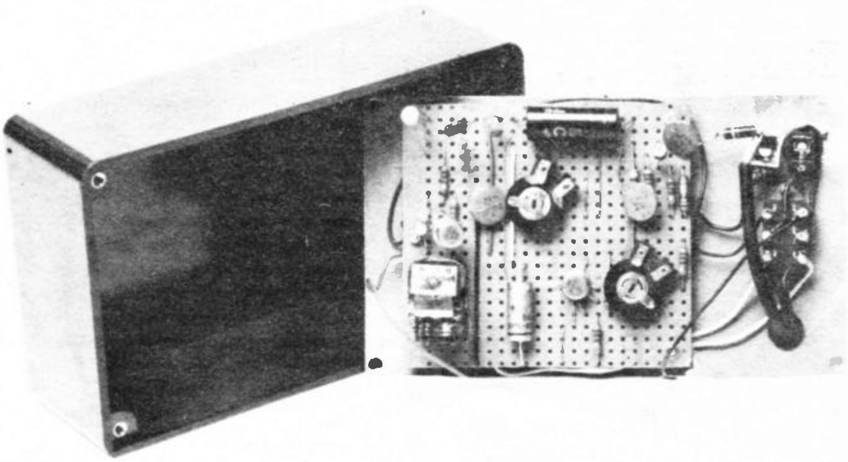
The audio and control leads run through a grommet, and are of similar length.

RELAY

A small 170 ohm relay was fitted to the prototype, and battery drain is about 30mA with this energised. A 47 ohm relay was also found suitable, with a 47 ohm series resistor to reduce current required from the battery.

In general, a relay of about 100 to 250 ohm or so will be most satisfactory. It should operate properly with a 6V supply, but not have a very low resistance coil for the reason mentioned.

COMPONENTS



Resistors

R1 100kΩ
R2 2·2MΩ
R3 4·7kΩ
R4 2·7kΩ
R5 2·2MΩ
R6 8·2kΩ
R7 8·2kΩ
R8 560kΩ
R9 3·9kΩ
R10 2·2kΩ
R11 2·2kΩ
All ¼W carbon ±5%

See **Shop Talk** page 425

Capacitors

C1 50nF disc ceramic
C2 50nF disc ceramic
C3 4μF 16V elect.
C4 50nF disc ceramic
C5 125μF 16V elect.
C6 470μF 16V elect.

Semiconductors

IC1 741 op-amp, TO-99 metal can package
TR1 2N3819 *n*-channel f.e.t.
TR2 AC128 *pnp* germanium
TR3 BC108 *npn* silicon
TR4 2N3053 *npn* silicon
D1 OA47 germanium switching diode
D2 1N4001 silicon 50V, 1A rectifier

COMPONENTS approximate cost £10

Miscellaneous

S1 d.p.d.t. slider
RLA miniature relay with 170 ohm coil and one set normally open contacts
SK1 3·5mm jack socket
SK2 2·5mm jack socket
PL1 3·5mm jack plug
PL2 2·5mm jack plug
VR1 250kΩ horizontal preset
VR2 50kΩ horizontal preset
B1 four HP7 type batteries in series mounted in special holder
Case, 155 × 95 × 50mm, plastics with metal front panel; stripboard, 0·15 inch matrix, 22 strips by 25 holes; screened cable; twin core cable; interconnecting wire; 8BA mounting hardware for circuit board; battery connector.

TESTING AND ADJUSTMENT

With S1 at MANUAL, the switch on the microphone should operate the tape recorder as usual. With VR1 set at maximum gain (slider at C3 end) and VR2 set for minimum delay (slider at R9 end) speech near the microphone should cause the relay to energise and contacts to operate almost immediately.

Subsequently gain can be reduced by means of VR1 so that unrequired noises do not operate the Auto Start, and VR2 set to provide a delay of a few seconds between the end of speech and stopping of the recorder.

MODIFICATIONS

This unit is specifically designed for use with tape recorders that are fitted with a remote switching control socket. This is in effect a normally closed switch in series with the positive battery supply line to the recorder and when the remote switch plug is inserted in this socket, it connects up a manually operated switch in series with the battery line. This switch is usually mounted on the microphone.

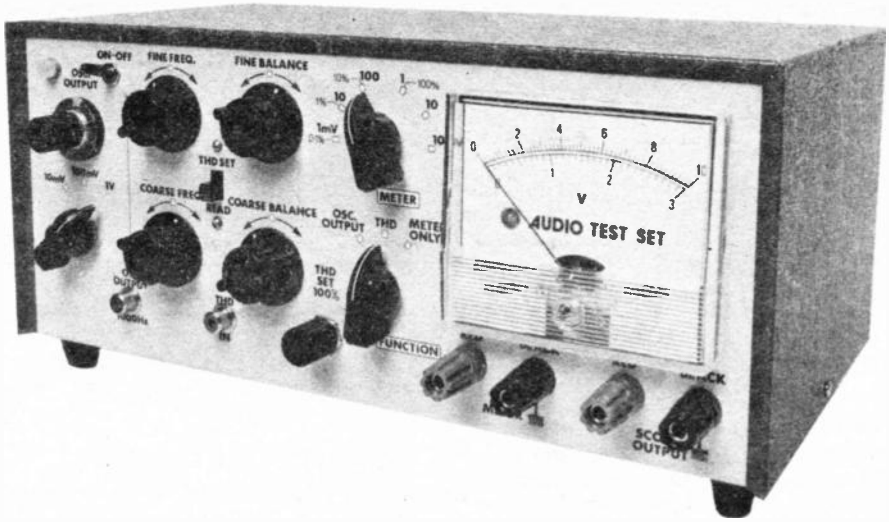
However a tape recorder without this facility can be modified so that the Auto Start can be used with it. You should get hold of a 2·5mm jack socket with a set of normally closed contacts and mount this somewhere convenient in the recorder near to the positive battery supply line.

Cut the positive wire and solder the cut ends to the two contacts on the socket. The tape recorder is now ready to use with the Auto Start. You may also need to provide a remote control switch if you don't have access to a microphone with one fitted.

This is no more than an ordinary single-pole, single-throw type, soldered to a long length of wire with a 2·5mm jackplug on the other end. You may well have to use some ingenuity when mounting this in a suitable holder or case for use. ☐

AUDIO TEST SET PART 2

F.C. Judd



HAVING checked the 1kHz oscillator waveform and output voltage and the calibration of the audio voltmeter section as described in Part One, the next stage is to verify that the t.h.d. bridge section is operating and at the same time check the oscillator for self distortion which should not exceed 0·03 per cent but should, if the circuit is functioning correctly, be as low as 0·02 per cent.

Variations in transistors may give rise to small differences. However, before carrying out this check it must be mentioned that all connecting leads used with the test set to and from external sources, for example to oscilloscope for monitoring, to any external audio signal generator and from any equipment being tested, must be screened otherwise 50Hz hum and other stray noise will be picked up and produce false readings.

T.H.D. SECTION

The procedure for checking the t.h.d. section is as follows and will allow a simultaneous check on oscillator self distortion. First set the oscillator output attenuator for maximum output signal, that is 1 volt, and check this with the audio voltmeter set to the 1 volt range.

Set S2 to position 2, and couple the oscillator output socket via a screened lead to SK1 (THD INPUT).

Leave the audio voltmeter to read 1 volt. Put the switch S1 to position SET. Now turn VR1 (SET 100 PER CENT) so that the meter once again reads full scale which is 1 volt. This also represents 100 per cent and all t.h.d. readings below this, that is at lower voltages, will be related to it. Connect an oscilloscope to the scope monitoring terminals using screened leads and display the 1kHz sine-wave to the largest amplitude the 'scope screen will accommodate.

The next stage requires some concentration and steady hands. Set the controls VR3, VR2, VR4 and VR5 to minimum, anti-clockwise, and put the switch S1 over to READ.

Now advance VR5, which is COARSE FREQUENCY, until a dip in the meter reading is noticed together with a reduction in amplitude on the 'scope screen. Now turn VR2, COARSE BALANCE, until a further dip in level is observed.

Now operate both controls very slowly and slightly backwards and forwards until the meter reads down to as near zero as possible. The amplitude of the signal displayed on the 'scope screen will have gone right down as well.

Now switch the meter to the next range down, that is, 100mV and continue to null out the fundamental with the two coarse controls, because what we are doing is trying to remove all trace of the 1kHz signal. You will now need to use the FINE BALANCE and FINE FREQUENCY controls because the coarse controls will be too abrupt to use when getting down to very low levels.

The procedure now is to go to the next range down on the meter (10mV) and continue with very slow and delicate movement of the fine controls to get the meter even lower. Continue on down to the 1mV range and careful adjustment should bring the meter down to about 0·5mV and then with ultra careful movement, right down to the oscillator self distortion of between 0·2mV and 0·4mV.

OSCILLOSCOPE GAIN

If you can increase the oscilloscope Y amplifier gain during the above procedures you will find it easier to watch the fundamental 1kHz signal gradually disappear until only the harmonic distortion content remains as shown in Fig. 8.

The lower trace (trace *B*) is an actual oscillogram of the oscillator self distortion at 0·02 per cent and taken from the prototype test set as described in this article. The upper trace *A* is the 1kHz sine-wave from the oscillator but of course there is no relationship between the amplitudes shown.

If there were then the sine-wave would be about 5000 times larger than in the photograph. Remember that the frequency and balance controls become very abrupt at the lowest levels of distortion and it requires quite a bit of practice to get the fundamental right out.

This is why accurate distortion measurements with an instrument of this nature can only be carried with the aid of an oscilloscope. You must be able to see the remaining distortion signals as well measure the level.

RATIO

Now assuming that you have obtained a minimum reading of say, 0·3mV and no further reduction can be obtained, then total harmonic distortion will be the ratio:

$$\frac{0\cdot3\text{mV}}{1\text{V}}$$

Converting 1V to millivolts this becomes:

$$\frac{0\cdot3\text{mV}}{1000\text{mV}}$$

To obtain percent distortion divide each figure by 10 because 1000mV represents 100 per cent.

$$\text{So } \frac{0\cdot3}{1000} = \frac{0\cdot03}{100} \text{ or } 0\cdot03 \text{ per cent.}$$

If your readout was 0·25mV then the t.h.d. would be 0·025 per cent. Incidentally, distortion factors can also be expressed in decibels below the level of the fundamental.

Since distortion percentage is obtained from a voltage ratio we can convert to decibels using $20\log_{10}(V_2/V_1)$ where V_2 is the largest amplitude, in this case the reference first used, that is, 1V or 1000mV and where V_1 is the smallest amplitude or that of the distortion level.

For example, with 0·02 per cent t.h.d. the voltage ratio is 1000/0·2=5000. The log of 5000 is 3·6989, or say 3·7 which times 20=74dB, or rather −74dB since the 1V reference will be called 0dB.

As a further point of interest the noise level of the t.h.d. bridge is 0·05mV (50μV) which, with respect to 1V r.m.s. output from the bridge (reference 0dB) is $20\log_{10}$ (1000/0·05) or −86dB so any noise contributed by the bridge circuitry can be considered as negligible.

INSTABILITY

However, there is one further point that should be noted with regard to measuring distortion. When the lowest reading has been established it must be noted quickly because it will not remain steady.

Inherent drift of the oscillator frequency, even by a very small fraction of 1Hz and variation in temperature will simply cause absolute minimum readings to drift, always higher of course.

Before attempting to carry out any distortion measurements have the set switched on for at least ten minutes to allow all the various circuit voltages to settle down and become stable.

Before attempting to carry out distortion checks on amplifiers practise with the controls on the 1kHz oscillator signal and get the feel of manipulating them until the fundamental is completely removed to leave only the distortion components.

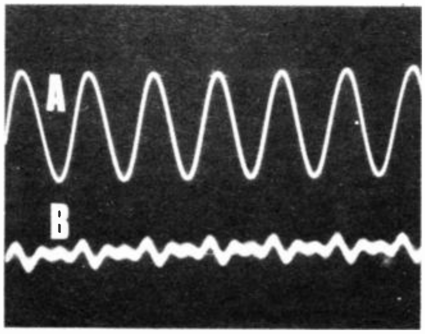


Fig. 8. Oscillograms showing **A** oscillator output and **B** self distortion.

The Wien bridge method of removing the fundamental is commonly used in harmonic distortion analysers and what really happens is that the test signal is put into anti-phase with itself and in this test set takes place after the t.h.d. bridge input transistor TR7.

The 1kHz signal appears at both the collector and emitter of TR7 and is phase cancelled by the bridge network connected between these points. In some commercial distortion bridges the controls for coarse and fine balance are called coarse and fine phase.

AMPLIFIER DISTORTION

It must be remembered that *total* harmonic distortion is the sum total of the amplitude of all harmonics; 2nd, 3rd 4th, 5th, and so on, remaining after the fundamental has been removed. The predominant harmonics are often the 2nd and 3rd and can usually be identified on the oscilloscope when the fundamental has been nulled.

Measurement of the distortion produced by audio amplifiers is a little more complex since consideration must be given to the limit of the power output of the amplifier and the load into which it is designed to operate.

Audio signal voltage amplifiers normally require no output load as such and that provided by the t.h.d. bridge input circuit will suffice. However, remember that if the output from such amplifiers, for example, microphone pre-amps, microphone and signal mixers, pick up and tape head preamps, is below 200mV then the distortion factor cannot be measured with this test set which must have an input signal of not less than 200mV.

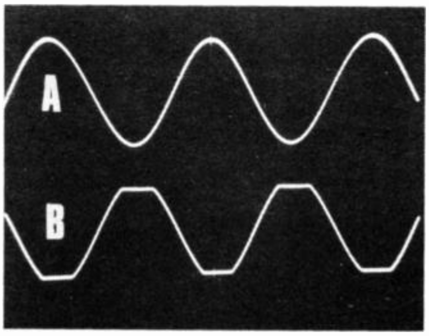


Fig. 10. Showing **A** undistorted and **B** distorted input signals to voltage amplifiers.

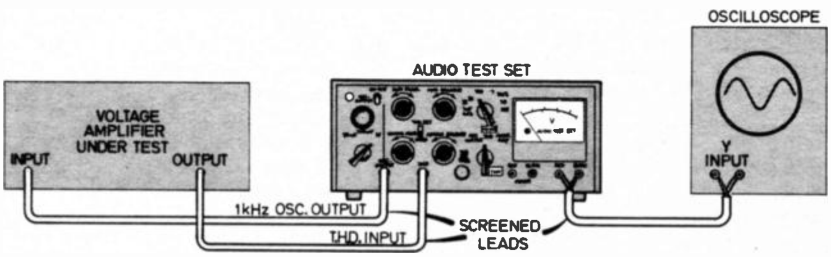


Fig. 9. Experimental set-up to measure distortion in voltage amplifiers.

Higher levels can of course be attenuated and this is the reason for the input level control VR1 (SET 100 PER CENT) which must always be used to obtain a meter reading of 1 volt f.s.d. and which is the 100 per cent reference.

VOLTAGE AMPLIFIERS

We deal first with the requirements and connections, for checking the distortion of purely voltage amplifiers. If an output of 200mV or more is available then connections are as shown in the block diagram Fig. 9. It is most important that the amplifier being tested has the requisite *input* signal which must not exceed that to produce the full rated output signal level permitted by the gain of the amplifier otherwise false distortion readings will be obtained.

This is why an oscilloscope must be used for all distortion measurements to verify that the signal from any amplifier being checked is purely sinusoidal and not being distorted in any way by overloading due to too much input signal. If the input signal does exceed that required the result may be clipped or partially squared as shown in the oscillogram Fig. 10 (lower trace, *B*) and which would produce a distortion factor far in excess of what should be generated.

The upper trace, *A*, in Fig. 10 is how the output signal should look before distortion is measured and this also applies to power amplifiers which we will deal with shortly. Having established that a 1 volt f.s.d. reading is obtainable on the test set meter then the procedure for checking distortion is as fully described previously.

POWER AMPLIFIERS

With power amplifiers it is normal to check distortion at maximum rated r.m.s. sine-wave power output as well as at lower power levels. The amplifier output must however be connected to a *dummy load* of pure resistance equal to the impedance of the amplifier output stage the most common being 4, 8, and 15 ohms.

The majority of amplifiers with transistor output stages will operate into either 4 or 8 ohms but this must be verified and the appropriate load resistance used. It is very important that the dummy load is both non-inductive and capable of dissipating the power fed into it without causing the load to heat up.

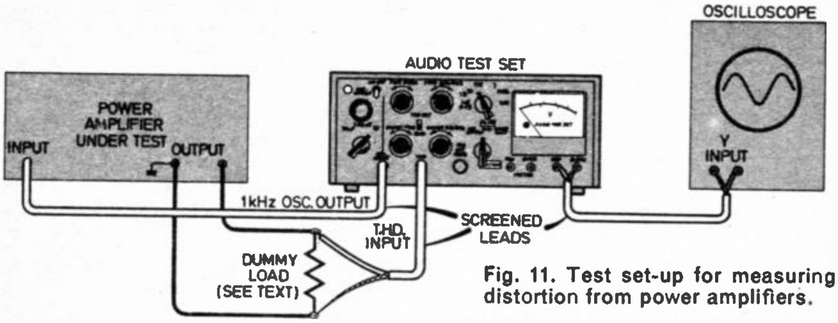


Fig. 11. Test set-up for measuring distortion from power amplifiers.

For example if the amplifier has an output power of say 50 watts r.m.s. then the dummy load should ideally have a rating higher than this to ensure adequate heat dissipation.

The test set up for measuring distortion from power amplifiers is shown in Fig. 11. Again the t.h.d. input attenuator VR1 must be set so than an input of 1 volt gives a 100 per cent meter reading. Make sure that the amplifier being tested is not overloaded at the signal input being used.

It is normal practice to set the amplifier gain control to maximum and then adjust the input signal (1kHz from the test set oscillator) to obtain full rated sine-wave power output without the slightest indication of clipping. Refer again to the oscillograms in Fig. 10.

The best way to make sure that clipping is not occurring is to increase the input signal until the sine-wave is just clipping visibly on the scope as in the lower trace, *B*, and then back off the signal until the clipping just disappears and the signal becomes perfectly sinusoidal as in the upper trace *A*.

It should be mentioned here that actual power output measurement also calls for this procedure and it may be prudent to check this before measuring distortion. However, having established the proper conditions the distortion can be measured as already described.

MORE EXAMPLES

Finally some examples from oscillograms showing typical harmonic distortion content. The upper trace *A* in Fig. 12 shows the sine-wave output from an amplifier which may look good but in fact has a large amount of distortion as in the lower trace *B* and which is about 1 per cent.

The oscillograms in Fig. 13 illustrate what happens if attempts are made to measure distortion from an amplifier which has run into overload, that is the output signal is clipped with the resultant high distortion of over 10 per cent in the lower trace *B*.

The last example in Fig. 14 is more typical with the upper trace *A* showing the output sine-wave and lower trace *B* showing the distortion which is virtually all second harmonic at a level of 0·3 per cent and was in fact from the through amplifier of a tape-recorder.

It is not possible in this article to deal with the measurement of amplifier gain, power output, signal to noise performance and frequency responses, as quite considerable and detailed explanations of the procedures for doing so are necessary if results are to be accurate and meaningful.

However, it is hoped to cover all this in detail at a later date in a special article on checking audio amplifier performance using the audio test set described in this article together with other items of test equipment. ☐

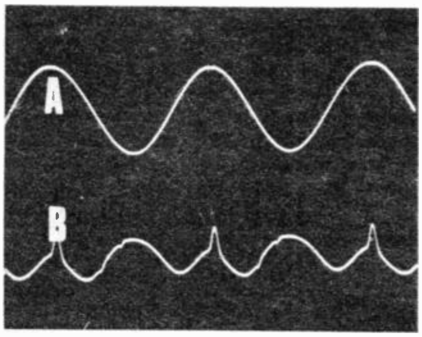


Fig. 12. Oscillograms showing about 1 per cent harmonic distortion.

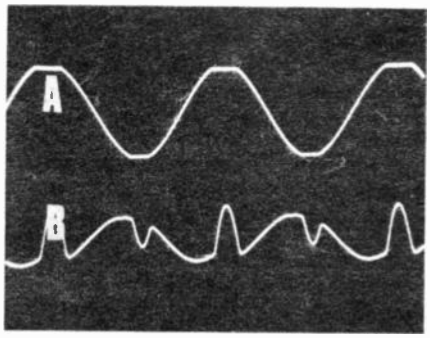


Fig. 13. Oscillograms showing **B** distortion measurements from a distorted input **A**.

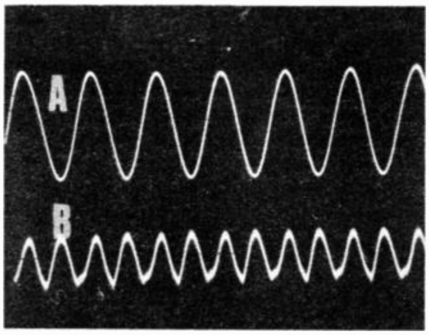


Fig. 14. Oscillograms showing 0·3 per cent second harmonic distortion.

LETTERS

Absorbing Challenge

I am writing to disagree with M. P. Horsey's letter "In Defence of Stripboard" in the April 1981 issue of EVERYDAY ELECTRONICS, in which he says that Veroboard is better than p.c.b.s. I used to use Veroboard but once I started making my own p.c.b.s I realised how much better and more convenient they are.

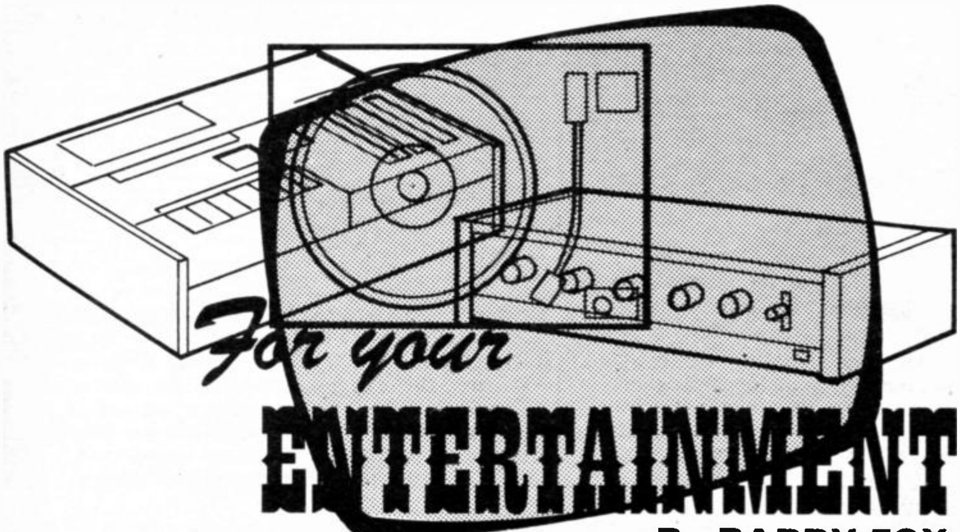
There are no wire links all over the board, there are no copper strips to break, you will not solder a wire into the wrong hole because there will only be holes that will be used. Because there will only be copper tracks where they are required the board will often take less space, and there is far less chance of bridging adjacent strips, and, as Mr. Hornsey said himself, they look much neater.

In reply to the extra time taken to produce a p.c.b. I am sure that most people are not interested in electronics purely so that they can produce gadgets to impress the neighbours cheaply, but also because they enjoy making them. I do not think that it is a bother making p.c.b.s, in fact designing and making them can be an interesting and absorbing challenge. However, in spite of all this, if Mr. Horsey wants to use Veroboard, that is up to him.

I do agree with Mr. Horsey about pricing projects, however. Many magazines do not do this and so you only have a rough idea of the cost.

With regard to under-pricing mentioned by Mrs. C. J. Jones (see *Letters* Feb '81), the approximate price for some projects is much higher than they really are. The *3-Channel Stereo Mixer* that was published in E.E. in February 1981, and that I am currently building, is quoted as costing £14·50, but can be built for £10, on a p.c.b. of course!

Richard Smith,
Torbay, Devon



For your ENTERTAINMENT

By BARRY FOX

In the Picture

A hidden advantage of the video systems battle is that protagonists for each system, having run out of new features to sell, are now looking towards improved picture quality to attract customers. Few people would now argue that, although the VHS format is winning the domestic video standards battle, the Sony C7 recorder produces by far the best pictures. And that the Sony C7 is, of course, working on the rival Beta format which has so far claimed less than half the sales of VHS.

It's really quite remarkable to think that the current and much improved V2000 machines and tapes from Grundig and Philips can produce pictures which compare fairly well with VHS. It's easy to forget that although V2000 and VHS tapes are the same width and run at around the same speed, V2000 uses only half the tape width on each pass through the machine.

Let's hope that the designers of these two systems can soon lick what has so far been their perennial problem; its best called the ragged edge effect. Although not immediately noticeable, this will usually irritate after you have got over the first thrill of seeing colour pictures moving on the screen.

Random Noise

Because domestic video recorders rely on very narrow tape tracks (less than the width of a human hair) the amount of magnetic signal that comes off the tape is very small. This puts a heavy strain on the video amplifier circuits and this in turn creates random noise on the picture.

It's fairly easy to conceal this noise in wide open spaces in the picture, but it's impossible to conceal it on the sharp edges of any object in the picture, such as a face or body. The object's edges are softened and polluted with noise and this produces a ragged shimmering effect.

The effect shows up more on some types of programme material than others but it can be very irritating once you've started to notice it. Hence the continued efforts by video tape chemists and machine designers to boost the output from tape by improving head-to-tape contact and developing new tape coating formulations.

Because V2000 with only half the tape width to play with and the most narrow tracks (23 microns) has the toughest noise problem of all, Philips and Grundig are continually pushing the tape manufacturers to improve performance. BASF, who supply practically all the tape sold by Grundig, have responded well to this challenge.

However, DuPont, an American company which has been supplying Philips, and with whom Philips now has a joint production venture in Europe, seems to be coping rather less well. Doubtless this is why Philips is known to have approached several Japanese manufacturers who have already responded with samples of V2000 tape.

Opto-electronic Analysis

A sophisticated opto-electronic equipment to analyse X-rays of miners unfortunate enough to have contracted pneumonoconiosis is one of Reading Universitys latest developments.

It isn't generally realised that when humans breathe dust of below 3 or 4 microns size it passes safely through the lungs and into the blood. If the dust is above 7 micron size we simply cough it up.

However, if the dust is between these sizes it sticks in the lung tubes and causes debilitating disease. Coal dust has a large percentage of these unfortunately sized particles; so does blue asbestos.

To analyse the amount of dust trapped in a human lung the Reading machine, which was developed for the Medical Research Council, scans a chest X-ray with a laser beam to produce a log of optical density variations. No less than 16 million readings are logged from a single X-ray picture, each reading optically sensing and registering the density of a discrete area one tenth of a millimetre wide.

Only a laser can provide accuracy of this order.

Colour Smudging

Mercifully, the problem of colour smudging which bedevilled virtually all early video recorders, of all formats, seems now to have been solved by most manufacturers. There is a little-known story behind this.

In a video cassette recorder the luminance (black and white) signals and the chroma (colour) signals are handled by different circuits. If the luminance signal leaks into the chroma circuits then it is mistaken for colour information and produces spurious colours in moire patterns. If chroma leaks into the luminance circuit then the result is unsteady verticals in the picture. So meticulous filtering is necessary.

Even more important is the need to compensate for the different lengths of circuit path through which the chroma and luminance signals must travel in the recorder. If a delay line isn't used to compensate for any difference then the two halves of the signal will become out of step, and the pictures on the screen will look as if the colour has been smudged sideways.

Olympics the Cause

At first it seems an easy task to incorporate simple delay lines in a video recorder to keep the chroma and luminance in step. But the issue is confused, believe it or not, by the 1936 Olympics which were held in Berlin!

German broadcasters wanted to televise the Olympics to as many people as possible and thus looked for the cheapest method of producing receivers. To cut a long story short, the engineers discovered that it was possible to compensate for poor high frequency performance in a receiver by doctoring the transmitted signal in a way which created a delay of 170 milliseconds in the high frequencies.

Although the *need* for this signal processing at the transmitter has long since disappeared, it has never been engineered out of some European TV systems. Also, it was never engineered into the British system; our signals are transmitted without any doctoring of the high frequencies and thus with no delays.

It so happens that the delay which is still inherent in some Continental TV signals is in exactly the frequency range which carries the colour or chroma information. So TV sets and video recorders over there must have compensation circuitry to counteract the delay effect. If not there is a smudge of around 3mm on a 26 inch TV screen.

What this means is that (forgetting for present purposes the other differences in transmission standard, such as sound-vision spacing) a video recorder designed for use on the Continent won't have the right in-built delay for the UK. So a recorder circuit that produces smudge-free pictures on the Continent will smudge in the UK and vice-versa.

It seems that this was overlooked by manufacturers of the early video recorders. And that is why they produced colour smudging which became especially noticeable on a large screen.

INTRODUCTION TO LOGIC

PART 2 BY J. CROWTHER

OTHER CODING SYSTEMS

Although logic circuits and computers work in binary, 1's and 0's, pure binary is tedious and cumbersome for humans to handle, being long and therefore liable to errors.

For example

1024_{10} = 10000000000 (eleven columns in binary).

To make it more simple and convenient for humans other coding systems are used, the most common follow:

THE OCTAL SYSTEM

For the convenience of humans, **octal** address references are sometimes used instead of decimal. Since each column in octal is eight times the one to the right, three binary columns are equal to one octal column, so the numbers are less wieldy to handle.

example

Suppose a computer has 1024 memory addresses numbered 0 to 1023 (decimal). This is equivalent to 0 to 1111111111 in binary.

Converting 1023_{10} to octal:

8) 1023
8) 127 and 7 over
8) 15 and 7 over
8) 1 and 7 over
0 and 1 over

Thus $1023_{10} = 1777_8$.

Decimal	Octal	Binary
1023	1777	1111111111

By writing the binary number in columns of three, and writing the decimal equivalent for each column we get the octal number:

Binary	001	111	111	111
Octal	1	7	7	7

So in a computer, memory address 1000 decimal would be given the octal address 1750. The address entry "switches" are then divided into groups of three. The switches in each group are then set to each octal number as shown in Fig. 2.1.

Exercises

2.1. Convert the following binary numbers to octal:
(*a*) 101010100 (*b*) 011110100000 (*c*) 111101001.

2.2. Convert the following octal numbers to binary:
(*a*) 1,263 (*b*) 65,217 (*c*) 426 (*d*) 5,625 (e) 3,273.

BINARY CODED DECIMAL SYSTEM

The **binary coded decimal system (b.c.d.)** is a four-bit system representing a decimal character for use with digital display read-outs and in some computer calculations. It can also be used for addressing to make this more convenient for human use. Since the highest number possible on an l.e.d. display is usually 9, and binary nine requires four bits, the system is divided into blocks of four-bits, each block representing the decimal numbers 0 to 9 as shown:

b.c.d. number	1001	0010	0011	0000
decimal equivalent	9	2	3	0

Since the highest number that can be represented by four bits is 1111, (15_{10}) and the highest b.c.d. number allowed is 1001 (9_{10}), there are six illegal numbers which are not allowed in b.c.d. namely decimal 10 to 15 (1010 to 1111).

Exercises

2.3. Convert the following decimal numbers to b.c.d.:
(*a*) 94 (*b*) 429 (*c*) 2947 (*d*) 1736 (*e*) 538 (*f*) 735.

2.4. Convert the following b.c.d. numbers to decimal:
(*a*) 10000101 (*b*) 01110001001 (*c*) 001101100100.

THE HEXADECIMAL SYSTEM

The b.c.d. system is a very convenient system for humans to use but is very inefficient as far as the computer is concerned. A four-bit binary string can represent sixteen different numbers (or addresses) numbered 0 to 15, and an eight-bit binary string can be represent 256 addresses numbered 0 to 255. If b.c.d. coding is used, a four-bit binary string can only represent 10 addresses, numbered 0 to 9, and an eight-bit string 100 addresses numbered 0 to 99.

It can be seen that with b.c.d. coding there are six unused combinations within a four bit string, and 155 unused combinations in an eight-bit string. Since computer memory space is at a premium it can be seen that the b.c.d. system is very wasteful and inefficient.

In the **hexadecimal system (HEX)** the first 10 locations retain the numbers code as in the b.c.d. system but the six unused locations (1010 to 1111) are given a letter coding, A to F. The full coding for the HEX system is shown below:

Binary	Hex	Binary	Hex
0000	0	1000	8
0001	1	1001	9
0010	2	1010	A
0011	3	1011	B
0100	4	1100	C
0101	5	1101	D
0110	6	1110	E
0111	7	1111	F

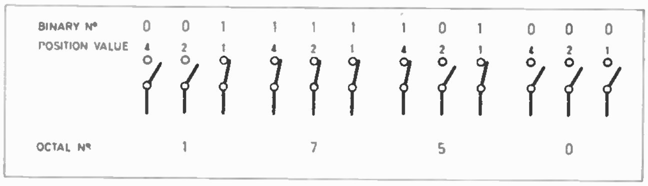


Fig. 2.1. Switches grouped in threes for octal coding from binary.

examples

01001111 = $4F_{hex}$ 10000011 = 83_{hex}
11111010 = FA_{hex} 10111100 = BC_{hex}

The more usual way nowadays of signifying a hexadecimal number, is to append an "H" to the number. We shall use this identification of a hexadecimal number throughout the series.

example

4096_{hex} is more usually written 4096H.

Converting Hexadecimal to Decimal

Since there are sixteen symbols in the hexadecimal system, 0 to F, this is a counting system to the base of 16, hence the radix is 16, remembering that 10 is represented by A, 11 by B and so on up to 15 by F.

Like all counting systems, the hexadecimal system is based on powers of the radix, powers of 16 as shown:

Powers of 16	16^3	16^2	16^1	16^0
Decimal number	4096	256	16	1
Hexadecimal number	0	3	A	F

Thus 03AFH = (0 × 4096) + (3 × 256) + (10 × 16) + (15 × 1)
= 0 + 768 + 160 + 15 = 943_{10}.

Converting Decimal to Hexadecimal

To convert decimal to hexadecimal divide by 16 until there is nothing left, then read the remainders up from the bottom as shown:

16) 813
16) 50 and 13 over = D
16) 3 and 2 over = 2
0 and 3 over = 3

Therefore 813_{10} = 32DH.

Exercises

2.5. Convert the following binary bits to hexadecimal:
(*a*) 11100001 (*b*) 101110001111 (*c*) 11111100 (*d*) 00010011.
2.6. Convert the following to binary:
(*a*) 4FH (*b*) 1ACH (*c*) 67H (*d*) 2A8H (*e*) EFH (*f*) A1BH.
2.7. Convert the following to decimal:
(*a*) 2DH (*b*) 1AFH (*c*) 21AH (*d*) 1AEH (*e*) FBH (*f*) 57H.
2.8. Convert the following decimal numbers to HEX:
(*a*) 1632 (*b*) 494 (*c*) 5174 (*d*) 67 (*e*) 123.

BINARY ARITHMETIC

(a) Addition

Binary addition is similar to addition in decimal, except you have to carry one to the next column for every two instead of for every ten.

example

Add 37 and 25.

decimal	binary	
1	*1*	*carry*
37	100101	
25 +	011001 +	
62	111110	equivalent to 62_{10}

The same principle applies if more than two numbers are to be added, remembering to carry one for every two in the total.

example

Add together 14, 11, 7 and 3.

decimal	binary	
1	*12221*	*carry*
14	1110	
11	1011	
7 +	0111 +	
3	0011	
35	100011	equivalent to 35_{10}

Note

As a computer can only deal in 1's and 0's it could not carry 2. Therefore it would do three separate additions as follows:

Add 14 to 11 to obtain 25, add 7 to this to obtain 32 and finally add 3 to this to obtain the result, 35.

Addition in b.c.d.

As stated earlier the b.c.d. system is divided into blocks of four, each block representing the decimal numbers 0 to 9, the remaining numbers, 10 to 15 being illegal and not allowed in b.c.d. These six illegal numbers can present problems when performing addition in b.c.d.

example

Add 6 and 5 in b.c.d.

decimal	b.c.d.
6	0110
5	0101
11	1011

It will be seen that although the answer obtained in the b.c.d. addition is binary eleven, which is correct, it is an illegal number which is not allowed in the b.c.d. system. Eleven in b.c.d. is 00010001.

When performing b.c.d. addition the two numbers are added together as above but if the answer is illegal, that means above 9, a further 6 must be added which will cause one bit to overflow into the next block of four giving the correct b.c.d. answer as shown:

b.c.d.	
0110	
0101 +	
1011	illegal in b.c.d. so
0110 +	add 6
0001 0001	eleven in b.c.d.

Exercises

2.9. Evaluate the following b.c.d. additions:
(*a*) 0011 + 0101 (*b*) 1001 + 0110 (*c*) 0011 + 0110 + 1001 (*d*) 00110001 + 01101001.

Addition in Hexadecimal

As hexadecimal is a counting system to the base of sixteen, addition is similar to decimal addition except that you have to carry one to the next column for every sixteen instead of every ten, remembering that instead of writing 10, 11, 12, 13, 14, 15, write A, B, C, D, E, F respectively.

example

Add 4F and 8A.

1	*carry*
4F	
8A +	
D9	answer

First add A (10) to F (15) which is 25. This is (1 × 16) and 9 over, write 9 and carry 1 to the next column. Now add 1, 4, and 8, which is 13, but 13 is represented by D in HEX, therefore write D in the second column of the answer.

Exercises

2.10. Evaluate the following hexadecimal additions:
(*a*) 1A + 21 (*b*) 6B + 5A (*c*) 23 + 4A + B1.

Answers to Exercises in Part 1

1.1. (*a*) 27·5 (*b*) 395·125 (*c*) 186.
1.2. (*a*) 1331 (*b*) 325 (*c*) 175.
1.3. (*a*) 1020·03 (*b*) 200·1043 (*c*) 110·14.
1.4. (*a*) 13·5 (*b*) 78·75 (*c*) 36·5 (*d*) 887.
1.5. (*a*) 111110 (*b*) 10000000000 (*c*) 101010·01 (*d*) 110011·001.

TO BE CONTINUED

BACK TO BASICS
The Electric Circuit

NEWCOMERS to electronics naturally want to get cracking and build things that work. That's fine . . . and a lot more interesting than theory. But most of us also want to understand how things work and even do a modest bit of designing ourselves.

In some ways it's getting easier all the time, with integrated circuits (or microchips) to do most of the job for us. But a general understanding of circuit basics is still essential.

My aim is to provide a painless introduction to the subject. Off we go, then.

THE GREEKS HAD A WORD FOR IT

Some interest in electricity was shown a couple of thousand years ago by the ancient Greeks. It didn't lead anywhere, because the Greeks were poor scientists. They preferred sitting around and philosophising to making experiments.

But even philosphers have to start somewhere. The Greeks started with the observation that the natural substance amber (a fossilised resin) when rubbed with a piece of dry cloth acquires the ability to attract and pick up light objects such as dust and bits of fluff.

There the matter rested for many centuries. When, in Western Europe, the first scientific investigations were done it was quickly discovered that many other materials have this same odd property.

A word was needed to describe it.

People might have said that all these materials have the property of "amber-ness" but being scholars they went back to the Greek word for amber, which is *elektron*, and coined the new word **electricity** from it.

Some of the other substances which turned out to be "electrical" were sulphur, some kinds of stone and wax, and glass. Nowadays we call such materials **insulators** or **dielectrics**.

STATIC CHARGES AND MOVING SPARKS

Rubbing insulators with cloth or fur is tedious and in the 18th and 19th centuries experimenters designed all manner of "electrical machines" in which the rubbing was done continuously by turning a handle or wheel. This provided a ready supply of **electric charge**.

It was discovered that the charge could be stored for a while in a device called a **condenser**. (The modern word is **capacitor.**) This was called a static charge.

A highly-charged condenser could be discharged very quickly by connecting its terminals together or bringing them so close that a spark jumped from one to the other or from one to the earth.

Evidently electricity existed in two forms: **static charges** and **moving sparks** which travelled instantaneously from one point to another. Benjamin Franklin's famous but extremely dangerous experiment of flying a kite into a thunderstorm and detecting electric charges on the string suggested that lightning was a natural form of electricity and that thunder clouds must be electrically charged.

FLUID OR CURRENT?

But how was the electricity produced? How could it move from one place to another? Franklin suggested that electricity involved an invisible fluid which permeated all matter. An electric charge involved changing the quantity of fluid in the charged object.

Give an object more than its normal amount of electric fluid and it **became positively** charged.

Take fluid away and the charge was **negative.**

Fluids can flow. A flow of electric fluid must be an **electric current**. Sparks and lightning showed that the current went very quickly.

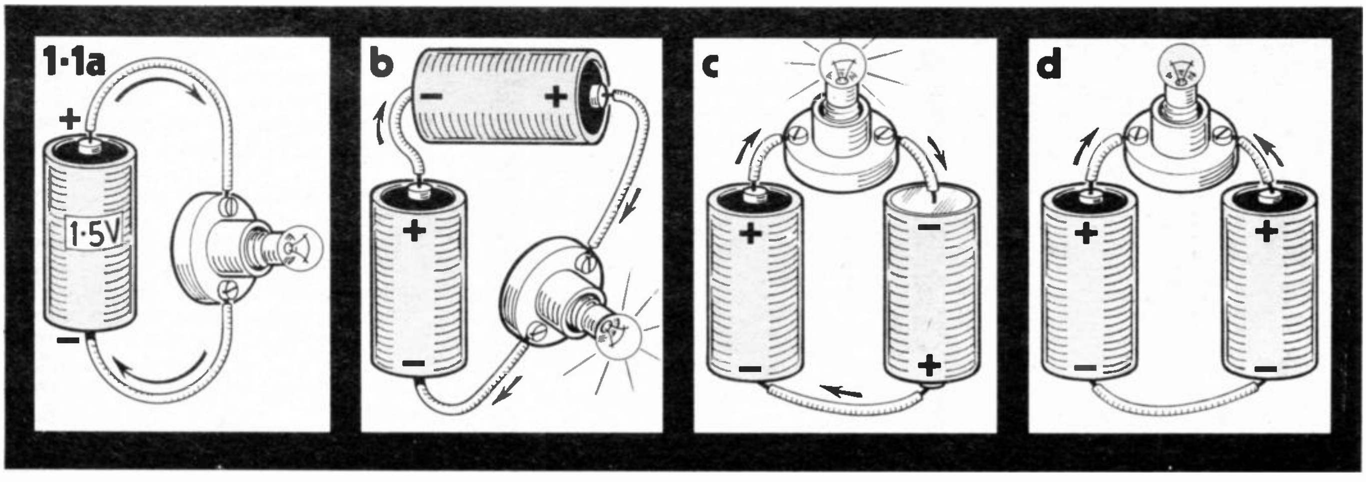
THE ELECTRIC CELL

Sparks and lightning are not very convenient for experiments. They are over too quickly and tend to kill people!

The great breakthrough came with the invention by Volta of the **electric cell.** This produced, not brief sparks but a continuous flow of electric current. You didn't even have to turn a handle.

A SIMPLE CIRCUIT

Let's consider a simple circuit **(Fig.1.1a)** with a single torch cell and bulb. The bulb gives us a great advantage over the earlier experimenters in lighting up to show that current is flowing. (Before electric light was invented they had to detect current flow by placing a compass near the wires. When current flows a **magnetic field** is created round the wire and this deflects the compass needle.)



A FOUR-PART INITIATION COURSE FOR NEWCOMERS

By George Hylton

1

The usual types of single cell produce enough output to light a 2·5 volt torch bulb. (Bulbs marked 1·3 volt or 1·4 volt may also be used.) What really happens is that the electrical energy created by the cell is turned into heat in the bulb. A thin wire (the "filament") inside the bulb glows white hot.

Cells can be connected together in various useful ways. Here we'll deal with only one way: connecting cells so that they aid one another by pushing current in the same direction through the circuit.

To achieve this the cells are connected "nose to tail" (**Fig.1.1b**). This increases their current-driving force and the bulb lights more brightly—so brightly in fact that it soon burns out. (Torches which employ two cells need 3-volt bulbs.)

If you experiment, you'll find that the bulb burns just as brightly when connected as at (**b**) or as at (**c**). This illustrates an important point. The current is evidently the same everywhere in the circuit. It doesn't diminish as it travels along.

A MOVEMENT OF PARTICLES

The modern way of explaining this is to regard an electric current not as a flow of invisible fluid but as a movement of charged particles. In most circuits the particles are **electrons**, which carry negative charges.

Now, just as the north pole of one magnet repels the north pole of another, so in electric circuits negative repels negative.

If, because of some electric bottleneck in the circuit the electrons piled up in a sort of traffic jam that bit of the circuit would become strongly charged negatively.

Any electrons coming along from behind would be repelled. They in turn would repel the electrons behind themselves, and so on all the way back to the battery.

The upshot of all this is that charges don't pile up in this sort of circuit and the current automatically regulates itself to be the same at all points.

A WATERWORKS ANALOGY

Inside the cell, the current must be flowing the wrong way, from negative terminal to positive.

If this seems peculiar, like water flowing uphill, remember that the water which comes out of the tap starts life uphill, in an elevated tank, water tower, or reservoir. It has to be pumped up there in the first instance.

The battery does this sort of job, in an electric circuit. It acts like the elevated tank from which things run downhill. But to keep the supply of electrons topped up it has to do some work.

How much current flows? Our two-cell circuits **Fig 1.1b** and **Fig. 1.1c** make the lamp shine brighter. Evidently more current flows when a number of cells all push the same way, like two or more locomotives pushing a line of wagons. But if the line of wagons is made longer they are harder to push.

In the electrical circuit, the work of the battery could be made harder by connecting two bulbs so that the current had to go first through one then through the other. Common sense says that the two-bulb circuit must offer more **resistance** to the flow of current.

Before we look into this further, consider **Fig. 1.1d.** If our ideas about cells helping one another are right, then in this circuit they ought to hinder one another since they are now trying to push currents in opposite directions.

Try it. You'll find, as you expected, that the bulb doesn't light.

RESISTANCE

At this point we can move away from drawings of actual cells and lamps and use a purely symbolic circuit (**Fig. 1.2**).

Each cell is shown as a thin line (the positive plate or electrode) and a shorter thick line (the negative). Ordinary connecting wires are shown as lines and are assumed not to impede the current flow significantly. The bulb, which offers an appreciable resistance, is drawn here as a zigzag. This is one way of drawing a resistance—any sort of resistance.

In the 19th century Georg Simon Ohm showed that, just as common sense suggests, the Intensity of the current (I) increases as the driving force of the battery increases. The driving force was called the **Electromotive Force** (E). But if the circuit **Resistance** (R) is increased the current diminishes.

Ohm's findings are illustrated in modern terms in **Fig. 1.3.** Each line represents a different resistance. You can see that doubling the resistance halves the current while doubling the **Voltage** (E) doubles the current.

This is the basic rule of battery circuits.

BATTERIES

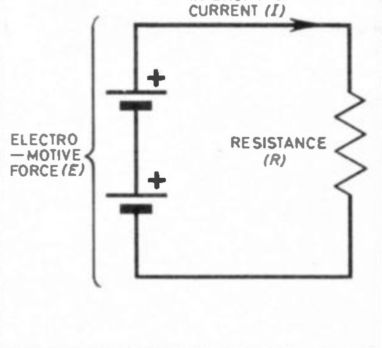
Batteries come in all shapes and sizes. A large 1·5 volt cell produces the same voltage as a small one but is capable of driving the same current for a longer time. The capacity of a cell or battery is quoted in ampere-hours, the **ampere** being the unit of current.

A car battery rated at 30 ampere hours can when fully charged supply one ampere for thirty hours, or 2A for 15 hours, and so on.

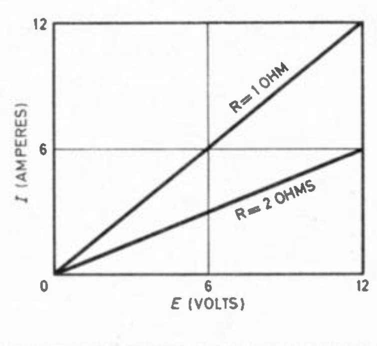
There is however an upper limit to the current which can safely be drawn without damaging the battery, and in the case of dry batteries like those in transistor radios and torches this safe limit is often quite low.

Drawing heavy currents shortens life so battery size must be properly chosen. Giving a dry battery numerous rests between uses helps it to recover and increases its useful life.

1·2



1·3



Continued next month

Everyday News

HOME VIDEO —

The story so far

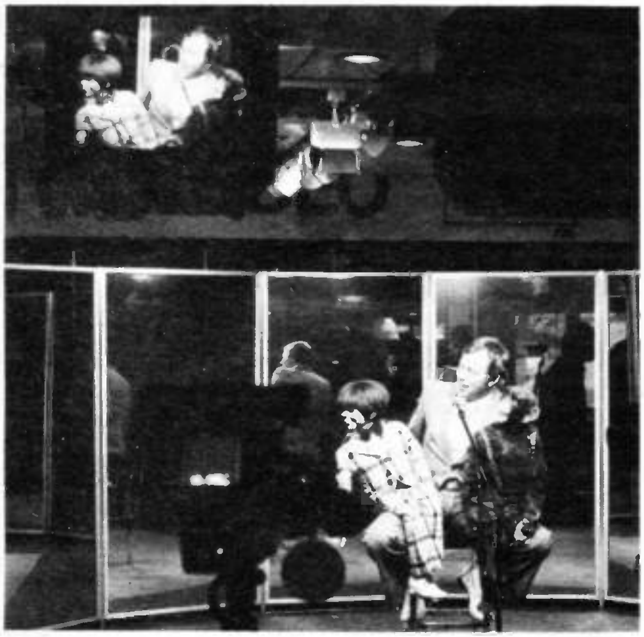
"Who's this, then?"—Hercules the Bear previews his latest film.

Confidence abounds—video's the thing, and if the ad-men have their way, you will definitely feel a social outcast if you're not sporting the latest video hardware by the end of the year.

As if to emphasise the point, Michael Barratt, late of Nationwide, has recently predicted that, "by July 28, you will not be able to rent or buy a VHS or Beta video recorder".

Strong words, but there are a lot of manufacturers spending a lot of money to make the video dream come true.

For example, the RCA Corporation in America are spending a staggering $20 million on promoting their SelectaVision VideoDisc alone! And there appears to be no shortage of buyers. Strangely enough, the recent recession has actually helped video sales. Perhaps people are even more anxious to escape from reality in times of uncertainty.



Midlands comedian Ken Wood entertains on the Sony stand at the Home Video Show.

Undoubtedly the biggest video event of the year so far has been the Home Video Show held at the Cunard Hotel in Hammersmith. The emphasis here was certainly "public participation" and this meant manufacturers actually trusting the public with some of their most expensive equipment.

Of course it isn't much good having the equipment if there's nothing to aim it at, a point that hadn't eluded the people from Sony. They had laid on an endless procession of acts, including the delectable Serena, the Sony Disco Queen.

Not to be outdone, Philips had sponsored a dance troupe all of their own called the Fabulous Apollo, an all girl singing and dancing team, guaranteed to liven up anyone's day, whilst JVC were rather more into the wild west approach with their bucking-bronco.

One visitor who needed no introduction was Hercules the Bear. He was putting in an appearance to promote his new film "Hercules the Wrestling Bear". This particular offering is exclusive to the Video Club, Britain's largest suppliers of pre-recorded cassettes.

It need hardly be said that these cassettes represent a tremendous growth sector of the video market and this was reflected in the number of suppliers at the show.

Mind you, one wonders what will happen to them all when the video disc really takes off. Certainly at an average £40, a cassette isn't cheap and who wants to watch the same old movie again and again anyway?

According to RCA, their SelectaVision discs will retail at between $14·98 and $27·98 with a player at around $500 and that's for two hours playing time. But the software—that is the major feature films and other programmes—must be available because, as one astute member of the trade put it, "the software sells the hardware".

Still, all is not alarm and despondency, because, as Professor Martin Roberts of Los Angeles said, "the future for home video is a rosy one".

Just a taste of the many films available on video cassette from Rank Video.

—ANALYSIS

MPUs — THE FIRST DECADE

In 1968 the then 31-year-old Dr. Marcian E. Hoff joined a new and virtually unknown semiconductor company called Intel. Given the task of producing eleven separate low-density LSI chips for a Japanese-designed desk-top calculator, Hoff did a redesign exercise to reduce the number of chips and in so doing developed by 1971 the Intel 4004, the world's first microprocessor or MPU.

The MPU is thus now 10 years old and in a single decade has transformed the electronics industry itself and practically every other industry in which the MPU can find a profitable application.

Where Dr. Hoff and Intel led, others were soon to follow although not necessarily on identical lines. Within a year National Semiconductor embarked on the bit-slice architecture which may be described as a range of standard building blocks from which more powerful microcomputers could be assembled. All the major manufacturers have since entered the MPU market.

Microprocessor technology is fascinating in its own right. But equally fascinating is the impact of the MPU on the way we live. Computing power is now cheap enough for everybody and its small size allows it to be incorporated in almost any piece of equipment, even children's toys.

The paradox of modern life is that while the husband is grumbling about redundancy in his factory through the introduction of MPU-controlled industrial robots, his wife at home is overcome with joy at her new MPU-controlled washing machine with its push-button selection of any nine programmes which together can provide any of 200 different wash conditions. Never has life been so blissful for her, yet so worrying to him.

Brian G. Peck

TV Beats The Gasman

The long suffering residents of an area of East London will welcome the news of a new TV relay station that has just been installed on a block of flats in Hackney by the BBC and IBA.

The problem has been that local residents are situated near several gasholders and these have been playing havoc with reception, particularly "ghosting." As the demand for gas fluctuates day and night so the metal gasholders rise and fall causing TV reception to vary dramatically.

The only problem is that to take advantage of the new station, viewers will need group E or wideband aerials fitted outside, directed towards the new relay and mounted with the rods set vertically. Aerials used for reception from Crystal Palace are not suitable.

Wideband aerials with good anti-ghosting characteristics are particularly recommended. The BBC and IBA do not advise the use of set-top aerials.

The organisers and sponsors of Compec, London's annual computer exhibition, have announced "Compec North," to take place at Belle Vue, Manchester, from June 23 to 25.

The second Sussex Mobile Rally to be held at Brighton Race Course will be on Sunday, July 19, from 10.30 a.m. to 6 p.m.

Entrance charge will be 50p. For disabled persons and children under 14 years there will be no charge.

The second "Electronic Hotel" exhibition and conference has been announced for June 3 and 4. This dual event will again be held at London's West Centre Hotel.

Global Specialities Corporation (UK) Ltd is the new name for Continental Specialities.

This change in name falls in line with the parent company in the US.

Safe Jobs

The safest jobs in the country are those for qualified electronic and electrical engineers.

While the national average of unemployment is now running at about 10 per cent of the working population and in some areas is as much as 20 per cent, unemployment of electronic and electrical engineers is just 0·8 per cent according to a recent IEE survey of 8,000 members who responded to a questionnaire. Average salaries vary between regions from £8,462 in Greater London to £6,789 in the East Midlands.

EURO FUNDS

The European Commission is inviting applications from UK companies for financial support of computer software and applications projects. A key object of the scheme is the support of collaborative projects involving at least two users or companies from at least two Member States.

The closing date is June 1, 1981. Proposals should relate to projects to be launched no earlier than in the last quarter of 1981 and the Community hopes to make the final choice of successful proposals in October.

Electronic Passport

Machine-readable code is expected to be a feature of future passports. This will enable identity checks at automated barriers at entry points, the passport details being automatically checked against records kept in a central computer.

The idea is being resisted by civil rights groups who fear that secret coded information on the owner of the passport could be included without the owner's knowledge.

SCHOOL FOR COMPUTERS

The Prime Minister has just announced a revolutionary £4 million plan to put a microcomputer into every secondary school by the end of 1982.

Commenting, "That quality requires not only that children should learn familiar basic subjects but that they should understand computers and how they are used and applied."

Mrs Thatcher went on to say "Those now at school will need to adapt to each new technological advance if we are to remain an industrial power to create new products and jobs in service industries".

She blamed her own generation for being "too cautious" about accepting computers. "Schoolchildren now take for granted electronic games and toys as well as the ubiquitous calculator. They find buttons and television screens an exciting way of playing and learning."

Speaking at the Department of Industry, she outlined the governments aim to put a microcomputer into every one of the 5000 secondary schools in the next 20 months.

Her most telling announcement was the proposal, through an Education Department £10 million scheme, to help teachers learn how to use computers. "When most teachers were at school, computers were hardly invented, let alone regarded as a piece of school equipment."

Schools wishing to take advantage of the scheme should approach their Local Education Authority.

It is our understanding that Britain's independent schools will also be eligible for government aid to buy their own microcomputers.

Two British microcomputers have been selected for this *Micros In Schools* scheme. They are the BAC computer from Acorn (£230) and Research Machines 380Z (£1,680).

TREMOLO UNIT

BY M.G. ARGENT

REMEMBER the good old sixties when the Shadows were top and petrol cost 2/6d a gallon? Apart from a barn-like echo, the most sought after special effect was the tremolo.

Unfortunately times have changed and the tremolo isn't as popular as it was, although with the recent sixties revival, interest is again being shown in these units. The tremolo design featured here is easy to build and will be suitable for a wide variety of applications including electric guitars, organs and other similar instruments.

CIRCUIT

The full circuit diagram of the Tremolo is shown in Fig. 1. The heart of the unit is IC1, the MC3340 electronic attenuator. The prime function of this i.c. is to reduce the amplitude of an a.f. signal entering it at pin 1 by a predetermined amount. This can be achieved either by applying a control voltage, which may be fixed or varying, to pin 2, or by controlling the resistance between pin 2 and 0V.

In our case we have chosen to obtain the tremolo effect by generating a sinusoidal control voltage and applying this to pin 2 of IC1. This slow sine-wave is generated by a twin-T type oscillator built around TR1. The frequency of oscillation and hence speed of the tremolo is controlled by VR1.

The output of the oscillator is passed through C8, a d.c. blocking capacitor. Components R8 and C9 serve to iron out any irregularities in the waveform.

OP-AMP

The sine wave is passed next to an op-amp, IC2, which controls the gain of this signal producing a suitable control voltage for the attenuator i.c. The overall amplitude of this control voltage can be controlled by VR2, and this forms the DEPTH control. The output of IC2 is fed via a footswitch, S1, and d.c. blocking capacitor C3 to the control input, pin 2, of IC1.

This switch is used to turn the effect on and off. When it is open, the varying control voltage is cut off from IC1 and the signal is not attenuated. When the switch is depressed and the circuit is completed, the control voltage can get to IC1 and the input signal is varied producing the tremolo effect.

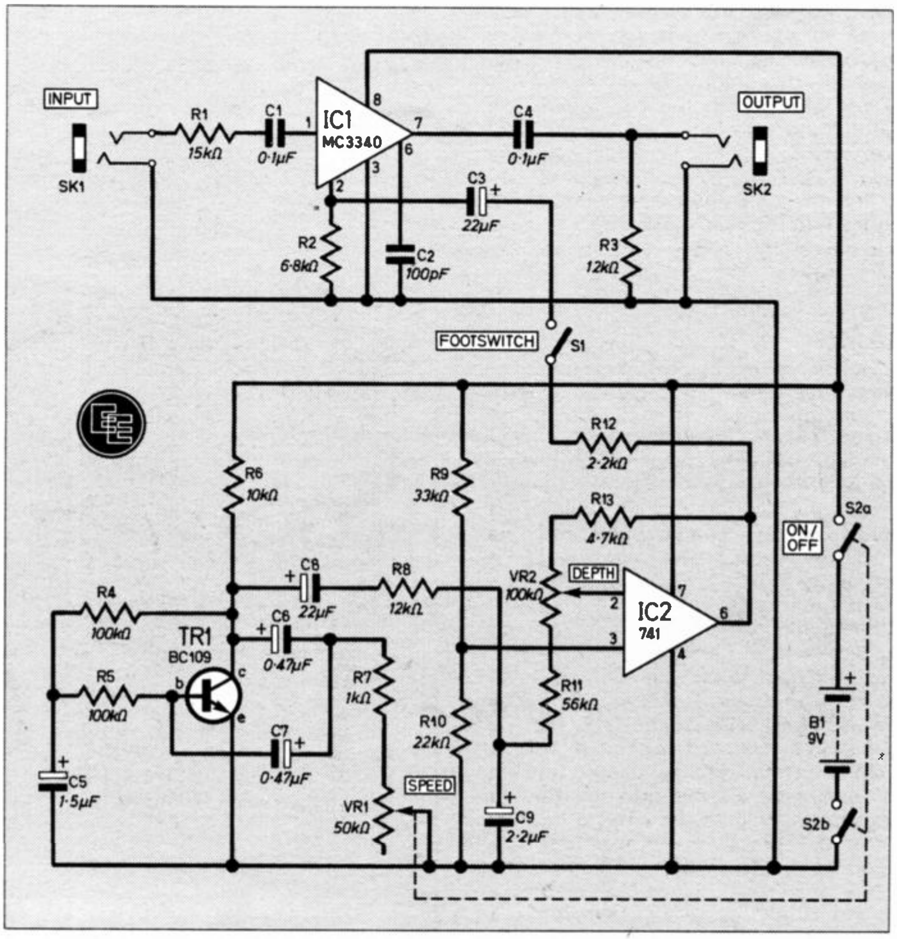


Fig. 1. Full circuit diagram of the Tremolo Unit.

Power is provided by a 9V, PP3 type battery. It would be a good idea to use a long life battery such as the Duracell type, because current drain is relatively high when the unit is in use. An ON/OFF switch S2 is also provided. This is ganged to the SPEED control, VR1. The Tremolo should always be switched off when not in use.

CONSTRUCTION starts here

STRIPBOARD

The bulk of the circuit is laid out on a piece of 0·1 inch matrix stripboard, 21 strips by 27 holes and the full layout is shown in Fig. 2. There are no special considerations here except to say that construction should start first with resistors and link wires, then capacitors and finally semiconductors.

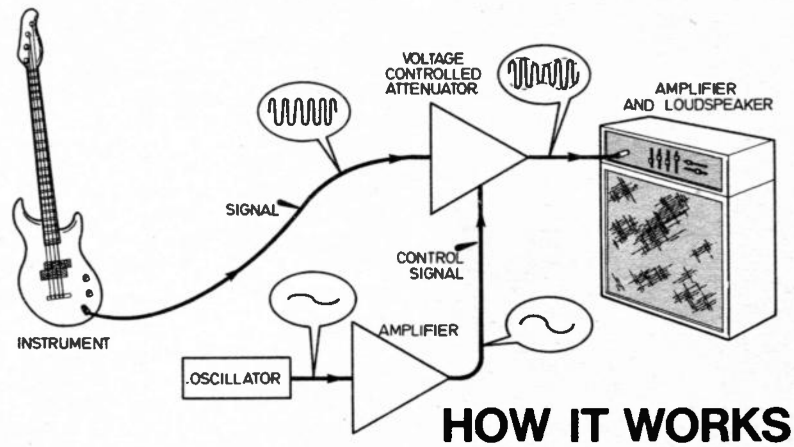
If you are going to use i.c. sockets, make sure they are low profile types otherwise the finished board may not fit in the case. You will see that C4 is connected between the board and SK2. Similarly C1 is connected between the board and R1 where these two are butt-jointed together. The other end of R1 is connected directly to SK1. Both of these unorthodox connections are necessary if the components are all going to fit inside the box.

CASE

The unit is housed in a wedge shaped case with a maximum width of 100mm and maximum height of 45mm. The length is 130mm and the case is obtainable from Maplin Electronics, order code LH09K. Components should be chosen for their small size and compactness and the prototype layout and interwiring is shown in Fig. 3 and the accompanying photographs.

Use light gauge stranded wire for the interwiring. Drill two holes in the end of the case for the two variable resistors and one hole in either side for the two sockets. The hole for the foot switch is already punched.

Once interwiring is complete, the board can be slotted into position in the shallow end of the case, a battery fitted and the base screwed on. The metal top-plate that comes with the case can be labelled with the various control functions using Letraset and protected with clear lacquer if this is thought necessary. The unit is now ready for use.



HOW IT WORKS

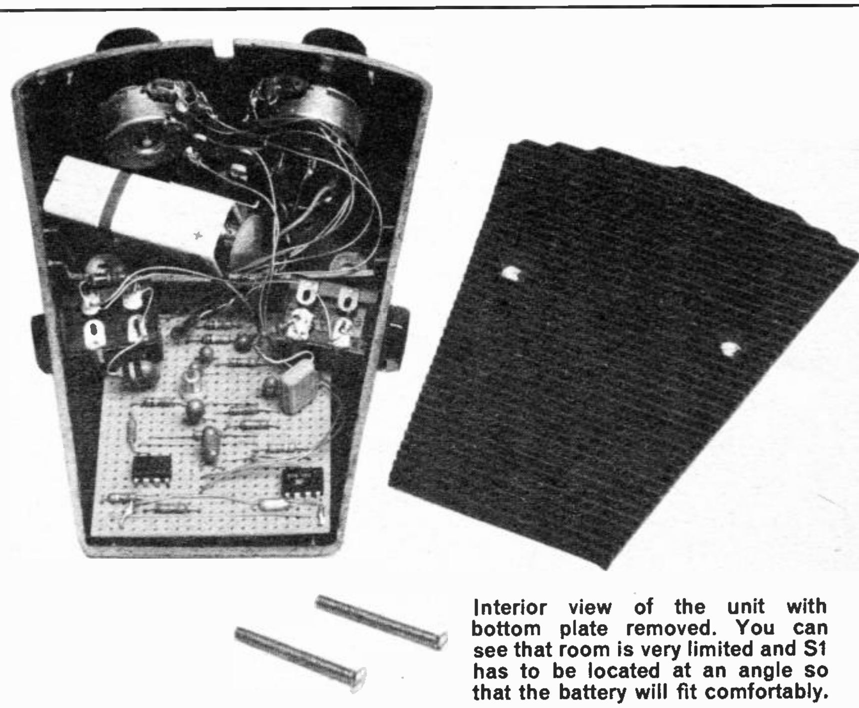
An electronic sound source such as a guitar is fed into a voltage controlled attenuator. The voltage control input is connected to an oscillator via a foot switch.

When the switch is on, the sine wave output from the oscillator causes the amplitude of the signal passing through the attenuator to rise and fall giving a tremolo effect. The depth of the effect can be controlled by altering the gain of the oscillator amplifier and the speed of tremolo can be changed by altering the frequency of the oscillator.

TREMOLO

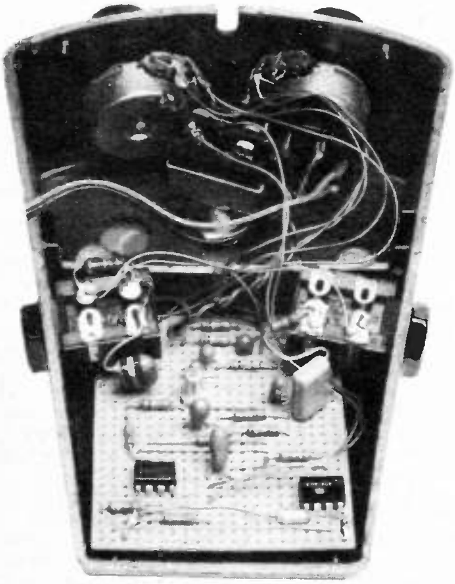
This tremolo unit is designed to be used between the instrument and the amplifier. With the unit switched off, plug the instrument lead into the INPUT, SK1, and connect a second lead between the OUTPUT, SK2, and the amplifier input.

Switch the unit on. The effect may or may not be heard depending on the setting of the footswitch, S1. Assuming S1 is in such a position that the effect is not working, check that the sound from the instrument is being reproduced satisfactorily without distortion or insertion loss.



Interior view of the unit with bottom plate removed. You can see that room is very limited and S1 has to be located at an angle so that the battery will fit comfortably.

TREMOLO UNIT



Another interior shot. Compare this with Fig. 3 opposite and this will show the control positions in the prototype unit.

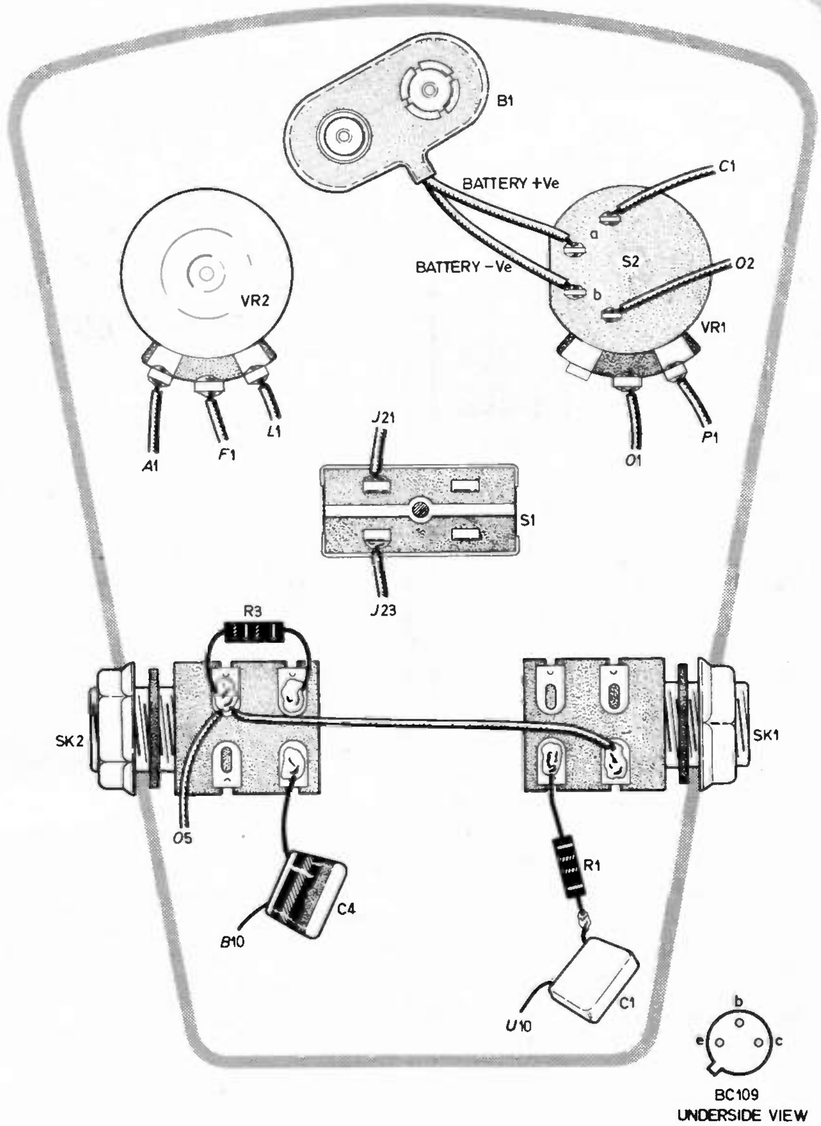
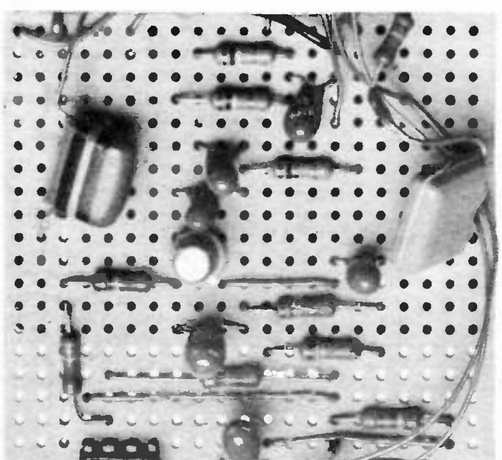


Fig. 3. (right) Wiring for the off-board components. These are not shown in their final positions as this will be determined by the choice of case made by the individual constructor. Note that capacitors C1 and C4 are wired directly between the stripboard and the sockets.



Close-up view of the circuit board. Capacitor C4 can be seen to the upper left of the photograph and C1/R1 to the upper right.

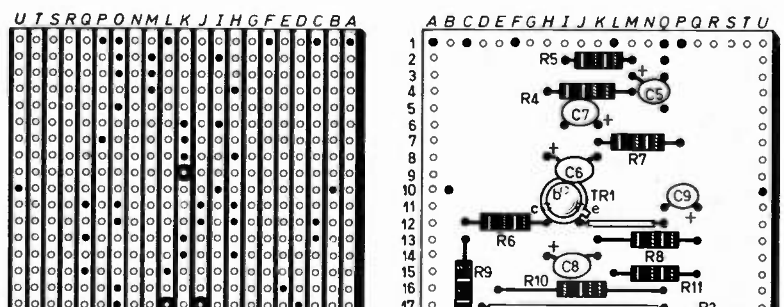


Fig. 2. Stripboard layout of the Tremolo showing component positions and breaks in the copper strips on the underside of the board. Note that C1 and C4 are not shown on this diagram. One each of their leads is soldered directly to the board, the other directly to off-board components.

COMPONENTS

Resistors

R1 15kΩ
R2 6·8kΩ
R3 12kΩ
R4 100kΩ
R5 100kΩ
R6 10kΩ
R7 1kΩ
R8 12kΩ
R9 33kΩ
R10 22kΩ
R11 56kΩ
R12 2·2kΩ
R13 4·7kΩ
All ¼W carbon ±5%

See Shop Talk page 425

Capacitors

C1 0·1μF C280 polyester
C2 100pF polystyrene
C3 22μF 16V tantalum
C4 0·1μF C280 polyester
C5 1·5μF 16V tantalum
C6 0·47μF 16V tantalum
C7 0·47μF 16V tantalum
C8 22μF 16V tantalum
C9 2·2μF 16V tantalum

Potentiometers

VR1/S2 50kΩ miniature carbon log. with ganged d.p.d.t. mains switch
VR2 100kΩ miniature carbon lin.

Semiconductors

IC1 MC3340 voltage-controlled attenuator i.c.
IC2 741 op-amp, 8-pin d.i.l.
TR1 BC109 *npn* silicon

Miscellaneous

SK1,2 standard mono jack socket (2 off)
S1 s.p.s.t. foot operated push-on, push-off switch
B1 9V, PP3 type battery
Stripboard, 0·1 inch matrix, 21 strips × 27 holes; wedge shaped plastics case, 130 × 100 × 45mm, maximum dimensions, Maplin type LH09K, or similar; knobs (2 off); battery clip; light gauge stranded wire for interconnections.

COMPONENTS approximate cost £15 including case

Depress S1 once and the tremolo effect should be immediately heard. Its speed can be varied with VR1 and its depth, that is the amount of attenuation between beats of the tremolo, can be controlled with VR2. As S1 is a sequentially acting switch, depressing it a second time should shut-off the tremolo effect, and so on. ☒

Tackling Electronics

I've always been an optimist myself and nothing is likely to change me now, even so, I still get saddened at the demise of any small business, especially if they sell electronic components.

This was brought home to me a few weeks ago when I wrote to a gentleman who wanted to join my buying group and had my letter returned "Gone away". This was followed a few days later by two customers, one from Colchester and one from Ipswich and each one told the same story, that they had a little man round the corner but he had closed down.

Always taking the optimist's view that "As one door closes another opens" I hurriedly scanned through the electronic journals to re-assure myself, and sure enough I found several new names presenting themselves to the public, perhaps for the first time! I'm told that the pessimist says, "As one door closes another shuts" but I am glad to report that in this instance they are wrong!

Mind you, it must be more difficult in the smaller towns and some of the retailers very sensibly diversify. For example, a friend of mine in a well known seaside town, switches to fishing tackle and buckets and spades during the summer.

Radio Chair

You may remember that a few months ago I asked readers if they could give me information on the construction of Radio Sets used in prisoner of war camps, because judging by the ones I had the opportunity of examining they contained sophisticated items such as valves, coils and tuning capacitors. I hinted that this looked as though bribery and corruption played a part.

I was delighted to receive a letter from one, Mr. Bill Stock, who told me that I had indeed hit the nail on the head. His letter makes such exciting reading that I feel justified in reproducing part of it here.

"I have still my pass allowing me out of camp after 5 p.m. and also a photograph of a chair which was made from tea chests and covered in hessian. The chair was constructed by a carpenter and included a secret compartment in the base where the 'Canary' (radio) was hidden from time to time. The chair lived in the islolation ward in the camp hospital, where I too was bedded and became my favourite piece of furniture—the only piece, in fact.

"Periodically the camp was searched by troops of the S.S. and on one occasion they were thundering through the hospital and ended up in my room. The N.C.O. in charge thought my chair was too much of a good thing for a P.O.W. and without bothering to open the window hurled it through the glass. The radio burst through the back of the chair and lay in full view. I was petrified, but miraculously the N.C.O. had not spotted it. As it happened, a couple of our men were on the rounds emptying the swill bins; spotted the radio and with the utmost calm retrieved it and dropped it in the swill bin they were carrying. Needless to say, the canary was silent for a few days after that!"

Mind you I don't think all the P.O.W.'s were as lucky as Bill and some had to fall back on Crystal Sets using a piece of coke and a strand of thin copper wire as the detector, but it's stirring stuff.

Moral Obligation

I see in the *Letters* page the question still being raised on the veracity of components Catalogues and our gallant Editor lucidly explaining the problems we face, which are mainly three:

(1) We never know the likely demand!
(2) We never know exactly the delivery time from our suppliers.
(3) Inflation has made it virtually impossible to carry large stocks.

I'm sure we all agree that if we catalogue an item we have a moral obligation to make sure it is available to the customer. Two things sometimes make that difficult. If there is only one supplier and this supplier discontinues the article and, as sometimes happens, the supplier suddenly raises his minimum order to three figures on a relatively slow selling line.

One reader raised a query on postage, where part of his order was delayed and he was requested to pay more postage on the balance. This is indefensible and speaking for myself and the majority of my colleagues, we would not expect a customer to pay more than one amount of postage on each order.

Finally, I think I can justly say, that in this present economic climate none of us is complacent, and try to give as good a service as possible. At any rate you won't see at the bottom of our advertisements, a statement to be seen at the bottom of many mail order firms adverts, dealing in general merchandise, usually written in small print, "Allow 28 days for delivery!!"

RADIO WORLD

By Pat Hawker, G3VA

Learning Morse

In my experience one of the most difficult things to do is to persuade newcomers to amateur radio that learning the Morse code (necessary to obtain a licence to operate in the h.f. bands, although not for the v.h.f. Class B licence) is really worth the trouble.

Most people find the learning process tedious, with periods when they seem to be making little progress and soon become convinced that the whole system must by now be obsolete and hopelessly slow compared with modern data transmission. It is often only after several years of operating that one becomes convinced that Morse is effective and *enjoyable*.

It has been estimated that the brain needs to hear each Morse letter, sent correctly, some 40,000 times before it gets used to responding automatically to the symbol. Some 70 to 100 hours of practice are needed to achieve the 12 words a minute necessary for the amateur licence—and then one needs "on air" experience to bring the speed up to about 18 to 22 words per minute, before one can really begin to sit back and enjoy the pleasure of good operating.

Yet once that sort of speed has been reached, it becomes a skill that is never really lost; it can last a lifetime and is still a system almost ideally suited to international communication with those not fluent in the English language as well as permitting long distances to be covered with simple and inexpensive equipment and aerials: a pleasure rather than a chore.

So I only wish it were easier to get people not just to take the first steps of memorising the code, but to keep at it until those early "humps" are overcome. Today, with practice tapes and random code generating machines, it is easier than in the days when one had to find an instructor who was often rather rusty himself.

High speed telegraphy

An American amateur radio journal is organising a "world championship" for those capable of copying Morse telegraphy at high speeds. They are hoping to find someone capable of challenging the long-standing record of Ted McElroy, ex-W1JYN, who in July 1939 succeeded in copying on a typewriter Morse signals at the incredible speed of 75·2 words per minute. Most of us would indeed be well pleased if we could show ourselves capable of copying at even half that speed!

This speed is appreciably more than that of a standard radio-teleprinter, the typewriter-like machine that prints incoming code signals (5-unit code and not Morse code) without requiring a human operator. For more than 30 years a number of radio amateurs have been using this form of machine-telegraphy (RTTY or radio teleprinting) even though the basic system is not really well suited to long-distance radio transmission, having originally been used for "line" working in the Post Office telegraph services. Amateurs often acquire old Creed machines though a number now use more sophisticated systems that display the messages on a television screen.

The problem is that a single error in reception causes an entirely wrong letter to be printed out. To achieve perfect copy one needs either fairly strong signals, without interference, or the use of more sophisticated systems with error correction or multiple tones. A human operator can copy weak, fading Morse signals under heavy interference far more accurately than an RTTY machine.

Hellschreiber

Recently a number of European amateurs, in an effort to overcome the problems of the often poor copy of RTTY machines, have been reviving a system developed in the 1930s called "Hellschreiber" invented by Dr Rudolf Hell in Germany and later manufactured by Siemens-Hell.

The system was widely used by the Germans in World War II for military communications, it also came into worldwide use for a number of years for press messages. But after a few years it was largely superseded by the faster RTTY machines which printed at about 60 wpm compared with the 25 wpm or so of Hellschreiber.

But "Hell" had a number of advantages that continue to be valid even today when the only commercial use of the system is in China. The machines can, in effect, be used with almost any radio receiver or telephone line circuit without the special circuitry needed for the frequency-shift-keying of RTTY.

Since they use what might be called an "analogue" rather than a "digital" system the performance in the presence of interference degrades only gradually—and the machines never print out wrong letters, although interference can cause a letter to become blurred and difficult to read. And although a "synchronous" system, the send and receive machines do not need to be kept accurately in step; they can run as much as 5 per cent out of synchronism.

A few years ago several Dutch and German amateurs managed to acquire old German field machines and got them going on the amateur bands. It was soon found possible to build such machines (particularly for reception) and various microprocessor-based systems have also been developed for displaying the messages on a television screen.

It is unlikely that this work will lead to any general revival of the system, but it still provides a good example of an interesting electromagnetic system.

Professional designers

The profession of electronics design engineer attracts many bright youngsters, offering as it does an opportunity for really creative work. The Institute of Electrical and Electronic Engineers in the USA recently asked 30 American design engineers, working in the semiconductor, instrumentation, systems and computer fields, what they thought of their work and what motivates them.

Looking through their comments one wonders whether "work" is the right word: if this was a really representative cross-section, then they all seem to be dedicated enthusiasts. Some indeed regard it more as "fun" than work ("I get a real kick out of it"), most look forward to starting work each morning ("I once got a speeding ticket rushing to work to try out an idea that came to me in the shower").

Some feel that "you can let your imagination run wild, because the boundaries aren't as defined as in other engineering areas". They really enjoy "being able to visualise a design and then building it".

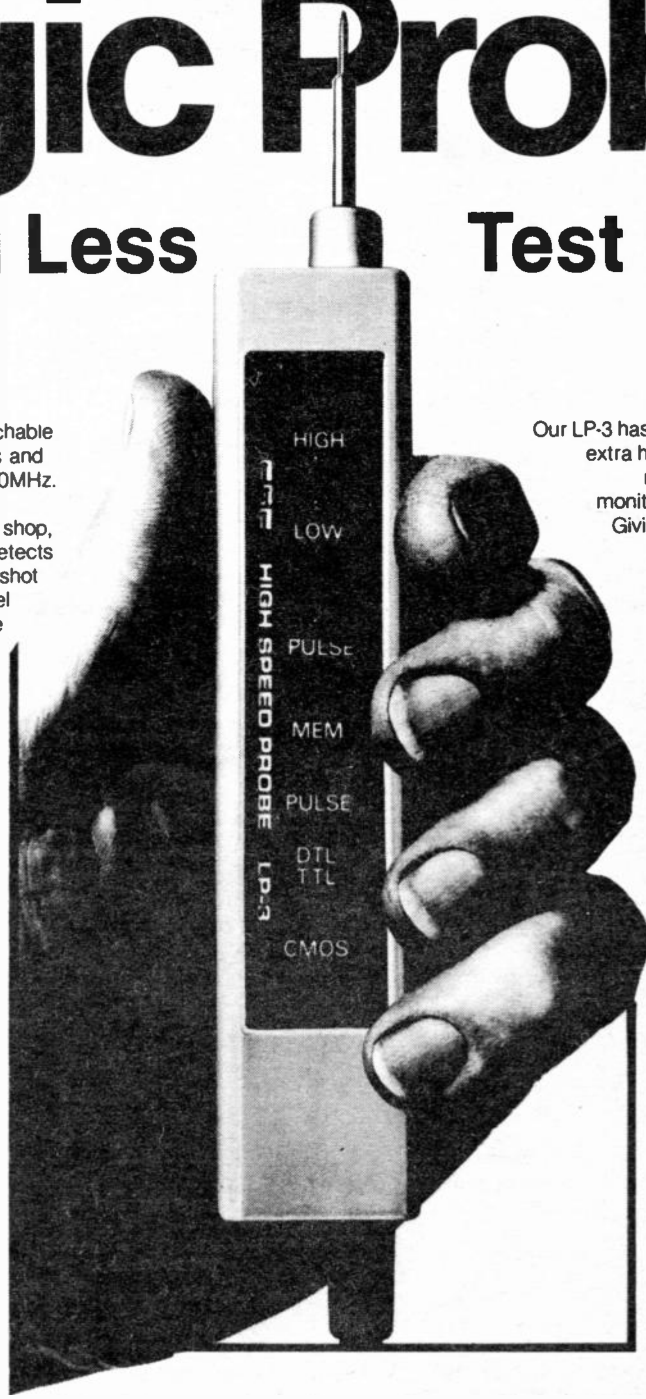
This group of what I can only call "paragons", spread out from New York to "Silicon Valley" (near San Francisco, California), reported that they regularly read engineering publications, attend trade shows and professional seminars, spend considerable time each week in technical discussion with colleagues and a quarter of them hold patents for designs they have developed.

Admittedly a few felt that even this idyllic profession has its share of headaches, including "constant pressure" to meet design objectives without sufficient resources, or enough time or help ("I don't like to sacrifice quality of performance to meet marketing schedules or money concerns"). Computer-aided design is now considered essential although the technology was felt to be always a few years behind design: "it may never catch up with the state of the art, because its always going to be dependent upon the technology used to build it."

In the field of semiconductors, design is seen as becoming so specialised that freelance designers and independent design groups are beginning to emerge: integrated-circuit designers can already command salaries in excess of $50,000, which is perhaps one of the reasons why American designers seem a happy and contented group of engineers!

The Logic Probes

Spend Less Test More



LP-1 Logic Probe

The LP-1 has a minimum detachable pulse width of 50 nanoseconds and maximum input frequency of 10MHz. This 100 K ohm probe is an inexpensive workhorse for any shop, lab or field service tool kit. It detects high-speed pulse trains or one-shot events and stores pulse or level transistions, replacing separate level detectors, pulse detectors, pulse stretchers and pulse memory devices. All for less than the price of a DVM

£31.00*

LP-2 Logic Probe

The LP-2 performs the same basic functions as the LP-1, but, for slower-speed circuits and without pulse memory capability. Handling a minimum pulse width of 300 nanoseconds, this 300 K ohm probe is the economical way to test circuits up to 1.5 MHz. It detects pulse trains or single-shot events in TTL, DTL, HTL and CMOS circuits, replacing separate pulse detectors, pulse stretchers and mode state analysers.

(Available in kit form LPK-1 £11-92)

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BY R.A.PENFOLD

LOOP AERIAL CRYSTAL SET

ALTHOUGH a crystal set does have advantages over other types of receiver, such as low cost, simplicity, and no running costs, unfortunately there are also drawbacks to this type of receiver. The main ones are the need for a longwire aerial in order to obtain an adequate signal pick-up, and the low output level which is only sufficient to drive an efficient pair of headphones or earpiece.

The crystal set which forms the subject of this article has been designed to operate without the need for a longwire aerial, making it usable in situations where such an aerial would be impractical, or at least very inconvenient. The receiver covers the normal medium wave broadcast band, and uses a loop type aerial.

A loop aerial really just consists of a large coil of wire although, as we shall see shortly, the size of the coil and number of turns on it are very important. It differs in this respect from a longwire aerial which is merely a substantial but random length of wire.

CONVENTIONAL CIRCUIT

The circuit diagram of a conventional crystal set is shown in Fig. 1. The longwire aerial picks up the electrical field radiated by the transmitter, this field producing voltage differences across the aerial wire, and giving the required signal voltages and currents.

The components L1 and C1 form what is known as a tuned circuit, and this circuit can be adjusted to resonate at any frequency within the medium wave band by means of C1. At this resonant frequency the tuned circuit has a high impedance, but it exhibits only a low impedance at frequencies significantly removed from the resonant one.

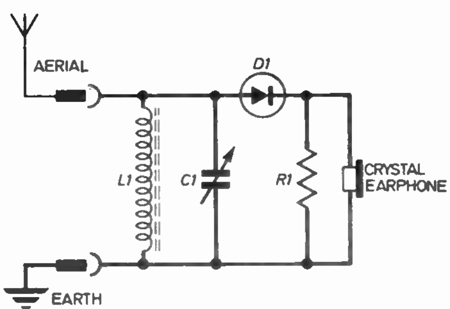


Fig.1.A conventional crystal set circuit.

Therefore, if the tuned circuit is set to resonate at the frequency of the desired transmission, little of this signal will be lost through the high impedance path of the tuned circuit.

Other stations will be at significantly different frequencies to the desired one, resulting in them being short circuited to the earth line through the tuned circuit. The unwanted signals are thus filtered out to leave only the wanted transmissions.

AMPLITUDE MODULATION

The signal picked up by the aerial is at a high frequency, or "radio frequency" (r.f.) as it is normally known. This signal will not produce an audible output from headphones or an earphone, but must first be demodulated to extract the audio frequency (a.f.) signal that is modulated onto the radio frequency "carrier-wave" signal.

The form of modulation used by m.w. broadcast stations is "amplitude modulation" (a.m.), and in this system the strength (amplitude) of the carrier wave is varied (modulated) in proportion to the audio signal level, as shown in Fig. 2(a).

A crystal set uses the most simple method of demodulating the signal, and this consists of first rectifying it, as shown in Fig. 2(b). Diode D1 only passes positive-going half cycles of the carrier signal, and blocks negative-going ones, since it is the function of a diode to only conduct in this one direction.

This demodulation or detection process was carried out using a "cat's

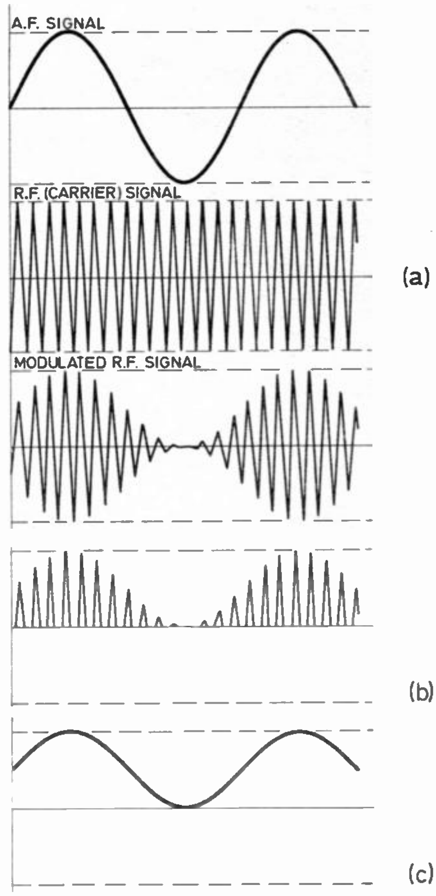


Fig.2.(a) An a.f. signal combined with a r.f. carrier wave to form a modulated r.f. signal. (b) Modulated r.f. signal that has gone through the first stage of demodulation, that is rectification. (c) Original a.f. signal recovered after second stage of demodulation, that is smoothing.

whisker" and a galena crystal, or other suitable crystal, in the original crystal sets. These days it is more normal to use a germanium diode to provide this rectification. Silicon types are inferior in this particular application because they have a higher forward resistance at the low voltages encountered here, resulting in poor efficiency.

OUTPUT SIGNAL

The rectified signal from the diode must be smoothed by a capacitor in order to produce an output signal that is a sort of average voltage. The average voltage of the rectified signal is determined by the modulting signal, and as can be seen from Fig. 2(c), the smoothed output is in fact the same as the modulating signal.

This ouput signal drives the earphone to produce an audible output. In this case the smoothing capacitance is provided by the self-capacitance of the crystal earphone. If a high impedance magnetic phone or phones were to be used it would be necessary to include a separate smoothing capacitor of a few nanofarads in value.

A crystal earphone is probably the better choice though, due to the low cost, easy availability, and high efficiency.

Resistor R1 provides a suitable discharge path for the smoothing capacitance so that it does not merely charge up to the peak value of the input signal and remain there.

LOOP AERIAL

A crystal set obviously needs to have a strong aerial signal in order to give a satisfactory volume level from the earphone, as it is actually the energy received from the transmitter that is used to drive the earphone!

There is no gain in the set to compensate for a weak input signal, and this discounts the use of a normal ferrite aerial which has an output level that is normally only a fraction of a millivolt. A longwire aerial is normally used as it can easily provide output levels of a few hundred millivolts from strong signals.

Loop aerials used to be quite popular in the days of the large, valved sets, when a large loop aerial could be wound around the inside of the case. This type of aerial was often referred to as a "frame aerial". Smaller more modern sets could only accommodate a comparatively small loop aerial, with a consequent reduction in the level of signal pick up, and so with the advent of the more convenient ferrite aerial the loop aerial virtually disappeared.

A loop aerial would seem to be a good choice for a crystal set however, as a loop of about 915mm (3ft) square gives a signal level that is roughly comparable to an outdoor long wire aerial of about 10metres or so in length, but is probably a more practical proposition in most situations.

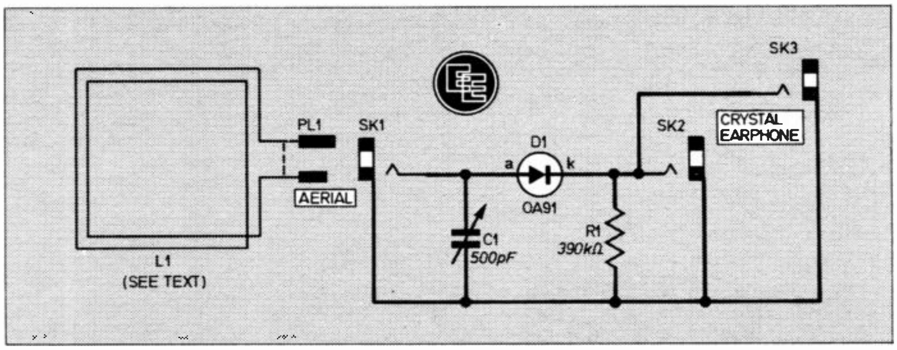


Fig.3. Complete circuit diagram of Loop Aerial Crystal Set.

CIRCUIT

The circuit diagram of a crystal set having a loop aerial is shown in Fig. 3. The aerial is really a very large inductor (in the physical sense) which forms part of a tuned circuit that is resonant at the desired reception frequency. In the case of a crystal set it is merely necessary to use the aerial winding as the tuning inductance, and it is for this reason that the size and number of turns on the aerial is important. An aerial of the wrong size simply will not tune the correct band of frequencies.

In other respects the circuit of Fig. 3 is identical to that of Fig. 1, except that there is provision to drive two crystal phones. This enables either two people to listen to a programme, or one person to use both phones in order to obtain better volume on weak stations. Two phones will also give better noise excluding properties, which is again an advantage on low volume stations.

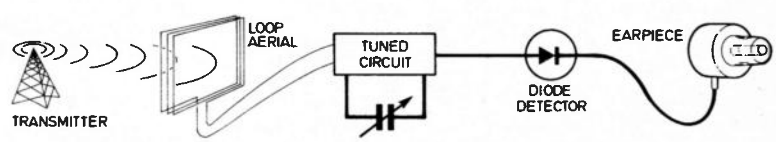
RESULTS

In Essex (SE England) the prototype receiver provides good volume from Radio 2 and the BBC World Service. Lower but adequate volume is produced by Radio 1, Radio 3, a second Radio 2 frequency, BBC Radio Medway, and even one foreign station is just audible. The selectivity is perfectly adequate to separate two fairly closely spaced stations.

CONSTRUCTION starts here

CASE

Virtually any small plastic or metal case should make a suitable housing for this project, provided of course that the case is large enough to accommodate the components, particularly C1. The specified tuning capacitor requires a standard 10mm diameter mounting hole, and those for the three sockets are about 6·5mm in diameter.



HOW IT WORKS

Signals from the transmitter are picked up by the loop aerial which is part of a tuned circuit.

Here the unwanted frequencies are screened out and only the required signals are passed on to the next stage.

The detector or demodulator separates the audio signals from the carrier by rectifying and smoothing the incoming signal.

This is finally taken to the earpiece where it is converted to sound waves.

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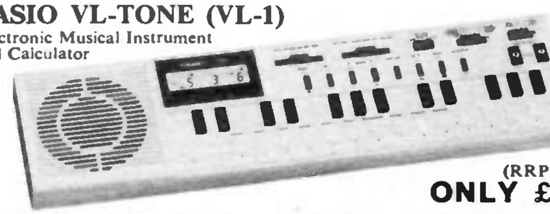

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Calculator: 8 digits, +, −, ×, ÷, square roots, %, constants and full memory.

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CT-401 As CT-301 but with Casio Auto Chord for one finger or auto accompaniment. Plays major, minor and seventh chords with bass. Integral sustain and hold. (RRP £345) £295

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There are 2 stages, each stage having 9 encounters. In stage 1 the game speeds up with each encounter and in stage 2 the invaders attack from a closer position. After stage 2 the game reverts to stage 1 but the score, displayed after each encounter, is incremental.

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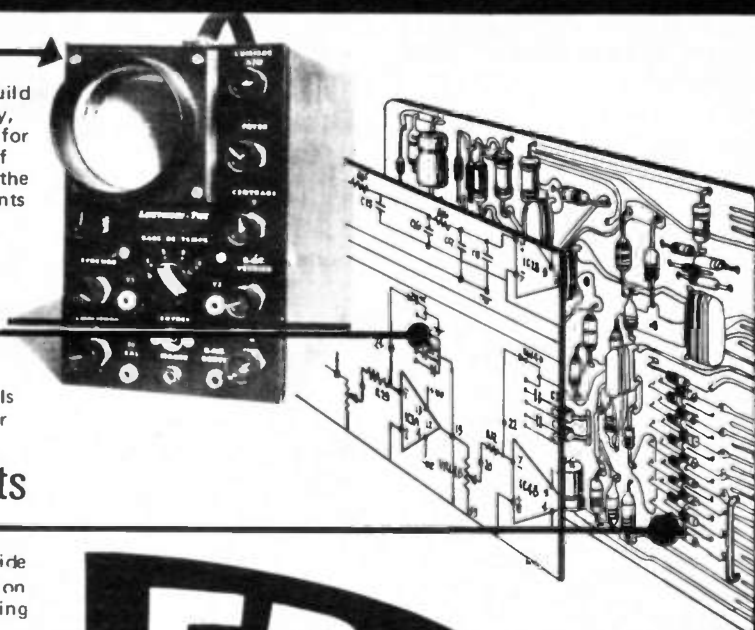

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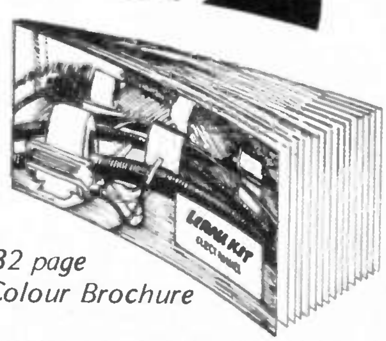


32 page Colour Brochure

COMPONENTS

R1 390kΩ ½ watt 5%
C1 500pF variable solid dielectric (Jackson) or similar
D1 0A91 small signal germanium diode
SK1—SK3 3·5mm jack sockets (3 off)
PL1 3·5mm jack plug
Verocase type 75-2860J (120 × 80 35mm) or similar plastic box; crystal earphone with 3·5mm plug; 4 oz. of 20 s.w.g. enamelled copper wire to form L1; twin-core cable; insulation tape; connecting wire; control knob.

Guidance only Approx. cost (See page 425) **£3·50** excluding case

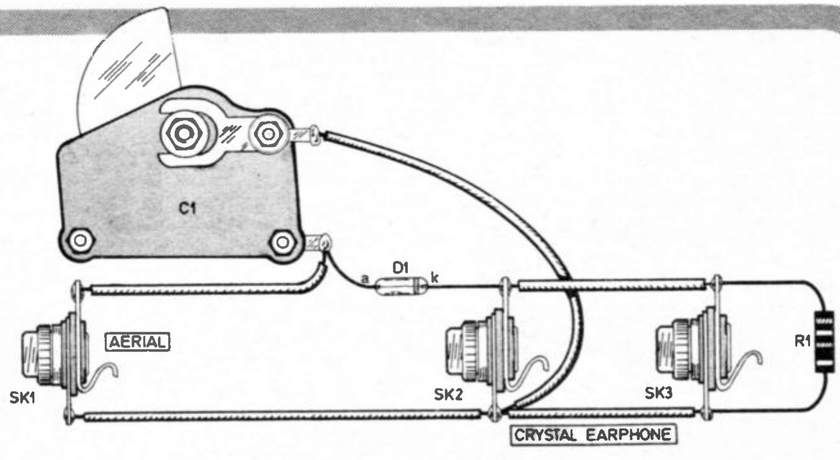


Fig.4. Complete interwiring details of the Loop Aerial Crystal Set. Note that there are two earphone sockets. These are wired in parallel and means that two different crystal earphones can be used at the same time.

Incidentally, the tuning capacitor can be any type having a maximum capacitance of about 500pF or so, and inexpensive surplus types are perfectly suitable.

WIRING

As can be seen from Fig. 4, there is very little wiring needed to complete the unit. Provided the tags of C1 and the sockets are generously tinned with solder prior to making a connection, and the ends of leads are similarly treated, there should be no difficulty in producing good strong joints. It is advisable to leave the leadout wires of D1 full length as this is a germanium device, and can therefore easily be damaged by overheating when being soldered into place if its leadout wires are trimmed short.

AERIAL CONSTRUCTION

The aerial is square in shape, and measures 915mm (3ft) along each side. It has five turns of 20 s.w.g. enamelled copper wire, and 4oz of wire is sufficient for the coil. It is necessary to have some form of rough temporary former on which to wind the coil, such as a large piece of chipboard with four nails or screws mounted at the corners of the square, and only partially driven home so that they act as corner posts for the coil to be wound around.

Any similar arrangement should do; the prototype aerial being wound around four loudspeaker cabinets set to form the appropriate sized square. It is really just a matter of using ones initiative here. Numerous bands of p.v.c. insulation tape are used to bind the turns of the coil together, and it can be removed from the former once this has been completed.

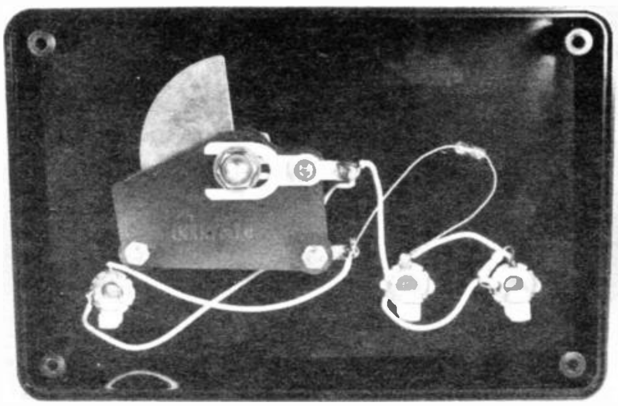
The aerial connects to the receiver via a piece of twin (figure of eight) lead which should be no more than about one metre long. A longer length is unsuitable as it would considerably add to the capacitance of the tuned circuit, making it impossible to tune to the high frequency and of the m.w. band.

The aerial and lead can be joined using a two way terminal block, or alternatively soldered connections can be used with insulation tape being strategically placed in order to ensure that the two joints do not accidentally short together. The free end of the lead is terminated in a 3·5mm jack plug which connects with SK1.

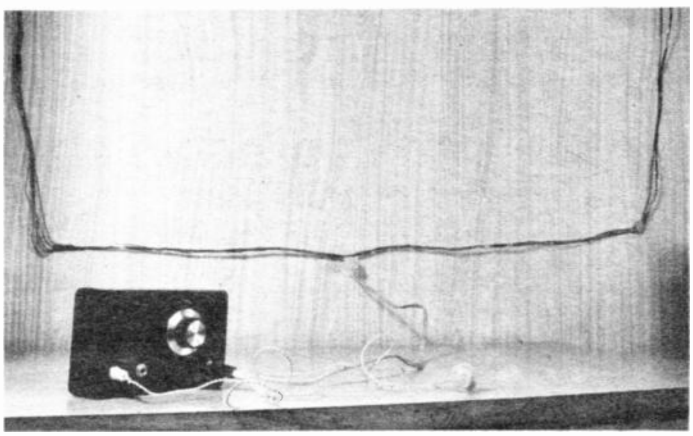
AERIAL MOUNTINGS

In use the aerial must be mounted vertically, and it should be possible to obtain good results with it simply hung over the edge of a table or shelf. Another method is to attach it to a wall using Bostic Blu-Tac. The aerial does not have to be kept perfectly square, and satisfactory results seem to be obtained even if it is considerably distorted. A loop aerial has the same directional properties as a ferrite type, giving maximum signal pick up with the wire in the horizontal sections of the aerial pointing towards the transmitter. ⌑

Rear view of front panel showing the component interwiring.



The Loop Aerial Crystal Set in use. Note that only the lower half of the loop aerial is shown. This is in fact about 3m square and the horizontal sections should point towards the transmitter.



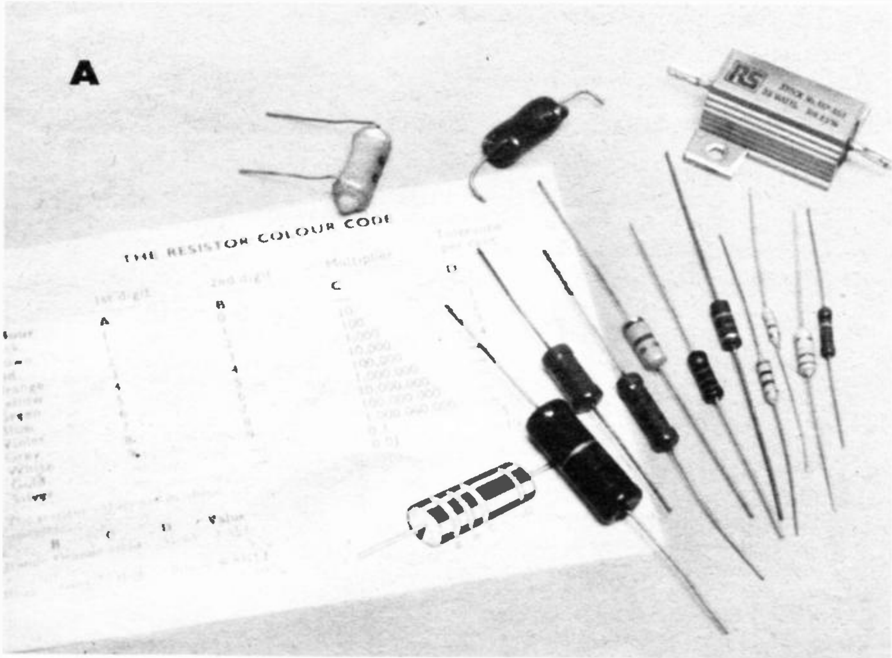
SQUARE one

COMPONENTS — the elements from which all electronic circuits are built. They come in all shapes and sizes, some large and expensive, some small and cheap. To the beginner, it can be a very confusing business just identifying the various classes, let alone particular types, so, starting this month, we are presenting a visual guide to all the major component families.

Briefly, components may be classified into five major categories: **resistors, capacitors** (both of which may be variable), **semiconductors, inductors,** and **sundries** (plugs, sockets, switches, and so on). This month we concentrate on the first of these categories.

Resistors can be found in many sizes. The bigger the size, the bigger the power handling. This is expressed in watts and always quoted in our component lists. Resistors may be made of different materials some of which are designed for low noise characteristics, others for high stability, or a combination of both.

Variable resistors, often called potentiometers, come in two types: presets for infrequent adjustments, and ordinary types for major control purposes. Sometimes you will see two potentiometers fastened together and operated from the same spindle. This is a dual ganged type, often found in stereo amplifiers.



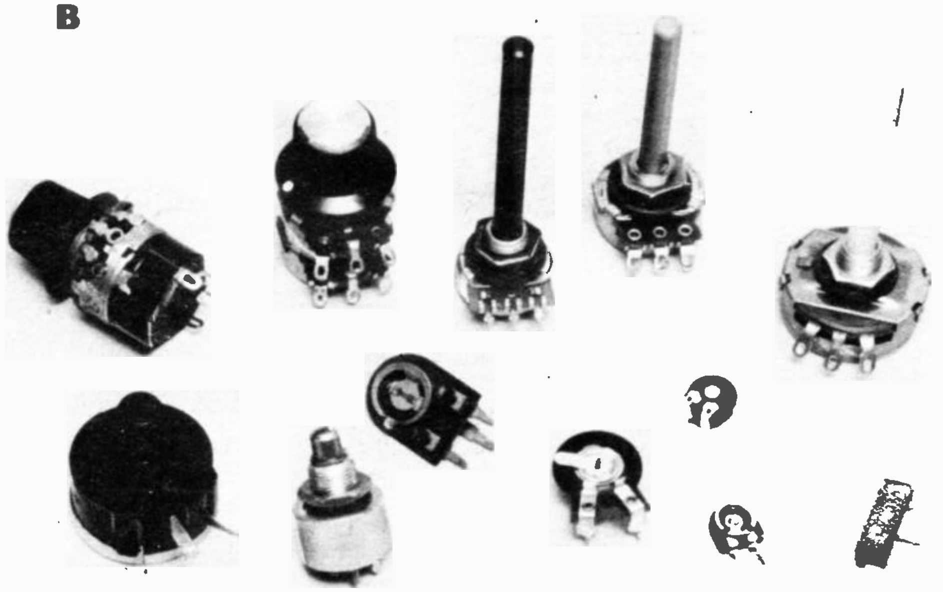
A A collection of fixed value resistors. Along the top of the picture are three high power wire-wound types. The large component on the right is an aluminium clad, 25W type.

Below this is a selection of various types of solid resistors, that is, resistors made from a solid mass or film of material. The largest component on the left is a 2W type and the resistors descend in power rating down to the tiny $\frac{1}{8}$W type third from the right.

The most common types of this sort of resistor are carbon film, carbon composition, metal film, and metal oxide. They are different in colour but different manufacturers tend to use different colours for the same type and there is no standard.

The actual value of each resistor is denoted by a standard colour code, and in the background is a booklet showing this code. Apart from the value, this code is also used to give other information such as tolerance, that is, the amount by which the actual value of the resistor deviates from the stated (nominal) value. The first two bands give the first two digits of the value, the third band gives the number of zeros that follow these two digits. The fourth band denotes the tolerance, and may be omitted altogether.

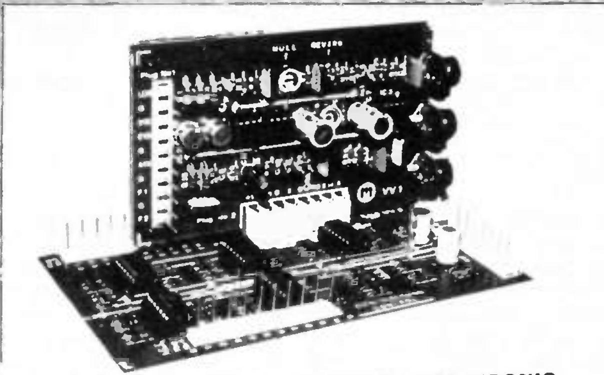
B



B A selection of potentiometers. In the front row we can see several preset types. On the far left is an old-fashioned enclosed type once common in TV sets, then a more modern enclosed type. After that is a vertical mounting skeleton preset followed by a similar horizontal mounting type. Just above that is a sub-miniature sealed trimmer below which is a miniature vertical skeleton preset. Finally on the right is a multi-turn trimmer.

Back row (left to right) shows first a standard type with integral d.p.d.t. mains switch. This is followed by a dual gang type of the sort often found in stereo amplifiers. Next to this is a miniature p.c.b. type with connections designed for slotting into a circuit board, and then a panel mounting miniature type. At the end is a standard size potentiometer.

All these components can be obtained with either a logarithmic (log) or linear resistance track. This denotes how the resistance between the terminals of the device changes with rotation of the spindle (see Down to Earth, April 1981).



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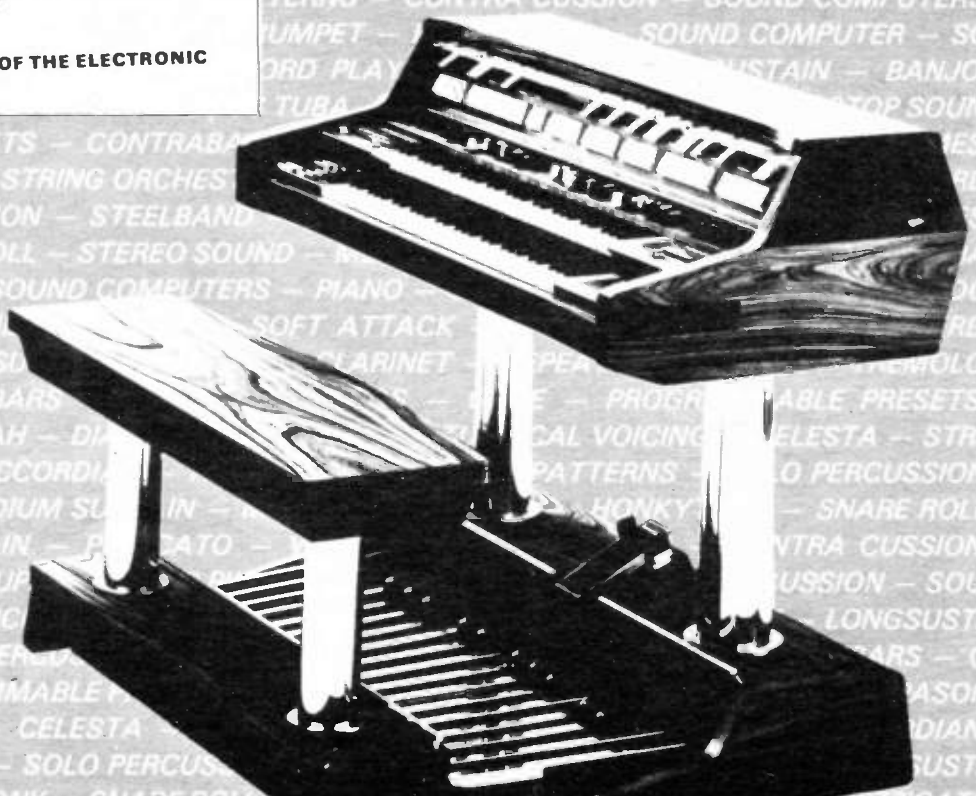

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SEC. 0 12V 0V 12V

TYPE	AMPS 12v	AMPS 24v	PRICE £	P/P £
242	0·3	0·15	1·70	0·40
213	1	0·50	2·32	0·70
71	2	1	2·51	0·90
18	4	2	3·24	1·43
68	3	1·5	3·15	1·43
85	5	2·5	5·52	1·43
70	6	3	6·26	1·43
108	8	4	7·36	1·73
72	10	5	8·05	1·65
116	12	6	8·57	1·90
17	16	8	10·53	2·05
187	30	15	17·62	2·45

15/30V RANGE PRI 220/240V

SEC. 0V 12V 15V 0V 5V 9V 15V

VOLTS AVAILABLE 3 ⟹ 15 — 0 — 15

TYPE	AMPS 15v	AMPS 30v	PRICE £	P/P £
112	1	0·50	2·47	0·95
79	2	1·0	3·16	0·95
3	4	2	5·64	1·43
20	6	3	6·59	1·73
21	8	4	7·80	1·73
51	10	5	9·68	1·90
117	12	6	10·97	2·05
88	16	8	14·65	2·20
89	20	10	16·93	2·35
90	24	12	18·84	2·55
91	30	15	21·56	2·65
92	40	20	30·08	3·50

25/50V RANGE PRI 120/220/240V

SEC. 0V 20V 25V 0V 8V 15V 25V

VOLTS OUT 5 ⟹ 25 — 0 — 25

TYPE	AMPS 24v	AMPS 50v	PRICE £	P/P £
102	1	0·50	2·88	1·43
103	2	1·0	3·60	1·43
104	4	2	7·04	1·73
105	6	3	8·33	1·90
106	8	4	11·18	1·90
107	12	6	14·79	2·20
118	16	8	20·49	2·55
119	20	10	24·52	2·55
109	24	12	29·39	3·50

30/60V RANGE PRI 120/220/240V

SEC. 0V 24V 30V 0V 10V 18V 30V

VOLTS 6 ⟹ 30 — 0 — 30

TYPE	AMPS 30v	AMPS 60v	PRICE £	P/P £
124	1	0·5	2·92	1·43
126	2	1	5·78	1·43
127	4	2	7·13	1·73
125	6	3	10·73	1·90
123	8	4	12·28	2·20
40	10	5	15·55	2·20
120	12	6	17·72	2·35
121	16	8	25·09	2·65
122	20	10	29·07	4·00
189	24	12	33·51	4·60

48/96V RANGE PRI 120/220/240V

SEC. 0V 36V 48V 0V 36V 48V

VOLTS 12 ⟹ 48 — 0 — 48

TYPE	AMPS 48v	AMPS 96v	PRICE £	P/P £
430	1	0·5	4·14	1·43
431	2	1	7·22	1·73
432	4	2	11·87	2·05
433	6	3	14·47	2·20
434	8	4	18·43	2·45
435	10	5	26·16	2·65
436	12	6	32·75	4·00
437	16	8	35·77	4·60

AUTOTRANSFORMERS 240/220—115V

65VA — 10KVA

0V 115V 220V 240V

TYPE	VA	PRICE £	P/P £
25	65	3·82	1·10
64	80	4·40	1·10
4	150	5·64	1·43
69	250	7·13	1·73
53	350	8·97	1·90
67	500	11·09	2·20
83	750	12·42	2·20
84	1000	16·88	2·65
95	2KVA	31·26	4·00
73	3	61·27	4·75
57	5	87·42	6·60
101	10	159·45	13·00

CASED AUTOTRANSFORMERS

240V LEAD IN 115V 2PIN SOCKET OUT

TYPE	VA	PRICE £	P/P £
56W	20	5·52	0·58
64W	80	7·63	1·43
4W	150	9·63	1·73
69W	250	11·98	1·90
67W	500	18·67	2·20
84W	1000	26·90	2·65
95W	2000	48·45	7·00
73W	3000	69·18	8·00

LINE ADJUSTMENT AUTOTRANSFORMERS

0 200 210 220 230 240 250

TYPE	VA	PRICE £	P/P £
415C	50	2·13	0·58
416C	100	3·13	1·10
417C	200	3·65	1·43
418F	350	5·63	1·43
419F	500	6·13	1·73
420E	750	7·60	1·90
421F	1000	10·55	2·05

MAINS ISOLATORS (SAFETY SCREEN)

PRI 120/220/240V SEC 60V 55V 0V 55V 60V 60V 55V 0V 55V 60V

TYPE	VA	PRICE £	P/P £
149F	60	7·35	1·73
150F	100	8·61	1·73
151F	200	12·15	2·05
152F	250	14·75	2·20
153F	350	18·22	2·55
154F	500	22·70	2·65
155F	750	32·08	7·00
156F	1000	41·26	7·00

MAINS ISOLATORS (SAFETY SCREEN)

PRI 380/415/460V SEC 60V 55V 0V 55V 60V 60V 55V 0V 55V 60V

TYPE	VA	PRICE £	P/P £
243F	60	7·35	1·43
244F	100	8·61	1·73
245F	200	12·15	2·05
246F	250	14·75	2·20
247F	350	18·22	2·55
248F	500	27·70	2·65
249F	750	32·08	7·00
250F	1000	41·26	8·00

TYPE	VA	PRICE £	P/P £
277PI	750	34·96	5·50
279PI	1500	50·60	7·00
280PI	2250	68·26	7·00

MAINS ADAPTORS
13 AMP PLUG-IN TYPE
REVERSIBLE SPIDER JACK LEAD

TYPE	VA	mA	PRICE	P/P
100	6-7·5-9v	250	3·85	58
	Regulated			
101	6-7·5-9v	300	4·70	58

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DISCO LIGHTING KITS

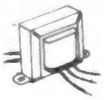
Each unit has 4 channels (rated at 1KW at 240V per channel) which switch lamps to provide sequencing effects, controlled manually or by an optional opto-isolated audio input.

DL1000K
This kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates master dimming control. **£14.00**

DLZ1000K
A lower cost version of the above, featuring unidirectional channel sequence with speed variable by means of a preset pot. Outputs switched only at mains zero crossing points to reduce radio interference to minimum. **£8.00**

Optional Opto Input
DLA1 60p

MINI TRANSFORMERS



Standard mains primaries 240V a.c. 100mA secondaries

6-0-6V	80p
9-0-9V	85p
12-0-12V	90p

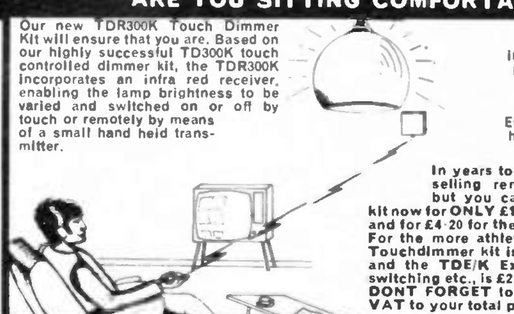
Opto Isolated Triac
MOC3020 0·6A/400V £1·10

LEDs

0·1" Red	9p
0·1" Green	12p
0·1" Yellow	12p
0·2" Red	9p
0·2" Green	12p
0·2" Yellow	12p
0·2" clips	3p
Rectangular Red	16p
Rectangular Green	17p
Rectangular Yellow	17p
Flat Face rectangular, Triangular, Arrowhead, Square Red	17p
Green	20p
Rec. Yellow	20p

ARE YOU SITTING COMFORTABLY?

Our new TDR300K Touch Dimmer Kit will ensure that you are. Based on our highly successful TD300K touch controlled dimmer kit, the TDR300K incorporates an infra red receiver, enabling the lamp brightness to be varied and switched on or off by touch or remotely by means of a small hand held transmitter.



The complete kit, which includes easy to follow instructions, will fit into a plaster depth box and the plastic front plate has no metal pads to touch, ensuring complete safety. Even a neon is included to help you locate the switch in the dark.

In years to come everyone will be selling remote control dimmers, but you can have your TDR300K kit now for ONLY £14·30 for the dimmer unit and for £4·20 for the transmitter.
For the more athletic of you, the TD300K Touchdimmer kit is still available at £6·50 and the TDE/K Extension kit, for 2-way switching etc., is £2·00.
DONT FORGET to add 50p P&P and 15% VAT to your total purchase.

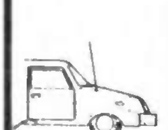
INTEGRATED CIRCUITS

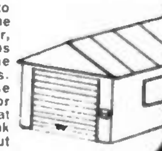
555 Timer	21p
741 Op Amp	19p
AY-5-1224 Clock	£2·60
AY 5-1230 Clock/Timer	£4·50
AY-3-1270 Thermometer	£8·20
CA3080 Transconductance Op. Amp.	72p
CA3130 CMOS Op. Amp.	75p
ICL7106 DVM (LCD Drive)	£7·00
LM377 Dual 2W Amp.	£1·45
LM379S Dual 6W Amp.	£3·50
LM380 2W Audio Amp.	80p
LM382 Dual low noise re amp.	£1·00
LM386 250mW low voltage amp.	75p
LM1830 Fluid level Detector	£1·50
LM2917 F/V Converter (14 pin)	£1·60
LM3909 LED Flasher/oscillator	60p
LM3911 Thermometer	£1·20
LM3914 Dot/Bar Driver (linear)	£2·10
LM3915 Dot/Bar Driver (log)	£2·20
MM74C911 4-digit Display Controller	£6·50
MM74C926 4-digit counter with segment output	£4·50
S566B Touchdimmer	£2·50
SL440 AC Power Control	£1·75
SN76477 Complex Sound Generator	£2·52
TBA800 5W Audio Amp.	68p
TBA810AS 7W Audio Amp.	£1·00
TCM7555 CMOS 555 Timer	79p
TDA 1024 Zero Voltage Switch	£1·20
TDA2020 20W Audio Amp	£2·85
TL081 J-FET Op. Amp.	37p
TL082 Dual J-FET Op. Amp.	60p
TMS1121 Clock/7 day timer	£8·50
ZN1034E Timer	£1·80
All ICs supplied with Data Sheets	
Data Sheets only—per device	10p

EVERY DOOR SHOULD HAVE ONE

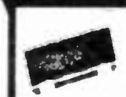
As featured in E.E. May '81

Whatever kind of door you have, our New Electronic Combination Lock will enable you to open it easily but make things very difficult for unwelcome visitors. The unit, which comes complete with a 10-way keypad, requires an easily remembered 8 digit code to be entered before the door can be opened, while the intruder has over 5,000 combinations to choose from. The code can be easily changed by means of a pre-wired plug and a momentary or latched output version can be made. The kit has even more uses in a car where it may be used to disable the ignition. Another useful feature is the Save Button. This stores the combination number, enabling the car to be used by authorised persons such as garage personnel without disclosing the code. The complete kit measures 7 × 6 × 3 cms. deep and consumes a mere 40mA when not in use and will drive a 5V to 15V (750mA) solenoid or relay coil (not supplied) directly. So why not treat your door to a new lock for **ONLY £10·50** and think about all the keys you can lose or forget without ever locking yourself out.





24 HOUR CLOCK/APPLIANCE TIMER KIT



Switches any appliance up to 1kW on and off at preset times once per day. Kit contains: AY-5-1230 IC, 0·5" LED display, mains supply, display drivers, switches, LEDs triac, PCBs & full instructions.

CT1000K Basic Kit	£14·90
CT1000KB with white box (56/131 × 71mm)	£17·40
Ready Built	£22·50

TRIACS

400V Plastic Case (Texas)

3A TIC206D	49p
8A TIC226D	58p
8A TIC225D Sensitive gate	66p
12A TIC236D	85p
16A TIC246D	95p
25A TIC263D	190p
6A with trigger Q4006LT	80p
8A Isolated tab TXAL226B	65p
Diac	18p

CMOS

4000	17p	4017	70p	4050	40p
4001	18p	4019	42p	4060	£1·08
4002	18p	4023	22p	4069	19p
4007	17p	4025	21p	4070	19p
4011	19p	4026	£1·30	4071	18p
4012	17p	4027	40p	4077	26p
4013	38p	4028	50p	4081	20p
4015	75p	4040	80p	4093	54p
4016	35p	4049	38p	4501	24p

ALL COMPONENTS ARE BRAND NEW AND TO SPECIFICATION. ADD 50p P&P and 15% VAT TO TOTAL. OVERSEAS CUSTOMERS ADD £1·50 (Europe) £4 (elsewhere) for P&P.
Send sae for price list and with all enquiries. Callers welcome 9.30-5.00 (Mon-Fri) 10·00-4·00 (Sat.)

TK Electronics

(EE), 11 BOSTON ROAD, LONDON W7 3SJ. TEL. 01-579 9794

By Dave Barrington

Portable Light

It is not until your car or motorcycle has broken down at night or you suffer a prolonged power cut that you realise the usefulness of a low voltage fluorescent lamp. Of course, to be low cost they are of necessity, due to their design, of limited power or light output but it is surprising how well they illuminate the average room.

Two slim line low voltage fluorescent lamps have just been produced by Electronic Products (Coventry) Ltd., under their Euro-Lite range.

The Euro-8 is a 12V or 24V version rated at 8 watts and the Euro-13 is a 13 watt version. The 8W version cost £8·60 and the 13W lamp cost £9·72. Postage, packing and VAT is extra.

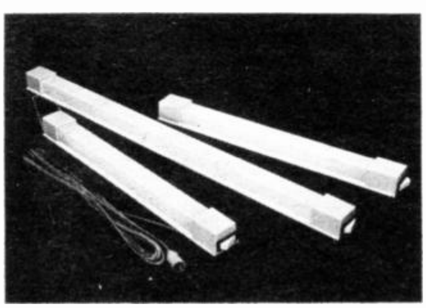
Ideally suited for use in caravans, tents, boats and any vehicle, the lights have a on/off rocker switch mounted at one end and also incorporate a fuse-link to protect external wiring should the inverter develop a fault. The light diffuser is easily removed for tube replacement.

Electrically the inverters are square wave high efficiency "ringing" choke type, operating in the frequency range of 20 to 40kHz. The lamps are claimed to be reverse polarity protected and radio frequency interference (r.f.i.) is minimal.

The camping models for use in tents come complete with metal hanging rings and long supply connecting leads terminated with crocodile clips or cigar lighter plug.

For more details contact Electronic Products (Coventry) Ltd., Dept EE, 20 Duke Street, Chapelfields, Coventry CV5 8BU.

Euro-Lites from Electronic Products.



Instant Circuit Boards

For those readers who do not like the idea of handling the various processes involved in making printed circuit boards but would like to make "instant" boards, without resorting to transfers and chemicals, should find the Quik-Circuit system now being marketed in the UK by Rastra Electronics worth a close look.

Consisting of pre-etched, pressure sensitive copper pads and strips, including transistor and i.c. outlines, with self-adhesive backing, the required circuit pattern is traced on plain or perforated board and suitable strips and patterns pressed into position on the board. Once complete the copper foil can be drilled or punched through with a sharp instrument according to type of base board used.

Also available in the Quik-Circuit range are "Cut-N-Peel" boards. These are plain or drilled matrix boards covered with adhesive copper foil on one or both sides. It is a simple matter to trace the circuit pattern on the foil, drill or punch the component mounting holes and then cut through the foil to the board surface using a sharp knife or scalpel and straight edge. It is now only a matter of peeling away the excess copper foil to complete the printed circuit board.

We regret that we are unable to vouch for its behaviour under the stress of soldering as the sample we requested for testing in our workshop has still not yet arrived. However, it is claimed that although excessive heat can cause the copper pads to slide they regain full adhesion on cooling.

For full details of the complete range of Quik-Circuit prototyping systems write to Rastra Electronics Ltd., Dept EE, 275-281 King Street, Hammersmith, London W6 9NF. We would point out that there is a minimum order charge of £10.

O.K. circuit-board repair kit.

PCB Repair Kit

Following on from p.c.b. foil transfers readers might like to investigate the latest p.c.b. repair kits from OK Machine & Tool.

Offered in deluxe, standard and economy kits all contain master frames with tracks and fingers, eyelets and eyelet setting tools. Tools included in the kits are clamps, tweezers and trimming knife with various blades.

Also included are etchant aids, abrasives, epoxy glue, flux and cleaners. The deluxe kit also has a temperature controlled fine point soldering iron and high quality pliers.

One item surprisingly omitted which would certainly prove most useful is a small tin of conductive paint. This would be useful for instant "running" repairs on hairline cracks which have a habit of appearing on the small copper tracks.

Details of price and nearest stockists of the 2570 series of PCB Repair Kits can be obtained from OK Machine & Tool (UK) Ltd, Dept EE, Dutton Lane, Eastleigh, Hants, SO5 4AA.

CONSTRUCTIONAL PROJECTS

Tremolo Unit

The heart of the *Tremolo Unit* is the MC3340 audio attenuator i.c. This appears to be only available from Magenta and Watford Electronics.

It is not essential to use the special footswitch case shown and any robust case would be suitable. If readers do require the one specified then this is obtainable from Maplin Electronic Supplies and should be ordered as foot-operated switch box type LHO9K.

Darkroom Timer

When ordering components for the *Darkroom Timer* be sure to specify a working voltage not less than 350V d.c. for capacitor C1.

The miniature wire-ended neons and all the remaining components are generally available from advertisers and should not cause problems.

Tape Auto Start

The components list for the *Tape Auto Start* calls for 4μF and 50nF capacitors. These may be difficult to locate but it is quite in order to use 3·3μF, 4·7μF and 47nF values here.

Any 6V to 12V relay with suitable contacts and a coil rating of between 100 and 250 ohms should operate in this circuit.

Burglar Alarm System

The only source of supply we have been able to locate for the moving armature type 4T earpiece used in the *Burglar Alarm* is J. Bull (Electrical). We understand that they are prepared to let any customer who orders six earpieces have them at the "bargain" price of £5, including postage, packing and VAT. If purchased individually they will cost £1·15 each.

If pressure mat switches are to be used for the parallel loop mode these are also available from the above company. Once again they are able to offer a special price for a large or small mat. The cost of four mats will be £9·00 for large and £8·00 small, including post, packing and VAT. Single item price is £2·50 large and £2·00 small, postage, packing and VAT is extra.

Any reader who experiences difficulty in locating a 6 inch alarm bell may care to note that the one used in our unit was obtained from Command Alarm Ltd., Dept EE, 27a Burden Lane, Cheam, Surrey.

The mains (KF2700) and audio (KF2702-PCB) transformers used in the prototype are available from Keston Manufacturing Co., Dept, EE, 69a Parkhall Road, Dulwich, London SE21 at an inclusive cost of £7·50 and £4·50 respectively. Other mains transformers can be used, for example the TTC471 (with the two secondary windings connected in series) from Titan Transformers and Components.

Semiconductor News

INTEGRATED A.M. RADIO

With the number of specialised linear i.c.s around today, it is possible to build all sorts of signal processing circuits with little more than the single i.c. and a few passive components.

One major exception to this cosy situation is the radio receiver. It is certainly true that parts of the circuit have been incorporated into several chips, but a single i.c. containing all active functions has not been available.

However, **Mullard** have now announced a new monolithic integrated a.m. receiver circuit that will do just that—namely perform all active functions between the aerial and the audio amplifier of an a.m. radio.

Designated the **TDA 1072**, this crafty design has a high signal to noise ratio, and low distortion figure which makes it suitable for use in high quality domestic and car radios. The two or three chip radio now looks a distinct possibility.

The TDA 1072 is particularly suitable for variable capacitance diode tuning and covers both major broadcast bands as well as short-wave up to 30MHz, so radio amateurs may well be interested.

A separate local oscillator output is available for driving a digital frequency counter and a logarithmic signal strength voltage output is provided for a field strength indicator.

The a.f. output voltage is 340mV for an r.f. input of 2mV and the device will operate from a supply voltage in the range 7·5 to 18V. Only a few peripheral components are needed for a complete radio circuit.

DIGITALKER

A rival to the recently mentioned SP0256 has been announced by **National Semiconductor**. This has been named the **Digitalker** and consists of a speech processor chip and several peripherals.

In fact this is a set of i.c.s rather than a single device and has the collective designation of the **D1000**. An emulator board is also available for evaluation and testing and provides 138 separate and individual "words", the term "word" including separate numbers, letters, tones, and so on.

The manufacturers hope that this chip set will be incorporated into such things as clocks, games, and other consumer products.

VIDEO MULTIPLEXER

The process of multiplexing signals is common to most data transmission systems and **Harris Semiconductor** have just come up with a new four channel CMOS Video Multiplexer to add to their line of data, acquisition products. Designated the **HI-524**, this device is a high performance analog multiplexer designed to process video signals with bandwidths up to 10MHz.

The makers claim that it can also be used where high channel isolation is required such as in telemetry and radar systems applications.

D/A CONVERTER

The latest addition to the **Burr-Brown** range is the **DAC-72**, a digital to analog converter with a 1μs settling time.

This is a 16-bit (or 4 digit BCD) device with a wide range of models, lower gain drift and higher operating temperature range.

Typical applications will include function generators, test equipment, and graphic composition machines and the 24-lead device comes in a welded metal, hermetically sealed package.

COMPUTER CHIPS

New from **Fairchild** is an advanced single chip 8-bit microcomputer known as the **F3870 MicroMachine 2**, specifically designed for use in the high volume cost sensitive industrial and commercial control market.

The chip features central control, 2K bytes of ROM, 64 bytes of RAM, on-board timer and 32 input/output lines. It will execute the full F8 processor instruction set of over 70 commands which allow it to be employed in multi-chip configurations with software compatibility.

Two versions of program memory are available—a mask programmed ROM or electrically programmed EPROM.

The latest addition to the popular Z80 microprocessor range is a controller-interface chip the **Z8036-Z** from **Zilog**.

This device contains three input/output ports and three independent 16-bit counter/timers. Sophisticated pattern match logic designed into the ports allows them to be used as interrupt controllers.

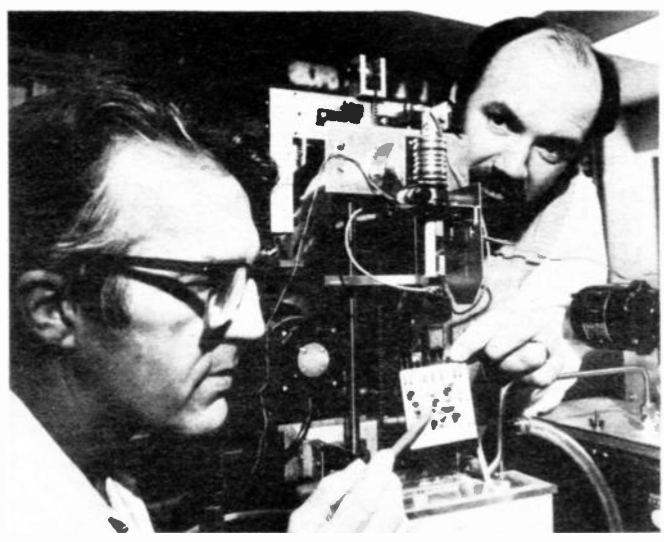
Two versions are available—one for multiplexed address/data bus structures such as the Z8000 and another for non-multiplexed CPUs like the Z80.

The latest offering from **Motorola** is a 32K bit EPROM. This is designated the **MCM2532** and has all the features one should expect from such a device including 5V operation and automatic power down and byte organisation. There is a choice of three access times and a low power version. The pin out arrangement of this device follows the usual industry standard and ensures full compatibility with other Motorola devices.

Not to be outdone, **Intel** are now offering a 64K bit EPROM. This is the **2764** and is the fastest device of its size with a worst case access time of only 200μs. The 2764 is manufactured using Intel's HMOS-E process and employs the lowest chip area of any 64K EPROM currently in production.

The 28-pin package conforms to the JC-42 MOS memory standard of *JEDEC* and has been selected because it allows bytewide ROMS, RAMS and EPROMS to share the same pinout and allows two line control to ensure proper system operation at high speed.

Another advantage is that different size memories can be plugged into the same 28-pin socket which reduces tooling and production costs for the mounting boards.

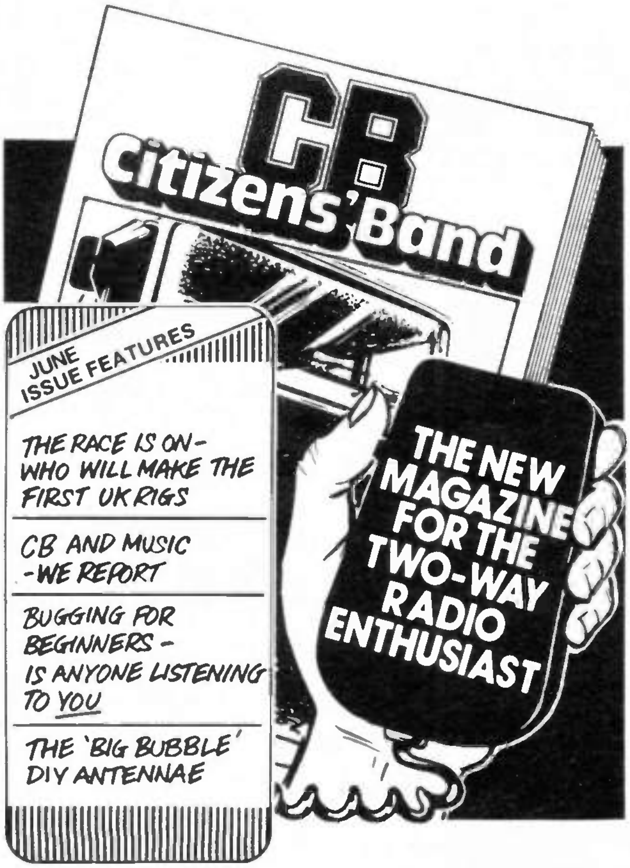


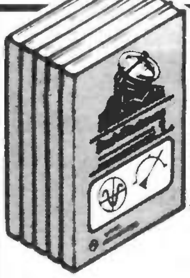
PORCELAIN CIRCUIT BOARD

Next time you're soldering in the components on your latest project, spare a thought for the poor circuit board. Excessive heat may seriously weaken its structure and whilst this is not particularly important to the amateur, it could be vital in a space-craft or military aircraft.

With this in mind, Wayne Anderson and Dr Kenneth Hang have developed a new kind of porcelain over steel circuit board at the **RCA Laboratory** in **Princeton**, New Jersey.

The RCA porcelain is unusual in that it is highly crystallised as opposed to most porcelains that are glassy in nature. Indeed this new material is so good that it can be repeatedly heated to high temperatures without deforming so many different electronic components can be formed directly on the boards.





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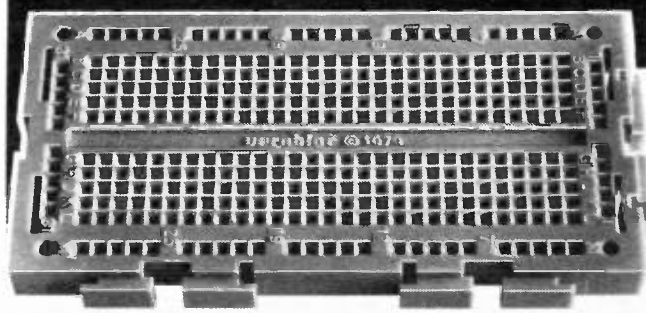
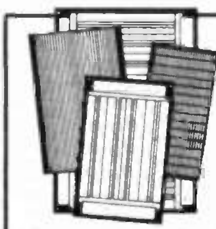


ADDS TO YOUR CAPABILITY

Already used in industry, this solderless breadboard is now available to the hobbyist. Unique because of its universal interlocking facility meaning you no longer need lots of different boards.

Send now for the unique Verobloc.
Order code 200-21092G. £4.16p inclusive.



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No.	Order Code	Description	Size (mm)	Price
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State quantity and order codes required

Name

Address

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Access No

Exp. date

EE 6

vero

AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

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LM348N 1.86
LF351N 0.38
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uA709HC 0.64
uA709PC 0.36
uA710HC 0.65
uA710PC 0.59
uA741CH 0.66
uA741CN 0.27
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uA748CN 0.36
uA753 2.44
uA758 2.35
TBA810AS 1.09
TBA820M 0.75
TCA940E 1.80
TDA1028 2.11
TDA1029 2.11
TDA1054 1.45
TDA1062 1.95
TDA1072 2.69
TDA1074A 5.04
TDA1083 1.95
TDA1090 3.05
HA1137 1.20
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HA1197 1.00
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MC1350 1.20
HA1370 1.90
HA1388 2.75
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MC1496P 1.25
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SL1611P 1.60
SL1612P 1.60
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SL1620P 2.17
SL1621P 2.17
SL1623P 2.24
SL624C 3.28
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KB4413 1.95
KB4417 1.80
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KB4420B 1.09
KB4423 2.30
KB4424 1.65
KB4431 1.95
KB4432 1.95
KB4433 1.52
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KB4437 1.75
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MSM5526 7.85
MSM5527 9.75
MSM55271 9.75
ICM7106CP 9.55
ICM7107CP 9.55
ICM7216B 19.25
ICM7217A 9.50
SP8629 3.85
SP8647 6.00
95H90PC 6.00
HD10551 2.45
HD44015 4.45
HD12009 6.00
HD44752 8.00

CMOS 4000 SERIES

4001 0.17
4000 0.17
4002 0.23
4008 0.80
4009 0.58
4010B 0.58
4011AE 0.20
4011B 0.20
4012 0.55
4013 0.55
4015 0.95
4016 0.52
4017 0.80
4019 0.60
4020B 0.93
4021 0.82
4022 0.90
4023 0.17
4024 0.76
4025 0.17
4026 1.80
4028 0.72
4029 1.00
4030 0.58
4035 1.20
4040 0.83
4042 0.85
4043 0.85
4044 0.80
4046 1.30
4047 0.99
4049 0.52
4050 0.55
4051 0.65
4052 0.65
4053 0.65
4063 1.09
4066 0.56
4068 0.25
4069 0.20
4070 0.20
4071 0.20
4072 0.20
4073 0.20
4075 0.20
4076 0.90
4077 0.20
4078 0.20
4082 0.20
4093 0.78
4175 0.95
4503 0.69
4506 0.51
4510 0.99
4511 1.49
4512 0.98
4514 2.55
4518 1.03
4520 1.09
4521 2.36
4522 1.49
4529 1.41
4539 1.10
4549 3.50
4554 1.53
4560 2.18
4566 1.59
4568 2.18
4569 3.03
4572 0.30
4585 1.10

TTL N and LSN

7400N 0.13
74LS00 0.20
7401N 0.13
74LS01 0.20
7402N 0.14
74LS02 0.20
7403N 0.14
74LS03 0.20
7404N 0.14
74LS04 0.24
7405N 0.18
74LS05 0.26
7406N 0.28
7407N 0.38
7408N 0.17
74LS08 0.24
7409N 0.17
74LS09 0.24
7410N 0.15
74LS10 0.24
7411N 0.20
74LS11 0.24
7412N 0.17
7413N 0.30
7414N 0.51
74LS15 0.24
7416N 0.30
7417N 0.30
7420N 0.16
74LS20 0.24
7421N 0.29
74LS21 0.24
7423N 0.27
7425N 0.27
7427N 0.27
74LS27 0.44
7428N 0.35
74LS28 0.32
7430N 0.17
74LS30 0.24
7432N 0.25
74LS32 0.24
7437N 0.40
7438N 0.33
74LS38 0.24
7440N 0.17
74LS40 0.24
7441N 0.74
7442N 0.70
74LS42 0.99
7443N 1.15
7444N 1.12
7445N 0.94
7446N 0.94
74LS47 0.89
7448N 0.56
74LS48 0.99
74LS49 0.99
7451N 0.17
74LS51 0.24
7453N 0.17
7454N 0.17
74LS54 0.24
74LS55 0.24
7460N 0.17
74LS63 1.24
7470N 0.28
7472N 0.28
7473N 0.32
74LS73 0.38
7474N 0.27
74LS74 0.28
7475N 0.38
7476N 0.37
74LS76 0.38
74LS78 0.38
7480N 0.48
7481N 0.86
7482N 0.69
7485N 1.04
74LS85 0.99
74LS86 0.40
7489N 2.05
7490N 0.33
74LS90 0.90
7491N 0.76
74LS91 1.10
7492N 0.38
74LS92 0.78
7493N 0.32
74LS93 0.99
7494N 0.78
7495N 0.65
74LS95 1.14
7496N 0.58
74LS96 1.20
7497N 1.85
74LS107 0.38
74109N 0.63
74LS109 0.70
74110N 0.54
74111N 0.68
74LS112 0.38
74LS113 0.38
74LS114 0.38
74118N 0.83
74120N 1.15
74121N 0.42
74122N 0.46
74123N 0.73
74LS124 1.75
74125N 0.38
74LS125 0.44
74126N 0.57
74LS126 0.44
74128N 0.74
74132N 0.73
74LS132 0.78
74LS136 0.40
74LS138 0.60
74141N 0.56
74142N 2.65
74143N 3.12
74144N 3.12
74LS145 0.97
74147N 1.75
74148N 1.09
74LS148 1.19
74150N 0.99
74151N 0.55
74LS151 0.84
74153N 0.64
74LS153 0.54
74154N 0.96
74155N 0.54
74LS155 1.10
74156N 0.80
74157N 0.67
74LS157 0.55
74LS158 0.60
74159N 2.10
74160N 0.82
74LS160 1.30
74161N 0.92
74LS161 0.78
74LS162 1.30
74163N 0.92
74LS163 0.78
74164N 1.04
74LS164 1.30
74165N 1.05
74LS165 1.04
74167N 2.50
74LS169 2.00
74170N 2.30
74LS170 2.00
74LS174 1.20
74175N 0.87
74LS175 1.10
74176N 0.75
74177N 0.78
74181N 1.65
74LS181 3.50
74LS183 2.10
74184N 1.35
74185N 1.34
74LS190 0.92
74192N 1.05
74LS192 1.80
74193N 1.05
74LS193 1.80
74194N 1.05
74196N 0.99
74LS196 1.10
74LS197 1.10
74198N 1.50
74199N 1.60
74LS247 0.93
74LS257 1.08
74LS260 1.53
74LS279 0.52
74LS283 1.20
74LS293 0.95
74LS365 0.49
74LS366 0.49
74LS367 0.43
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Pairs AM 3.10

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455kHZ 5.00
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3.2768MHz 2.70
4.000MHz 2.00
4.19439MHz 2.30
6.5536MHz 2.10
10.0MHz 2.50
10.6985MHz 2.50
10.7015MHz 2.50
10.245MHz 2.50
10.7MHz 3.00
11.52MHz 2.50
100MHz 3.00

LEDs

5MM RED 0.12
3MM RED CLEAR 0.15
3MM RED 0.15
2.5 X 5MM RED 0.17
5MM GREEN 0.15
3MM GN CLEAR 0.16
3MM GREEN 0.16
2.5 X 5MM GN 0.20
5MM YELLOW 0.15
3MM YELLOW CL 0.16
3MM YELLOW 0.18
2.5 X 5MM YE 0.20
5MM ORANGERED 0.20
5MM ORA CL 0.29
3MM ORANGERED 0.19
2.5 X 5MM ORA 0.24
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BPW41 IR DET 1.51
IR OPT CPLR 1.44
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KV1226 1.95
KV1225 2.75
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SHOTTKY DIODES

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BA182 0.19
BA244 0.17
BA379 0.35
TDA1061 0.95

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1N4148 0.06
1N4001 0.06
1N4002 0.07
1N5402 0.15
OA91 0.07
AA112 0.25
BRIDGES:
1A/50V 0.35
6A/200V 0.75

TRANSISTORS AUDIO DEVICES

BC237 0.08
BC238 0.08
BC239 0.08
BC307 0.08
BC308 0.08
BC309 0.08
BC413 0.10
BC414 0.11
BC415 0.07
BC416 0.08
BC546 0.12
BC556 0.12
BC550 0.12
BC560 0.12
BC639 0.22
BC640 0.23
2SC1775 0.18
2SA872A 0.14
2SD666A 0.30
2SB646A 0.30
2SD668A 0.40
2SB648A 0.40
2SD760 0.45
2SB720 0.45
2SC2546 0.19
2SA1084 0.20
2SC2547 0.19
2SA1085 0.20

AUDIO POWER DEVICES

2SB753 2.34
2SB723 2.34
2SK133 3.00
2SJ 48 3.00
2SK134 3.10
2SK135 3.75
2SJ 50 3.75
BD535 0.52
BD536 0.52
BD377 0.33
BD378 0.33
BD165 0.30
BD166 0.31

SMALL SIGNAL RF DEVICES

BF194 0.18
BF195 0.18
BF224 0.22
BF241 0.18
BF274 0.18
BF440 0.21
BF441 0.21
BF362 0.49
BF395 0.18
BF479 0.66
BF679S 0.55
BFR91 1.33
BFW92 0.60
BFT95 0.99
BFY90 0.90
40238 0.85

RF POWER DEVICES

VN66AF 0.95
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BF256 0.38
2SK55 0.28
2SK168 0.35
J310 0.69
J176 0.65
40823 0.65
40673 3SK51
3SK45 0.49
3SK51 0.54
3SK60 0.58
MEM680 0.75
BF961 0.70
BF960 1.24
3SK48 1.64

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CM161
Miniature clock, 12/24 hr., alarm, day, date, backlight.
All for......9.95

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All 5mm or less spacing

CERAMIC 50v
2P2,3P3,4P7,6P8
8P2,10P,15P,18P..0.04
22P,27P,33P,47P
56P,68P,82P,100P.0.05
150P,220P,270P
330P,390P,470P...0.055
1N0,2N2,3N3,4N7..0.06
10N (0.01uF)....0.05
22N,47N..........0.06
100N,220N........0.09
MONOLITHIC CERAMIC
10N,100N.........0.16
FEEDTHRU
1N0 SOLDER IN....0.09
POLYESTER (SIEMENS)
10mm LEAD SPACING
10N,22N,33N......0.17
47N,68N,100N.....0.19
220N,470N........0.22
1uF..............0.29
POLYESTER (GENERAL)
10mm LEAD SPACING
10N,15N,22N,33N..0.06
47N,68N,100N.....0.08
220N.............0.11
20mm LEAD SPACING
220N,330N,470N...0.18
MYLAR
5mm LEAD SPACING
1N0,10N,22N,33N..0.08
100N.............0.09
20mm LEAD SPACING
220N,470N....... 0.17
POLYSTYRENE
10P,15P,18P,22P,
27P,47P,56P,68P..0.08
100P,180P,220P,
270P,330P,390P...0.09
470P,680P,820P...0.10
1N0,1N2,1N5,1N8..0.11
2N2,2N7,3N3,3N9..0.12
4N7,5N6,6N8,10N..0.13
TANTALUM BEAD CAPS
16v: 0.22,0.33,
0.68,1.0.........0.18
16v: 2.2,4.7,10..0.19
6v3: 22,47.......0.30
10v: 22,100......0.35

ALUMIN ELECTROLYTICS RADIAL (VERT. MOUNT)

(uF/voltage)
1/63,2.2/50,4.7/35
10/16,15/16,22/10
33/6.3...........0.08
22/16,33/10,
47/10............0.09
10/63,22/50,33/50,
47/16,100/16.....0.10
47/63,100/25,220/16
470/6.3..........0.12
100/63,470/16,
1000/10..........0.18
1000/16,470/63...0.23
1000/63,2200/16..0.30
3300/25..........0.69
1000/100.........0.88
10000/70.........3.00
AXIAL (HORIZ. MOUNT)
1/25,4.7/16,6.4/25
10/16............0.08
4.7/63,22/10,22/16
33/16............0.09
47/25,100/16.....0.10
100/25...........0.11
1000/16..........0.25
2200/16,1000/25..0.36
1000/35,4700/16..0.45
1000/50..........0.58

RESISTORS

0.25W, 5% E12 CARBON
1ohm-10M.........0.02
0.25W 1% E12 METAL FILM
1.1ohm-1M........0.05
HORIZ CARBON PRESETS
10mm TYPE
100ohms-2M5......0.12
HORIZ CERMET PRESETS
1k, 10k..........0.27

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CIRCUIT EXCHANGE

BURGLAR ALARM SYSTEM

I recently designed this circuit as part of a home burglar alarm system, but it obviously has other applications. The circuit can be used to detect and register a fault condition on any of four separate inputs. An input can be any normally closed circuit, a warning occurs when the input circuit is broken. Detection of a fault causes the "safe" green l.e.d. to be extinguished, the "warning" red l.e.d. to light and the audible alarm to sound.

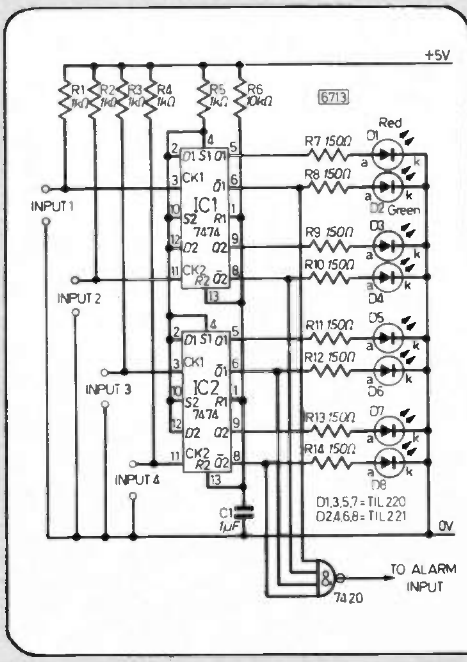
The design uses two 7474's each containing two D-type flip-flops, a 7420 four input NAND gate, and a 555 timer. More inputs can be added by using extra 7474's and a NAND gate with more inputs.

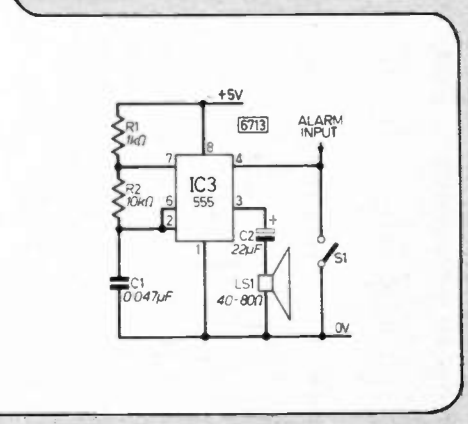
The circuit operation is very simple. The data and preset lines of the 7474 flip-flops are held at logic one. The clear lines are initially at logic zero (setting the outputs Q=0 and $\bar{Q}$=1, that is red l.e.d. off and green l.e.d. on), C1 and R1 then take the clear lines to logic one.

Any positive going pulse on the clock line will now cause the flip-flops outputs to toggle (Q=1 and $\bar{Q}$=0, that is red l.e.d. on and green l.e.d. off). The change in state of the Q line from logic one to logic zero is detected by the NAND gate whose output changes to a logic one, triggering the 555 audible alarm. The circuit remains in this state even if the fault now clears.

The alarm may be silenced by closing switch S1. The circuit is reset by switching off the power, this will restore the original state provided all inputs are safe.

T. E. Valleby,
Stockton-on-Tees





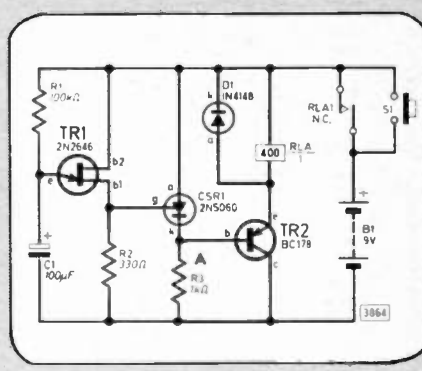
30 SECOND TIMER

This is a timer circuit, with a time period of approximately 30 seconds, but can be varied with the addition of a potentiometer. The circuit consumes no current while it is not in use, owing to the normally open relay contacts, RLA1.

As the pushbutton is depressed, TR2 turns on, through R3. This turns on the relay which closes RLA1, thus latching the relay on. R1, C1, TR1 and R2 form a u.j.t. relaxation oscillator. After 30 seconds, a pulse is fired into the gate of CSR1, which turns on and raises the base voltage at TR2, turning it and the relay off which opens RLA1. CSR1 is necessary to hold the voltage at *A* high until the relay turns off. The load is switched by a second set of contacts, RLA2.

If the time period is to be altered, R1 should be 22 kilohm, and a 470 kilohm linear potentiometer should be put in series with it, to give times up to a couple of minutes.

Nicholas Ray,
Buntingford, Herts



LETTERS

Electro-Etching

I have just been reading the article in the January edition of E.E. on making p.c.b.s and I was impressed by the variety of methods shown, though I was surprised that you did not mention electrolysis or electroplating. I have found this method very rewarding because I could use the same resist materials needed for etching (for example, etch resist pen, transfers and best of all, nail varnish!) to mask out the copper tracks.

After that has been done, the areas of unwanted copper are joined together electrically and connected to the positive terminal of a 6-12V d.c. power supply. The copper board is then be placed in a solution of dilute sulphuric acid.

The negative terminal of the power supply is connected to a piece of metal (I use a clean nail), and this is also placed in the solution. On switching on the current, hydrogen is liberated from the solution at the piece of metal, and copper from the board enters the solution as copper ions.

The following reactions take place:

at the p.c.b.

$$Cu \rightarrow Cu^{++} + 2e^-$$

at the metal

$$2H^+ + 2e^- \rightarrow H_2$$

The process depends on the voltage applied—this should not be too large as to produce an over-vigorous reaction—and the concentration of the acid. Generally the acid should not be too strong or too weak. A concentration of 2 Molar is adequate. The end result is a very clean-cut p.c.b.

Philip Micallef, Sliema, Malta G. C.

This is an interesting method of p.c.b production and one that we hadn't considered when preparing the p.c.b. article mentioned above.

However, several points of caution must be borne in mind. Sulphuric acid is corrosive and although the strength specified is no more dangerous than battery acid, nevertheless it must be treated with respect.

Once the process is under way, hydrogen gas will be liberated. Although the quantities are not vast, the process should be carried out in a well ventilated area so that the gas is not given a chance to build up.

Finally a word about the process itself. As stated in the letter, the speed of reaction depends on applied voltage and hence the size of the passing current. The bigger the current, the more vigorous the reaction. Unless you are very familiar with the process it would be very unwise to start off with large currents. The answer is to start with a very small current and then slowly increase it until satisfactory results are obtained.

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- **AUTOMATIC PHASE BOX.** Dec. 77 — £9·55 inc. p.c.b.
- **VHF RADIO.** Nov. 77 — £14·36
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Miniature synthesiser featuring vibrato, envelope, tempo, volume + pitch controls. Uses 24 push button switches in a keyboard style layout. Based on a custom designed I.c. The accessible memory stores a 32 beat length sequence of notes + spaces. Can be played 'live'. Fitted with an internal speaker. Jack socket allows the use of an external amplifier if wished. **Memory Bank Synthesiser £33·85.**

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Simple T.R.F. Design. Covering most Amateur Bands and Short Wave Broadcast Bands. Five controls. Bandset, Bandspread Reaction, Wavechange and Attenuator. Coil section is by Wavechange Switch. Use with Headphones or a Crystal earpiece. Kit contains all the components required including the P.C. Board and Case. Instructions are included with this kit. **KIT £18·97. Headphone extra £2·98.**

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E.E. 12 part series. Oct '79-Sept '80. Covers the basics of electronics—lots of practical work. Circuits are built on a plug-in Eurobreadboard, which is built into a wooden console which houses the power supplies, speaker, meter, pots and LED indicators. The series uses a range of electronic components in the experimental work including a photocell, I.C.s, transistors, etc.
Wooden Console (Tutor Deck) kit **£5·98** extra. Includes all the wood, glue, feet and strap handle.
Electronic components, including Eurobreadboard, for the console and the experiments **£25·40** (called list A + B + C by E.E.). Reprints available—Parts 1-12, **45p** each.
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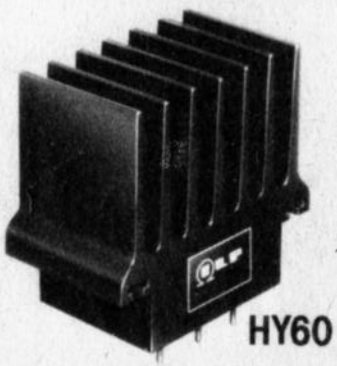


HY60

MOSFET

CHOOSE AN I.L.P MOSFET POWER AMP when it is advantageous to have a faster slew rate, lower distortion at higher frequencies, enhanced thermal stability, the ability to work with complex loads without difficulty and complete absence of cross-over distortion. I.L.P's exclusive encapsulation technique within fully adequate heatsinks has been taken a stage further with specially developed computer-verified 'New Profile' extrusions. These ensure optimum operating efficiency from our new MOSFETS, and are easier to mount. Connection is via five pins on the underside. **I.L.P MOSFETS ARE IDENTICAL IN PERFORMANCE TO THE COSTLIEST AMPLIFIERS IN THIS EXCITING NEW CATEGORY BUT ARE ONLY A FRACTION OF PRICES CHARGED ELSEWHERE.**

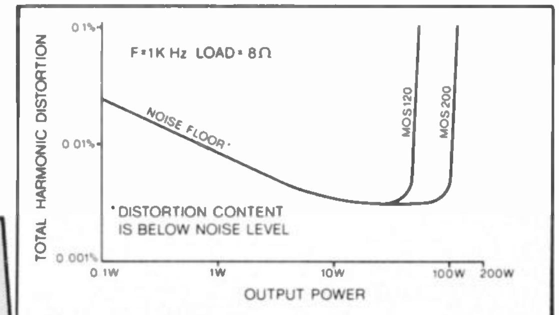
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

BIPOLAR *(Standard o/p transistors)*

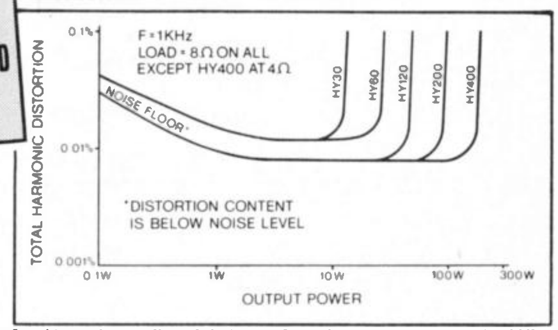
CHOOSE AN I.L.P BIPOLAR POWER AMP where power and price are first consideration while maintaining optimum performance with hi-fi quality and wide choice of models. From domestic hi-fi to disco and P.A., for instrument amplification, there is an I.L.P Bipolar to fill the bill, and as with our new Mosfets, we have encapsulated Bipolars within our New Profile extrusions with their computer-verified thermal efficiency and improved mounting shoulders. Connections are simple, via five pins on the underside and with our newest pre-amps and power supply units, it becomes easier than ever to have a system layout housed the way you want it.

Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.29 + £1.09
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£8.33 + £1.25
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£17.48 + £2.62
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£21.21 + £3.18
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£31.83 + £4.77

ILP POWER AMPS ARE ENCAPSULATED FOR THERMAL STABILITY AND LONGER LIFE

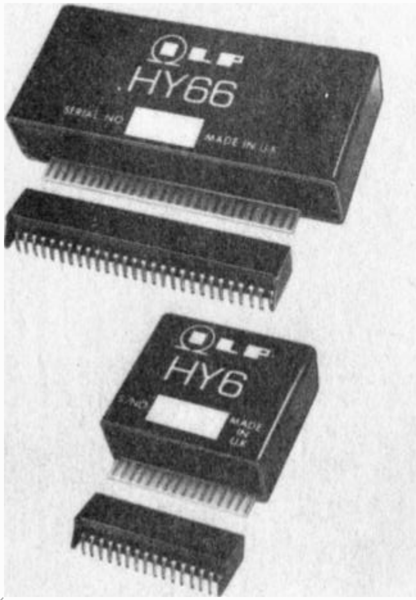


Load impedance both models 4Ω - ∞ Input sensitivity both models 500mV
Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz - 3dB



Load impedance all models 4Ω - ∞ Input sensitivity all models 500mV
Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz - 3dB

THE NEW PROFILE EXTRUSIONS
The introduction of standard heatsink extrusion for all I.L.P power amplifiers achieves many advantages: - Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for higher thermal conductivity. Extrusions vary in size according to module number.



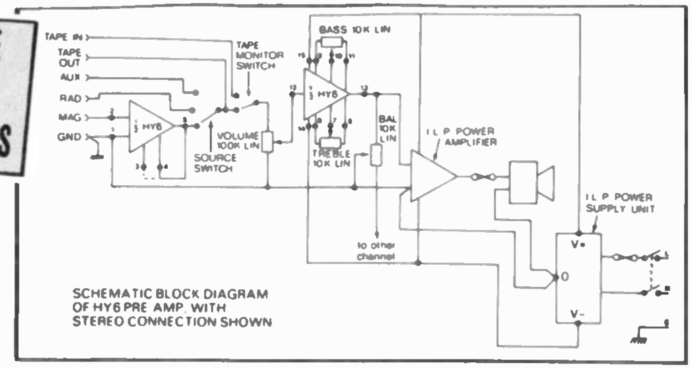
I.L.P. PRE-AMPS

HY6 (mono) and **HY66** (stereo) are new to I.L.P's range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.

Sizes – **HY6** – 45 x 20 x 40 mm. **HY66** – 90 x 20 x 40 mm.
Active Tone Control circuits provide ±12dB cut and boost.
Inputs Sensitivity – Mag. PU. –3mV: Mic – selectable 1-12mV: All others 100mV. **Tape O/P** – 100mV: **Main O/P** – 500mV: **Frequency response** – D.C. to 100KHz – 3dB.

HY6 mono £6.44 + 97p VAT Connectors included
HY66 stereo £12.19 + £1.83 VAT Connectors included
B6 Mounting Board for one HY6 78p + 12p VAT
B66 Mounting Board for one HY66 99p + 15p VAT

COMPATIBLE WITH ALL ILP MODULES



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE AMP. WITH STEREO CONNECTION SHOWN

- **DISTORTION TYPICALLY 0.005%**
- **S/N RATIO – 90dB (Mag. P.U. – 68 dB)**
- **38 dB overload margin on Mag. P.U.**
- **LATEST DESIGN HIGH QUALITY CONNECTORS**
- **ONLY POTS, SWITCHES AND PLUGS/SOCKETS NEED ADDING**
- **NEEDS ONLY UNREGULATED POWER SUPPLY ±15 to ±60v**

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Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus these I.L.P power supply units are space-saving, more efficient and their better overall design helps enormously when assembly building. All models in the range are compatible with all I.L.P amps and pre-amps with types to match whatever I.L.P power amps you choose.

PSU30 ± 15V at 100mA to drive up to 12 x HY6 or 6 x HY66 — **£4.50 + 0.68p VAT**

● *THE FOLLOWING WILL ALSO DRIVE I.L.P PRE-AMPS*

PSU36 for use with 1 or 2 HY30's — **£8.10 + £1.22 VAT**

● *ALL THE FOLLOWING USE TOROIDAL TRANSFORMERS*

PSU50	for use with 1 or 2 HY60's	**£10.94 + £1.64 VAT**
PSU60	for use with 1 HY120	**£13.04 + £1.96 VAT**
PSU65	for use with 1 MOS120	**£13.32 + £2.00 VAT**
PSU70	for use with 1 or 2 HY120's	**£15.92 + £2.39 VAT**
PSU75	for use with 1 or 2 **MOS120**	**£16.20 + £2.43 VAT**
PSU90	for use with 1 HY200	**£16.20 + £2.43 VAT**
PSU95	for use with 1 **MOS200**	**£16.32 + £2.48 VAT**
PSU180	for use with 1 HY400 or 2 HY200	**£21.34 + £3.20 VAT**
PSU185	for use with 1 or 2 **MOS200**	**£21.46 + £3.22 VAT**

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HIGH POWER MODULE KITS

SPECIFICATIONS

Max. Output power .... 125 watt RMS
Operating voltage (DC) .... 50-80 Max.
Loads .... 4-16 ohms
Frequency response Measured at 100 watts 25Hz-20Khz
Sensitivity for 100 watts .... 400mV @ 47K
Typical T.H.D. @ 50 watts 4 ohms load 0.1%
Dimensions .... 205 x 90 and 190 x 36mm

The P.E. power amp kit is a module for high power applications—disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC Board is backprinted, etched and ready to drill for ease of construction, and the aluminium chassis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

ACCESSORIES

Suitable LS coupling electrolytic for 125W. model £1.00 plus 25p p&p.
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Suitable Mains Power Supply Unit for 125W. model £7.50 plus £3.15 p&p.
Suitable Twin Transformer Power Supply for 200W. model £13.95 plus £4.00 p&p.

125 WATT MODEL
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200 WATT MODEL
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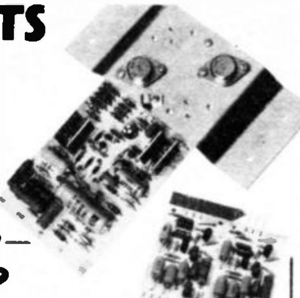

FREE!
MULLARD LP1183 STEREO PREAMP
Original listed price over £5.00. Suitable for ceramic and auxiliary inputs, when you purchase 2 power module kits.

STEREO DISCO PREAMPLIFIER

Matching other modules, suitable for twin deck mixing with P.F.L. output and Mic/Tape input. Ready built, ready to play with circuit diagram and application notes to suit our power module kits.

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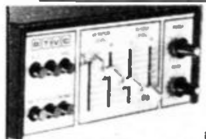


10+10 WATT STEREO HI-FI AMPLIFIER KIT

- Featuring latest SGS/ATES/TDA 2006 10 watt output I.C.'s with in-built thermal and short circuit protection
- Mullard Stereo Preamplifier module
- Attractive ready made black vinyl finish cabinet
- Converts to a 20 Watt Disco amplifier

£14.95
plus £2.90 p&p

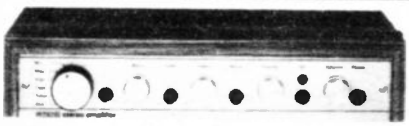
To complete you just supply connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs—tape, speakers and headphones. By the press of a button it transforms into a 20 watt mono disc amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus power amplifier assembly kit and mains power supply. Also featured 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia panel with matching knobs and contrasting ready made black vinyl finish cabinet and ready made metal work. For further information instructions are available price 50p. Free with kit. Size 9" x 8⅝" x 3⅝" approx.

SPECIFICATIONS Suitable for 4 to 8 ohms speakers. Frequency response – 40Hz-20KHz; Input Sensitivity – P.U. 150mV Aux. 200mV Mic. 1.5mV; Tone controls – Bass ± 12db @ 60Hz; Treble ± 12db @ 10KHz; Distortion – 1% typically @ 4 watts; Mains supply – 220-250 volts 50Hz.

BSR chassis record deck with manual set down and return, complete with stereo ceramic cartridge. £8.50 plus £3.15 p&p when purchased with amplifier. Available separately £10.50 plus £3.15 p&p.

8" SPEAKER KIT. 2 8" approx. twin cone domestic use speakers. £4.75 per pair plus £1.70 p&p when purchased with amplifier. Available separately £6.75 plus £1.70 p&p.

STEREO MAGNETIC PRE-AMP CONVERSION KIT
All components including P.C.B. to convert your ceramic input on the 10+10 amp to magnetic. £2.00 when purchased with kit featured above. £4.00 separately inc. p&p.



30 + 30 WATT STEREO AMPLIFIER BUILT AND TESTED

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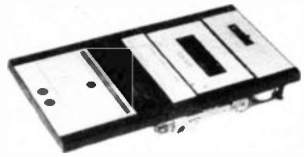

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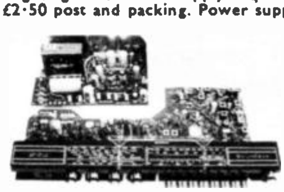

G.E.C. TUNER AMPLIFIER CHASSIS—AM/FM
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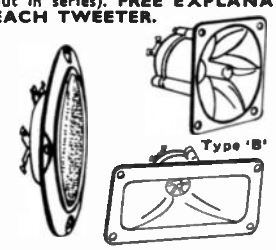

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