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Data Sheet

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Telephone 01-434 1781/2

HALVOR W. MOORSHEAD
Editor

LES BELL, G4CFM
RON HARRIS B.Sc
Editorial

TONY ALSTON
Project Development

JIM PERRY
Specials Editor

JEAN BUTTERWORTH
JULIAN ZINOVIEFF
Production

SANDRA ZAMMIT-MARMARA
Subscriptions

MARGARET HEWITT
Administration

DAVID LAKE (Manager)
BRENDA GOODWIN
Reader Services

ROBERT C. EVANS
Advertisement Manager
Telephone 01-437 5982

INTERNATIONAL EDITIONS

AUSTRALIA: Collyn Rivers, Editorial Director; Steve Braidwood, Assistant Editor

HOLLAND: Anton Kriegsman, Editor-in-chief

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SEMICONDUCTORS - COMPONENTS

TRIACS

2 Amp Volts	TO5 Case No.	Price	10 Amp. Volts	TO48 Case No.	Price
100	TR12A/100	£0.31	100	TR110A/100	£0.77
200	TR12A/200	£0.51	200	TR110A/200	£0.92
400	TR12A/400	£0.71	400	TR110A/400	£1.12

6 Amp Volts	TO66 Case No.	Price	10 Amp Volts	TO220 Case No.	Price
100	TR16A/100	£0.51	400	TR110A/400P	£1.12
200	TR16A/200	£0.61			
400	TR16A/400	£0.77			

DIACS

BR100 £0.23 D32 £0.23

SUPER UNTESTED PAKS

PAK	No.	Order No.	Price
U50	100 Germ. Gold bonded OA47 diode	16130	£0.60
U51	150 Germ. OA70/81 diode	16131	£0.60
U52	100 Silicon Diodes 200mA OA200	16132	£0.60
U53	150 diodes 75mA 1N4148	16133	£0.60
U54	50 Sil Rect Top Hat 750mA	16134	£0.60
U55	20 Sil Rect Stud Type 3 Amp	16135	£0.60
U56	50 400mW Zeners DO7 Case	16136	£0.60
U57	30 NPN Trans BC107/8 Plastic	16137	£0.60*
U58	30 PNP Trans BC177/178 Plastic	16138	£0.60*
U59	25 NPN TO39 2N697/2N1711 sil.	16139	£0.60
U60	25 PNP TO59 2N2905 silicon	16140	£0.60
U61	30 NPN TO18 2N706 silicon	16141	£0.60
U62	25 NPN BFY50/51	16142	£0.60
U63	30 NPN Plastic 2N3906 silicon	16143	£0.60*
U64	30 PNP Plastic 2N3905 silicon	16144	£0.60*
U65	30 Germ. OO71 PNP	16145	£0.60
U66	15 Plastic Power 2N3055 NPN	16146	£1.20
U67	10 TO3 Metal 2N3055 NPN	16147	£1.20
U68	20 Unijunction trans IIS43	16148	£0.60
U69	10 1 amp SCR TO39	16149	£1.20
U70	8 3 amp SCR TO66 case	16150	£1.20

Code No's mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

COMPONENT PACKS

Pack No.	Qty.		Order No.	Price
C1	200	Resistor mixed value approx. (Count by weight)	16164	*£0.60
C2	150	Capacitors mixed value approx. (Count by weight)	16165	£0.60
C3	50	Precision resistors. Mixed values	16166	*£0.60
C4	80	1/8th W Resistors mixed preferred values	16167	*£0.60
C5	5	Pieces assorted ferrite rods	16168	*£0.60
C6	2	Tuning gangs, MW/1W VHF	16169	*£0.60
C7	1	Pack wire 50 metres assorted colours single strand	16170	£0.60
C8	10	Reed switches	16171	*£0.60
C9	3	Micro switches	16172	*£0.60
C10	15	Assorted pots	16173	*£0.60
C11	5	Metal jack sockets 3 x 3.5mm. 2 x standard switch types	16174	*£0.60
C12	30	Paper condensers preferred types mixed values	16175	*£0.60
C13	20	Electrolytics trans. types	16176	*£0.60
C14	1	Pack assorted hardware — Nuts / bolts, grommets, etc.	16177	*£0.60
C15	5	Mains slide switches ass.	16178	*£0.60
C16	20	Assorted tag strips and panels	16179	*£0.60
C17	15	Assorted control knobs	16180	*£0.60
C18	4	Rotary wave change switches	16181	*£0.60
C19	2	Relays 6 — 24V operating	16182	*£0.60
C20	1	Pak. copper laminate approx. 200 sq. ins.	16183	£0.60
C21	15	Assorted fuses 100mA-5 amp.	16184	£0.60
C22	50	Metres PVC sleeving assorted size and colour	16185	£0.60
C23	60	½ watt resistors mixed preferred values	16188	*£0.60
C24	25	Presets assorted type and value	16186	*£0.60
C25	30	Metres stranded wire assorted colours	16187	£0.60*

SLIDER PAKS

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

CERAMIC PAKS

Containing a range of first quality miniature ceramic capacitors. Unrepeatable value.

		Order No.	Price
MC1	24 miniature ceramic capacitors, 3 of each value — 22pf, 27pf, 33pf, 39pf, 47pf, 68pf, 82pf	16160	*£0.60
MC2	24 miniature ceramic capacitors, 3 of each value — 100pf, 120pf, 150pf, 180pf, 220pf, 330pf & 390pf, 270pf	16161	*£0.60
MC3	24 miniature ceramic capacitors, 3 of each value — 470pf, 560pf, 680pf, 820pf, 1000pf, 1500pf, 2200pf & 3300pf	16162	*£0.60
MC4	24 miniature ceramic capacitors 3 of each value — 470pf, 560pf, 680pf, 820pf, 1000pf, 1500pf, 2200pf & 3300pf	16163	*£0.60

ORDERING

Please word your orders exactly as printed, not forgetting to include our part number.

V.A.T.

Add 12½% to prices marked *. Add 8½% to others excepting those marked † these are Zero.

CARBON POTENTIOMETERS

SINGLE GANG with wire end terminations, 6mm x 50mm plastic shaft 10mm bushes supplied with shake-proof washer and nut. Tolerance ±20% of resistance.

LINEAR TRACK Value	No.	Price	LOG TRACK Value	No.	Price
1K	1831	*£0.22	4K7	1842	*£0.22
2K2	1832	*£0.22	10K	1843	*£0.22
4K7	1833	*£0.22	22K	1844	*£0.22
10K	1834	*£0.22	47K	1845	*£0.22
22K	1835	*£0.22	100K	1846	*£0.22
47K	1836	*£0.22	220K	1847	*£0.22
100K	1837	*£0.22	470K	1848	*£0.22
220K	1838	*£0.22	1M	1849	*£0.22
470K	1839	*£0.22	2M2	1850	*£0.22
1M	1840	*£0.22			
2M2	1841	*£0.22			

DUAL GANG. These high-quality pots. are fitted with wire end terminations, 6mm x 50mm plastic shaft 10mm bushes supplied with shakeproof washer and nut. Track tolerance ±20% but matched to within 2dB of each other

LINEAR TRACK Value	No.	Price	LOG TRACK Value	No.	Price
4K7	1851	*£0.68	4K7	1860	*£0.68
10K	1852	*£0.68	10K	1861	*£0.68
22K	1853	*£0.68	22K	1862	*£0.68
47K	1854	*£0.68	47K	1863	*£0.68
100K	1855	*£0.68	100K	1864	*£0.68
220K	1856	*£0.68	220K	1865	*£0.68
470K	1857	*£0.68	470K	1866	*£0.68
1M	1858	*£0.68	1M	1867	*£0.68
2M2	1859	*£0.68	2M2	1868	*£0.68

SINGLE GANG SWITCHED. Fitted with double pole on-off switches. The switch action is incorporated within the rotary action of the pot. Switch rating 1.5 amps at 250V AC.

LINEAR TRACK Value	No.	Price	LOG TRACK Value	No.	Price
4K7	1870	*£0.48	4K7	1879	*£0.48
10K	1871	*£0.48	10K	1880	*£0.48
22K	1872	*£0.48	22K	1881	*£0.48
47K	1873	*£0.48	47K	1882	*£0.48
100K	1874	*£0.48	100K	1883	*£0.48
220K	1875	*£0.48	220K	1884	*£0.48
470K	1876	*£0.48	470K	1885	*£0.48
1M	1877	*£0.48	1M	1886	*£0.48
2M2	1878	*£0.48	2M2	1887	*£0.48

VEROBOARDS

DRILLED COPPER P.C.B.

.1 Pitch Size	No.	Price	.15 Pitch Size	No.	Price
2.5" x 5"	2201	£0.46	2.5" x 17"	2209	£1.13
2.5" x 3.75"	2202	£0.39	2.5" x 5"	2210	£0.42
2.5" x 17"	2203	£1.42	2.5" x 3.75"	2211	£0.31
3.75" x 5"	2204	£0.52	3.75" x 17"	2212	£1.51
3.75" x 3.75"	2205	£0.46	3.75" x 5"	2213	£0.57
3.75" x 17"	2206	£1.82	3.75" x 3.75"	2214	£0.42
4.75" x 17.9"	2207	£2.34	2.5" x 1" (pack of five)	2216	£0.52
2.5" x 1" (pack of five)	2208	£0.57			

DRILLED PLAIN P.C.B.

.1 Pitch Size	No.	Price	.15 Pitch Size	No.	Price
3.75" x 17"	2217	£1.18	2.5" x 17"	2221	£0.78
3.75" x 2.5"	2218	£0.26	3.75" x 17"	2222	£1.00
5" x 3.75"	2219	£0.42	2.5" x 5"	2223	£0.26
			2.5" x 3.75"	2224	£0.21
			5" x 3.75"	2225	£0.36

VERO SPOT-FACE CUTTER
Order No. 2231 **Price £0.68**

PLUGS AND SOCKETS

PLUGS

		No.	Price
P1	DIN/LSP 2-pin speaker	1689	*£0.08
P2	DIN 3-pin	1690	*£0.12
P3	DIN 4-pin	1691	*£0.16
P4	DIN 5-pin 180°	1692	*£0.14
P5	DIN 5-pin 240°	1693	*£0.15
P6	DIN 6-pin	1694	*£0.20
P7	DIN 7-pin	1695	*£0.20
P8	Jack Plug 2.5mm screened	1696	*£0.12
P9	Jack Plug 3.5mm plastic	1697	*£0.10
P10	Jack Plug 3.5mm screened	1698	*£0.15
P11	Jack Plug mono plastic	1699	*£0.14
P12	Jack Plug mono screened	16100	*£0.28
P13	Jack Plug stereo screened	16101	*£0.32
P14	Phono	16102	*£0.10
P15	Car aerial	16103	*£0.16
P16	Coax free TV	16104	*£0.16
P17	Right angle jack	16105	*£0.12
P18	Jack 2.5mm plastic	16106	*£0.12
P19	Jack stereo plastic	16107	*£0.20
P20	Phono free, screened	16108	*£0.14
P21	D.C. 2.1. plug	16109	*£0.12
P22	D.C. 2.5mm plug	16110	*£0.12
P23	2-pin AC plug U.S. type	16111	*£0.18
P24	AM aerial	16112	*£0.13
P25	Cassette mains plug	16113	*£0.15
P26	FM 300 ohms plug	16114	*£0.13

CHASSIS SOCKETS

		No.	Price
CS1	DIN/LS 2-pin loudspeaker	1652	*£0.08
CS2	DIN 3-pin	1653	*£0.10
CS3	DIN 5-pin 180°	1654	*£0.10
CS4	DIN 5-pin 240°	1655	*£0.12
CS5	Jack 2.5mm	1656	*£0.06
CS6	Jack 3.5mm	1657	*£0.06
CS7	Jack Mono switched	1658	*£0.15
CS8	Jack Stereo switched	1659	*£0.18
CS9	Phono single	1660	*£0.08
CS10	Phono double	1661	*£0.10
CS11	Coax surface	1662	*£0.21
CS12	Coax flush	1663	*£0.25
CS13	Jack switched. Mono	1664	*£0.20
CS14	Jack socket DPDT switch	1665	*£0.32
CS15	Car aerial	1666	*£0.10
CS16	AC mains US type	1667	*£0.16
CS17	Phono 4-way	1668	*£0.16
CS18	D.C. power	1669	*£0.18
CS19	AC switched	1670	*£0.32
CS20	Phono 8-way	1671	*£0.32

INLINE SOCKETS

		No.	Price
IS1	DIN/LS5 2-pin speaker	1672	*£0.10
IS2	DIN 3-pin	1673	*£0.18
IS3	DIN 5-pin 180	1674	*£0.17
IS4	DIN 5-pin 240	1675	*£0.18
IS5	Jack inline 2.5mm	1676	*£0.08
IS6	Jack inline 3.5mm	1677	*£0.08
IS7	Jack ¼" mono plastic	1678	*£0.14
IS8	Jack ¼" mono Chrome	1679	*£0.28
IS9	Jack stereo plastic	1680	*£0.20
IS10	Jack stereo Chrome	1681	*£0.42
IS11	Phono screened	1682	*£0.12
IS12	Car aerial	1683	*£0.22
IS13	Coax television	1684	*£0.40
IS14	Coax back-back	1685	*£0.21
IS15	2-pin AC connector US	1686	*£0.21
IS16	2-pin AC connector US	1686	*£0.21
IS17	Phono plastic	1687	*£0.12
IS18	Back to back phono	1688	*£0.24

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

U721 30 ASSORTED LINEAR TYPES
709-741-747-748-710-588, Etc.
ORDER No. 16227 Price *£1.50

U76SO FM STEREO DECODER
5 I.C.'s 76110 Eqv. to MC1310P-MA767. Data supplied with pak.
ORDER No. 16229 Price *£1.50

U76A AUDIO POWER OUTPUT AMPLIFIERS
8 Assorted types SL403 76013, 76003, Etc. Data supplied with pak.
ORDER No. 16228 Price *£1.00

74 SERIES PAKS

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

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74F 50 Flip-Flops assorted 7470-72-73-74-76-104-109, Etc. Order No. 16225 **£1.20**

74M 30 MSI Assorted Types. 7441-47-90-154, Etc. Order No. 16226 **£1.20**

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VB1 Approx. 30 sq. ins. various sizes, all .1" matrix. Order No. 16199 **£0.60**

VB2 Approx. 30 sq. ins. various sizes. .15" matrix. Order No. 16200 **£0.60**

ELECTROLYTIC PAKS

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

EC1 Values from .47mFD to 10mFD Order No. 16201 *£0.60

EC2 Values from 10mFD to 110mFD Order No. 16202 *£0.60

EC3 Values from 100mFD to 680mFD Order No. 16203 *£0.60

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75 Mullard C280 capacitors, mixed values ranging from .01uF to 2.2uF complete with identification sheet Order No. 16204 *£1.20

CARBON RESISTOR PAKS

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

R1 60 mixed ⅛w 100ohms-820ohms Order No. 16213 *£0.60

R2 60 mixed ⅛w 1Kohms-8.2Kohms Order No. 16214 *£0.60

R3 60 mixed ⅛w 10Kohms-82Kohms Order No. 16215 *£0.60

R4 60 mixed ⅛w 100Kohms-820Kohms Order No. 16216 *£0.60

R5 40 mixed ½w 100ohms-820ohms Order No. 16217 *£0.60

R6 40 mixed ½w 1Kohms-8.2Kohms Order No. 16218 *£0.60

R7 40 mixed ½w 10Kohms-82Kohms Order No. 16219 *£0.60

R8 40 mixed ½w 100Kohms-820Kohms Order No. 16220 *£0.60

R9 60 mixed ⅛w 1 Meg-10Megohms Order No. 16230 *£0.60

R10 40 mixed ½w 1 Meg-10Megohms Order No. 16231 *£0.60

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Transistors - Germ and Silicon Rectifiers - Diodes - Triacs - Thyristors - I.C.'s and Zeners. ALL NEW AND CODED. Approx. 100 Pieces. Offering the amateur a fantastic bargain PAK and an enormous saving. Identification and data sheet in every pak.

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High quality modules for stereo, mono and other audio equipment.

NEW

PUSH-BUTTON STEREO FM TUNER

OUR PRICE ONLY £20.45

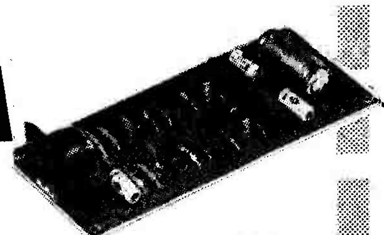
Fitted with Phase Lock-loop Decoder

The 450 Tuner provides instant program selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.
Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T538.**
The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

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

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

MPA 30



Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new M.P.A. 30, a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.
It is provided with a standard DIN input socket for ease of connection. Full instructions supplied.

£2.85

VAT ADD 12½%

POSTAGE & PACKING
Postage & Packing add 25p unless otherwise shown. Add extra for airmail. Min. £1.00

STEREO PRE-AMPLIFIER PA 100

OUR PRICE £13.75

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

Frequency Response + 1dB 20Hz - 20KHz. Sensitivity of inputs
1. Tape Input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms

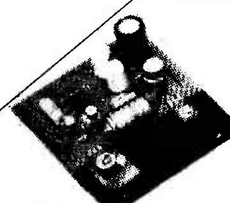
P.U. Input equalises to R1AA curve with 1dB from 20Hz to 20KHz.
Supply — 20-35V at 20mA

Dimensions — 299mm x 89mm x 35mm.

MK. 60 AUDIO KIT: Comprising 2 x AL60's. 1 x SPM80. 1 x BTM80. 1 x PA100. 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £29.55** plus 85p postage.

TEAK 60 AUDIO KIT: Comprising: Teak veneered cabinet size 16¾"x11½"x3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £10.70** plus 85p postage.

AL-20-30 AUDIO AMPLIFIER MODULES



The AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 5 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the home.

SPECIFICATION:
- **Harmonic Distortion Po=3 watts f=1KHz 02.5%**
- **Load Impedance 8-16ohm**
- **Size: 75mm x 63mm x 25mm**
- **Frequency response ±3dB Po=2 watts 50Hz-25Hz**
- **Sensitivity for Rated O/P — Vs=25v. RL=8ohm f=1KHz 75mV.RMS**

AL20 5w R.M.S. £2.95   AL30 10w R.M.S. £3.25

STEREO 30

COMPLETE AUDIO

7+7 WATTS R.M.S.

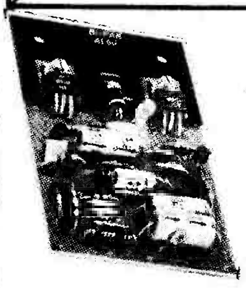
P & P 45p

£16.25

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

TRANSFORMER £2.45 plus 62p p &p
TEAK CASE £5.25 plus 62p p & p.

AL 60



25 Watts (RMS)

★ Max Heat Sink temp 90C. ★ Frequency response 20Hz to 100KHz ★ Distortion better than 0.1 at 1KHz ★ Supply voltage 15-50v ★ Thermal Feedback ★ Latest Design Improvements ★ Load — 3,4,8, or 16 ohms ★ Signal to noise ratio 80db ★ Overall size 63mm. 105mm. 13mm.

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

£4.35

NEW

PA12

NEW PA12 Stereo Pre-Amplifier completely redesigned for use with AL 20/30 Amplifier Modules. Features include on/off volume. Balance, Bass and Treble controls. Complete with tape output.

Frequency Response 20Hz-20KHz (—3dB). Bass and Treble range 12dB. Input Impedence 1 meg ohm. Input Sensitivity 300mV. Supply requirements 24V .5mA. Size 152mm x 84mm x 33mm.

£6.70

PS12

Power supply for **AL20/30, PA12, SA450** etc.

Input voltage 15-20v A.C. Output voltage 22-30v D.C.
Output current 800 mA Max. Size 60mm x 43mm x 26mm.
Transformer T538 £2.30

OUR PRICE £1.30

Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (R.M.S.) per channel simultaneously. With the addition of the Mains Transformer **BMT80,** the unit will provide outputs of up to 1.5A at 35V. Size: 63mm. 105mm. 30mm. Incorporating short circuit protection.
Transformer BMT80
£2.60 + 62p postage

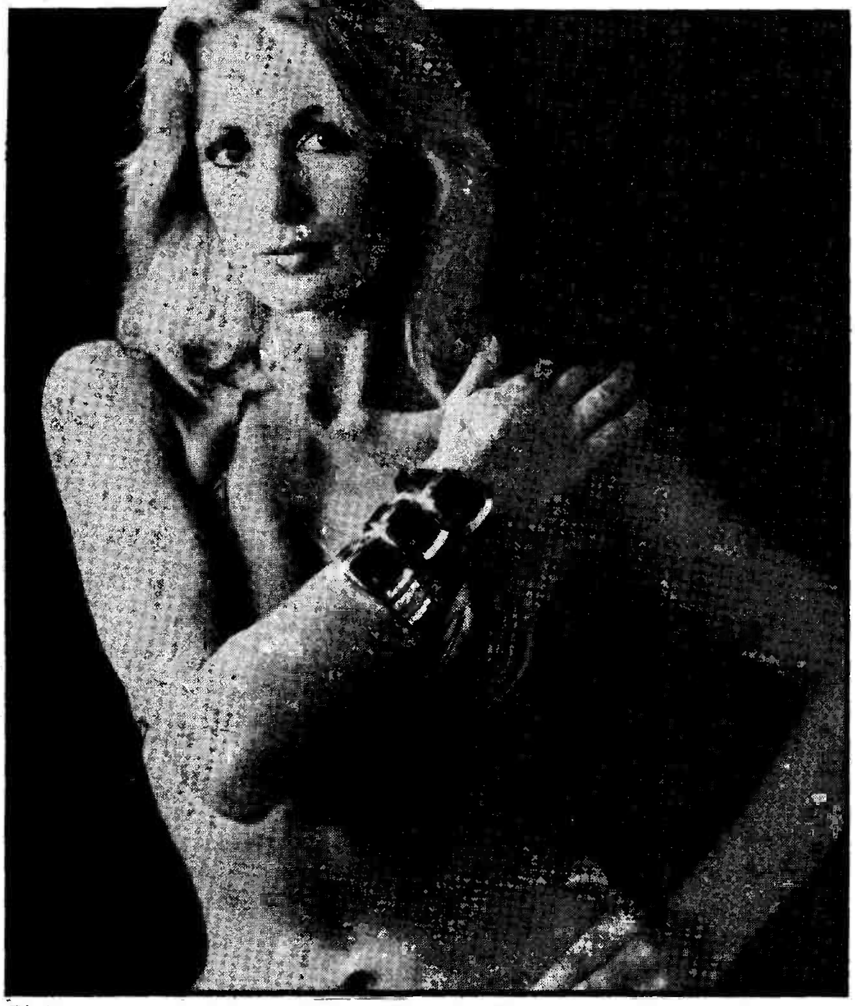
£3.75

BI-PAK

P.O. BOX 6, WARE, HERTS.

SHOP AT 18 BALDOCK ST., WARE, HERTS
OPEN 9 to 5.30 Mon./Sat. *Tel. 61593*

CBM AGAIN!



Right — now you've stopped staring at the picture can we proceed with this month's news. Thank you. Once again our old friends CBM have managed to get in on the act. The above watches — yes **watches** — represent their long-awaited entry into the digital watch market — with the 5,000 series. All three use a common module, with the casings making for a price range of £17.50-£21.00.

The watches are five function with single button control of the LED display. I^2L has been used for the clever bits, and the whole thing is put together (and through a pre-sale hot and cold aging process), in Nice.

CBM are mustering arms and men to launch a range of LCD wrist compressors later in the year (they'd better be quick!) although details are very sparse at present.

Commodore are undoubtedly best known though, for the millions of calculators they turf out every year, and for the 'specialist' pre-programmed monsters lurking therein, i.e. the Statistican S61, the Navigator N60 and of course the SR4190R. To add to this herd now we have a **user** programmable machine called, somewhat appropriately, the PR100.

Features include 10 independent addressable memories, 72 program steps and 30 mathematical functions already on the keys, along with the usual conversion factors and 8+2 digit display. The price is £49.95 including charger.

For those who don't have to solve three simultaneous partial differential equations in five variables each and every day, but might have to figure out some simpler mathematical paradox, the new X24 might be more

appropriate. This is an unusually styled, aluminium cased 'Slimline' device with four function memory and % key. Batteries are rechargeable and the price (non-rechargable) is £17.95. Expect the discount axe to fall on these prices. Both machines should be in the shops in time to become that Xmas present you want but never get!

BBC 500, WALES 53

On Friday, November 11, Auntie opened her 500th colour television transmitter. This is sited in Montgomery, Wales, and serves 30,000 people. It is the 53rd transmitter in Wales. The first UHF transmitter went into service at Crystal Palace in 1964, and now the BEEB are opening small relay stations like Montgomery at the phenomenal rate of one a week! 500 in 12 years, including 47 major installations some of which can pour out in excess of 1MW, is quite an achievement.

By comparison it took nearly 20 years to install the VHF network of 110 stations. Well done the BBC.

REELS OF RED TAPE?

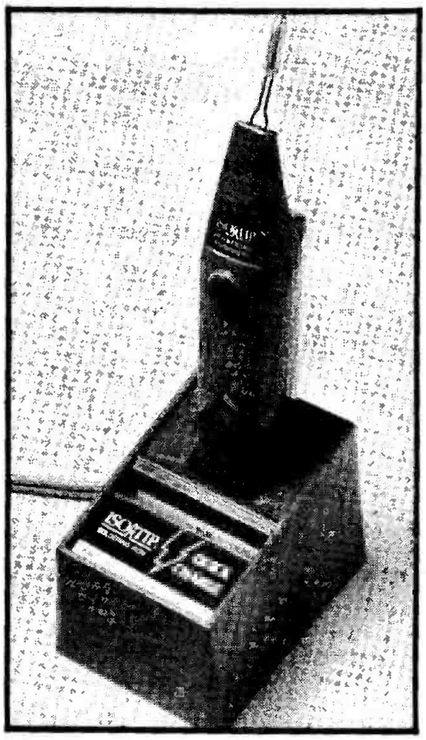
Tandberg are engaged in furious negotiations to open themselves a new factory — behind the red drapes of all places. A tape recorder factory capable of 400,000 units per year is the objective, with 'know-how' agreements on Tandberg products and production equipment. Tandberg would provide assistance with the factory, and with maintaining "compatibility with Tandberg products and quality levels."

I hope they aren't russian into anything!

IRONING OUT TIPS AND CORDS

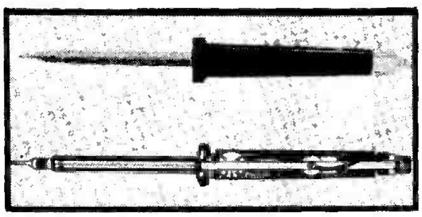
Two unusual ways of getting heated in the right spot.

The first is the Iso-Tip 'Quick Charge' cordless soldering iron. This uses nickel-cadmium batteries, and takes ⅓ of the time of its preceding brethren to attain a recharged state. Tip performance is equivalent to a 50W iron, and heat-up time (to 370° C) is 5 secs. About 50-70 joints/charge should be possible.



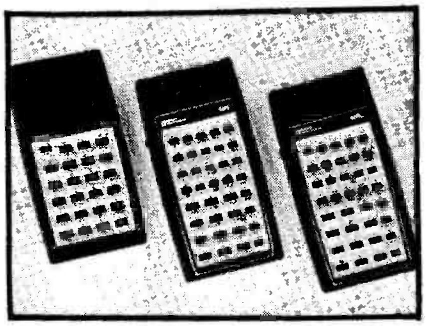
The working base incorporates a neat light to illuminate your soldering and the low voltage is claimed to eliminate leakage and the need for earthing. A wide range of accessories is available.

The second black sheep is a very ingenious temperature controlled iron which is entirely self-contained. No control box is needed, and the working



temperature is adjustable over a range of 300-425° C. A control unit is built into the handle which pulses the current into the element, and the temperature sensor is located virtually in the tip. Titled the Oryx 75 it comes from the same stable as the Iso Tip namely Electroplan Ltd, P.O. Box 19, Orchard Rd, Royston, Herts, SG8 5HH.

CALCULATING ON A NATIONAL SCALE

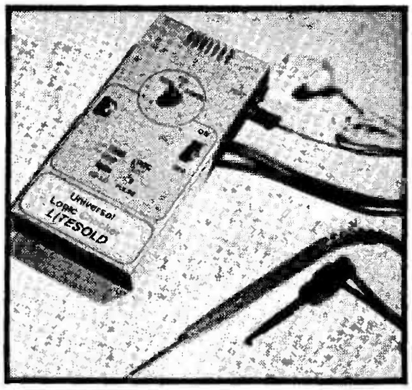


Three new button-boxes from National Semiconductors emerge this month. The 852 is a basic scientific machine with 5+2 display with all the trig and log functions etc with memory. It carries a £16.50 RRP after VAT, before discount. The 4650 and 4660 are increasingly more complex scientific creations, carrying tags of £39.95 and £59.95 respectively. The latter boasts 3 memories with statistical functions such as $\bar{x}$ and Σ and has 3 angular modes available. Chargers are naturally included in the RRP's.

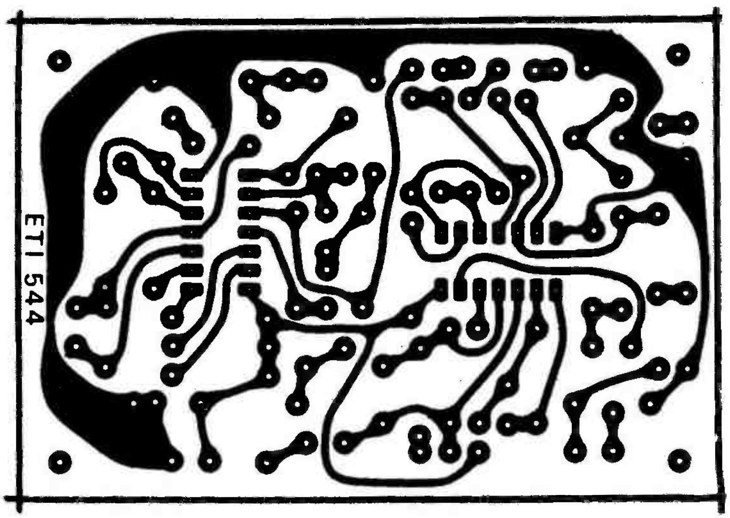
HEARD OVER THE GARDEN (NAND) GATE?

A new audible logic level checker has risen to the surface of Litesold Ltd. The LC1 lets loose a high tone on a '1' state and logically, a low one for a 'o' state. In the presence of a pulse train it warbles. Suitable for TTL or CMOS if can detect pulses down to 200nS, is claimed to place no load on the circuit under test (. . . and comes complete with Karnaugh Map to play God Save the Queen?)

Litesold Ltd, 97-99 Gloucester Road, Croydon, Surrey.



BOARDING PARTY

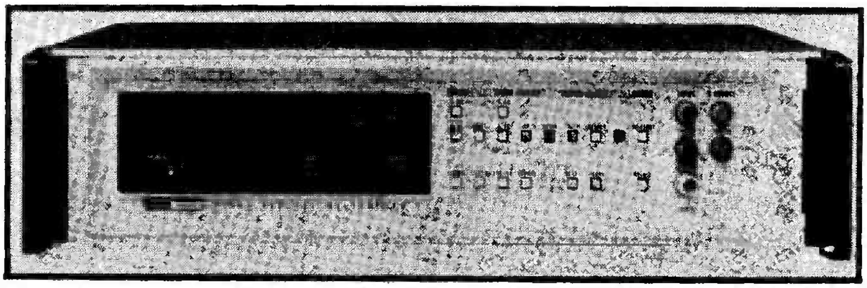


Full size 91 x 64mm.

This is the PCB track pattern for the Heart-Rate Monitor, ETI Project Number 544, which was omitted from last month's article. Copies of the board were sent to our regular PCB supplier advertisers, and so should be available from them in the usual manner. See the Mini-Ads section in this issue

MPU DVM LINK UP

Fluke has introduced the 8500A digital voltmeter, which is a bus-oriented, microprocessor controlled measurement system capable of registering a.c. and d.c. votage and current, and resistance, by the addition of plug-in modules accommodated in available locations in the bus structure.



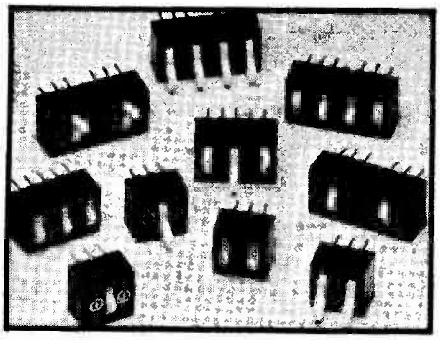
D.C. voltage measurement and d.c. ratio are standard features. There are five d.c. voltage ranges from 1 μV to 1,200V with a basic accuracy of ±0.001%, while a.c. voltage is measured with one of two options; the 01, has an accuracy of ±0.05%. An ohms converter offers 4-terminal resistance measurements from 10 ohms full scale to 100 megohms full scale, to an accuracy of ±0.03%. A.C. and d.c. current measurement, from 1nA to 1.28A are also included.

With its microprocessor controller, the 8500A allows for a calibration memory option, which will calibrate all ranges of all functions from the panel by simple one stroke keying of the calibration offset at each cardinal range point.

Once the range calibration error is entered, the precise proportion of correction required from zero to end scale is automatically added to or subtracted from the display. All calibration corrections remain permanently in non-volatile memory, unless re-calibrated.

LOGICAL SWITCHING

This little lot represents quite a versatile range of DIL switches from Highland Electronics. The options include 2, 3 or 4 'change-over' packs 1 or 2 double-pole double throw packs and toggle or rocker operation for panel or PCB operation. Details and data sheets from Highland Electronics Ltd, 33 Dallington Street, London EC1V 0BD.



FARADAY STROLLING AROUND — ON WATER

This year's Faraday lecture is to be given by the R.N. and is entitled 'The Electron Rules The Waves'. (Doesn't seem so long ago Britain used to does it? . . . Ah well) Keeping to tradition the accent will be on practical demonstrations, and the theme will be the many electronic aspects of H.M. Navys' ships and warfare techniques. Venues still to be covered at date of going to press are:

BRISTOL — Colston Hall, 9/10 December.
BIRMINGHAM — Town Hall, 17/18 January (4 performances).
LONDON — Wembley Conference Centre, 3 February (3 performances).
SHEFFIELD — City Hall, 10/11 February (3 performances).
MANCHESTER — Free Trade Hall, 28 February/1 March (4 performances).
BRADFORD — St George's Hall, 8/9 March.
LEICESTER — De Montfort Hall, 15/16 March.
NEWCASTLE — City Hall, 22 March (2 performances).
EDINBURGH — Usher Hall, 28/29 March.
GLASGOW — City Hall, 31 March (2 performances).
LIVERPOOL — Philharmonic Hall, 27/28 April (3 performances).
SOUTHAMPTON — The Guildhall, 3/4 May.

REMEMBER REMEMBER

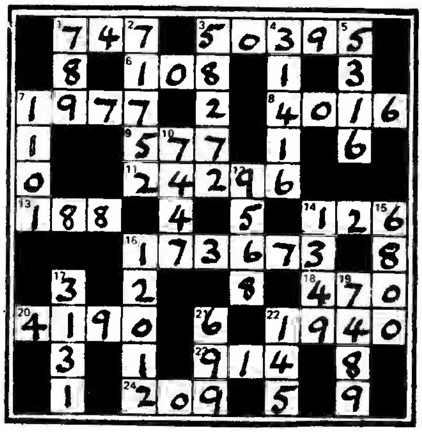
A 16-page brochure describing the full RCA Solid State line of memory products is now available.

The brochure gives basic parameters and benefits for six C-MOS memories (five static RAMs and one ROM), ranging from 4 x 8s to 512 x 8s; static and dynamic n-MOS RAMs, both 1K and 4K types; and three static 1K SOS RAMs.

Copies of the brochure may be obtained by writing to RCA Solid State — Europe, Sunbury - on-Thames, Middlesex, TW16 7HW.

TIMELY COMPETITION WINNERS

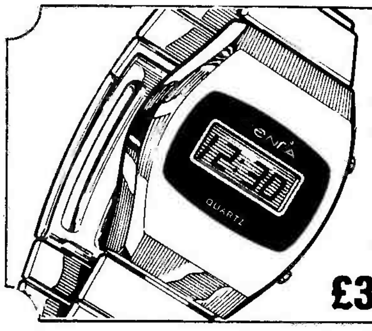
Despite the omission of a clue from our October issue competition, around 700 of you managed to unravel it, and come up with the answers! Alas not all of you got them right! One person who did was *F. I. WOODWARD, 24 Sands Way, Benson, Oxon*, and we declare him the winner. The nine runners-up were: *P. C. INGLIS, 14 Arbour Lane, Chelmsford, Essex; K. N. METCALF, 90 Wayside Green, Woodcote, Reading, Berks; C. R. GALE, 23 Military Road, Gosport, Hants; A. J. DINGLE, 81 Brandreth Road, Lady Mary Estate, Cyncoed, Cardiff, Gwent; C. E. UNDERY, 5 Holywell Court, Trinity Road, Luton, Beds; D. P. FRANCIS, 22 Finglen Gardens, Milngavie, Glasgow; P. WINTER, 29 Keedwell Hill, Long Ashton, Bristol; K. HARIA, 138 Birchfield Road, Northampton, Northants; C. THOMPSON, 11 Bernadette Crescent, Carfin, Lanarkshire.*



To all of you who entered and failed — better luck next time and thanks for entering.

Metac Digital Watches

NEW TO METAC

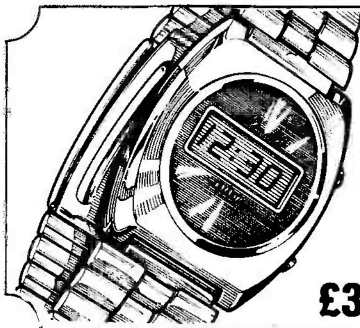


TLC6 TV LIQUID CRYSTAL ELECTRONIC WATCH

Continuous display with backlight. Hours, mins, secs, date, month. Automatic 28, 30, 31 day calendar. Metal bracelet in choice of gold or stainless steel. Slimline case.

£33.95 *No more to pay 2 year guarantee*

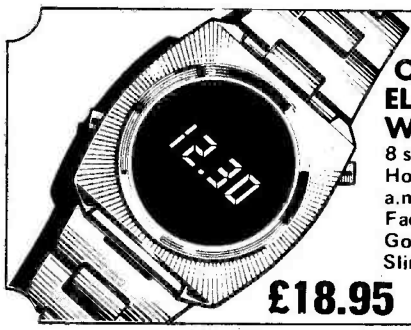
NEW TO METAC



TLC6 B LIQUID CRYSTAL ELECTRONIC WATCH

Continuous display with backlight. Hours, mins, secs, date, month. Automatic 28, 30, 31 day calendar. Metal bracelet in choice of gold or rhodium. Slimline case.

£33.95 *No more to pay 2 year guarantee*

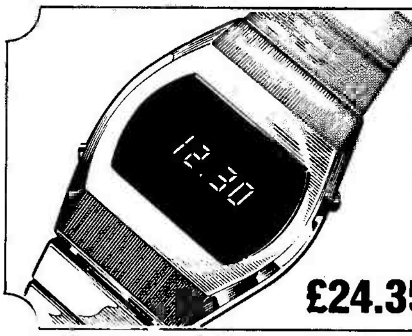


TLE5EA QUARTZ CRYSTAL ELECTRONIC WATCH

8 separate functions, Hours/minutes/day/date/ a.m./p.m. indicators/Auto-Fade. Available in 18ct. Gold/Rhodium plated. Slimline Case.

£18.95 *No more to pay 2-year guarantee*

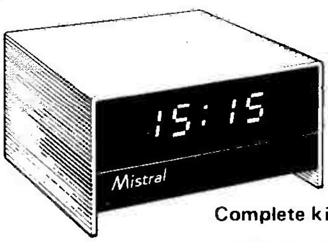
A QUALITY WATCH
You save £15.00 on retail price



TLE5 TV QUARTZ CRYSTAL ELECTRONIC WATCH

£24.35 *No more to pay 2 year guarantee*

A GENUINE BARGAIN
You save £17.00 on retail price



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In kit or built form. Large 4 digit display. Push button setting. 12-24 hour read out. Pleasing green display. Pulsating second indicator. Build in 1 hour.

Complete kit **£11·07** Incl. V.A.T.
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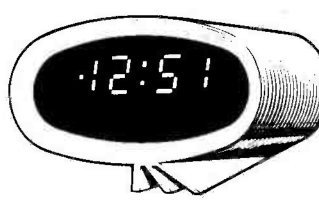
BRITAIN'S TOP SELLING DIGITAL ELECTRONIC CLOCK



Bright Planar Gas digit display. A.M./P.M. Indicator and flashing second indicator, 24 hour bleeper alarm, 5 minute repeater. Mains failure indicator. 5" across x 3½" deep. Attractive white case. Thousands sold.

Recommended Retail Price £17.95

Our Price **£13·95** Incl. V.A.T.

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STOP PRESS NOW AVAILABLE. AMAZING VALUE LIQUID CRYSTAL ELECTRONIC DIGITAL WATCH. HOURS, MINS, PULSATING SECS. METAL BRACELET. £24.50 COMPLETE. NO MORE TO PAY

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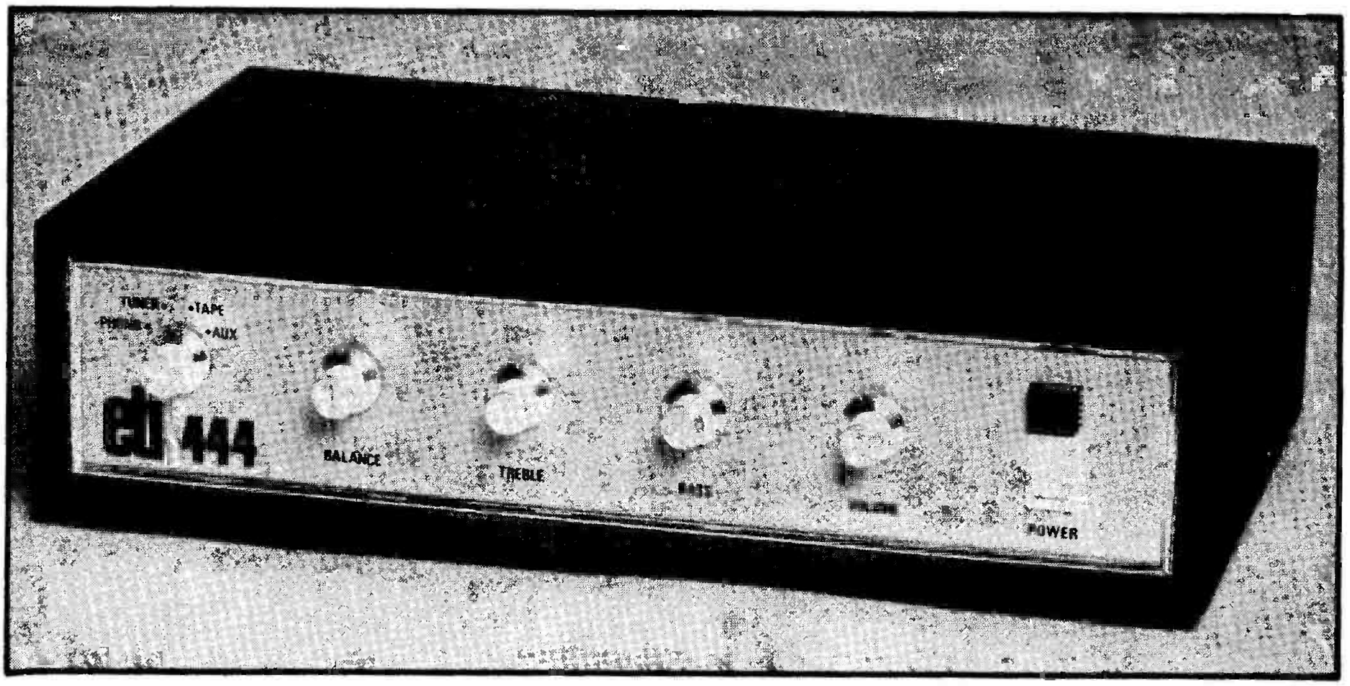
Signature . . . .

Mail Order Customers. **Trade enquiries welcome**

ETI project 444

FIVE WATT STEREO

This simply-constructed amplifier gives high quality reproduction for surprisingly low cost. The five watts per channel output is sufficient for the average listening room even when inefficient loudspeakers are used.



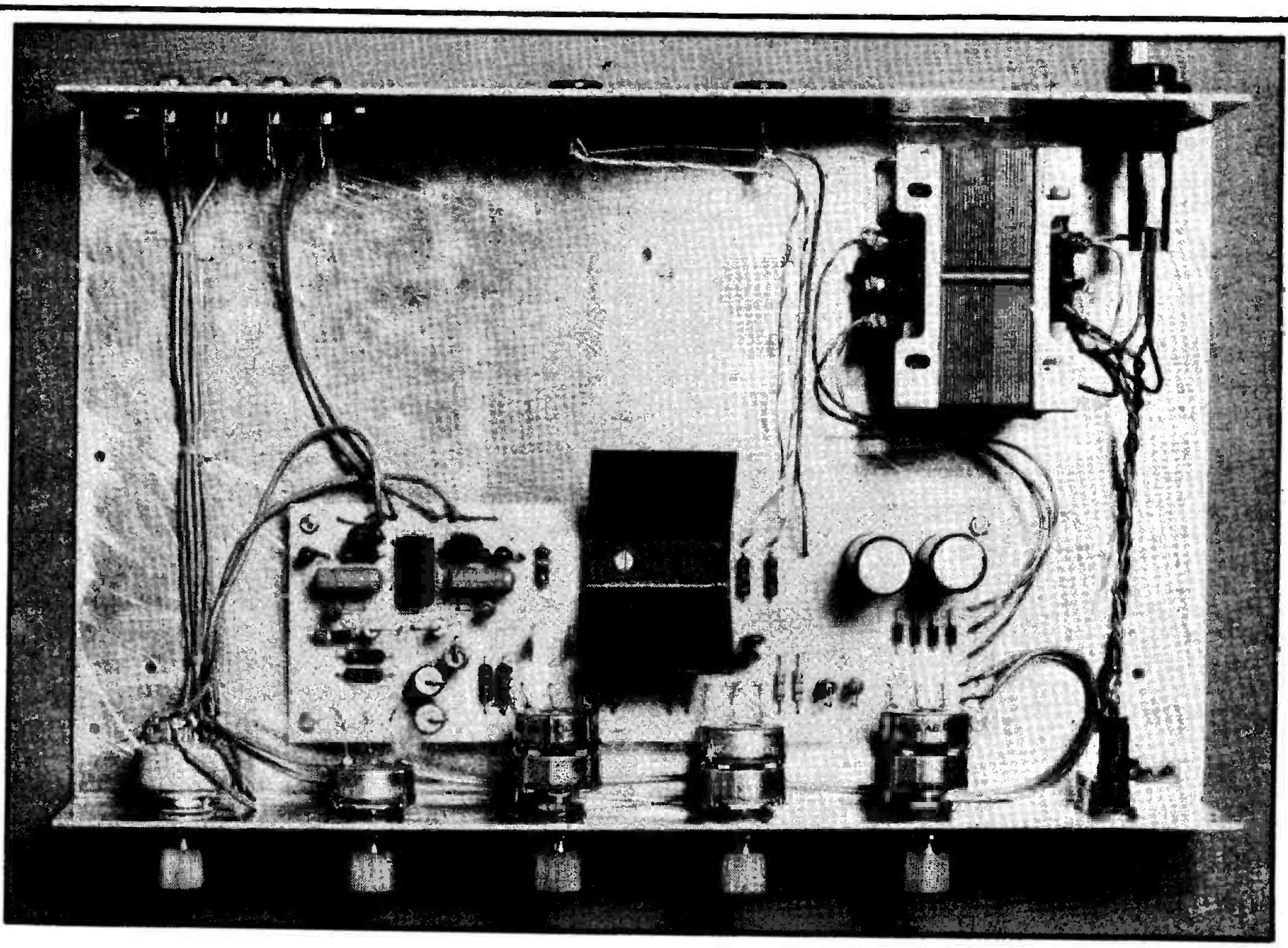
THIS PROJECT UTILISES A NEW advance by IC manufacturers. A few years ago no one would have believed a complete stereo hi-fi amplifier could be made from just two ICs plus a few passive components. Today more and more components are contained within the IC so a power amplifier is as easy to use as an op-amp.

Easy to build — Readers who were previously apprehensive about building audio power amplifiers should have no trouble with this design — there is little to go wrong.

Adequate Power — The output is unlikely to be found lacking unless the loudspeakers are very inefficient. Speakers of this type usually belong to the hifi enthusiast who spends lots of money on his system; the inefficiency of the speakers is compensated for in the amplifier. In an average set-up it is unlikely that you would, under normal listening conditions, be able to tell the difference between the ETI444 and a twenty watt amplifier.

MEASURED PERFORMANCE OF PROTOTYPE ETI 444

POWER OUTPUT	
Into 8 ohms	5 watts per channel
DISTORTION	
At 3 watts out	0.15%
At 4 watts out	0.5%
At 5 watts out	3.0%
FREQUENCY RESPONSE	
High-level input	+10 dB, −3 dB 4 Hz to 200 kHz
SENSITIVITY	
Magnetic input	1.5 mV
High level input	190 mV
LOAD IMPEDANCE	8 ohms or higher
INPUT IMPEDANCE	
Magnetic input	approx. 100 k
High level input	approx. 10 k
SIGNAL TO NOISE RATIO	
High level input	67 dB
Phono input (ref 10 mV in)	64 dB unweighted



FIVE WATT HI-FI AMPLIFIER

LM379 — National Semiconductor recently supplied ETI with samples of their new dual five-watt audio amplifier IC — the LM379. The circuitry around the IC is very simple in comparison to most of those previously available. The gain is set in a similar way to that for an operational amplifier: by the ratio of two resistors in the feedback network. In addition the IC features internal stabilization, current limiting and thermal protection.

Preamp — We decided to try the IC in conjunction with the dual low-noise preamplifier IC also from National Semiconductor — the LM382. The combination results in a simple stereo amplifier which works very well indeed.

Whilst tone control could be achieved very simply it was decided that the performance of the amplifier deserved good treatment. So we use more effective tone controls.

The result is a five-watt stereo amplifier, ETI444, simple and inexpensive to build, and with a surprisingly high performance.

CONSTRUCTION

As with most straightforward projects the use of a printed circuit board is not only desirable from an ease of construction point of view, but it also helps to ensure identical results to those of our prototype.

The components may be assembled to the board in any order but we find it preferable to assemble the low-height components first, ie, resistors, diodes. Before installing IC2 make sure that a hole of about 6 mm diameter is drilled in the board at the end where the heatsink is to

How it works

THE OUTPUT OF a magnetic cartridge is normally of the order of 5mV at 1kHz. However, in the recording process the high frequencies are recorded at a higher amplitude than the low frequencies (in order to reduce noise). The curve of amplitude-versus-frequency that is used is known as the RIAA curve. When the record is replayed the reverse characteristic of gain-versus-frequency must be applied to restore a flat frequency response. This process in the amplifier is known as equalization.

The first stage of the ETI 444 amplifier uses an LM382 dual low-noise preamplifier IC. This stage is designed to amplify and to equalise the output of a magnetic cartridge. Note that many of the resistors needed to bias the IC (and to provide equalization) are provided within the chip and very few external resistors are reqired to make it function as an RIAA compensated amplifier.

The second IC is an LM379 – a dual stereo power amplifier which provides six watts RMS per channel with supply rails of ±13 volts. The IC is unusual amongst power amplifiers in that it can be used in a similar fashion to conventional op-amps (except that it is capable of driving a low impedance load of 8 ohms).

The gain-versus-frequency response of the power amplifier is set by the bass and treble controls. The overall gain is set by the ratio of 1 + R15 / (R17 + RV4). The part of RV4 corresponding to a particular amplifier is that between the wiper and the outside tag connected to the amplifier. Thus the gain of the two amplifiers may be varied differentially by varying RV4 (which acts as a balance control). The level of the input to the power amplifier is set by RV1 (which acts as a volume control). Switch SW1 selects the input to the power amplifier from either the RIAA power amplifier or from tuner tape or auxiliary inputs as required

The power supply is simply a bridge rectifier and centre-tapped transformer arrangement which provides ±12Vdc. With both channels driven this is adequate to provide an output of 5W per channel before clipping.

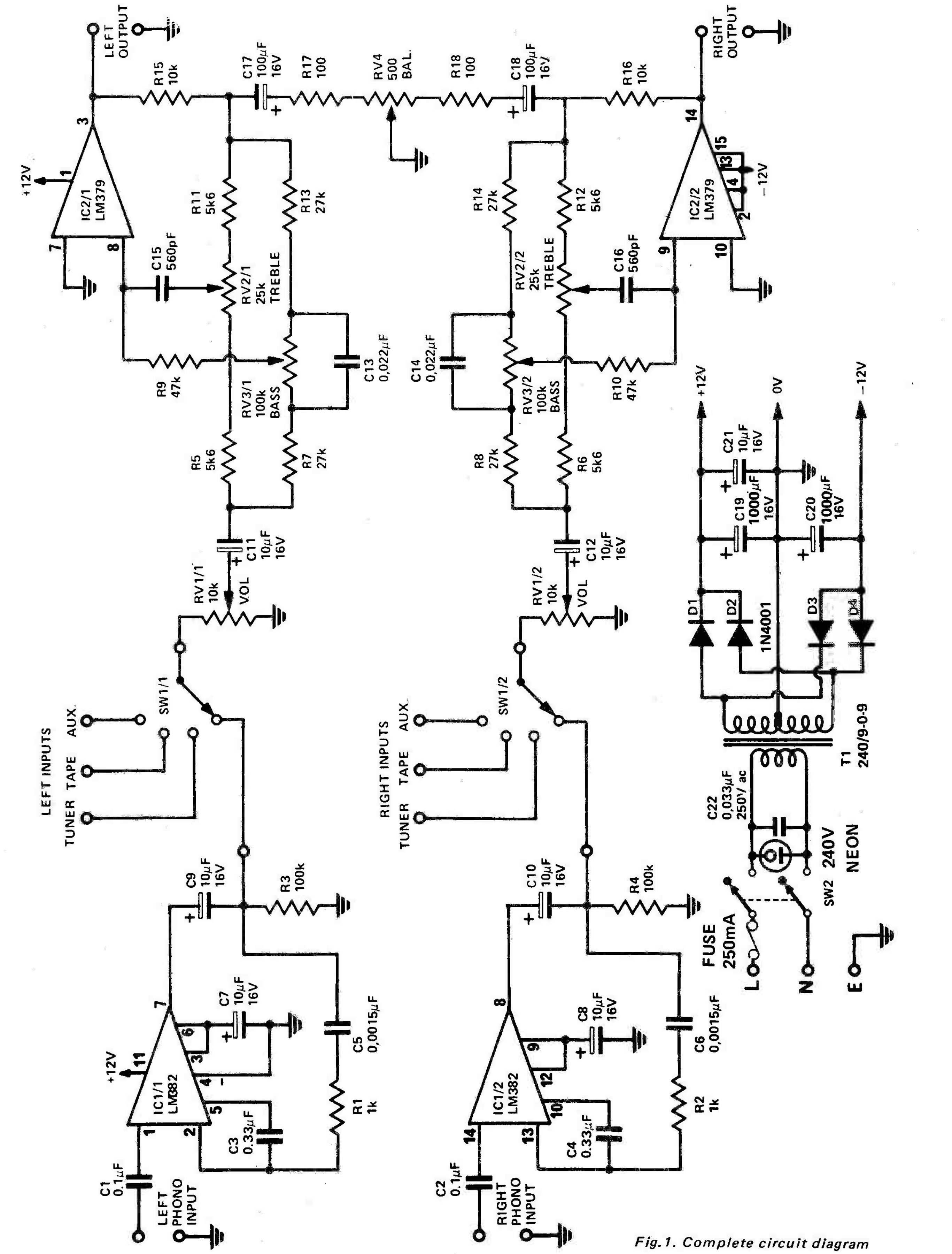


Fig.1. Complete circuit diagram

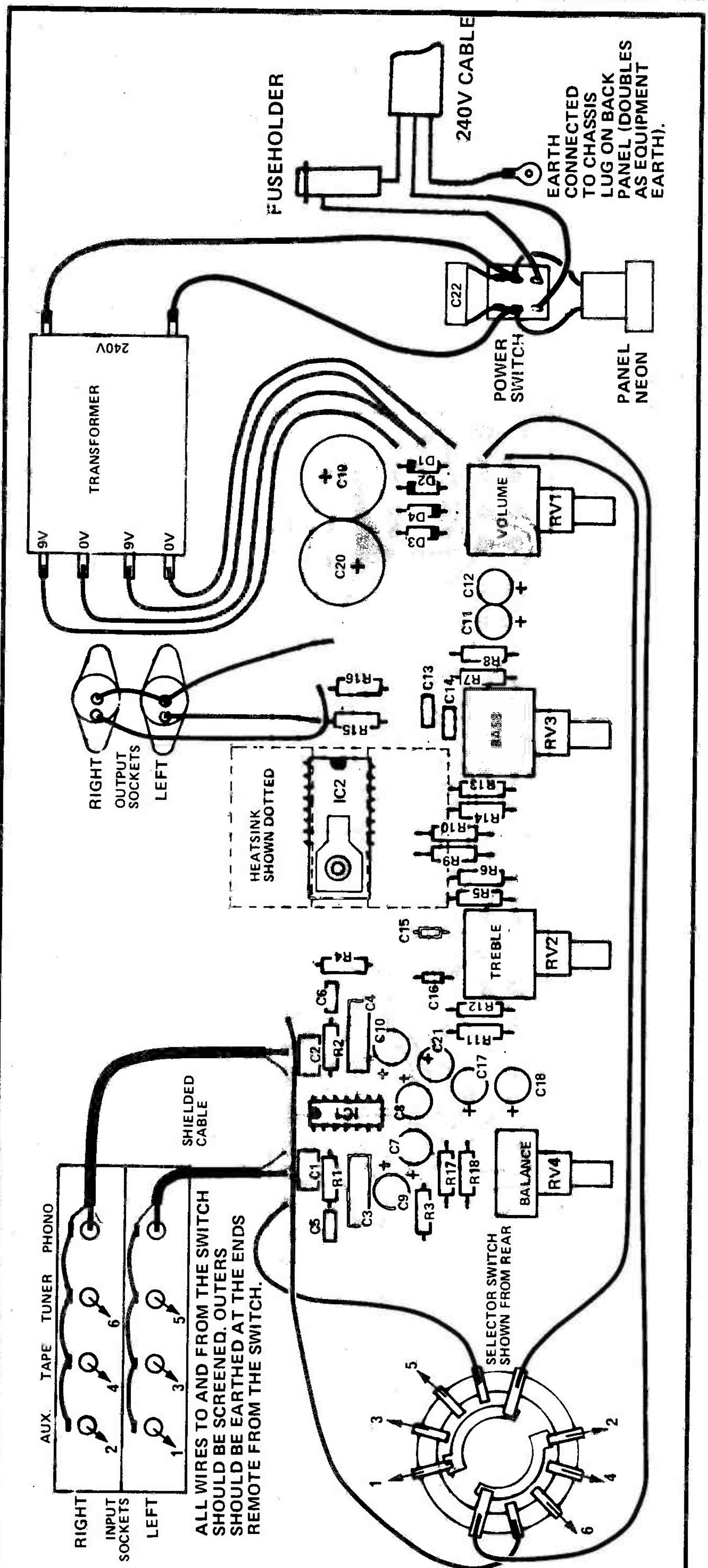


Fig.2. PCB overlay and interconnection diagram.

be mounted (after the IC is installed). Take care that all polarized components, such as diodes, ICs, electrolytic capacitors and integrated circuits, are mounted with the correct orientation.

Solder 25 to 50 mm lengths of tinned copper to each of the lugs on the potentiometers and then mount the potentiometers in the appropriate position by threading the tinned copper wires through the holes provided in the printed-circuit board. Pull the wires down so that the lugs are almost flush with the board and the potentiometers are all in line. Then solder the wires.

The heatsink may now be mounted onto IC2 using a single nut and bolt. Care must be taken to ensure that the heatsink does not touch any of the potentiometers as it is at a potential of −12 volts.

The unit may now be mechanically assembled by securing it to the front panel by means of the potentiometer shafts and nuts, and by fitting two 6.4 mm spacers between the rear of the board and the chassis.

Finally wire the unit as shown in the component overlay diagram. ●

continued overleaf

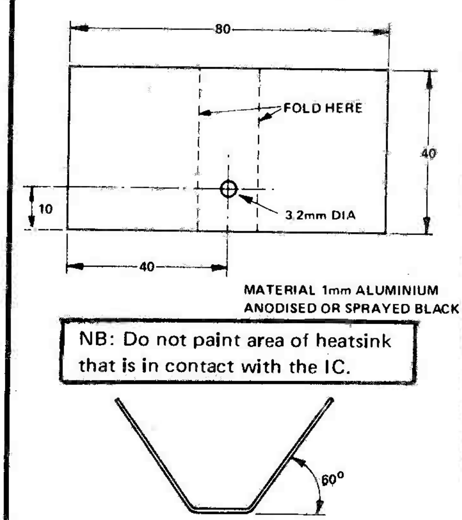


Fig.3. The heatsink for the LM379. The heatsink described will get quite hot when the amplifier is run at full output. If it has been blackened by painting it may smell a little at first but this will soon pass away. For normal domestic listening this size heatsink will be found to be entirely adequate but if the amplifier is to be run continously at full sinewave output it would be advisable to increase the size of the heatsink. No damage can be caused by using the smaller heatsink however as the IC is thermally protected and will simply shut down if it gets too hot.

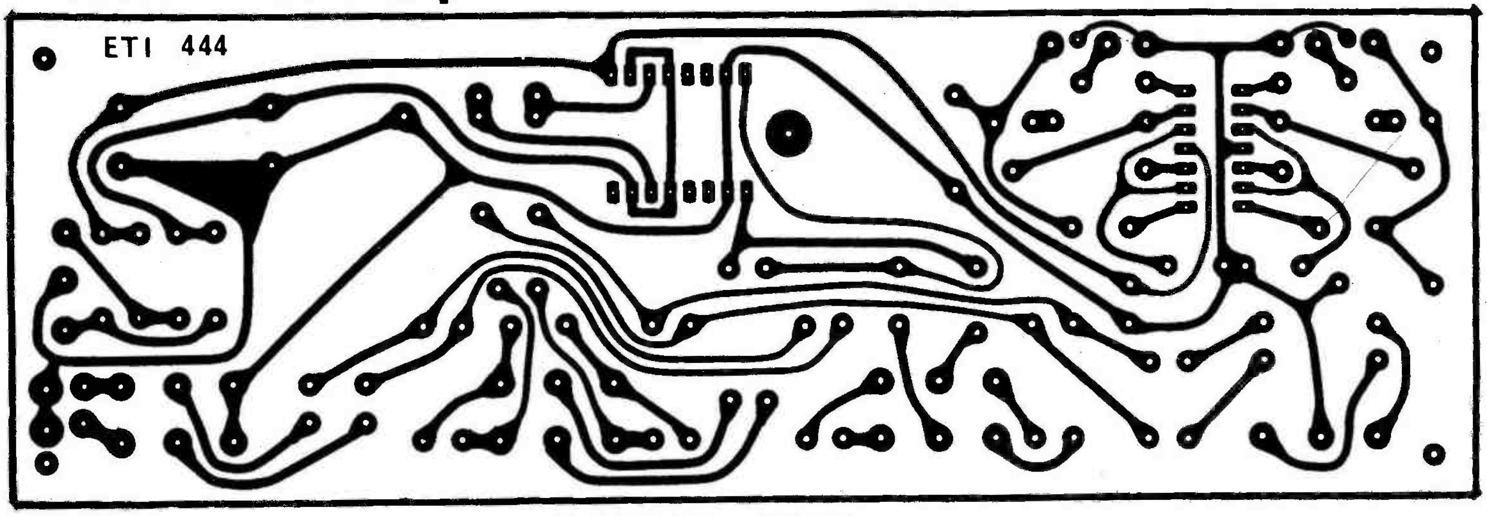


Fig.4. PCB Pattern (full size).

Parts List

Resistors

R1,2	1 k	¼W	5%
R3,4	100 k	"	"
R5,6	5k6	"	"
R7,8	27 k	"	"
R9,10	47 k	"	"
R11,12	5k6	"	"
R13,14	27 k	"	"
R15,16	10 k	"	"
R17,18	100	"	"

Potentiometers

RV1	10 k log rotary dual
RV2	25 k lin rotary dual
RV3	100 k lin rotary dual
RV4	500 ohm lin rotary wirewound

Capacitors

C1,2	0.1 µF poly
C3,4	0.33 µF poly
C5,6	0.0015 µF poly/ceramic
C7-C12	10 µF 16 V
C13,14	0.002 µF poly/ceramic
C15,16	560 pF ceramic
C17,18	100 µF 16 V
C19,20	2200 µF V*
C21	10 µF 16 V
C22	0.033 µF 250 V ac

* 1000µF 16 V will do if 2200 µF is not available.

Semiconductors

D1-D4	1N4001 or similar
IC1	LM382
IC2	LM379

Switches

SW1	2 pole 4 position rotary
SW2	2 pole rocker

Miscellaneous

2 Two pin DIN sockets
2 Four way phono sockets
4 Rubber feet
2 6.4 mm spacers
5 Knobs
3 Core flex, plug, clamp, grommet and earth lug
Panel mounting fuseholder & 250 mA fuse to suit.
Screened cable
Heatsink to Fig. 3.
240V Neon indicator
Transformer 240V to 9-0-9V 1A

PC board ETI 444 Ramar, Crofton, Tamtronik, etc. Price from Ramar is £1.50.
Chassis 3 19x190x60mm (Type A) from H. L. Smith & Co., 289 Edgware Road, LONDON W2 Price is £1.72.
Case 341x201x85mm (992-779), £3.38, from Doram Electronics Ltd., PO Box TR8, LEEDS LS12 2UF.
LM379, LM382 £6.15 the pair from A. Marshall (London) Ltd., 40-42 Cricklewood Broadway, London NW2 3ET
All quoted prices are inclusive of VAT and postage

Ron Harris reports on

VCT AN INVENTION THAT WILL CHANGE THE FACE OF ELECTRONICS

SOME MONTHS AGO we ran a short item about a device totally unknown in this country at that time - the VCT or Voltage to Current Transactor. Well now we hope to make it considerably less unknown. The VCT will get get its commercial launch from Texas Instruments early in 1977, no doubt accompanied by the usual choir of angels and 200 piece brass band.

So before all the shouting begins we went to talk to the co-inventor, Professor W.Gosling of Bath University where the device was initially developed. If you're sitting comfortably we'll begin!

The basic op-amp has been with us since the days of the valve, and when semiconductors crept up on us, it was simply re-designed to use transistors. This, in the opinion of many designers, means that the advantages of transistors are not being fully exploited.

BASIC IDEAS

One of the better improvements to the basic op-amp was the comparator input designed by Carl S. Brinkler - a name to which we shall return - and patented in April 1965. However Mr. Brinkler was still dissatisfied with the op-amp and some years ago began discussions with Professor Gosling, with a view to producing a totally new circuit block. The basic guidelines were finally set as being that

1. No feedback should be needed to stabilise the device by limiting the high frequency response, or to define the stage gain.
2. Both the input and output ports must be totally floating - a true four terminal device. This leads to much greater freedom with respect to the output - it can quite simply be fed into anywhere!
3. The output should be a constant current source i.e. very high impedance. Then, should a voltage output be required at any time, a resistor need only be inserted across the port.

TEXAS AND THE PROTOTYPES

In 1974 Texas Instruments authorised Carl Brinkler to undertake research into producing such a device. Because of the scope and magnitude of the task, it was to be a joint undertaking with Bath University i.e. Professor Gosling. In the autumn of 1974 the microcircuit design was breadboarded up for the first time with discrete components, and early in 1975 the first I.C.s rolled out of the ovens. The first vast improvement over the op-amp to become apparent was the slewing rate, up to 20V per microsecond, as compared to 0.5V/microsecond for the 741

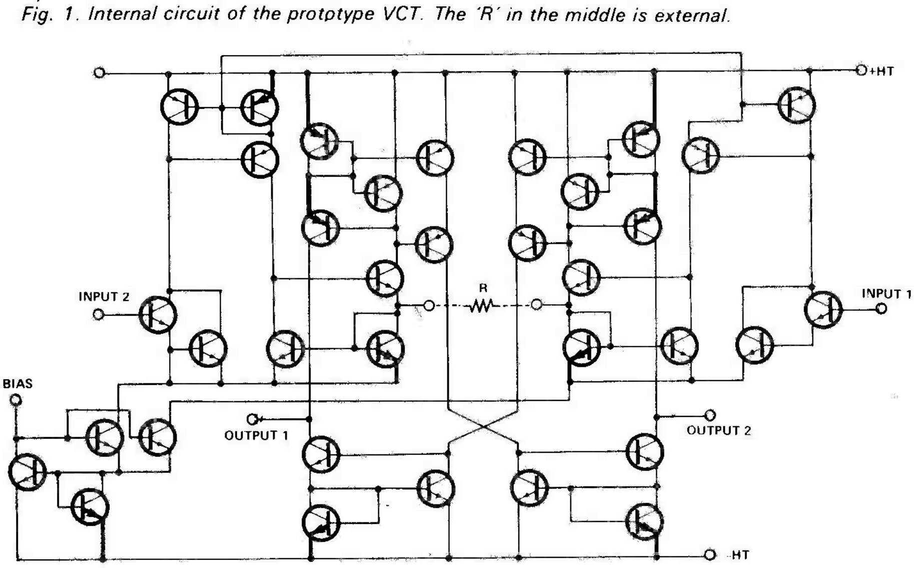
The offset on these prototypes was ≏10mV due to the layout not being totally symmetrical. Production models, when they appear, will have a much much lower offset. Up to this point in the proceedings, the project had been running on a shoe-string. But with the prototypes showing this incredible potential, Texas whipped the whole show off to Dallas for development. They feel the VCT is the greatest advance in circuit design for a long time, and we have to agree with them.

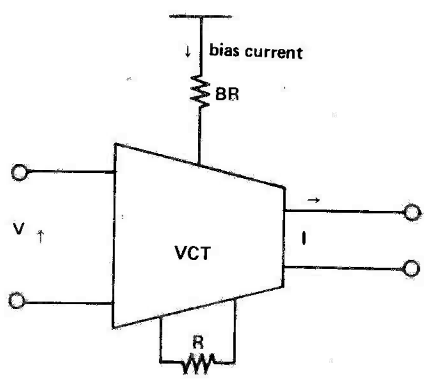
ABILITIES IN CIRCUIT

Let's take a look at what the VCT will do. Figure 1 shows the internal circuit of the Mark 1 VCT. The thick lines represent multiple emitters, and these provide the current gain. You may recognise the current mirrors around the top centre of the circuit.

The agreed symbol for the VCT is shown below, the circuit is that used

Fig. 1. Internal circuit of the prototype VCT. The 'R' in the middle is external.





The agreed symbol for VCT.

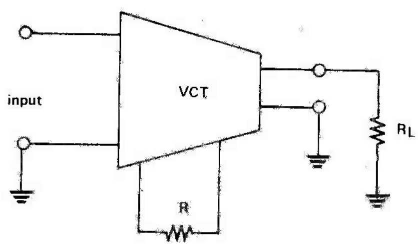
VCT

for all linear applications. For a voltage input, we get a pure constant current output. Both input and output impedances are very high, around 10s of Megohms in the production devices.

There is a fixed ratio between V_{in} and I_o, which is set by one fixed resistor R. i.e. $I_o = k\ 1/R\ V_{in}$. The constant k can be designed to be any value - it will be four in the Texas VCTs. A bias current is applied down BR, and the device can only output twice as much current as it draws through BR. Early devices will be 20mA output VCTs, but later marks will be up in the amps range. A ±15V rail is used with the VCTs, and a 13V signal is quite permissable!

Some circuits now, for instance an amplifier:

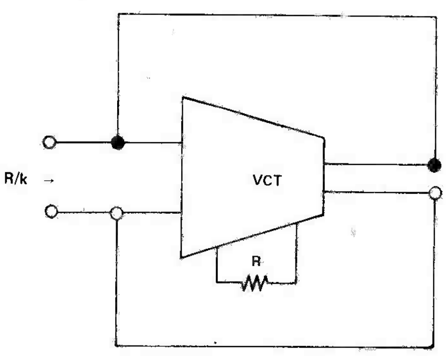
Non-inverting:



VCT as an amplifier.

Voltage gain = k. RL/R

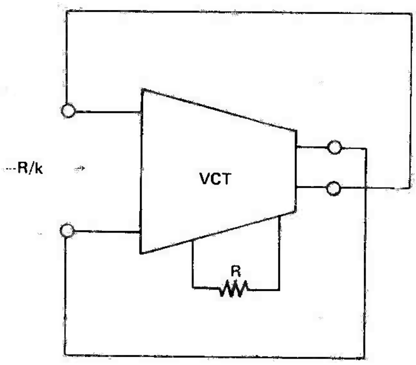
The simplicity of gain inverting arises because the output port naturally has a fixed phase relationship to the input. Since we get a current out for a voltage in, a VCT connected thus:



VCT as a simple resistor.

will look like a resistance; value R/k ohms.

Consider however a device cross connected:



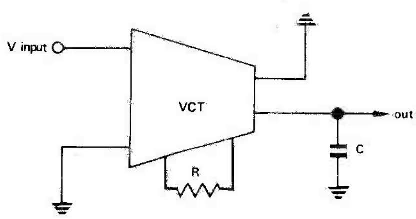
VCT working as a negative resistance.

What we have now, looking in at the input terminals, is no less than a negative resistance! i.e.

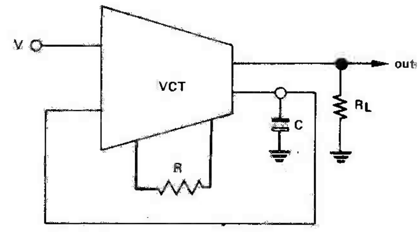
$$V_{in} = -\text{const}.I_o.$$

What's more, the transfer characteristic is perfectly linear!

Applications are literally infinite. Anything an op-amp can do, so can a VCT - only usually it does it better! For instance an integrator:



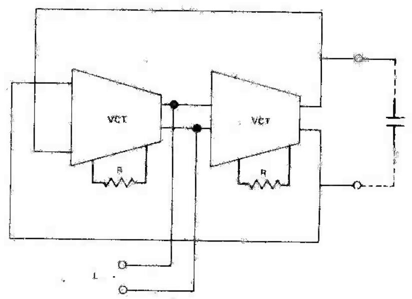
At point A we have $\int V_{in}\,dt$ since the output is a constant current which follows the input voltage. If we feed back this integral to the input so:



VCT differentiator.

the output will be the differential of V_{in}.

Gyrators are by now quite common place, but what about one which can reach inductor values of 10s of Henrys and with a Q of well over 100? Easy!

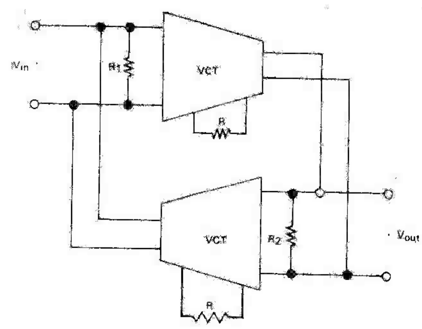


A VCT gyrator.

Values of Q up to 200 have been achieved experimentally. This circuit introduces the concept of using two VCTs together. Texas are packaging the VCT in a 16-pin DIL dual package. There are more pins to a VCT than a 741, since we have those already mentioned, plus a centre tap on the output which is not always used, but extends the versatility.

AMAZING GRACE

The application we found initially most amazing is the VCT's ability to replace a transformer, better than a transformer! All transformers exhibit some power loss, but this circuit has a selectable loss factor, which naturally can become a *gain* if so desired.



VCT as a transformer.

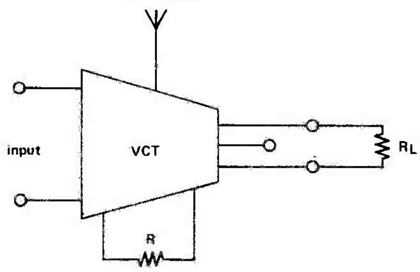
Transformer Ratio = $(R_1/R_2)^{1/2}$.

Choose R such that $R^2=R_1R_2$ to give no loss/gain in circuit i.e. a perfect transformer.

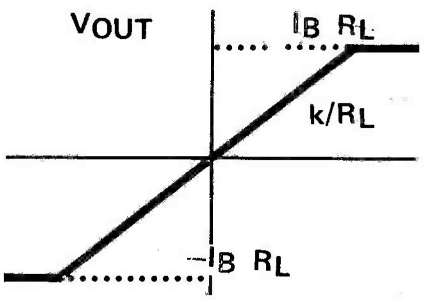
The GPO are looking at this application with a view to replacing all those messy coils in telephones.

NON-LINEAR

We will consider just one non-linear application to show it can be done - that of a limiter. Since the VCT can output only 2x bias current with



we will get a characteristic



very simply indeed with only two resistors.

GAINS FROM LESS

It is apparent from the preceeding circuits that one of the biggest gains when using VCTs, is in reducing external component count over a similar op-amp or discrete circuit. In industrial applications this will lead to less P.C.B. design and assembly complications, with resultant reduction in costs.

Another gain is the fact that when used as an inverting amp, no input resistor is used to drop the signal, as it is in op-amp circuits. In these circuits, since the input is usually a virtual earth, most of the signal is dissipated in the resistor, with a resultant poor signal-to-noise ratio upon amplification at the output. With VCTs no resistor is required, and this gives a distinct improvement in S/N ratio, with the attendant gain in dynamic range.

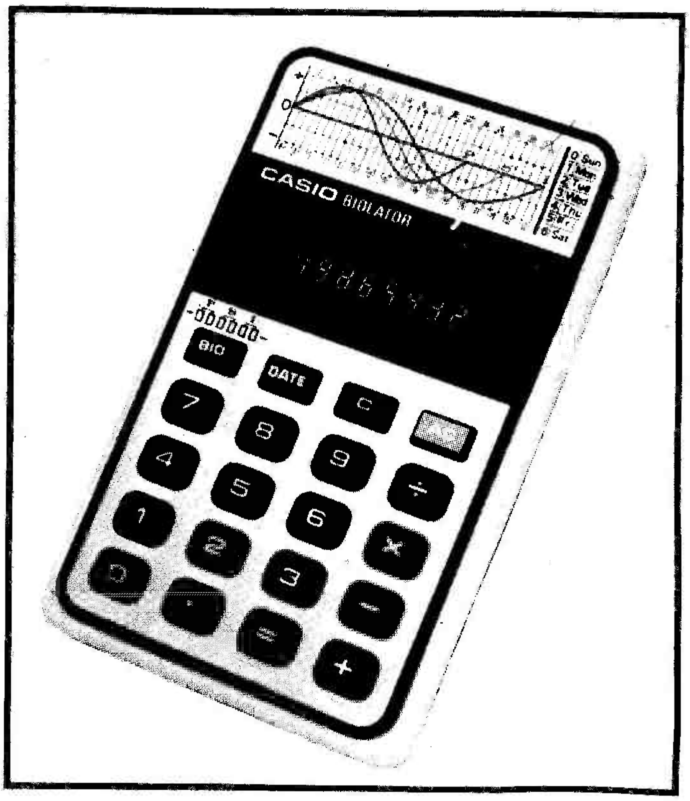
THE PRICE OF A FUTURE

One question remains - how much? Well, this depends entirely on Texas Instruments, and the marketing policy they persue. No doubt the price will be high at first, falling as the volume of sales climbs, as it surely must. Interestingly, the VCT occupies only half the chip area of a 741 op-amp, but whether this affects pricing remains to be seen. We'll keep you informed of developments, as we're convinced you'll be hearing much more of VCT in the years to come. ●

OUR THANKS and congratulations to Professor W. Gosling of Bristol University, who provided the information for this article.

Is this a high, low or a critical day in your life? Find out on this

BIORHYTHM CALCULATOR



The Casio Biolator is an eight-digit calculator with built-in 99 year calendar and digital biorhythm computer.

We all know of the monthly cycle of hormones in women, but did you know there are similar cycles in all people, irrespective of age or sex? At the beginning of this century a German doctor discovered that the body is regulated according to three cycles of differing periods. The 23-day cycle is the one that describes variations in physical health, strength, endurance, etc. In the first half of the cycle (days 2 to 11) the stamina is high and the body is in good shape. In the second half of the cycle (days 13 to 23) the body is more tired and prone to illness.

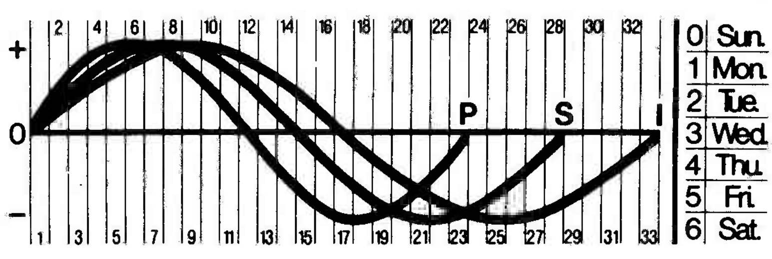
The theory puts special importance on the crossover days, the days between the positive and the negative halves of the cycle. On these days the condition of the body is undergoing its fastest rate of change and the likelihood of an accident or sudden worsening of an illness is higher than at any other time of the month. Days 1 and 12 of the physical cycle are critical days.

The two other cycles concern the condition of one's mental performance and this is looked at from two viewpoints — activity in the subconscious regions of the brain and activity in the fully-conscious regions.

The theory holds that there is a 28-day cycle in the activity of the mind's emotional, or instinctive, processes. For the first fourteen days of the cycle one's intuition is keenest, the artistic side of your personality is at its most creative and your natural charm is at a maximum. However for the next fourteen days life is more humdrum and you are advised to be careful with your relationships with other people. On the critical days (1 and 15) your non-rational side is likely to dominate your normal restraints, resulting in 'irresponsible' behaviour, slips of the tongue, quarrels, etc. On the Casio machine this cycle is called the sensitivity cycle.

The third rhythm is the intellectual cycle of 33-day period. When the cycle is high, thinking power is at its greatest; judgement, wit and concentration are at their best. When the cycle goes low it is the time for mundane work, for activities low in their demands on concentration. Days 1 and 17 are the critical days when errors are likely, when the memory might fail, when accidents might result from silly mistakes.

These then are the three biorhythms, the physical (23-day) the sensitivity (28-day), and the intellectual (33-day). According to the theory all three rhythms start their upward half-cycle on the day you are born. And in the first 58 years of your life each day will be under the influence of a unique combination of these three variables.



The biorhythm graph as printed on the front of the calculator. The P, S, and I waveforms represent the body's physical, sensitivity (emotional) and intellectual cycles.

How the Biolator works

The Biolator is based on a 4-function, 3-register, 8-digit, calculator with automatic constant. Readout is on a green digitron tube display. This section works just like an ordinary calculator of this type: algebraic logic is used, there is an overflow indicator, the decimal point is fully-floating and leading zeroes are suppressed.

Now to the interesting bit. This can be examined from two aspects: calendar calculation and biorhythm calculation. The calender covers all dates from 1901 to 1999 inclusive. It is accessed by inputs in the format: 76.10. 21. (for 21st October 1976) where the three decimal points are lit by pressing the DATE button after entering each pair of figures. The calendar then replies (instantaneously) by displaying 76.10. 21-4, the 4 after the - signifying that the 21st of October 1976 lands on a Thursday. By this method the day of the week for any given date can be calculated.

If after one date has been entered the operator presses the — (minus) button and enters another date, then he can find the number of days between these two dates by pressing the = button. So 76.10.21.-4 minus 73.02. 09.-3 equals 1716 days. This facility has obvious uses in calculating daily, weekly, or monthly rates when you

THE DESIRABLE AFFINITY CONDITIONS

	Physical	Sensitivity	Intellectual
SPOUSE	High	Medium	High
LOVER	—	High	—
FRIEND	—	High	High
CO-WORKER	High	Medium	High
TEACHER	—	High	High
SPORTS MATE	High	High	—
CO-ADMINISTRATOR	High	High	Medium
CO-RESEARCHER	—	—	High
SECRETARY	—	Low	High

know a specific quantity of a resource was expended between two given days.

Biorhythm calculation

To find a person's biorhythms on a given day you first enter that date and subtract the date of birth of the person in question (as if you were calculating their age in days). However, instead of pressing the equals button after entering the second date, you press the BIO button. The biorhythm computer now replies by displaying —PP.SS.II—, where PP gives the status of the physical rhythm, SS the status of the sensitivity rhythm, and II the status of the intellect rhythm. These numbers correspond to the day of the cycle for each rhythm, they do not show amplitude. To interpret the numbers there is a graph above the display and a chart on the back of the calculator.

The product of 23, 28, and 33 is 21252 which means that there are this many possible permutations of the three rhythms, and these permutations follow the same sequence for all people.

No matter when you were born your biorhythms on day 14610 of your life will be -06.23.25-. The Biolator works by calculating your position on its 21252-day biorhythm sequence.

Using the Biolator

In calculating your own biorhythms you can arrange your diary to avoid disappointment. Picking a day for a wedding, for an interview or a driving test, planning an expedition or training for sportsmen, warning your friends or family in advance of your 'off' days, etc., can be done with a simple calculation.

The Biolator can be used to calculate the daily condition of other people, too. Businessmen can forecast the good days for their key personnel (or the bad days of their rivals!), team managers can pick players as soon as they know fixture dates, and so on.

Interesting conclusions can be drawn when you consider the biorhythms of two people, with respect to each other. The time difference between the individual rhythms of two people will always remain constant — if two people's emotional rhythms are in phase they'll always stay in phase. The difference between the rhythms can be calculated easily by finding the condition of the older person on the day the younger one was born. This then can be used to map the affinity of the two people: High affinity for one cycle is when the two waveforms are in phase (the difference numbers are high or low), low affinity is when the waveforms are out of phase (difference numbers around half a period), and medium affinity corresponds to a phase difference of about ninety degrees. On the physical biorhythm, for example, high affinity is shown by difference numbers like 1 to 5 and 20 to 23, low affinity is shown by numbers 9 to 16, and other numbers show medium affinity.

To interpret the significance of affinity the table above has been drawn up.

The Biolator comes with an instruction booklet and a simulated leather case. It is attractively styled in a plastic case with a brushed aluminium front panel.

LIKE THE MANUFACTURERS OF THE BIOLATOR, THIS MAGAZINE EXPRESSES NO OPINION AS TO THE VALIDITY OF THE BIORHYTHM THEORY.

The staff of ETI wish all readers a merry Christmas and a prosperous New Year

ETI project 570

REACTION TESTER

Measuring the speed of your reactions can be fascinating. Our project not only allows you to do this to a considerable degree of accuracy, but allows for competition between two players.

THE MOST NOTICEABLE EFFECT of a night on the ale, apart from the revolving universe, is the immediate slowing up of a person's reaction time. The project to be described here will give an indication of that time, measured to 1/100ths of a second.

There are three possible versions of the project; which one you build depending on the usage or abusage you intend to subject the unit to. The CMOS version is much more expensive initially, but draws under half as much current from the batteries, and will thus even up its cost over a period. The 'standard' version if you like, is the TTL circuit of Fig.1, which can be run from a battery pack as a portable unit.

PLAYING THE GAME

The tester provides an intriguing party game which will cause many an argument. It is set up as a contest between two people, with indication of who has won - and the winning time. It might be an idea to take some readings on the known drinkers at the start of that party - and when their reactions have slowed to half, pack 'em off in a taxi!

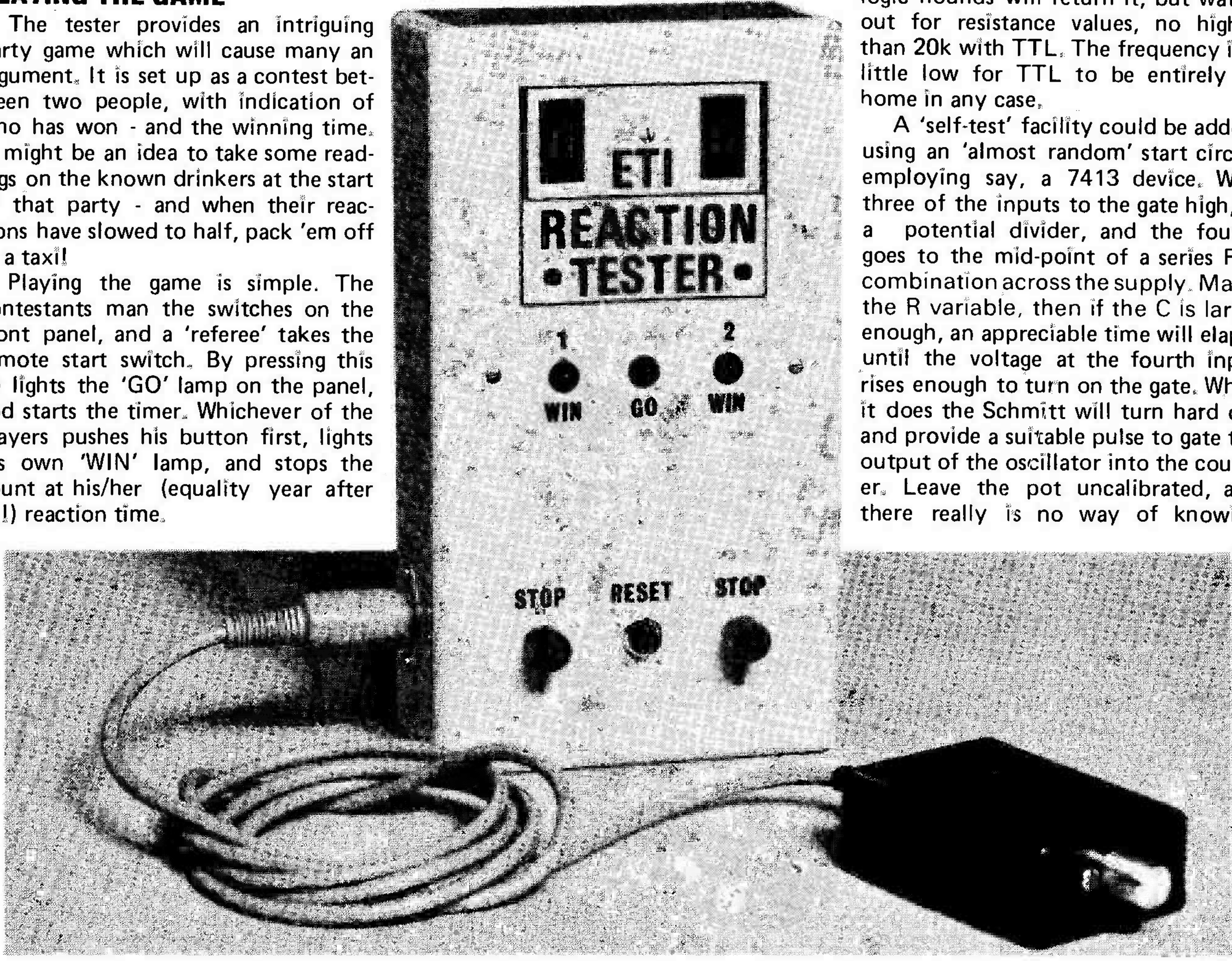
Playing the game is simple. The contestants man the switches on the front panel, and a 'referee' takes the remote start switch. By pressing this he lights the 'GO' lamp on the panel, and starts the timer. Whichever of the players pushes his button first, lights his own 'WIN' lamp, and stops the count at his/her (equality year after all!) reaction time.

CONSTRUCTION

Building up the 'standard' version is best done by constructing the display and counter sections first. Check the former by applying a high level to pins 7, 1, 2, 6, in turn of ICs 3 and 4. The numbers 1, 2, 4 and 8 will appear on the display if all is well.

Remove the 'decimal point' pin on the displays, this will vary from type to type, ours were DL707s. This aids location on the P.C.B. The lead from the hand-held unit to the main unit *must* be screened - four-core individual screen recording lead is ideal - otherwise stray capacitance can 'clock' the 7490 without the switch being operated. Earth one end to pin 2 of the DIN socket on the unit, and the switch end to the output earth side.

We used a small Verobox for the remote button, but this is obviously not critical. If you are going to use a mains supply, check the output of this before applying Vcc to the circuitry. Too high (>7V) will send the logic to join its ancestors on that great breadboard in the sky.



Constructing the CMOS unit is simpler. The display module comes complete from Sintel (details in parts list) so all you have to add is the oscillator and switching circuits, as shown in Fig.3. Once more - be careful with the CMOS chips: don't handle them if you can help it.

Possible modifications and additions to the basic unit are legion. We originally used a 7400 as the oscillator, but settled on the discrete circuit for simplicity. No doubt the logic hounds will return it, but watch out for resistance values, no higher than 20k with TTL. The frequency is a little low for TTL to be entirely at home in any case.

A 'self-test' facility could be added, using an 'almost random' start circuit employing say, a 7413 device. Wire three of the inputs to the gate high,by a potential divider, and the fourth goes to the mid-point of a series R-C combination across the supply. Make the R variable, then if the C is large enough, an appreciable time will elapse until the voltage at the fourth input rises enough to turn on the gate. When it does the Schmitt will turn hard on, and provide a suitable pulse to gate the output of the oscillator into the counter. Leave the pot uncalibrated, and there really is no way of knowing

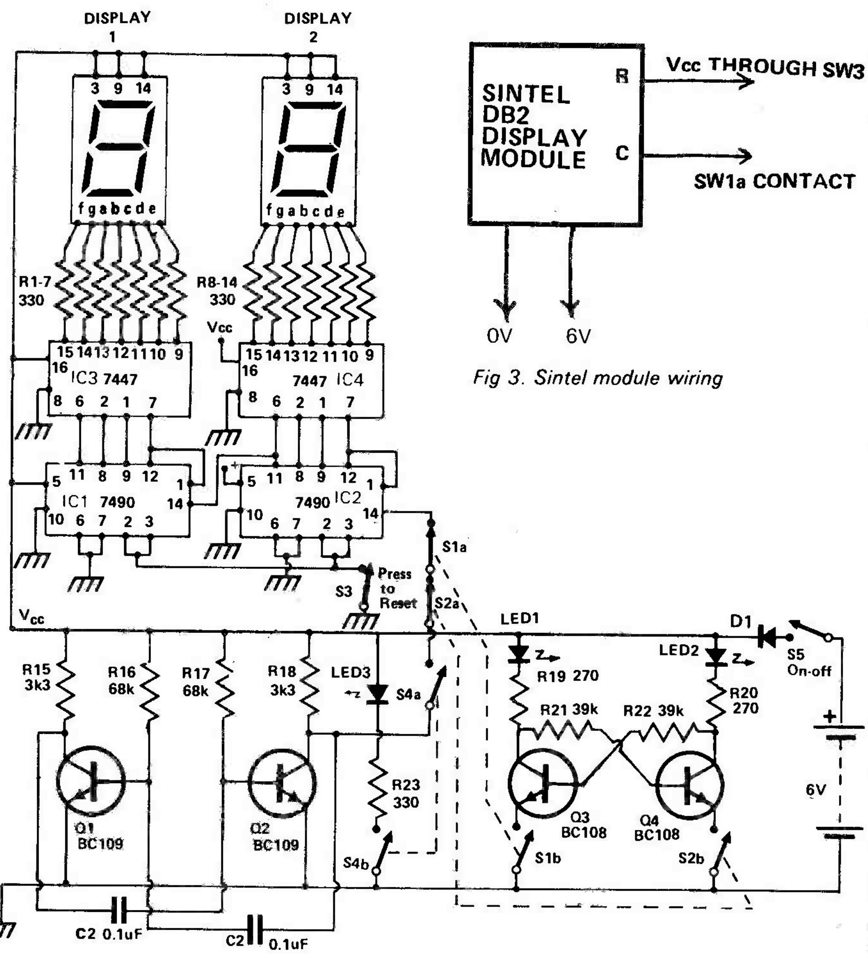


Fig 3. Sintel module wiring

Fig. 1: Circuit Diagram of the Tester.

How it works

If we consider the TTL circuit (the CMOS version functions in exactly the same manner) and begin with the display driver/ counter section, we see that the counting is done by two cascaded 7490 devices. These are working as ÷10 BCD counters, and the outputs feed two 7447 BCD decoders/ display drivers. The input pulses, 4.2V p.t.p. square waves, are generated by Q1 and Q2 in a multivibrator mode at a frequency of approximately 100Hz. Greater accuracy can be obtained by making one of the charging resistors (R16 or R17) variable, and tuning the oscillator to exactly 100Hz. In this way the tester will read exact reaction times, ±.01 secs.

When the 'Go' button is pressed, green LED3 in the front panel lights, and pulses are fed into the counter chain. When either contestant's switch (S1a, S2a) is pushed, the link between oscillator and counter is broken and the counter will 'hold' the number of pulses that have entered i.e. time in 100ths of a second.

At the same time S1b and/or S2b operate the 'Windicator' circuit comprising Q3 and Q4. Either one of the LEDs can lock on turing off the other transistor, and so ensuring only one light can be on at any given time - that corresponding to the first button pushed. Diode D1 serves both as a voltage dropper to bring Vcc down to a logic supply level (5.4V) and also to prevent damage due to supply reversal.

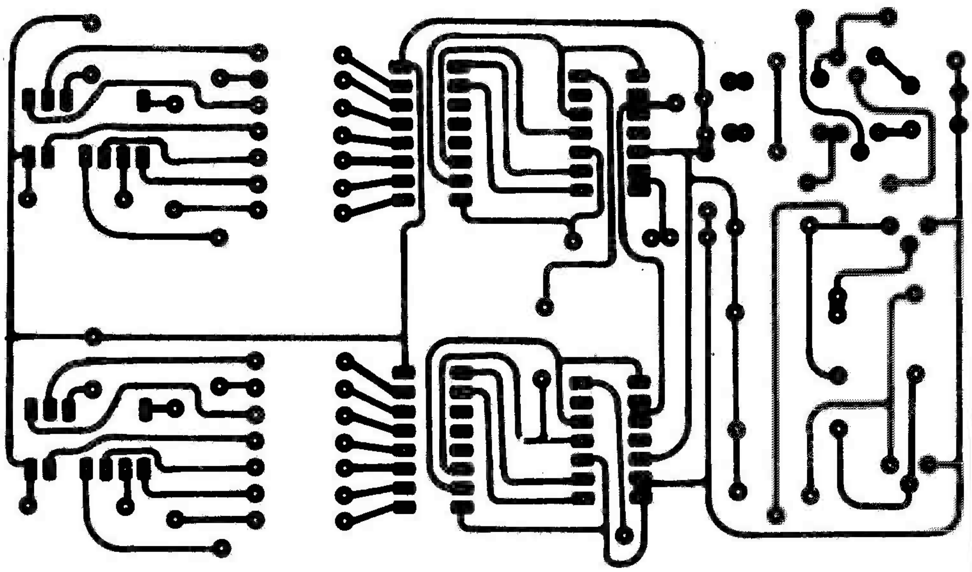
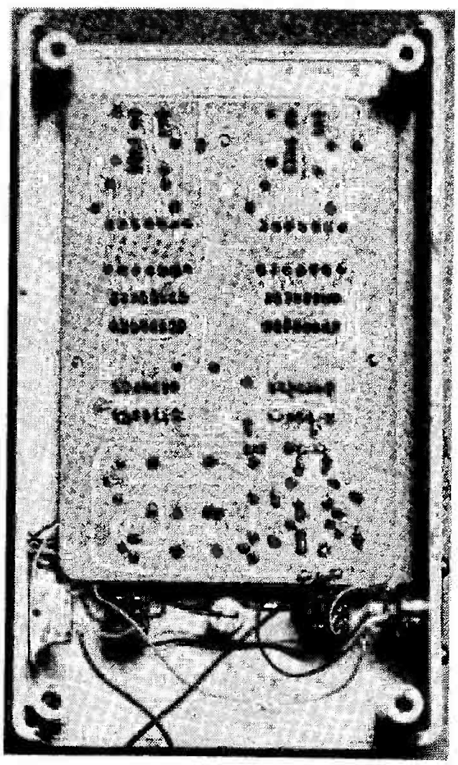


Fig. 2: PCB foil pattern — full size.



REACTION TESTER
Parts List

Resistors

R1-14, 23	330R
R15, 18	3K3
R16, 17	68K
R19, 20	270R
R21, 22	39K

All ¼W 5%

Capacitors

C1, 2	0.1 μF minifoil etc.

Transistors

Q1, 2	BC109 or similar
Q3, 4	BC108 or similar

Diodes

D1 IN 4001 or equivalent
LED 1, 2 RED 0.2"
LED 3 GREEN 0.2"

Integrated Circuits

IC1, 2	7490
IC 3, 4	7447

NOTE: CMOS version uses Sintel Module DB2 in place of IC1-4 and displays. This is available as a complete kit from Sintel price £10.94 inc. See ad. in this issue.

Switches

SW1, 2	Double Pole Changeover—Push On, Push Off.
SW3	Single Pole, Single Throw—Push to Break, non locking.
SW4	Double Pole Changeover—non locking.
SW5	Single Pole, Single Throw—rocker type.

Misc

I.C. sockets
Verobox 75-1413E
Verocase 65-2522K
Battery holder to suit
(Use 4 x HPII Alkaline version)
5 pin DIN 180° chassis skt
5 pin DIN 180° in-line plug
1m 4 core individual screened lead
Board spacers etc.

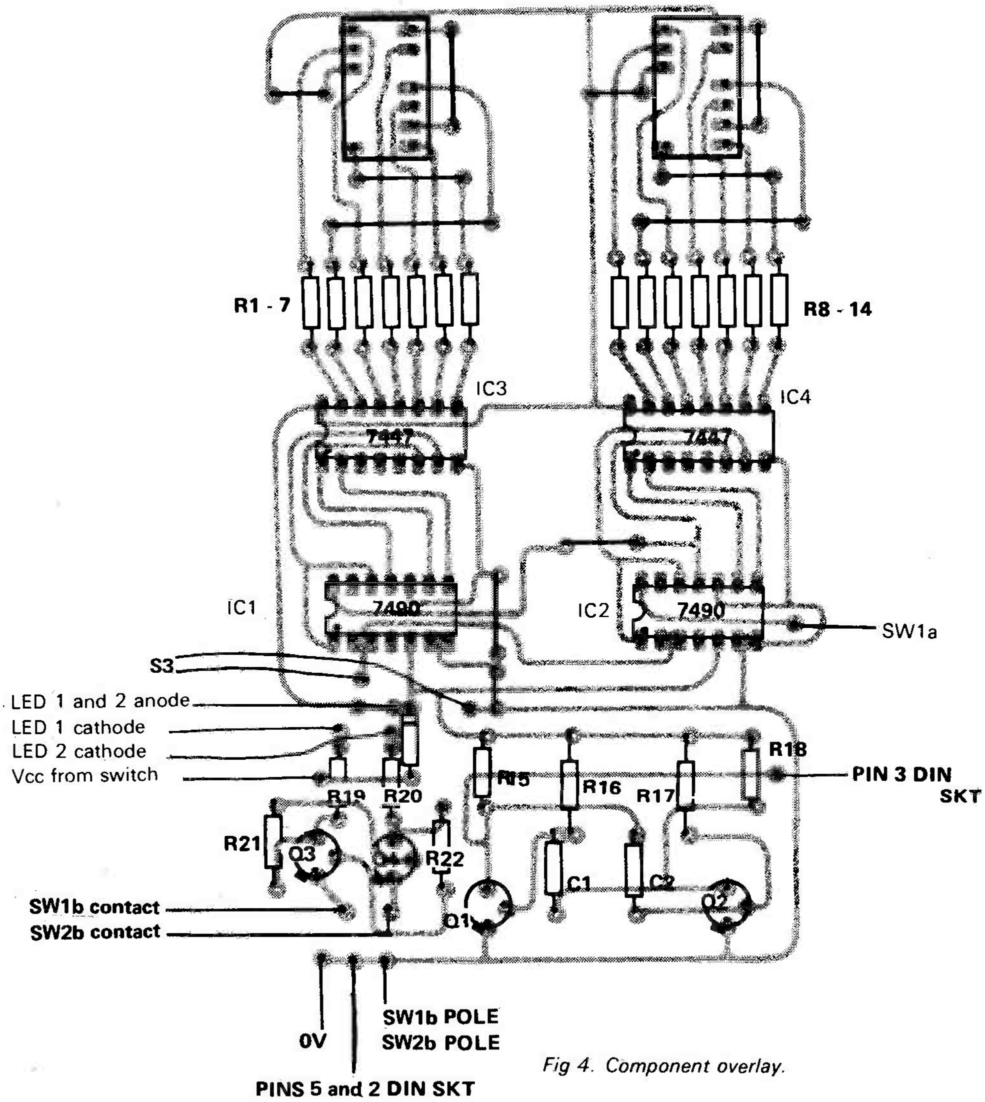
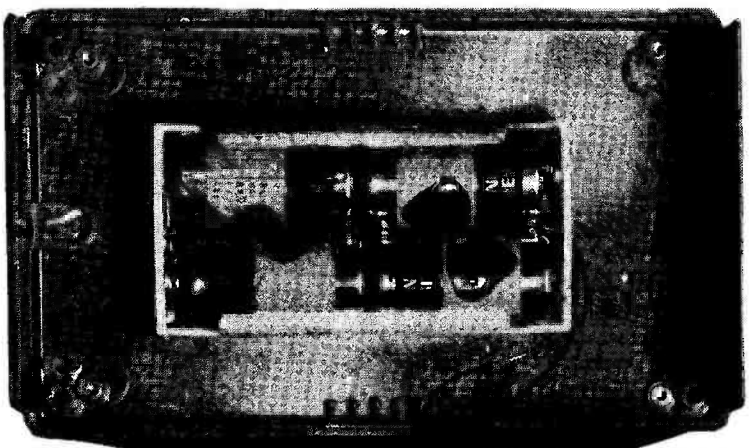


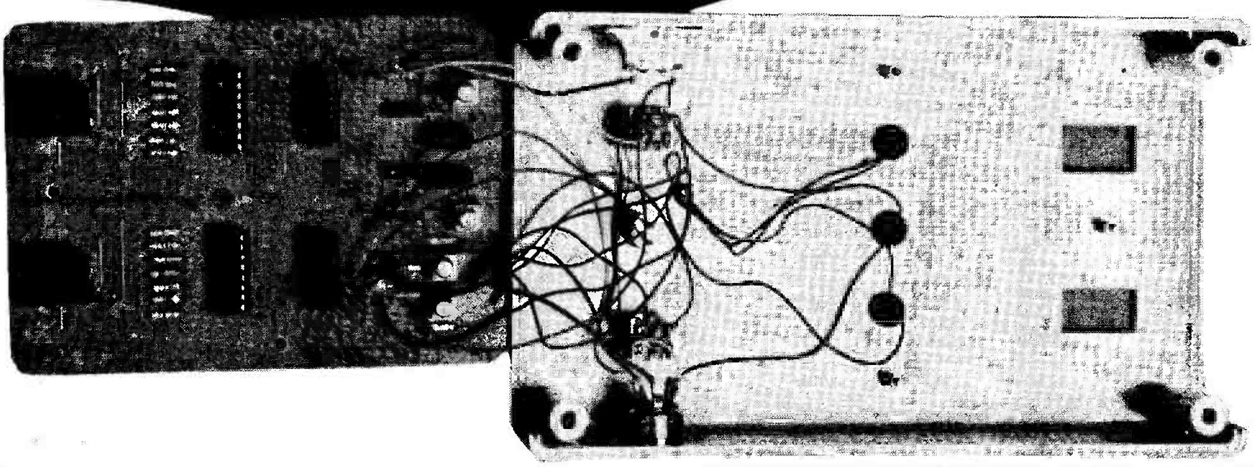
Fig 4. Component overlay.



exactly when the circuit will fire the LED Anyway we offer the idea for experiment - no guarantees!

By speeding up the clock oscillator to 1kHz, and adding a third 7490/7447 stage, timings can be taken in 1/1000ths of a second, or up to 9.99 seconds, depending on which end you add it! If anyone takes 9 seconds to find the button - call the undertaker.

Many more ideas will undoubtedly occur to the constructor - it is a case of knowing where to stop, as the actress.....



Sparkrite mk2

Capacitive discharge
electronic ignition kits

VOTED BEST OF 8 SYSTEMS TESTED BY 'POPULAR MOTORING' MAGAZINE

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

Sparkrite Mk. 2 is a high performance, high quality capacitive discharge electronic ignition system in kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in 15/30 mins.

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

THE KIT COMPRISES EVERYTHING NEEDED

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

OPTIONAL EXTRAS

Electronic/conventional ignition switch.

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

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

Improve performance & economy NOW

Note: Vehicles with **current** impulse tachometers (Smiths code on dial R.V.1) will require a tachometer pulse-slave unit. PRICE £3.35.

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POST TODAY!

Quick installation No engine modification required

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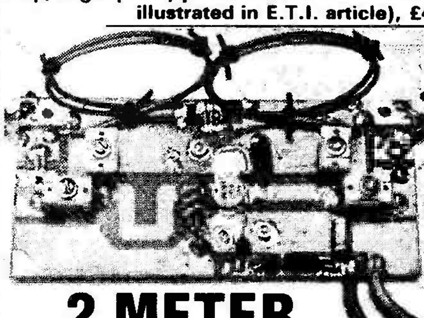

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PAGING BY NUMBERS

LOW-COST METHODS FOR CONTACTING PEOPLE IN BUILDINGS

by K.J.Young

PAGING SYSTEMS in factories, hotels and other large buildings can minimise loss of time involved in searching for people and can offer considerable economies in the cost of long-distance telephone calls. Some existing paging systems make use of audio public address systems, possibly interrupting music already being distributed. Other methods involve the carrying of small transceivers linked to a central point by radio or an inductive loop (references 1, 2).

The scheme discussed here is a visual one, which can have the advantage of silent operation. It is hence more unobtrusive and avoids disturbing people whom the call does not concern. It is also unaffected by ambient noise, which in some factories may mask audio messages. Moreover the call can be displayed continuously until answered. The essence of the system is that each person likely to be called has a denary number or letter code alloted to him, and any of these codes, as appropriate can be displayed visually at as many key positions as may be required, by means of wired control from a central exchange or lobby. When a person sees his number or letter code displayed, he then goes to the nearest internal telephone, or reports to a pre-arranged position.

DISPLAYS

It is necessary to decide how large and bright the slave displays of number or letter codes need to be at each position; they need not necessarily all be of the same type, provided they are compatible with the system in use, and smaller displays, such as miniature l.e.d. indicators, can be used in small rooms. If desired the visual display can at certain locations be supplemented by an audio tone which draws attention to it. There now exist a wide choice of digital display devices. Illuminated digits about 1in by 1in are given by a small lens system and lamp, the outlines being advanced by the application of a current pulse to a moving coil; larger models are about 4½in by 2½in by 1½in. Many miniature alphanumeric displays are now available, the seven-segment type operation at 5V now tending to supersede the earlier 180V type with a separate cathode for each outline. The 5-volt design eases power supply problems, as the same supply can be shared by the associated TTL logic; on the other hand for long wiring runs, voltage drop has to be allowed for. There is evidence that decoder-drivers for 5V are more reliable than for 180V. Low-voltage L.E.D. displays have some advantage over the earlier 5V filament type. Several types are also obtainable in clusters of several digits and various strobing and sequential-drive arrangements can reduce the logic and interconnections needed per digit, as compared with systems using a group of separate digits. Electromagnetic registers with up to 6 digits are readily available for various voltages, count sequentially, afford the simplest "carry' from one digit to the next, and can have electrical reset. They are also cheaper than electronic indicators, but require rather heavy current pulses and in general cause audible clicks. Some more recent types give quieter operation, e.g. they can be driven by stepper motors and/or have more refined methods of 'carry'.

WIRING

When we consider a scheme for a master digital display and several slave displays distributed through a building, an important factor is the cost of the wiring. Cost of cable rises with the number of cores used and current carried, also insulation voltage, whilst installation cost depends chiefly on the length and

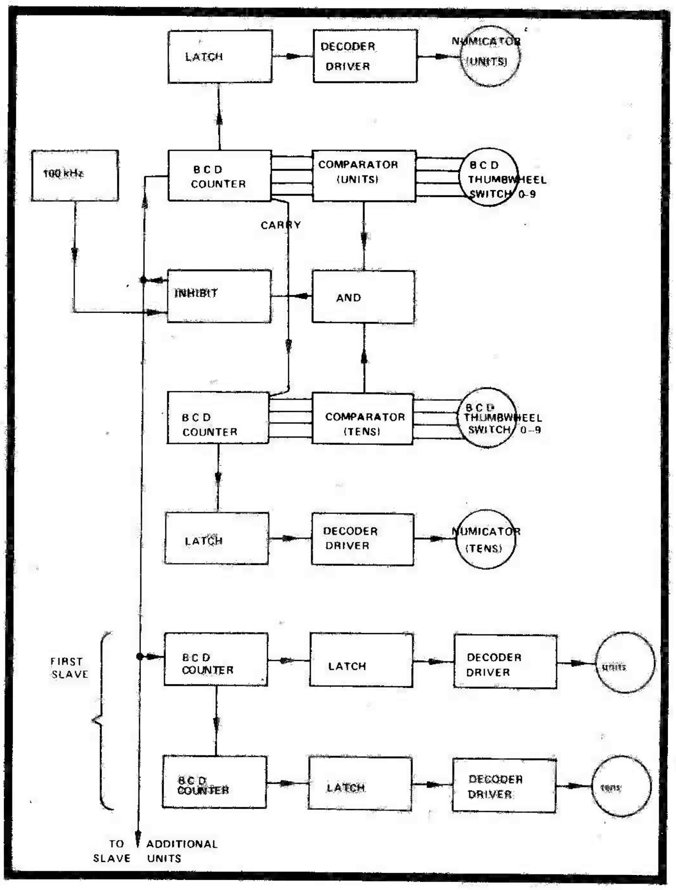

Fig. 1. A numicator-based paging system.

nature of the cable run, and whether wiring has to be concealed; the cost of concealment is much less in a new building, or in one already having ducts for other telecommunication services (not fire alarms), segregated from mains wiring.

Broadly speaking there is a choice between sending a rapid pulse-train to count from zero to the number required when the master controls are set, or alternatively arranging for the slaves merely to copy the central indication, without going through all the intermediate numbers. The former method fits in more readily with the use of only two wires, apart from power supplies, between the master and each slave, since to send BCD numbers over two wires would call for scanning and serial transmission. One possible method using numicators for silent operation is outlined in Fig. 1 (see also ref. 3). In this method, a multivibrator or u.j.t. pulse generator operates continuously, but drives the counters only when the number displayed at all locations differs from that set up on central denary thumbwheel switches. When no call is wanted, the operator resets them to 0000, 000 or 00, depending on the number of digits in use. Owing to the speed of the count, only the final result is visible.

TONES

A system based on the transmission of audio tones simultaneously over a single pair of wires may commend itself owing to the low wiring cost, assuming that independent power supplies are available at the master and at each slave.

Such a scheme might use, for two digits, two binary-output thumbwheel switches marked 0-9 at the master. Each position would connect or disconnect one or more of four audio oscillators, requiring a total of 8 audio oscillators at the master for two denary digits in the display. The tones would be picked up at each slave by eight tone filter/detectors, for which modules are now available, the outputs then being decoded to control a two-digit display by numicators or other devices. Alternatively the decoding could be omitted and each tone filter/detector could turn on a thyristor controlling a coloured mains lamp. If desired the lamps could also be numbered 1-8. In this way (2^8-1) or 255 different codes would be available, compared with only 99 by the BCD method. Such a method is perhaps less readily comprehended by the viewer, but enables more persons to be catered for, and the use of the higher-power mains lamps might sometimes be advantageous, particularly from the point of view of saving on power supplies.

Perhaps the simplest system however is afforded by the use of two stepping motors at the master and at each slave, in an add-subtract mode, driving registers of the required number of digits. The central operator would have two push-buttons — add and subtract, and would press these alternately as required until the appropriate number was displayed on counters driven by the motors. The slave motors would operate in synchronism and hence always display the same number as the master; during intervals of non-use, this would be reset to 0000. ●

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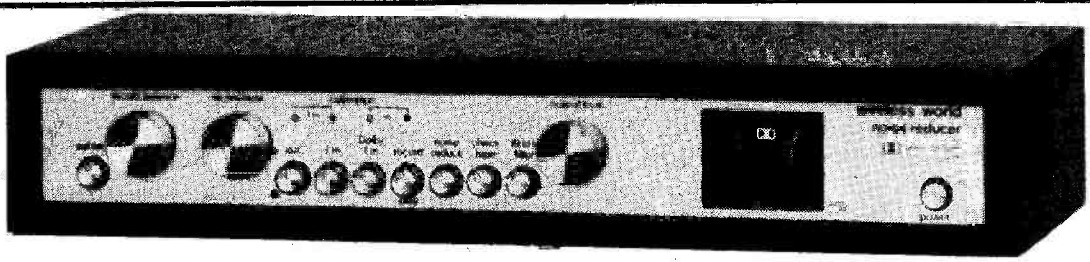
1. Paging systems for power station staff, Elect. Times, p.41-42, 16 July, 1971.
2. How to select the right system when shopping for a pager, G. C. Gedney, Communications, p.18-21, July, 1971.
3. Digital remote control system, H. N. Griffiths, Wireless World, Vol. 76, no. 1414, p. 175-177, April, 1970.



ELECTRONICS IN NORTH SEA OIL

THE NORTH SEA IS BEING CONQUERED BY ENGINEERS IN SEARCH OF ENERGY – AMONGST THEM ELECTRONICS ENGINEERS. LES BELL REPORTS:

TV AND PRESS reports on the North Sea Oil boom have always concentrated on the heavy mechanical engineering aspects of the industry, with shots of enormous oil rigs, welders at work with sparks flying and gigantic dry docks carved out of the Scottish shoreline. The fact of the matter is, though, that most industries today rely heavily on the 'modern miracles' of electronics and oil exploration (and production) is no exception. So in this article we shift emphasis from the gargantuan aspects of multi-thousand ton steel

skeletons to the (in comparison) tiny, micro-miniature electronics behind the scenes.

The North Sea is full of electronic equipment – from communications equipment to computers. The oil boom has brought with it a form of information boom – data has to be analysed quickly, messages have to be sent at high speed for urgent parts and a vast support organization is marshalled behind each rig. Reliability is the keynote; each rig has thousands of pumps, valves and meters which require monitoring and control, since a failure could be very expensive.

One recent application of electronics is of particular interest. Burmah Oil Development wanted to sink a 700 ft. high oil platform in the Thistle 'A' field, and obviously, when something that large and heavy is sunk, it has to be done in such a way that the stresses and strains on the structure are kept to the absolute minimum. In addition, the platform has to be sunk in the right place, and preferably first time!

A consortium of British companies called SEATEK was contracted to supply all the control equipment, and organize just how the operation would be done. SEATEK comprises EMI Electronics Ltd., Hawker Siddeley Dynamics Ltd., and R.&H. Green and Silley Wier Ltd., each of whom supplied special skills and abilities.

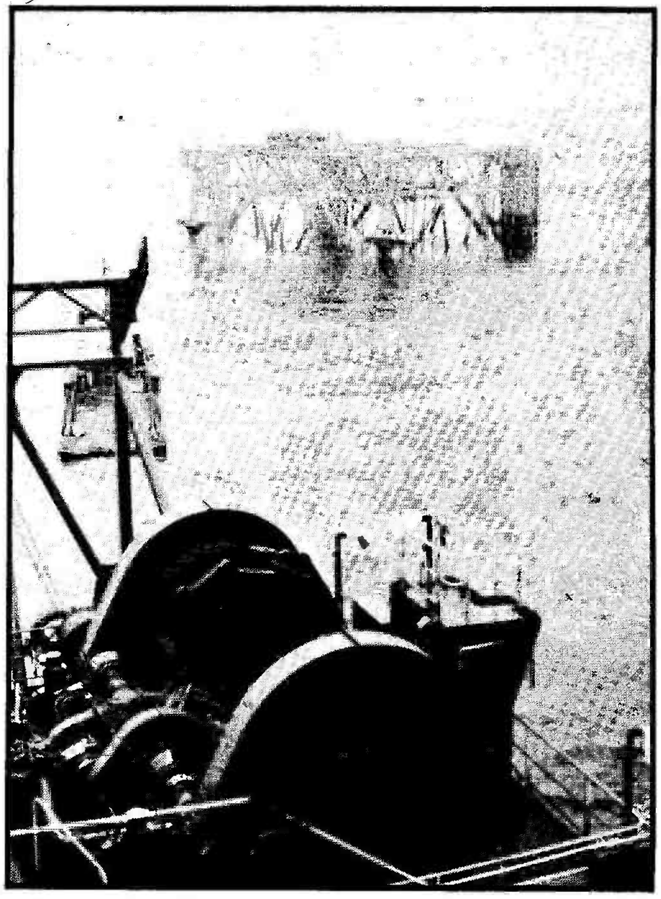
The project started out with the development of computer simulation equipment and software, which enabled engineers to try out various techniques without the danger of any physical damage, so that they could end up with a very good idea of how the rig would behave when it came to the actual operation. Later, in the period before the rig was towed out, the simulation equipment was used to train the key operators who would sit at the controls during the operation, in a similar way to the training of pilots in simulators.

The rig itself was fitted out with a nervous system of sensors linked by cables to a 120-ton, 80ft. long tower placement control module, which can be seen at the top of the platform on the opposite page. The sensors continuously monitored the status of tank levels, control valves, pressure switches and platform attitude. During the five day tow-out this information was received and displayed on board the lead tug. On August 10th 1976, the platform was in position 250 miles north of Shetland.

On board the command vessel 'ORCA' was a 30 ton, 30ft. long module containing the remote control consoles, computer and event recording equipment. From this module the deployment commander directed the entire up-ending operation. This was achieved by controlled flooding of the ballast tanks in the main legs of the platform to turn it through 90 degrees and control its descent to the sea bed. The control module continuously monitored signals from sensors all over the rig, such as acoustic sensors fitted on the structure to measure the depth of water under each leg, and transmitted these over a two-way data link to the 'ORCA'. 200 platform status indications, 60 analogue indications and 150 control signals were transmitted over this link which was based on an EMI 'System 36'.

Special projects like this one can present a stiff challenge to industry as oil companies demand high levels of performance, high reliability, and, most difficult of all, they demand these things fast. Every hour of delay can cost thousands of pounds. Fortunately, in this case SEATEK were able to operate to a very short timescale and sank the platform in the right position first time, although it could have been lifted and moved again under remote control.

Fig. 2. The platform finally in position.



BIG BUSINESS

As an indication of the kind of investment necessary for oil exploration, take a look at the latest IBM add-on for their 370/158 and /168 computers. The 3838 array processor is just the gadget required by geophysicists to identify potential oil-bearing formations, which requires some very fast and very complex mathematics indeed. As an example, the machine can execute a 1024-point Fast Fourier Transform in 2.95 milliseconds. The smallest version of this device will set you back about £500,000 and the top-line model around £650,000!

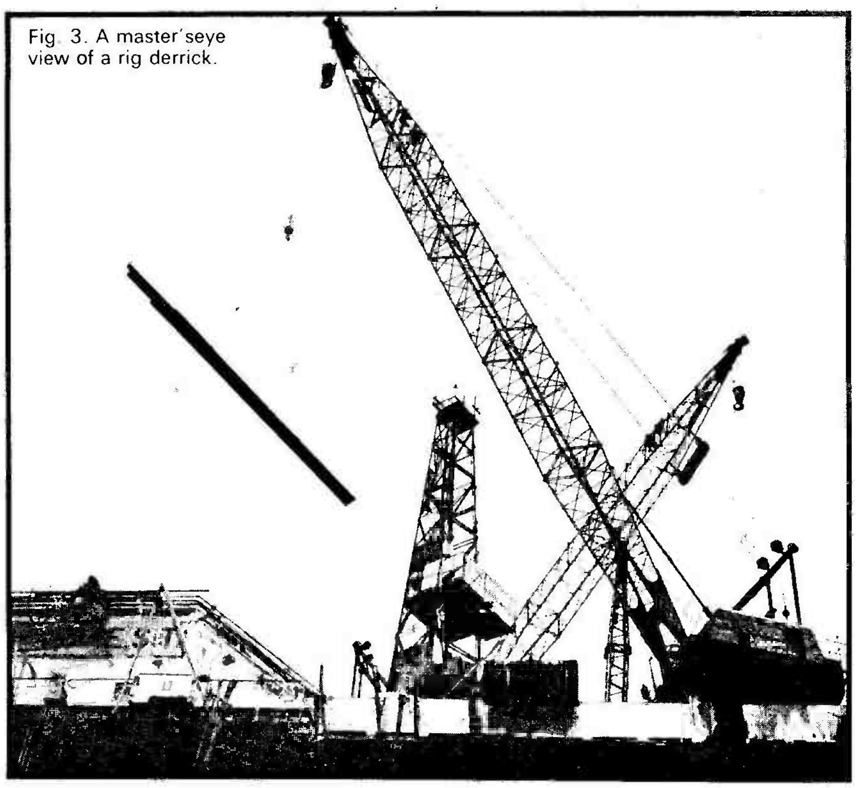


Fig. 3. A master'seye view of a rig derrick.

ELECTRONICS IN NORTH SEA OIL

LOADING

One interesting application of electronics in the North Sea is, believe it or not, in the control of cranes for loading and unloading supplies for rigs at sea. The North Sea is not a particularly hospitable place,and controlling a crane hook is difficult enough on land — it becomes well nigh impossible at sea. As the ship rises and falls in the swell, the crane driver has to use all his skill in lowering the hook for shackling and then in judging the right moment to lift the load. The whole process is both difficult and dangerous.

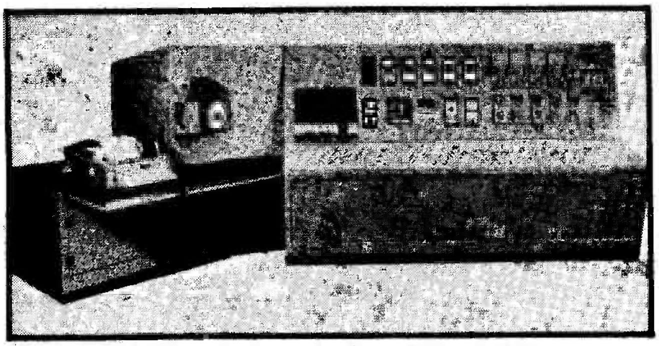
The KM Load Transfer System manufactured by Ferranti simplifies the whole procedure. In the Manual mode, the crane behaves like any other but when switched to Auto, it automatically follows the heaving of the ship. In addition, there is a unit mounted on the hook with a rope suspended from it to the deck. When this rope is pulled the hook lowers, and when it is released the hook lifts. Once the load has been shackled and the rope released, the hook automatically rises until the hoist cable is taut with a tension of around 1000 lbs. This then initiates the collection of heave statistics by a computer to predict the best instant for lift-off. The driver simply pulls his joystick fully back, but nothing happens until the ship's deck reaches its maximum height and then starts to drop. The load is then automatically lifted as fast as possible, and the system reverts to the manual mode.

To deposit a load onto the deck of a supply vessel, the crane driver simply places the load at the right position slightly above the maximum height of the deck. The load then automatically descends very slowly until it comes into contact with the deck, whereupon the system releases the load, and the hook can be unshackled.

OIL AND GAS METERING

Naturally enough, the oil companies, having spent millions of pounds on exploration and drilling, are eager to reap the maximum profit on their products, and in order to do this they have to know, accurately, just how much oil or gas they are producing as it flows through a pipeline. Daniel Industries, a Texas company, manufacture computer-controlled metering systems at their factory at Larbert, near Falkirk.

At the heart of their fluid metering system, shown in Fig. 5, is the Daniel turbine flow meter — a propeller-like device that is inserted into the fluid flow during a tanker or other loading operation. The turbine rotates as the fluid flows over it, and by measuring its speed of rotation, which is proportional to the fluid flow rate, and combining this measurement with others such as fluid temperature, pressure, density, etc., a value for the mass of fluid flowing through during a given time can be determined.



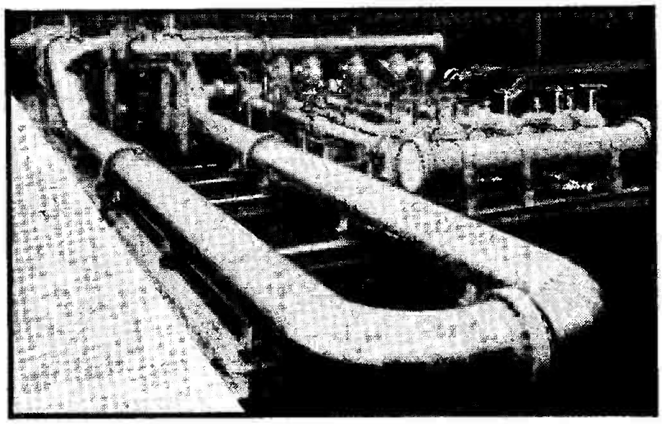


Fig. 4. (above). The control console of a metering system.

Fig. 5. (right). The 'plumbing' of an oil metering system on the Ekofisk centre

The 'brain' of the control console, (see Fig.4), is a Computer Automation ALPHA LSI-2 minicomputer which performs several functions. It controls the sampling of the various parameters and performs the complex calculations necessary to obtain an accurate figure for the flow rate. In addition, by communicating with the minicomputer through a Teletype terminal, the station operator can control all phases of a tanker loading operation from start-up, through meter calibration to termination and the production of printed reports relevant to that tanker load.

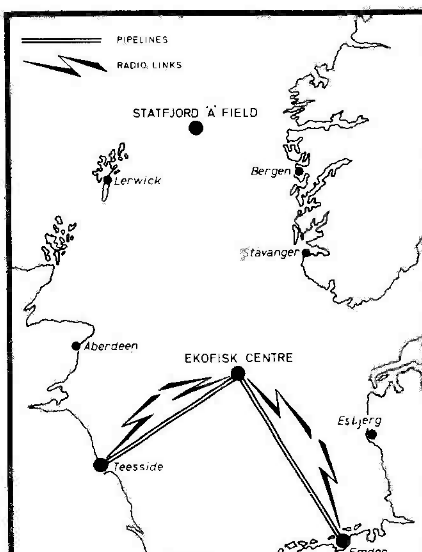
Calibration of the oil flow through the turbine meter is carried out in a proving section — in essence an accurately known volume (the U-tube in the foreground in Fig.5). The computer activates valves to divert the fluid flow through the proving section and the fluid flow is measured between the times of entering and leaving the section to give an accurate flow rate figure.

COMMUNICATIONS

With so many rigs, platforms and supply ships in the North Sea, there is a tremendous demand for radio communication services. When exploration began, standard ship-to-shore radiotelephone services were used, and these were later expanded to telex links. Today the main communications link for both speech and data is tropospheric scatter. Probably, before long, there will be a move to satellite communications.

The type of equipment and communications mode used will depend on the distance of the rig or ship from the shore, the type of service required (voice, data, telex) and whether or not Home Office Regulations permit operation. The size and complexity of the equipment can vary from a small transceiver for the HF marine band to an extremely complex troposcatter station costing anything up to £1M.

Much ship-to-shore communication is in the 1.6 to 4.2 MHz marine band using single sideband. Propagation on this band is mainly by ground wave by day and since it is over sea, (salt water is a beautiful earth!), the path loss is only slight. However, at night, the reflective layers of the ionosphere move up, and due to the lengthening of skip, all hell breaks loose as Continental and other distant stations come



This map shows the location of oil metering stations in the North Sea up in strength. The 3.5MHz amateur band is shared with maritime services and during daylight hours one can quite often come across oil rig stations. Facilities for this system are installed at the Post Office Coastal Radio Stations at Humber, Ilfracombe, Stonehaven and Wick.

Telex facilities can be used over this type of link with as many as 15 channels of telex on one frequency. Where graphical information has to be transmitted, e.g. maps or logging details from exploration rigs, facsimile transmission can be used. Error-correcting equipment can be used to 'clean up' the signal to obtain the high quality required.

In addition, communication has to be maintained with nearby supply vessels and helicopters using VHF AM and FM channels. Another requirement is for communication between work parties on a rig, or from a rig to supply ship at close range. This is usually achieved using hand-held 'walkie-talkies', or in some cases, using paging systems and public address systems.

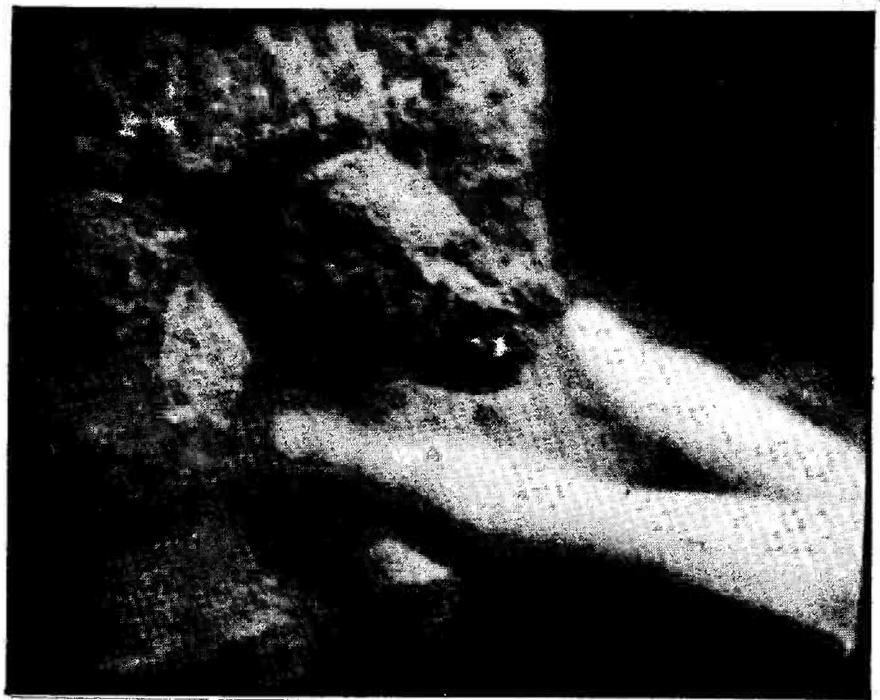


Fig. 6. A frame from the videotape of the wreck of the 'Mary Rose' taken by the MUT/BP Stage II camera using no artifical lighting. The protruding object in the centre of the frame is a trenail which is a wooden peg used by Tudor shipwrights to hold the planks of the ship together. The trenail is protruding about 3½in.

TROPO

There is a requirement for unattended and highly automated platforms to transmit vast amounts of computer data back to shore stations. For this type of communications link, VHF has proved to be most reliable, but will not operate out to the newer platforms which are beyond 'line-of-sight' propagation.

The Tropospheric scatter mode used to overcome this utilises highly directional beam aerials to concentrate signals at the horizon in the direction of the receiving station. About 2 to 3 miles up, the signals hit the troposphere and are scattered and redirected back to earth where high gain, highly directional aerials are used to pick up the small field-strength of the signal. Because of their greater bandwidth capability, these signals can carry increased amounts of data, either computer data or extra channels of voice or telex.

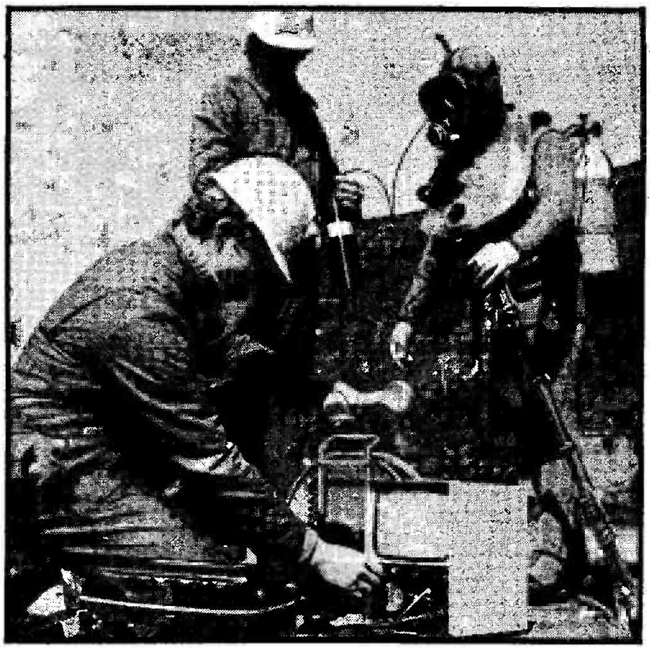


Fig. 7. This camera is similar to the one which produced Fig. 6.

UNDERWATER TV

Inspection of underwater structures is a job that has to be done by divers — it's not really on to train an engineer to dive to do an inspection. How, then, can the engineer get enough information to enable him to assess what repairs or modifications may be necessary? The answer lies in the use of underwater TV cameras by divers. Recently, Marine Unit Technology Ltd. have cooperated with BP to produce the MUT/BP Stage II camera.

This camera may be either diver-held or used remotely. When used by a diver there is a two-way communications link between diver and surface via a small bone-conduction microphone behind the diver's ear so that the surface controller can direct the diver to make sure the results he is obtaining are suitable for the required purpose, and the diver can give a running commentary on his activities.

Three options are available: the standard unit uses a regular vidicon tube for use in good light conditions, but for deeper work a version with a silicon diode tube is available. A third tube — the Silicon Intensified Target (SIT) tube — is suitable for very deep work over 100 feet in the North Sea where there is very little available light; an example of the quality of this tube is given in Fig.6. This is taken from a videotape made during a survey of the wreck of the Mary Rose in the Solent. It is under 10ft. of mud in waters about 40ft. deep. The divers had a visibility of about 3 to 5ft. during the time the survey was carried out, and conditions were far too severe for a conventional underwater camera to be used even with artificial lighting.

On the surface, there is a control unit comprising a television monitor, microphone and loudspeaker, which is specially ruggedised for North Sea conditions. The controller can also remotely control a zoom lens on the camera, so that all the diver has to do is point the camera where he is told! ●

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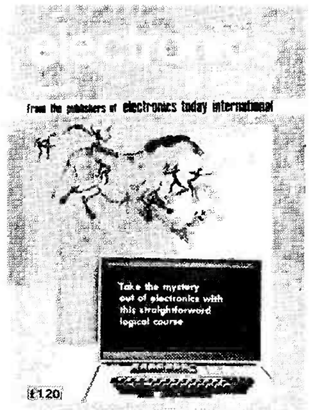

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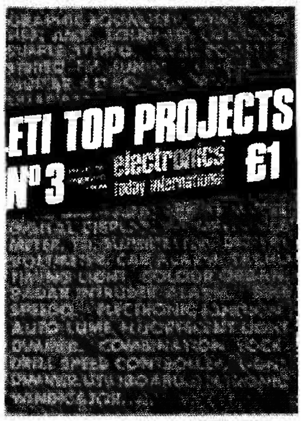

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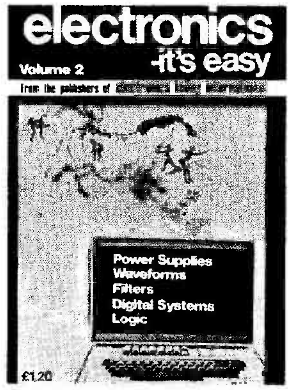

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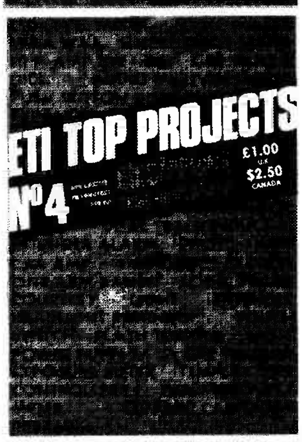

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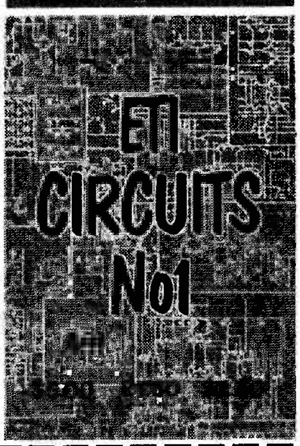

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THERE IT STANDS: gleaming. On the surface, a secondhand car in really good nick but think! Modern materials, especially resin body filler and a quick blow-over with the spray gun can make a rusty heap look like a new car.

Our Patch Detector will quickly find areas of the body-work which have been filled — or even patched with aluminium.

Only a handful of components are used. The key to the operation is the transistor output transformer; we used the best known, the LT700 in our prototype but we tried other types and all worked.

It is necessary to modify the transformer. First remove the shroud over the laminations. Then, using a pair of fine-nosed pliers carefully remove the laminations, These are held together by wax: the first lamination may be

Parts List

Q1	Transistor	BC108 etc
R1	Resistor	47k ¼W
C1	Capacitor	0.1µF disc ceramic etc
C2	"	0.018µF "
C3	"	100µF 12V electrolytic
T1	Transformer	LT700

Earphone: 8Ω type, 3.5mm jack plug
Earphone socket, 3.5mm
PCB to design shown
Vero box type "HAND HELD BOX"
Battery: PP3 and Battery clip

Total cost, inclusive of Box and VAT about £2.00

How it works

The circuit is a Hartley oscillator using an LT700 as the inductor. The primary of T1 is tuned by C2 and feedback is avoided by C1. The secondary of T1 connects via the socket/switch to the earphone.

Due to the modification of the transformer, when metal is brought near to the open end of the E laminations this alters the inductance of the primary and consequently the frequency of the note produced.

C1, C2 and R1 all affect the note produced and as long as R1 is not reduced below 33k, these may be modified to give the desired frequency. Current drain from the battery will be between 5 and 10mA.

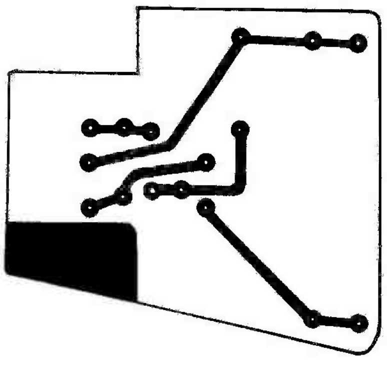


Fig. 3. PCB foil pattern — full size.

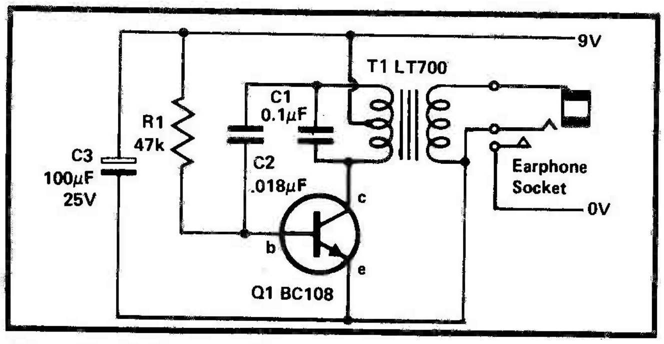


Fig. 1. Circuit diagram of the detector.

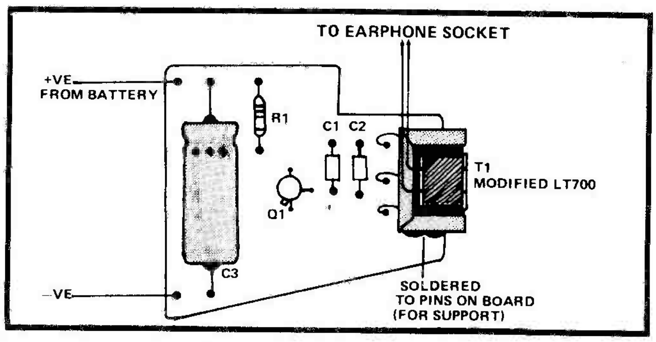


Fig. 2. Component overlay.

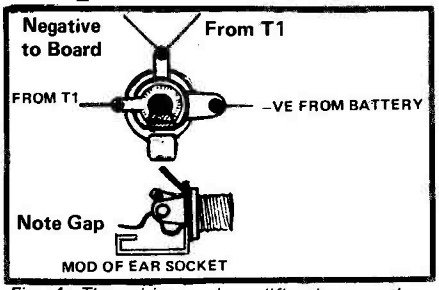


Fig. 4: The wiring and modifications to the earphone socket

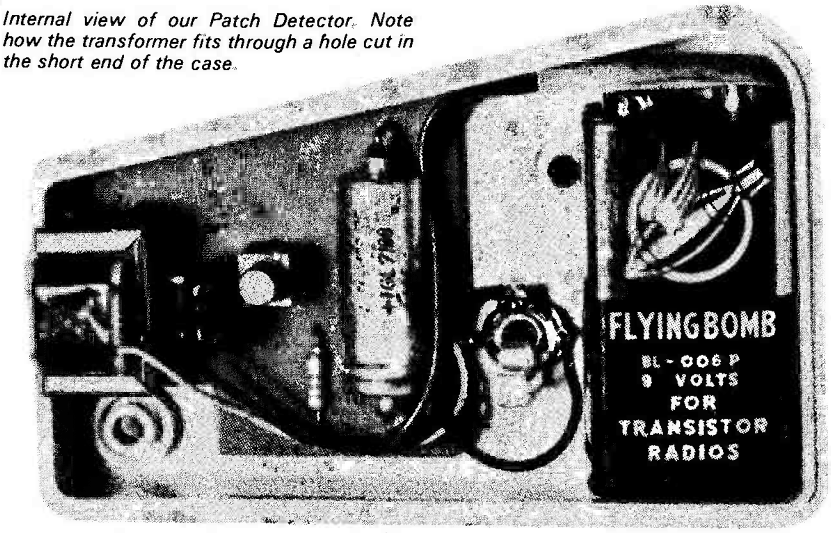
tricky to remove but thereafter you won't have any difficulty. The laminations in the LT700 (and the others we tried) are E shaped with a bar enclosing the exposed end, they are layed alternately.

When all the laminations have been removed reassemble them all the same way round to form an E. Fit this back into the transformer and replace the shroud.

We used one of the new "HAND-HELD" Vero boxes and built a small PCB to hold the components. The transformer can't fit directly onto the PCB so two thick wires are soldered to the shroud, these in turn are soldered to the PCB, this effectively stands the transformer away from the board.

A hole is necessary on the short end of the plastic box to take the transformer's face; the open ends of the E should face out.

Internal view of our Patch Detector. Note how the transformer fits through a hole cut in the short end of the case.



The circuit is simple and will only be used with an earphone so an on-off switch will only complicate matters. Instead the switch section of the earphone socket is bent so that it switches on when the earphone is inserted.

A PP3/VT3 battery will fit nicely across the long end of the box if one of the plastic buttresses on the pillar and two pips inside the same area are cut away.

The circuit is really a simple metal locator. In free air an audio tone is heard but when run along the body of a car the note is lower. When filler is encountered the note rises: even aluminium causes note change. There is no danger of the unit scratching the paintwork as the only thing to touch the bodywork is the soft plastic of the transformer's former.

A change in note can be detected when sheet steel is about 10mm (3/8in) from the laminations. Greater sensitivity is not an advantage incidentally. ●

HEADS OR TAILS

THE MULTIVIBRATOR IS ONE OF the most commonly-used circuit blocks in electronics – especially in digital circuitry. And the multivibrator forms the basis of this 'head or tails' project.

The multivibrator is a basic form of square-wave oscillator which in our design runs at about 700Hz whenever the push-button is pressed. When the button is released the oscillator will stop and the circuit will assume one of the two possible stable states. Either Q1 will be conducting and Q2 will be cut off, or Q2 will be conducting and Q1 will be cut off. Whichever transistor is conducting draws enough current down through the resistor and the light-emitting diode (in series with its collector) to cause the LED to light.

Notice that the circuit is symmetrical and that the two transistors are cross-coupled between their collectors and bases (via R3, C1 and R4, C2). If corresponding components on each side are matched there is equal probability of either transistor being on

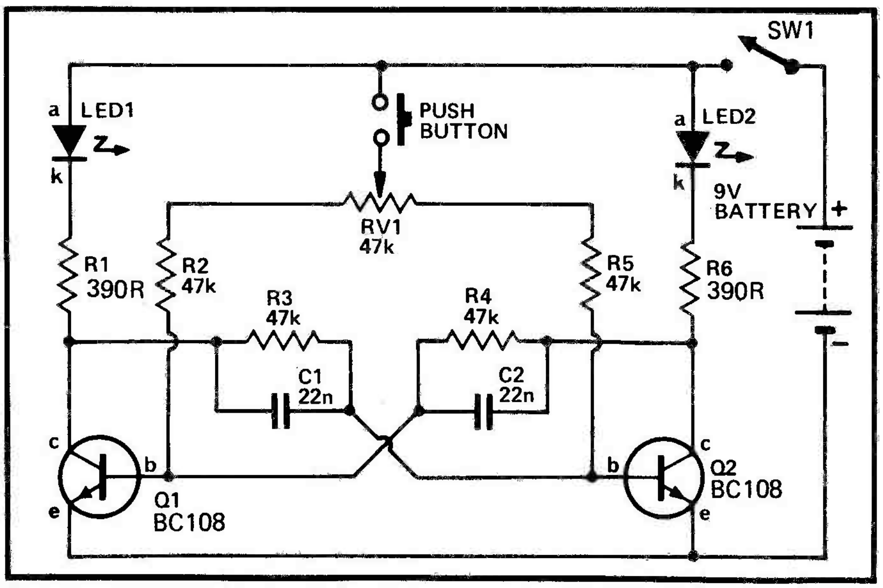
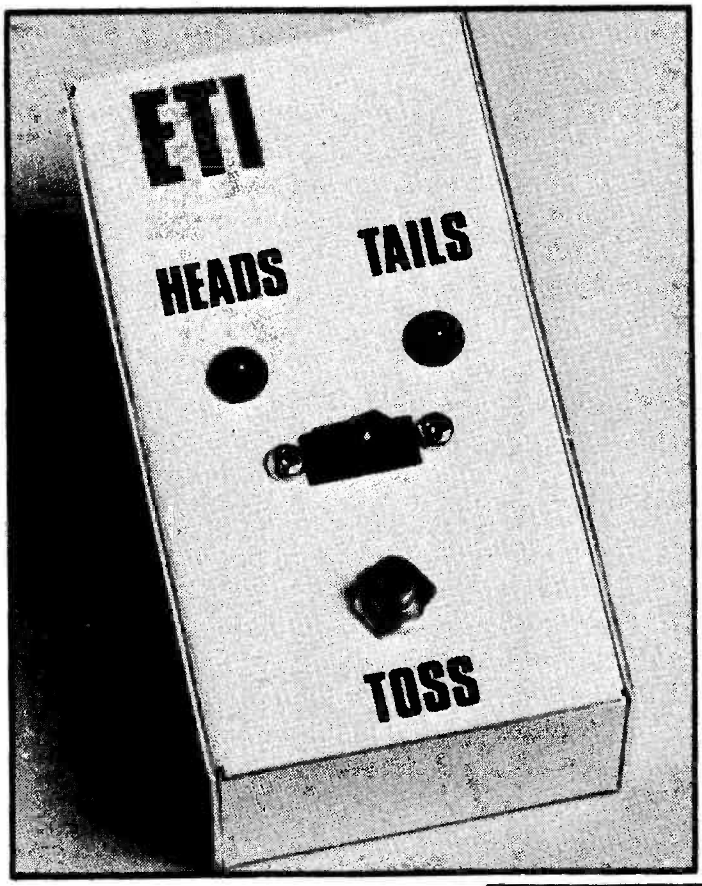
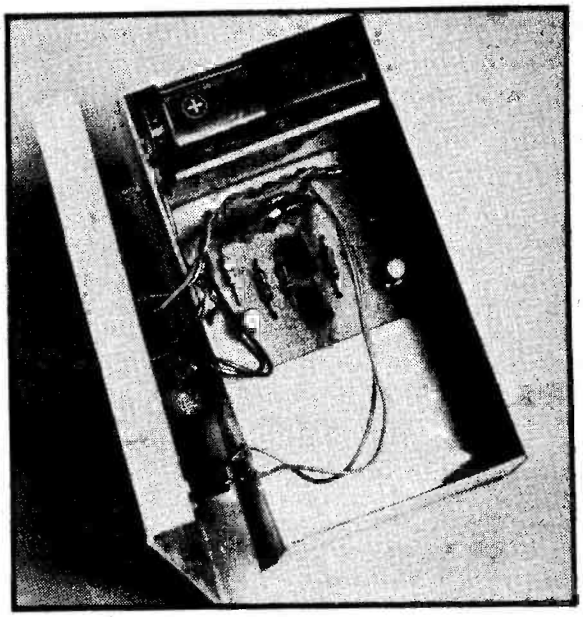


Fig 1: The circuit of our Heads-or-Tails unit.

when the button is pressed. However, electronic components do not have exactly the values they are supposed to have so it is necessary to include potentiometer RV1 to adjust for equal probability. Alternatively it may be useful to maladjust RV1 so that the effect of bias on the results can be assessed.

When either Q1 or Q2 is on, as said before, the associated LED will be on





Internal view of the completed unit.

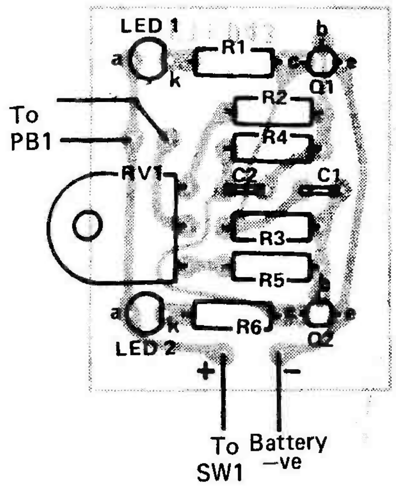


Fig. 3: The component overlay.

Parts List

R1	Resistor	390R ¼w 5%
R2-5	Resistor	47k ¼w 5%
R6	Resistor	390R ¼w 5%
RV1	Potentiometer	47k trim
C1,2	Capacitors	22nF polyester
Q1,2	Transistors	BC108
LED 1,2	Light emitting diodes (large type)	
P.B.1	Press to make	
S.W.1	On/off switch	
Battery	PP3	
Battery clip		

Aluminium box 4 x 2 x 1½in.

Total cost, inclusive of box and VAT: about £2.00

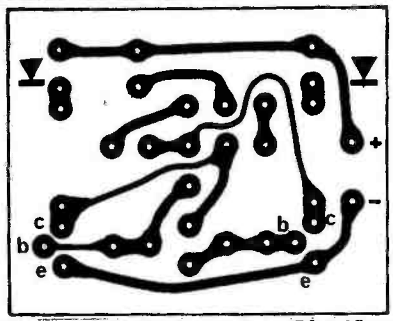


Fig. 2: The PCB layout. Full size 50 x 40mm.

How it works

This circuit may be considered as a multivibrator, when the button is pressed, and as a flip flop when the button is released. If initially we consider the circuit with R2, R5, C1 and C2 deleted we have a standard flip flop. If Q1 is on, it robs current from the base of Q2, thus turning it off. Transistor Q1 will be held on by the current through R6 and R4. However, if Q2 is on, the reverse is the case. Thus only one of the transistors can be on at any time - never both.

The addition of R2, R5 and C1, C2, will not alter the above, providing the push button is not pressed. However if the button is pressed the current through R2 and R5 will try to turn on both transistors.

Take the case where initially Q1 is on and Q2 is off. The voltage on the collector of Q1 will be about 0.5 volts and the voltage on Q2 collector, about seven volts. We therefore have about 6.4 volts across C2 (as the base of Q1 is at about 0.6 volts). When the button is pressed Q2 will turn on and its collector will drop to 0.5 volts.

However a capacitor cannot instantly change its voltage and the base of Q1 will therefore be forced to −5.9 volts which turns off the transistor. Capacitor C2 then discharges via R2 and R4 until the base voltage is again at +0.6 volts when Q1 will turn on again. This however forces the base of Q2 to −5.9 volts (due to C1) thus turning Q2 off. This process continues back and forth until the push button is released. The circuit then stops in the state it was at the instant of releasing the button.

To add bias to the circuit RV1 can be adjusted to change the discharge time of C1 or C2 by up to 50%. In this case the two transistors will not be on for equal times and the results will be biased towards one side.

LEDs are included in the collector circuits of each transistor to indicate which transistor is on. If, for display purposes, a slower-running unit is required the values of C1 and C2 may be increased. If both are 10 microfarad electrolytic capacitors the rate will be about 1.5 seconds. Make sure if electroytics are used that the positive terminal is connected to the collector of the transistor.

and this gives us our 'heads' or 'tails' indication. When the button is pressed, however, the LEDs are switched on and off alternately at a rate of 700Hz. The switching cannot, of course, be seen due to the limited flicker-frequency response of the eye. Both LEDs will therefore appear to be illuminated.

CONSTRUCTION

The unit can be assembled onto a small printed-circuit board such as that illustrated.

The main points to watch are that the transistors are correctly orientated and that the LEDs are the correct way around.

The unit should be thoroughly checked — a transistor or LED can be destroyed if it is wrongly connected. Double-check the battery connection — a reversed battery can also destroy semiconductors. ●

SCR TESTER

SCRs ARE INCREASINGLY being used for power control in mains circuitry (e.g. sound-to-light converters and drill speed controllers) and also in battery circuits (e.g. flash triggers). Testing any semiconductor can be a bit of a bind if you have to breadboard a test set-up to do the job, so that there are now many circuits available for transistor testers. Now, here's a simple SCR tester which will give an instant indication of a faulty device.

CONSTRUCTION

As can be seen from the circuit there are only a handful of components but we opted to mount most of these onto a small tag-board; there are almost as many components on the front panel, however.

SCRs come in a variety of encapsulations; the small ones are usually in TO5 cans and a socket is fitted to the front panel to accept these directly. Other types are not suitable for plugging in so the connections to the socket are taken to three sockets into which extension leads with croc clips can be plugged.

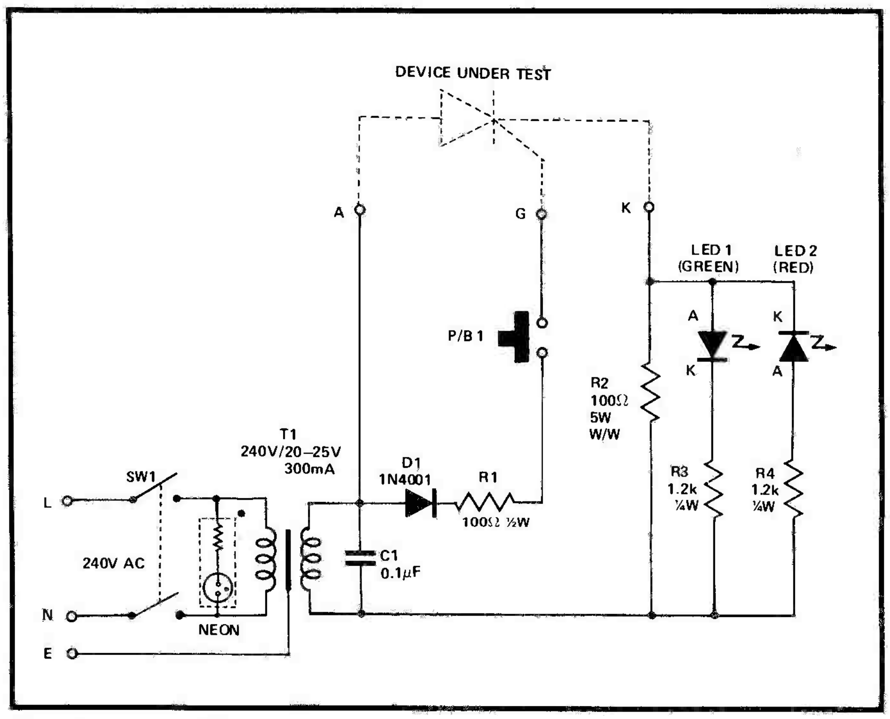


Fig. 1: Circuit of the SCR Tester.

How it works

On switch on, assuming a good SCR, there is approximately 20V AC across the SCR, but it does not conduct so that with no current flowing through R2, no volts are dropped across it, hence neither LED will light. When P/B1 is pressed, thyristor gate current will flow, and the thyristor will turn on when the anode is positive with respect to the cathode. Thus, for half of each cycle, current will flow through R2, so that LED1 will light up.

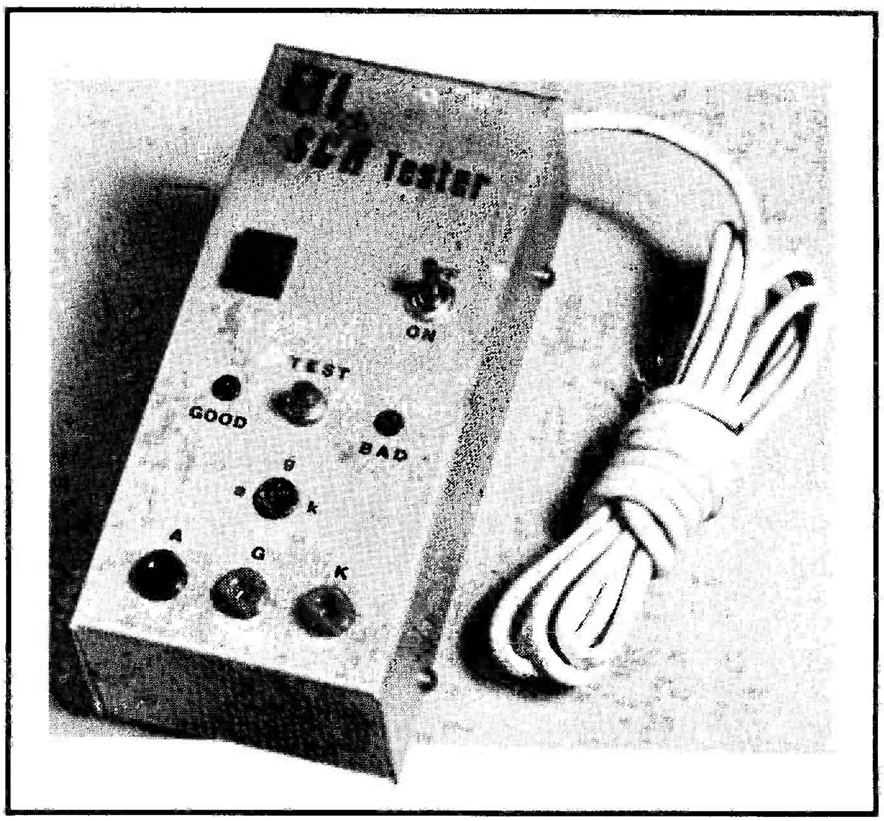
If both LEDs light up, this means that the SCR is conducting both ways, i.e. internally short circuiting. If neither LED lights up, when PB1 is pressed, the SCR has failed open circuit.

Parts List

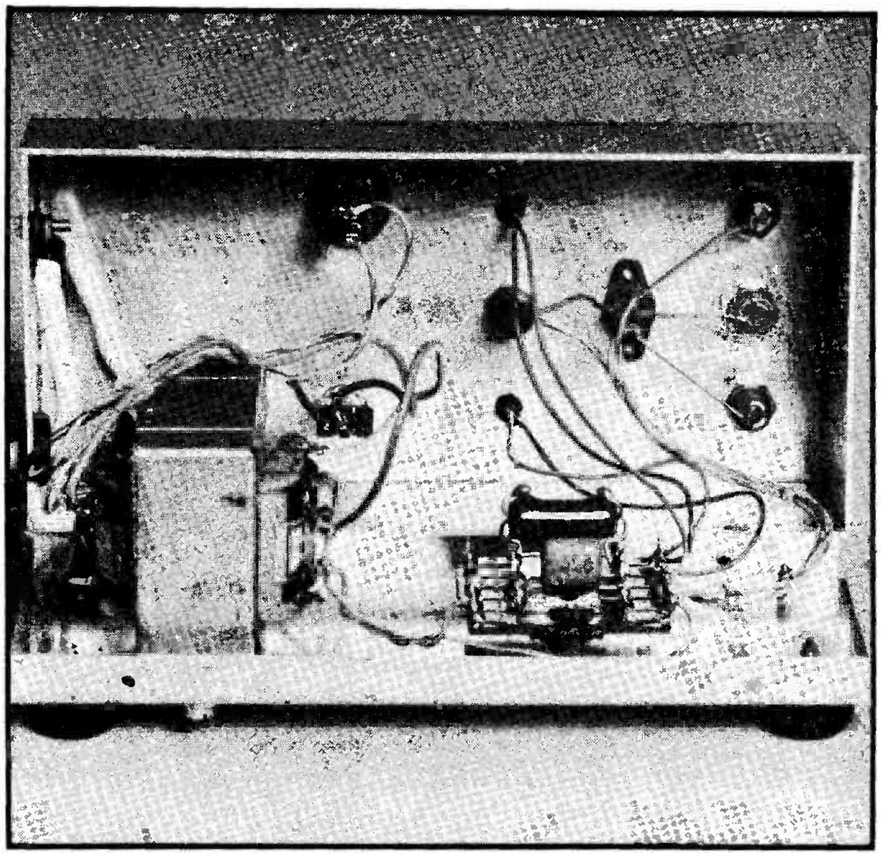
T1	240V–25V .3A MIN TRANS		
NEON	240V TYPE		
C1	0.1.μF 160V		
D1	1N4001		
R1	100R	½W	
R2	100R	5W	W/W
R3, 4	1k2	¼W	
LED 1	GREEN	TIL 209 TYPE	
LED 2	RED	TIL 209 TYPE	
PB 1	Push to test type		
SW1	OFF/ON mains toggle		

TO5 Transistor test socket, wander sockets, mains cable, RS miniature tag board. feet. Aluminium case (6 3/8" x 2 7/8" x 1 7/8") (162 x 73 x 48mm) H. L. Smith.
2 Vero ½" stand off pillars.
Nuts and bolts.

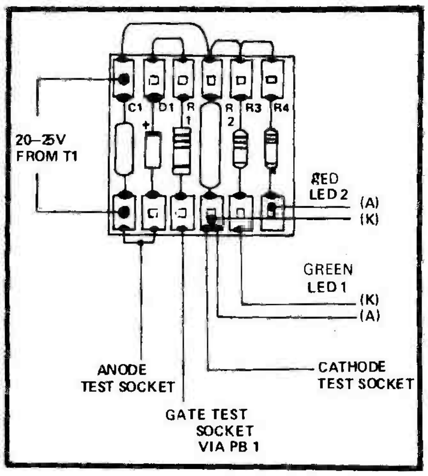
Approx. Price £5.00.



The completed unit is built into a strong aluminium box.



The majority of the components can be wired to a small tag board.



Test gear tends to be mishandled and a nice strong aluminium case is advisable in view of the propensity of small test gear to disappear under piles of components at the back of the workbench.

In a no-go condition, both LEDs will light under a short-circuit condition so don't be misled by the green light being on.

OPERATION

1. Insert SCR.
2. Switch on. If either or both LEDs come on, reject the SCR.
3. Press button 1. LED1 *only* should come on; if anything else happens, reject the SCR.

eti microfile

PART 11

PROGRAMMING

We talked last month of the logical, structured method of programming, making use of subroutines. For a program, which has to do calculation, the standard method of doing arithmetic is to use subroutines for the arithmetic operators. Note that an 8 bit microprocessor can only, of itself, represent a number between 0 and 255, or, in BCD, using the 8 bit byte as 2 BCD digits it can represent a number between 0 and 99. This is not really much use for most applications.

Consequently, numbers are represented using two or more consecutive locations in memory. With two locations, in binary we can get up to 65 535, or in BCD, up to 9999. This, of course, only takes account of positive numbers — if negative numbers are required, these can be represented in binary using the 'two's complement' method, or by placing a sign bit in front of the number. This now spreads the number range from entirely positive numbers to I 32 767 using binary positive numbers using BCD.

The reason that BCD is used is that it is easier to encode into ASCII — one simply splits each byte into two, and adds the BCD digit to 0110000, or Hex 30; this then gives the correct ASCII code to be output to a Teletype. For binary, the process is obviously more complex, as the binary number has to be decoded to decimal before outputting.

The use of BCD means that many computers (and microprocessors) have been designed with BCD in mind. Many can perform addition directly on BCD digits, automatically producing a BCD result. In other cases, and many microprocessors fall into this category, the CPU performs a straightforward binary addition, i.e. it adds the pairs of BCD digits as if they were pure binary, and then performs an adjustment instruction to correct the answer to BCD. The M6800 chip, for instance, uses this trick — it has a flag in the Condition Codes Register called the Half-Carry bit, which can be set if there is a carry from bit 3 during an addition. When a Decimal Adjust Accumulator (DAA) instruction is executed, the CPU samples the condition of this bit, the Carry bit, and the two half-bytes of the A accumulator and then adds 00, 06, 60, or 66, depending on the various parameters, to correct the contents of ACCA into two BCD digits.

— these will come from location 51. We then add the least significant digits of the second number into ACCA — these are stored in location 53. This process will have affected the various flags in the CCR, and so the next instruction should be a Decimal Adjust Accumulator. We are now left with the (correct) BCD result in ACCA and must store it in memory while we perform other calulations in the accumulators, so the next instruction is STAA 56 — we will explain why we chose 56 and not 55 (as you may have anticipated) in a moment.

Once again, we load the Accumulator — this time with the most significant digits of the first number. This time, when we add the digits of the second number, we must take account of any carry left over from the previous calculation (which will have been stored in the form of the Carry flag in the CCR), and so we use the ADC A instruction. Next, we store the result in memory location 55.

Location	Contents	Representing
50	12	1234
51	34	
52	98	9878
53	78	
54	01	11112 (result)
55	11	
56	12	

Fig. 1. (a) Memory contents

Location	Contents		Label	Assembly Language Instructions		
70	96	51		LDA	A	51
72	9B	53		ADD	A	53
74	19			DAA		
75	97	56		STA	A	56
77	96	50		LDA	A	50
79	99	52		ADC	A	52
81	19			DAA		
82	97	55		STA	A	55
84	25	87		BCS		CARI
86	39			RTS		
87	96	01	CARI	LDA	A	01
89	97	54		STA	A	54
91	39			RTS		

Fig. 1. (b). Simple addition program

ADDITION SUBROUTINE

The important thing to know is not how the CPU does this, but to know that it can be done. Let's look at one, almost trivial example of how this instruction can be used. For the purpose of simplicity, we shall assume that we want to add together two 4-digit numbers which are each stored in the form of two consecutive bytes of BCD, starting, say, at locations 50 and 52 respectively. Lets also assume that we want to place the result into the following locations in memory.

The first operation we perform is to load the two least significant digits of the first number into ACCA

FORGOTTEN SOMETHING?

This leaves a gap between location 53 (the 2nd byte of the 2nd number) and the beginning of our result so far. The reason is that we have, as yet, taken no account of any carry which may have been generated from the last addition. Accordingly, we insert a Branch on Carry Set instruction, so that if there is a carry, we branch to a routine which loads the Accumulator with 01 and stores this in location 54, to complete the calculation. Finally, we finish off with a Return from Subroutine instruction. The completed program, together with a memory map showing the use of memory, is shown in Fig. 1.

This program is deliberately simplified, in that we have only represented 4 digit numbers, and only integer ones at that. This is a simple representation of **fixed point** numbers, i.e. the decimal point is always assumed to be in the same position. One obvious improvement to the above subroutine would be to use indexed addressing, which would enable a more compact subroutine to be written for much longer numbers. Similar subroutines may be written for subtraction, multiplication, and division.

However, a more useful technique for representation of numbers is the floating-point technique, where a number is put in the form of a mantissa and exponent, as in the case of many scientific calculators. Floating point arithmetic packages are considerably more difficult to write, and they mainly find their application in interpreters and compilers for high-level languages, so that they are brought as part of an interpreter program. You may like to think about the problems involved in writing some floating point routines — such as: how does the routine know where to find the number it will add? What happens when you try to add a very large number to a very small number (try this on a scientific calculator)?

HIGH-LEVEL LANGUAGES

High-level languages are what make the writing of large scientific and commercial problems feasible. For the amateur, they can take out a lot of the drudgery of program writing, and possibly more important, they allow the transfer of programs from one computer to another. For example, many games programs are available written in BASIC, and these can be run on any computer having a BASIC interpreter or compiler providing there are no non-standard features used in the program.

What is the difference between a compiler and an interpreter? Briefly, a compiler is a program which converts the code written in high-level language into machine code so that it can then be run directly. An interpreter, on the other hand, is a program which is resident in the machine at the same time as the program being executed, and looks at it line by line, executing the source code *directly*. To sum up, the compiler alters the program to be run on the machine, while the interpreter effectively alters the machine to run the program.

In addition an interpreter offers the ability to edit and alter a program directly, whereas with a compiler, the entire program has to be re-compiled. On the other hand, a compiled program can be considerably faster in execution than an interpreter/program combination.

AVAILABLE INTERPRETERS

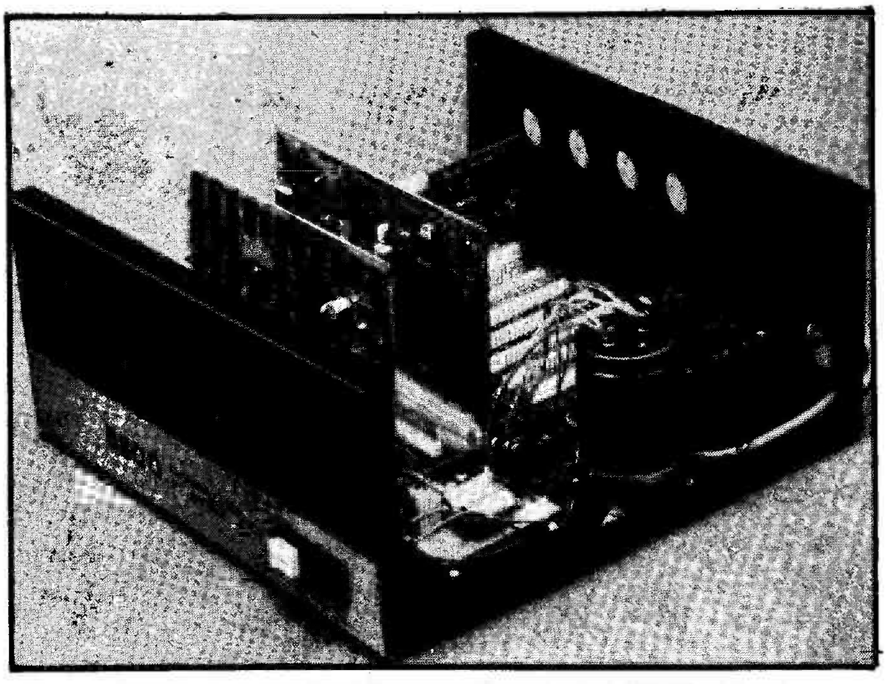
Most of the hobby activity today is in the States, and it is there that most interpreters are available, and of course, most of these have been written to suit the Altair/Imsai and South West Technical computers. In most cases, BASIC interpreters are available in various sizes (to suit various amounts of memory) and offer widely ranging facilities, such as string handling and double-precision variables on the Extended Basic. Altair BASIC, for example has the functions: SIN, COS, TAN, LOG, EXP, SQR, SGN, ABS, INT, FRE, RND, POS and TAB and SPC in PRINT statements. This program takes up 5.9K bytes for the 8080.

At the opposite end of the scale is VTL/1 a Very Tiny Language for the Altair 680 which comprises both a BASIC-like interpreter and a use collection of subroutines that can be used by the machine language programmer. This occupies 768 bytes of ROM, and is intended to be used with the minimum 680 configuration of 1K bytes of RAM and a terminal. Editing can be done as in Basic, and VTL/1 will print strings. Compelec Electronics can supply further information, although it may be worth waiting for VTL/2, which I believe is in the pipeline.

Computer Workshop of 174 Ifield Road, SW10, have now got 3 different versions of a BASIC interpreter suitable for their 6800 based system, which offer a wide range of facilities. Typically, these are available in the form of both paper tape or CUTS standard cassette, and will run in systems using the MIKBUG/PIA-TTY interface combination. Incidentally, we hope to have a review of their CT-1024 VDU next month

COMPILERS

In general, compilers are not so convenient for amateur use, and so



The new MP-68 computer from Computer Workshop of 174 Ifield Road, London SW10 is based on the 6800 microprocessor. A wide range of software and hardware extras are available for this machine, including BASIC interpreters and an audio cassette interface, the AC-30, which is also available separately.

the main compilers on the market are for professional use, so that, a) they are expensive and b) they require a lot of memory, often backed up with floppy discs, to run. Motorola do a resident FORTRAN compiler for their EXORciser, while Intel do a resident PL/M compiler for their Intellec MDS system. In addition, GCE do a compiler for Coral 66 which requires 48k of memory and a floppy disc, which is probably a bit more than most amateurs would use! Assemblers are probably more useful — these are available from 'hobby' computer suppliers as well as the MPU manufacturers.

ADDITIONS TO 9900 FAMILY

Texas Instruments Limited will add a new microprocessor and four peripheral circuits to its TMS 9900 family to expand the applications spectrum of all 9900-series products, according to a company spokesman.

The TMS 9980 is a new MOS microprocessor — a lower performance version of the powerful 16-bit TMS 9900 microprocessor. It is packaged in a 40-pin DIP, and like the TMS 9900, it is a 16-bit central processing unit and executes the full 9900 instruction set including hardware multiply and divide. It features an 8-bit data bus and a 16-bit address bus, making it compatible with byte-oriented microprocessor memories.

The same I/O system is employed as on the TMS 9900, offering the user capability to do DMA, memory mapped I/O, or a serial I/O port (the Communications Register Unit, or CRU). Six interrupts including a nonmaskable interrupt and reset will be available.

The oscillator and clock generator of the 9980 will be contained on-chip. The new microprocessor is targeted to be extremely cost effective in systems requiring smaller memory size and less I/O, particularly where board space and chip count may be critical. The TMS 9980 will compete head-on in the medium performance range with currently available 8-bit MPUs such as 8080 or 6800. The 9980 gives TI a complete software compatible family including: TMS 9900 16-bit microprocessor, 990/4 microcomputer and 990/10 minicomputer implemented in TTL. TMS 9980 samples are scheduled for 1977.

The TMS 9904 is the 4-phase clock generator and driver for the TMS 9900.

The TMS 9901 is a programmable system interface using NMOS technology. It can be used with 9900 or 9980 systems. The 9901 interfaces directly to the processor CRU port, and provides three functions — interrupt prioritization, I/O control and interval timing.

The TMS 9902 is an NMOS asynchronous communication controller (UART) and interval timer which can take advantage of the CRU I/O port of the 9900 and 9980. Programmable features include data rates from 5 to 76,800 bits per second, character lengths from 5 to 8 bits, 1, 1.5 or 2 stop bits, and even/or no parity.

The TMS 9903 is an NMOS peripheral which performs the synchronous communication control, from DC to 250K bits/second in various formats including IBM Bi-Sync and SDLC.

Texas Instruments Limited, Manton Lane, Bedford.

SCRUMPTIOUS!

Now available from Bywood Electronics is SCRUMPI, a complete microcomputer/controller on a board based on the National Semiconductor SC/MP MPU. SCRUMPI uses 8 toggle switches for data input and 24 LEDs for address/data and status display. This means that all you have to add to get a complete working MPU is a power supply and a program (demo programs are included).

Programming and testing of a program with SCRUMPI is simplicity itself — by using the RESET switch the MPU addresses location X'0001' which is the program start location; the first instruction is then entered at this address and executed. After execution of the instruction, the MPU will halt at the next location where the second instruction is to be entered and executed. Execution can be by byte steps, by automatic increment at about 5Hz or at full speed (100 kHz or faster). An extender card will be available in a few weeks to enable interfacing to additional RAM, PROM and EAROM as well as an extended instruction set (using add-on hardware) and chip or device selection logic. Around the same time VDU/keyboard interface and PROM software will be introduced.

Bywood Electronics, 68 Ebberns Road, Hemel Hempstead HP3 9RD.

TALK TO ME!

The COMPUTALKER CT-1 Speech Synthesizer is a high quality voice generator unit designed for the standard I/O bus configuration used in Altair, Imsai and Polymorphic microcomputers. The storage required is 900 bytes per second of speech using the Direct Control method of programming, which operates the CT-1 directly from parameters stored in memory. However, this demands considerable attention to detail in programming, and it is easier to program the CT-1 using a system of phonetic rules to generate the synthesis control parameters from input phonetic text. The parameters generated by the CSR1 synthesis-by-rule software system do not produce the same natural quality possible with the Direct method, yet the speech is easily intelligible. From Compelec (see below) for £395.

An Introduction to Microcomputers, Adam Osborne & Associates.

Here, at last, is a sensibly written book on the subject of microprocessors that doesn't go into market predictions, doesn't tell us what success the Acme Corp. have had with their new microprocessor-based product and isn't lavishly illustrated with photographs of multimeters and VDUs which we are told have MPUs inside them. This book sticks strictly to the matter at hand — what goes on inside and around a microprocessor. The layout of the book is very definitely American — bold type is important, light type is additional information so that you know which bits to skip if you want to.

Programming is covered in considerable depth, with explanations of Assembly Language, the various commonly-used addressing modes and a hypothetical instruction set. The best thing about the book, though, is the way it doesn't play coy and ignore real microprocessors, but actually examines and classifies 7 real MPUs (Fairchild, National, Intel Motorola, Rockwell, Signetics).

Lots of information, sensibly presented. An Introduction to Microcomputers is available from Peleo (Electronics) Ltd., 61 Lansdowne Place, Hove, Sussex, BN3 1FL for £4.50 inc. postage.

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ETI SUPPLEMENT

555 TIMER APPLICATIONS

DESCRIBED BY R. M. MARSTON

THE 555 TIMER is a highly versatile low-cost IC that is specifically designed for precision timing applications, but which can also be used in a variety of monostable multi-vibrator, astable multivibrator, and Schmitt trigger applications. The device was originally introduced by Signetics, but is now available under the '555' designation from many other manufacturers.

The 555 has many attractive features. It can operate from supply voltage in the range 4.5V to 16V. Its output can source (supply) or sink (absorb) any load current up to a maximum of 200mA, and so can directly drive loads such as relays, LED's, low-power lamps, and high impedance speakers. When used in the 'timing' mode, the IC can readily produce accurate timing periods that can be varied from a few microseconds to several hundred seconds via a single R-C network. Timing periods are virtually independent of actual supply rail voltage, have a temperature coefficient of only .005% per °C, can be started via a TRIGGER command signal, and can be aborted by a RESET command signal.

When used in the monostable mode, the IC produces output pulses with typical rise and fall times of a mere 100nS. It can be made to produce pulse-width modulated (PWM) pulses in this mode by feeding fixed frequency clock pulses to the TRIGGER terminal and, by feeding the modulation signal to the CONTROL VOLTAGE terminal.

When used in the astable mode both the frequency and the duty cycle of the waveform can be accurately controlled with two external resistors and one capacitor. The output signals can be subjected to frequency sweep control, frequency modulation (FM), or pulse-position modulation (PPM) by applying suitable modulation signals to the CONTROL VOLTAGE terminal of the IC.

THE 555: HOW IT WORKS

The 555 is available under a variety of specific type numbers but is generally referred to simply as a '555 timer.' The device is available in a number of packaging styles, including 8 and 14-pin dual-in-line (DIL) and 8-pin TO-99 types. Throughout this article all circuits are designed around the standard 8-pin DIL versions of the device.

Fig 1 shows the outline and pin notations of the standard 8-pin DIL version of the 555, and Fig 2 shows the functional block diagram of the same device (within the *double* lines), together with the connections for using it as a basic monostable generator. The following explanation of device operation assumes that the 555 is used in the monostable configuration shown in Fig 2.

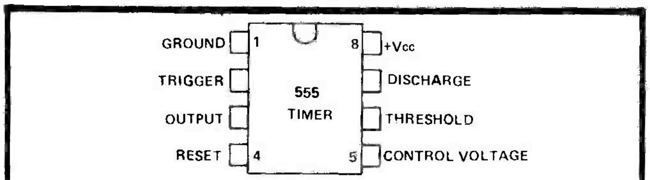


Fig. 1: Outline and pin notations of the standard 8-pin dil version of the 555 timer I.C.

The 555 houses 2 diodes, 15 resistors, and 23 transistors. These components are arranged in the form of one voltage-reference potential divider, two voltage-comparator op-amps, one R-S flip-flop, a low-power complementary output stage, and a slave transistor. The voltage-reference potential divider comprises three 5kΩ resistors in series, and is connected across the supply lines. Consequently, 2/3 V_{cc} appears at the junction of the upper two resistors of the potential divider, and is fed to one input terminal of the upper voltage-comparator op-amp and 1/3 V_{cc} appears at the junction of the two lower resistors of the potential divider, and is fed to one input terminal of the lower voltage-comparator op-amp. The outputs of the two comparators control the R-S flip-flop, which in turn controls the states of the complementary output stage and the slave transistor. The state of the flip-flop can also be influenced by signals applied to the pin 4 RESET terminal.

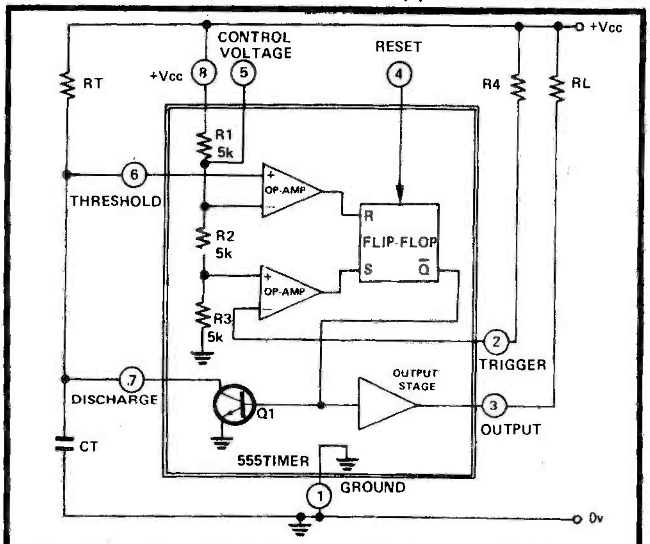


Fig. 2: Functional block diagram (within the square) of the 555 timer i.c., together with the connections for using the i.c. as a basic monostable generator or timer.

When the monostable or timing circuit of Fig 2 is in its quiescent state the pin 2 TRIGGER terminal of the chip is held high via R1. Under this condition Q1 is driven to saturation and forms a short circuit across external timing capacitor C_T, and the pin 3 output terminal of the IC is driven to the low state. The monostable action can be initiated by applying a negative-going trigger pulse to pin 2. As this pulse falls below the 1/3 V_{cc} reference value of the built-in potential divider the output of the lower voltage comparator op-amp changes state and causes the R-S flip-flop to switch over. As the flip-flop switches over it cuts off Q1 and drives the pin 3 output of the chip to the high state.

As Q1 cuts off it removes the short from timing capacitor C_T, so C_T starts to charge exponentially towards the supply rail voltage until eventually the voltage across C_T reaches 2/3 V_{cc}. At this point the upper voltage comparator op-amp changes state and switches the R-S flip-flop back to its original condition, so Q1 turns on, rapidly discharging C_T, and simultaneously the pin 3 output of the IC reverts to its low state. The monostable operating sequence is then complete. Note that, once triggered, the circuit cannot respond to additional triggering until the timing sequence is complete, but that the sequence can be aborted at any time by feeding a negative-going pulse to pin 4.

The delay time of the circuit, in which the pin 3 output is high, is given as

$$t = 1.1\ R_T\ C_T$$

where t = mS, R_T = kΩ, and C_T = μF. Fig 3 shows how delays from 10μS to 100 seconds can be obtained

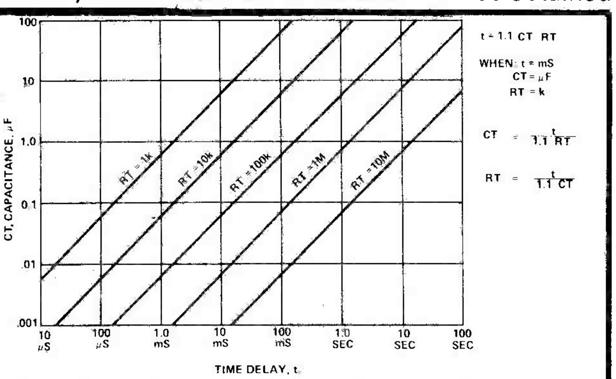


Fig. 3: 555 time delays for different values of resistance and capacitance.

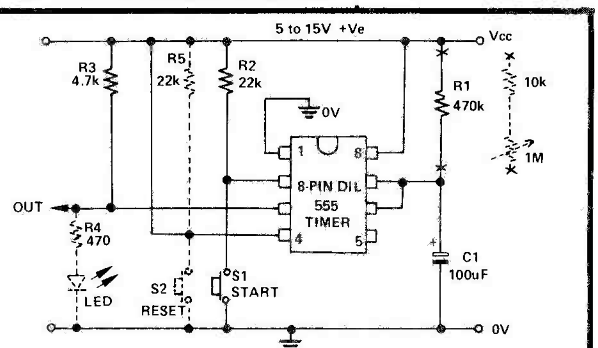
by selecting suitable values of C_T and R_T in the range .001μF to 100μF and 1kΩ to 10MΩ. In practice, R_T should not be given a value less than 1kΩ or greater than 20MΩ, and capacitor C_T must always be a low-leakage component. Note that the timing period of the circuit is virtually independent of the supply voltage but that the period can be varied by applying a variable resistance or voltage between the ground and pin 5 CONTROL VOLTAGE terminals of the chip. This facility enables the periods to be externally modulated or compensated.

The pin 3 output terminal of the IC is normally low, but switches high during the active monostable sequence. The output can either source or sink currents up to a maximum of 200mA, so external loads can be connected between pin 3 and either the positive supply rail or the ground rail, depending on the type of load operation that is required. The output switching rise and fall times are typically about 100 nanoseconds. Having cleared up these points, let's now go on and look at some practical applications of the 555 timer I.C.

50 SECOND TIMER

This 50 second timer or pulse generator gives a direct voltage output at pin 3 which is normally low, but goes high for the duration of the timing period. Optional components R_4 and LED (shown dotted) give a visual indication of the timer action. The circuit works in the same basic way as already described, except that the timing action is initiated by momentarily shorting pin 2 to ground via START switch S_1. Note from the circuit waveforms that a fixed-period output pulse is available at pin 3 and an exponential sawtooth with an identical period is available at pin 7: The sawtooth waveform has a high output impedance.

The basic timer circuit of Fig 4 can be varied in a number of ways. The timing period can be made variable between approximately 1.1 seconds and 110 seconds by replacing R_1 with a 10kΩ fixed resistor and a 1MΩ variable resistor in series.



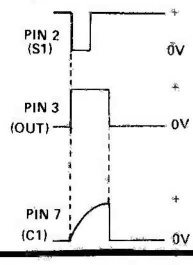


Fig. 4: Circuit and waveforms of simple manually-triggered 50 second timer or pulse generator.

The period can be further varied, if required, by switch-selecting decade values of timing capacitance. The dotted section shows how the circuit can be provided with a RESET facility, so that a timing period can be aborted at any time, by taking pin 4 to the positive supply rail via resistor R_5 and wiring RESET switch S_2 between pin 4 and ground.

The timing circuit of Fig 4 can be used to drive non-inductive loads at currents up to 200mA directly. They can be used to drive inductive relay loads by using the basic connections shown in Fig 5.

The Fig 5 circuit is designed to apply a connection to a normally-off external load for a pre-set period of 50 seconds when START switch S_1 is momentarily closed. The relay is normally off, but turns on for the 50 second period when the timing cycle is initiated. D_2 is wired in series with the relay coil to counteract the slight residual

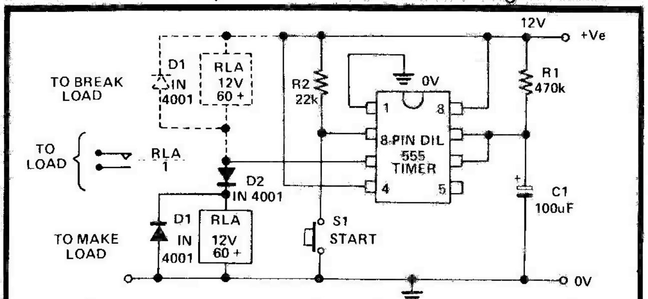


Fig. 5: Relay-output timer makes or breaks connection to load for pre-set period of 50 seconds when S, is momentarily operated.

voltage that appears at pin 3 of the IC under the OFF condition and thus ensure that the relay turns fully off. The dotted section shows how this circuit can be used to switch off a normally-on load.

Note in Fig 5 and all other relay-output circuits described here, that the relays used can be any 12 volt types that draw ON currents of less than 200mA, e.g., that have coil resistances greater than 60Ω.

The basic relay-driving timer circuit of Fig 5 can be adapted for use in a variety of useful applications. Some typical examples are shown in Figs 6 to 9.

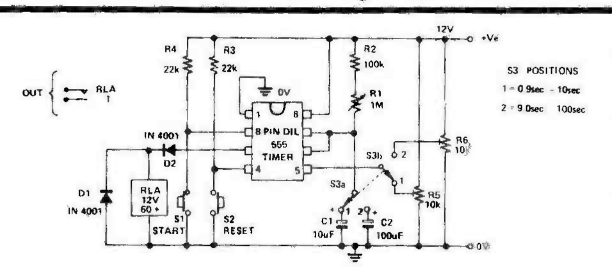


Fig. 6: Relay-output general-purpose timer covers 0.9 sec to 100 sec in two decade ranges.

Fig 6 shows the practical circuit of a relay-output general-purpose timer that covers 0.9 seconds to 100 seconds in two decade ranges: The circuit has a RESET facility provided via S_2, so that timing periods can be aborted part way through a cycle if necessary. A noteworthy feature of this circuit is that the maximum timing periods of each decade range of the timer can be precisely pre-set via R_5 or R_6, which effectively shunt the built-in potential divider of the 555 and thus influence the timing periods: This facility enables the circuit to give precise timing periods even when wide-tolerance timing capacitors are used.

To set up the Fig 6 circuit, first set R_1 to maximum value, set RANGE switch S_3 to position 1, activate START switch S_1, and adjust R_5 to give a timing period of precisely 10 seconds. Next, set S_3 to position 2, activate START switch S_1, and adjust R_6 to give a timing period of precisely 100 seconds. All adjustments are then complete, and the timer is ready for use.

DELAYED HEADLIGHT TURN-OFF

Fig 7 shows the practical circuit of an automatic delayed-turn-off headlight control system for automobiles. This facility enables the owner to use the car lights to illuminate his path for a pre-set time after parking as he leaves the garage or walks along a driveway, etc. The circuit does not interfere with normal headlight operation under actual driving conditions. It works as follows.

When the ignition switch is turned to the ON position current is fed to the coil of the relay via D_3 and the 12 volt supply rail, so the relay turns on and contacts RLA/1 close. As the contacts close they connect the 12 volt supply to the timer circuit and to the headlight switch. Thus, under this 'ignition on' condition the headlights operate in the normal way. Note that, since one side of C_2 is connected directly to the positive supply rail and the other side is taken to the positive rail via R_2, the capacitor is fully discharged under this condition.

The moment that the ignition switch is turned to the OFF position the D_3-derived current supply to the relay coil is broken, and simultaneously a negative-going trigger pulse is fed to pin 2 of the 555 as the C_2-R_3 junction drops to ground volts and C_2 charges up. Now, relays are inherently slow-acting devices, so contacts RLA/1 do not open instantaneously as the ignition switch is turned off. Conversely, the 555 is a very fast triggering device, and the instant that the trigger pulse is generated via the turn-off action of the ignition switch a timing cycle is initiated and current is fed to the relay coil via output pin 3 of the IC as it goes high. Thus the relay remains on for a pre-set period after the ignition switch is closed, and the positive supply rail remains connected to the headlight switch for the duration of this period. With the component values shown this period is roughly 50 seconds.

At the end of the 50 second timing period, pin 3 of the 555 switches to the low state and the relay turns off. As it does so, contacts RLA/1 open and remove the supply from the timer and the headlight switch, and the headlights turn off. The operating sequence is then complete.

Readers may care to note that the above system of operation is consistent with the practice adopted in many modern vehicles of feeding the headlight switch via the ignition switch, so that the headlights operate only when the ignition is turned on. On older types of vehicle, where headlight operation is independent of the ignition switch, a manually-triggered delayed-turn-off headlight or spotlight control facility can be obtained by using the circuit shown in Fig 8. The action of this circuit is such that, if the vehicle is parked with its lights off, they turn on for a pre-set 50 second period as soon as a push-button START switch is momentarily closed, and at the end of this period turn off again automatically.

The Fig 8 circuit uses a relay with two sets of normally-open relay contacts. The timing sequence is initiated by momentarily closing push-button switch S_1. Normally, both S_1 and the relay contacts are open, so zero power is fed to the timer circuit and the lights are off. C_2 is discharged under this condition.

When S_1 is momentarily closed power is fed directly to the relay coil, and the relay turns on. As the relay

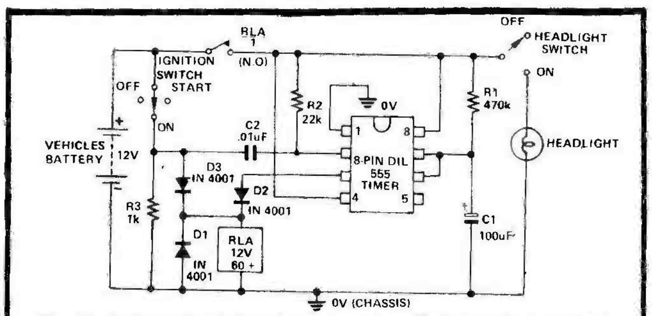


Fig. 7: Automatic delayed-turn-out headlight control system for automobiles.

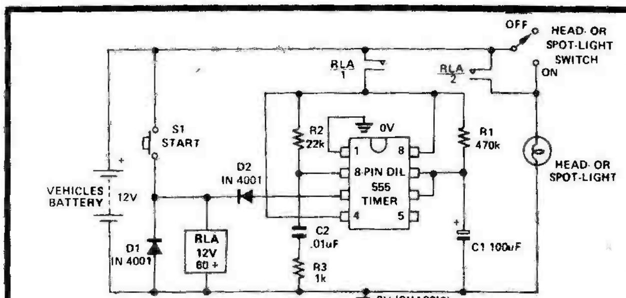


Fig. 8. Manually-triggered delayed-turn-off head- or spot-light control system for automobiles.

turns on contacts RLA/2 close and apply power to the vehicle lights and contacts RLA/1 close and apply power to the timer circuit, but pin 2 of the IC is briefly tied to ground via C_2 and R_3 at this moment, so a negative trigger pulse is immediately fed to pin 2 and a timing cycle is initiated. Consequently, pin 3 of the 555 switches high at the moment that the relay contacts close, and thus locks the relay into the ON condition irrespective of the subsequent state of START switch S_1, so the lights remain on for the duration of the 50 second timing cycle. At the end of the timing cycle pin 3 of the I.C. switches to the low state, so the relay turns off and contacts RLA/1 and RLA/2 open, disconnecting power from the timing circuit and the lights. The operating sequence is then complete.

PORCH LIGHT

Finally, to conclude this 'Timer Circuits' section of the 555 story, Fig 9 shows the circuit of a relay-output automatic porch light control unit that turns the porch lights on for a pre-set 50 second period only when suitably triggered at night time or under 'dark' conditions. The circuit is triggered via switch S_1, which may take the form of a microswitch activated by a porch gate or a pressure-pad switch activated by body weight and concealed under a porch mat or rug.

The operation of the Fig 9 circuit relies on the fact that for correct timer operation the negative-going trigger pulse that is fed to pin 2 of the IC must fall below the internally-controlled '1/3 V_{cc}' voltage value of the 555. If the trigger pulse does not fall below this value, timing cycles can not be initiated by the trigger signal.

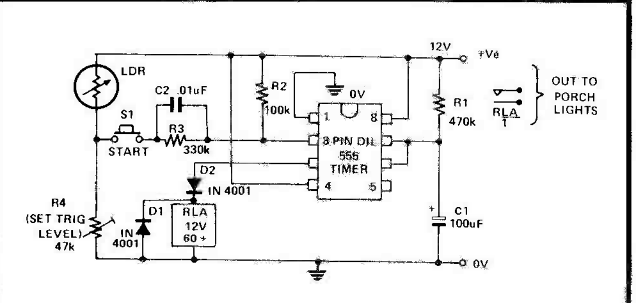


Fig. 9: Automatic porch light turns on for a pre-set period only when triggered at night.

In this design, light-dependent resistor LDR and pre-set resistor R_4 are wired in series as a light-dependent potential divider. One side of switch S_1 is taken to the output of this potential divider, and the other side of the switch is taken to pin 2 of the IC via the C_2-R_3 combination. Under bright or daylight conditions the LDR acts as a low resistance, so a high voltage appears at the output of the potential divider. Consequently, the act of closing S_1 causes a voltage pulse much higher than '1/3 V_{cc}' to be fed to pin 2 of the chip, so the timer is not triggered via S_1 under the 'daylight' condition.

Conversely, the LDR acts as a high resistance under dark or 'night' conditions, so a low voltage appears at the output of the potential divider. Consequently, the act of closing S_1 causes a voltage pulse much lower than '1/3 V_{cc}' to be fed to pin 2 of the IC, so the time circuit is triggered via S_1 under the 'night' condition.

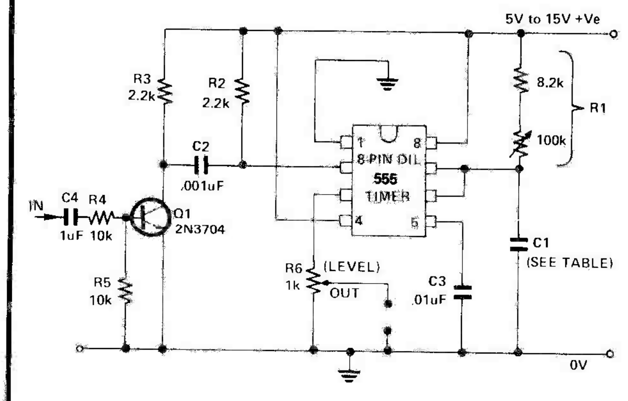
In practice, the LDR can be any cadmium-sulphide photocell that presents a resistance in the range 1kΩ to 100kΩ under the required minimum 'dark' turn-on condition, and R_4 can be adjusted to preset the minimum 'dark' level at which the circuit will trigger. Note that the trigger signal is fed to pin 2 of the IC via the C_2-R_3 combination, which act as a trigger signal conditioning network that effectively isolates the d.c. component of the LDR-R_4 potential divider from the trigger pin of the IC.

MONOSTABLE PULSE GENERATOR CIRCUITS

All the 555 timer circuits that we have looked at so far act essentially as monostable multivibrators or pulse generators. The 555 can be used as a conventional electronically-triggered monostable multivibrator or pulse generator by feeding suitable trigger signals to pin 2 and taking the pulse output signals from pin 3. The IC can be used to generate good output pulses with periods from 5μS to several hundred seconds. The maximum usable pulse repitition frequency is approximately 100kHz.

The trigger signal reaching pin 2 must be a carefully shaped negative-going pulse. Its amplitude must switch from an OFF value greater than 2/3 V_{cc} to an ON value less than 1/3 V_{cc} (triggering actually occurs as pin 2 drops through the 1/3 V_{cc} value). The pulse must have a width greater than 100nS but less than that of the desired output pulse, so that the trigger pulse is removed by the time the monostable period terminates.

One way of determining a suitable trigger signal for the 555 monostable circuit is to convert the input signal to a good square wave that switches between ground volts and the full positive supply rail voltage, and then couple this square wave to pin 2 of the IC via a simple short time-constant C-R differentiating network, which converts the leading or trailing edges of the square



C1 VALUE	PULSE WIDTH RANGE	
10uF	90mS	1.2sec
1uF	9mS	120mS
0.1uF	0.9mS	12mS
.01uF	90uS	1.2mS
.001uF	9uS	120uS

Fig. 10a: Simple add-on pulse generator is triggered by rectangular input signals: circuit can be used at trigger frequencies up to 100kHz.

wave into suitable trigger pulses. Fig. 10a shows a practical circuit that uses this basic principle, but is intended for use only with input signals that are already of square or pulse form.

Here, transistor Q_1 converts the rectangular input signal into a signal that switches between the ground and positive voltage rails, and the resulting signal is fed to pin 2 via the C_2-R_2 differentiating network. The circuit can be used as an add-on pulse generator in conjunction with an existing square or pulse generator. Variable-amplitude output pulses are available from pin

3 via variable potential divider R6. The output pulse widths can be varied over more than a decade range via R_1, and can be switched in overlapping decade ranges by using the values of C1 listed in the table. With the component values shown the pulse width is fully variable from 9 μS to 1.2 seconds. Note that C3 is used to decouple the pin 5 CONTROL VOLTAGE terminal and improve the circuit stability.

Fig 10b shows how the above circuit can be modified so that it can be driven from any type of input waveform, including sine waves. Here, IC1 is connected as a simple Schmitt trigger, which converts all input signals into rectangular output signals, and these rectangular signals are used to drive the IC2 monostable circuit in the same way as described above. The Fig 10b circuit can thus be used as an add-on pulse generator in conjunction with an existing waveform generator of any type that produces output signals with peak-to-peak amplitudes greater than 1/2 V_{cc}.

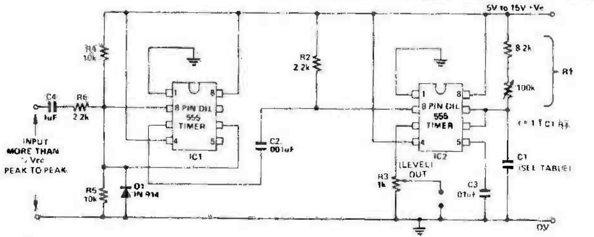


Fig. 10b: Improved add-on pulse generator is triggered by any input waveform.

Fig 11 shows how two basic monostable pulse generators can be connected in series to make a delayed pulse generator, in which IC1 is used as a Schmitt trigger and IC2 controls the delay width and IC3 determines the output pulse width. The final output pulse appears some delayed time after the initial application of the trigger signal. This circuit can be made into a self-contained instrument by building it into the same cabinet as a simple square wave generator, which can be used to provide the necessary drive signals.

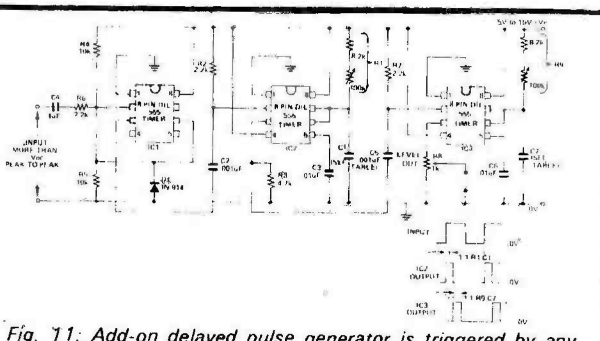


Fig. 11: Add-on delayed pulse generator is triggered by any input waveform. For C1 (and C7) values, see table in Fig. 10a.

Any number of basic monostable pulse generators can be wired in series to give a sequential form of operation. Fig 12 for example, shows the circuit and wave-forms of a 3-stage sequential generator, which can be used to operate lamps or relays, etc., in a pre-programmed time sequence once an initial START command is given via push-button switch S_1. Note that the pin 4 RESET terminal of all ICs are shorted together and positively biased via R7, and that these terminals can be shorted to ground via SET switch S2. This SET switch should be closed at the moment that power is

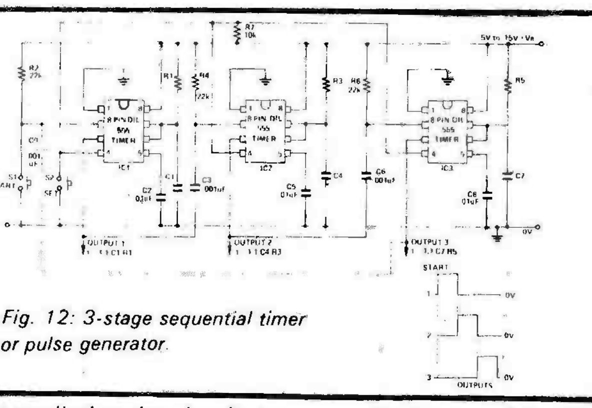


Fig. 12: 3-stage sequential timer or pulse generator.

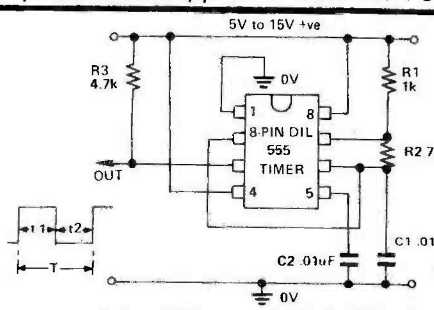
first applied to the circuit, to ensure that none of the ICs are falsely triggered at this moment.

Finally, three or more monostable circuits can be connected, via C9, in a continuous loop, with the output of the last monostable feeding back to the input of the first monostable, to form a 'chaser' circuit in which the sequential action repeats to infinity. This type of circuit can be used to drive lamp or LED displays, etc. Note that the circuit is again provided with the S_2 SET facility, so that the circuit can be emptied at the moment that power is first applied.

ASTABLE MULTIVIBRATOR CIRCUITS

Fig 13 shows the practical circuit of a basic 1 kHz astable multivibrator, together with the formulas that define the timing of the circuit. Note that TRIGGER pin 2 of the chip is shorted to the pin 6 THRESHOLD terminal, and that timing resistor R2 is wired between pin 6 and DISCHARGE pin 7.

When power is first applied to the circuit C1 starts to



t1 = 0.693(R1 + R2)C1
t2 = 0.693(R2)C1
T = 0.693(R1 + 2R2)C1
f = $\frac{1.44}{(R1 + 2R2)C1}$

IF R2 IS GREATER THAN R1:
t1 = 0.7 R2 C1
t2 = 0.7 R2 C1
T = 1.4 R2 C1
f = $\frac{0.72}{R2\ C1}$

Fig. 13: Basic circuit of 1KHz astable multivibrator, with timing formulas.

charge exponentially (in the normal monostable fashion) via the series R1-R2 combination, until eventually the C1 voltage rises to 2/3 V_{cc}. At this point the basic monostable action terminates and DISCHARGE pin 7 switches to the low state. C1 then starts to discharge exponentially into pin 7 via R_2, until eventually the C1 voltage falls to 1/3 V_{cc}, and TRIGGER pin 2 is activated. At this point a new monostable timing sequence is initiated, and C1 starts to recharge towards 2/3 V_{cc} via R1 and R2. The whole sequence then repeats add infinitum, with C1 alternately charging towards 2/3 V_{cc} via R1-R2 and discharging towards 1/3 V_{cc} via R2 only.

Note in the above circuit that, if R2 is very large relative to R1, the operating frequency of the circuit is determined essentially by the R2 and C1 values, and that a virtually symmetrical output waveform is generated. The graph of Fig 14 shows the approximate relationship between frequency and the C1-R2 values under the above condition. In practice, the R1 and R2 values of the circuit can be varied from 1kΩ up to tens of megohms. Note, however, that R1 has a significant

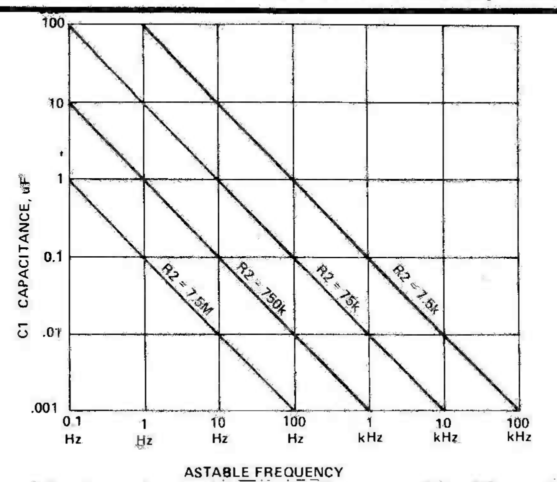


Fig. 14: Approximate relationship between C1, R2, and frequency when R2 is large relative to R1.

effect on the total current consumption of the circuit, since pin 7 of the IC is virtually grounded during half of the timing sequence. Also note that the duty cycle or mark/space ratio of the circuit can be pre-set at a non-symmetrical value, if required, by suitable choice of the R1 and R2 values.

The basic circuit of Fig 13 can be usefully modified in a number of ways. Fig 15, for example, shows how it can be made into a variable-frequency square wave

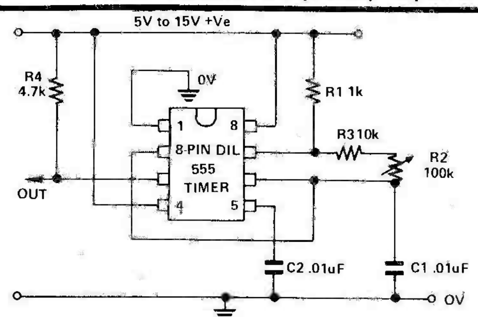


Fig. 15: Variable frequency square wave generator covers the range 650Hz-7.2kHz approximately.

generator by replacing R2 with a fixed and variable resistor in series. With the component values shown the frequency can be varied over the approximate range 650Hz-7.2kHz via R2.

Fig 16 shows how the circuit can be further modified

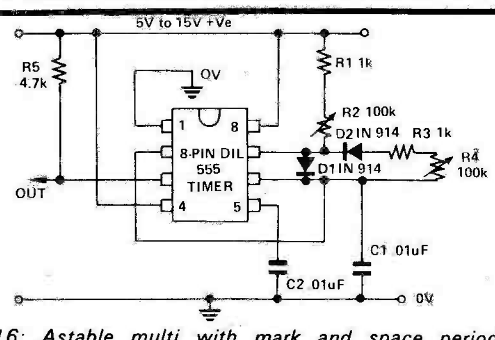


Fig. 16: Astable multi with mark and space periods independently variable over the approximate range 7.5µs to 750µs.

so that its MARK and SPACE periods are independently variable over the approximate range 7.5µS to 750µS. Here, timing capacitor C1 alternately charges via R1-R2-D1 and discharges via R3-R4-D2.

Fig 17 shows how the circuit can be additionally modified so that it acts as fixed-frequency square wave generator with a mark/space ratio or duty cycle that is fully variable from 1% to 99%. Here, C1 alternately

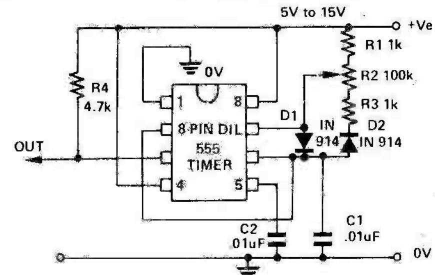


Fig. 17: Astable multi with duty cycle variable from 1 to 99% with frequency approximately constant at 1.2kHz.

charges via R1 and the top half of R2 and via D1, and discharges via D2-R3 and the lower half of R2. Note that the sum of the two timing periods is virtually constant, so the operating frequency is almost independent of the setting of R2.

GATING A 555 ASTABLE

The 555 astable circuit can be gated ON or OFF, via either a switch or an electronic signal, in a variety of ways. Figs 18 and 19 show two basic ways of gating the IC via a switch.

In Fig 18 the circuit is gated via the pin 4 RESET

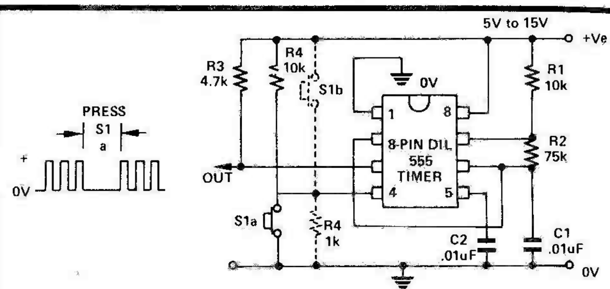


Fig. 18: Gated 1kHMZ astable with 'press to turn-off' or 'press to turn-on' operation.

terminal. The characteristic of this terminal is such that, if the terminal is biased significantly above a nominal value of 0.7 volts, the astable is enabled, but if the terminal is biased below 0.7 volts by a current greater than 0.1mA (by taking the terminal to ground via a resistance less than 7kΩ, for example) the astable is disabled and its output is grounded. Thus, the Fig 18 circuit is normally on but can be turned off by closing S1 and shorting pin 4 to ground, while the circuit shown in dotted lines is normally gated off via R_4 but can be turned on by closing S_2 and shorting pin 4 to the positive supply rail. These circuits can alternatively be gated by applying suitable electronic signals directly to pin 4.

The Fig 19a and 19b circuits are gated via the pin 2 TRIGGER and pin 6 THRESHOLD terminals. The characteristic here is such that the circuit functions as a normal astable only as long as pin 6 is free to swing up to 2/3 V_{cc} and pin 2 is not biased below 1/3 V_{cc}. If these pins are simultaneously driven below 1/3 V_{cc} the

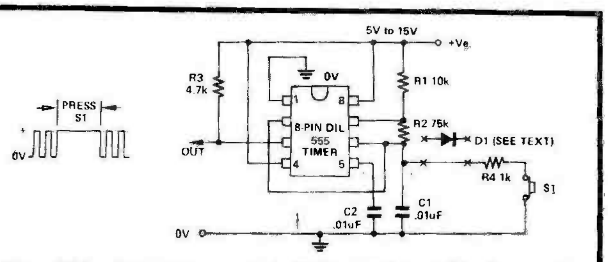


Fig. 19A: Alternative gated 1kHz astable with 'press to turn-off' operation.

astable action is immediately terminated and the output is driven to the high state. Thus, the Fig 19a circuit is normally on but turns off when S1 is closed. Note that an electronic signal can be used to gate the circuit by connecting a diode as indicated and eliminating S_1. In this case the circuit will gate off when the input signal voltage is reduced below 1/3 V_{cc}.

The Fig 19b circuit is connected so that it is normally gated off by saturated transistor Q1, but can be gated on by closing S1 and thus turning the transistor off. This circuit can be gated electronically by eliminating R5 and S1 and applying a gating signal to the base of Q1 via a 10kΩ limiting resistor. In this case the astable turns off when the input signal is high, and turns on when the input signal is reduced below 0.7 volts or so.

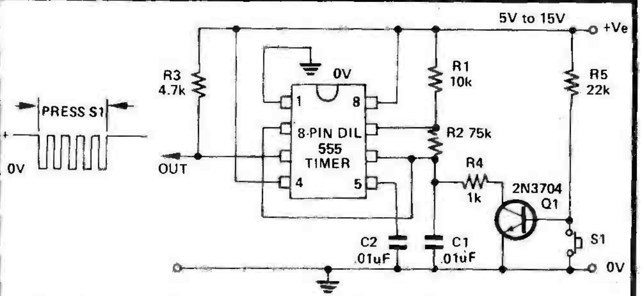


Fig. 19B: Alternative gated 1kHz astable with 'press to turn-off' operation.

All the 555 astable circuits that we have looked at can be subjected to frequency modulation (FM) or pulse-position modulation (PPM) by simply feeding a suitable modulation signal to pin 5. This modulation signal can take the form of an A.C. signal that is fed to pin 5 via a blocking capacitor, as in the case of Fig 20a or a D.C. signal that is fed directly to pin 5, as in the case of Fig 20b. The action of the chip is such that the voltage on pin 5 influences the width of the 'mark' pulses in each timing cycle, but has no influence on the 'space' pulses. Thus, since the signal on pin 5 influences the position of each 'mark' pulse in each timing cycle, this terminal provides pulse-position

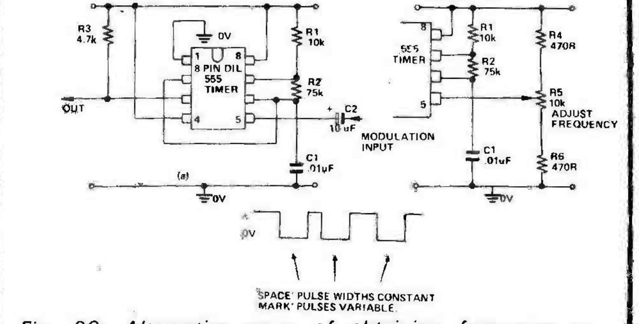


Fig. 20: Alternative ways of obtaining frequency or pulse-position modulation (FM or PPM) from the 555 astable circuit.

modulation (PPM), and, since the signal influences the total period of each cycle (and thus the frequency of the output signal), the terminal also provides frequency modulation (FM). These facilities are useful in special waveform generator applications, as is shown in the next section.

MISCELLANEOUS ASTABLE APPLICATIONS

The 555 astable multivibrator has three outstanding advantages over other types of astable circuit. First, its frequency can be varied over a wide range via a single resistive control. Second, its output has a low impedance and can source or sink current up to 200mA. Finally, its operating frequency can readily be modulated by applying a suitable signal to pin 5 of the IC. These features make the device exceptionally versatile, and it can be used in a vast range of practical applications of interest to both the amateur and professional user.

MORSE PRACTICE OSCILLATOR

Fig 21 shows how the 555 timer I.C. can be used as a morse-code practice oscillator. The circuit acts as a

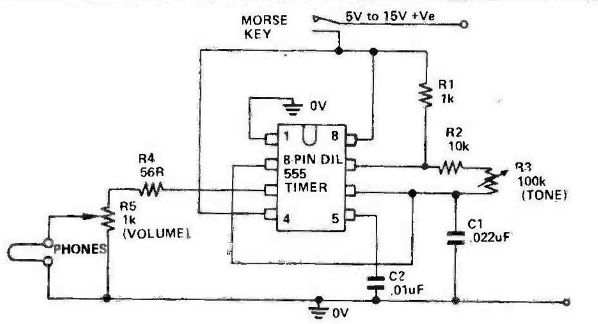


Fig. 21: Code-practice oscillator with variable tone (300Hz..3kHz) and variable volume.

normal astable, with frequency variable over the approximate range 300Hz — 3kHz via TONE control R3. The 'phone volume is variable via R5, and the 'phones can have any impedance from a few ohms up to megohms. The circuit draws zero quiescent current, since the normally-open morse key is used to connect the circuit to the positive supply rail, which can have any value in the range 5 volts to 15 volts.

Fig 22 shows how the 555 astable circuit can be used in LED flasher applications. This circuit operates at approximately 1 Hz, and has a single LED. The Fig 22 circuit has a single LED output; the dotted section shows how a second may be added, such that one LED is on while the other is off, and vice versa. Any types of LED's can be used in this circuit. Series resistors R_1 or

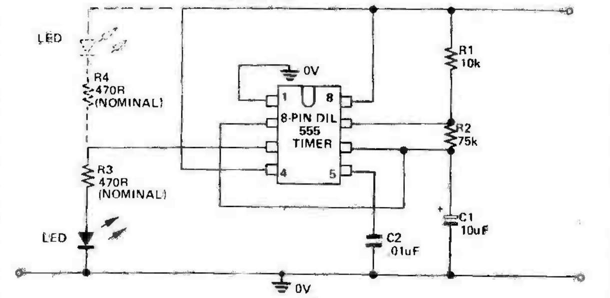


Fig. 22: Single and dual output led flashers give symetrical 1Hz outputs.

R_4 determines the ON current of each LED.

Fig 23 shows how the Fig 22 circuit can be modified to give automatic dark-activated operation. Here, R4 and R5 are wired as a fixed potential divider that sets $1/2\ V_{cc}$ on the emitter of Q1, LDR and R7 are wired as a light-sensitive potential divider that applies a variable voltage to the base of Q1, and the collector of Q1 is taken to RESET pin 4 of the IC, which is normally biased to ground via R6.

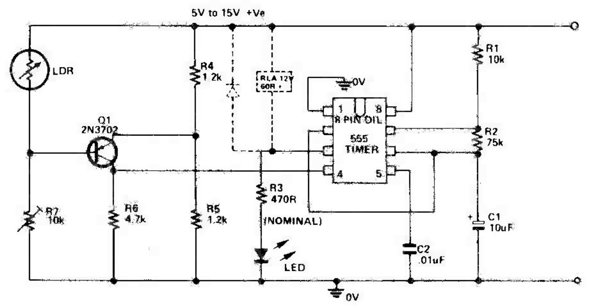


Fig. 23: Automatic (dark-activated) flasher.

In use R7 is adjusted so that the voltage to the base of Q1 is greater than $1/2\ V_{cc}$ under 'daylight' conditions, so Q1 is cut off, but under 'dark' conditions Q1 base is biased below $1/2\ V_{cc}$, so it is driven on. thus, under daylight conditions Q1 is cut off, so the 555 astable is disabled, with its output driven low, by 4.7kΩ resistor R6 which is wired between pin 4 and ground. Under 'dark' conditions, on the other hand, Q1 is biased on, so pin 4 is positively biased, and the astable operates normally and activates the LED.

The LDR used in the above circuit can be any cadmium-sulphide photocell that presents a resistance in the approximate range 470Ω to 10kΩ under the minimum 'dark' turn-on condition.

The dotted section shows how the 555 astable circuit can be used as a 12 volt relay pulser, which turns the relay on and off at a rate of one cycle per second. The relay can be any type with a coil resistance greater than 60Ω.

ALARM GENERATOR

Fig 24 shows the connections for making an 800Hz monotone alarm-call generator. The circuit can be used with any supply in the range 5 to 15 volts, and with any speaker impedance. Note, however, that R_x must be wired in series with speakers having impedance less than 75Ω, and must be chosen to give a total series impedance of at least 75Ω, to keep the peak speaker currents within the 200mA driving constraints of the 555. The available alarm output power of the circuit depends on the speaker impedance and supply voltage

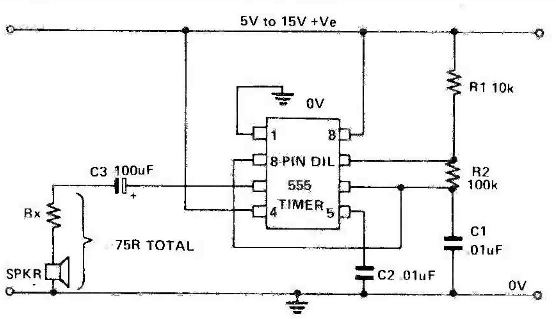


Fig. 24: 800Hz Monotone alarm call generator.

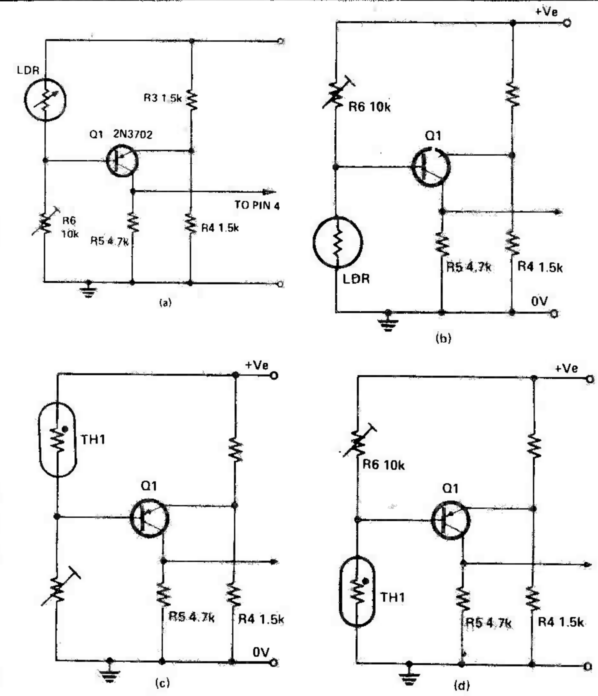


Fig. 24 a, b, c, d: Monotone alarm activated by dark (2), light (b), under-temperature (c), or over-temperature (d).

used, but may be as great as 750mW when a 75Ω speaker is used with a 15 volt supply.

The above circuit can be modified so that it is activated by darkness (a), by brightness (b), by an under-temperature (c), or by an over-temperature (d). Pin 4 is disconnected from the + Ve supply, and connected to the triggering circuit, which is designed around Q1. This works in the same way as already described for the automatic (dark-activated) LED flasher. The LDR used in the light-activated versions of this circuit can be any cadmium-sulphide photocells that present resistances in the approximate range 470Ω to 10kΩ at the desired turn-on levels. The thermistors used in the temperature-activated versions of the circuit can be any negative-termperature-coefficient types that present resistances in the same range at the required turn-on temperatures.

ALARMS AND SIRENS

The next 4 diagrams show a variety of useful alarm-call generator circuits. The Fig 25 circuit generates an 800Hz pulsed tone alarm call. Here, IC1 is wired as an 800Hz alarm generator, and IC2 is wired as a 1Hz astable which gates IC1 on and off via D1 once every second, thus causing a pulsed-tone output signal to be generated.

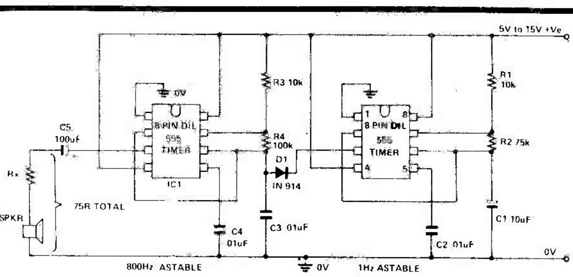


Fig. 25: Pulsed-tone (800Hz) alarm call generator.

The Fig 26 circuit generates a warble-tone alarm signal that simulates the sound of a British police siren. Here, IC1 is again wired as an alarm generator and IC2 is wired as a 1Hz astable multivibrator, but in this case the output of IC2 is used to frequency modulate IC1 via R5. The action is such that the output frequency of IC1 alternates symmetrically between 500Hz and 440Hz, taking one second to complete each alternating cycle.

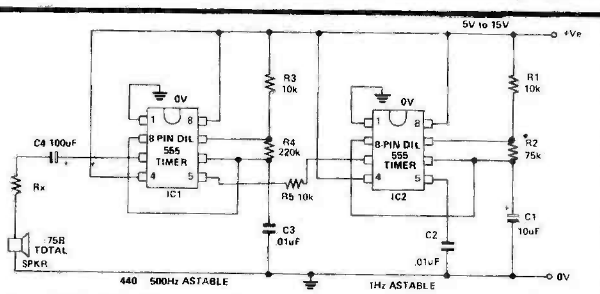


Fig. 26: Warble-tone alarm-call generator simulates British police siren.

The circuit of Fig 27 generates a 'wailing' alarm that simulates the sound of an American police siren. Here, IC2 is wired as a low frequency astable that has a cycling period of about 6 seconds. The slowly varying 'ramp waveform on C_1 of this chip is fed to pnp emitter follower Q1., and is then used to frequency modulate alarm generator IC1 via R6. IC1 has a natural centre frequency of about 800Hz. The circuit action is such that the alarm output signal starts at a low frequency, rises for 3 seconds to a high frequency, then falls over 3 seconds to a low frequency again, and so on add infinitum.

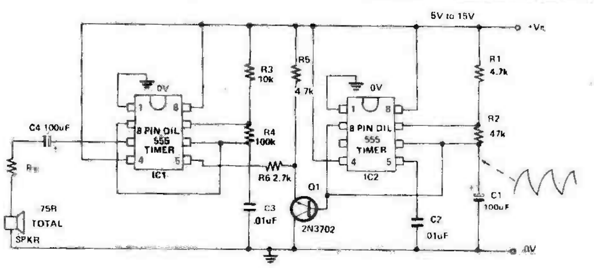


Fig 27: 'Wailing' alarm simulates American police siren.

Finally, to complete this quartet of alarm generator circuits, the Fig 28 circuit generates a siren alarm signal that is a simulation of the 'Red Alert' alarm used in the STAR TREK T.V. programme: This signal starts at a low frequency, rises for about 1.15 seconds to a high frequency, ceases for about 0.35 seconds, then starts

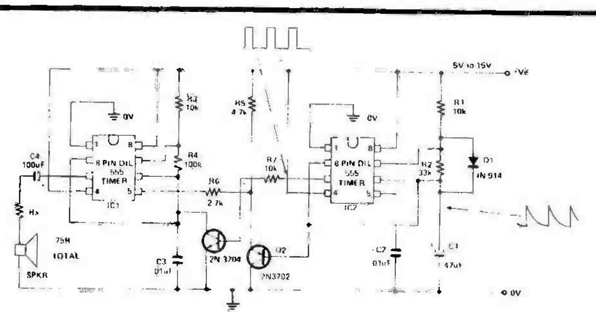


Fig. 28: 'Red alert' siren alarm simulates Star Trek alarm signal.

rising again from a low frequency, and so on add infinitum. The circuit action is as follows:

IC_2 is wired as a non-symmetrical astable multivibrator, in which C1 alternately charges via R1 and D1, and discharges via R2, thus giving a rapidly rising and slowly falling 'sawtooth' waveform across C1. This waveform is fed to pnp emitter follower Q1, and is thence used to frequency modulate pin 5 of IC1 via R6. Now, the frequency modulation action of pin 5 of the IC1 astable circuit is such that a rising voltage on pin 5 causes the astable frequency to fall, and vice versa; consequently the sawtooth modulation signal on pin 5 causes the astable frequency to rise slowly during the falling part of the sawtooth and collapse rapidly during the rising part of the sawtooth. The rectangular pin 3 output of IC_2 is used to gate IC1 off via npn common emitter amplifier Q2 during the collapsing part of the signal, so only the rising parts of the alarm signal are in fact heard, as in the case of the genuine STAR TREK 'Red Alert'.

MISCELLANEOUS APPLICATIONS

To complete the 555 story, this final section shows a miscellany of 555 applications, of varying degrees of usefulness. Fig 29 shows how a single 555 can be used as the basis of an event-failure alarm or a missing-pulse detector, which closes a relay or illuminates an LED if a normally recurrent event fails to take place.

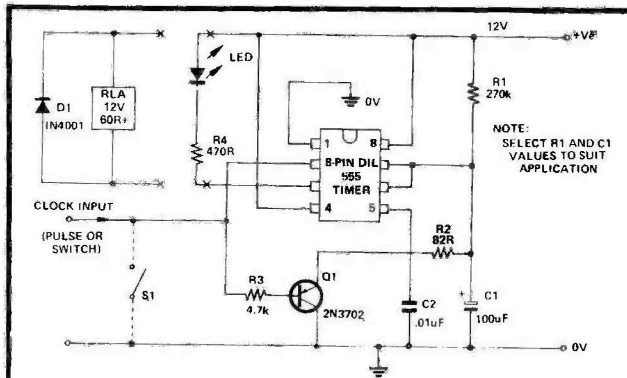


Fig. 29: Event-failure alarm or missing-pulse detector has relay or LED output.

The operating theory of the circuit is fairly simple. The 555 is wired as a normal monostable pulse generator, except that transistor Q1 is wired across timing capacitor C1 and has its base taken to TRIGGER pin 2 of the IC via R3: The TRIGGER pin is fed with a train of pulse- or switch-derived clock input signals from the monitored event, and the values of R1 and C1 are selected so that the monostable period of the IC is slightly longer than the repetition period of the clock input signal.

Thus, each time a clock pulse arrives, a monostable timing period is initiated via pin 2 of the IC, and C1 is discharged and the pin 3 output is driven high via transistor Q1. Before each monostable period can terminate, a new clock pulse arrives, and a new monostable period is initiated, so the pin 3 output terminal remains high so long as clock input pulses continue to arrive within the prescribed period limits. Should a clock pulse be missed, or the clock period exceed the pre-determined limits, however, the monostable period will be able to terminate normally, and pin 3 of the IC will go low and drive the relay or LED on. The circuit thus functions effectively as an event-failure alarm or missing-pulse detector. With the component values shown, the monostable has a natural period of about 30 seconds. This period can be varied via R1 and C4 to satisfy specific requirements.

Fig 30 shows how a couple of 555s can be used to make a pulse-width modulation (PWM) circuit. This circuit can be used for transmitting coded messages, or for applying variable power to a load at maximum efficiency.

Here, IC1 is wired as a 1kHz astable multivibrator, which is used to feed a continuous train of clock pulses

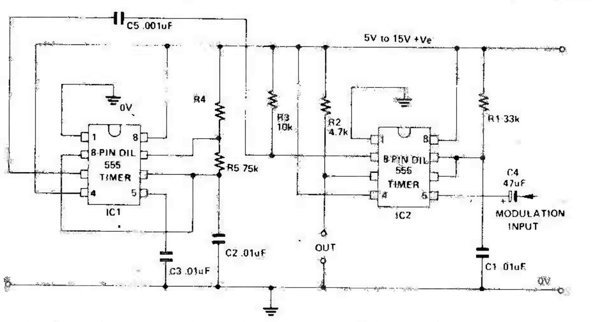


Fig. 30: Pulse-width modulation (PWM) circuit.

to the pin 2 TRIGGER terminal of IC2, which is wired as a normal monostable multivibrator or pulse generator and has a natural monostable period of approximately 0.36mS. The external modulation signal is fed to the pin 5 CONTROL VOLTAGE terminal of the monostable via C4, and determines the instantaneous widths of the generated pulses. Thus, the circuit generates a train of pulse-width modulated (PWM) pulses at a fixed repitition frequency of 1kHz.

SCOPE TIMEBASE

Fig 31 shows how a basic 555 monostable multivibrator can be modified so that it generates a

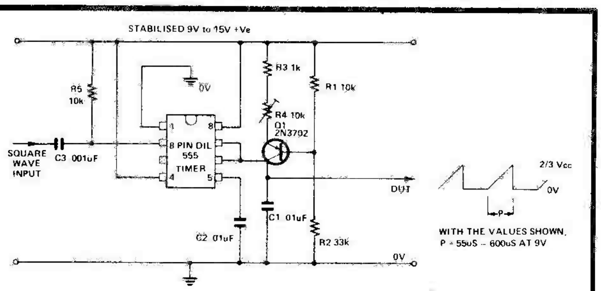


Fig. 31: Triggered linear-ramp generator can be used as the basis of an oscilloscope timebase.

linear ramp waveform of fixed duration each time it is triggered: This circuit can form the basis of an excellent oscilloscope time-base generator. The circuit works just like a normal monostable circuit, except that timing capacitor C1 is charged via constant-current generator Q1 during each timing cycle, thus causing a linear ramp voltage to be generated across C1.

When a capacitor is charged via a constant-current generator, the voltage across the capacitor rises linearly at a predictable rate that is determined by the magnitudes of the charging current and the capacitance. The relationship can be expressed as:

Volts-per-second = I/C, when I is expressed in Amps and C is expressed in Farads.

In this circuit the charging current can be varied over the approximate range $90\mu A$ to 1mA via R_4, thus giving rates of rise on the .01 μF capacitor of 9V-per-mS to 100V-per-mS. Now, remembering that each monostable period of the 555 circuit terminates at the point when C1 voltage reaches $2/3\ V_{cc}$, and assuming that a 9V supply is used (giving a $2/3\ V_{cc}$ value of 6V), it can be seen that the monostable cycles of the Fig 32 circuit have periods variable from $666\mu S$ to $60\mu S$. Periods can be increased beyond these values by increasing the C1 value, or vice versa. Note when using this circuit that its supply rail must be stabilised if stable timing periods are to be obtained.

If the circuit of Fig 31 is to be used as the basis of an oscilloscope timebase, note that the input driving signal must first be converted to a good square wave, from which suitable trigger pulses can be derived via C3 and R5. The minimum useful ramp period that can be obtained from the circuit is about $5\mu S$, which, when expanded to give full deflection on a ten-division 'scope screen, gives a maximum timebase speed of $0.5\mu S$-per-division. Flyback beam-suppression signals can be derived from the pin 3 OUTPUT terminal of the IC.

The 'timebase' circuit gives superb signal synchronisation at trigger frequencies up to about 150kHz. If the timebase is to be used with input signal frequencies greater than this, the input signals should be divided down via a single- or multi-decade digital divider. Using this technique, the timebase can be used to view input signals up to many MHz.

Fig 32 shows how a 555 can be connected for use as a simple but effective Schmitt trigger or Sine/Square converter. The circuit acts as a good converter at input frequencies up to 150kHz or more. It works by changing its output state each time the pin 2 input signal swings from above the $2/3\ V_{cc}$ level to

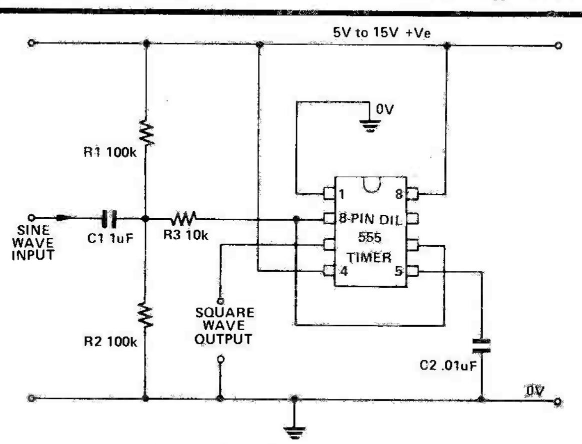


Fig. 32: 555 Schmitt trigger circuit acts as excellent sine/square converter up to about 150kHz.

below the $1/3\ V_{cc}$ level, or vice versa. Resistor R3 is wired in series with pin 2 of the chip to ensure that the input signal is not adversely influenced by the transition action of the IC.

Fig 33 shows how the basic Schmitt circuit can be adapted to a dark-activated relay driving application by wiring light-dependent potential divider R1-LDR to the pin 2 input terminal of the IC. This circuit has an inherently high degree of input backlash, and is likely to be of value in only very specialised applications.

A far more useful relay-driving switching circuit is shown in Fig 35. This circuit has negligible input backlash, and can be used as either a light- or

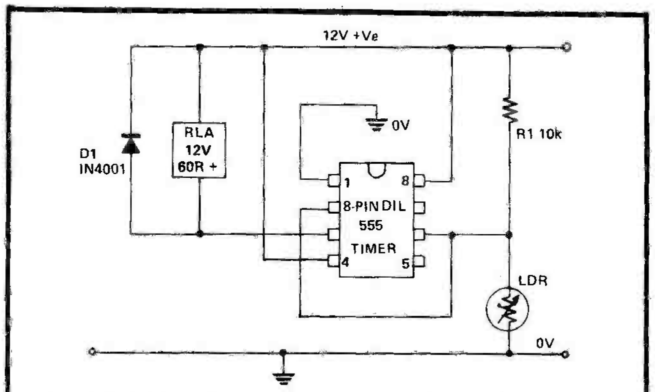


Fig. 33: Dark-activated relay switch has built-in backlash.

temperature-activated switch. In light-activated applications R1 is wired in series with a cadmium-sulphide photocell that presents a resistance in the approximate range 470Ω to 10kΩ at the required turn-on level. Dark-activated operation can be obtained by using the connections shown in Fig 34a or light-activated operation can be obtained by using the connections shown in Fig 34b.

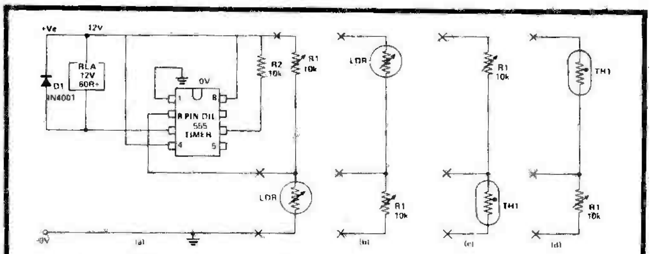


Fig. 34: Minimum-backlash relay switch can be activated by dark (a), light (b), under-temperature (c), or over-temperature (d).

For temperature-activated operation, R1 must be wired in series with a negative-temperature-coefficient thermistor. This thermistor must present a resistance in the range 470Ω to 10kΩ at the required turn-on level. Under-temperature operation can be obtained by using the connections shown in Fig 34c, or over-temperature operation can be obtained by using the connections shown in Fig 34d.

1kHz ANALOGUE FREQUENCY METER

This circuit needs a square-wave input driving signal with a peak-to-peak amplitude of 2 volts or greater. In this circuit the 555 is wired as a standard monostable multivibrator or pulse generator, and is powered from a regulated 6V supply. Transistor Q1 is used to amplify the square wave input signals to a level suitable for triggering the monostable stage, and the output of the monostable is fed to 1mA fsd meter M1 via multiplier resistor R5 and offset-cancelling diode D1. This meter gives a reading that is directly proportional to the frequency of the square wave input signals, and its operating theory is as follows:

Each time the monostable multivibrator is triggered it generates a pulse of fixed duration and fixed amplitude. If we assume that each generated pulse has a peak amplitude of 10V and a period of 1mS, and that the pulse generator is triggered at an input frequency of 500Hz, it can be seen that the pulse is high (at 10V) for 500mS in each 1000mS (one second) total period, and that the MEAN value of output voltage measured over this total period is 250mS/1000mS x 10V = 5V, or 50% of 10V. Similarly, if the input frequency is 250Hz the pulse is high for 250mS in each 1000mS total period, so the mean output voltage equals 250mS/1000mS x 10V= 2.5V, or 25% of 10V. Thus, the mean value of output voltage of the pulse generator, measured over a reasonable total number of pulses, is directly proportional to the repitition frequency of the generator.

Normal moving coil meters are 'mean' reading instruments, and in the Fig 35 circuit a 1mA f.s.d. moving coil meter is wired in series with voltage multiplier resistor R5, which sets the meter sensitivity at about 3.4V fsd, and is connected so that it reads the

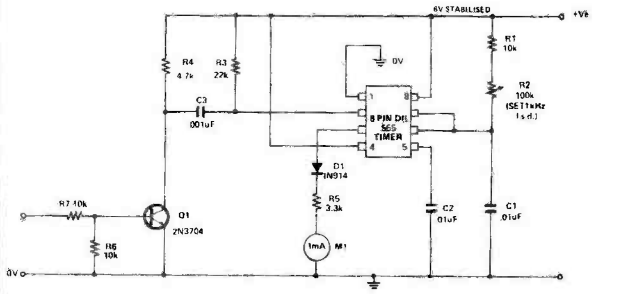


Fig. 35: Simple 1kHz linear-scale analogue frequency meter.

mean output voltage of the pulse generator. This meter thus gives a reading that is directly proportional to frequency, and the circuit thus acts as a linear-scale analogue frequency meter. With the component values shown the circuit is intended to read fsd at 1kHz. To set up the circuit initially, simply feed a 1kHz square wave signal to its input, and then adjust R2 (which controls the pulse lengths) to give full-scale reading on the meter; all adjustments are then complete.

The full-scale frequency of the above circuit can be varied from about 100Hz to about 100kHz by suitable choice of C1 value. The circuit can be used to read frequencies up to tens of MHz by feeding the input signals to the monostable circuit via a single- or multi-decade digital divider, thereby reducing the input frequencies to values that can be read by the monostable circuit. The circuit can form the basis of an excellent and inexpensive multi-range linear-scale analogue frequency meter. ●

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When the coils are brought near metal the electro-magnetic fields are disturbed and an output is produced. That's the theory behind our induction balance metal locator which will be described in next month's issue. We don't pretend it's easy to build (though the electronics present few problems) but our prototype will sniff out a 2p coin at a foot — and that's very much better than any design published up until now!

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'Scope Test your Car

A HIGH PROPORTION of ETI readers have cars and a lot of those will have a 'scope. This article acts as a marriage broker and shows how the workshop type 'scope can be hooked up to your car and tells you how to analyse the waveforms to spot faults.

SHORT CIRCUITS

WE CONTINUE our series which began in this issue with another three Short Circuits:

1. Test-bench Amplifier. Useful by itself but ours has been modified simply to act as an audio millivoltmeter as well.

2. LED Dice Unit. An electronic dice using only two ICs and six inexpensive LED's.

3. Two Tone Doorbell. Another straightforward project for the home — this time using a 555.

DISCO MIXER

This article describes a general purpose mixer which can be tailored by the reader to meet a specific application. Prefade 'listen' is included as a facility and allowance is even made for balanced inputs.

The articles described here are in an advanced state of preparation but circumstances may necessitate changes in the issue that appears.

PART 2

ELECTRONICS IN THE YEAR 2000

EVOLUTION OR REVOLUTION

By Peter Sydenham

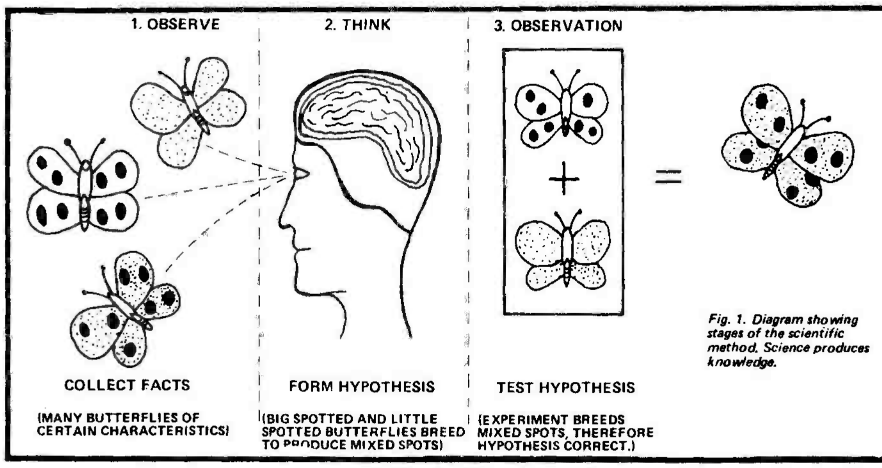


Fig. 1. Diagram showing stages of the scientific method. Science produces knowledge.

SCIENCE PROVIDES US WITH knowledge about existence. It is based on a procedure of collecting facts which are placed into apparently logical groupings in order to lead to stage two of scientific method – the realisation of one or more hypotheses. Man's imaginative powers then enable ideas about these facts to be "tried out" in the mind. (The mind creates what are called 'models'). After a brain-storming session some ideas emerge about the collected facts. These are likely contenders of generalised models that will describe many seemingly different ideas by one unified concept. Figure 1 depicts this process.

Having hit upon an hypothesis it is then tested by performing experiments upon it to see if more examples that would appear to also be correct are indeed allowed for. The hypothesis, as long as it is found satisfactory, is then held as current and applicable until a new case emerges that is not described adequately enough by it. The scientific process is then begun again to find a new hypothesis that is better than the earlier one.

Old hypotheses are not necessarily useless. They find their use in limited cases. We are quite satisfied in every-day life to regard mass as a constant entity but on some special occasions, in the design of some cathode ray devices for example, mass must be considered as being convertable to energy. Einstein's work predicted that conversion process.

New hypotheses produce new ideas for technology to take up and apply. Once it was *known* that the atom was divisible, scientists sought to split it further.

This brings us to the role of technology in the development of ideas. Technology and engineering is the broad discipline that devises machines and structures that do not exist as such in nature but using resources that are available naturally – see Fig. 2. Machines provide us with power conversion, with mechanisms and with measuring and information tools.

Technology is a sister requirement of scientific pursuit – inseparable partners in progress, each affecting the other's progress at varying degrees with time. Figure 3 shows an example of this interaction.

One often-seen mis-statement is that scientists build the so-called scientific machines. "Scientists put a package on Mars is the greatest scientific achievement yet made by man". If it had been a failure then it would have been due to engineering failure! The Mars' probe is rather the greatest *technological* achievement.

It is important to see how much technology compared with how much science goes into a manufactured product for this helps us predict when new ideas will come into practical use.

There is, however, another aspect to technology. Many lifestyle changing ideas do not occur as the result of applying science in a systematic manner. In fact many valuable machines and ideas arrive by way of an unknown, often poorly trained, inventor who applies an uncommonly good amount of common-sense to solving an immediate problem.

But society itself is also a strong influence on the application of new ideas. Somehow a new idea appears out of place. We now accept spectacles as normal technology, but think how a person wearing a filtering false nose (a possibility for reducing hay-fever allergies) would be received. Organ transplants were, and still are to some extent, opposed. Test-tube babies are currently controversial.

Many problems of society could be solved more speedily if we were prepared to accept change and make what appears at the time to be sacrifice more readily. We have seen over the past two years a strong swing toward the smaller car. Air travel is now cheaper than by sea – the reverse of a decade ago. A trans-world telephone call now gives more message content than a telegram for the same price.

This introduction and the previous part of this study sets the scene for what I see could be some aspects of future living. I possess no crystal ball; I claim no extra sensory perception ability, nor do I have a pact with the maker or devil! What is given now is composed from studying the past trends and extending them into the future, this being sprinkled with some personal ideas of myself and others.

GETTING ABOUT IN THE FUTURE

Although there have been instances in history where knowledge of man has been lost by chance or by political decree (the 1930's burning of the books in Germany) – technological change has continued to advance in all civilisations (albeit sometimes extremely slowly). It is most unlikely that the "alternative" communes we

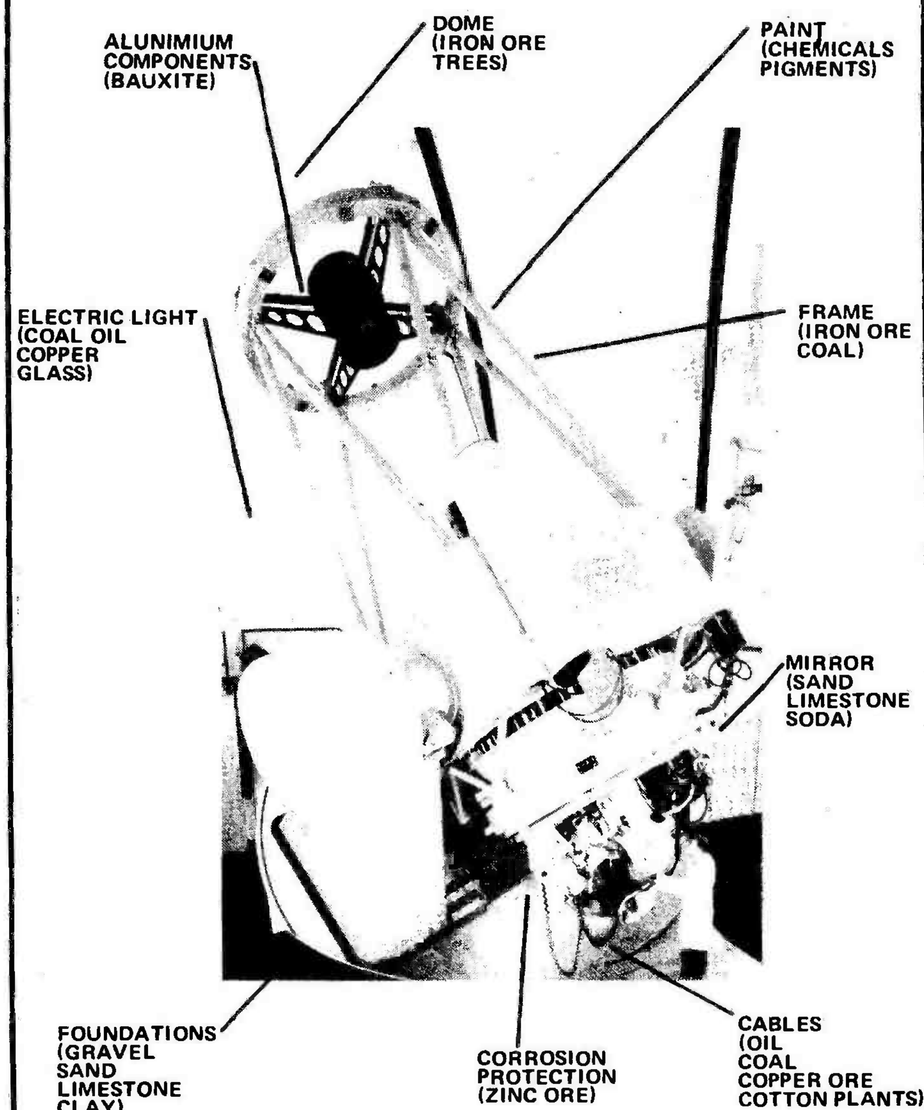


Fig. 2. Technology produces new objects, using naturally available resources, for specific tasks. (98 inch telescope at Royal Greenwich Observatory).

see today will be how man will live in future. It would need a global catastrophe to destroy all technology so thoroughly that the survivors would have to live as cave men and reinvent all inventions again.

Technology of long-distance transportation — railways, ships and even cars — requires great financial investment. Few people can afford a hand-made car today — even mass-produced ones are becoming harder to reach. Thus, if big commercial business survives into the 2000s, or the State takes over, we can confidently expect changes to slowly emerge in transport. It takes about four to six years for a current design railway and its rolling stock to be built from conception. A new technology such as airships (a revival really), needs a decade and a half once a serious commitment is given to using it.

Electric cars are constantly being researched and developed — Fig. 4 — but it has become vitally clear that two areas of difficulty exist. The first is that the lead-acid battery is not adequate to power a car with performance that we have become accustomed to. The best produced to date is not an equal to the smallest family petrol car. What is needed is much more effective electrical storage arrangement. High-temperature sodium-sulphur batteries, as pictured in Fig. 5, have been developed to prototype stage, (see ETI April 1975) but the manufacturers suggest these cells will not be available to car makers before 1980. Add a few years more for design testing in practice and we may have a better electric car proposition by 1985. The second difficulty, however, may be a more serious barrier to the widespread use of electric vehicles. This is the general reluctance to move on a downward trend of performance. Petrol will still be available in the '90s so the choice will probably move toward smaller, just as well-performing cars that stretch the litre further.

Other likely developments are automatically steered vehicles running on specially modified highways. The cars would be guided by control units sensing guidance paths laid in the surface. Collision prevention by short distance doppler-radar and optimal route selection using telemetry signals picked up by radio or from transmitters also laid in the road (ETI, December 1974) can be implemented now that research is in progress on these devices.

The computing capability needed, including built-in redundancy to improve reliability, is now available in micro-processors that will soon be as cheap as a good transistor radio. Social influences, people's suspicions and mistrust and overall cost are the constraints on rapid developments in this area.

With the thirst for speed perhaps settled to a resonable level the next thrust will be safety and again, perhaps, longevity of the vehicle. New ideas obtain much publicity — but promotion and worthwhileness of the product are not always related attributes.

Experimental Safety Vehicles, ESVs, have reached advanced levels. Fig.7 is Nissan's E_2 model. Urathane bumpers are now being used; other safety features are gradually being introduced. Perhaps vehicles adhering to the surface will be displaced by slightly levitated ground-effect machines like the hovercraft. Again, experience has shown that these are not the complete replacement for all ground transport systems. As yet they are still noisy, power hungry and not as responsive to directional control as the wheel-borne car.

The electric tram is another development that may come back again in a new form. Melbourne, for example, has a workable mass passenger transit system that now gets people into and out of the city generally faster than by car — yet it was not so long ago that the tram was regarded as archaic. Today it is recognised that mass transportation routes are better for concentrated city mobilisation than a melee of cars.

Magnetically levitated vehicles running on relatively inexpensive tracks were forecast to be capable of over 500 km/h speeds (see ETI Oct. 1973). Development of short test tracks and vehicles continues but the pace of development is slow to provide economic alternatives to maintenance and repair of existing systems. Figure 8 shows a Maglev vehicle around 1973 remember that prototypes are quicker to materialise than service vehicles. For inter-city distances in big countries we need a speed of about 500 km/h to make journeys sufficiently shorter than the current alternative of the car or train. Airflight time is becoming limited by cost and airport turnaround time — door to door and with no connections to make, a 1000 km distance takes about three hours. Maglev inter-city systems, however, now must designed in light of a new social barrier not obviously in existence five years back — they need great quantities of power to run at such high speeds. Societal values no longer ignore such demands on resources. Superconducting Maglev systems (ETI October 1973) will require vast quantities of scarce helium — this may limit their widespread useage.

The bicycle is good for the health but its slowness and effort requirements do not suit most people who live far from their workplace. A compromise between the bicycle and the car seems how things should develop but social constants, personal comfort and the ability to carry passengers and loads require a wide degree of flexibility for the future personal transport vehicle.

Moving on to transport at sea we can confidently expect to see automatic ships navigating by electronic control. Position sensing devices (see ETI March 1974, and September 1974) are sufficiently developed for the task — especially when the Omega navigational net is complete across the globe. Computer control is well capable of the data processing needed and machinery control is now extremely reliable and well defined. Automation of ships, however, would need global acceptance of the concept and more faith in machinery. Automatic fishing is also a realisable goal — for we can now detect where fish are in the sea.

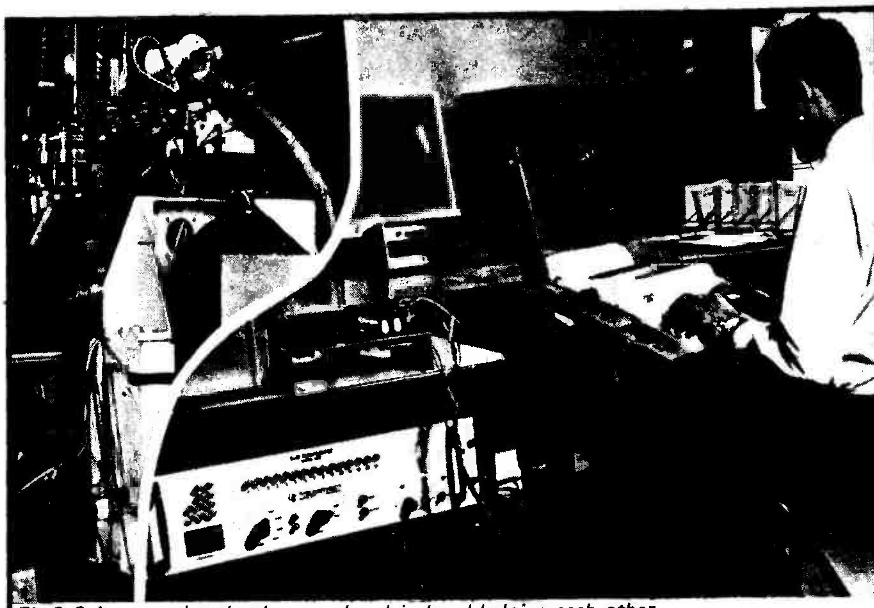


Fig.3 Science and technology go hand in hand helping each other continuously. (Computer controlled engine-testing at Cranfield).

Ship-forms may shift to surface-effect designs — plans were announced in the US last year for design studies of a 10 000 tonnes naval cruiser that could move at speeds double those of today. Ship speeds are decided by physical limitations arising because of the wetted area surface drag and the disturbance caused to the water physically displaced by the ship's motion. Raising speeds above 10 knots or so demands enormous increases in fuel consumption. Solutions to this are to go completely under like the submarine for this also reduces the power needed, or rise out of the water on skis or the hover principle. One advantage of the latter is that the swell and roll of sea travel is greatly reduced. Hover ships can run today at speeds of 80 knots but problems with skirt sealing in rough weather appears to be a major current limit on usefulness on the open sea. The history of naval architecture, however, shows that ships change in only minor ways and at a slow pace.

Finally, in the air: what will happen there? There was once a time — just a few years ago — when air travel had become the pinnacle of transport comfort and speed. But today it fails to provide a fast enough overall journey time because of airport regulations of arrival before departure time, clearance at security barriers, checking of tickets, settling of passengers and the like. It seems, as a rule of thumb, that the actual flight time is about equal to the

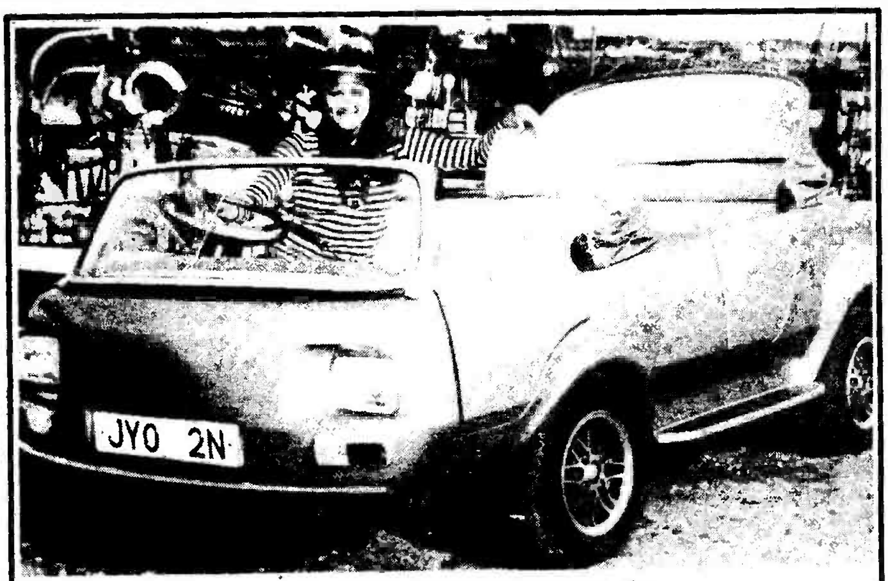


Fig.4. The electric car can only provide satisfactory transportation for short land tasks. This is a pleasure version by ElecTraction.

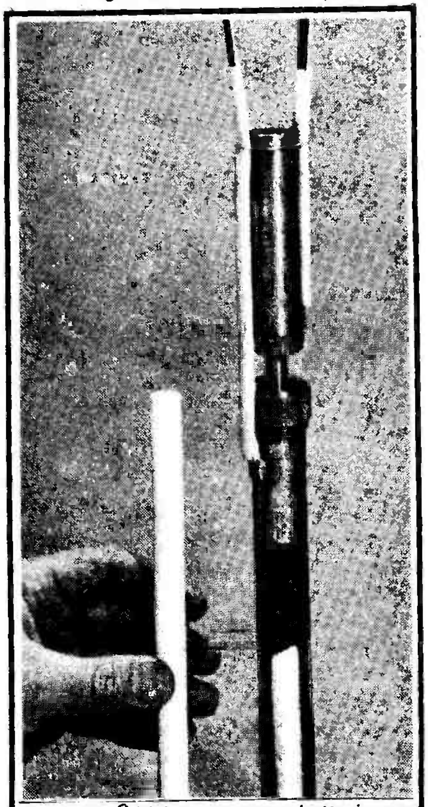


Fig. 5 Na-S high temperature batteries can store much more power for a given weight than lead acid cells but they will not be available for another five years or more.

sundry time involved for short international flights. Plans were published in the early seventies of cabins (in which people were assembled) ready to be attached to the plane. In some countries super highways link the remote airports from the city centres. Somehow these plans did not provide the answer now seen to be needed.

Supersonic transportation is finding difficult acceptance, and it is just not possible to state at present whether it is good or bad with any degree of certainty. Only time will tell; hypotheses need verification by experiment.

The air ship is a strong contender especially if a design needing less helium were invented (certainly not one based on hydrogen, for it is highly inflammable when oxygen is available). The hot air balloon is thirsty for energy due to huge heat losses from the balloon surface — new materials and processes may provide us with an insulated enclosure of light enough structure for these to become viable for long flights.

Several companies have been formed to exploit commercial freight transport by airships. The idea is appealing — quiet, safe, speedy, not plagued with terrain problems and capable of loads equalling many semi-trailer cargoes put together. Airships are an example of past design hopes being reborn due to better technological availability.

In the next part we will look at communications and entertainment developments of the future.

(To be continued . . .)

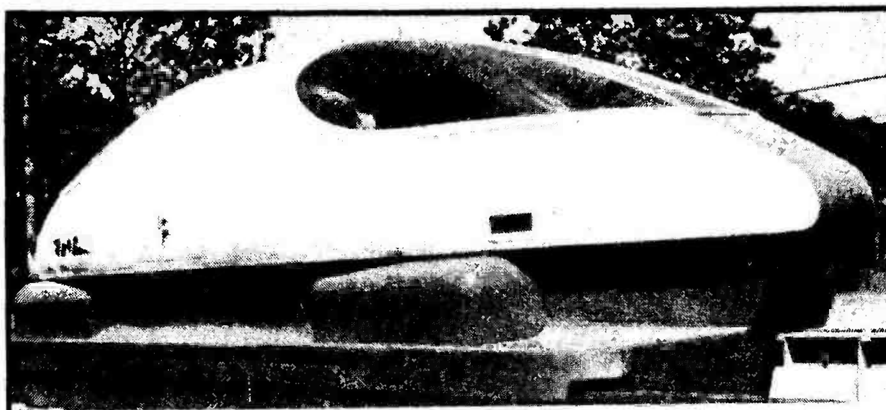


Fig.8. Maglev vehicles can provide great speeds but they will require much more development and testing before they replace current forms of railway.

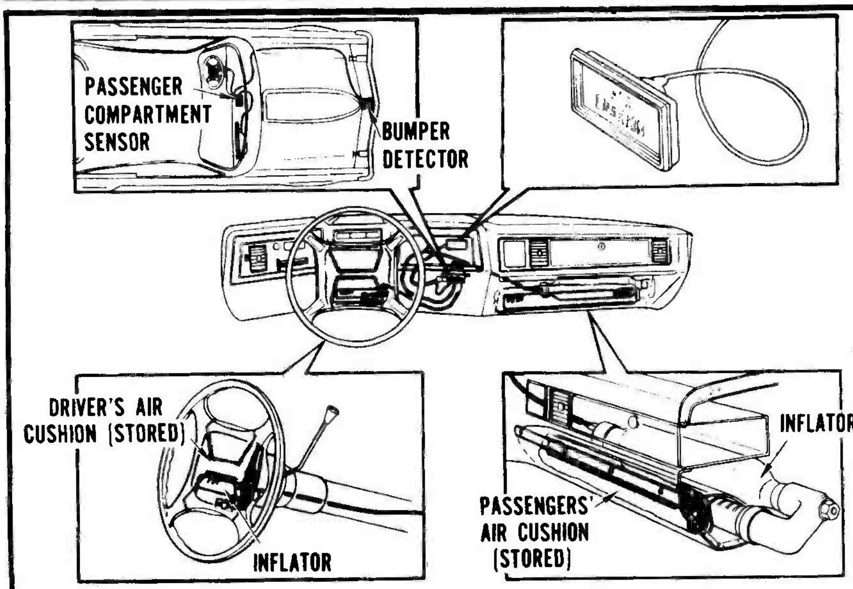
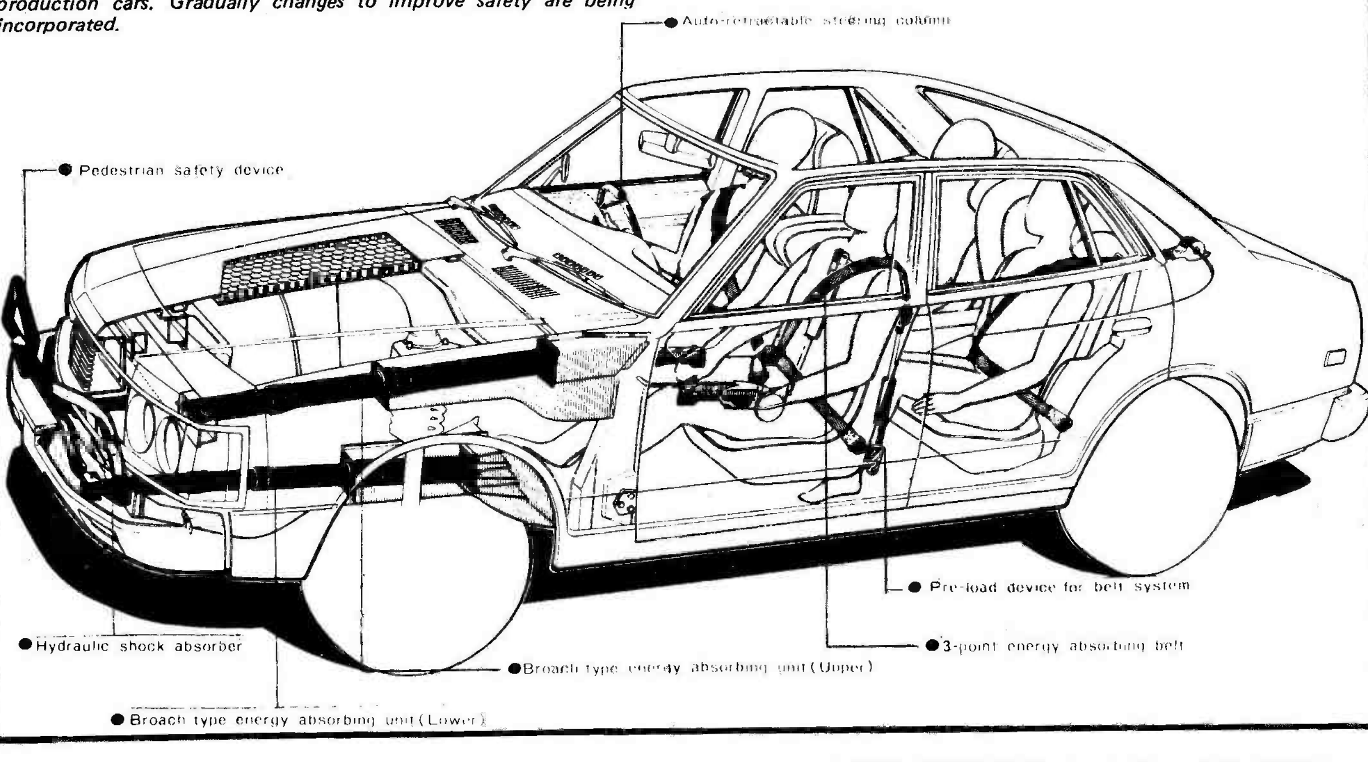


Fig.6. General Motors' air cushion restraint system. These may the answer to collision survival in the near future.

Fig.7. Nissan E_2 type ESV incorporates ideas yet to be included in production cars. Gradually changes to improve safety are being incorporated.



ETI READER OFFER

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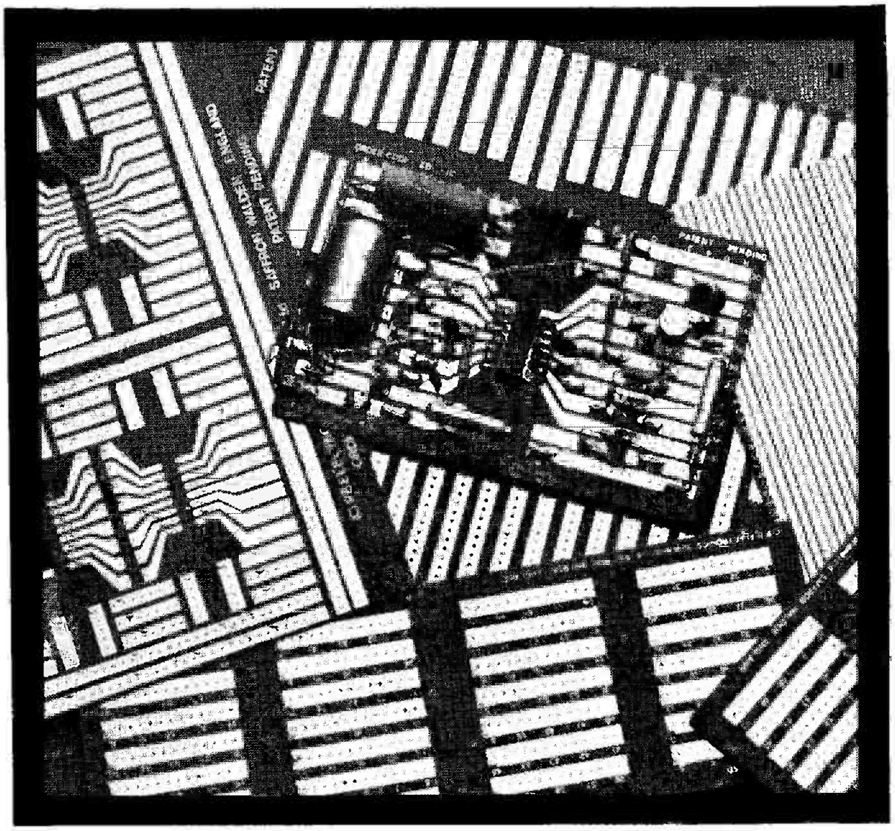

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Is that you?

-a computer that checks signatures

A growing need to check people's identity automatically has led to the development of a computer that verifies signatures by the speed and sequence of pen movements as well as by the finished sample — this report by R. S. Watson & P. J. Pobgee of Britain's National Physical Laboratory.

MODERN TECHNOLOGY HAS, ironically, increased the opportunities for crime and its rewards. Easier and more widespread facilities for getting goods on credit and the introduction of electronic fund transfer systems have made it possible to make money directly by fraud.

Nowadays, too, there are many places where people cannot be allowed to enter unless they are authorised. They may house stocks of valuable or dangerous material or stores of confidential information, often in the form of computer records. Providing guards to check people's identity costs a lot of money — there is a need for some automatic system of checking that people are who they are supposed to be.

There are two ways of tackling the problem. First is the method of providing tokens such as credit cards or pass cards or even secret codes. But tokens can be lost or stolen or lent to other people. The second method is to make use of some human property such as fingerprints, body weight, or other physical dimension. Unfortunately, people often object to such things being used and, in any case, measurement can be expensive to automate. Together with voice 'prints' these visible attributes can still be imitated, another drawback.

PEN MOVEMENTS

Signing is the traditional method for authorising documents, and signatures represent a well practised human behaviour pattern. Although the visible mark can be easily copied or traced, the *way* in which it is written is also characteristic of the writer. This means that additional information can be obtained by measuring the *speed* and *sequence* with which the pen is moved across the paper.

It follows that, in any automatic system for recognising signatures as they are written, the first requirement is for an economic way of obtaining this hidden information without upsetting the writer's natural rhythm. This was obtained by inventing a simple electronic notepad that produced a sequence of electrical signals corresponding to the signing action without being connected to the writer's pen. This pad has been further developed commercially and is marketed by Quest Automation as a data entry device under the name Datapad.

The second stage was the study of a great number of signatures to choose a method of measurement that could ignore minor variations between samples from the same writer, while preserving his distinguishing features. Over 10 000 signatures were collected from more than 500 writers from all walks of life. When we examined these with a view to isolating the variables, four rather obvious factors emerged. These were name, style, context and noise.

The *name* forms the basic structure. It may be short, such as B. Nye or long, with 30 letters or more — Sir Frederick Marmaduke Bertwhistle. The name may be written in different languages, or scripts such as Roman, Russian, Arabic, Japanese, Hebrew or for that matter any well practised group of symbols. In some cases a person's initial are acceptable.

By *style* we mean the variations about the name form. Many people have a repertoire of styles which they use on various occasions. A number of common examples which we met were a 'working or everyday use'style, a 'cheque book' style and what might be called an 'impress the boss' style.

Context is the modification to a given style caused by what the individual is doing at the time. The rhythmic properties of a person's signature can vary according to his attitude to the transaction. The signing of an important document will affect the way he writes more than a trivial event such as the receipt of articles worth a few pence.

All the other influences that may affect the signing behaviour we have called the *noise* factor. The weather may be included in this category and a number of signatures were collected

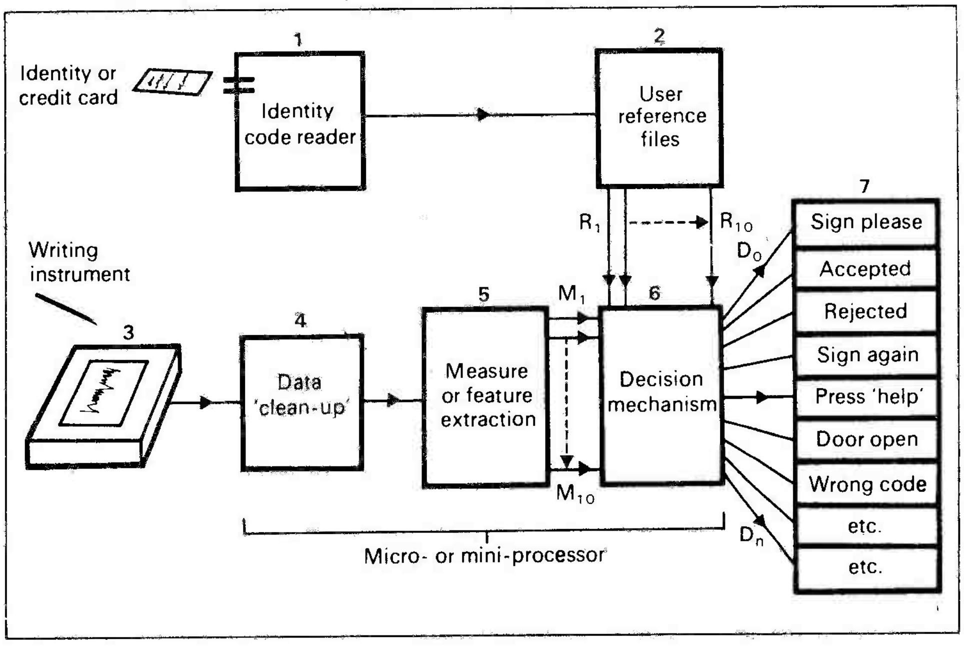


Fig. 1. Basic signature validation machine. The numbers are referred to in the text.

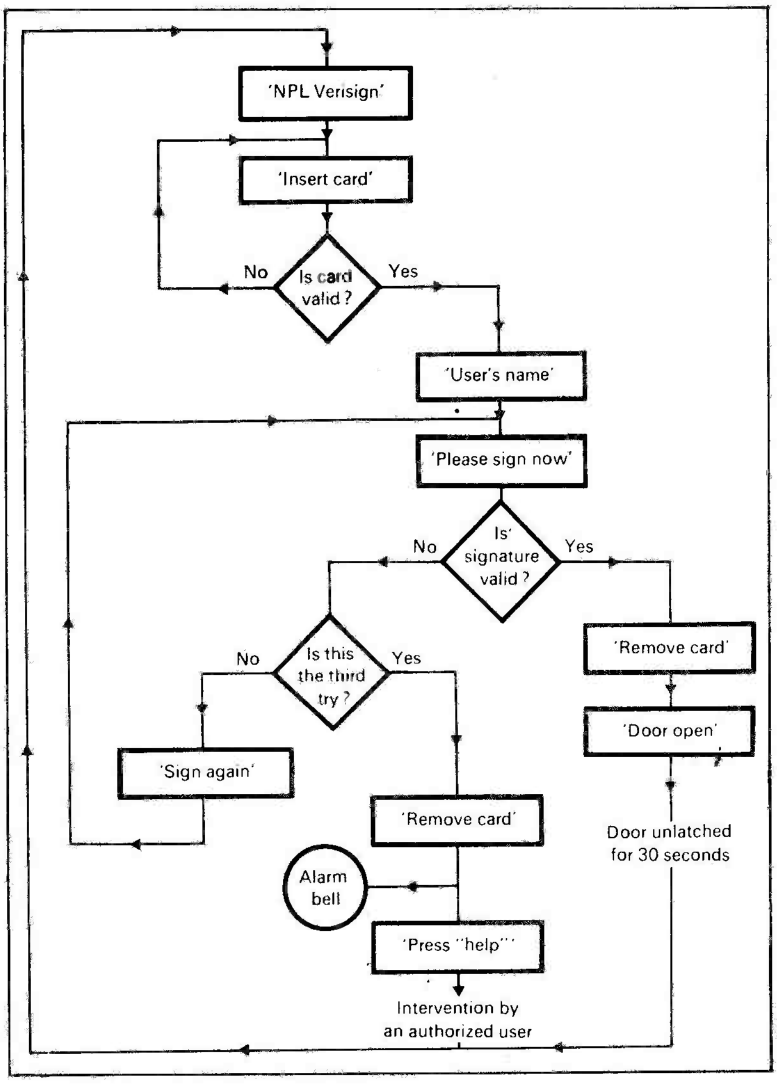


Fig. 2. Simplified flow chart of operation.

from people arriving at the laboratory in midwinter. Other samples were obtained from people in various states of health. In one case drugs were being taken to alleviate the symptoms of a nervous condition. Then there is the 'after business lunch effect' which can influence the signing rhythms!

Our large data bank of signatures was supported by other experiences of interaction between man and machine. This enabled a team led by Dr J. Parks of NPL to develop powerful techniques to overcome many of the difficulties.

Peter Hawkes of the UK's National Research Development Corporation and Stephen Dennis of Inter-Bank Research Organisation had been following progress with interest, and a joint venture was formed between NRDC, INRO and NPL to construct a prototype machine for VERIfication of SIGNatures (VERISIGN).

Diagram 1 illustrates the basic building blocks of the Verisign machine. A user first enters his personal identity code either through keyboard or badge reader(1). The code, which in our case is a four digit number, is used to extract the user's reference file (2) containing a set of 10 reference parameters (R1-R10). These are passed to the decision mechanism (6) and a request flashed to the output display (7) for the person to sign his name on the Datapad (3).

The Datapad has an electro-sensitive surface on which movements of the writing stylus are converted into a 'string' of interleaved x, y co-ordinates showing how far across and up or down particular points are. This 'data string' is then processed (4), to remove artifacts such as marks made accidentally by the user.

Analysis of the 'cleaned up' data occurs at (5) in which measurements are made on certain properties which characterise the signing pattern. Examples of possible measurements are the number of crossings made by the x or y co-ordinates over a datum line or the total time spent in writing. Many other functions of position and time may be chosen.

The properties or parameters can be selected 'locally', that is within certain areas, or 'globally', with the measurements taken over the whole signature.

Over 100 measures were tested for their ability to discriminate between writers, while remaining insensitive to each person's own variation. From these, ten measures were selected and used to generate the values M1-M10 which are passed to the decision mechanism (6). Here a comparison is made with those obtained from the claimed reference set (R1-R10). The degree of similarity or closeness of fit in relation to a set threshold value determines one of a number of decisions (D1-Dn). A close fit, that is below the threshold value, is accepted. A poor fit causes the signature to be rejected and displays a request for further samples.

A hierarchy of decision procedures is used allowing 'context' factors such as customer importance or the value of the transaction to be incorporated. The decision mechanism can be easily organised in a number of different ways to suit individual requirements.

Establishing a set of measures to use as a reference for one person is a vital part of the smooth functioning of the machine. Security against impersonation, without the rejection of genuine attempts, will depend on how well the reference measures characterise the writer.

Anyone who will be using the machine is first asked to submit five specimen signatures. The spread of this group is then examined by the machine for any gross inconsistencies. Signatures that lie outside a given tolerance band are rejected and further samples requested to make up the number. The variation in the reference group (variability factor, VF) provides a useful means of assessing what the chances are for successful impersonation by unauthorised users. The lower this factor the higher the security and, of course, the reverse is true.

Knowledge of the degree of security is unknown to either the user or impersonator and in any case the rating value together with the reference list is updated each time a test signature is accepted. This updating mechanism can also keep track of long-term variation in the way a person writes his signature.

The basic flow chart of the Verisign machine is shown in diagram 2. Three attempts at writing a signature are permitted before some form of alert is given.

The computer program, apart from a few modules, is written in standard Fortran IV language and occupies about

Is that you?

-a computer that checks signatures

12 000 words of core store. Twenty words are required for each person's reference parameters plus an extra 10 for performance logging.

We used a 16K mini-computer which provided reference file space for up to 120 people. The time to verify a signature was less than 100 milliseconds. This meant that a complete transaction, including the entry of a personal identity code, could be completed inside 20 seconds.

TESTS

The system was tested in various situations including remote operation over public telephone lines. In addition, two full-scale experiments were carried out. For the first, in the entrance hall at our laboratory, the participants identified themselves as they entered and left the building. The 71 people who took part included typists, security officers, members of the services, professional engineers and scientists. Out of 2000 attempts made at identification by signing, 96 per cent were successful.

The second experiment controlled entry to the computer room of a different government establishment. Here, the 47 passholders, often carrying equipment or trays of cards, used the Verisign terminal over a period of several weeks. The results of this experiment were similar to the first.

It is, of course, one thing to ensure that the genuine person is identified correctly with the minimum fuss or bother. It is another to prevent the less scrupulous their practising art! With this in mind, at the end of both experiments we displayed a number of target signatures and invited everyone to try his hand at copying them. With the first experiment at NPL, although one or two came very close, no-one was able to obtain a 'signature valid' signal. A lower threshold was used for the second experiment and the decision scores were displayed as an incentive. No limit was placed on the number of attempts, allowed and under these less rigorous, unrealistic conditions a few people were eventually successful.

No security system is perfect but the hierarchy of this one allows the degree of security to be balanced against the possibility of rejecting an authorised user. ●

RESISTORS

part 6

Last month we looked at the most common resistors, the carbon composition types. This article now looks at resistors in general and introduces the other types we will be considering.

RESISTORS MUST BE THE MOST commonly used of electronic components — to the point where they tend to be taken for granted.

Resistors are, however, made in a variety of ways either for general use or because their particular characteristics suit certain areas of application. Modern resistors can be classified into four broad groups:

(a) composition resistors
(b) film resistors
(c) wirewound resistors
(d) semiconductor resistors

There is a variety of construction styles in each group, each style having particular characteristics, advantages and disadvantages.

General Characteristics — Resistors are not quite the passive components they are usually taken to be. All the resistors vary in value with variations in temperature. They also change value with applied voltage and with frequency. All resistors generate noise, and thus certain types are better suited to applications requiring low noise components, such as audio amplifier input circuits. Knowing what the various characteristics of a resistor mean in different situations enables you to make a proper selection for a particular application — or to make substitutes without introducing problems. There is a generally agreed convention on how the various resistor characteristics are expressed and these are explained below.

Temperature coefficient — With many resistors, the change in value of resistance is fairly linear across a large range of temperature. With such resistors the temperature coefficient is usually expressed in 'parts per million per degrees centigrade' or ppm/°C. It is also sometimes expressed in percent of value per degrees centigrade, or %/°C. Some resistors have a nonlinear temperature coefficient and this characteristic is usually referred to as the 'resistance-temperature' characteristic. Some types of resistor, particularly those in the semiconductor group, are manufactured to have a large, controlled resistance-temperature characteristic. They are usually used for temperature sensing, compensation, or in measurement applications.

Voltage Coefficient — The nominal value of a resistance is not independent of the applied voltage, usually decreasing with increase in applied voltage. The voltage coefficient is usually expressed as a percentage of the change in resistance against variation in applied voltage from 10% of maximum working voltage to maximum working voltage. This is a characteristic that is only of importance with carbon composition resistors and some types of semiconductor resistors (i.e. voltage dependant resistors).

Frequency Effects — All resistors have an inherent small amount of inductance and capacitance and this affects the way they behave at high frequencies and above. The length of the actual resistance path in the resistor and the length of the leads contributes inductance in series with the apparent dc resistance. Capacitance, which may be distributed along the resistor body or through the resistance path, contributes capacitance which is effectively in parallel with the apparent dc resistance. This changes what should look like an ordinary resistor into a circuit like that in Fig. 1. The actual amount of series inductance and shunt capacitance depends largely on the type of resistor and its construction. Some styles of resistor are constructed to minimise these effects.

Carbon composition and wirewound resistors are the most affected of any group. Generally, for values above 100 ohms or so, the apparent resistance will decrease as the frequency is increased. Thus low value resistors exhibit the least variation with increasing frequency while the apparent resistance of high value resistors (i.e. about 100 k and above), rapidly decreases as the frequency increases.

Noise — All resistors generate 'noise' in the form of tiny voltage fluctuations which originate in the resistive element. Further noise is generated in the lead connections. The total noise voltage is contributed from a number of different sources. One form of noise that is present in *all* resistors is called 'Johnson Noise' and the magnitude of this depends on the temperature and the value of the resistor. Some resistors (particularly carbon composition types) produce extra noise caused by the current flowing through the component. Faults in the component also cause noise, i.e. for solid body types, minute cracks may add to the noise. Some styles of construction can contribute to noise, for example, those constructed with end caps connecting to the resistive element may become noisy (more noisy) when the end caps are subjected to tension and become slightly loose. For adjustable resistors, added noise may be caused by imperfect contact between the moving contact and the resistive element. The noise is worsened during the time the contact is moving. To obtain the lowest noise from a resistor it should be operated well below its wattage rating.

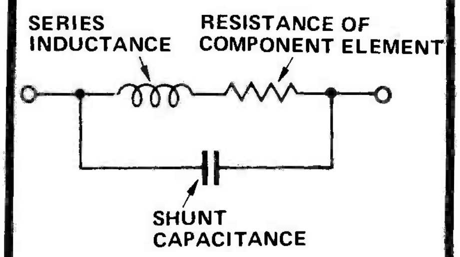


Fig. 1. Equivalent circuit of practical resistor.

The noise figure for resistors is usually quoted in microvolts per volt (μV/V) or in dB related to a reference figure (usually 1μV/V).

RESISTOR RATINGS

Resistors are rated to remain within specified resistance limits under specified conditions of power dissipation, temperature and applied voltage. These ratings depend on the style and construction of the resistor as well as the way in which it may be used in practice, i.e. if it is subjected to high temperatures or operated at a high voltage.

The primary rating of a resistor is its wattage or power rating, that is, how much power it will dissipate. This is more or less analogues to the voltaqe rating of a capacitor — how high a voltage it will withstand.

Power or Wattage Rating — The maximum power rating of a resistor, as quoted by the manufacturer, is determined by the power it can dissipate continuously for an unlimited time without exceeding a specified maximum temperature and without drifting from its nominal value more than a specified amount.

The power rating of a resistor depends largely on its construction. Low power resistors are quite small in size — the size increasing with power rating as illustrated in Fig. 2. These are representative of most composition and film types. Wirewound resistors are inevitably larger as they are generally manufactured to dissipate considerable amounts of power.

Film resistors are made in a range of power ratings from 1/20th (0.05) watt up to five watts, composition types range from 1/10th (0.1) watt to two watts. Some special film types, made for RF power applications and high voltage, high power applications, are manufactured in wattage ratings from one watt to 100 watts or more.

Wirewound resistors are manufactured in wattage ratings that range from half watt right up to 200 watts. Very low value resistors (i.e. less than a few ohms) are usually wirewound. They may only need to dissipate small amounts of power and are consequently generally quite small.

When a resistor is dissipating power, its temperature will rise above that of its surroundings (or the 'ambient' temperature as it is called). The maximum temperature of the resistor due to both the internal heating and the ambient temperature is called the 'hot spot' temperature. The maximum allowable hot spot temperature for a resistor depends on its construction and the material of the resistance element. The maximum hot spot temperature of a resistor may not be exceeded under normal operating conditions. Thus, resistors are rated to dissipate a given amount of power up to a specified ambient temperature, usually 40°C or 70°C, so that the combination of internal heating and the ambient temperature do not exceed the maximum allowable hot spot temperature. This is usually between 100°C and 170°C depending on the component style and construction, for composition and film types. Wirewound types may have a maximum hot spot temperature in excess of 250°C, which is sufficient to melt solder and fry fingers to a crisp golden brown.

Excessive power dissipation with a resistor causes large, often sudden, changes in resistance, in some types the resistance may decrease — definitely the wrong direction as it will then try to dissipate yet more power — until it reaches its thermal limit and breaks down.

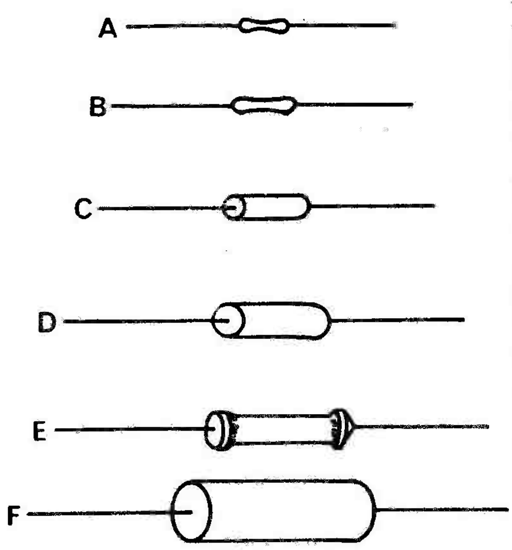
The first signs of overload in carbon composition and carbon film resistors are a pungent burning odour accompanied by a steady stream of smoke. Finally, it breaks down altogether in one of several possible ways:—

(a) The resistor gives a final puff of smoke, becomes open circuit and joins its ancestors in that great big pc board beyond the sky.

(b) The resistor becomes short circuit, everything else begins to smoke and *they* join their ancestors you-know-where.

(c) The resistor turns into a miniature Vesuvius, splutters hot carbon particles all over the place and eventually bursts into flames, not unlike a Roman candle.

To summarise with the obvious, it is good practice to select resistors which go open circuit under extreme overload and which are non-flammable. Many modern resistors, particularly power resistors, are manufactured this way.



SIZE	TYPE	WATTAGE RATING @40°C	@70°C	LENGTH	DIA
A	Carbon Film		.05	4 mm	1.5 mm
B	Composition		.25	6.5 mm	2.3 mm
	Carbon Film		.25	7 mm	2.3 mm
	Metal Film		.25	7 mm	2.5 mm
	Metal Oxide		.125/.25	7.2 mm	2.5 mm
C	Composition		0.5	10 mm	3.5 mm
	Carbon Film	0.5	0.33	9 mm	3 mm
	Composition	0.35	0.2	10.3 mm	4.3 mm
D	Composition	0.5	0.25	11.5 mm	4.1 mm
	Composition	0.35	0.2	12.7 mm	5.3 mm
	Carbon Film	0.5	0.25	11 mm	4 mm
	Metal Film		1.0	12 mm	5.5 mm
	Metal Oxide		0.25/0.5	11.2 mm	4.2 mm
E	Composition	0.75	0.35	17.8 mm	4.1 mm
	Carbon Film		1.0	14 mm	4.8 mm
F	Composition	2.0	1.0	30 mm	7.8 mm
	Carbon Film		4.0	24 mm	8 mm

Fig. 2. Sizes and ratings of modern resistors.

RESISTORS

High value resistors are more likely to break down under the stress of high applied voltage rather than excessive dissipation.

Power Derating — A resistor may be operated above the maximum specified *ambient* temperature provided it dissipates less power than its nominal rating. In other words it has to be 'derated', With few exceptions, the derating is usually linear from the maximum ambient temperature to the maximum hot spot temperature, where it can dissipate no power at all. This is illustrated in Fig. 3. Here the graph shows that the resistor can dissipate full power according to its rating up to 70°C but this is decreased linearly until it can dissipate no power at 125°C, which is the hot spot temperature. If the resistor was a 1 watt type, then, from the graph, it could only dissipate less than ½ W at 100°C.

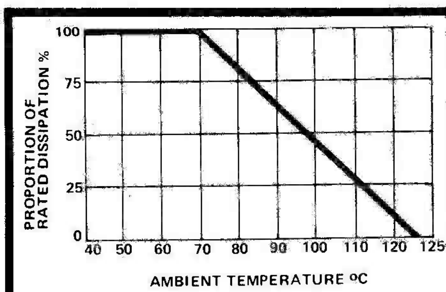


Fig.3. Typical power derating curve for composition and film resistors.

The ambient temperature of a resistor is obviously affected by nearby devices that produce heat. One should ensure that resistors mounted near power transistors, wirewound resistors, or other heat producing sources are adequately rated. The same goes for equipment that may be mounted in a high temperature environment, such as in a car engine compartment or under the dash — temperatures here can reach 80-100°C under a hot summer sun. Resistors stacked together must be operated below maximum rating as they do not experience the same cooling as resistors mounted with free space around them. For other than wirewound resistors it is good practice to allow at least the same distance as the component width or diameter around it in order to obtain adequate cooling. Resistors may be mounted right down on a printed circuit board however, without appreciably degrading the cooling. But, if the component is a two watt type or more, and dissipating some power, it is best to mount it above the board by at least its own diameter or thickness to avoid scorching the board.

Although a resistor rated to dissipate ½ W at 40°C will obviously dissipate considerably more at more normal room temperatures of 20-25°C it is not good practice to use it in such a manner. It will, most likely change value permanently, most probably by an amount exceeding the specified tolerance. That is why power derating graphs only indicate a permissable 100% dissipation below the maximum allowable ambient temperature.

Chemical changes within the resistive element destroys a resistor that is operated at excessively high temperatures.

Voltage Rating — The value of a resistor is not independent of the applied voltage. It changes with increasing voltage, usually decreasing. This characteristic is worst for composition resistors. A *voltage coefficient* may be specified for a resistor. This is expressed as a percentage of the change in resistance versus the nominal (low voltage) value of the component multiplied by the inverse of 0.9 times the rated maximum working voltage.

The *maximum working voltage* and the *voltage coefficient* of a resistor depend on the materials and composition of the resistance element, the allowable deviation from the nominal (low voltage) value and the physical configuration of the component. For a given type of construction and resistive element, the voltage coefficient decreases with decreasing resistance value and thus the maximum working voltage may be increased.

High value resistors used in high voltage applications, e.g. in EHT voltage dividers for CRO tubes, may suffer from voltage breakdown across the spiral-grooved turns of the resistance element. 'Voids' also occur in the resistance element, causing an increase in value, and sparking occurs across these with consequent detrimental effects. Catastrophic failure of a resistor usually occurs by these voids spreading through the element.

Pulse Rating — The reaction of resistors to voltage stresses is almost instantaneous. Where a resistor is subject to voltage pulses it will still be subjected to the sort of limitations placed on it for the voltage rating. Power dissipation is not a limiting factor, it is rather the voltage stress that the component is able to withstand. The spreading of voids through the resistance element increases with increasing pulse frequency. Carbon film resistors are able to withstand about twice their rated dc working voltage under pulse conditions. Usually the pulse voltage rating of the component will be exceeded before the power dissipation becomes significant. ●

MC 1312/15/14P CBS SQ LOGIC SYSTEM — MOTOROLA

A complete SQ decoder system in three chips. The MC1312P is the decoder and consists of two high input impedance pre-amplifiers which are fed with left total, L_T, and right total, R_T, signals. The preamplifiers each feed two all-phase networks which generate two L_T signals in quadrature and two R_T signals in quadrature. The four signals are matrixed to yeild left front, left back, right front and right back signals (L_F', L_B', R_F', R_B').

The MC 1314P is a voltage controlled attenuator, a gain control and balance adjustment unit for use with any quadraphonic system. It has four channels whose gain can be varied by an external dc voltage. In addition, the relative gain between channels can be set by three external dc voltages. Thus with four variable resistors the master volume L_F/R_F, L_B/R_B and F/B balance may be controlled.

The logic circuitry for the system is in the MC1315P which provides the basic logic function to enhance the front to back separation in the CBS SQ four channel decoding system. This device is designed to interface with the MC1312 decoder and MC 1314. The MC1315 provides dc logic enhancement control signals which extend the performance of the basic SQ system to the levels desired for top-of-the-line systems.

Power Supply Requirements:	60 mA at 20 V
Nominal Signal Level:	0.5 V
Maximum Input Voltage:	1.9 V
Input Impedance:	2 MΩ
Output Impedance:	2 kΩ
Total Harmonic Distortion at 1 Hz	0.2% at nominal input 1.0% at maximum input
Voltage Gain (at quiescent):	1.0
4 Channel Volume Control:	Range 70 dB
4 Channel Balance Control:	Tracking — within 3 dB −35 dB at −20 dB gain

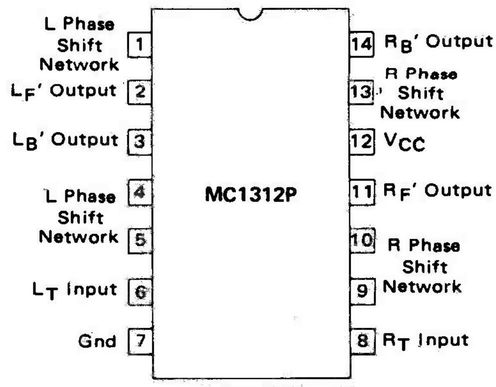
Just at the time of writing, Motorola have announced a 30% reduction in the price of this chip set.

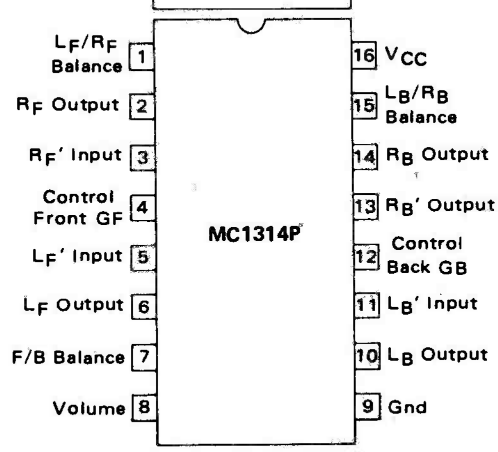
ELECTRICAL CHARACTERISTICS

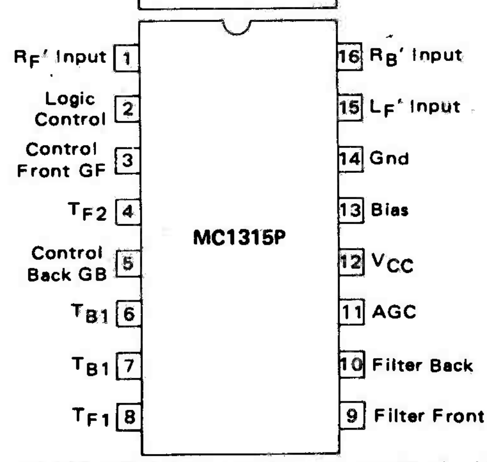
Characteristic	Typ
Supply Current Drain	16 mA
Input Impedance	3.0 MΩ
Output Impedance	5.0 kΩ
Channel Balance (L_F/R_F)	0 dB
Voltage Gain L_F/L_T or R_F/R_T	0 dB
Relative Voltage Gain L_B'/L_F', R_B'/L_F', L_B'/R_F', R_B'/R_F' L_F' measurements made with L_T input, R_F' measurements made with R_T input.	-3.0 dB
Maximum Input Voltage for 1%THD at Output R_T or L_T	2.0 V(RMS)
Total Harmonic Distortion R_T or L_T	0.1 %
Signal to Noise Ratio (Short-Circuit Input V_O = 0.5 V(RMS) with Output Noise Referenced to Output Voltage, V_{OI} (BW = 20 Hz to 20 kHz)	80 dB

Characteristic	Typ
Maximum Gain (V_8 6 V)	1.0 dB
Minimum Gain (V_8 0 V)	0.5 dB dB
Gain Spread @ Gain Max	1.0 dB
Total Harmonic Distortion (V_{in} = 0.4 Vrms, max gain)	0.2 %
Signal/Noise Ratio (20 Hz 15 kHz Bandwidth) Note 1 V_{IN} 0.4 Vrms (ref)	80 dB
Channel Separation	60 dB
Balance Control Range V_8 6.0 V (Max Gain)	20 dB
Gain Reduction (V_4' V_{12}' 3.12 Vdc compared to V_4' V_{12}' 0.60 Vdc, V_{CC} 25 Vdc)	14 dB
Supply Current (max gain) (V_{IN} 0 V) (min gain) (V_{IN} 0 V)	19 mA 9.0 mA
Input Impedance	13 kΩ
Output Impedance	2.0 kΩ
Control Current I_4 or I_{12}	-20 μA
Intermodulation Distortion (f_1 7 kHz, f_2 60 Hz)	0.6 %

Characteristic	Typ
Supply Current (Pin 12) @ V_{IN} 0 @ V_{IN} 1.4 Vrms	7.0 mA 15 mA
Input Resistance @ Pin 1, 15, 16	20 kΩ
Output Resistance @ Pin 3, 5	1.5 kΩ
Paraphase Filter Resistance @ Pin 9, 10	4.0 kΩ
Front-Back Logic Discharge Resistance @ Pin 7, 8	5.0 kΩ
Bias Voltage (10 k to ground) @ Pin 13	1.4 Vdc
Logic Control Input Current @ Pin 2 (V_2 V_{13} or V_2 0)	0.5 mA
Relative Output Change Front output with L_B or R_B inputs or back output with L_F or R_F inputs	2.8 V/V



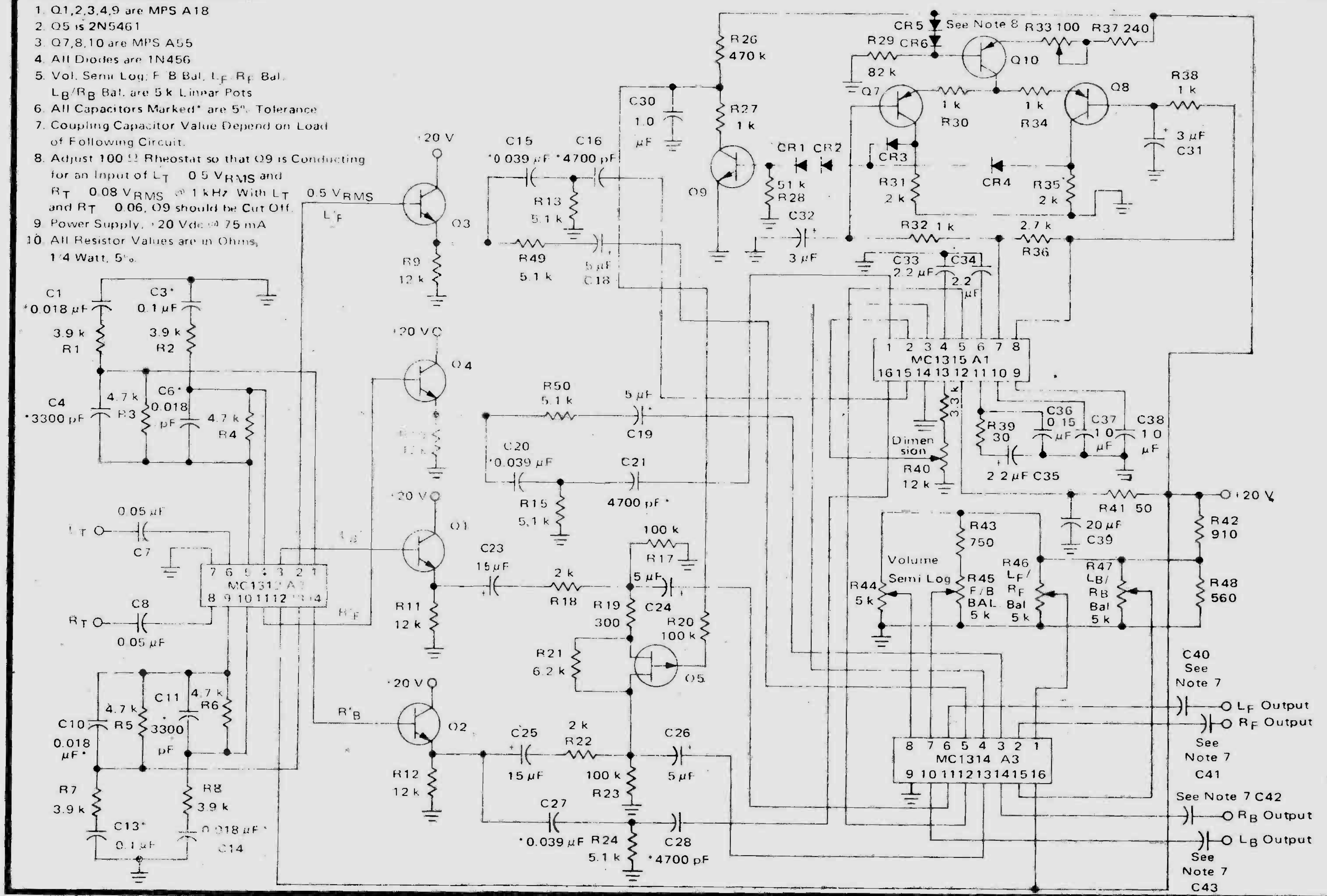




CBS LOGIC SYSTEM WITH VARIABLE BLEND

NOTES: (Unless otherwise specified)

1. Q1,2,3,4,9 are MPS A18
2. Q5 is 2N5461
3. Q7,8,10 are MPS A55
4. All Diodes are 1N456
5. Vol. Semi Log; F/B Bal, L_F/R_F Bal, L_B/R_B Bal. are 5 k Linear Pots
6. All Capacitors Marked* are 5% Tolerance
7. Coupling Capacitor Value Depend on Load of Following Circuit.
8. Adjust 100 Ω Rheostat so that Q9 is Conducting for an Input of L_T = 0.5 V_{RMS} and R_T = 0.08 V_{RMS} @ 1 kHz. With L_T and R_T = 0.06, Q9 should be Cut Off.
9. Power Supply, +20 Vdc @ 75 mA
10. All Resistor Values are in Ohms, 1/4 Watt, 5%.

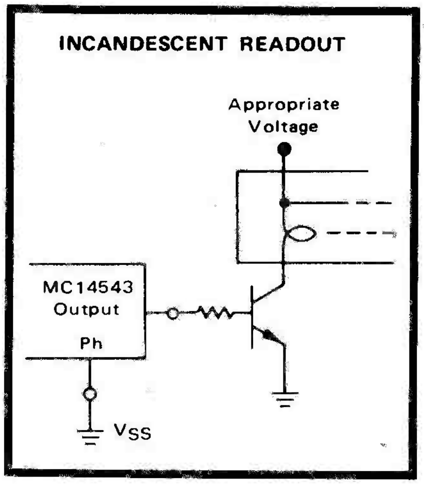


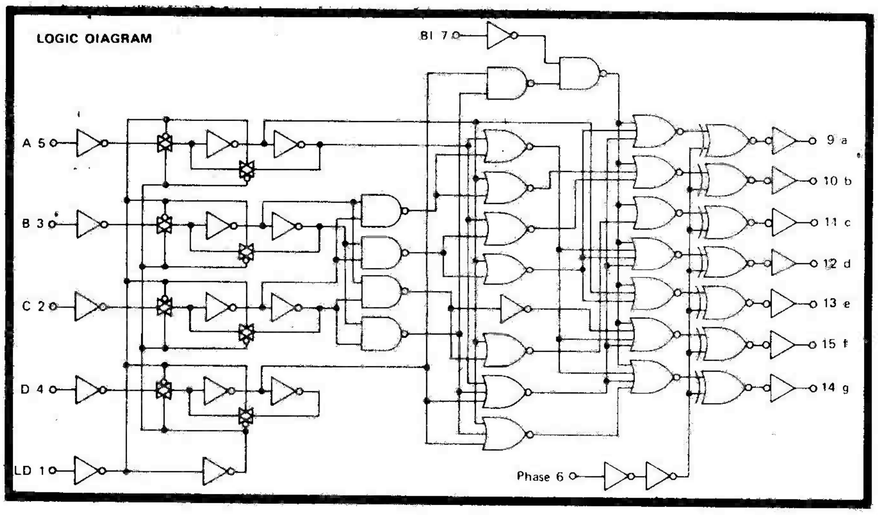
The MC1453 BCD-to-seven segment latch/decoder/driver is designed for use with liquid crystal readouts, and is constructed with complementary MOS (CMOS) enhancement mode devices. The circuit provides the functions of a 4-bit storage latch and an 8421 BCD-to-seven decoder and driver.

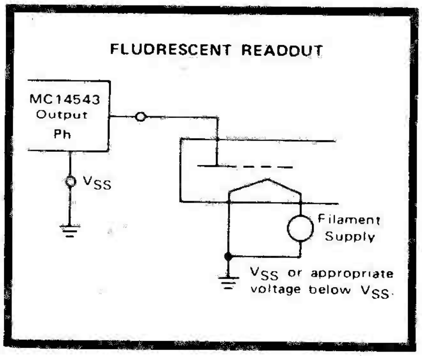
In order to drive LCD displays, which require a non-polarised drive, the MC 14543 has a 'phase' input. With a square wave applied to this pin, the output phase reverses in step, thus satisfying the requirement. To drive common anode LED displays, Ph input should be held high, and low for common cathode LEDs. Other display types can be driven, but with transistor interface.

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.For proper operation it is recommended that V_{in} and V_{out} be constrained to the range $V_{SS} \leqslant (V_{in}$ or $V_{out}) \leqslant V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}).

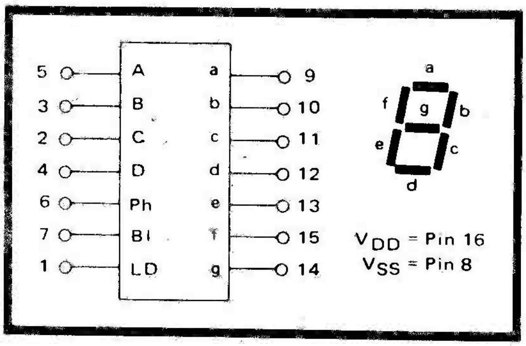






ELECTRICAL CHARACTERISTICS

Characteristic	V_{DD} Vdc	MC14543CL/CP +25°C Min	Typ	Max	Unit
Output Voltage "0" Level	5.0	–	0	0.01	Vdc
	10	–	0	0.01	
	15	–	0		
"1" Level	5.0	4.99	5.0		
	10	9.99	10		
	15		15		
Noise Immunity*					
($V_{out} \geqslant$ 3.5 Vdc)	5.0	1.5	2.25		Vdc
($V_{out} \geqslant$ 7.0 Vdc)	10	3.0	4.50		
($V_{out} \geqslant$ 10.5 Vdc)	15		6.75		
($V_{out} \leqslant$ 1.5 Vdc)	5.0	1.5	2.25		Vdc
($V_{out} \leqslant$ 3.0 Vdc)	10	3.0	4.50		
($V_{out} \leqslant$ 4.5 Vdc)	15		6.75		
Output Drive Current					
(V_{OH} = 2.5 Vdc) Source	5.0	-0.20	-1.9		mAdc
(V_{OH} = 9.5 Vdc)	10	-0.20	-1.0		
(V_{OH} = 0.5 Vdc)	10		9.7		
(V_{OH} = 13.5 Vdc)	15		3.9		
(V_{OL} = 0.4 Vdc) Sink	5.0	0.20	0.78		mAdc
(V_{OL} = 0.5 Vdc)	10	0.50	2.0		
(V_{OL} = 9.5 Vdc)	10		11.4		
(V_{OL} = 1.5 Vdc)	15		7.8		
Input Current			10		pAdc
Input Capacitance			5.0		pF
Quiescent Dissipation**†					mW
(C_L = 15 pF, f = 0 MHz)					
P_D = (4.8 mW/MHz) f + 0.000025 mW	5.0		0.000025	0.25	
P_D = (19 mW/MHz) f + 0.00010 mW	10		0.00010	1.0	
P_D = (43 mW/MHz) f + 0.00023 mW	15		0.00023		
Minimum Latch Disable Pulse Width (Strobing Data)					ns
	5.0		125	375	
	10		50	150	
	15		40		



INPUTS							OUTPUTS							
LD	BI	Ph*	D	C	B	A	a	b	c	d	e	f	g	Display
X	1	0	X	X	X	X	0	0	0	0	0	0	0	Blank
1	0	0	0	0	0	0	1	1	1	1	1	1	0	0
1	0	0	0	0	0	1	0	1	1	0	0	0	0	1
1	0	0	0	0	1	0	1	1	0	1	1	0	1	2
1	0	0	0	0	1	1	1	1	1	1	0	0	1	3
1	0	0	0	1	0	0	0	1	1	0	0	1	1	4
1	0	0	0	1	0	1	1	0	1	1	0	1	1	5
1	0	0	0	1	1	0	1	0	1	1	1	1	1	6
1	0	0	0	1	1	1	1	1	1	0	0	0	0	7
1	0	0	1	0	0	0	1	1	1	1	1	1	1	8
1	0	0	1	0	0	1	1	1	1	1	0	1	1	9
1	0	0	1	0	1	0	0	0	0	0	0	0	0	Blank
1	0	0	1	0	1	1	0	0	0	0	0	0	0	Blank
1	0	0	1	1	0	0	0	0	0	0	0	0	0	Blank
1	0	0	1	1	0	1	0	0	0	0	0	0	0	Blank
1	0	0	1	1	1	0	0	0	0	0	0	0	0	Blank
1	0	0	1	1	1	1	0	0	0	0	0	0	0	Blank
0	0	0	X	X	X	X	**							**
1	1	1	*				Inverse of Output Combinations Above							Display as above

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2N456	1.40
2N456A	1.54
2N457A	1.70
2N490	4.60
2N491	5.00
2N492	5.75
2N493	5.98
2N696	0.25
2N697	0.16
2N698	0.82
2N699	0.55
2N706	0.12
2N706A	0.12
2N708	0.21
2N709	0.50
2N711	0.55
2N718	0.22
2N718A	0.40
2N720	0.69
2N914	0.22
2N916	0.43
2N918	0.34
2N929	0.25
2N930	0.26
2N1302	0.37
2N1303	0.37
2N1304	0.40
2N1305	0.40
2N1306	0.45
2N1307	0.45
2N1308	0.60
2N1309	0.60
2N1671	1.80
2N1671A	1.92
2N1671B	2.12
2N1711	0.27
2N1907	5.50
2N2102	0.60
2N2147	1.40
2N2148	1.65
2N2160	1.10
2N2218A	0.47
2N2219	0.42
2N2219A	0.52
2N2220	0.35
2N2221	0.22
2N2221A	0.26
2N2222	0.25
2N2222A	0.25
2N2368	0.17
2N2369	0.25
2N2369A	0.21
2N2646	0.55
2N2647	1.10
2N2904	0.36
2N2904A	0.37
2N2905	0.37
2N2905A	0.38
2N2906	0.28
2N2906A	0.25
2N2907	0.21
2N2907A	0.22
2N2924	0.15
2N2926	0.13
2N3053	0.25
2N3054	0.50
2N3055	0.65

2N3390	0.37
2N3391	0.29
2N3391A	0.34
2N3392	0.14
2N3393	0.15
2N3394	0.15
2N3414	0.15
2N3415	0.17
2N3416	0.23
2N3418	0.27
2N3440	0.57
2N3441	0.78
2N3442	1.20
2N3638	0.16
2N3638A	0.16
2N3639	0.30
2N3641	0.20
2N3702	0.17
2N3703	0.15
2N3704	0.15
2N3705	0.15
2N3706	0.14
2N3707	0.18
2N3708	0.14
2N3709	0.15
2N3710	0.14
2N3711	0.15
2N3712	1.20
2N3713	2.30
2N3714	2.45
2N3715	2.45
2N3716	2.60
2N3771	1.60
2N3772	1.70
2N3773	2.65
2N3779	6.00
2N3790	2.75
2N3791	2.75
2N3792	2.90
2N3794	0.20
2N3819	0.36
2N3820	0.29
2N3823	0.61
2N3904	0.21
2N3906	0.22
2N4036	0.67
2N4037	0.55
2N4058	0.20
2N4059	0.15
2N4060	0.20
2N4061	0.17
2N4062	0.18
2N4126	0.17
2N4289	0.30
2N4919	0.85
2N4920	0.90
2N4921	0.60
2N4922	0.65
2N4923	0.70
2N5190	0.70
2N5191	0.80
2N5192	1.00
2N5195	1.10
2N5245	0.29
2N5294	0.35

2N5295	0.40
2N5296	0.36
2N5298	0.40
2N5457	0.29
2N5458	0.26
2N5459	0.29
2N5492	0.42
2N5494	0.45
2N5496	0.50
2N5777	0.45
2N6027	0.45
3N128	0.80
3N139	1.45
3N140	1.00
3N141	0.85
3N200	2.60
40361	0.45
40362	0.48
40363	1.00
40389	0.50
40394	0.60
40395	1.20
40406	0.48
40407	0.38
40408	0.50
40409	0.55
40410	0.55
40411	2.30
40594	0.75
40595	0.85
40601	0.70
40602	0.50
40603	0.60
40604	0.60
40636	1.15
40673	0.73
AC126	0.37
AC127	0.44
AC128	0.37
AC151V	0.35
AC152V	0.50
AC153	0.40
AC153K	0.42
AC154	0.45
AC176	0.40
AC176K	0.45
AC187K	0.46
AC188K	0.45
AD142	0.65
AD143	0.75
AD149	0.74
AD150	1.20
AD161	0.75
AD162	0.75
AF106	0.45
AF114	0.85
AF115	0.65
AF116	0.65
AF117	0.65
AF118	0.65
AF124	0.65
AF125	0.65
AF126	0.65
AF127	0.65
AF139	0.69

AF186	0.50
AF200	0.70
AF239	0.74
AF240	0.90
AF279	0.80
AF280	0.85
AL102	1.50
AL103	1.50
BC107	0.14
BC108	0.12
BC109	0.15
BC113	0.17
BC115	0.19
BC116	0.19
BC116A	0.20
BC117	0.22
BC118	0.16
BC119	0.30
BC121	0.45
BC125	0.18
BC126	0.25
BC132	0.30
BC134	0.15
BC135	0.15
BC136	0.19
BC137	0.14
BC140	0.60
BC141	0.65
BG142	0.30
BC143	0.30
BC147	0.10
BC148	0.10
BC149	0.13
BC153	0.27
BC154	0.27
BC157	0.12
BC158	0.11
BC160	0.78
BC167	0.12
BC168	0.12
BC169	0.12
BC170	0.16
BC171	0.14
BC172	0.12
BC177	0.19
BC178	0.18
BC179	0.21
BC182	0.11
BC182L	0.14
BC183	0.11
BC183L	0.14
BC184	0.12
BC184L	0.14
BC207	0.11
BC208	0.10
BC212	0.14
BC212L	0.17
BC214L	0.17
BC237	0.14
BC238	0.12
BC239	0.15
BC251	0.15
BC253	0.22
BC257A	0.17
BC258A	0.17

ENQUIRIES WELCOME FOR DEVICES NOT LISTED

BC259B	0.18
BC261A	0.21
BC262B	0.19
BC263C	0.24
BC300	0.45
BC301	0.45
BC303	0.60
BC307	0.20
BC308	0.18
BC309C	0.25
BC317	0.14
BC318	0.13
BC337	0.19
BC338	0.21
BC547	0.12
BC548	0.10
BC549	0.13
BCY30	1.03
BCY31	1.06
BCY32	1.18
BCY33	0.90
BCY34	0.98
BCY38	2.00
BCY42	0.60
BCY58	0.55
BCY59	0.32
BCY70	0.25
BCY71	0.26
BCY72	0.24
BD115	1.20
BD116	1.20
BD121	2.00
BD123	2.00
BD124	2.00
BD131	0.51
BD132	0.54
BD135	0.42
BD136	0.42
BD137	0.45
BD138	0.48
BD139	0.50
BD140	0.50
BD529	0.35
BD530	0.38
BDY20	1.13
BF115	0.36
BF117	0.70
BF121	0.55
BF123	0.55
BF152	0.25
BF153	0.25
BF154	0.25
BF159	0.35
BF160	0.30
BF161	0.60
BF166	0.40
BF167	0.33
BF173	0.33
BF177	0.38
BF178	0.45
BF179	0.48
BF180	0.45
BF181	0.45
BF182	0.45
BF183	0.45
BF184	0.35
BF185	0.35

BF194	0.12
BF195	0.11
BF196	0.13
BF197	0.14
BF198	0.15
BF200	0.31
BF225J	0.25
BF244	0.35
BF245	0.34
BF246	0.75
BF254	0.20
BF255	0.20
BF257	0.37
BF258	0.49
BF259	0.49
BF459	0.39
BFR39	0.24
BFS21A	2.60
BFS28	1.04
BFS61	0.30
BFS98	0.27
BFX29	0.36
BFX30	0.38
BFX84	0.38
BFX85	0.41
BFX87	0.35
BFX88	0.32
BFX89	0.95
BFY50	0.30
BFY51	0.38
BFY52	0.36
BFY53	0.34
BFY90	1.27
BRY39	0.50
BSX20	0.31
BSX21	0.32
BU105	3.05
BU205	2.40
CA3028A	0.85
CA3030A	1.50
CA3035	1.35
CA3046	0.73
CA3048	2.15
CA3052	1.62
CA3080A	1.10
CA3089E	2.00
CA3090Q	4.25
CA3130	0.88
LM301A	0.47
LM308N	1.32
LM309K	1.80
LM380	0.98
LM381AN	2.07
LM702C	0.75
LM709CAN	0.40
LM741CAN	0.38
8DIL	0.35
14DIL	0.40
LM710	0.45
LM3900N	0.55
LM723C	0.60
LM733	0.88
LM709CAN	0.40
8DIL	0.40
14DIL	0.40
LM747	0.78
LM748	0.44

8DIL	0.44
14DIL	0.41
LM7805P	1.39
LM7812P	1.39
LM7815P	1.39
LM7824P	1.39
MC1303	1.47
MC1310	1.96
MC1330P	0.75
MC1351P	0.87
MC1352P	0.87
MC1466L	3.95
MC1469R	2.50
ME0402	0.20
ME0404	0.15
ME0412	0.20
ME4102	0.10
ME4104	0.10
MJ480	1.05
MJ481	1.30
MJ490	1.05
MJ491	1.55
MJ2955	1.21
MJE340	0.58
MJE370	0.68
MJE371	0.81
MJE520	0.65
MJE521	0.75
MJE2955	1.25
MJE3055	0.75
MP8111	0.35
MP8112	0.40
MP8113	0.45
MPF102	0.30
MPSA05	0.20
MPSA06	0.20
MPSA12	0.35
MPSA55	0.20
MPSA56	0.20
MPSU05	0.40
MPSU06	0.40
MPSU55	0.45
MPSU56	0.45
NE555V	0.48
NE556	1.30
NE560D	4.48
NE561	4.48
NE565	1.30
OC28	2.00
OC35	1.50
OC42	0.50
OC45	0.75
OC71	0.45
OC72	0.45
OC81	0.75
OC83	0.50
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SL611C	2.35
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TBA651	1.80
TBA810	1.16
TBA820	1.03
TBA920	1.79
TIL209	0.30
TIP29A	0.50
TIP30A	0.60
TIP31A	0.62
TIP32A	0.75
TIP33A	1.00
TIP34A	1.20
TIP35A	2.50
TIP36A	3.35
TIP41A	0.70
TIP42A	0.90
TIP29c	0.75
TIP30c	0.85
TIP31c	0.85
TIP32c	1.00
TIP33c	1.45
TIP34c	1.70
TIP41c	1.00
TIP42c	1.20
TIP2955	1.00
TIP3055	0.50
TIS43	0.30
ZTX300	0.15
ZTX301	0.15
ZTX302	0.20
ZTX500	0.15
ZTX501	0.15
ZTX502	0.18
ZTX530	0.23
ZTX531	0.22

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CD4011	0.20	CD4027	0.56	CD4510	1.54
CD4012	0.20	CD4028	0.91	CD4511	1.54
CD4013	0.57	CD4029	1.17	CD4516	1.40
CD4014	1.01	CD4030	0.57	CD4518	1.26
CD4015	1.01	CD4031	2.26	CD4520	1.26
CD4016	0.56	CD4037	0.97	CD4553	4.07
CD4017	1.01	CD4041	0.83		

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SN7402	0.21	SN7416	0.46	SN7441	0.80	SN7470	0.35	SN7485	1.48	SN74118	0.99	SN74157	0.78	SN74176	0.98
SN7403	0.26	SN7417	0.46	SN7442	0.61	SN7472	0.29	SN7486	0.32	SN74119	2.02	SN74160	1.20	SN74180	2.96
SN7404	0.26	SN7420	0.21	SN7446	0.98	SN7473	0.33	SN7490	0.49	SN74121	0.39	SN74161	1.20	SN74181	2.85
SN7405	0.26	SN7423	0.30	SN7447	0.89	SN7474	0.33	SN7491	0.77	SN74122	0.54	SN74162	1.20	SN74190	1.48
SN7406	0.59	SN7425	0.30	SN7448	0.89	SN7475	0.46	SN7492	0.49	SN74123	0.46	SN74163	1.20	SN74191	1.27
SN7407	0.59	SN7427	0.30	SN7450	0.21	SN7476	0.39	SN7493	0.49	SN74141	0.80	SN74164	0.98	SN74192	1.27
SN7408	0.22	SN7430	0.21	SN7451	0.21	SN7480	0.55	SN7494	0.85	SN74145	0.83	SN74165	0.98	SN74193	1.27
SN7409	0.22	SN7432	0.20	SN7453	0.21	SN7481	1.25	SN7495	0.61	SN74150	1.66	SN74167	4.20	SN74196	1.27
SN7410	0.21	SN7437	0.43			SN7482	0.77	SN7496	0.88	SN74151	0.85			SN74197	0.90
														SN74198	0.90
														SN74199	2.28
														SN76003N	2.28
														SN76013N	1.90
														SN76023N	1.91
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¼" stereo chrome plug	30p
¼" stereo plastic line socket	20p
¼" stereo chrome line socket	35p
¼" stereo plastic switched socket	25p
3.5mm plug	10p
3.5mm socket	10p
3.5mm line socket	10p
2.5mm plug	10p
2.5mm socket	10p

SWITCHES

1p on off Min Toggle	50p
1p 2w Min Toggle	55p
2p 2w Min Toggle	60p
1 pole push test	15p
2p 2w Slide	15p
2p 2w C off Slide	20p
1p 2w C.off Rocker	30p
Mains Neon Rocker	65p
10A C off Toggle	50p
1p on off Std Toggle	28p
2p 2w Std. Toggle	35p
1p on off Latching Button	60p
1p 2w Latching Button	65p
2p 2w Latching Button	80p
Stoppable Rotary 1p–12W, 2p–6W, 3p–4W, 4p–3W	45p

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ELECTRONICS —it's easy! PART 35

Digital Computers

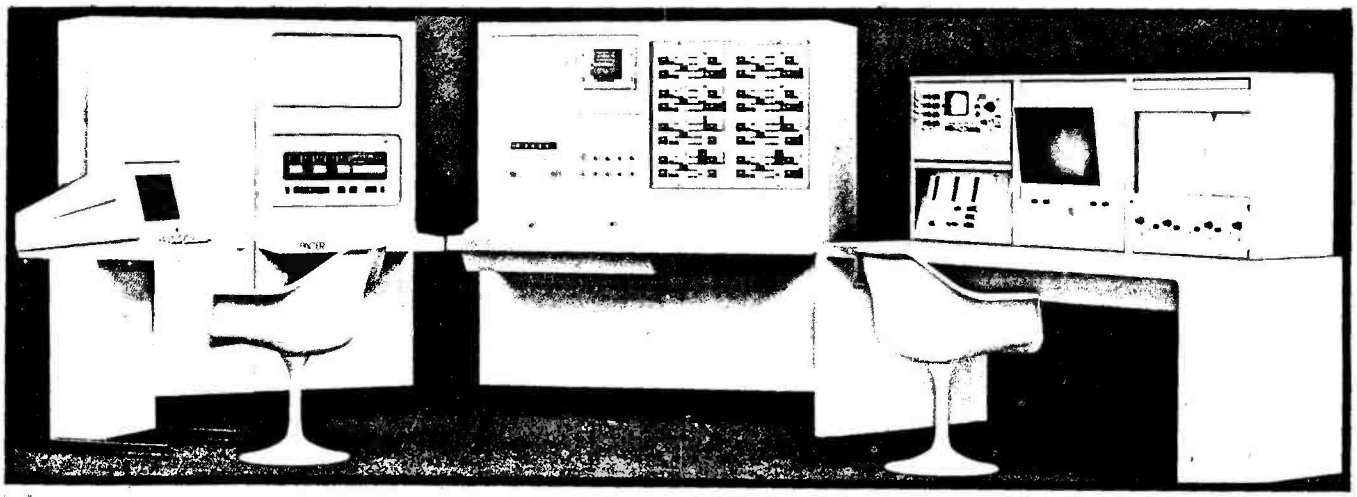

Fig. 1. Here a digital computer and an analogue computer are combined — the result is known as a hybrid computer.

THROUGHOUT THIS COURSE we have been steadily building up sufficient information to enable discussion of computing machine operations. What follows is necessarily an introduction only — computers are now extremely sophisticated in design and the manufacturing methods very specialised. It is, however, quite important that the operation of computers be understood by electronic craftsmen at a general systems level. This, and the next part, will introduce the philosophies, the hardware and the operation of digital computers from a technical rather than user-only viewpoint. (Analogue computers were briefly mentioned in part 13 — they are still valuable in some applications but in general, machine computing is now mainly done digitally).

WHAT IS A COMPUTER?

Regardless of whether a computer is digital or analogue in operation its role is to perform various kinds of mathematical operations. The analogue machine cannot perform logic operations: (unless joined with a digital computer, in which case it is known as a hybrid computer — as shown in Fig. 1) its use is generally restricted to what are called linear mathematical problems in which signals vary continuously and information is transferred as levels not as digital codes. Analogue computers can be very good at such operations, often better than a digital computer of similar cost. The digital machine, on the other hand, (a general purpose installation is shown in Fig. 2) can perform almost any kind of mathematical manipulation, however special techniques are often needed to solve analogue problems. Analogue type signals must be sampled and each sample converted into a digital equivalent before they can be processed in digital machines: this is where the digital machine in certain applications may be less efficient than the analogue alternative.

As well as performing arithmetical operations (called scientific computing) the digital machine can be instructed to process or sort discrete data in digitally encoded form (called data processing or DP, for short). Typical computer data processing operations are the sorting of numerical data — for example to see how many people have heights of various chosen values, or the booking of airline seats. Mixed working, where scientific calculation and data-processing are both involved, occurs for example, in costing out a building estimate, raising a stock value for a business, or producing pay-slips.

Digital computers may also calculate tables by automatically incrementing the input data between preset limits. For example the computer could be asked to generate and print the sines of all angles between 10° and 90° at 1° intervals.

We pause now to note that we call such machines computers *not* calculators. The term calculator has

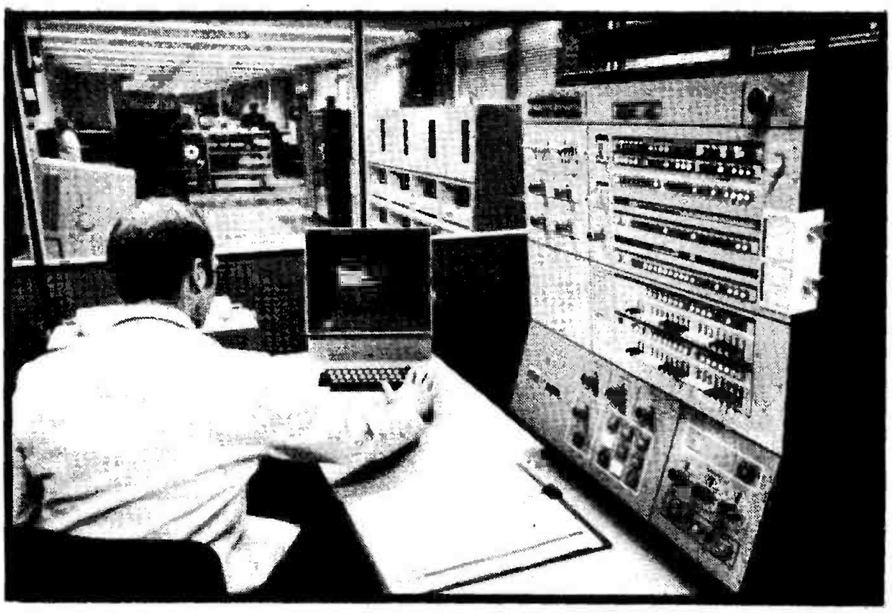

Fig. 2. General purpose digital computer, this centre is used by Lloyds Bank.

traditionally been used to describe machines which perform a fixed set of mathematical calculations. The term computer on the other hand, is reserved for those machines which may be reconfigured by a set of programme instructions to perform any particular task. However such distinction between the roles of calculator and computer is becoming increasingly difficult to make. Some computers are now dedicated to performing calculator like tasks and some calculators are now so flexible that they can be programmed to perform a variety of tasks.

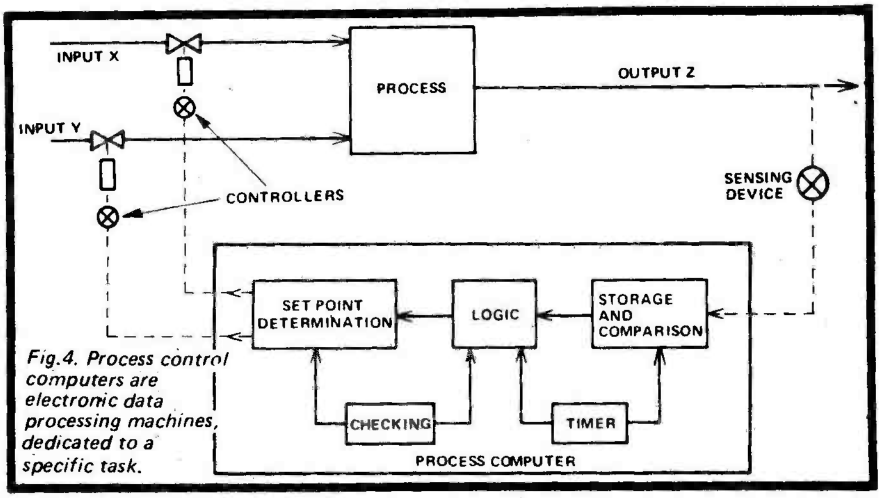

Fig.4. Process control computers are electronic data processing machines, dedicated to a specific task.

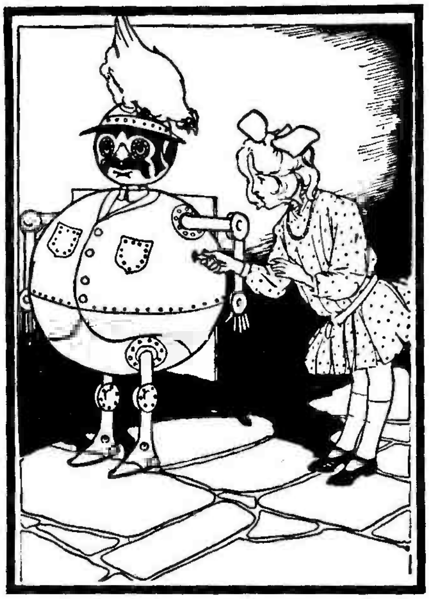

Fig. 3. As yet, computers can only do what they are programmed to do.

In the 1950s, when powerful electronic computers were emerging, the popular concept was of a machine that would soon have thinking powers of its own — and its own will and imagination — as depicted in Fig. 3. Although we must concede such is probably possible one day — no one has yet gained an inkling into how this extra facility could be realised. Computers are merely machine slaves that, if working internally as the designer thinks and intends, will perform as commanded. The operator informs the machine of its job via the programme presented to it. Where the computer has valuable merit is in its ability to perform calculations and process numerical data at rates vastly greater than a human mind, with rarely an error, and for hours on end if need be. It is a tool and no more. To say the computer accidently sent the £1,000,000 bill to Bill Blogs is entirely incorrect. The programmer or the machine did not perform as hoped through one or the other being defective in the instructions given or the way they were obeyed.

As well as computers that operate only when the operator gives instructions there is also the dedicated machine that, once set internally to compute or process in a predetermined way, becomes part of a process. It helps control by working at the same rate as signals are generated in the process — real time working. Process-control computers, as these are called, operate on data and perform calculations as part of many feedback loops in, say, a chemical plant. Figure 4 shows this use in a diagrammatic form. Other names variously used to describe this use are in-line, on-line, direct-digital-control (DDC) or just plain computer control. Wherever automation of extensive complex process is necessary a computer will usually be found — waste-water treatment plants, paper manufacture, natural gas and electricity distribution networks, satellite control and power-station plant operation are but a few of thousands of in-line applications. Computers are far more useful in this task than human operators — see Fig. 5.

On-line operation (although not generally agreed upon) is a term probably best reserved for cases where each of many input terminals connected to a central computer can gain access to the unit when it becomes available. This is also known as time-sharing and is used where the signal processing rate need not match the process. The computers used in banking in Britain operate in a time-sharing mode — bank branches,

	Machine	Man
Speed	Much superior	Lag 1 sec.
Power	Consistent at any level	1500W for about 10 sec, 350 W for a few minutes, 150 W for continuous work over a day.
Consistency	Ideal for routine, repetition, precision	Not reliable — should be monitored by machine.
Complex activities	Multi-channel	Single channel.
Memory	Best for literal reproduction and short-term storage	Large store multiple access. Better for principles and strategies.
Reasoning	Good deductive	Good inductive.
Computation	Fast, accurate — poor at error correction	Slow, subject to error Good at error correction.
Input sensitivity	Some outside human senses, e.g. radioactivity	Wide range (10^{12}) and variety of stimuli dealt with by one unit, e.g. eye deals with relative location, movement and colour.
	Insensitive to extraneous	Affected by heat, cold, noise and vibration.
	Poor for pattern detection	Good at pattern detection. Can detect signals in high noise levels.
Overload reliability	Sudden breakdown	Graceful degradation.
Intelligence	None	Can deal with unpredicted and unpredictable. Can anticipate.
Manipulative abilities	Specific	Great versatility.

Fig. 5. Fitt's list summarizes the relative advantages of man versus machine control.

Fig. 6. Mini-computers come in all shapes and sizes. On the left, in the console, is the H.P. 2000 that controls the pattern being knitted on the Kirkland knitting machine.

can gain access to the central account records – a short wait may be necessary. When the computer works on diverse problems at the will of the operator and is not used for any dedicated purpose it is said to be off-line.

Originally electronic computers were huge – several rooms filled with racks of valve electronic circuits. In the mid-sixties manufacturing techniques and designs were such that a new style of less versatile but compact computer was marketed – the so-called minicomputer. Figure 6 shows but one kind of mini-computer system employed to control a process by providing instructions as needed. (It is not used in closed-loop as this process does not feed data back to the computer).

We do not use the word "generation" in connection with the minicomputer because that term is used in computer jargon in two distinct ways. It may describe the hardware used – first generation computers use thermionic valves and ordinary cable wiring, such

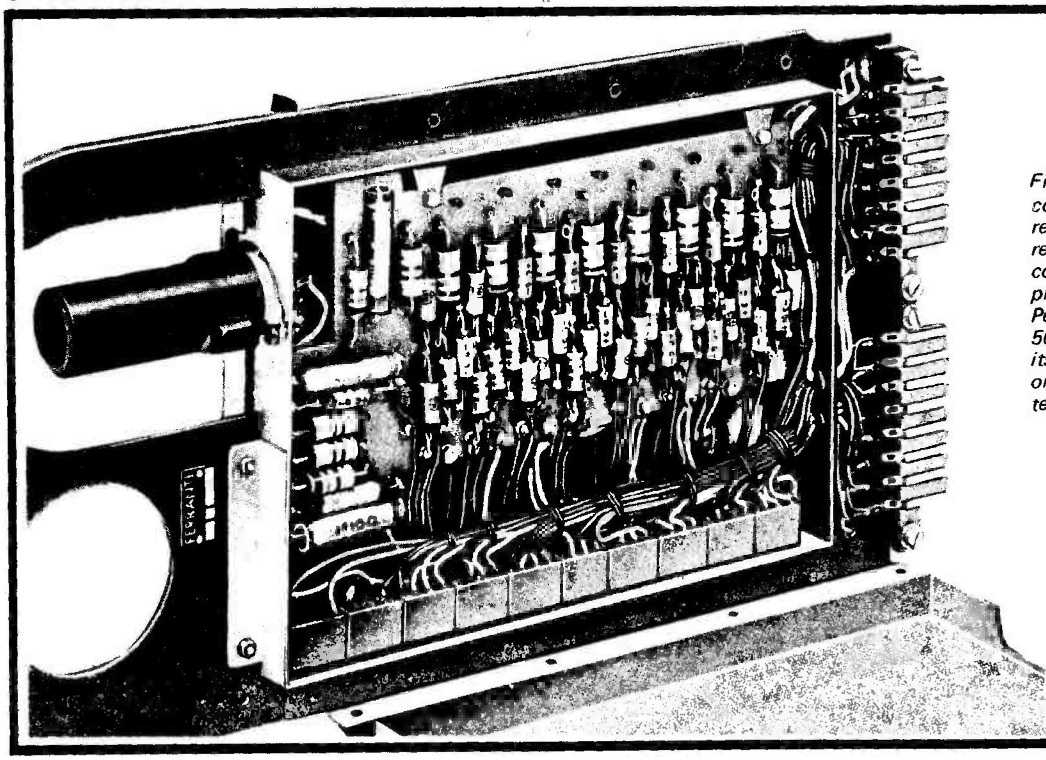

Fig. 7. Compact electronic computer systems become reality when valves were replaced by solid-state components. This single plug-in unit, from a Pegasus computer of the 50s, would today have its entire function made on a pinhead in LSI technology.

as shown in Fig. 7, second generation machines use discrete transistor circuits on printed-circuit boards, third generation machines use integrated-circuitry and the most recent, about to emerge, fourth generation computers use large-scale-integration LSI manufacturing methods – A fifth generation computer is yet to emerge as an accepted concept. The other use of "generation" is in describing the system interconnections – the philosophy of system hardware philosophy of system hardware interconnection and style, and capacity of the store involved.

A HISTORY OF COMPUTING MACHINES

Intertwined with the development of machine operated logic (studied at the beginning of Part 24) was the gradual increase in sophistication of computing machine systems.

Earliest devices were simple calculators based on mechanical concepts. They performed simple addition, subtraction and sometimes multiplication and division, doing this without the ability to store or hold values other than inputs and computed output.

Space does not permit extensive description of this history – see the reading list for that. Figure 8 shows the style of the first calculating machine of the "modern" kind. This performed arithmetic addition and subtraction only, by mechanically manipulating interconnected counting wheels and was probably made by Pascal in 1642. In 1671 Leibniz modified the same mechanism (see Fig. 8) to obtain multiplier action, producing his own design calculator much later – in 1694. Because mechanism manufacture at that time was crude indeed – all parts were individually hand-crafted – the Leibniz machine was not reliable even though the concepts involved were sound. Improvements in mechanical manufacture had to occur before a routinely useful gear and crank calculator could be built (by de Colmar in 1820). Thus, through these and many other gradual improvements to method and manufacture, the scene was set for grander ideas.

A major advance was made by Babbage. Charles Babbage was born in Devon, England. In 1792, he became a Professor of Mathematics at Cambridge University and had a consuming passion for mechanical machines that could perform far more advanced mathematical operations than any previous apparatus. His first machine, shown in Fig. 9, was devised to solve differential equations by calculating differences. This was his

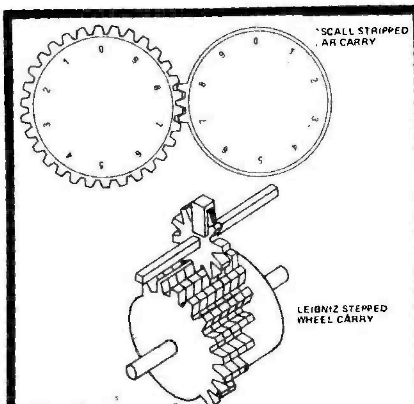

Fig. 8. Pascal's calculator of 1642 used stripped gear toothed-wheels to produce a carry to the next decade: The Leibniz machine made use of the stepped wheel.

"Difference Engine" of about 1812. In 1833 he conceived a second, quite different general-purpose engine – the so-called "Great Calculating Engine". In principle, it could do any mathematical operation by following instructions programmed into it by the operators. It could also make decisions, on what to do next, that were based on its just calculated results.

Babbage used punched-cards for input information (a reasonably logical choice in view of the many repetitive industrial processes using this control medium at that time), a memory (which he called "the store"), a number processing section (called the mill), a means of transferring results to and from the store, and automatic output (as cast type ready to print). It was a grand machine having ability to store 1000 fifty-digit numbers in its store. It even had overflow indication.

The intended power supply was steam. Sadly, Babbage's engines were not proven in practice in his time; those built were either not completed or proved too unreliable. Manufacturing methods were still incapable of maintaining the tolerances needed – it was a classical example of a concept waiting for the requisite technology.

Complicated mathematical equation solving in the 19th and very early 20th century was performed on other kinds of special purpose mechanical calculating devices. The planimeter, which determines area under a curve, was devised in 1814, the mechanical ball-and-disk integrator was deviced in 1876 (by Lord Kelvin's brother). With these and other basic mechanical-function solving ideas, Lord Kelvin and others put systems together that carried out specialised calculations. Kelvin produced a tidal

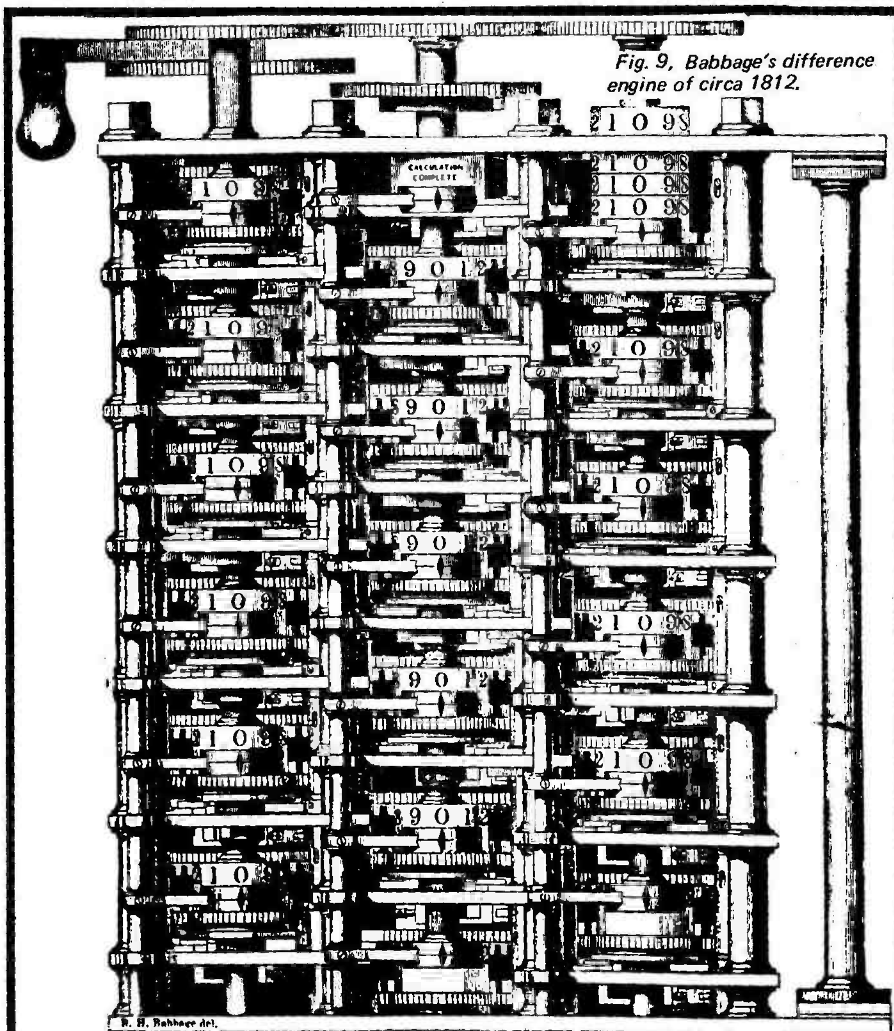

Fig. 9, Babbage's difference engine of circa 1812.

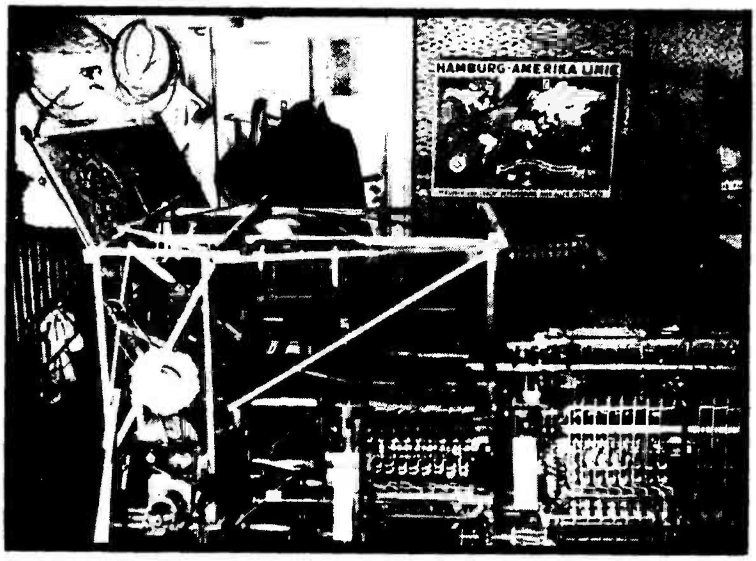

Fig. 10. This relay-switched digital calculator was built by Zuse in Germany in 1936. ((This photograph has been included because of its historical interest — unfortunately the original print is of border-line quality).

amplitude and phase predictor for sea-tide forecasting around 1874. Later in 1898 Michelson (of speed of light fame) worked with Stratton to produce a mechanical harmonic analyser.

Special-purpose mechanical calculators were still in use in the 1940s. During World War II, for instance, gun crews fed data concerning range, direction and wind strength into computers by which the correct aiming information for the gun was computed.

Today a few equipments still perform simple operations by mechanical means for in applications where electrical power is not available and the inputs not in electrical form it may be more economic to use mechanical methods.

With the advent of electronic amplification at the turn of this century electronic circuitry gradually replaced mechanical mathematical functions. This was feasible because of the superior speed of calculation, reduced manufacturing tolerances and greater reliability of electronics. The swing to electronics was intensified by the need to process an ever increasing amount of data that arises in, for example, more complex equation solving, census taking, or warfare. Hollerith devised the punched-card sorting machine to help handle the U.S. census data. This device won an 1890 competition organised by the U.S. Government.

Electric computers using the same basic system that we use today became reality around 1936 when Zuse, in Germany, built the relay-switched digital calculator (shown in Fig. 10). This machine featured automatic computing, binary arithmetic, floating decimal point and punched-tape programming. In 1937 the USA's IBM Corporation began development of a machine called the Automatic Sequence-Controlled Calculator, or, locally, just Mark I.

The trend toward total electronic working continued. ENIAC, generally recognised as the first all-electronic computer, had 18 000 valves and could operate at 500 additions per second. This was followed, after many other developments, by the first production computer — the Remington Rand UNIVAC I. It has been estimated that all computers installed in the U.S. in 1955 could do just 250 000 additions per second. Just one low-cost mini can do that today.

In 1959 a U.S. refinery installed the first process-control computer system and in 1960 a large steel corporation in U.S. was the first to use a computer to carry out inventories, handle orders and control production. Airline booking by computer began in 1964.

Integrated circuits (in the third generation machines) came into use in 1964 via the IBM 360 system and by 1970, in the U.S. alone, roughly 1 000 000 people were employed in making and using digital computers.

Single chip, fourth generation machines came to reality around 1972 with the use of LSI. Today (or at least when this was written early in 1976) pocket scientific calculators containing over 30 000 transistors in LSI form can be purchased for less than a week's wages. In 1974 the world market for small calculators was estimated to be 40 million! The cost of modern computers is now governed by the cost of the peripheral bits and pieces rather than the processing unit itself — the cost of the electronic components is now just a minor part of the whole. ●

Further reading

Two books, already referred to in Part 22, are relevant, these are:

"A Computer Perspective", C. and R. Eames, Harvard University Press, Massachusetts, 1973. (This is a definitive work on the development of data processing equipment from 1800 to 1940).

"Electronic Computers — Made Simple", H. Jacobowitz and L. Basford, W.H. Allen, London, 1967. (Although out of date with respect to certain aspects of hardware this provides a valuable basis for technical understanding of both analogue and digital computers. It also explains the arithmetrical operations).

"Introducing Computers", M. Laver, HMSO, London, 1973. (A version compiled for users with a little technical knowledge. It discusses programming procedures).

"Computers at work" J.O.E. Clark, Bantam Books, London 1973 (A most useful book on where computers are used).

"Electronic Computers", S.H. Hollingdale and G.C. Tootil, Penguin Book A524, Harmondsworth, 1965. (A fine layman's summary of analogue and digital computers including a lengthy chapter on what sort of jobs computers do).

Computer programming is covered in many texts and booklets. One example is:

"Elements of Computer Programming", K.P. Swallow and W.T. Price; Holt, Rinehart and Wilson, New York, 1965.

ALGOL language began to emerge in 1958 as a step toward a universal computer language for scientific working. COBOL is the commercial counterpart. Relevant books are:

"Basic ALGOL", W.R. Broderick and J.P. Barker, IPC Electrical and Electronic Press, 1970.

"A Guide to COBOL Programming", D. McCracken, Wiley, New York, 1970. ●

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AND NOW THE LINEAR MPU?

THE MICROPROCESSOR GREW from the requirement for a general purpose digital logic handling system, in eighteen months or so that requirement has caused the growth of a sackful of different devices. Now two new types of technology look as if they could do the same for linear or digital/linear applications.

The first of these new technologies is called bi-MOS or bi-FET and these usually have bipolar outputs and matched field-effect transistors at their inputs. This means that the devices have input bias currents that are typically 1,000 times lower than those of bipolar only chips, also they respond more than 10 times faster, offer broader bandwidths and have lower noise figures. The difference between bi-FET and bi-MOS is that bi-MOS is easier to produce but has problems like diode protection requirements on the inputs to guard against static and they have slightly worse noise and drift characteristics than bi-FETs.

Most of today's mixed-process linears are operational amplifiers but other types of devices are beginning to appear with our old friends National Semiconductors leading the field at present with a list of op-amps, instrumentation amplifiers, comparators, analogue switches and sample and hold circuits. Motorola is getting in on the act with a quad op-amp where each amplifier in the package will have a 10MHz bandwidth, at about £15 per package it will look expensive but the savings in associated circuitry could be vast. The problem which most manufacturers seem to be having is in deciding which direction to take from here, with so many combinations of technologies possible on one chip the range of possible products is enormous, so if they don't have what you want at present they probably will have within the next eighteen months. With RCA working on a bipolar/CMOS op-amp and Siliconix using bi-MOS in a 3½ digit A-D converter the days of standard hybrids is coming to an end and the day of the linear MPU is coming; just imagine what you could do with bi-polar and MOS linear and digital circuits on one chip!

According to National, bi-FET processing, besides being more complex than straight bipolar technology, requires 5 to 10 times more die area than the equivalent bipolar function. As a result bi-FETs will always cost about 15% more than the bipolar equivalent, if there is a bipolar equivalent.

MORE BITS IN ONE BASKET

Signetics Corp, a division of Philips, have recently announced a new technique which may help to cut back the requirements for additional die area mentioned above. Consider a standard bipolar or MOS memory or shift register, each data byte is defined by eight data bits (or ten or sixteen) each of which could be in a logic '0' or '1' status. With the advent of bus structured systems a third (TRI-STATE) output was required which had a very high impedance state and thus followed the status ('0' or '1') of any other data connected to that bus. TRI-STATE is however simply a third alternative output state, any data inside the memory, buffer or gate is still stored in binary for the simple reason that the memory transistors can only be in an ON or OFF state; with my knowledge of transistors even I can see that a transistor system can hold a current level which is between ON and OFF.

Signetics have announced that they have built and tested some non-binary circuits which could increase the processing capability of bipolar LSI some 4 to 10 times, with figures of 1000 times being muttered for the future. The firms first multivalued circuits use integrated injection logic and current-mode thresholding for a four-level system; eight, ten or sixteen level logic systems are also practical. In such systems, metal conductors carry either 0, 1, 2 or 3 levels of current with resultant savings in pin counts and die area.

So far as I can gather, the technique is simply to adjust the outputs of the input transistors so that one set of transistor outputs are connected together to form a weighted version of the input, this is virtually a digital to analogue converter. The ability to discriminate from several input thresholds is derived from binary based ECL. It differs because I^2L requires a conversion from current to voltage at its output. This conversion is adapted from operational amplifier circuits that use current-mirroring techniques to produce a current that varies linearly with the applied input voltage.

To test the concept Signetics have built several commercial ICs that have threshold function gates with binary inputs and outputs for connecting to external binary circuits but with multi-level weighted summing and detection circuitry internally. As an example of the savings possible the 8X04 FIFO memory uses such gates to determine whether the memory was ¼, ½, ¾ or completely full. If ordinary TTL or even I^2L had been used at least 4000 transistor devices would have been required; with this new technique the transistor count was cut drastically — to four!

Put a few design engineers into a lab with the concepts of bi-MOS, multi-level logic and a few thousand dollars and we could have some very nice toys to play with in 1977 or 1978!

POSITRONIC BRAINS?

The positronic brain was invented by Isaac Asimov for his robot stories; it has never been built or even defined. Now that you can buy 16 Kilobit dynamic RAMs that allow a 256 Kilobyte memory to be built on a PCB measuring 16" x 18" and 4 or 8 Kbit ROMs in 24 pin packages the idea of a positronic brain is now not so far-fetched as it might have first seemed to Dr Asimov. Apparently there is no restriction on the possible size of RAM or ROM chips except package pin-count and production yield, the former has a practical limit of 40 pins but the latter can mean that a 256Kbyte memory with one bit faulty means that the whole device is faulty. Assuming that yield problems could be overcome can we look forward to a 40 pin package containing as much RAM as possible? With 40 pins using 8 bit common I/O pins, a single power supply and two pins for chip select (TRI-STATE output enable) and READ/WRITE control we are left with 28 pins for addressing. If we assume that binary addressing rather than multi-level circuitry is used this gives us a possible RAM or ROM size of 256Megabytes. At present this is impractical because of the die size which would be required, but the promised savings of up to 1000 times in area our 256 MBYTE memory could be feasible in a few years' time. Even if we are prepared to come down to using a 24 or 28 pin package we could still look forward to one-chip memories of 16 or 256Kbyte in the not too distant future. Commercial computers at present have memory sizes in the range 16Kbyte to 1 or 2Mbyte on-line with several multi-megabyte random-access storage systems for data which is not permanently required in main storage. These commercial CPUs have the capability of doing several things at the same time as well as doing any one thing correctly, repetitively and at very high speeds. With this sort of software connected to our future hardware the feasibility of building a robot brain is likely to become reality within the foreseeable future. It is now up to the mechanical engineers to perfect the artificial limb technology to the same point and suddenly a few hundred Science-Fiction stories could become Science-Fact stories or pre-written history books. ●

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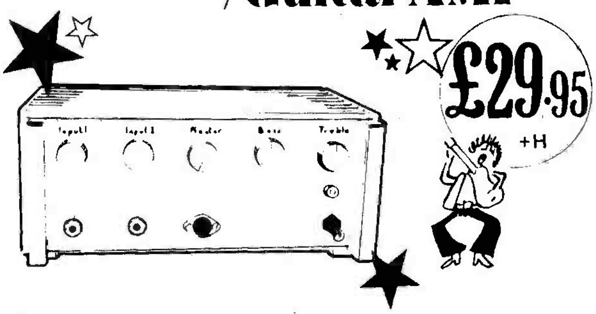

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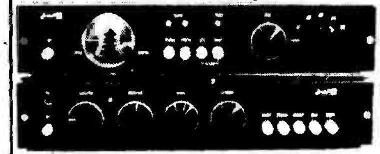

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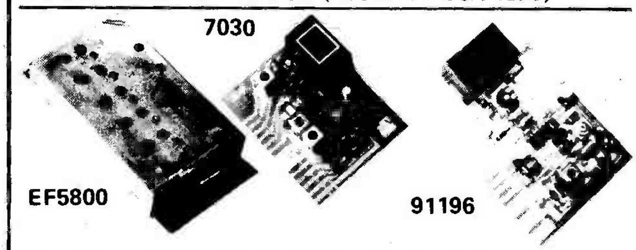

From left to right, the EF5800 6 circuit varicap FM tunerhead. Two MOS RF stages, both with AGC control, and an ultra stable oscillator. Next the 7030 Linear Phase 10.7MHz IF. Distortion 0.08%, muting, AGC, meter, auto stereo switch outputs. Finally the new 91196 mpx decoder and combined birdy filter. Mono THD 0.05%, stereo sep. 55dB at 1kHz, 42dB at 10kHz - the best decoder module yet.
EF5800.....£14.50 7030.....£10.95 91196.....£12.99 (Built).
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Components: Coils, ICs Filters, etc.

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uA720/CA3123E AM rad	1.40	CFT types ceramic (455)	0.55
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tech-tips

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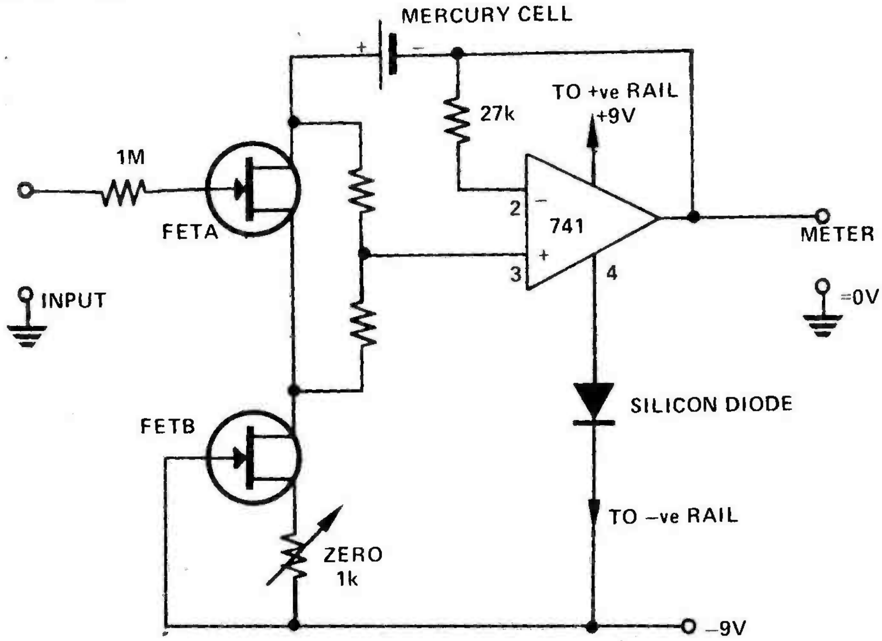
The input current of a junction FET, usually less than 1nA, flows out of the gate, and is constant at a particular temperature, provided the voltage across the device is constant. By making the gate positive to the source this leakage current can be made to flow back into the device, reducing the input current almost to zero.

FET A should be a low loss, low Vp device (ideally Vp should be about 0.5V). FET B must be somewhat higher but is less critical, the bargain pack is usually a good source of such devices. Forward bias should be about 150mV and current through the FETs about 400mA.

The mercury cell holds the voltage across the input FET constant at 1.5V (1.35V plus 150mV) and the silicon diode in the op amp's negative lead prevents the cell from discharging when the power is off.

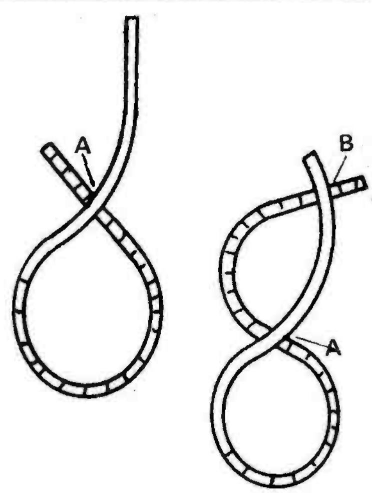


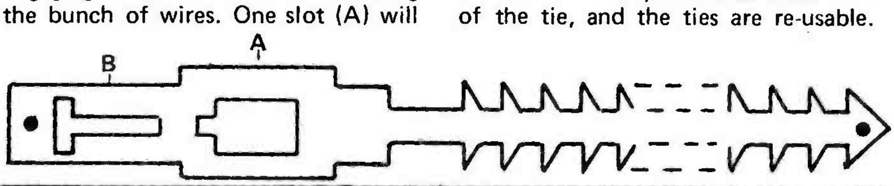
By adjusting values in the potential divider it is possible to achieve input currents within a few picoamps either way and to measure the voltage on a small capacitor without changing it.

SUBSTITUTE CABLE CLIPS

A project involving large amounts of interconnecting wiring between units requires cable ties or lacing cord to organise them. Purpose designed polythene ties retail at about £2.16 per 100. Polythene – PLASTIC-TIES for gardeners, for plant stems at 36p per 100, are available.

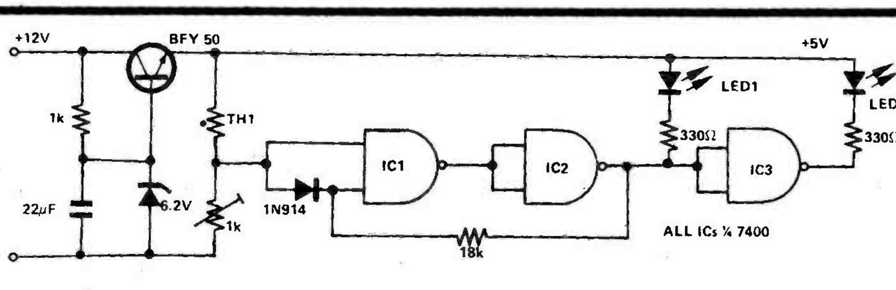
The tie consists of a serrated tail on the end of which are two slots for engaging the serrations after encircling the bunch of wires. One slot (A) will permit the tying of bunches of wires from 6–28mm in 2mm steps. The second alternate slot (B) will enable wires from 10-32mm diameter to be secured. Use of both retaining slots simultaneously will result in a figure 8 configuration, thus securing two bunches of wires alongside each other – their maximum diameter being 10 and 16mm. A hole which will accept an 8BA bolt is present at both ends of the tie, and the ties are re-usable.





'WARMTH' INDICATOR

The sensing element used was a thermistor, attached to the outlet which is warm when the pilot light is on. A rod-type thermistor was used for cheapness, with a resistance of about 3k @ 20°C, but a bead type would work as well and with a faster response time.



Two gates of the 7400 provide a Schmitt trigger with a low hysteresis (determined by the 18k feedback resistor) and the third gate inverts that output. When the pilot light is on, the input of IC1 is high, IC3 output is logic 0 and LED2 (green) is on. If the pilot lights fails, the temperature falls, all ICs change state, LED2 goes off and LED1 (red) comes on.

The temperature at which the changeover takes place is set by the 1k preset.

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2513 Character Generator, u/c ASCII	£9.00

HARDWARE

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Keyboard Kit: 55 keys, upper/lower case options, KDP 5 Kit	£42.00
Printer: 40 column dot matrix printer with interface for parallel ASCII input. PR-40 kit	£225.00
Floppy: SA800 or SA801 floppy disk drive, disks and interface, built, not kit	£625.00
Minifloppy: SA400 mini disk drive, disks and interface, delivery end of year	£495.00

BOOKS, DATA

SCRUMPI Data	75p*
SC/MP Technical Description	£1.95*
SC/MP Programmers Guide	£6.30
6800 Data (Xerox)	75p*
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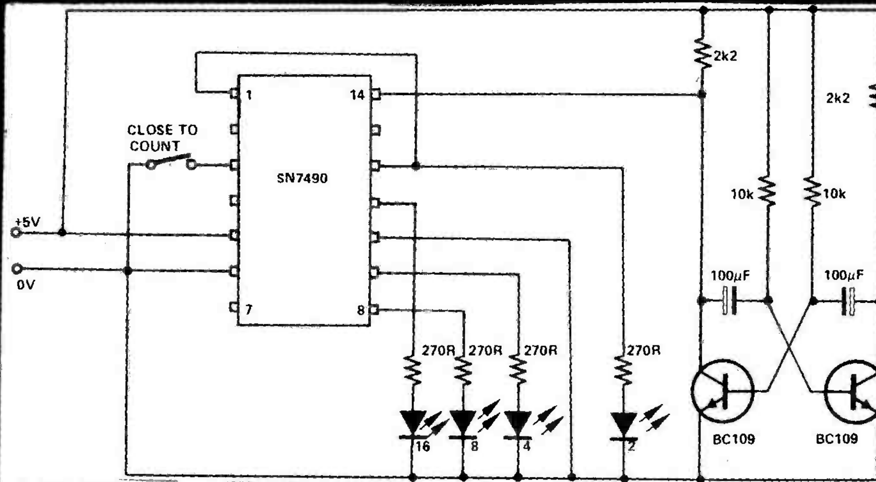
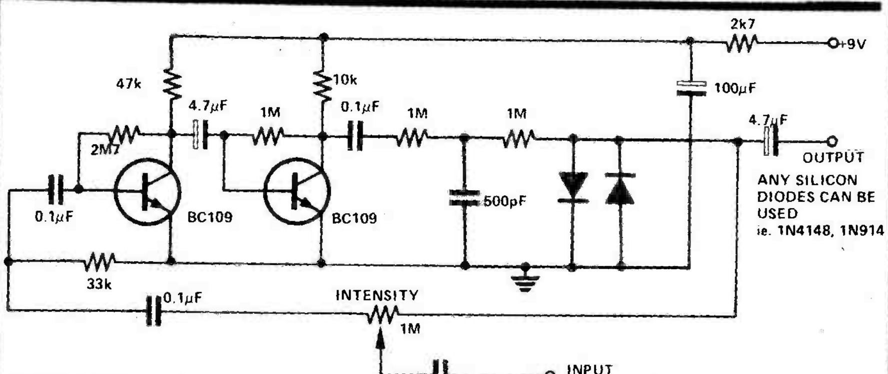


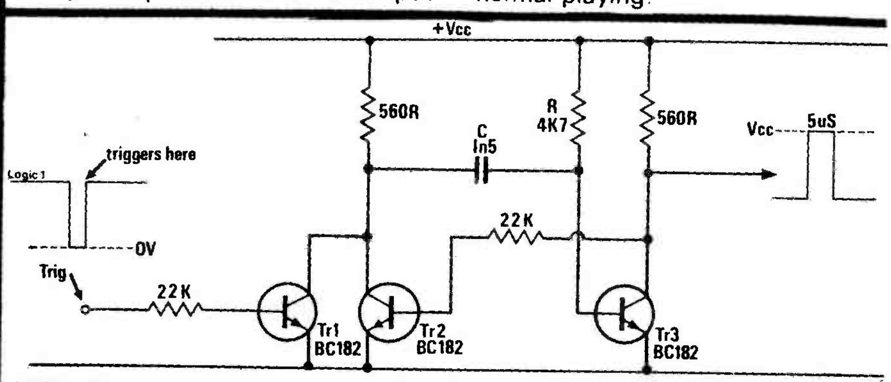
LED COUNTER

The astable multivibrator is used to generate pulses which operates the four integrated bistables. The 7490 gives a binary counting sequence and the 7490 gives a BCD count. This circuit is very useful for testing the IC's.



GUITAR FUZZ

The input signal is amplified by the two transistors. The distorted output is then clipped by the two diodes and the high frequency noise is filtered from the circuit via the 500pF capacitor. The 1M pot adjusts the intensity of the fuzz, but this tends to make the unit oscillate, so a 33k resistor is put between the input and ground to stop this. When the pot is at minimum intensity the unit may be switched off to allow normal playing.



RISING EDGE TRIGGER

The diagram shows a method of triggering a conventional monostable on the rising edge of a short negative-going pulse. The additional transistor, TR1, provides good isolation between the output pulse and the triggering circuitry. The circuit shown gives a pulse of 5μsec duration, but of course the usual design formula $\tau = 0.65$ RC can be used to determine circuit values for other pulse widths.

One slight disadvantage of this circuit is that the collector of TR2 is held down by the triggering waveform, so the switch-on of TR3 is not regenerative. For this reason the falling edge of the output pulse is not as fast as it might be, but is sufficient for most purposes.

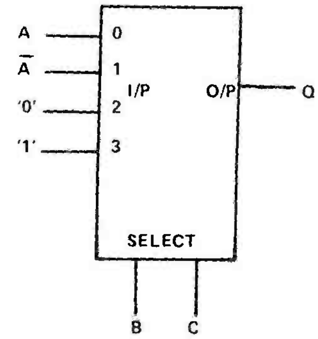
MULTIPLEXER IMPROVED

In the June edition of ETI Tech-Tips, there is an idea for using a multiplexer for implementing arbitrary logic functions. Although the suggestion is quite feasible, in some cases it can be improved on.

To demonstrate the idea, consider a logic function, with three variables A, B, C and an output Q, represented by the truth table as shown.

If the two most significant bits, in this case B and C are used to drive the select inputs of a four input multiplexer (eg. ½ 74153), then the above logic function can be implemented as follows:- Levels 0 and 1 of the truth table will select input 0 of the multiplexer. By comparing bit A of the input, with the required output, it can be seen that they are similar. Thus A should be connected to input 0. Similarily, levels 2 and 3 will select input 1. In this case, Q is the complement of A and thus $\bar{A}$ should be connected to this input. Levels 4 and 5 will select input 2, and as, in this case, Q is low, this input should be tied low. Conversely input 3, which is selected in levels 6 and 7 should be tied high, as the output in this case, is high. Naturally, if the multiplexer used has only a complementary output available, then the outputs should be accordingly complemented.

This idea can quite easily be expanded to 8 and 16 input multiplexers, whether they be of TTL or CMOS type. The advantage compared with the idea in the June edition is that the capacity of a given multiplexer, used for logic function implementation, is effectively doubled.



LEVEL	C	B	A	Q
0	0	0	0	0
1	0	0	1	1
2	0	1	0	1
3	0	1	1	0
4	1	0	0	0
5	1	0	1	0
6	1	1	0	1
7	1	1	1	1

tech-tips

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS Electronics Today International, 36 Ebury Street, London SW1W 0LW.

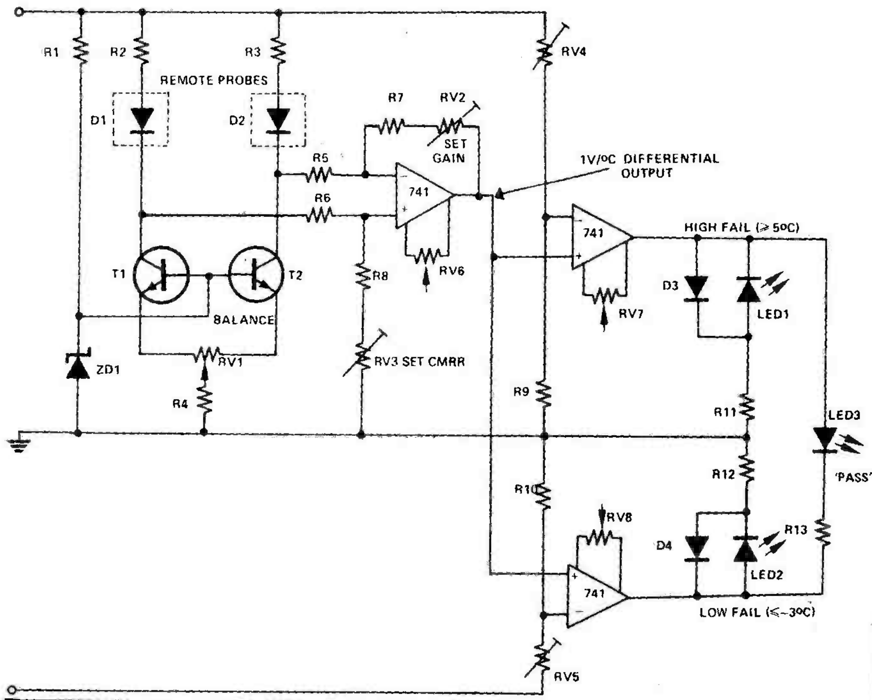
DIFFERENTIAL TEMPERATURE SENSOR AND ALARM SYSTEM

The circuit is comprised of three parts (i) the differential temperature sensor (ii) a differential amplifier to provide gain (iii) a switching circuit to monitor the output from the differential amplifier.

Two diodes D1 and D2 are used as probes for the sensor. A small preset, RV1 provides fine adjustment of the current through each branch so as to give zero differential output between D1 and D2 when they are at the same temperature.

A gain of 500 must be provided at the differential output to provide a useful voltage to switch the LED's (....ie 1V corresponding to 1°C.) RV2 provides fine adjustment of the gain and RV3 adjusts the CMRR.

A potential divider network is set up by RV4, R9, R10, RV5 to provide the necessary switching voltages for the voltage comparators, thus enabling LED1 or LED2 or LED3 for voltages set up by RV4 and RV5 ..ie.. −3V and +5V.



SETTING UP

1. Adjust offset-null on all Op. Amps for zero output by connecting input terminals together and taking to ground and adjusting either RV6, RV7 and RV8.
2. Adjust CMRR for differential amplifier by shorting input terminals and connecting to +15V line, then adjusting RV3.
3. Apply probes D1 and D2 to a liquid, say at room temperature, and adjust RV1 until there is zero output across collectors of T1 and T2.
4. Apply probe D1 to a liquid at a temperature 10°C different from above, then adjust gain control RV2 until there is 10V at the diff. amplifier output. The CMRR should again be set.
5. Adjust RV4 and RV5 so that the comparators switch at −3V and +5V corresponding to −3°C and +5°C.

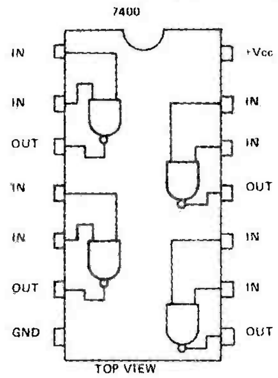
COMPONENT LIST

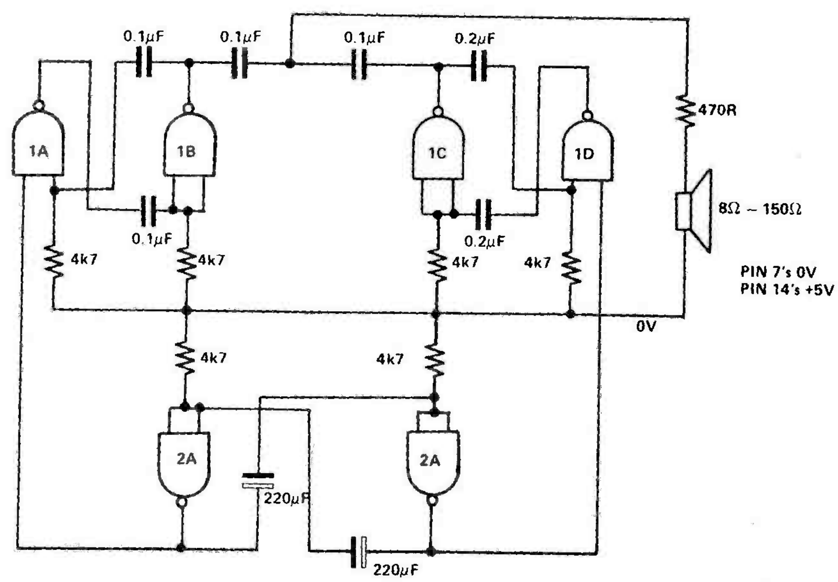
RESISTORS		RV4,RV5	2.2k
R1	2.2k	RV6,RV7,RV8	10k
R2,R3	51k	**TRANSISTORS**	
R4,R10,R13	1k	T1,T2	BC108
R5,R6	2k	**DIODES**	
R7,R8	910k	D1,D2	1N4004
R9	390Ω	D3,D4	1N914
R11,R12	1.2k	LED1,LED2	miniature RED
PRESETS		LED3	miniature GREEN
RV1	100Ω	ZD1	400mW,3V3
RV2,RV3	100k	3 Operational Amplifiers	741

7400 SIREN

The siren consists of two oscillators which generate the tones. A third oscillator is used to switch the others on and off alternately, giving the two tone effect

By changing thr capacitor values different tones can be produced.





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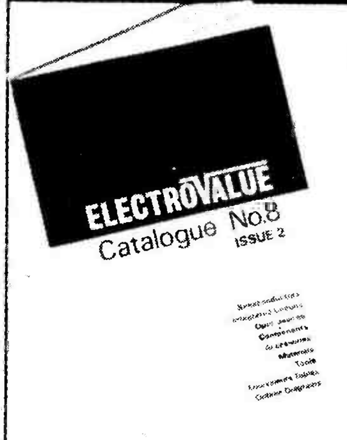

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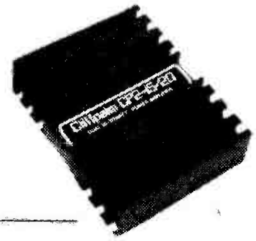

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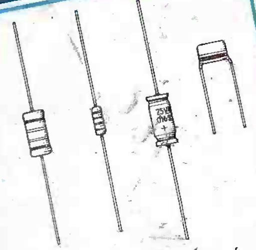

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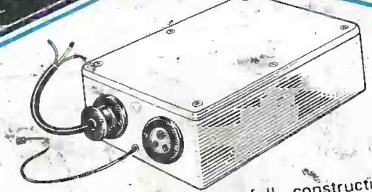

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