# electronics tomorrow

1-98

75p

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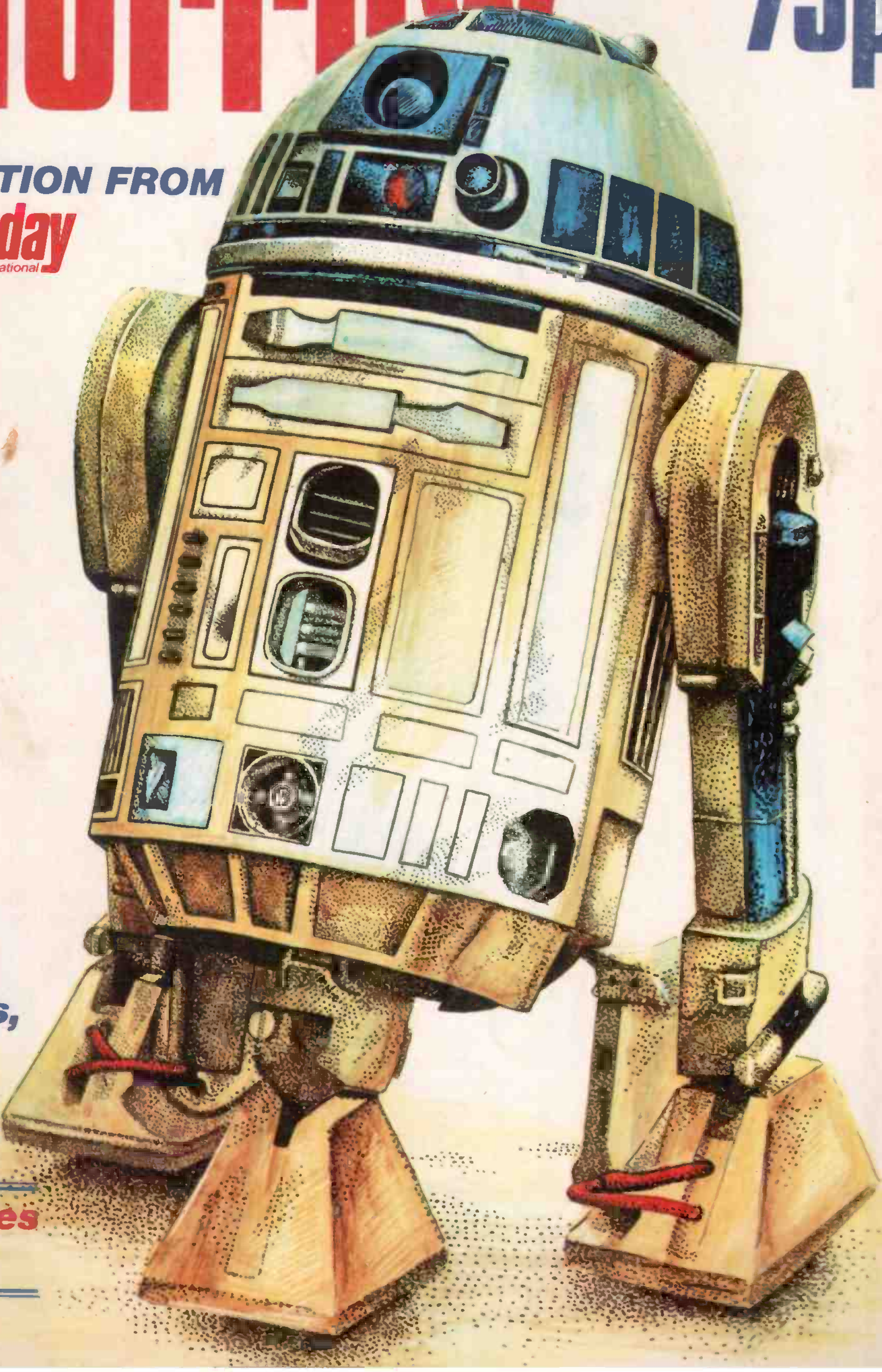
electronics today international



WHAT'S HAPPENING IN:
Projects, MPUs,
Hi-Fi, Calculators,
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Behind the scenes of STAR WARS

# WATFORD ELECTRONICS

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**POLYESTER CAPACITORS:** Axial lead type (Values are in μF)
**400V:** 0.001 0.0015 0.0022 0.0033 **8p**; 0.0047 0.0068 0.01 0.015 0.018 **9p**; 0.022 0.033 **10p**; 0.047 0.068 **14p**; 0.1 **15p**; 0.15 0.22 **22p**; 0.33 0.47 **39p**; 0.68 **45p**.
**160V:** 0.039, 0.15 0.22 **13p**; 0.33 0.47 **22p**; 0.68 1.0 **29p**; 1.5 **33p**; 2.2 **38p**; 4.7 **47p**.
**DUBILIER: 1000V:** 0.01 0.015 **16p**; 0.022 **18p**; 0.047 **16p**; 0.1 **34p**; 0.47 **43p**.

**POLYESTER RADIAL LEAD** (Values in μF) **250V:**
0.01 0.015 **6p**; 0.022 0.027 **7p**; 0.033 0.047 0.068 0.1 **8p**; 0.15 **12p**; 0.22 0.33 **14p**; 0.47 **16p**; 0.68 **20p**; 1.0 **24p**; 1.5 **27p**; 2.2 **31p**

**FEED THROUGH CAPACITORS**
1000μF/350V **8p**

**ELECTROLYTIC CAPACITORS:** Axial lead type (Values are in μF)
**63V:** 0.47 1.0 1.5 2.2 2.5 3.3 4.7 6.8 8 10 15 22 **9p**; 47 32 50 **12p**; 63 100 **27p**; **50V:** 100 **7p**; 50 100 220 **25p**; 470 **50p**; 1000, 2200 **68p**; **40V:** 22 33 **9p**; 100 **12p**; 3300 **62p**; 4700 **64p**; **35V:** 10 33 **7p**; 330 470 **32p**; 1000, **49p**; **25V:** 10 22 47 **6p**; 80 100 160 **8p**; 220 250 **13p**; 470 640 **25p**; 1000 **27p**; 1500, 30p; 2000, **34p**; 3300 **52p**; 4700 **54p**; **16V:** 10 40 47 68 **7p**; 100 125 **8p**; 470 **16p**; 1000 1500 **20p**; 2200 **34p**; **10V:** 4 100 **6p**; 640 **10p**; 1000 **14p**.
**TAG-END TYPE: 70V:** 2000 **98p**; 4700 **121p**; **50V:** 3000 **75p**; **40V:** 4000 **70p**; 2500 **65p**; **25V:** 4700 **48p**; 2000 **37p**; **40V:** 2000+2000 **95p**. **325V:** 200+100+50+100 **190p**.

**TANTALUM BEAD CAPACITORS**
**35V:** 0.1μF 0.22 0.33 0.47 0.68 1.0 2.2μF 3.3 4.7 6.8 **25V:** 1.5 10 **20V:** 1.5 **16V:** 10μF 13p each **10V:** 22μF 33 47 **6V:** 47 68 100 **3V:** 68 100μF **20p** each

**POTENTIOMETERS** (AB or EGEN)
Carbon Track ¼W Log & ½W Linear values
1KΩ & 2KΩ (lin only) Single gang **26p**
5KΩ-2MΩ single gang **26p**
5KΩ-2MΩ single gang 0/P switch **55p**
5KΩ-2MΩ dual gang stereo **70p**

**OPTO ELECTRONICS** *
LEDs + clip
TIL209 Red **13**
TIL211 Grn **24**
TIL212 Yellow **27**
2" Red **17**
2" Amber Green Yellow **21**
OCP70 **40**
ORP12 **68**
2N5777 **54**
7 Seg Displays
TIL312 C An.3" **125**
TIL313 C Cth 3" **125**
TIL321 C An .5" **130**
TIL322 C Cth .5" **130**
DL704 C Cth **99**
DL707 C.A **99**
DL747 C A **180**
FND 357 **140**
DRIVERS
75491 75492 **85**

**MYLAR FILM CAPACITORS**
**100V:** 0.001, 0.002, 0.005, 0.01μF **5p**
0.015 0.02 0.04, 0.05, 0.056μF **6p**
0.1μF 0.15, 0.2 **7p**. **50V:** 0.47μF **10p**

**SLIDER POTENTIOMETERS**
0.25W log and linear values 60mm
5KΩ-500KΩ single gang **60p**
10KΩ-500KΩ dual gang **70p**
Self Stick Graduated Bezels **20p**

**CERAMIC CAPACITORS 50V**
Range: 0.5pF to 10 000pF **3p**
0.015μF 0.022μF 0.033μF
0.047μF **4p**. 0.1μF **6p**.

**PRESET POTENTIOMETERS**
0.1W 50Ω–5MΩ Miniature Vertical & Horizontal **8p**
0.25W 100Ω–3.3MΩ Horiz. larger **10p**
0.25W 200Ω–4.7MΩ Vert. **10p**

**SILVER MICA** (Values in pF) 3.3 4.7 6.8, 10 12, 18 22 33 47 50 68, 75, 82, 85, 100, 120, 150, 220 **9p** each
250, 300, 330, 360, 390, 600 820 **16p** each
1000, 1800 2000 2200 **20p** each

**RESISTORS** — Erie make 5% Carbon Miniature High Stability. Low noise

| RANGE | VAL | 1-99 | 100+ |
|---|---|---|---|
| ¼W 2.2Ω-4.7M | E24 | 1.5p | 1p |
| ½W 2.2Ω-4.7M | E12 | 2p | 1.5p |
| 1W 2.2Ω-10M | E12 | 5p | 4p |
| 2% Metal Film 10Ω-1MΩ | | | 6p |

100+ price applies to Resistors of each type not mixed values

**CERAMIC TRIMMER CAPACITORS**
2.7pF 4-15pF 6-25pF 8-30pF **20p**

**MINIATURE TYPE TRIMMERS**
2.5-6pF 3-10pF 10-40pF **22p**
5-25pF 5-45pF 60pF 88pF **30p**

**COMPRESSION TRIMMERS**
3-40pF 10-80pF; 25-190pF **25p**
100-500pF. 1250pF **38p**

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**SWITCHES***
TOGGLE 2A 250V
SPST **26p**
DPDT **35p**
4 pole on/off **58p**
**SUB-MIN TOGGLE**
SP changeover **59p**
SPST on off **54p**
DPDT 6 tags **78p**
DPDT Centre off **92p**
DPDT Biased **115p**
**SLIDE 250V:**
1A DPDT **14p**
1A DP c/over **16p**
½A DPDT **13p**
4 pole c/over **24p**
**PUSH BUTTON**
**Spring loaded**
SPST on/off **55p**
SPDT c/over **65p**
DPDT 6 Tag **85p**

| JACK PLUGS | | SOCKETS | | |
|---|---|---|---|---|
| Screened chrome | Plastic body | open metal | moulded with break contacts | in line couplers |
| 2.5mm **12p** | 8p | 8p | | 11p |
| 3.5mm **15p** | 10p | 8p | | 12p |
| MONO **23p** | 15p | 13p | 20p | 18p |
| STEREO **31p** | 18p | 15p | 24p | 22p |

| DIN | PLUGS | SOCKETS | In Line |
|---|---|---|---|
| 2 PIN Loudspeaker 3, 4, 5 Audio | 13p | 8p | 20p |
| CO-AXIAL (TV) | 14p | 14p | 14p |
| PHONO assorted colours | 9p | 5p single | 15p |
| Metal screened | 12p | 8p double 10p 3-way | – |
| BANANA 4mm | 10p | 12p | – |
| 2mm | 10p | 10p | – |
| 1mm | 8p | 8p | – |

**SWITCHES * PUSH BUTTON:**
Miniature Non Locking
Push to Make **15p** Push to Break **25p**
**ROCKER** (white) 10A 250V
SP changeover centre off **28p**
**ROCKER:** (black) on/off 10A 250V **23p**
**ROCKER:** Illuminated (white)
Lights when on 3A 240V **52p**
**ROTARY:** (ADJUSTABLE STOP) 1 pole/2-12 way 2p/2.6W 3p/2.4W 4p/2.3W **41p**
**ROTARY:** Mains 250V AC 4 Amp **42p**

**DIL SOCKETS*** (Low Profile – Texas)
8 pin **10p**; 14 pin **12p**; 16 pin **13p**; 18 pin **20p**; 24 pin **30p**; 28 pin **42p**; 40 pin **58p**.

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"Sure Fire Rifle" Kit for other TV games **£10.25** incl VAT (40p p&p)
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**STOP PRESS** . . . Watford Electronics announce the introduction of their **"ECONOGAME"** the obvious answer to **CHEAP** yet reliable **TV GAMES**. This simple to build Kit comes complete with **AY-3-8500** IC, Fibre Glass PCB, semiconductors and full instructions. All you need to complete the Unit is, two Pots., Switches, Loudspeaker and Control Boxes. The finished board fits our NJSF1 Box (**£1.75**) to complete an attractive inexpensive TV Games Unit. Price only **£10.45** incl VAT (35p p&p insured).
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Anhydrous 1lb bag
**65p** + 30p p&p

DALO ETCH Resist Pen + Spare Tip **75p***

**COPPER BOARDS***
Fibre Glass Single Sided
6×6" **75p**
6×12" **130p**
S R B P 8×10 **65p**

**VOLTAGE* REGULATORS**
723C **45p**
TBA625B **95p**
**TO3 Can**
1A 5V **170p**
1A 12V **180p**
1A 15V **190p**
1A 18V **210p**
LM309K **150p**
LM323K **625p**
1A –5V **220p**
1A –12V **220p**
**Plastic**
1A 5V **115p**
1A 12V **115p**
1A 15V **120p**
1A 18V **125p**
1A 24V **130p**
0.1A 8V **51p**

## TTL 74*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7400 | 14 | 7480 | 50 | 74162 | 116 | 4022AE | 90 |
| 7401 | 14 | 7481 | 97 | 74163 | 116 | 4023AE | 20 |
| 7402 | 16 | 7482 | 82 | 74164 | 121 | 4024AE | 76 |
| 7403 | 16 | 7483 | 95 | 74165 | 130 | 4025AE | 19 |
| 7404 | 20 | 7484 | 95 | 74166 | 141 | 4026AE | 180 |
| 7405 | 22 | 7485 | 110 | 74167 | 198 | 4027AE | 55 |
| 7406 | 38 | 7486 | 36 | 74170 | 240 | 4028AE | 90 |
| 7407 | 38 | 7489 | 320 | 74172 | 625 | 4029AE | 109 |
| 7408 | 20 | 7490 | 36 | 74173 | 175 | 4030AE | 58 |
| 7409 | 20 | 7491 | 80 | 74174 | 113 | 4033AE | 145 |
| 7410 | 15 | 7492 | 53 | 74175 | 90 | 4034AE | 196 |
| 7411 | 24 | 7493 | 35 | 74176 | 120 | 4040AE | 105 |
| 7412 | 23 | 7494 | 85 | 74177 | 116 | 4042AE | 81 |
| 7413 | 37 | 7495 | 70 | 74180 | 142 | 4043AE | 96 |
| 7414 | 74 | 7496 | 82 | 74181 | 299 | 4044AE | 95 |
| 7416 | 35 | 7497 | 262 | 74182 | 127 | 4045AE | 145 |
| 7417 | 39 | 74100 | 125 | 74184 | 225 | 4046AE | 130 |
| 7420 | 16 | 74104 | 62 | 74185 | 146 | 4047AE | 99 |
| 7421 | 33 | 74105 | 62 | 74188 | 650 | 4048AE | 58 |
| 7422 | 24 | 74107 | 33 | 74190 | 140 | 4049AE | 52 |
| 7423 | 32 | 74109 | 54 | 74191 | 140 | 4050AE | 52 |
| 7425 | 30 | 74110 | 54 | 74192 | 140 | 4054AE | 120 |
| 7426 | 36 | 74111 | 70 | 74193 | 140 | 4055AE | 134 |
| 7427 | 36 | 74116 | 198 | 74194 | 140 | 4056AE | 134 |
| 7428 | 38 | 74118 | 90 | 74195 | 110 | 4060AE | 116 |
| 7430 | 18 | 74120 | 115 | 74196 | 118 | 4067AE | 380 |
| 7432 | 32 | 74121 | 28 | 74197 | 118 | 4068AE | 22 |
| 7433 | 40 | 74122 | 48 | 74198 | 248 | 4069BE | 22 |
| 7437 | 30 | 74123 | 70 | 75150 | | 4070AE | 32 |
| 7438 | 33 | 74125 | 65 | 75491 | 75 | 4072AE | 21 |
| 7440 | 17 | 74126 | 60 | 75492 | 80 | 4075BE | 23 |
| 7441 | 74 | 74128 | 77 | **CMOS*** | | 4076AE | 129 |
| 7442 | 68 | 74132 | 73 | **(RCA)** | | 4077AE | 40 |
| 7443 | 115 | 74136 | 56 | 4000AE | 15 | 4078AE | 21 |
| 7444 | 112 | 74141 | 72 | 4001AE | 17 | 4081AE | 22 |
| 7445 | 94 | 74142 | 280 | 4002AE | 17 | 4082AE | 21 |
| 7446 | 94 | 74143 | 314 | 4006AE | 105 | 4502AE | 120 |
| 7447 | 82 | 74144 | 314 | 4007AE | 18 | 4507AE | 55 |
| 7448 | 74 | 74145 | 85 | 4009AE | 58 | 4510AE | 135 |
| 7450 | 17 | 74147 | 175 | 4010AE | 58 | 4511AE | 168 |
| 7451 | 17 | 74148 | 143 | 4011AE | 19 | 4512 | 98 |
| 7453 | 17 | 74150 | 118 | 4012AE | 18 | 4516AE | 125 |
| 7454 | 17 | 74151 | 75 | 4013AE | 55 | 4518AE | 102 |
| 7460 | 17 | 74153 | 82 | 4015AE | 93 | 4519AE | 59 |
| 7470 | 30 | 74154 | 140 | 4016AE | 52 | 4520AE | 108 |
| 7472 | 28 | 74155 | 82 | 4017AE | 99 | 4528AE | 99 |
| 7473 | 32 | 74157 | 80 | 4018AE | 99 | 4532AE | 127 |
| 7474 | 32 | 74159 | 225 | 4019AE | 60 | 4539AE | 110 |
| 7475 | 42 | 74160 | 116 | 4020AE | 102 | 4585AE | 101 |
| 7476 | 30 | 74161 | 116 | 4021AE | 99 | | |

## LINEAR IC'S

| | | | |
|---|---|---|---|
| 702 | 75 | MC845P | 150 |
| 709C 14 pin | 35 | MC1303 | 148 |
| 710* | 46 | MC1304P | 260 |
| 741C* 8 pin | 22 | MC1310P | 185 |
| 747C | 70 | MC1312PQ | 195 |
| 748C | 36 | MC1458P* | 90 |
| 753 | 150 | MC1496 | 101 |
| 8038CC* | 355 | MC1710CG | 79 |
| AY-1-0212 | 580 | MFC6040* | 97 |
| AY-1-5051 | 125 | MK50253* | 550 |
| AY-1-6721/6 | 195 | MK50362* | 550 |
| AY-3-8500* | 510 | MM2101-2 | 210 |
| AY-3-8550* | 850 | MM2112-2N* | 310 |
| AY-5-1224* | 349 | NE518A | 210 |
| AY-5-1230* | 490 | NE555* | 36 |
| AY-5-3500* | 810 | NE556DB* | 90 |
| AY-5-4007 | 655 | NE560* | 325 |
| CA3011* | 82 | NE561* | 410 |
| CA3014* | 137 | NE562* | 410 |
| CA3018* | 82 | NE565A* | 185 |
| CA3020 | 170 | NE566* | 180 |
| CA3023 | 170 | NE567V* | 187 |
| CA3028A* | 95 | RAM2102-2* | 210 |
| CA3035 | 140 | ROM2513* | 700 |
| CA3036 | 180 | SG3402* | 255 |
| CA3043 | 190 | SL414A | 250 |
| CA3046 | 80 | SN72733N | 125 |
| CA3048 | 200 | SN76003N | 240 |
| CA3075 | 175 | SN76013 | 240 |
| CA3080E | 80 | SN76023 | 140 |
| CA3081 | 190 | SN76033N | 230 |
| CA3089E | 210 | SN76115N | 215 |
| CA3090AQ | 390 | SN76227N | 175 |
| CA3123E | 200 | TAA621AX1 | 238 |
| CA3130* | 94 | TAA661A | 155 |
| CA3140 | 95 | TAA700 | 353 |
| ICM7205* | 1150 | TAA960 | 300 |
| LM300H | 170 | TAD100 | 150 |
| LM301A | 39 | TAD110 | 170 |
| LM308 | 140 | TBA120S | 90 |
| LM318 | 195 | TBA540Q | 220 |
| LM379 | 395 | TBA550Q | 355 |
| LM380 | 98 | TBA641BX11 | 250 |
| LM381 | 170 | TBA651 | 180 |
| LM382 | 125 | TBA800 | 90 |
| LM3900 | 65 | TBA810S | 105 |
| LM3909N | 70 | TBA820 | 80 |
| M252AA* | 750 | TBA920Q | 350 |
| M253AA* | 795 | TDA2020 | 320 |
| MC724* | 175 | ZN414 | 110 |
| | | ZN424 | 130 |

## TRANSISTORS

| | p | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AC117 | 35 | BC160* | 42 | BF196 | 12 | OC44* | 35 | ZTX503 | 19 | 2N3615* | 135 |
| AC125* | 19 | BC167A | 11 | BF197 | 15 | OC45* | 35 | ZTX504 | 25 | 2N3663 | 26 |
| AC126* | 15 | BC168 | 12 | BF198 | 18 | OC46* | 35 | ZTX531 | 28 | 2N3702 | 10 |
| AC127* | 18 | BC169C | 12 | BF200 | 30 | OC70* | 30 | ZTX550 | 25 | 2N3703 | 11 |
| AC128* | 18 | BC170 | 18 | BF224 | 18 | OC71* | 30 | 2N526* | 58 | 2N3704 | 10 |
| AC141* | 24 | BC171 | 11 | BF244B | 30 | OC72* | 30 | 2N696* | 35 | 2N3705 | 11 |
| AC141K* | 38 | BC172 | 10 | BF256* | 50 | OC77* | 76 | 2N697* | 21 | 2N3706 | 10 |
| AC142* | 24 | BC177* | 18 | BF257* | 29 | OC79* | 76 | 2N698* | 39 | 2N3707 | 10 |
| AC142K* | 38 | BC178* | 16 | BF258* | 30 | OC81* | 28 | 2N699* | 50 | 2N3708 | 11 |
| AC176* | 18 | BC179* | 18 | BF259* | 30 | OC82* | 45 | 2N706A* | 19 | 2N3709 | 11 |
| AC187* | 20 | BC182 | 10 | BF394 | 22 | OC82D* | 35 | 2N707* | 50 | 2N3710 | 16 |
| AC188* | 20 | BC182L | 11 | BF594 | 40 | OC83* | 48 | 2N708* | 19 | 2N3715* | 245 |
| ACY17 | 35 | BC183 | 10 | BF595 | 38 | OC84* | 44 | 2N914* | 32 | 2N3771* | 164 |
| ACY18* | 40 | BC183L | 12 | BFR39 | 25 | OC123* | 115 | 2N916* | 27 | 2N3772* | 170 |
| ACY19* | 40 | BC184 | 11 | BFR40 | 28 | OC139* | 140 | 2N918* | 30 | 2N3773* | 275 |
| ACY20* | 40 | BC184L | 14 | BFR79 | 28 | OC140* | 125 | 2N920* | 51 | 2N3819 | 22 |
| ACY21 | 35 | BC186C | 24 | BFR80 | 28 | OC141* | 157 | 2N930* | 18 | 2N3820 | 44 |
| ACY22* | 40 | BC187* | 28 | BFX29* | 28 | OC170* | 40 | 2N961* | 61 | 2N3823* | 65 |
| ACY28* | 40 | BC212 | 11 | BFX81* | 130 | OC171* | 40 | 2N1131* | 22 | 2N3824* | 70 |
| ACY39 | 78 | BC212L | 12 | BFX84* | 24 | OC201* | 125 | 2N1132* | 22 | 2N3866* | 90 |
| ACY40* | 48 | BC213 | 11 | BFX85* | 28 | OC202* | 140 | 2N1302* | 35 | 2N3903 | 20 |
| ACY44 | 39 | BC213L | 14 | BFX86* | 28 | OC203* | 150 | 2N1303* | 35 | 2N3904 | 18 |
| AD140 | 69 | BC214 | 14 | BFX87* | 23 | OC204* | 150 | 2N1304* | 50 | 2N3905 | 18 |
| AD149* | 70 | BC214L | 15 | BFX88* | 26 | TIP29 | 43 | 2N1305* | 28 | 2N3906 | 17 |
| AD161* | 42 | BC307B | 20 | BFY18 | 50 | TIP29A | 44 | 2N1306* | 35 | 2N4037* | 52 |
| AD162* | 42 | BC328 | 15 | BFY50* | 17 | TIP29C | 60 | 2N1307* | 35 | 2N4058 | 17 |
| AF114* | 20 | BC338* | 15 | BFY51* | 17 | TIP30 | 52 | 2N1308* | 46 | 2N4061 | 17 |
| AF115* | 20 | BC441* | 38 | BFY52* | 17 | TIP30A | 52 | 2N1613* | 20 | 2N4064* | 120 |
| AF116* | 20 | BC461* | 38 | BFY71* | 47 | TIP30B | 64 | 2N1671* | 190 | 2N4236* | 145 |
| AF117* | 22 | BC462* | 45 | BSX20* | 18 | TIP30C | 70 | 2N1671B* | 195 | 2N4289 | 20 |
| AF118* | 55 | BC547 | 12 | BSY65* | 30 | TIP31* | 50 | 2N1893* | 28 | 2N4859 | 65 |
| AF121* | 48 | BC548 | 12 | BSY95A* | 18 | TIP31A* | 50 | 2N1986 | 60 | 2N5135 | 42 |
| AF124* | 55 | BC549C | 13 | BU105* | 140 | TIP31B* | 58 | 2N2160* | 105 | 2N5136 | 42 |
| AF125* | 35 | BC558 | 13 | BU205* | 190 | TIP31C* | 66 | 2N2217* | 35 | 2N5138 | 29 |
| AF127* | 35 | BCY30* | 57 | BU208* | 225 | TIP32* | 55 | 2N2218A* | 35 | 2N5179* | 60 |
| AF139* | 35 | BCY34* | 75 | E5567 | 65 | TIP32A* | 60 | 2N2219A* | 26 | 2N5180* | 60 |
| AF178* | 70 | BCY39* | 80 | MO8001* | 158 | TIP32B* | 75 | 2N2220A* | 25 | 2N5191* | 65 |
| AF179* | 70 | BCY40* | 90 | MJ400* | 90 | TIP32C* | 77 | 2N2221A* | 26 | 2N5305* | 40 |
| AF180* | 70 | BCY59* | 90 | MJ491* | 160 | TIP33* | 85 | 2N2222* | 20 | 2N5457 | 35 |
| AF186* | 50 | BCY70* | 15 | MJ2955* | 120 | TIP33B* | 100 | 2N2297 | 45 | 2N5458 | 36 |
| AF239* | 42 | BCY71* | 20 | MJE340* | 50 | TIP33C* | 110 | 2N2303* | 50 | 2N5459 | 38 |
| ASY26* | 40 | BCY72* | 15 | MJE370* | 68 | TIP34* | 95 | 2N2368 | 25 | 2N5485 | 38 |
| ASY27* | 45 | BD115* | 62 | MJE371* | 80 | TIP34A* | 95 | 2N2369* | 15 | 2N6027 | 40 |
| BC107* | 9 | BD121* | 78 | MJE520* | 65 | TIP34B* | 120 | 2N2476 | 125 | 40311* | 56 |
| BC107B* | 10 | BD123 | 98 | MJE521* | 74 | TIP35* | 219 | 2N2483* | 28 | 40313* | 125 |
| BC108* | 9 | BD124* | 115 | MJE2955* | 115 | TIP35A | 225 | 2N2484* | 30 | 40316* | 95 |
| BC108B* | 12 | BD131* | 38 | MJE3055* | 80 | TIP35C* | 270 | 2N2646* | 48 | 40317* | 52 |
| BC108C* | 12 | BD132* | 38 | MPF102 | 36 | TIP36A* | 280 | 2N2784 | 55 | 40326* | 52 |
| BC109* | 9 | BD133* | 43 | MPF103 | 36 | TIP41A* | 66 | 2N2846 | 140 | 40327* | 62 |
| BC109B* | 12 | BD135 | 49 | MPF104 | 36 | TIP41B* | 73 | 2N2894 | 30 | 40347* | 99 |
| BC109C* | 12 | BD136 | 36 | MPF105 | 36 | TIP42A* | 72 | 2N2904A* | 22 | 40348* | 116 |
| BC113 | 17 | BD137 | 36 | MPF106 | 50 | TIP42B* | 82 | 2N2905A* | 20 | 40360* | 43 |
| BC114 | 20 | BD138 | 50 | MPF107 | 50 | TIP2955* | 65 | 2N2906* | 18 | 40361* | 45 |
| BC115 | 20 | BD139 | 34 | MPSA05 | 32 | TIP3055* | 52 | 2N2907* | 20 | 40362* | 43 |
| BC116 | 20 | BD140 | 36 | MPSA06 | 32 | TIS43 | 32 | 2N2907A* | 22 | 40411* | 289 |
| BC117 | 20 | BD142 | 59 | MPSA55 | 30 | TIS44 | 45 | 2N2926G | 10 | 40412* | 42 |
| BC118 | 20 | BD145* | 198 | MPSA56 | 30 | TIS46 | 45 | 2N2926O | 8 | 40576* | 190 |
| BC119 | 28 | BDY17* | 195 | MPSA70 | 34 | TIS50 | 47 | 2N2926R | 8 | 40594* | 90 |
| BC134 | 20 | BDY60* | 128 | MPSU02* | 58 | TIS74 | 47 | 2N2926Y | 8 | 40603* | 113 |
| BC135 | 20 | BDY61* | 165 | MPSU05* | 50 | TIS91 | 24 | 2N3011* | 30 | 40636* | 165 |
| BC136 | 18 | BF115* | 22 | MPSU06* | 56 | ZTX107 | 22 | 2N3053* | 17 | 40673* | 80 |
| BC137 | 20 | BF154* | 25 | MPSU52* | 65 | ZTX108 | 20 | 2N3054* | 49 | **Matched Pair 10p extra** | |
| BC140* | 35 | BF156* | 29 | MPSU55* | 55 | ZTX109 | 25 | 2N3055* | 60 | | |
| BC142* | 28 | BF173* | 25 | MPSU56* | 60 | ZTX300 | 16 | 2N3108 | 60 | | |
| BC143* | 28 | BF177* | 24 | MPU131* | 39 | ZTX301 | 16 | 2N3121 | 40 | | |
| BC147 | 7 | BF178* | 25 | OC25* | 120 | ZTX302 | 25 | 2N3133 | 43 | | |
| BC148 | 7 | BF179* | 30 | OC26* | 170 | ZTX303 | 17 | 2N3135 | 33 | | |
| BC149 | 8 | BF180* | 30 | OC28* | 105 | ZTX304 | 24 | 2N3250 | 30 | | |
| BC153 | 27 | BF181* | 30 | OC29* | 160 | ZTX311 | 17 | 2N3252 | 36 | | |
| BC154 | 27 | BF182* | 30 | OC35* | 100 | ZTX314 | 24 | 2N3302 | 35 | | |
| BC157 | 10 | BF183* | 30 | OC36* | 170 | ZTX341 | 20 | 2N3442* | 142 | | |
| BC158 | 11 | BF184* | 28 | OC41* | 48 | ZTX500 | 17 | 2N3563 | 32 | | |
| BC159 | 11 | BF194 | 10 | OC42* | 40 | ZTX501 | 15 | 2N5777 | 56 | | |
| | | BF195 | 10 | OC43 | 65 | ZTX502 | 19 | 2N3614* | 165 | | |

**NOISE DIODES**
Z5J **105p**

**DIAC***
ST2 **25**

## DIODES

| DIODES | p | | | | |
|---|---|---|---|---|---|
| AAZ15 | 15 | OA90 | 6 | 3A 600V* | 27 |
| AEY11 | 60 | OA91 | 6 | 3A 1000V* | 30 |
| BA100 | 10 | OA95 | 8 | 6A 600V | 54p |
| BY100 | 24 | OA200 | 9 | | |
| BY126 | 14 | OA202 | 8 | | |
| BY127 | 14 | IN914 | 4 | | |
| OA9 | 60 | IN916 | 5 | | |
| OA10 | 20 | IN4001/2* | 5 | | |
| OA47 | 12 | IN4003* | 6 | | |
| OA70 | 12 | IN4004/5* | 6 | | |
| OA79 | 12 | IN4006/7* | 7 | | |
| OA81 | 15 | IN4148 | 4 | | |
| OA85 | 12 | 3A 100V* | 18 | | |
| | | 3A 400V* | 20 | | |

**ZENERS**
Range 3.3V to 33V
400MW **9p**
1.3W **17p**

**VARICAPS**
MVAM2 **135p**
BB104 **40p**
BB105B **40p**
MVAM115 **95p**

**BRIDGE RECTIFIERS***

| (plastic case) | p | | |
|---|---|---|---|
| 1A50V | 20 | 4A800V | 120 |
| 1A100V | 22 | 6A100V | 73 |
| 1A200V | 25 | 6A400V | 92 |
| 1A400V | 29 | BY164 | 56 |
| 1A600V | 34 | | |
| 2a50V | 35 | | |
| 2A100V | 44 | | |
| 2A200V | 46 | | |
| 2A400V | 53 | | |
| 4A100V | 72 | | |
| 4A400V | 79 | | |

**TRIACS***

| | |
|---|---|
| 3A 400V | 113 |
| 3A 500V | 140 |
| 6A 400V | 140 |
| 8A 400V | 100 |
| 15A 400V | 240 |
| 40430 | 110 |
| 40528 | 87 |
| 40669 | 110 |

**THYRISTORS***
**SCRs**

| | |
|---|---|
| 1A50V | 38 |
| 1A 100V | 42 |
| 1A 200V | 47 |
| 1A 400V | 52 |
| 3A 100V | 43 |
| 3A 400V | 110 |
| 5A 400V | 120 |
| 7A 200V | 120 |
| 7A 400V | 125 |
| 8A 400V | 150 |
| C106D | 55 |
| TC45 | 45p |
| TIC44 | 25 |
| TIC45 | 37 |
| 2N4444 | 191 |

*Dear Reader,* G. DREW 011 471425

*Electronics Today International has been around for more than five years, serving the intrepid electronics enthusiast. Each month we have kept readers supplied with the latest information, new devices, interesting features and top notch constructional projects. The formula is a successful one (if circulation is a reflection of readers satisfaction). With this special edition we take a step away from the specific world of Electronics Today, and look at the trends and developments over the last year, with their implications for the future.*

*But not being a weighty intellectual bunch (even at the best of times!), we also have Roy Pullen's slightly wacky view of typical readers — which one are you? The biggest feature is on the film Star Wars, with exclusive photographs of the robot insides and an in-depth account of the production, hope you enjoy it. Projects for everybody, from beginner to MPU builder, include a nice power-supply and CMOS switched amplifier — our DIY version of R2-D2 is not quite ready yet though!*

*Other features include an interview with the legendary electronics entrepreneur Clive Sinclair (he thinks robots will be here soon), and a look at the world of video by Angus Robertson. Unlike most of our previous special editions, all of the material has been specially commissioned, no editorial has appeared in the monthly magazine. All in all, we think Electronics Tomorrow is our best special yet.*

*Hope you enjoy it.*

Jim Perry

*Jim Perry*
*Specials Editor.*


INTERNATIONAL EDITIONS

AUSTRALIA Collyn Rivers Publisher; Les Bell Assistant Editor
HOLLAND Anton Kriegsman Editor-in-chief
CANADA Steve Braidwood Editor
GERMANY Udo Wittig Editor

ABC

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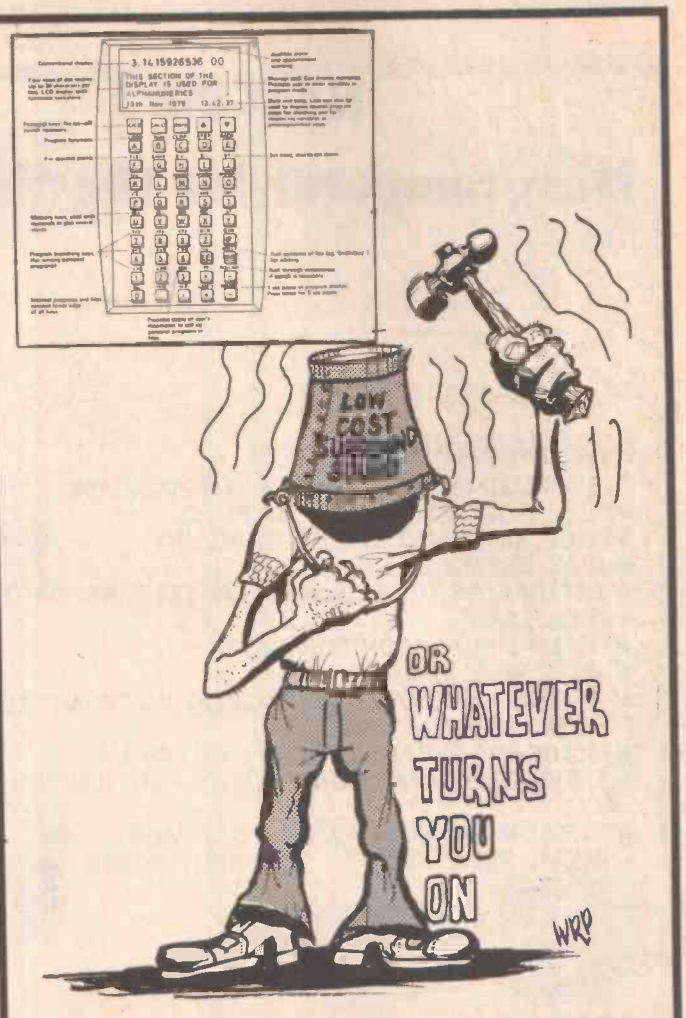
## FEATURES



## PROJECTS






Clive Sinclair tells the story of Sinclair, Angus Robertson investigates video, the inside story of Star Wars, calculators of the future designed by our Editor, wacky cartoons by Pullen and Cisco — just some of the treats inside this bumper special edition.

## NEWS & INFORMATION

# THE ETI STORY

As the British Empire contracts to a handful of islands and enclaves, the star of ETI is in the ascendency (granted that this is a highly pompous statement, but we couldn't resist it).

ETI is now published in Britain, Australia, Canada, Holland and Germany - each edition operating independently but also freely exchanging articles and information. Being as this is a special issue, we thought we'd take time out to tell you a bit about ourselves and show you some examples from our scrapbook.

## ETI—Australia

ETI-OZ (big brother to ETI-UK, ETI-NED, ETI-CAN and ELRAD) was born in April 1971. It is published in Sydney by Modern Magazines, who also publish Modern Motor, Modern Boating, Modern Fishing, Rugby League Week, Australian Cricket, Australian Golf, Revs Motor Cycle News, Off-Road Australia, Camera and Cine, Movie 78, Hi Fi Review and CB Australia.

The publisher of the electronics trio (ETI, Hi Fi, and CB) is Collyn Rivers, who has been Editor/Editorial Director of ETI-OZ since before the first issue appeared. He set up a projects laboratory and took on an engineer, Barry Wilkinson, to manage it. It is Collyn's original formula and Barry's approach to project design that account for the quick success which led Collyn to add 'International' to the title in 1972, when the first overseas edition started.

In 1976 Barry Wilkinson broke free of Modern Magazines and started his own design company: Nebula Electronics. However, through Nebula, Barry still designs most of the projects used in ETI-OZ. When Nebula was formed a vacuum appeared in the ETI office and Steve Braidwood (Then Assistant Editor of ETI-UK) went down under to fill it. Today Steve has moved (to Canada) and Les Bell is handling editorial.

The sales of the Australian issue are almost 35,000 - which is not bad for a country a ¼ the size of the UK (by population). ETI-OZ covers a wider spectrum than ETI-UK. There's more Hi-Fi, and recently quite a bit on CB. Even though Australia's CB bands were legally authorised only in June this year, ETI gave away the first five issues of 'CB Australia' before the announcement was made.

## ETI—UK

Originally published in Britain in April 1972 by Whitehall, ETI-UK had a chequered start with several editors in the first year. The present editor is Halvor Moorshead who joined in March, 1973 having been with Practical Wireless for 4½ years.

For its first year ETI was published from a couple of rooms in Fleet Street with three staff (Editor, Ad Manager and Secretary) and the fourth staff member didn't join until shortly after the offices were moved to a converted house in Ebury Street. In November, 1973 the magazine was taken over by the Australian company though the staff didn't change.

Since then ETI-UK has been extremely successful. In


**The first ETI-UK appeared in April, 1972, contents included one of the first test reviews of the Dolby professional noise reduction system. Another feature on Video Cassettes described them as "This exciting new audio/visual technology" — not bad for 1972!**

late 1973 sales were around 24 000 which has built up to about 53 000 at present and it's still increasing regularly at about 1.5% a month and this has been in a period when other titles have lost substantial sales.

Currently ETU-UK employs seventeen. Seven journalists and technicians, three on artwork and design, five on accounts, reader services and subscriptions, and two on advertising; all staff are based in the Oxford Street offices.

## ETI—Holland

We're sure that one of our competitors in Britain reckon we entered Holland as a reprisal but it wasn't that way. ETI (pronounced 'Eighty' in dutch) is produced by Anton Kreigsman who has two large components shops in Holland. The first issue appeared in October, 1976 and since then has established itself firmly.

We THINK it's a good magazine - trouble is the term 'double-dutch' has a foundation in that none of us understood a word of it!

The magazine is very much a family as Mr. Kreigsman's wife and daughter both work for it from the Den Dolder offices.

## ETI—Canada

Until February 1977, Canada had not had its own magazine devoted to amateur electronics. That was put right after a successful experiment in exporting the British edition during 1976.

ETI-CANADA is based in Toronto and published by a company established specifically to produce the magazine. The editor is Steve Braidwood who has emigrated there after having been Assistant Editor of ETI in both Britain and Australia. The first editorial person was Les Bell who was lent from Britain and he has subsequently gone to Australia (join ETI and see the world!).

The All-Canadian editorial influence is provided for by Graham Wideman, the Assistant Editor.

The problems facing a magazine in Canada are entirely different from those we experience in Britain. You have to be careful not to choose a small-town printer - they're sometimes snowed in for days. Even in ideal conditions the vastness of the country means it takes three weeks for the final copies of the magazine to reach the Maritime Provinces and British Columbia. ▷

Collyn Rivers
Publisher
ETI-Australia

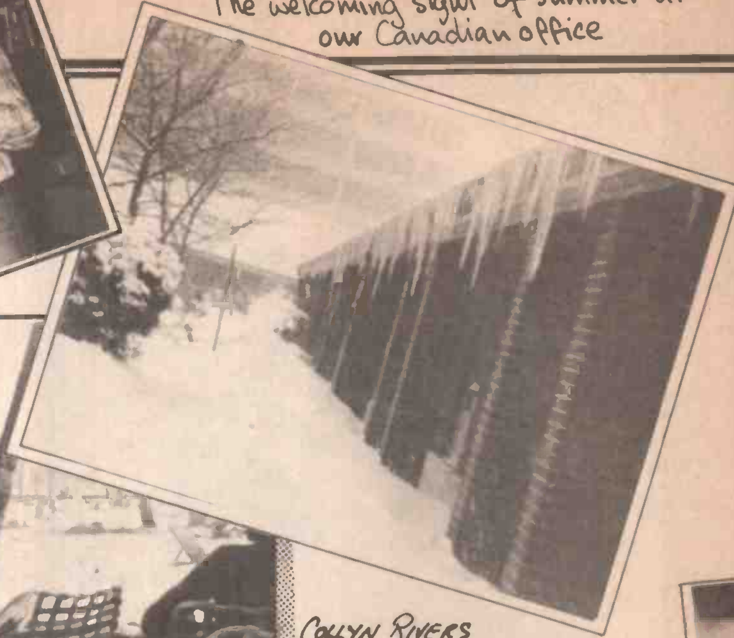

Halvor Moorshead
Editor
ETI-United Kingdom


Anton Kriegsman
Editor-in-chief
ETI-Holland


Steve Braidwood
Editor
ETI-Canada


Udo Wittig
Editor
Elrad-Germany

The welcoming sight of summer at our Canadian office



HIS SPECIALLY POSED HOTO IS EXTREMELY RARE, HALVOR SPENT 2 HOURS SCOURING THE LOCAL PUBS TO GET ALL THE STAFF IN THE OFFICE AT THE SAME TIME

COLLYN RIVERS WORKING IN EXTREMELY DIFFICULT CONDITIONS...

John and Tony contemplating on how to make an electric tea-cosy — look closely and you can see the unexpurgated November '77 cover.

MAREE, MARGARET, SANDRA AND BREN PLOTTING THE FORMATION OF ETILIB

Publishing in Canada presents hazards which the British mind finds difficult to guess at: one of our covers showed a young couple at a table playing 'Mastermind' with a glass of Dry Ginger - we received several letters complaining of our encouraging young people to 'partake of hard liquor'!

## Elrad

Latest addition to the family is Germany where the title is ELRAD, it doesn't mean anything being simply an amalgamation of Electronics and Radio, titles of this type are common in Germany.

Elrad will appear with no. 1 in January 1978 but the zero issue, a free copy given to potential subscribers, is due to appear at the same time as this issue.

Editor is Udo Wittig, a dedicated electronics enthusiast with a special interest in amateur radio which he shares with Les Bell who handles the editorial in Australia and Steve Braidwood, editor of ETI-CANADA.

Elrad is published in Hanover by an existing company Heinz Heise Hannover. Although only just getting under way, Elrad have their own minicomputer, a Siemens based on the 8080 with floppy disc, VDU and printout facilities. This is used for advertising analysis (something which is considered ultra-important in Germany), subscriptions and accounts.

The importance of the English language in electronics is demonstrated by a feature which has no parallel in the other editions: the left column contains English technical text, the right column carries the translation of specific terms.

Hobby-electronics magazines are undergoing an enormous growth in Germany; even eight years ago there was only one and that was a combined Wireless World and servicing magazine. Elrad will be the fourth magazine of its type in Germany: we wish this edition all the best.

## Where The Articles Come From

The various editions of ETI employ fourteen full time technical journalists - considerably more than any other magazine - and a very high proportion of articles are re-

JMK TRYING TO FIND HIS TREE HUT - HE SAYS THAT IF WE EVER PAY HIM HE'LL BE ABLE TO AFFORD A CARAVAN TO LIVE IN!

HALVOR, PAUL, GARY, BREN AND DIEGO FILLING IN THE OFFICE FOOTBALL COUPON



BREN, TIM AND DAVID AFTER ONE OF HALVOR'S JOKES — TIM MISSED THE PUNCH LINE

ETI'S 5TH BIRTHDAY BOOZE UP, ANY EXCUSE!

searched and written 'in-house'. All editions however, use a number of free-lance authors from time to time and in fact anyone can send in manuscripts.

Both the Australian and British editions have fairly extensive labs/workshops where practically all the projects are built - or rebuilt if submitted from outside. In Britain there are two technicians, Tony Alston and recently John Koblanski both of whom were (and we hope still are) strongly devoted to project building.

Most of the projects are designed 'in-house', the technical staff and technicians working together. The workshop is equipped to a carefully planned standard - the principle adopted is to have it equivalent to really good home workshop using the tools and test gear available to everyone. If we had highly specialised equipment we'd be tempted to use it but of course readers wouldn't then be able to duplicate it. Most of the test gear is what we have presented as projects except for an inductance bridge, three 'scopes and regular multimeters.

All Tech-Tips, one of our most popular features, are submitted by readers and you certainly keep them coming — we accept about half of those submitted. □

Steve in his lumberjack outfit before flying to Canada

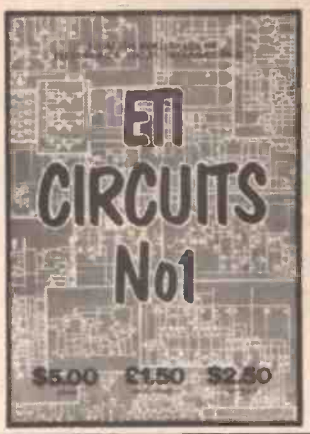
# ETI SPECIALS

## TOP PROJECTS No. 1 + No. 2

A massive 180 page book containing all the projects originally described in our first two Top Projects Books -- originally published in October 1974 and June 1975 -- which are now out of print.

Projects include: Master Mixer, 100W Guitar Amp, Low Power Laser, Printimer, Transistor Tester, Mixer Preamp, Logic Probe, Simple Amp, Ni-Cad Battery Charger, Loudhailer, Scope Calibrator, Electronic Ignition, Automatic Car Theft Alarm, Turn Indicator Canceller, Brake Light Warning, LM380 Circuits, Temperature Alarm, Aerial Matcher, UHF TV Preamp, Metal Locator, Four Input Mixer, Super Stereo, IC Power Supply, Rumble Filter, IC Tester, Ignition Timing Light, 50W Stereo Amp PLUS MANY MORE.

**£2.50 + 25p P&P**


## ETI CIRCUITS No. 1

Contains nearly 250 circuits, largely taken from the best of our Tech-Tips. Great care has been taken to index each circuit for rapid selection. An additional section at the back gives plenty of reference data including transistor specs and equivalents.

Sales of this publication have been excellent -- hardly surprising when the circuits cost less than 1p each!

**£1.50 + 25p P&P**

## TOP PROJECTS No. 3

Originally published in March 1976, Top Projects No. 3 contains 27 constructional projects including: Graphic Equaliser, International 25W Stereo Amp, Simple Stereo, New Sound for your Guitar, Bass Booster, Line Amplifier, Loudness Control, Electronic Ignition, Tacho Timing Light, Car Alarm, Dual-Beam Adaptor, AF Meter, Impedance Meter, Digital Display, Digital Voltmeter, TTL Supertester, Fluorescent Light Dimmer, Radar Intruder Alarm, Light Dimmer, FM Tuner, Colour Organ, Drill Speed Controller plus many more.

**£1.00 + 25p P&P**



## ELECTRONICS — IT'S EASY

Our successful series (which finishes with the very issue!) is to be available in three volumes.

Volume 1 and 2 have now been reprinted to meet the continuing demand, and can be ordered from our offices — as can Volume **3**.

**£1.20 + 25p P&P**

## TOP PROJECTS No. 4

Published October, 1976. This includes Sweet-Sixteen Stereo Amp, Waa-Waa, Audio Level Meter, Expander-Compressor, Car Anti-Theft Alarm, Headlight Reminder, Dual-Tracking Power Supply, Audio Millivoltmeter, Thermocouple Meter, Intruder Alarm, Touch Switch, Push-Button Dimmer, Exposure Meter, Photo Timer, Electronic Dice, High Power Beacon, Temperature Controller, Electronic One-Armed Bandit, plus many more.

**£1.00 + 25p P&P**



## ETI 4600 SYNTHESISER

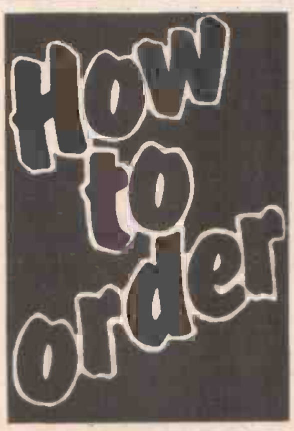
A complete reprint of our superb synthesiser design, published with Maplin Electronics (who also supply the parts). This reprint will also be of interest to those not specifically wanting to build the unit as the circuitry is highly original and is in fact patented by ETI!

**£1.50 + 25p P&P**

## TOP PROJECTS No. 5

Twenty-two complete projects including: 5W Stereo Amp, Stage Mixer, Disco Mixer, Touch Organ, Audio Limiter, Infra-Red Intruder Alarm, Model Train Controller, Reaction Tester, Headphone Radio, STD Timer, Double Dice, G.P. Power Supply, Logic Tester, Power Meter, Digital Voltmeter, Universal Timer, Breakdown Beacon, 1-2 Hour Timer, Heart Rate Monitor, IB Metal Locator and Temperature Meter.

**£1.00 + 25p P&P**


## HOW TO ORDER

ETI Circuits No 1 and Top Projects No 5 are available at newsagents or direct from ETI. Others are available only direct from ETI.

Postage and packing is 25p overseas. Send remittance in sterling only.

**ETI Specials,**
**ETI Magazine,**
**25-27 Oxford Street,**
**London W1R 1RF.**

Please mark the back of your cheque or PO with your name and address.

# CONSTRUCTIVE

**A short history of construction with thoughts on future developments.**

The present-day electronics enthusiast needs a wide variety of skills and equipment to get the most from available technology. In the early days of experimental electronics all you needed was a selection of woodworking tools, wire cutters and a soldering iron. You could even, literally, knock together a circuit with square wire and nails on the kitchen table. Alas, the days of a single valve radio sets are long since past . . . the boom in home construction started with the introduction of transistor technology, rapidly accelerated by IC technology. With the availability of more and more sophisticated devices came the need for more sophisticated contructional techniques, and deeper understanding of the actual device characteristics.

To help the enthusiast (and development work in industry) various constructional aids were developed. One of the earliest aids was pre-punched paxolin matrix board; with this, prototype circuitry could be assembled reasonably neatly and quickly, but all the actual wiring between components was still a major part of construction. Of course this was still not as neat as a specially designed printed circuit board, but in 1965 Veroboard was invented — with the copper in the stripes! This invention immediately made construction a lot neater, quicker and more flexible — leaving a lot more of the constructor's time available for the more creative aspects of electronics. Various other fixed and variable pattern circuit boards have been introduced since Veroboard revolutionised the home constructer's lot, the most recent being Blob-Board (similar to ETI's Utiliboard), which has the stripes but no holes!

## Plug It And Print It

All of the above techniques are suitable for one-off prototype work. More flexible development aids include S-Dec or the newer Protoboard. Both of these devices enable you to plug in components, without soldering, with the benefit of no possibility of heat damage and easy re-use of components.

Of course for a neat professional finish to any project a printed circuit board is best. Here there have been several advances in technology — to make the home constructor's lot a happier one.

The first aid for the constructor was the appearance of photo-sensitive board — which enabled masters to be used for more than one board. A drawback to this method is the need for an ultra-violet exposure unit — although cheap units are now becoming available — at a push the sun can be used (in the UK this can be hard to find!).

## It's In The Bag

Next came the PCB pen, first marketed by Dalo, so that you could draw your circuit directly onto the board. By using dry transfer sheets for IC mounts, the tracks can be quickly drawn in for 1-off boards.

The Seno 'etch-in-a-bag' system removed the mess and danger of hot ferric chloride — a necessary evil of PCB production.

## ETI PRINTS

All of these aids to PCB production are good, but the amateur is stuck with making up the master artwork, or drawing it each time. The latest innovation (brought to you by ETI) is PCB artwork complete, on etch resistant dry transfer sheets. ETIPRINTS cost 75p a sheet and can

# THINKING

Amatek universal box, virtually any small project will fit inside.

be used as photomethod masters, or laid down direct onto the PCB — with six separate project designs per sheet.

## Tooling Up

The mechanics of construction demand a reasonable selecting of hand tools. Side-cutters and screwdrivers haven't really changed in the last twenty years — they just get more expensive! A good idea is to spend as much as you can on good quality tools, they last longer and will not get any cheaper. A pair of sidecutters from Lindström cost about £4 in 1974 — the ETI pair still cut paper!

Good soldering irons seem to be the exception to the above rule, they are still amazingly cheap — considering how useful they are! Rechargeable irons are becoming cheaper and with higher capacities — the throwaway iron may be just over the horizon.

Temperature-controlled irons can be bought for between £10 and £20, the price is well worth it — all ETI projects are assembled with controlled irons.

## A Pain In The . . .

Hand, finger — metal bashing can be painful, not to mention dangerous, high speed drills slipping off panels can work wonders on the kitchen table. The actual work of bending sheet metal into a vaguely rectangular shape is now done for you, but the various holes and slots are a time-consuming part of any project. In fact 90% of home-built gear falls down when it comes to the exterior finish. Even the most gifted electronics designer may cut slider slots crooked, and lettering usually ends up as stick-on labels.

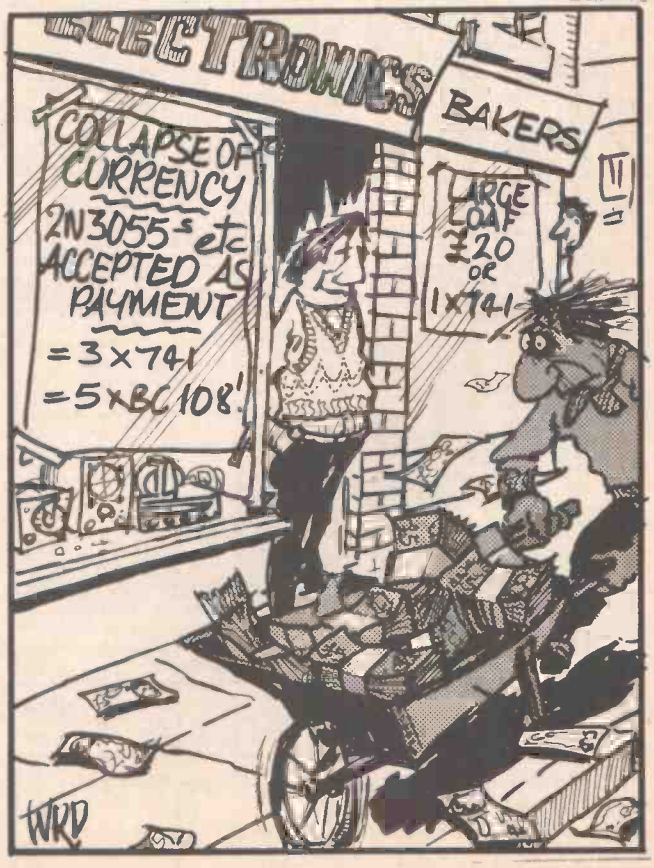
Do not fear, ETI is here! Panel transfers of complete words add the professional touch to any project. This is still not much use if all your holes are like a dog's hind leg; pre-punched boxes are the answer. The latest in this line is from Amatek; they produce a really neat case with lots of holes, and rectangular cut-outs. The Amatek PDS case comes complete with a front panel that can be used to mask unwanted holes. Expect more of this sort of Universal box in the near future.

## What Next?

As the complexity of ICs increases the size seems to decrease. Finer and finer tools and techniques are needed for all constructional projects. One result is that a lot of people lose interest in actually building equipment, they find it much more interesting to just work the concepts out and possibly breadboard the design.

But lots of people actually enjoy the physical side of life, and are continually looking for new ideas to bring to mechanical and electronic life. Sometimes now, and probably more so in the future, the best combination is that of constructor and designer working as a team. This particularly applies in the MPU area — any competent constructor can put one together, but it needs a programmer to develop the software.

An interesting possibility is the establishment of an exchange/meeting centre, putting hardware constructors in touch with software ideas constructors — both doing what they enjoy most. □



# ETI TYPES

**Which type are you? Our favourite cartoonist Roy Pullen puts pen to paper, and gives his impressions of ETI readers.**

## THE BEGINNER ~AND HIS ENVIRONMENT

Never before captured either by camera or pen, we see here the hesitant emergent moments of an individual TECHNOLOGICAL COMMITMENT; in fact the crucial turning point in what might be loosely described as Arnold Skulfington's formative years.

Fortified by the stability, identity and sense of purpose of this close knit family group, he receives enthusiastic guidance and encouragement from his Dad, here savouring the bottle of ETI SPECIAL OFFER scotch that first introduced ETI, and advanced technology to the household. Mum, after contemplating a tedious journey to the channel selector (mysteriously set to an unfamiliar channel), decides to settle to the ECOLOGICAL QUESTION. It may have something to do with young brother Mark, an aspiring marine biologist.

In the background are the relics of last months fleeting

Action replay of 3 handed technique. Get your leadpoisoning here! Arnold Favours plumbers solder sticks and Boscoe's grudge (Fuming vitriol flux paste.)

interest — at least the sump oil spilt on the woven axminster has cleared the mould caused by fallout from the glue factory where the fumes signal the melting down of another batch of dead nags. Well, perhaps facilities are not ideal but fortunately Grandad has donated his plumbing toolkit toward the enterprise. No doubt the Skulfington after-dinner drawing room conversation will turn to the Crisis in Society and the contribution to be made by the rational technologists' disciplined mind — like Arnolds!

(After all a rabble never came up with anything, except possibly the French Revolution — and look at them!)

# THE PROJECT BUILDING FIEND

1 TALKING SOAPDISH Collection (or rather — non-talking).
2 Workshop radio.
3 Mini Drill (axis of rotation is well outside the drill diameter!)
4 Tea being warmed by "green concrete" dropper section.
5 All right! — We have ways of making YOU confess to it too!
6 Faithful old MULTIMETER. Has been dropped on floor 87 times, now has to be nursed along.
7 Unorthodox method of cutting studding, etc.
8 HOLE. Thought to lead to SPACE/TIME warp. Vital components drop through never to be seen again.
9 Instructional BOY-SCOUTS-KNOTS generator and display.
10 Equipment to simulate characteristics of length of wire.
11 Electronic MOTHER-IN-LAW. With late night auto-muting.
12 Digital display of cumulative ELECTRICITY BILL (SINTEL KIT).
13 DUSTBINMEN approach detector. (Programmed to monitor CLANGS OF E.E.C. approved EUROBIN hitting deck . . . range 2½ miles).
14 Electronic Amoeba (ETI 639).
15 TTL Traffic Jam Synthesizer (MARSHALL'S OFFER).
16 EMT Source, High energy laxative, Senior Citizen Rejuvenator.
17 Dry Joint Simulator for testing dry joint testers (PW 975).
18 Electronic GRASS display (with variable differential growth and adjustable clipping) (Nominated by E.T.I. for the 1978 Wedgwood Benn Award for Innovation)
19 Farmyard Effects (EE 34).
20 Electronic Pterodactyl (WATFORD ELECTRONICS KIT).
21 VHF/FM to MW/AM Converter. (Also adds homely whistles, crackles, fading and distortion; strips treble, compresses and feeds into TRANNY (AMBIT KIT).
22 Infra-red SCORPION grill for toasty crunchy snacks. With timer.
23 Unit for making very loud HOOTING noise (Halvor simulator).
24 Quark detector (WW 946/83).
25 MACROCALENDER with ice ages and Solar super-nova


Twenty-eight years of relentless struggle with his home made television. The EF54s finally deliver. The picture is 3" X 4", and bright green!

prediction (plus optional PUROMETER — calibrated to 30 million degrees) (BYWOOD OFFER).
26 Reproduction vintage spark transmitter (R&EC 434).
27 Thermonuclear trigger (licence required). (DORAM KIT).
28 Analogue COMPOST heap (PE 966).
29 AQUARIUM TV display with moving Fishes — in colour. Also optional add-on EELS unit.
30 No-one knows what this does — let alone how it does it (MAPLIN KIT).
31 Sonic radar jammer to confuse bats.
32 STAR PROJECT . . .★ Mini TOMOSCANNER and display. For dubious sausage rolls and ailing hamsters (ETISCANNER!)

# THE PROFESSIONAL AUDIO AMATEUR

1 Fibre wedges to control room reverberation.
2 Variable geometry tracked speaker array. Gas-filled mid and treble range systems corrected for phase.
3 Electrostatic dust extractor.
4 Mood lighting.
5 Intercom to WORLD outside.
6 Lead-shielded duct for delivering antistatic radioactive isotope "bomb".
7 Headphone park.
8 Latest consignment of STATE-OF-THE-ART apparatus.
9 Sound pressure level meter.
10 Caesium frequency standard.
11 On-line spectrum analyzer.
12 Ultimate F.M. tuner with panoramic display.
13 Tuner co-ax S.W.R. indicator.
14 Thermometer and Hygrometer.
15 Seismograph.
16 Barometer.
17 LIFE SUPPORT SYSTEM. (Uses existing Dental plumbing.)
18 Aerial rotator.
19 Record turntable — on stack of paving slabs through to substrate!
20 Disc hygiene trolley. Handling, decontaminating, examing, ionizing.
21 Omnidirectional combined channels deep basshorn in chimney.
22 Cryogenic plant for low noise preamp.
23 Secret development model of Giant NABCASSETTE recorder on loan from R★★★★.
24 Looney-box. All known Quadro systems decoder — and one or two unknown!
25 X-Y Stereo display.
26 Card and Memory store for programmable equipment.
27 Converted dentists chair for maximum comfort and minimum acoustic interference.
28 Emergency escape facility.
29 Programmable graphic equalizer with group delay and phase shift displays.
30 IKON: Original 'Williamson' mummified in transparent potting resin (might be exhumed if transistors Lose Favour!)
31 Phial containing speck of dust found on stylus: to be sent for annihilation in CERN Synchotron, Geneva.
32 Continuity Announcer.


Roy Pullen
Your dinner's ready, if you want any
QUAD
Bok
IVASA
HAYNER BODELEY
ENTERTAINS DE-LUX LIVE AT BERWICK LIGHT INDUSTRIAL ESTATE
THIS IS QUACKRO
ASTOUND YOUR BARMY FRIENDS
1000 MAGICAL NIGHTS IN OLD VIENNA
HI-FI TEST DISC
PHASE 5
THREE DEGREES SING LIGETI
1
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# THE MPU MAN

**The amateur computer man shares with the Hi-Fi fanatic the same highly developed mania for interconnected SEPARATES. There is no way that a one box personalised high performance system could be tolerated. However, whereas audio equipment hovers on the strife-torn domestic borderline between FURNITURE AND MACHINERY, computer tackle is definitely machinery and as such (apart from the Skulfington household) is relegated to cellar, attic or shed.**

**Colleagues more familiar with the world of exotic signal processing, as found in audio, communications and television tend to scorn the pathetic ups and downs of the rustic digital signal, and insist that waveform processing is intrinsic to genuine electronics. They even scornfully question whether the computer man is concerned with ELECTRICITY!**

**Meanwhile the inscrutable practitioners of this new and bizarre branch of mathematical sorcery toil on — on a higher and rarified plane of intellectual existence to that of the dirty finger-nailed, scope battering radio rabble.**

**KEY**

1. Teletype unit.
2. Punched paper tape reader.
3. Floppy disc 'player' unit.
4. Home-made floppy disc experimental unit.
5. Incompatible systems interface patch-board.
6. Skeleton keyboard for manual entry.
7. Modulator for feeding display material to domestic magic lantern.
8. Domestic magic lantern showing results of simulated World cup final.
9. Another advanced game in progress.

There are rumours of an Opto-Pneumatic Power Cue being evaluated by leading players. Integral Laser Theodolite system determines range and angles while Microprocessor backpack computes and controls shot dynamics.

10 Working microprocessor module.
11 Well ventilated reprogrammable read only memory.
12 Interesting teleprinter graphics — genuine system check — no kid!
13 Early home-made 8-bit processor.
14 Power supply with outboard cooling and attractive economy housing.
15 Another development module. Seems to have undergone pre-frontal lobotomy. . . . Last Night of the Proms?
16 Junked cassette player with sprinkling of cassette programmes. Alternative to papertape or manual entry.
17 Primitive one-shot switch input unit.
18 Aerosol spray for de-bugging.
19 Mighty de-bugged noughts and crosses programme listing being triumphantly brandished.
20 Attempt to fabricate home brew floppy disc.
21 Another teletype unit.
22 Personalised low density punched tape storage system.

# Build a microprocessor electronic musical door chime which can play 24 different tunes!

*A complete* chroma-chime *Kit for only £18 inc. p.&p. & VAT.*

Plays:

| | |
|---|---|
| Greensleeves | Cook House Door |
| God Save the Queen | The Stars & Stripes' |
| Rule Britannia' | Beethoven's Ode to Joy |
| Land of Hope and Glory | William Tell Overture |
| Oh Come All Ye Faithful | Soldier's Chorus |
| Oranges and Lemons | Twinkle, Twinkle Little Star |
| Westminster Chimes' | Great Gate of Kiev |
| Sailor's Hornpipe | Maryland |
| Beethoven's "Fate Knocking" | Deutschland uber Alles |
| The Marseillaise | Bach |
| Mozart | Colonel Bogie |
| Wedding March | The Loralie |

'These tunes play longer if the push button is kept pressed

* Handsome purpose built ABS cabinet
* Easy to build and install
* Uses Texas Instruments TMS1000 microcomputer
* Absolutely all parts supplied including I.C. socket
* Ready drilled and legended PCB included
* Comprehensive kit manual with full circuit details
* No previous microcomputer experience necessary
* All programming permanently retained is on chip ROM
* Can be built in about 3 hours!
* Runs off 2 PP3 type batteries.
* Fully Guaranteed

* *A great introduction to the fascinating world of microcomputers.*
* *Save pounds on normal retail price by building yourself.*

The Chroma-Chime is the world's first electronic musical door chime which uses a pre-programmed microcomputer chip to generate tunes. Instead of boring old buzzes, dings or dongs, the Chroma-Chime will play one of its 24 well known tunes from its memory using its tiny 'brain' to all the music synthesizing! Since everything is done by precise mathematics, it cannot play the notes out of tune.

The unit has comprehensive built-in controls so that you can not only select the 'tune of the day' but the volume, tempo and envelope decay rate to change the sound according to taste.

Not only visitors to the front door will be amazed, if you like you can connect an additional push button for a back door which plays a different tune!

This kit has been carefully prepared so that practically anyone capable of neat soldering will have complete success in building it. The kit manual contains step by step constructional details together with a fault finding guide, circuit description, installation details and operational instructions all well illustrated with numerous figures and diagrams.

To CHROMATRONICS, River Way, Harlow, Essex, U.K.

Please send ☐ Chroma-Chime Kits at £18·00 each including VAT and post and packing

PLEASE USE BLOCK CAPITALS

Name ______________________

Address ______________________

______________________

______________________

I enclose cheque/PO value £ ______________

or debit my ACCESS/BARCLAYCARD account No.

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |

Signature ______________________

N.B. The CHROMA-CHIME is also available, fully assembled, price £24·95 inc VAT and post and packing.

Please allow 7-21 days for delivery.

The CHROMA-CHIME is exclusively designed by

**CHROMATRONICS**

River Way, Harlow, Essex.

# CALCULATORS OF THE FUTURE

**Crystal (liquid?) gazing by H. Moorshead**

One of the statistics that we have about ETI readers is that on average they own 1.8 calculators. This may sound extraordinary but it becomes mind boggling when you consider that pocket calculators have only been around for about seven years, and prices only broke the £20 barrier in the early summer of 1974. The first calculator survey we did in ETI was August 1974 and the cheapest was £10.95 (Minuteman 6) but we believe that it was a model about to be replaced: The Sinclair Cambridge kit was £14.95!

These prices were of course for simple, 4-function models, the least expensive scientific was the Sinclair at £53.90.

OK, it's an old story, we all know how prices have gone down but what of the future — are we going to see the £2 disposable calculator? We think not.

Calculators and transistor radios share a common history. In the very early 1960s the first 'trannies' appeared at £20 or so (then 1½ weeks' wages) but the competition was such that the price of a pocket transistor radio fell to about £5 in 1962-63 but although there were exceptions at £3 or so, the competition at the low end of the market was not for price but for quality and facilities. Even the Japanese giants were finding the going tough and concentrated their production and advertising on firstly LW and MW, then SW, 'Pirate Bands', tone controls and later still, FM band. Joe Public was far more interested in a decent sound at a reasonable price than an ultra-cheap model.

So with calculators. We don't know which is the cheapest calculator at the moment but few people would care. From 4 functions, the manufacturers began to include % keys, fixed/floating decimals and then memory.

With competition at the bottom end of the market far too hot for most companies, resources were channelled into chip technology and scientific facilities.

Hewlett-Packard, who were the first in the field, always refused to be pulled into the price wars, relying instead on being a year or two ahead of everyone else. A number of companies were envious of this and company after company went bankrupt, presumably many of them were muttering on until the last minute that the public did not appreciate their quality, not realising that HP were the only ones in the real, as opposed to imaginary, quality table.

So, what do we look for in the next couple of years?

## Prices

We have said already that calculators parallel transistor radios remarkably. If we take this a step ahead we can expect prices to hold at their present level for some time. Certainly we'll hear from time to time of the barriers being broken yet again but it will not be dramatic or newsworthy.

What will happen is for replacement models to come out at the same price but to improve continually in facilities.

The current price brackets are approximately £4-£9 for a standard calculator — many of them with memory, square root and percentage keys. Next are the specialised and inexpensive scientifics at £10-£25. Further along still are the super-scientifics and programmables over the £25 mark.

The facilities in the upper section will fall into the middle bracket fairly quickly and we feel that the excitement will be in the £25 plus area.

## Developing

The falling price of memory will bring about the biggest change in the next couple of years. Bubble memories which are non-volatile, cost about £300 for 20K. We feel that two years is a bit early for these to be incorporated in normal calculators but it will follow not all that long afterwards. CMOS, or other semiconductor memory will have an enormous growth rate and be cheap enough to provide enormous memory capacity.

At present a number of calculators use magnetic program cards — this is only used because of the cost of memory and we shall see these systems disappear in the next couple of years. It will be replaced by a memory having a capacity of say 2 000 steps. This will not of course be used (normally) for a single program as the 2 000 steps can be broken up to hold 50 personally written programs with an average of 40 steps. In addition another chip — possibly included automatically with the main chip — with 50 programs supplied by the manufacturers will be included (this is with us now of course).

Already several calculators are displaying letters in association with the programming modes. This will be expanded to a complete alphanumeric display using a dot matrix LCD display. We are certain that LCD will dominate the market in the near future as the battery savings are enormous.

Recent LCD calculators have guaranteed battery life of 5 000 hours and this had led them to use available mercury cells. The battery workers must be working on long life batteries, possibly bigger than the mercury cells.

The highly complex functions of our calculators in two years will mean that current consumption will not be insignificant, but it is likely that the machine will auto- ▷

matically dump any figures being worked on into low current consumption memory if no key presses are made — this will cut down current drain considerably.

If we have a calculator which will be storing a considerable amount of user material which needs some current to hold it, there will be two batteries which are changed one at a time, each capable of retaining the information.

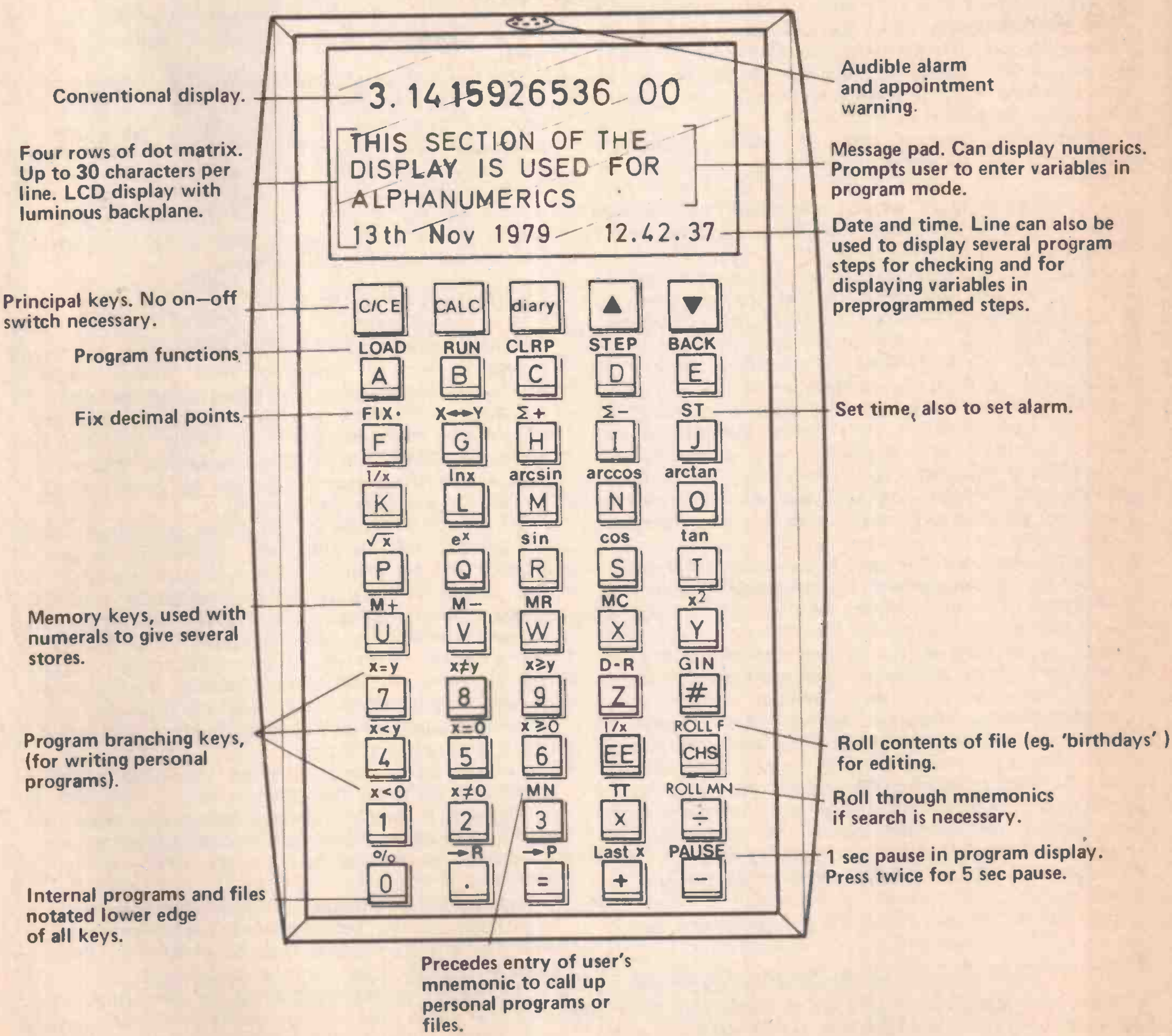
## The 1979 Calculator

If, as we predict, your calculator can handle and store alphanumerics, a whole range of possibilities occur — it becomes as much a diary as a calculating machine and can store telephone numbers, appointments or any other information you might care to retain. A clock will be built in to display day, date and time and, with a small buzzer, will act as an alarm to give you notice of the events stored in the diary.

Our 1979 model will do everything that current calculators do: simple addition is still likely to be a major use but the extended keyboard will show you the last five or six figures entered so that an interuption in the entry will not be serious.

A full Alphanumeric keyboard will be provided and whilst mnemonics could be used to take the place of scientific function (eg. SR for square root) we expect the keys to serve two or three functions as they do now on several calculators. In our drawing we have shown this as the upper shifts.

The maker would have already built in 50 or so prog-



rams — we show these as the lower shift functions. Instruction books, once they have been read, are a nuisance so the program key, once pressed will give (on one or two lines of the four line display) the information to be entered. This could read: *F = frequency, L = inductance in millihenries, C = capacitance in picofarads. Enter L, Enter C, Ans. in kilohertz.*

Alternatively on a more advanced machine the display could prompt each entry. After you access the "LCF" (or similar mnemonics) program the display replies:

*"LCF" PROGRAM*
*RESONANT FREQUENCY OF INDUCTOR*
*AND CAPACITOR*

Then you press E (for 'enter'; this moves the program on to the next stage). The machine then displays:

*ENTER INDUCTANCE IN*
*MILLIHENRIES*

You then press 2.5, check your entry, and then press E. The machine continues:

*ENTER CAPACITANCE IN*
*mF (M) nF (N) OR pF(P)*

You press 470P and the machine displays *470 EE-12 FARADS,* so you press E and your result appears:

*2.5 EE-3 HENRIES*
*470 EE-12 FARADS*
*RESONANT FREQUENCY (HERTZ)*
*146825.4019*

There will be plenty of permanent memory for entering and retaining your own programs. These will only take up as many spaces as necessary in the memory.

To avoid the need for separate notes, there will be various 'search' keys. Since it may be difficult to remember the identification of your own programs, you may have to roll through all the titles. Similarily appointments can be run through for checking or amending.

The display will be LCD in a dot matrix — it is quite possible that instead of say four rows there will be a continuous dot pattern and some calculators will be able to display graphs and other simple graphics.

We have shown the 1979 model very much as a conventional calculator but there may be big changes in the appearance as well. The most obvious format would be similar to that of a diary which opens on a hinge, thus protecting the keys.

Although this model will almost certainly have many facilities similar to a minicomputer and some machines will undoubtably be aimed at the computer enthusiast, we do not see any larger numbers in this field. This is not because the power isn't available but because the mass market is unlikely to demand or desire a personal computer.

## Five Years On . . . . .

Our 1979 model is simply using more of current technology but whole new fields will be opened by new techniques, as yet only a twinkle in the engineer's eye. Our 1982/83 model is likely to bear little resemblance to current machines.

Our two-year hence machine has a cluttered keyboard and this will have to go. Looking into our crystal ball we see complete elimination of moving parts. We see our calculator being about the size, but half the thickness, of a packet of 20 cigarettes — or about the size of a thickish pocket diary ... it will be metal except for one surface being like a glassy slate.

Touch the top and a display comes up listing several words:

*Math*
*Scientific*
*Diary*
*Memory Aid*
*Teletext*
*Compute*

Touching *Math* (because it's likely to originate in the US) will bring up a display of a fairly simple calculator keyboard probably just like our current ones. Touch the keys and a section at the top will act as a display.

When you've finished adding up the groceries touch the top again and you revert to our prime index.

Now let's try *Scientific.* Instead of a scientific keyboard we'll be looking at a subsidiary index giving us further choices enabling us to use programs or make simple calculations.

Choosing *Diary* we'll be able to look at several pages of information and by touching a portion of the display, we'll be able to bring up an alphabet to 'type' in our new information.

Memory aid will enable us quickly to search through hand written notes: to enter these write on the surface with a pen and the impression will be remembered. (We do not see hand written character recognition in five years but a reproduction of your own handwriting isn't too hard.)

Selecting *Teletext* will display for you a choice of Ceefax 1, Ceefax 2 and Oracle (It takes more than ETI's crystal ball to predict an Oracle.). Selecting these will bring up the index page instantly and you'll be able to work your way through the various indices to find the news, TV programmes, share prices etc.

This calculator will be small and will probably need rather an efficient aerial but it will update every page in its own memory whenever the signal strength is high enough and will continually correct any errors. Everything will be stored in the calculator's own memory so take it to Central Africa and it'll show you for ever the last data it picked up.

In our discussions on what a calculator might be like some of the contributors suggested central plug-in points where batteries can be recharged and new data entered. Most thought that this is unlikely as whenever national standards, let alone international standards, are concerned that things have to wait for a decade or more.

By this time many readers will have their own mini computers and a battle will be raging as to whether it's best to have a good pocket calculator (though we doubt if they'll be called that) or a home computer.

In writing this piece we have to admit to a certain feeling of being ill-at-ease. We came across a copy of Strand magazine of 1905 which had an apparently serious feature on what aircraft would be like in 50 years time — there was a drawing of ladies (in fashions which to our eyes look no different from 1905) playing tennis on the wings of an almighty flying machine! We hope we're not that wrong but if we are this will make an amusing article to reprint in ETI in five years time! □

# THE HISTORY OF HI~FI 1978~2008

**This article has a strange story behind it. While we were compiling the magazine, a strange box turned up out of the blue on Ron Harris's desk. It contained this report. The box disintegrated shortly afterwards, leaving nothing for analysis.**

**As the subject covered is *exactly* that which Ron Harris was working on at the time, we can only wonder at the origin of the work. The historical tone points to someone somewhen deciding to help us out with our predictions . . .**

It is clear, in retrospect, how audio technology came to be in such a confused state in the later half of the 1970s. Having only recently progressed from such techniques as thermionic emission amplification and rubber band driven turntables (literally!) and having perfected neither, the industry was hardly in a condition to handle the newer and more promising ideas beginning to make themselves heard.

A classic case of nerves set in.

Things were a little better in the semiconductor field. VFETs were only introduced into the market in 1977, until which time bipolar transistors with all their inherent linearity and harmonic problems were universally employed. Perhaps it was the dissatisfaction felt with this device which caused the widespread vacillation that gripped the field at this time.

## The Great Diversion

Early in 1976 the hi-fi press began to crystalise the feeling that 'things could be better', but in the most extraordinary, and to us, unbelievable manner. The forerunner of the transistor amplification circuit had been the thermionic or valve amplifier. Instead of controlling carrier movement within a doped semiconductor substance, these devices operated by modulation and retardation of electrons released from a heated electrode within an evacuated glass envelope.

Essentially the concept was a linear one, whilst transistors at that time were not. It was noted by such enthusiasts who had run both systems that the newer semiconductor amplifiers added an unpleasant 'edge' or harshness to the sound when compared to their predecessors. Not unnaturally two schools of thought drew themselves up, almost overnight.

The first stated flatly that valves were superior - and that was that. Transistors were 'edgy', 'harsh' and 'unmusical'. Bring back the 'good old days' (groan) of the 50s and 60s etc, etc.

Facing them were arranged the advocates of the new technology. Valves generated more distortion, more heat, required HT, deteriorated with age very rapidly and were generally to be ridiculed. Transistors gave a clean analytical sound much more faithful to the original (undefined but still held inviolate) and rightly replaced the outmoded valves.

At the outbreak of this polarisation, there were very few left in the middle to attempt to explain the phenomenon in a scientific manner. Both camps rapidly began producing evidence to support their own beliefs. Magazines began to take sides. One particularly infamous publication, seeking to bolster its failing circulation in the face of a congested marketplace, took up a decidely radical stance and was responsible for a good deal of the resulting escalation of the arguments.

Amid the effects of the debate, the cause began to get lost. Transistor technology was flawed - that much was recognised - but valves were beginning to gain acceptance as the answer to that flaw. Instead of harking back to the basic non-linearity of the amplification element itself, and attempting to correct this, it seemed for a depressingly long while as though valves would sweep back in, cheered on by the press, and set back sound reproduction technology twenty years or more.

### Economic Pressure Begins To Tell

Thankfully the battle was a protracted one. As in all extended conflicts, eventually it is economics which decide the issue. While it is undoubtedly true that valve design had not fully exploited the potential of the single carrier device, being abandoned too quickly in the face of an apparent overwhelming semiconductor superiority, and that early bipolar power amplifiers were wont to exhibit a particularly nasty sound spectrum, the big industry money had gone into transistor designs.

The initial changeover coincided with the advent of the consumer society in the widest sense. Hi-fi equipment began to appear in more and more homes, and the industry grew rapidly. Expansion continued unabated until the world-wide economic depression of the early seventies.

By this time however the die was cast and the framework of the new giant corporations, mainly Japanese, and their 'feeder' firms producing specialist items (i.e. the British loudspeaker industry), was firmly set.

So when the public began to apparently reject transistor designs, reaction was not slow in coming. Within a year most big companies had a valve amplifier on the market – at a price. Valves were considered as a fanatic's tool, and as such were available only in small numbers at high prices.

At the same time however the massive investments in semiconductor production had to be protected. With the power of the Yen behind it research at last began to identify and eradicate the faults of transistor amplifiers.

Meanwhile, back in print, some publishers were beginning to give space to freelancers who were coming up with ideas of their own. Microphony was belatedly identified as the cause of a supposed 'ambience' possessed by valve amps. This effect is a modulation of the election beam within the glass envelope by the action of sound waves striking that envelope. The valve acts like a microphone. Playing an uncased valve amp (as most of them were) in the same room as the loudspeakers gave an effect rather like turning up the reverberation control on modern signal processors. Pleasant, but highly disposable!

British firms acted totally in character. Small specialist concerns began to market the first truly acceptable semiconductor amplifiers. (Firms like Lecson, Naim and Quad began their climb to ascendancy here.) Close behind came the Japanese with all the speed and industry indiginous to that nation; they produced a whole new generation of 'soft sound' hi-fi tailored to the ears of their predominantly western market.

Valve amplifiers settled into a niche, a minority taste to be catered for a huge profit, and gradually faded away again never to reappear. By 1980 they had vanished completely. ▷

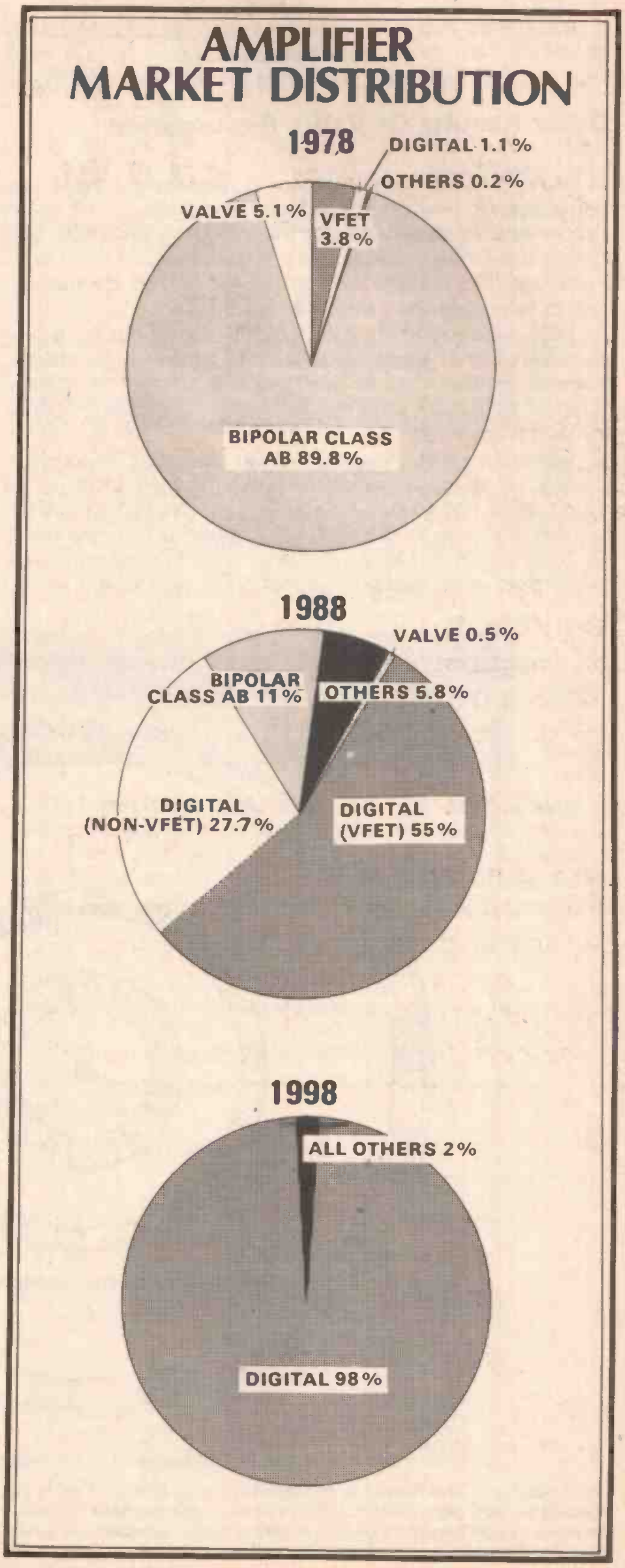



**Fig 1: — the three diagrams show how the share of the amplifier market has been divided over the years. 1978 still shows the dominance of the early class AB hybrid design. Just ten years later, however, digital amps are accounting for a total of 77.7% of the total. 1998's figures require no comment!**

Investment had been protected, and sound technology advanced. A luckily advantageous outcome from a most embarrassing incident. Progress could now be made.

## Other Results Of Valve Resurgence

A furore of such magnitude could not help but have consequences far beyond the primary engagement. At about the same time as semiconductors came under attack, belt driven turntables were at last being replaced. Direct-drive units began to replace them at the top end of the market, and to seep downward into the mass sales area.

This 'watering-down' of a basically sound but expensive technique led to some degradation of performance at first, with the result that it was possible for the inherently inferior belt-drive units to outperform similarily priced direct drive devices.

Suddenly turntables too were in the great 'musicality' debate. Just as transistors suffered for their birth pains, direct drive had to pay for its early mis-application. Belt-drive was hailed as the ultimate manner of spinning discs. Such terms as 'information loss' 'hunting' and of course 'un-musical' were applied to direct drive turntables.

Once more the camps drew up, only this time they had somewhere to go! Belt-drive was a natural bedfellow for valve amplifiers, and the new sorely pressed direct drive fell gratefully in with the amplifier technocrats.

Mercifully this alteration was not to last long. Moderation has apparently been learned by now and opinion, divided though it was, never became so fiercely intransigent over the subject. Faults were recognised on both sides, and work progressed smoothly to correct them. Belt-drive reached its zenith with the Linn Sondek and Planar 3 designs, and once direct drive design surpassed these, belts began to fade from the hi-fi horizons.

Other smaller ressurections occurred elsewhere in audio. Moving coil cartridges, unjustly abandoned due to low output and tracking problems began to receive attention once more, and were developed considerably. Amplifiers began to incorporate circuitry to facilitate their usage just as the more advanced designs dispensed with the necessity!

Loudspeakers remained strangely untouched by the blight, national tastes continued to dominate with the British once more convincing the world that *theirs* was somehow more tasteful than anyone else's with a resultant domination of the market. The incredible Quad elec-

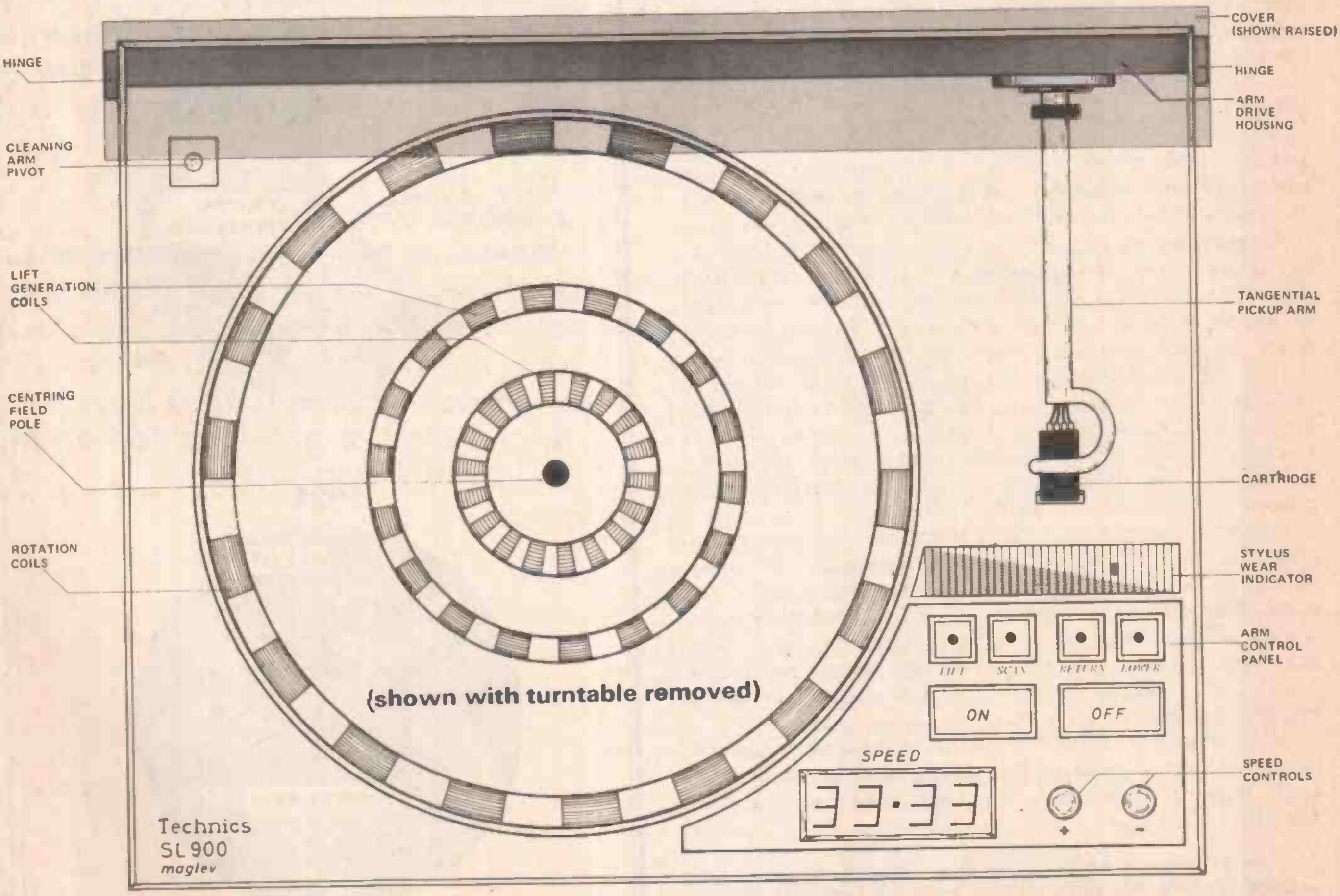



**Fig 2: Above — The first truly modern turntable design, Technics famous SL 900 unit. Launched in 1979 it swept the field in a way no other model has done before or since. Early versions suffered from field problems, but these were eliminated very rapidly, and the benefits of a turntable with the platter and arm as the only moving parts were quickly realised by both competitors and the public. All present day manufacturers producing magnetic levitation turntables do so under license from Technics.**

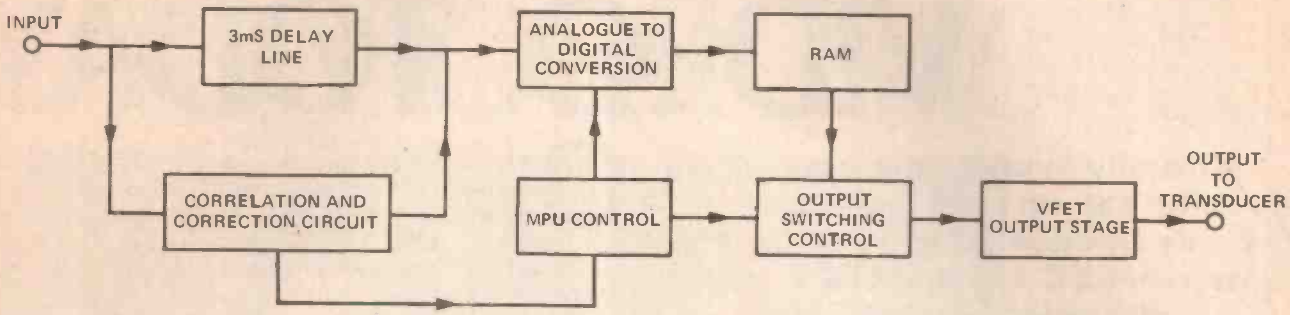



**Fig 3: Block diagram of the early digital power amplifier circuits. Opinions at the time differed on the length of delay line used, and on the required sampling rate. The basic premise, however, was not questioned until 1986 with the advent of Pioneer TSA 5190 unit. (Full details Viewdata Listing Elec 177/H).**

trostatic design was still largely unsurpassed twenty years after its introduction.

## Dawn Of The New Technology

Nineteen seventy-eight saw perhaps the most rapid progression of any one year in the period. This was when VFET amplifiers, led by Sony and Yamaha, moved to take a much larger segment of the market. This was when several companies simultaneously launched the new direct drive machines which rapidly settled that particular debate.

The research financed by the giants mentioned previously advanced digital sound processing seriously for the first time, but foundered initially due to the failings of signal processing generally. It was not until late 1978 that MPUs were first employed to control the A to D conversions and the output switching functions.

Soon afterwards someone somewhere put a very fast MPU controlled processor on the same breadboard with an output stage of VFET power types, and modern amplification was born.

Signals presented to the input where shunted around a 3 ms delay line, and correlated to eliminate noise. From here the signal was digitalised at the fast ( for the 'time) sampling rate of 100 MHz and used to control the 'power-switch' output stage of VFET devices.

(The reader is referred to his data terminal for a more detailed discussion of amplifier types. Historical tapes will have to be accessed for treatment of types previous to H. As this is a general survey details would be inappropriate here.)

Amplifier design wavered back and forth for a while as each failing of the bipolar circuits was indentified and dealt with. Lecson's was the first commercial design to acknowledge the importance of the rectifing metal-semiconductor junction in low level control circuits. Their solution was to employ FETs wherever possible in the signal path instead of switches. Naim simply left out as many switches (and hence facilities) as possible!

By the time charge contoured semiconductor material with its programmable carrier distribution in the surface layers appeared in the eighties, audio processing was almost entirely digital and so this solution was never seriously adopted.

Turntable design was reasonably static through 1978, refinements occupied most companies for a long while, and the first mag-lev design did not appear until well into 1979. This was the Technics SL900 which can still be found in modified form today.

Radially mounted drive elements in both the base and the table are used with a cycling drive signal to rotate the platter at the required speed. Control is achieved electronically by a sampling technique, and the high mass provides a good deal of smoothing. Isolation from external disturbance is of course very good.

The SL900 was also the first unit to employ a fixed height radial tracking arm, also mag-lev controlled, driven by pulses derived from the turntable drive circuitry for synchronisation. All in all quite a revolution for its time.

## Conclusion

Thus audio technology emerged into the mid-eighties with a sound and undisputed base despite the dangerous turbulance of the late seventies. Loudspeaker development was thus able to bring about the startling advances of 1986 unhindered. Had the diversions of 1975-1978 gone much further however it is doubtful in the extreme whether we could now look back so smugly from our present day state of the art.

One is tempted to conjecture whether in a century or so a report such as this may be written in exactly these tones concerning our present day technology. □

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Our thanks also to the staff of IBM and ICL for their help in accessing the historical data necessary for this report. Without their programming skill the task would have been far more onerous.

# VIDEO TODAY

**Virtually every home has a television set, up until recently the only freedom to view was between BBC 1, 2 and ITV — the video revolution is happening. Angus Robertson investigates the next five years of liberated video in the home**

ONE thing is for certain — over the next five years we will be finding numerous other uses for the domestic television receiver than watching *Crossroads*. New technology and the continually reducing cost of microelectronics will combine to enable equipment that used to be cumbersome and unreliable to be produced satisfactorily — and in quantities sufficiently large to make this equipment economical for the home purchaser.

### Television displays

The glass-envelope cathode ray tube has been with us for over fifty years and will almost certainly be here in twenty years time. Improvements are continually being made which enable CRTs to be produced more cheaply and reliably. The latest type places the three electron guns (required for a full-colour display) in-line rather than in the conventional delta formation. This considerably simplifies the convergence circuitry necessary to ensure that the correct electron beam falls on the correct coloured phosphor. Delta gun tubes required twelve dynamic and four static convergence adjustments, Sony *Trinitron* in-line tubes use four adjustments while the latest precision in-line tubes use toroidal deflection yokes wound with such accuracy that all dynamic adjustments are eliminated. Both static and purity adjustments are made by magnets preset during manufacture. This circuitry simplification not only reduces price but increases reliability and long term picture quality. RCA and Hitachi call such tubes *PIL* while Mullard has a similar type called the *20AX*. Sony recently developed a 32 inch *Trinitron* but it costs several hundred dollars and is unlikely to come into common use.

Another CRT that might be developed is the focus-mask or focus-grill type which has larger grill openings than the normal shadow mask which act as small focusing lenses — allowing a brighter display for the same beam current. However an intermediate suppressor grid is required to increase picture contrast, and manufacturing difficulties currently make the focus-mask tube non-competitive.

A colour CRT that eliminates all convergence problems is the beam index tube which uses a single electron gun scanning vertical phosphor stripes on which index stripes have been deposited. These release either secondary electrons or ultraviolet radiation to indicate which colour stripe is being scanned — colour information is then electronically switched to the single gun to match. Problems rise when the electron beam scans more than one stripe at a time.

**Large screen projection TV in the home for £3 000 today — who knows tomorrow?**

# & TOMORROW

**Phillips prototype Picturephone, can be used for face to face contact, or transmission of vital images.**

## Up against the wall

Flat TV screens have been demonstrated in several laboratories but they are still curiosities. There are primarily two different types of display — using either light-emitting or light-controlling cells. Light emitting panels usually use gas discharge or plasma cells, arranged in a matrix which requires over 600 000 elements to provide full colour rendition. The light source of a plasma cell is ultraviolet; the three primary colours are produced using suitable phosphors. However, picture contrast and colour rendition are limited by the method used to provide varying intensities in each cell (for the grey scale). Each cell must also have some form of memory since it is being scanned only once every fiftieth of a second.

Brightness leaves something to be desired and current screen sizes are more suited to the Sinclair miniature TV rather than the average living room. Resolution is only about a tenth of that required for full-definition pictures. Undoubtedly research will continue and eventually flat screen television will become the norm, but I feel this is at least ten years away.

Large-screen colour television was introduced into the home about three years ago by the Advent Corporation with its *Videobeam 1000A* television projector. This uses the Schmidtt optical technique (like telescopes) with three separate sealed tubes projecting red, green and blue television images onto a special 2.2m diagonal high-gain screen 2.5m away. The screen is very directional: instead of spreading a little light over a large area, it concentrates a lot over a small viewing angle. Advent has just introduced its *Videobeam 750* which uses three 120mm diameter CRTs each with a glass and acrylic lens system projecting onto a 2m diagonal screen, and costs around £3 000. Over seventy companies in the USA produce large-screen television sets by using an acrylic lens in front of a standard 13 inch television set. Although very simple to implement, picture brightness is very poor and viewing is generally only possible in darkness. Large screen flat displays are limited by power dissipation and cell size.

## Video recording

One big drawback with living in Europe is that our television system is different to that of Japan and America. Most recent video tape recording developments have occurred in these two countries, and they account for around 90% of the total market for such equipment. Consequently there is little incentive for manufacturers to modify their developments for our market so when we eventually receive new developments they are 12 months to three years out of date. This does, however, simplify marketing here, since only successful lines find their way to Europe and after all bugs have been discovered in America.

There are currently five main competitors in the video cassette recorder market. Sony developed the *U-Matic* format which provides up to one hour recording on 19 mm wide video tape in a cassette costing about £16. The *U-Matic* format is now finding its main application in business and industry, because the recorders are very robust and picture quality and performance are exceptional. A basic recorder costs around £1 400 and when used with the correct monitor, will also replay tape recorded in America with NTSC colour. This compatibility has been found to be very useful in industry. ▷

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| 4016 | 0.60 | 4040 | 1.19 | 4067 | 4.13 | 40102 | 2.16 |
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**Telefunken/Decca have developed their Teldec video disc system for use in the home.**

A number of other companies manufacture *U-Matic* format recorders, these include JVC, NEC and National Panasonic. It is estimated that around fifteen to twenty thousand *U-Matic* format video cassette recorders have been sold in the UK.

Philips introduced its VCR format video cassette recorders in 1972 and the *N1502* currently sells for £649 and provides one hour's recording on cassettes costing about £20. The unit has a built-in TV tuner and digital time clock, allowing off-air programmes to be recorded automatically during a three day period. Principal market is the home, with education following up behind. Around thirty to thirty-five thousand have been sold in the UK.

## Seconds out . . .

Three new contending video cassette recorders are being launched in the UK this autumn. Philips has *VCR Long Play* which enables 130 minutes to be recorded on the same "one-hour" cassette used in the VCR — by running the tape at half speed. The *N1700* recorder costs about £700 and also features built-in tuner and time clock. Grundig has launched the *VCR4000* which uses the same *VCR LP* format, and also the *VCR5000* which is dual-standard (it plays back both new and old format tapes).

Sony is launching its *Betamax* recorder which has been extremely successful in America and has even prompted a law suit (from Walt Disney and Universal against Sony, for manufacturing a video cassette recorder that can illegally record programmes off-air for which they hold copyright). Recording time is two hours and again the unit includes a built-in tuner and time clock. A number of other manufacturers have lined up behind Sony to manufacture *Beta* format recorders, including Toshiba, Sanyo, Zenith and Magnavox (USA Philips).

The other Japanese manufacturers are lining up behind Matsushita (brand name National Panasonic) with the *VHS* format. Standing for Video Home System, this again allows two hour recording, with optional skip field recording four hours. Skip field only records one of the two interlaced fields of a normal TV frame giving 312½ lines vertical resolution and slight loss of smoothness on very rapid movement. Since the horizontal bandwidth has already been reduced from 400 lines to 300 odd lines by the recording process, the advantage of skip field recording (cost) far outweighs the slight loss of quality. RCA, JVC (51% owned by Matsushita), Sharp and Sylvania will be bringing out *VHS* recorders.

## Copyright Penetration

Although three contending formats for the home market *(VCR LP, Beta* and *VHS)* will make life difficult for suppliers who will have to stock different types of blank video cassette and spares for each, it is quite likely that each will achieve considerable market penetration. This is because each will normally be used in one location to record programmes off-air for watching at a later date on the same set and not for interchange with other video cassette recorder users. Problems will, however, arise when pre-recorded programmes are sold on all video cassette formats.

The other problem likely to delay the availability of pre-recorded programmes is copyright. Although the BBC and ITV have a vast stock of old programmes in archives, they commonly hold the copyright for only three screenings — after which repeat fees must be re-negotiated with every person concerned in making the programme. The complexity of such agreements, and their cost, will preclude using these archives until some broad new principles can be established. Videograms, as the industry has started calling video-taped programmes, will initially be documentary-type programmes which will withstand repeated viewing — who wants to watch *Z-Cars* 10 times?

## Video discs

One report recently published uncovered twenty-six different video disc formats. Obviously very few will reach the market place. At the time of writing, although launch dates have been repeatedly reported, only one system has ever been marketed and that was a dismal failure. The most likely disc to appear is the *VLP/Discovision* from Philips/MCA, a joint venture. *VLP* uses a reflective disc 300 mm in diameter. This looks like a normal audio record but with a shiny surface and "grooves" consisting of pits of different lengths. The disc rotates at 1500 rpm and has 600 pit tracks per millimetre. The pits are read by directing a low-power laser at the track, the reflected light is then passed to a photo diode for processing. The disc provides 30 minutes of playing time. The cost of the player is expected to be £250 to £300 and a feature-film sized disc will cost £6 to £11.

*Teledec* video discs have been on the Central ▷


**JVC's VHS cassette machine with two hour recording time.**

European market for two years but sales have been minimal (a few thousand). *Teledec,* developed jointly by Decca and Telefunken, actually uses grooves on the record although these are very fine and are played by a special stylus up against which the flexible 190 mm disc is pressed by a cushion of air. Discs cannot yet be cut in real time so all programmes must originate from film. The player sells for about £330 and discs cost £3 each. The lack of suitable pre-recorded discs is probably instrumental in *Teledec's* lack of success to date. Other manufacturers developing discs include Hitachi (holographic), MDR (magnetic), RCA (capacitive) and Thomson-CSF (laser modulation).

Even when the technology for video discs is freely available at a price the consumer can afford (less than £500), again programme availability is likely to limit market penetration especially since they cannot be used for recording TV programmes off-air. Considerable losses must be sustained by programme distributors before the equipment becomes widespread. Only one video disc is likely to "win", probably *VLP/Discovision.*


## TV sound

Although the pictures are normally considered most important, sound must not be forgotten. With the introduction of low-cost ICs it is probable that sound will soon be digitally encoded within the TV waveform. This type of system is already in use by the BBC and the Eurovision network ("sound-in-syncs"). Transmitting the digitally-encoded signal simplifies transmitting stations which normally use separate sound and vision transmitters, and also increases the sound quality heard at home.

Stereo television has been discussed and stereo programmes are transmitted on an occasional basis by the BBC using a radio network for stereo sound. ITV has transmitted a couple of local stereo programmes but has more difficulty since the commercials must work in sound only and be jointly sold with the participating local radio station. The logistics of such an exercise become very complicated and it can be safely said that no network stereo will be carried by ITV for many years.

There are more technical problems with transmitting stereo sound. Transmission of pilot tone stereo is possible with more recent UHF transmitters but it will not work with older types. Distribution between studio and transmitter also requires thought since the long term performance of normal audio circuits is inadequate for stereo and the existing sound-in-syncs system does not have sufficient bandwidth for stereo. Origination of stereo sound in studios creates artistic problems, since if the sound perspective remains stationary so should the picture. If a camera pans past a talking person, presumably the sound should pan as well . . . With time, these problems will be overcome, but even then a larger TV picture would be required to complement the wide

**Betamax from Sony is rapidly becoming the standard in the USA for home recording.**


**Phillips VLP-Discovision developed jointly with MCA is the most promising disc system for use in the home.**

sound image. Watching a picture 15 inches wide with speakers 6ft apart, the minimum for stereo, is not really on.

## Picture Telephones

A favourite with science fiction writers, picture telephones will undoubtedly appear, eventually.

In the meantime certain limitations of transmission circuits must be overcome. There appear to be no problems over the local terminal or lines. A basic picturephone terminal should cost no more than £200 and the same audio pair that connects the ordinary telephone to the exchange could, providing the distance was no more than a couple of kilometres, be used for video. The principal problem lies in interconnecting, telephone, or rather picturephone, exchanges together.

Many years ago solid twisted pairs of copper wire were used for all telephone circuits. Then came multiplexed high frequency circuits with thousands of channels down a coaxial cable for long distances. More recently the utilisation of local twisted pairs has been increased by using pulse code modulation to transmit 24 channels down a cable that used to carry one circuit. This increase in technology has helped keep down the cost of phone calls, especially international calls. It means that long-distance video channels cost a few hundred times as much as an audio channel.

The recent PO trials might assist in reducing these costs: a waveguide that allows many microwave channels to be sent down what is essentially a glorified drainpipe, and fibre optics, which again provide extremely wide bandwidths for low cost. Decreasing semiconductor costs enable digital circuits to be provided cheaply along cables that would otherwise be inadequate.

## Teletext and Viewdata

Until wide-bandwidth telephone circuits become economically viable, we will have to make do with still pictures from teletext services. Broadcast teletext, still called *Ceefax* and *Oracle* by the BBC and ITV respectively, is now (after two years of trials) being operated as a full-scale public service by both BBC and ITV. The content is still originated in London but there are plans to establish between 10 and 15 regional editorial units which would contribute local news and information. This is unlikely to occur, however, until a far larger proportion of the public has purchased or rented teletext receivers.

Current estimates of teletext decoders in use is about 3 000. By the end of 1977 this should be 12 000, by the end of 1978 50 000, by the end of 1979 250 000 rising to 7 000 000 by 1985.

There are currently three means of receiving teletext — you can but a new set with teletext already built-in (cost around £700), buy an adaptor which plugs into the TV aerial socket — but which for various technical ▷


**Phillips were virtually first in the field with their VCR cassette recorders, introduced in 1972 about 35 000 have been sold in the UK.**

**At last you can shoot back at your TV! Videomaster Superscore set for fun with your box, includes pistol attachment.**

**Viewdata will provide information in the home from centralised information banks.**

**Home computers are about to take off — the Commodore PET has integral TV display.**

reasons gives reduced quality display (costing about £350), or finally, you can actually modify an existing set by either building your own decoder or installing one of the teletext modules that are now becoming available costing between £150 and £200.

Five UK manufacturers are known to be developing teletext ICs and is it quite possible that European, and eventually Japanese companies will be doing so soon. Texas is ahead in the race with its *XM-11* module used in 95% of current sets, which costs £80 in quantity, but which is electronically 'primitive' using fifteen ICs plus an interface chip for standard remote control ICs. A more versatile unit, the *DM-11* which provides access to the memory and output circuits enabling *Viewdata* to be added, is on the way, and then eventually the *VDP-11* complete with *Viewdata*.

Mullard and GEC semiconductors are next in the running with more versatile decoders that interface directly with remote control ICs, provide buses for a *Viewdata* chip or a microprocessor, and use fourteen (will be reduced by five or six) and five or six chips respectively. Plessey and General Instrument Microelectronics are both developing sets of chips for teletext and *Viewdata* but are still very much in a developmental state.

## Interactive use

*Viewdata* has both advantages and disadvantages over teletext. The principle disadvantage is cost — probably around 1p to 5p a page, with some material such as public information and advertising free. Advantages however are vast information store of many hundreds of thousands of pages with an access time of two seconds (teletext has a 20 second access time for 100 pages), and, secondly, interaction, allowing questions to be asked of the computer.

This interaction is extremely important since it enables messages to be sent from one terminal to another and either stored in the computer for later display on your TV set, or for printing out as hard copy. This facility will be considerably enhanced by interconnecting the *Viewdata* network to the international telex system enabling messages to be sent both ways. Games can also be played with the computer, but in the early stages of *Viewdata* these types of interactive service will be restricted, because of their considerable demands on the central processor.

When the market trial commences in July 1978, some 1 000 subscribers will be participating in London, Birmingham and Norwich by using TV licence and telephone records, a representative group of potential subscribers will be selected and offered the service at concessionary rates — subscribers will however be required to purchase a *Viewdata* terminal. The earliest opportunity that the general public or business in the geographical areas mentioned above will have to obtain *Viewdata* will be early 1979. Market penetration for *Viewdata* in 1985 is estimated at 3 000 000 by the PO but only 300 000 by other sources. Unlike teletext which requires a single computer for all the millions of viewers, *Viewdata* requires an input port for each subscriber calling the computer simultaneously, so that a network of computers will have to be set up throughout the country. Even so, this cost will still be small in relation to total PO capital expenditure.

Potentially *Viewdata* can provide numerous other facilities such as reading your bank statement, paying bills, and buying items advertised directly by credit card (this facility will be used on the market trial). Although the *Viewdata* system being developed by the PO uses numerical page selection, Mullard Research Laboratories is working on a similar system using mnemonics (short words) for simplicity.

One way to decrease the access time of broadcast teletext is to use more lines in each field for transmitting information. Taking this to the extreme, if a TV channel is dedicated to teletext (with no TV pictures as such) an access time of 20 seconds could be achieved with 15 000 pages. Our future developments could be transmitting teletext information with VHF radio

programmes although the information content could be used giving approximately the same capacity as the existing TV service.

## TV games

Many believe that video games will be the next consumer item to make the considerable achievement of reaching sales of several millions per annum within two or three years of launch (following calculators and digital watches). The original patent on video games was taken out in 1966 by the Sanders Corporation; Magnavox subsequently acquired an exclusive licence to manufacture and market TV games, the first being the *Odyssey* game marketed in 1972. Magnavox now licences other companies to market video games, the basic agreement being £60 000 up-front and 5.5% of gross sales. At the last count, there were five licencees in Europe, five in America, eleven in Hong Kong, nine in Japan, one in Korea and one in Taiwan. In addition there are numerous manufacturers who are unlicenced (and thus open to prosecution — in the past, Magnavox has pursued patent infringements with great vigour).

There have been four generations of games so far. The early *Odyssey* displayed only a ball and bats (paddles) on the screen, plastic overlays being used to denote pitches and courts. The next generation had electronically displayed court boundaries but the games were still simple, with a couple of game variations and with score being kept mentally. Discrete components with TTL ICs were used in these early games, but then in 1975 General Instruments came out with the *AY-3-8500* chip which was immediately purchased by anybody who could lay their hands on it, resulting in dozens of different manufacturers all making and marketing virtually the same game, these being the third generation using a single IC.

Fortunately, since the GI chip was designed in Scotland, versions were made for both European and US standards, most unlike ICs developed in America. It now sells for £3 in respectable quantities (100 000) and games made using it in the Far East cost, typically, £10 to make. During 1977, this third generation of games has progressed and colour games have become available, some using the GI chip with a modulator, others using the National Semiconductor chip (such as Videomaster), and finally some using the Sportel chip. Again, as part of the third generation, other dedicated games are being developed such as battles *(AY-3-8700)*, black jack *(AY-3-8888)*, noughts and crosses and lunar landing *(AY-3-8889)* and car racing games.

Such dedicated games now have a restricted market, since four generation games are appearing in America these use microcomputers programmed with cartridges to give space wars, fun with numbers and educational-type games. The RCA *Studio II* is still monochrome although colour is promised. Coleco market a versatile colour console game that includes a steering wheel, gear lever, speedo and pistol, called *Telstar Aracade*. Cartridges contain up to eight colour games and other add-on accessories are available. The Ball *Professional Arcade* game includes a four-function printing calculator (built-in) and uses a custom chip from AMI and a microprocessor — this year six cartridges with twelve games each are expected. The cost is £180 with cartridges at £12. Atari, who also manufacture pub games using hundreds of TTL chips, market a game called the *Video Computer Systems* which uses MOS technology microprocessor with plug-in cartridges. Games include combat (27 variants), street racer (27 variants), space mission (17 variants), air-sea battle (27 variants), and video pinball (14 variants). Atari also manufacture a rather interesting unit called *Video Music* which takes music from a radio or record player and produces rapidly changing synthesised colour pictures on a TV set. Price is around £90.

Most TV games generate sound, and Texas recently introduced a chip specially designed for this purpose which contains a variety of circuits including oscillators, VCO, noise generator and modulator. By hanging resistors, capacitors and assorted volts on pins, one has a dedicated synthesiser capable of simulating bells, sirens, explosions, engines etc. ▷

### Teletext and Viewdata games

*Viewdata* games can be played directly with the computer because of the interactive capability (a maze has been demonstrated), and *Oracle* is currently working on something called 'telesoftware' which allows a software program for a microprocessor to be transmitted on a teletext page, and sorted in an intelligent teletext decoder which can then play the game.

### Home computers

Of course the ultimate games could be played on a home computer, such as those described on the microfile pages of ETI. The *PET* from CBM features a 14K ROM operating system (BASIC language), 4K RAM expandable to 32K, and a keyboard with 73 keys including full alphanumerics and graphic (including diamond, spade, heart and club symbols). The display is a dedicated 230mm monochrome monitor with 40 columns by 25 rows. *PET* also includes a cassette recorder and IEEE-488 instrument interface for peripherals, such as a printer. The market will initially be educational and business, but at only £600, it should also reach the consumer market where it will find numerous applications. The CBM *PET* is just the first of the whole range of home computers that will become available during the next five years.

### Conclusions

Without doubt, the next five years are going to see numerous technical developments, especially where the application of microelectronics is concerned. After all, LSI is only five years old now, and development has hardly started. Video equipment will benefit from reduced cost although in applications where mechanics are required, the cost is bound to remain high. Teletext and *Viewdata* will become widely available, as will TV games and computers. Developments might even bring a change in our basic life style, although the electronic newspaper is still fifteen years away, and Big Brother even further? □

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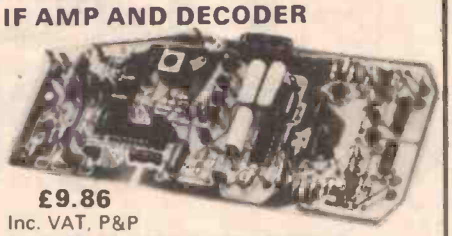

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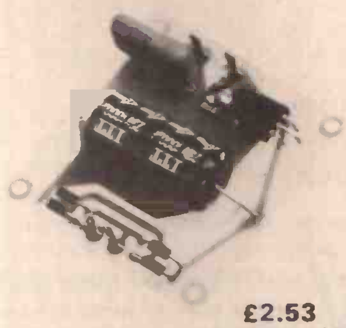

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Double sided epoxy circuit board; Monolithic integrated circuit

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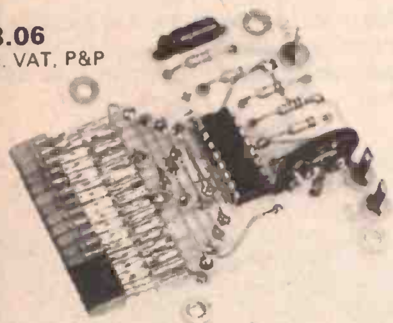

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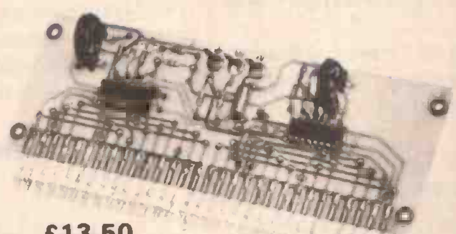

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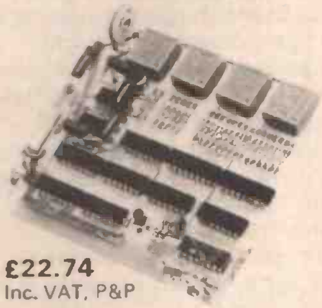

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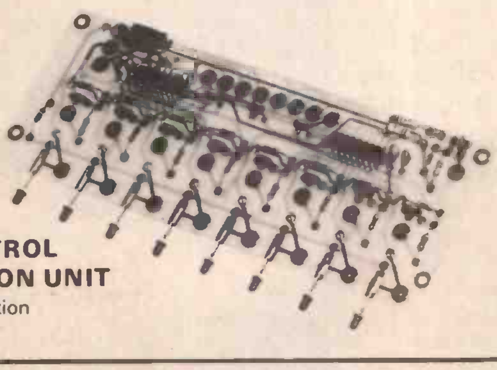

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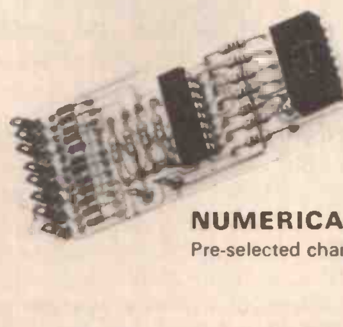

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# PERSONAL COMPUTING

## A bit of the future recalled(?) by Gary Evans

When the Editor came along and asked me if I would like to write a few words on personal computing over the next year or so, I instantly said yes.

The reason for the instantaneous affirmative was not that I liked the idea of gazing into the future, but that I have long since given up saying no to people who are bigger than me (the route to a long healthy life) or to people who employ me (the way to have the where-with-all to enjoy your healthy life). I said yes to the Editor for both reasons.

### Getting Things Straight

Having now committed myself, I found that the idea of looking at the future of personal computing began to appeal to me, but before going any further I would just like to get something straight.

In my view it seems that when people are asked to write about the future, in any field, they will adopt one of two courses:

The first is to predict a few events and present them in such a way that it seems as if the author has incredible insight. In fact the events could have been foreseen by anyone in the field.

At the end of the year this type of fellow can, rightly, claim to have been accurate in his predictions he fools no one though.

The second approach is to make numerous, outrageous, suggestions in the hope that one of the many may just come about.

When, at the end of the year, this type of fellow has been lucky, instead of being credited with amazing insight and knowledge of the field, the reaction is to group the prediction with the first type with an "anybody could have seen that" reply.

You just cannot win!

Having said that, what I will do is to assess the current situation, give a few personal views on personal computing and leave the star gazing up to you!

### Year of Growth

Having got the above out of my system (a 1954 organic), now is the time to get my feet wet — the penalty for having no confidence, according to some sources — with a few of my ideas and opinions.

I think it would be generally accepted that 1978 will be a year of growth in the home computer industry. Generally accepted because of the fact that there is very little activity in this area at present. The reason for this lull is because until recently there have been no ready-built systems specifically aimed at the home user. (I am discounting development systems and the more small business/education orientated products available from people like Computer Workshop.)

By the end of next year, according to all present indications, the situation will be somewhat different, with a significant number of ready-built home systems available.

Many of these new products will be imported from America, although it is encouraging to note that some all-British systems have been developed and are just coming onto the market (eg those from Sintel and Crofton).

It would take up too much space to go into the details of all the various systems, so I shall just pick on one that is typical of most, and interesting in that it comes from an unexpected quarter.

### Tandy Terminal

The machine, designated the TRS-80, is based on Zilog's muscular and intelligent Z-80 MPU. The surprise, for me at any rate, is that the TRS-80 has been developed by Radio-Shack, better known under the Tandy banner in this country.

Tandy are known for their electric/electronic component outlets which also sell "mid-fi" audio gear. The venture into the personal computing field marks a departure from their present operation and I for one shall follow it with interest.

A brief description of the machine, which as I have said will be typical of most home systems, is that it consists of four major units:

A PSU, a 12in VDU monitor, a cassette interface unit and a CPU housing, which also contains a 53-key keyboard.

The memory supplied with the minimal system will comprise 4K user RAM plus a 4K BASIC package.

Radio Shack aim to support the system by introducing a collection of peripherals, mini-floppies, printers, memory expansion cards (up to 62K), etc.

Launch date is January the first, so nip down to your Radio Shack shop (don't say that in too much of a hurry) and see it then.

Other systems that should be available during 1978 are those from Commodore (PET), Heathkit (H8) and Apple II based on MOS Technology's 6502 MPU.

## The Hard Sell

With all of these systems, one of the major problems faced by the manufacturer concerns how to market them. The problem being that nobody in this country has much idea of what type of person will want to buy a home system, for what purposes the system is likely to be used, or what form the retail outlet should take (mail order, local non-specialist shop or large dedicated computer store).

The first two questions are closely linked. It seems likely that the major use of these home systems, in the early stages at least, will be for information handling/manipulation tasks rather than control applications.

With over 5 000 teletext units already in use it would seem that there is already a demand for sophisticated data-handling media. The teletext experience also shows that people are prepared to accept data displays on a TV screen rather than on the printed page they are more used to.

Any home system should be able to provide, perhaps in conjunction with a teletext decoder or information on cassette tapes, a far superior system to that offered by present day teletext.

This then points to a large potential market for home computers. There are of course many other applications. The American experience is that people at first use the machine in tasks related to their job, doctors store lists of drugs, shopkeepers calculate tax, but soon many more applications at first not considered, come to light.

The third point mentioned when discussing marketing was that of the form of the retail outlet.

Tandy, with their TRS-80, will probably adopt the policy of selling the machine in their many retail outlets. The problem with this sort of operation, as with mail order, is that the necessary technical back-up for the product may not be available.

Again turning to America, those shops which have been most successful in this field have been those which have provided competent advice at the time of purchase, plus good after-sales service.

A lot of thought is going into the marketing plans of the various manufacturers and the next year should show how successful the various strategies are.

**Commodore's PET shown in our photograph is typical of the small, micro based, computers that will appear on the British market during 1978.**

## And Now the Soft Sell

Having had a look at the hardware we can expect to see appearing over the next few months, I shall now turn to software.

Just as most systems aimed at the home seem to follow the same pattern of hardware configuration, most seem to have adopted BASIC as their high-level language.

BASIC was originally formulated with large mainframe installations in mind, and whilst easy to learn and fairly powerful, it is not necessarily the most suitable language for home use on micros.

Names like FLEX, SMALLTALK and perhaps APL, may be heard soon in an effort to bring purpose-built languages into the home.

I think that the next year or so will see a vigorous development of software as people begin to realise that the difference between a good machine and one that's OK will be in the quality of software, and not in how many lights and levers a machine has.

## Bubbles Finally

Finally just a word about new products appearing on the professional market: bubbles, CCD, single chip computers, etc. These products are very expensive at the moment and even if the usual price/learning curves are followed, it will be some time before they appear in devices offered to the home user.

This means that it will be some time before (as your latest memory card blows up in a puff of smoke) you can coin the phrase "I'm forever blowing bubbles".

So to sum up, the next year will be a year of growth rather than startling technological developments, after which we shall see real computing power in a large number of homes for the first time. Whilst Arthur C. Clarke's hand-held "Minisec" is some way off, I doubt that it will be the twenty-third century before a hand-held computer with large computing power will appear on the shelves of your local matter transmitter/receiver.

The potential problems that the home computing revolution will produce are not a subject for these pages, but I hope someone, somewhere is thinking about them. □

# INSIDE STAR WARS

**Specials Editor Jim Perry looks behind the scenes and inside the robots**

BY the time this story is printed STAR WARS will have probably grossed 200 000 000 dollars worldwide. All those zeros are the result of six years work by writer-director George Lucas, and an end product that makes the TV series Star Trek look as spectacular as News at Ten!

As early as 1971 George Lucas had the idea of filming a space fantasy. Originally he wanted to make an up-to-date version of Flash Gordon — but couldn't obtain the copyright to the characters created by Alex Raymond. Thwarted by this setback, he started researching the possible sources that inspired Flash Gordon. After a fair bit of digging, he realised that the Flash Gordon concept was probably based on a series of books by Edgar Rice Burroughs (of Tarzan fame) about "John Carter of Mars." In turn it looks as though Burroughs had been inspired by Edwin Arnold's "Gulliver on Mars" published in 1905. Jules Verne had preceded even this but never made his hero battle space creatures or have adventures on distant planets — the basis for a whole new concept (then) in adventure stories.

As soon as he finished American Graffiti George started writing Star Wars — that was in January 1973. He worked on the story virtually full time right up to and even during the actual filming in March 1976. At one point there were four different scripts, each one with a different blend of storyline and characters.

United Artists were the first to be offered the embryo idea, but they turned it down because they couldn't see the potential! Universal were more interested at first, but also gave it the thumbs down. Finally 20th Century Fox were persuaded to back it, but nobody thought it would be a big success — little did they know!

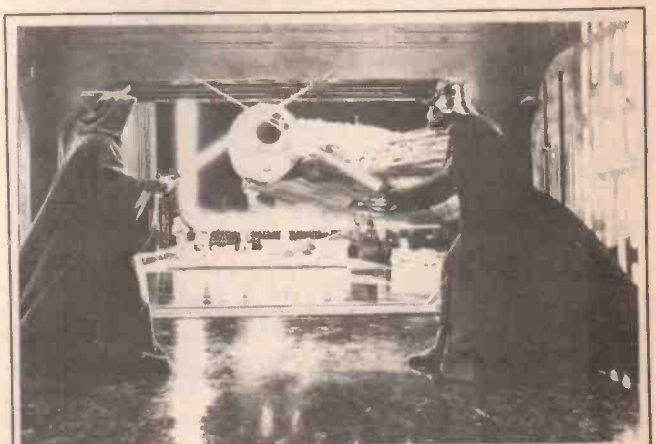
## New Worlds

The first step after completing a satisfactory basic script concept was to visualize a whole new world. Collin Cantwell, who had worked on "2001 — A Space Odyssey," was brought in to design the spacecraft models. Starting off with simple sketches, Ralph McQuarrie began visualizing the characters, costumes, robots and scenery — finally producing a series of full colour paintings to give an idea of what George Lucas wanted in various scenes.

Meanwhile producer Gary Kurtz had the headaches of finding a suitable place to film, working out logistics and budgeting. In turn all American, North African and Middle Eastern deserts were visited; the aim was to find a suitable location for Tatooine, the desert planet home of hero Luke Skywalker. Finally the southern part of Tunisia was chosen, near Tozeur in the Sahara desert.

Partly as a result of the decision to film locations in Tunisia, but mainly because of the facilities and people available, the interior work was to be done at EMI

**Han Solo (Harrison Ford) and Luke Skywalker (Mark Hamill) in the bottom right of the main hangar of the secret Alliance (hurray) fighter base.**



**Ben Kenobi (Alec Guinness) battling forcefully with the superevil (boo,hiss) Lord Darth Vader (David Prowse) near the captured Millennium Falcon space freighter.**

Studios in Elstree. It was the only studio complex in England or America that could provide up to nine sound stages simultaneously, and the technical staff are among the best in the world.

Production designer John Barry and his crew began designing and building the huge number of props and sets in August 1975. In order to make things look realistic £25 000 was spent on junk and scrap metal; anything from sewage pipes to jet engines were used to make scenery look realistic. One of the interesting aspects of Star Wars is that everything looks used — just like real life!

The job of making the robots was given to John Stears (alias Special Effects Worldwide), who won an Academy Award for his special effects in Thunderball. John had also worked on six other Bond movies — he fitted out the legendary Aston Martin that did everything except make tea!

John's job was to turn Ralph McQuarrie's illustrations into reality (or as near as possible). He was also responsible for the production effects. The main robot is R2-D2 (Artoo Detoo): the one that looks a bit like a dustbin with three legs. Artoo's partner is C-3PO (See Threepio), an android type. The only robot not made by John was Threepio, as he was just a casing designed by art director Norman Reynolds and sculptress Liz Moore — with Anthony Daniels entombed inside.

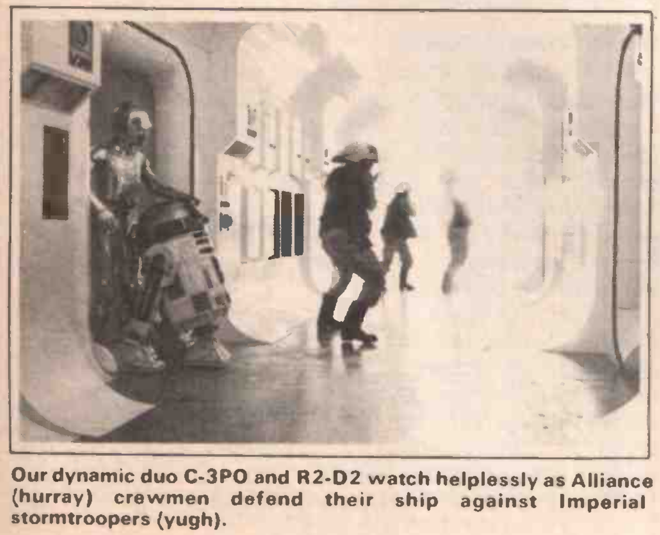
Besides Artoo types there were four other basic robot types used in the film, these were the Umbrella-type, Stick-type, Dome-type and Box robots. All of these were radio controlled — internal shots are given later in this article.

### Now You See It . . .

As well as the variety of robots, John designed the Speeders used as transport on Tatooine, the multitude of explosions and the light sabres. The Speeder shells were moulded in fibreglass, and supported on a boom arm; after filming the boom was painted out frame by frame. ▷

**Imperial stormtrooper (hiss) blasting after Princess Leia inside the Alliance ship.**

**Luke Skywalker, Han Solo, Chewbacca (Peter Mayhew) and the lovely Princess Leia Organa (Carrie Fisher) trapped inside the Death Star.**



**Our dynamic duo C-3PO and R2-D2 watch helplessly as Alliance (hurray) crewmen defend their ship against Imperial stormtroopers (yugh).**

**Luke Skywalker having a natural break during the Tunisian location work. The Speeder suspension system can be seen clearly in the background.**

The light sabre effect was produced with the aid of reflective and non reflective facets of the sabres. With a light mounted on the camera, the sabres appeared dark if their non-reflective part was towards the light, and glowed when revolved to expose their reflective section. By spiraling the reflective portion and spinning the sabre the effect of the light moving out was created.

Even though John Sears is an electro-mechanical wizard and special effects veteran, he hadn't made anything quite like Artoo and his (its?) fellow robots — even though his hobby is radio-controlled models. Asking for advice at St. Mary's College (University of London), where he met Professor Thring, the robotics expert, and Queen Mary's Hospital in Roehampton where he met artificial limb specialists, he gained useful information on pneumatics and electronics. The only problem was that when told the time available, everyone said it was impossible! In fact John did the impossible — with one exception: there wasn't enough time to produce a version of Artoo that wobbled on two legs.

The wobble effect was needed to make Artoo a bit more human and, as a final solution, a special Artoo casing was constructed for 3ft. 8in. Kenny Baker to wobble around in! Simple way of telling which version is in a scene is two legs Kenny, three legs the real Artoo with radio control. In March, 1976, the production unit moved into Tozeur in the South of Tunisia, to begin the transformation of desert into desert (from a different galaxy), and construction of massive Jawa transport vehicles. The Algerian army caught sight of these massive props and thought they were real!

After eight weeks of preparation the filming started. During the first week the entire crew had to wear sand goggles due to a big sandstorm. The filming lasted two-and-a-half weeks on location before moving to Elstree for the next 14½ weeks, where all nine sound stages were filled with John Barry's 30 sets. Planets, starships, caves, control rooms, cantinas and a vast network of corridors from inside the Death Star were at Elstree — but the Alliance's secret hangar full of X-wing and Y-wing fighters

**Owen Lars (Phil Brown), uncle of Luke Skywalker, being shown the Jawa robot collection by the chief Jawa (Jack Purvis). The**

had to be built at Shepperton Studios, because it was the only place in Europe big enough!

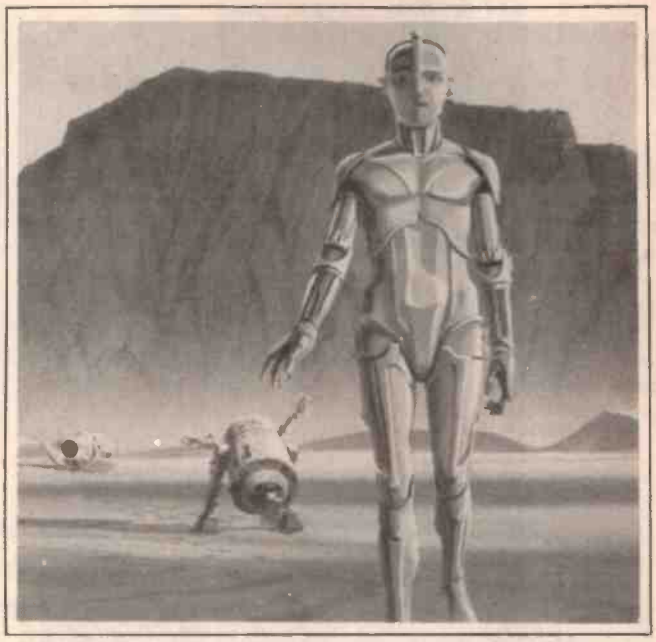
When on location all the robots had to be cleaned every day -- the sand and salt got in everywhere! One problem arose with the radio control systems because of static-charged windborne sand particles present in the Sahara; an extra aerial wire had to be attached to Artoo. Also being miles from nowhere the internal batteries had to be charged from mobile generators, which also had to be maintained. Trying to keep track of up to 30 sets of batteries is guaranteed to give anyone a twitch! Artoo and company were operated by John Stears and his crew, with Dick Hewitt (of Compact Video Systems) supervising the electronics.

## Built from Scratch

As well as the robots and mechanical effects, Star Wars uses the most advanced optical and miniature effects — the deep space shots, laser guns, etc. In June 1975 John Dykstra was asked to supervise all the photographic special effects. There was a slight problem — no commercial facility had either the time or even equipment to produce what was required — so John built Industrial Light and Magic Corporation, from scratch, in an empty warehouse in the San Fernando Valley.

The ILM complex included a carpentry shop and machine shop, which had to build or modify the special camera, animation equipment, editing and projection equipment needed to produce the effects. Other departments included optical printing (for putting the many different layers of film together), a rotoscope department (for matte work and general backgrounds) and a library section for keeping track of the thousands of pieces of film.

huge sandcrawler in the background was mistaken for a military vehicle by the Algerian army.



Ralph McQuarrie's original illustration of R2-D2 and C-3PO, pictured after their landing in the deserts of Tatooine.

## Dykstraflex Films O.K.

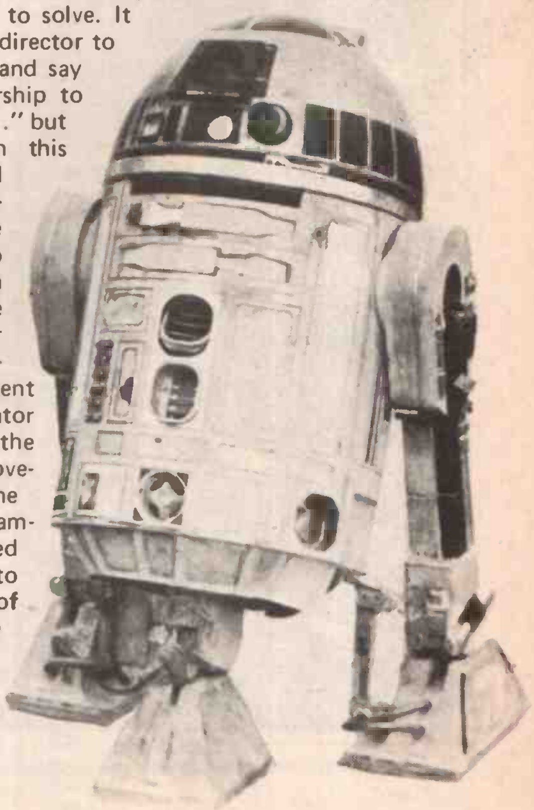
The most important part of ILM is the Dykstraflex camera, this is based on an old VistaVision camera, linked into a computer. The VistaVision camera runs 35mm film through sideways, like a 35mm still camera, whereas normal movie cameras run the film vertically — the benefit is increased resolution, which is needed when up to 12 shots are put together on one print. The computer is used to store movement information and provide "action replay" of the camera movement, with control of seven separate parameters simultaneously.

Each of the 365 special effects needed between two and 12 separate exposures of film, in all 3 838 exposures were needed. For example in the battle sequence you see an X-wing fighter swooping and soaring over the Death Star — in fact, the model of the X-wing never moved an inch! The camera moves, creating the illusion that the fighter is moving, the Death Star is filmed seperately with different camera movements. The two exposures are then printed together to create the impression of X-wing swooping over revolving Death Star — not to mention more fighters, laser flashers, stars, etc.

This is where the computer comes in. If the angle of the camera changes during a shot, the other shots change as well — hence each separate frame has to be exactly matched for each different component of the composite shot. The computer remembers everything and moves the camera accordingly — simple, but until the Dykstraflex, no camera could do it.

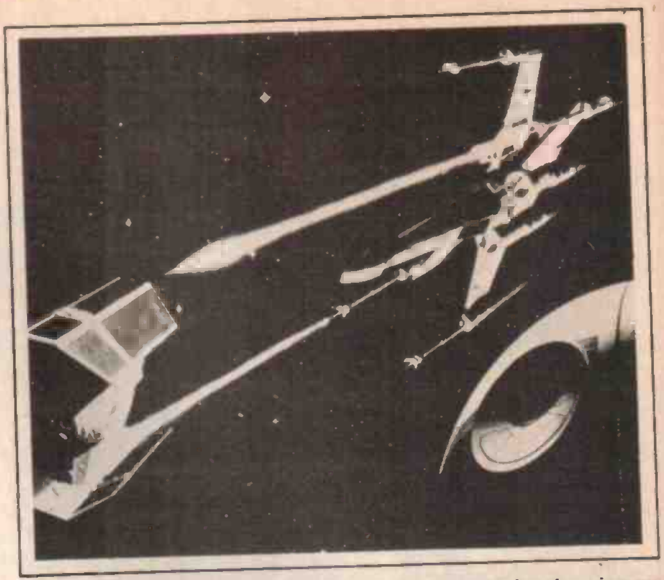
To create realism in the dogfight scenes, thousands of feet of World War II movies were viewed, together with storyboards. By studying the real life movements of the planes, the model shots were planned to be the most realistic ever made — they succeded.

Even with the aid of the Dykstraflex the ILM crew had several problems to solve. It was easy for the director to move his hand, and say "I want the starship to move like this . . ." but to actually turn this into a finished shot was a problem. Firstly the movement had to be put down on paper, so that the camera operator could try and emulate the movement — then the operator had to teach the computor the movement, in fact he had to 'fly' the camera over the fixed model. Needless to say at the end of the filming the camera operators were all accomplished pilots! □

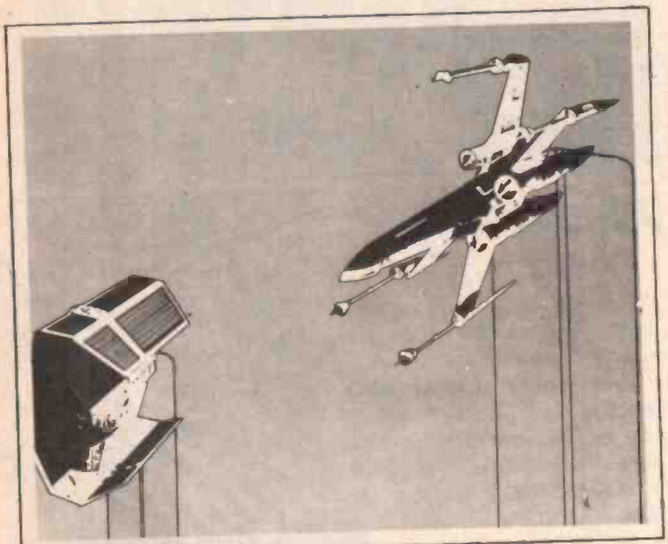


# 1,2,3...

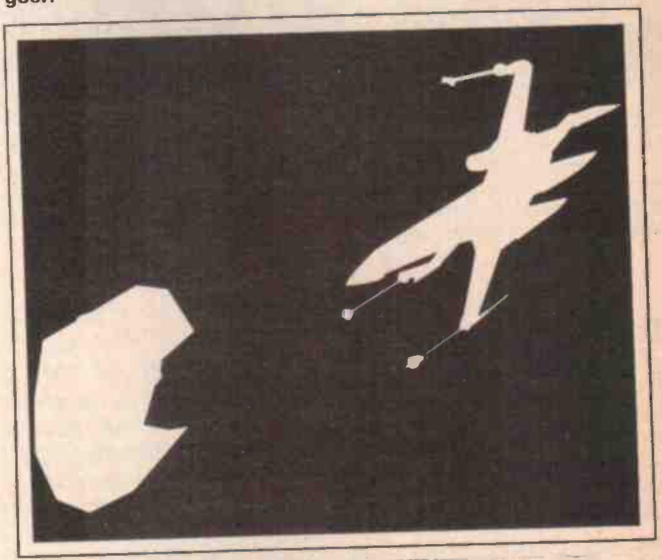
**An example of the shot sequence needed to produce the stunning optical effects in Star Wars . . .**



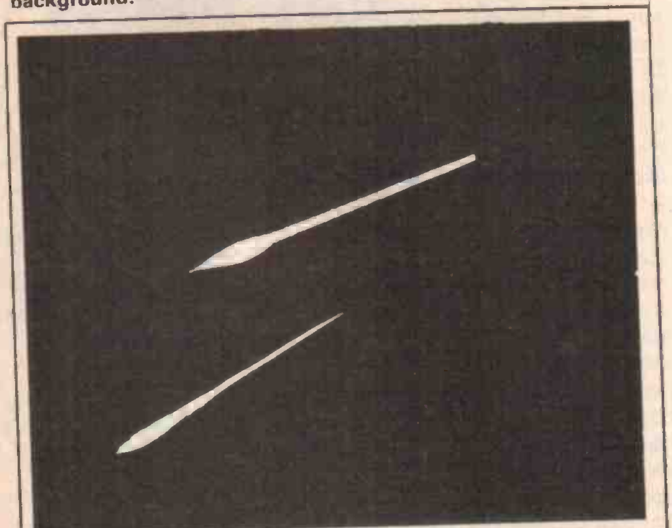
Final product, the assembled film print as seen by the cinema goer.



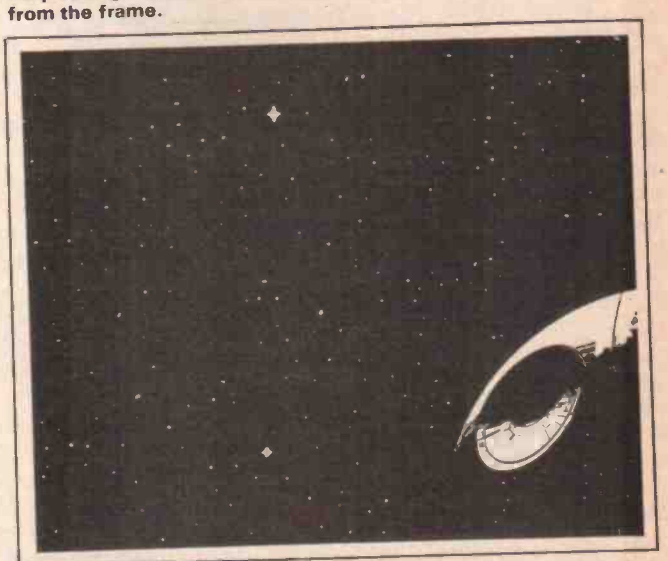
Step 1, models are fixed in their relative positions on a blue background.



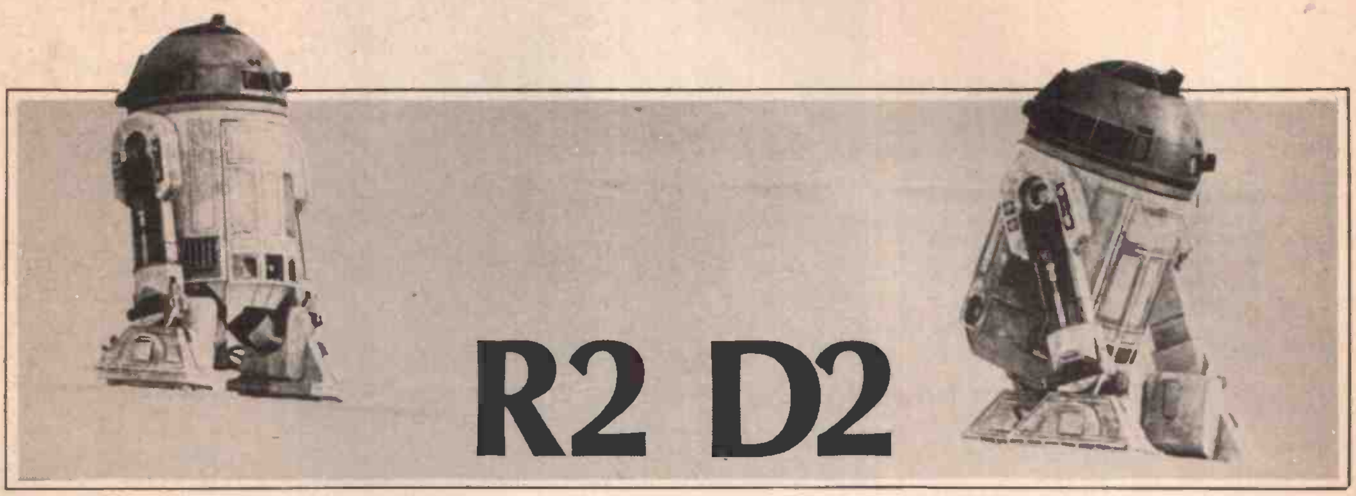
Step 2, a 'garbage' mask is used to obliterate unwanted images from the frame.



Step 3, laser flashes are added in the third exposure.

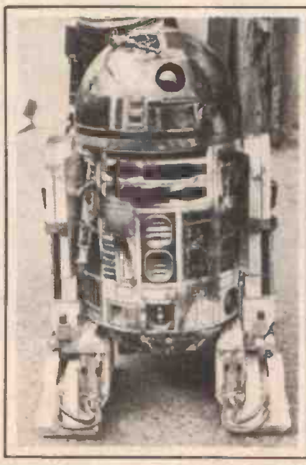


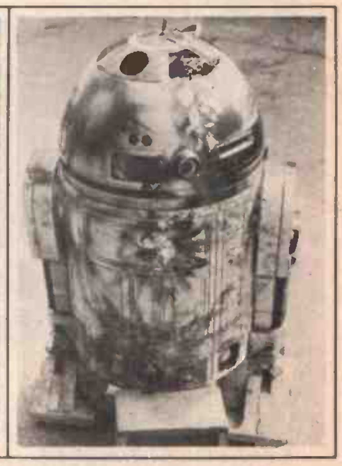
Step 4, background detail of stars and Death Star complete the frame.



# R2 D2

**Contrary to some reports, most of the R2-D2 sequences were with a real robot, built by mechanical wizard John Stears — read all about the real R2-D2 here!**





Two versions of R2-D2 were made, one for Kenny Baker to fit inside and the three-legged radio controlled version. Our interest is centred on the radio controlled version.

R2 D2 has three forward speeds, but no reverse, and is steerable. Provision is made for the change from two legs to three legs by radio control, also when tilted the third leg drops automatically. The reason for this is that R2 would fall over if left on only two legs!

## Mechanical

In order to achieve forward motion, the two rear legs have individual traction motors which drive twin inline wheels. Steering is via the front drop leg, with a proportional self centring servo unit. The twin wheels in the steering foot remain parallel to the other wheels during turns.

The front leg and foot can be retracted inside the body. When the front leg drops it is held at the correct distance by wires, R2-D2 can then move off at full speed.

The casings for all the R2s were specially made by a company called Petric Engineering for the modest sum of £18 000, which may seem a trifle high — but they were precision pieces of engineering to the highest standard, in fact John Stears says they were excellent value.

## Cleaning Up

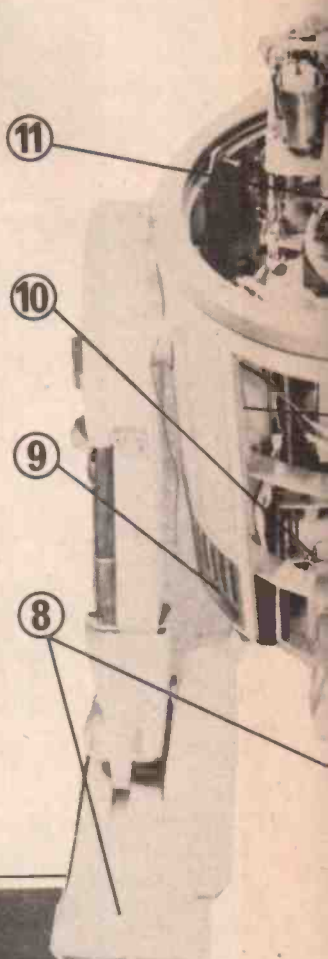
For several of the scenes R2-D2 was made to appear thoroughly blasted, or covered in grime. The only way was to virtually blast it in real life, and then clean up for the next shot. While in the Tunisian desert John Stears was also continuously cleaning real dirt and sand from R2, it got in everywhere!

**Top of page, rare shot of Kenny R2 being chased by radio R2. Above, R2-D2 in two stages of disorder — heart-breaking work, wrecking such a nice machine! Left, R2-D2 in action as a fire extinguisher.**

# R2

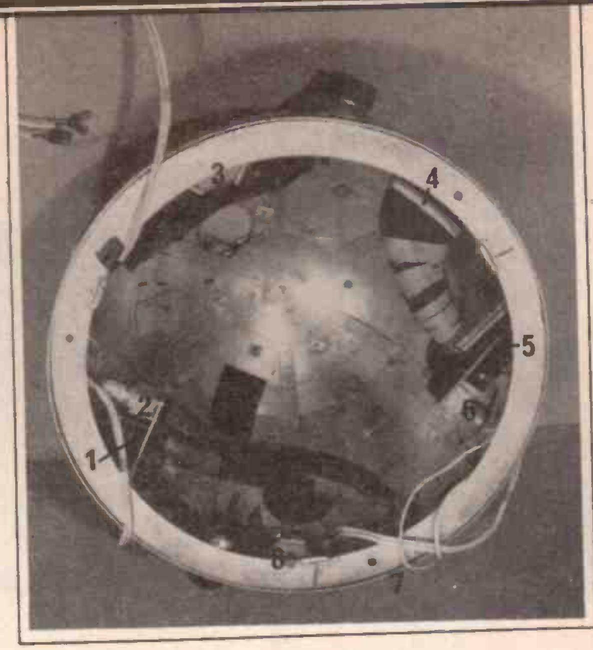
## General

1. Radio control gear
2. Head ring
3. Shoulder bearing
4. Two 6V batteries for lights and steering (removable)
5. Six 6V batteries for traction (not removable)



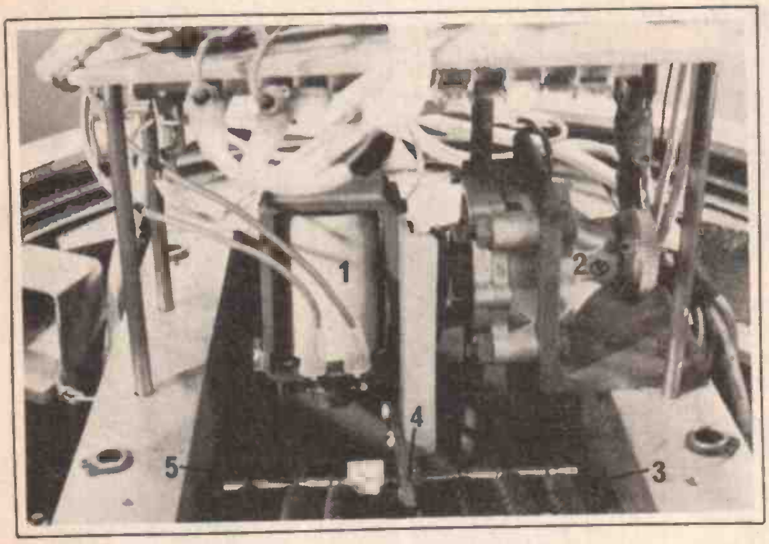

## Head Interior

1. QI light source (front)
2. Coloured disc motor (front)
3. Pulsating lights (green/yellow)
4. Fibre optic display (rear)
5. QI light source (rear)
6. Coloured disc motor (rear)
7. Fibre optic display (front)
8. Pulsating lights (red/blue)



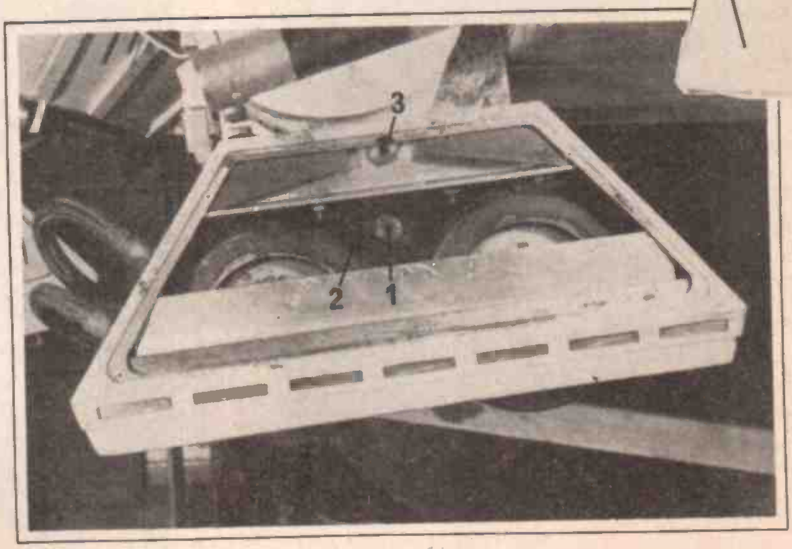

## Leg Drop

1. Leg drop solenoid
2. Damper
3. Body tilt tension springs
4. Leg drop locking arm
5. Leg drop locking rod




## Driving Foot

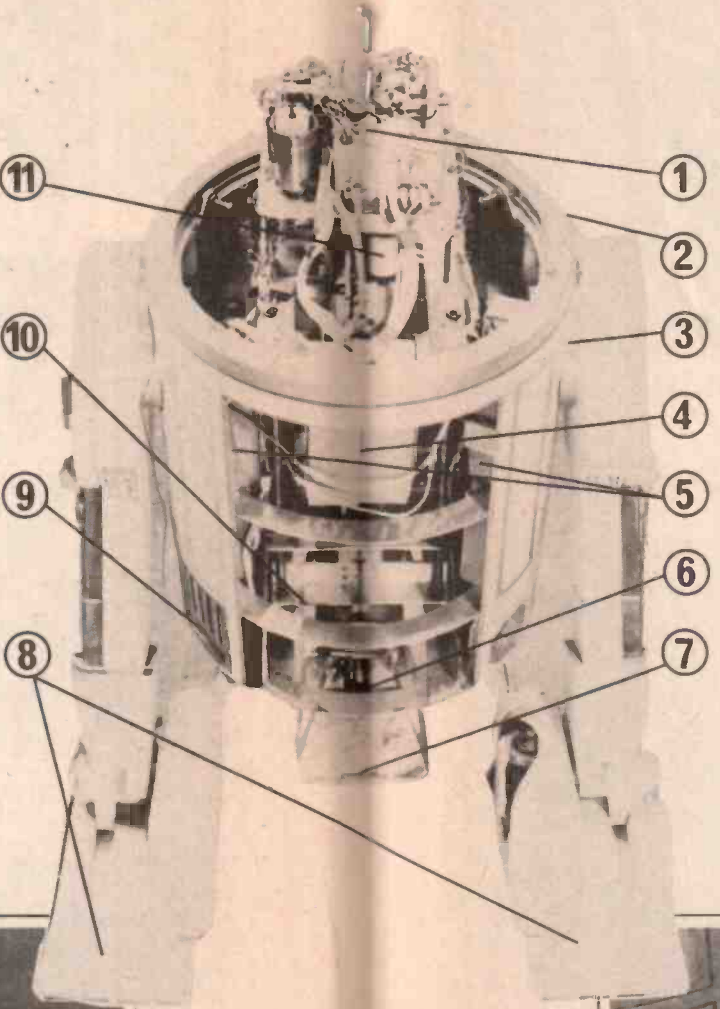
1. Drive front gear box
2. Chain sprocket, both wheels in each foot driven by single chain
3. Foot retaining pin




# R2 D2

## General

1. Radio control gear
2. Head ring
3. Shoulder bearing
4. Two 6V batteries for lights and steering (removable)
5. Six 6V batteries for traction (not removable)
6. Headlight switch
7. Front foot (steering)
8. Rear feet (traction)
9. Radio on/off switch
10. Led drop (mechanical)
11. Leg drop (electrical)


## Leg Drop

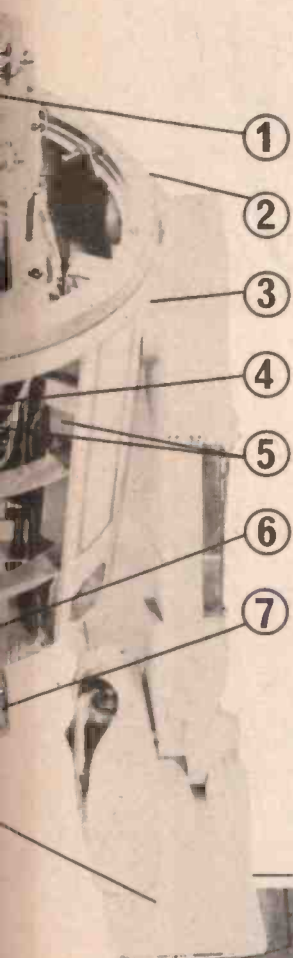
1. Leg drop solenoid
2. Damper
3. Body tilt tension springs
4. Leg drop locking arm
5. Leg drop locking rod

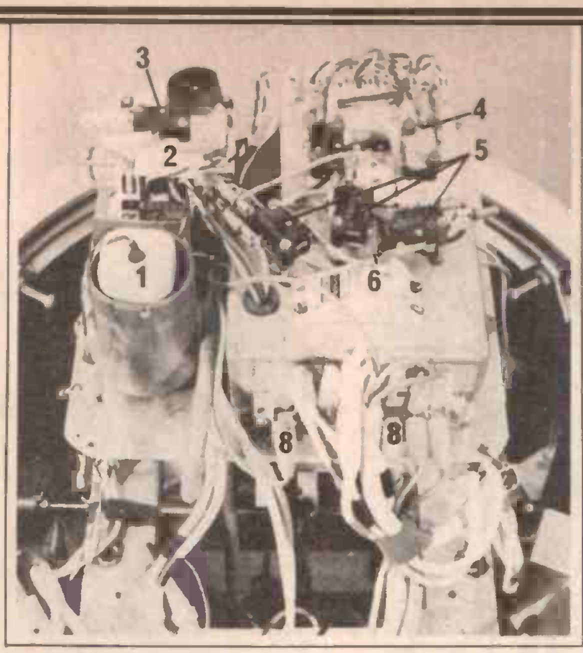
## Pulsating Light Drives

1. Pulsating light control box
2. Pulsating light connections
3. Leg drop solenoid
4. Light and steering batteries.


# D2

6. Headlight switch
7. Front foot (steering)
8. Rear feet (traction)
9. Radio on/off switch
10. Led drop (mechanical)
11. Leg drop (electrical)



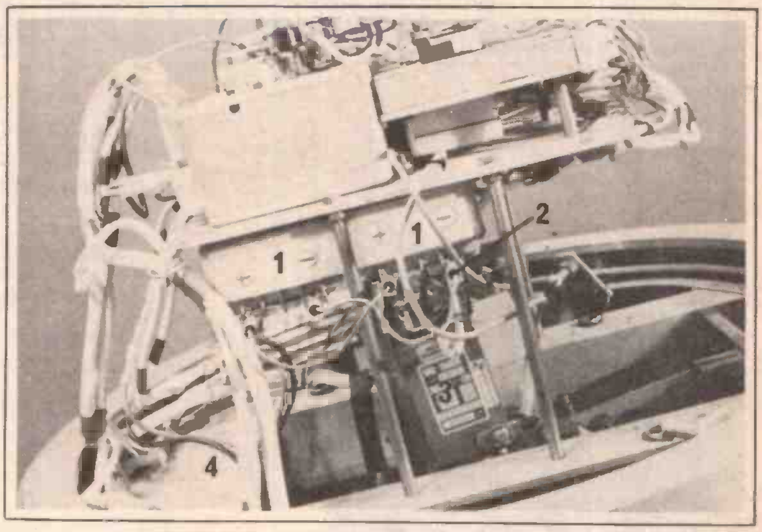



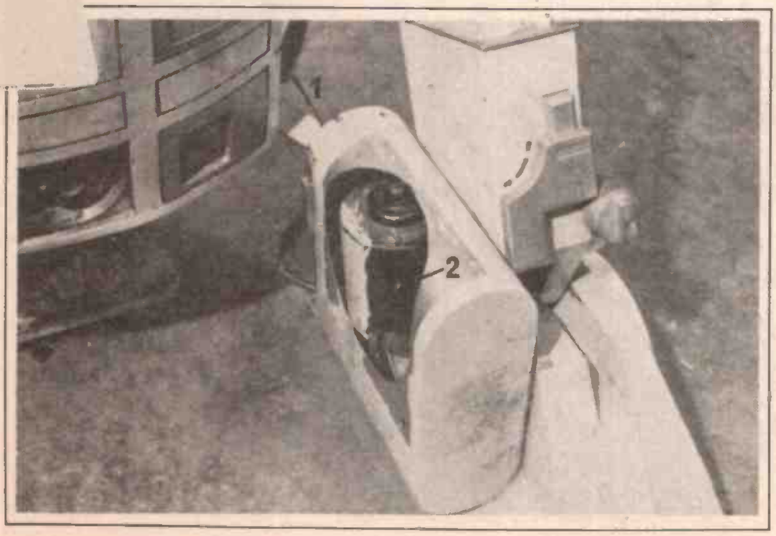
## Radio Control Gear

1. Deac
2. Main receiver
3. Leg drop servo and microswitches
4. Steering servo and microswitches
5. Speed control microswitches
6. Speed control servo
7. Traction motor connections
8. Traction batteries charge terminals

## Pulsating Light Drives

1. Pulsating light control box
2. Pulsating light connections
3. Leg drop solenoid
4. Light and steering batteries.

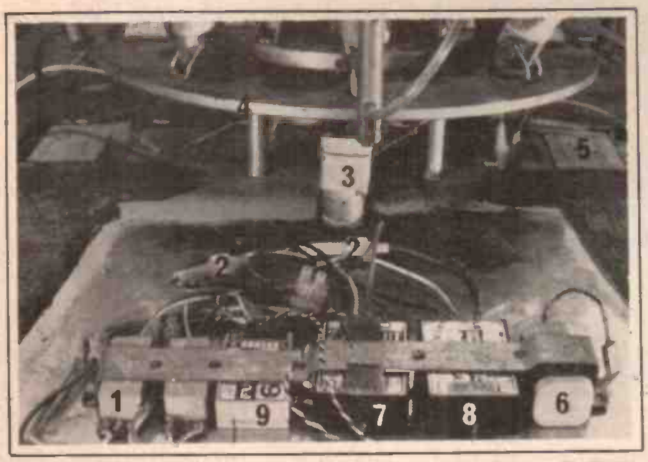




## Drive Motor

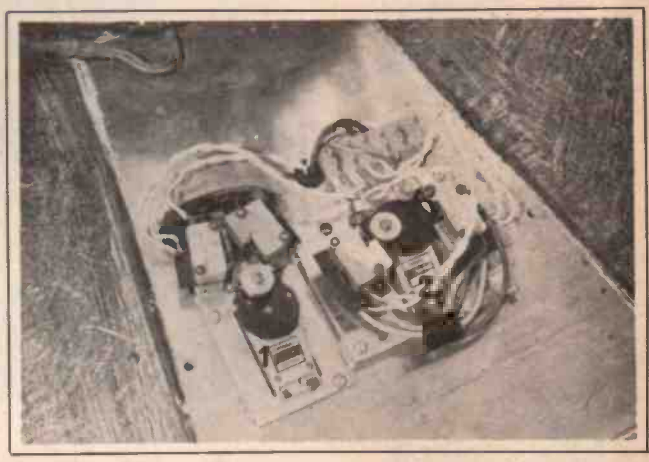
1. Leg distance wire and strut
2. Traction motor, 36V for full speed, 12V or 24V for reduced speed

# UMBRELLA



## Radio Control

1. Suppressors
2. Fuse holders
3. Turntable motor
4. Arm turntable
5. Batteries
6. Deac
7. Left speed control
8. Right speed control
9. Receiver

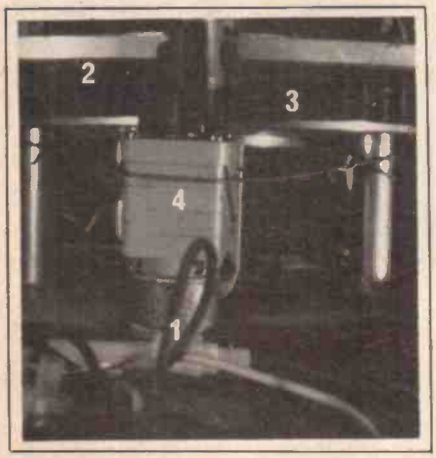


## Compartment

1. Eyes turn servo
2. Turntable servo

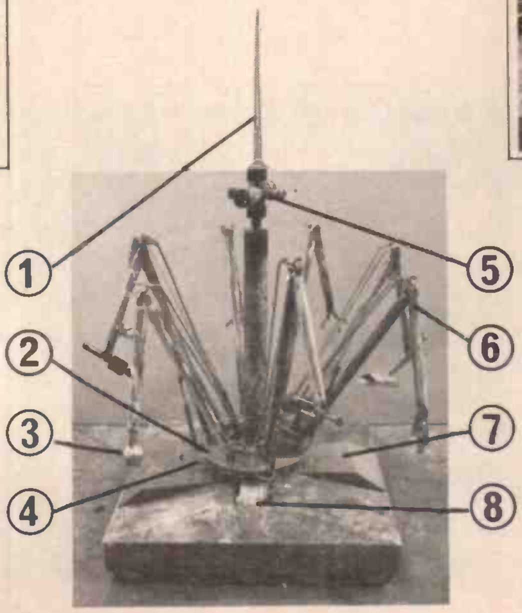
## General

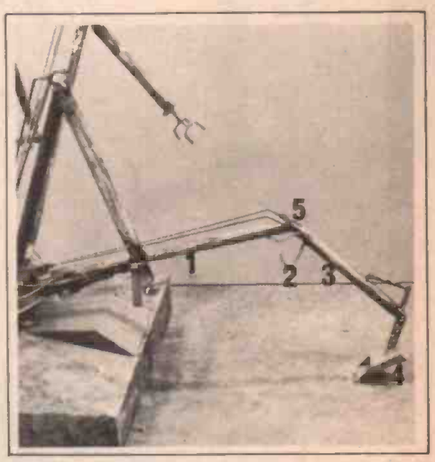
1. Dummy aerial
2. Radio control cover
3. Real aerial
4. Arm turntable
5. Rotating head
6. Pneumatic arm
7. Servo cover
8. Battery compartment



## Turntable Motor

1. Drive motor
2. Turntable
3. Ring gear
4. Gearbox

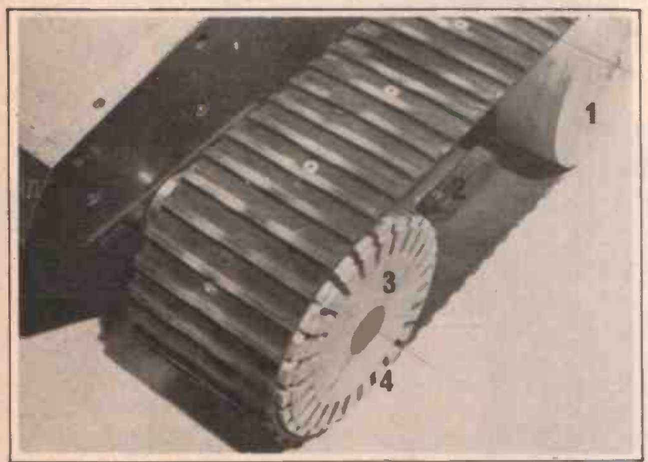




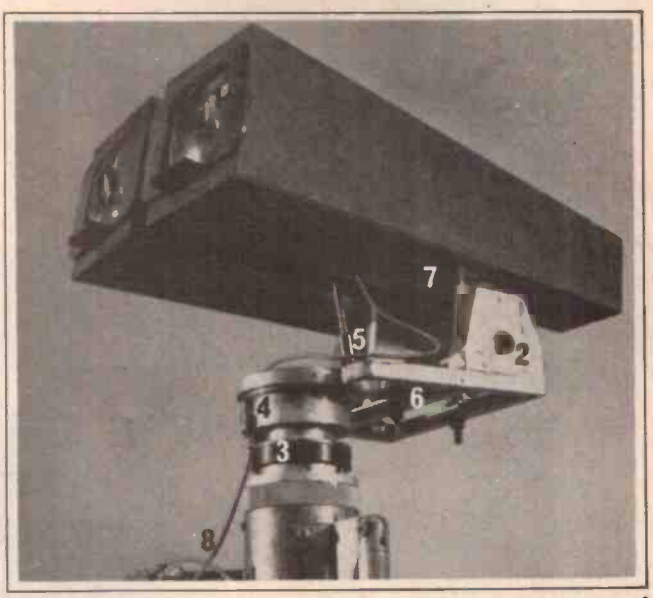
## Arm

1. Raise/lower ram
2. Airlines
3. Scoop ram (inside)
4. Scoop
5. Elbow

# STICK

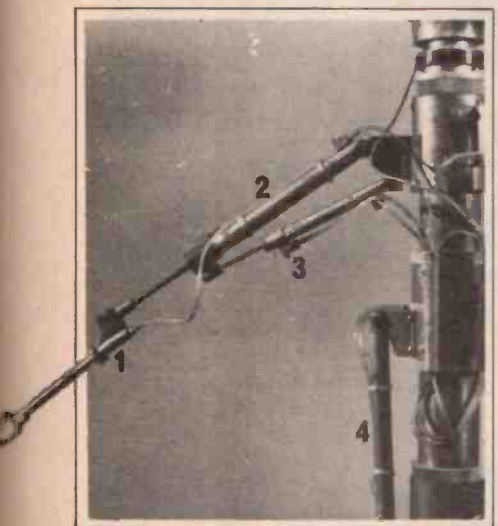



## Track
1. Idler wheel
2. Track guide
3. Drive wheel
4. Sand escape vents

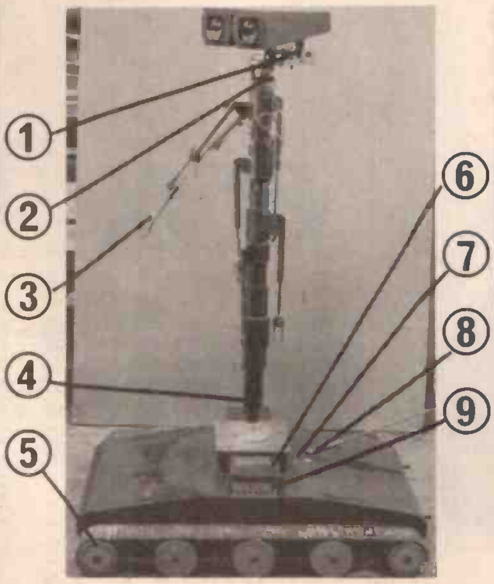



## Head
1. Eyes
2. Pivot
3. Slipring
4. Brush
5. Eyes up/down crank
6. Counter balance spring
7. Eyes up/down motor
8. Slip ring feed

## General
1. Eyes pivot
2. Head swivel
3. Practical arm
4. Stick
5. Drive wheels
6. Battery compartment
7. Receiver on/off
8. Real aerial
9. Pneumatic connections



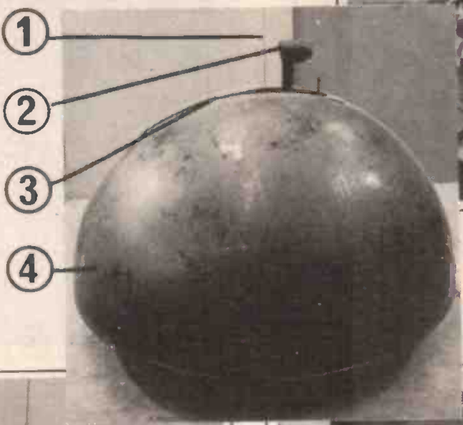

## Arm
1. Claw ram
2. In/out ram
3. Up/down ram
4. Dummy ram





## Base
1. Right traction motor
2. Auxiliary battery
3. Traction batteries
4. Receiver
5. Pneumatic connections
6. Left traction motor
7. Gearboxes
8. Flexible couplings

# DOME

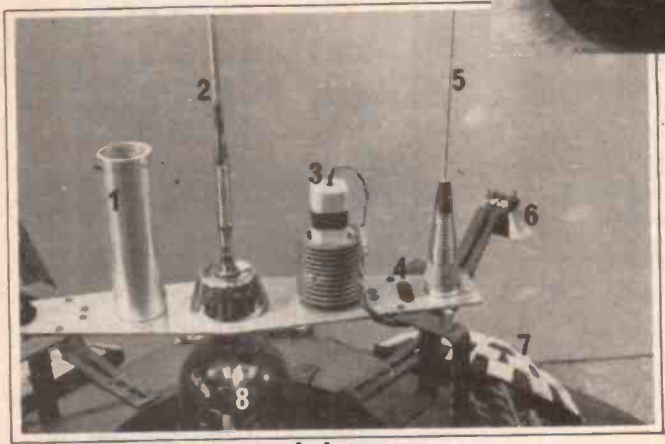


## General

1. Real aerial
2. Eye
3. Slot
4. Perspex dome

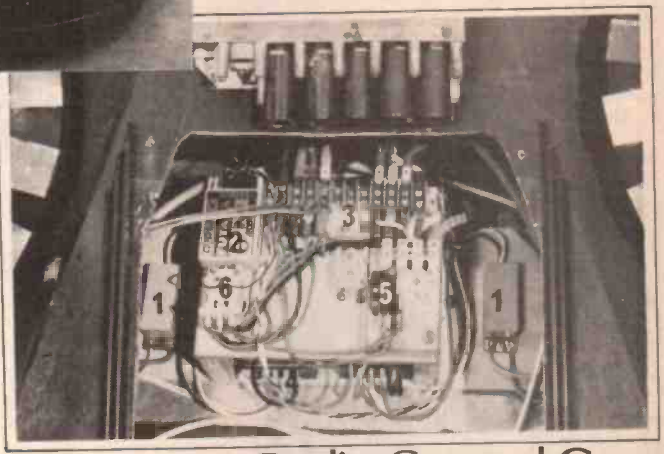
## Super Structure

1. Dome locating blocks
2. Mirror domes
3. Electronics compartment



## Bridge Assembly

1. Eye Socket
2. Dummy aerial
3. Deac
4. Receiver on/off
5. Real aerial
6. Oil light
7. Mirror dome
8. Flashing beacon

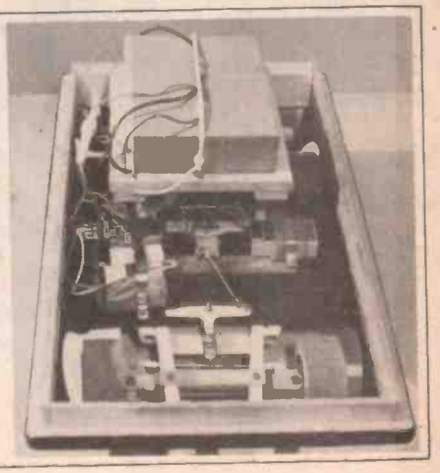


## Radio Control Gear

1. Suppressors
2. Receiver
3. Connecting block
4. Speed controls
5. Lighting servo
6. Lighting relay

# BOX

**Most people think the Box robot should have been called the Rat robot, its the one that runs around the Imperial Death Star. A Radio controlled yellow streak, makes Box robots turn and run when confronted with a Wookie!**



**ETI's Editor, Halvor Moorshead, went to see Star Wars in North America, where it has been playing to packed houses since the summer.**

# ONCE UPON A TIME

George Lucas in his book of the film states ". . . instead of making 'isn't-it-terrible-what's-happening-to-mankind' movies . . . I decided I'd try to fill the gap. I'd make a film so rooted in imagination that the grimness of everyday life would not follow the audience into the cinema, in other words, for two hours, they could forget." The fact that Star Wars has overtaken Jaws as the fastest box office success of all time shows that he's succeeded.

SF fans have been badly served until now, the notable exception Kubricks '2001' but in that you were obliged to argue for hours about the inner meaning of it all. Star Wars is uncomplicated. The heroes are all good, the baddies are super evil; that in itself itsn't unknown in the current cinema but as often as not such stories are 'self-spoofs'.

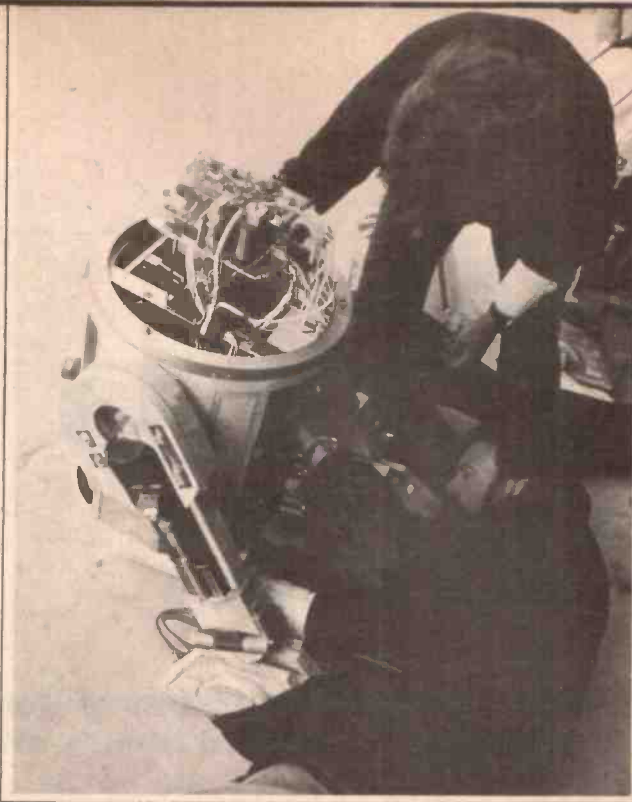
The effects are brilliant — they're almost dominant — and the director has avoided the temptation of over-displaying a set, or an effect simply because it was expensive to arrange.

We see believable space shops and background. We see sunset on a planet of a binary star pair but they don't explain it or make a meal of it — SF addicts will understand. Alien creatures and androids continually crop up and are extremely well done.

The story? The book is available and reading it in advance won't spoil the movie — it may even make it more interesting but the story is almost irrelevant. Mix up the 'Dam Busters,' "Battle of Britain," "The Magnificent Seven' and add characters like Merlin and Laurel and Hardy and you've got the gist of it: this isn't meant unkindly.

We're told in the opening sequence that Princess Leia has acquired vital plans from the controllers of the all-evil Galactic Empire and is trying to deliver them to the freedom-loving rebels, the last vestiges of the Republic, the Galactic organisation which preceded the Empire. It doesn't occur to us to ask what a Princess has to do with a Republic but that is only because we have abandoned the complexities of our world. (Some of us must take some satisfaction from the fact that the Galactic Empire is apparently controlled by the British). The film does give the impression that a lot has been left on the floor of the cutting room and, as most of the audience are spending most of their time looking at effects, its a bit difficult to follow occasionally but not enough to spoil your enjoyment.

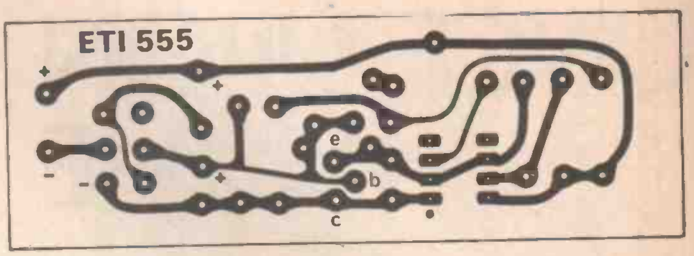
If you note a measure of enthusiasiam, you're right. I did get in free to see the film — and I went to see it again the next night I enjoyed it so much! □



**Above, John Stears gropes under R2-D2 on location, even the best robots need repairs. Below, Kenny Baker takes his head off in between scenes.**

**Thanks are due to John Stears and 20th Century Fox for their help in producing this feature.** 

# 500 SECOND TIMER




**This is the first of four straightforward projects using the ETI 555 PCB shown above, Veroboard layouts are also given.**

MOST TIMING DEVICES ARE clockwork mechanisms which ring a bell at the end of a preset period. They are relatively cheap and reliable but often difficult to build into existing equipment or adapt to specific needs.

The timer described here has none of these limitations. It is small and light so it may readily be built into existing devices — and the actual warning device may be mounted remotely from the timer itself.

Timing is adjustable (by RV1) from a minimum of a few milliseconds to a maximum of approximately 500 seconds. At the end of the preset period the loudspeaker will produce a loud warning tone.

The circuit is based on the ubiquitous 555 timer IC. This is used here not only as part of the timing circuit but also as an oscillator to generate the warning tone at the end of the preset period.

The components may be assembled on Veroboard or on the printed circuit board designed for this project. Usual care must be taken to ensure that the main components are located exactly as shown in our drawings.

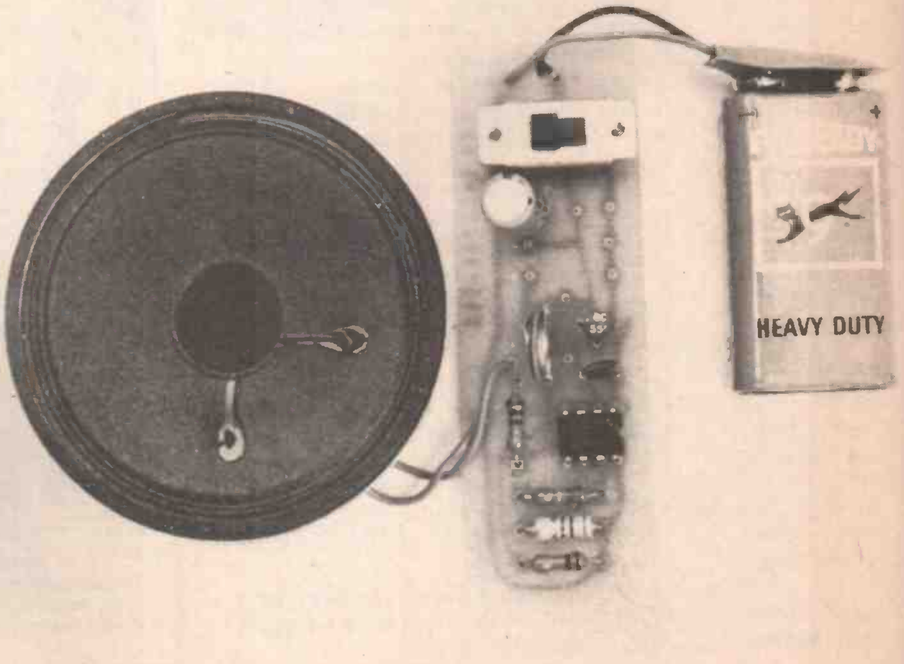
## Notes:

Switch SW1 must be a double pole unit as specified. If desired this switch may be removed from the board and connected via a suitable length of multicore cable.

The timing potentiometer may also be located at a distance from the unit in this case it will be better to replace the small preset unit with a ½ watt rotary unit.

If more accurate control is required over a limited range simply reduce the value of RV1 from the specified 5 M to 1 M or less (experiment with fixed value resistors until you have the required result then substitute a suitable value potentiometer).

The speaker and the battery may also be mounted away from the circuit board. If this is done you may find that at the end of the preset time the warning signal starts at a low volume. This may be remedied by connecting a 10 nF capacitor across pins 1 and 8 of the 555 IC. □



## HOW IT WORKS

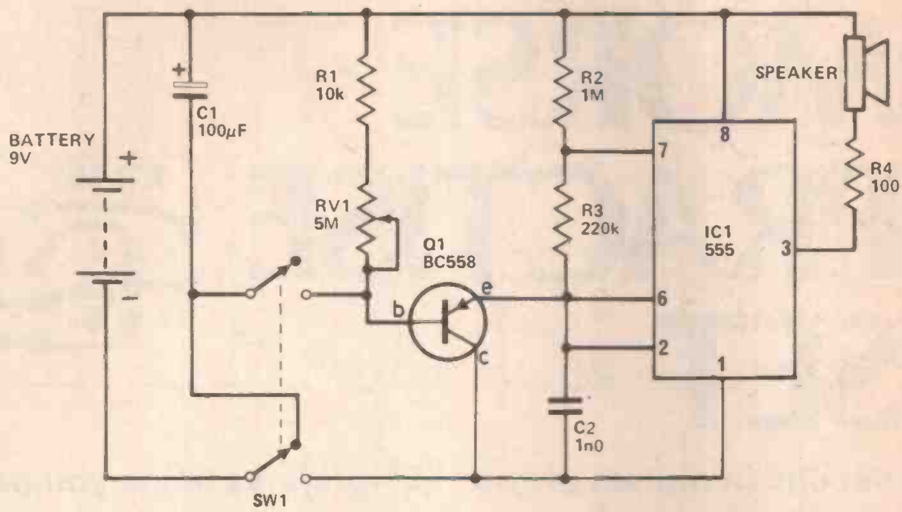
### ETI 555/1

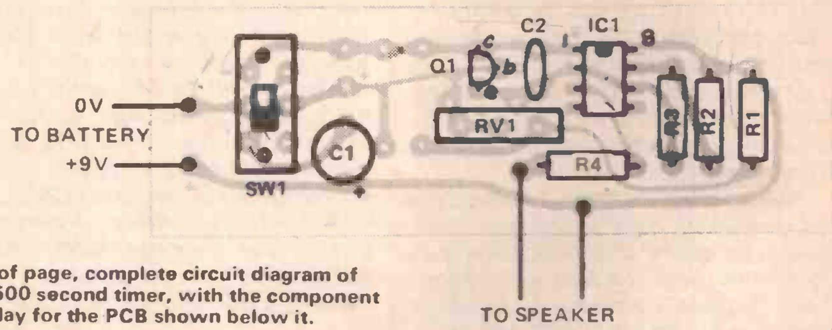
The unit produces a warning tone at a preset period after switching on. The delay period is dependent upon C1/R1 and RV1 and is adjustable from a minimum of a few milliseconds to a maximum of approximately 500 seconds.

The 555 IC will oscillate if a voltage greater than 2/3rds of the voltage across the device is applied to pins 2 and 6. When it oscillates it produces a square wave which is turned into an audible warning tone by the loudspeaker.

In its 'switched off' state the circuit is arranged such that the 100 uF capacitor C1 is connected across the battery and is thus normally fully charged. When the timer is energised i.e. by closing SW1, C1 discharges via transistor Q1 at a rate determined by the bias resistors R1 and RV1. Thus the emitter of Q1 is held at a low voltage, in turn clamping pins 2 and 6 of the 555 IC below the '2/3rds' level.

As the capacitor slowly discharges, the voltage at pins 2 and 6 slowly rises until the '2/3rds' level is exceeded. As soon as this occurs the 555 commences to oscillate thus producing the warning tone.




**Top of page, complete circuit diagram of the 500 second timer, with the component overlay for the PCB shown below it.**

## PARTS LIST

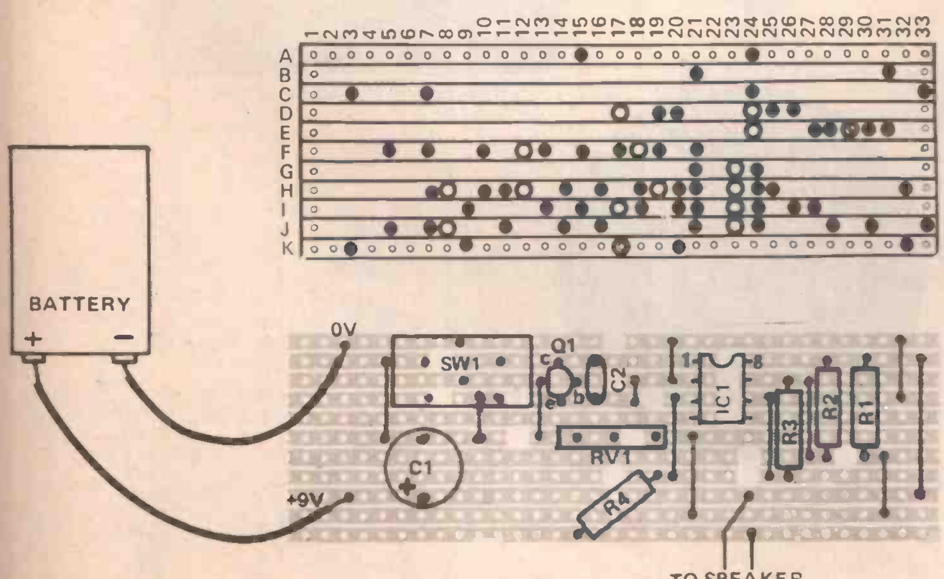
**ETI 555/1**

Resistors all ½ W 5%

| | |
|---|---|
| R1 | 10 k |
| R2 | 1 M |
| R3 | 220 k |
| R4 | 100 R |
| RV1 | Preset 5 M |
| **Capacitors** | |
| C1 | 100u 16 V electrolytic |
| C2 | 1n0 polyester |
| **Semiconductors** | |
| Q1 | BC558 or equivalent |
| IC1 | NE555 |

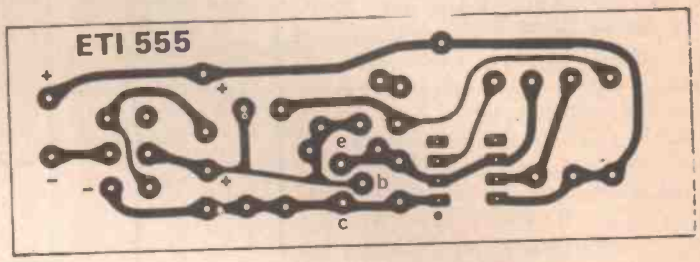
**Miscellaneous**

SW1 slide switch dpdt
PP3 battery plus clip
Speaker 8-16 ohms
PC Board ETI 555 or small piece of 0.1 matrix Veroboard.




**Veroboard layout and pattern for this project.**

# MORSE PRACTISE SET




**Second in our set of four 555 projects helps you practise for a radio amateur licence.**

THE MORSE CODE was the original telegraphic code – a slightly modified version – still known as the Morse Code – is used today. Today's version differs in some respects from the original but it's a truly international code recognised by all countries.

The great advantage that Morse Code has over speech communication is that it has a far greater chance of being read correctly in poor reception conditions. This is because it consists of a sequence of dots and dashes of fixed pitch and providing one is familiar with the Code it is possible to interpret the sequences correctly in reception conditions that would render speech quite unrecognisable.

A really experienced operator can transmit and receive Morse at speeds as high as 60 words a minute (that's about a third of the rate of normal speech). Most operators work slower than that – twenty to twenty five words per minute is usual for radio amateurs – many of whom still use Morse regularly.

The project described in this article is an oscillator designed specifically for Morse Code practice. It is based on the same 555 IC used in all the other projects in this series.

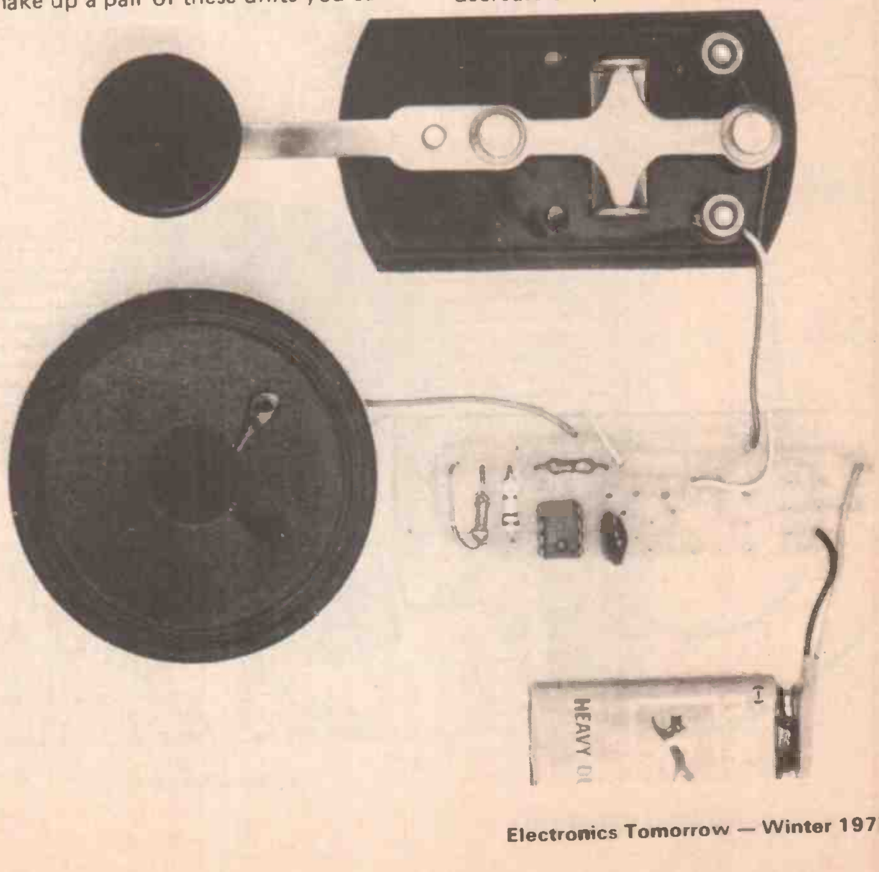
## Construction

Apart from the battery, speaker and Morse key – all of which are located away from the main circuit – the oscillator requires only one 555 IC plus four other components. These may be mounted on a short strip of Veroboard. An alternative approach is to use the printed circuit board shown in this article. The printed circuit is a multi-purpose board designed to be used also for the Buzz-board Game, Temperature Alarm and 500 Second Timer published in this series.

The layout of the Morse Code oscillator is in no way critical. If desired the speaker may be located hundreds of metres away from the oscillator. If you make up a pair of these units you can establish a simple two way telegraph link.

The Morse key may be purchased quite cheaply from many electronic component suppliers. Alternatively a key can be made using a strip of springy brass with a suitable knob mounted on one end.

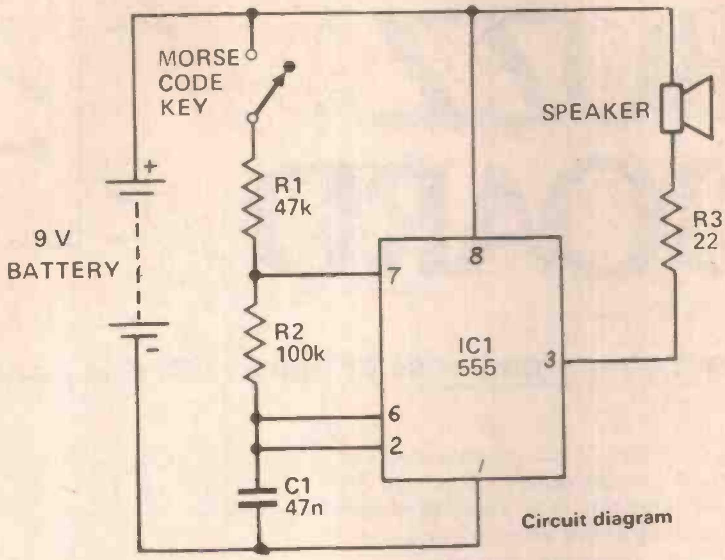
If desired the pitch of the unit may be changed by varying the value of capacitor C1. Increasing the value will decrease the pitch – and vice-versa. □



## HOW IT WORKS

**ETI 555/2**

When the Morse key is pressed down current flows through resistors R1 and R2 thus charging up capacitor C1. When the voltage across C1 reaches the required 2/3rds battery voltage level, the 555 conducts – discharging C1 via R2 until the voltage is 1/3 Vc. The cycle is continuously repeated whilst the key remains depressed thus causing a tone to be generated by the loudspeaker.



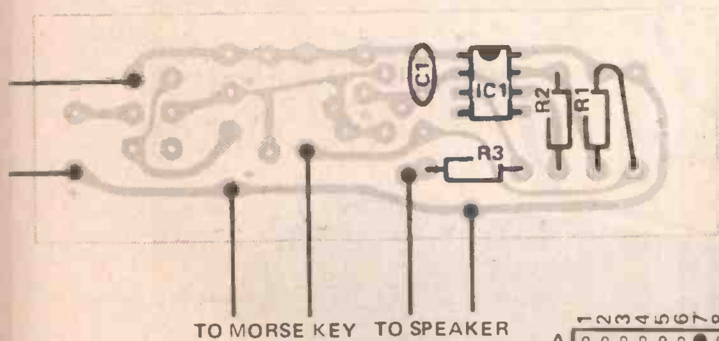

Circuit diagram

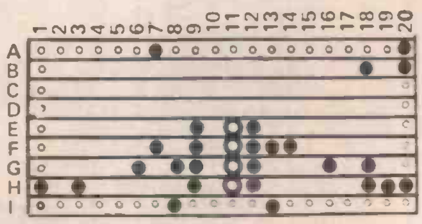
## PARTS LIST

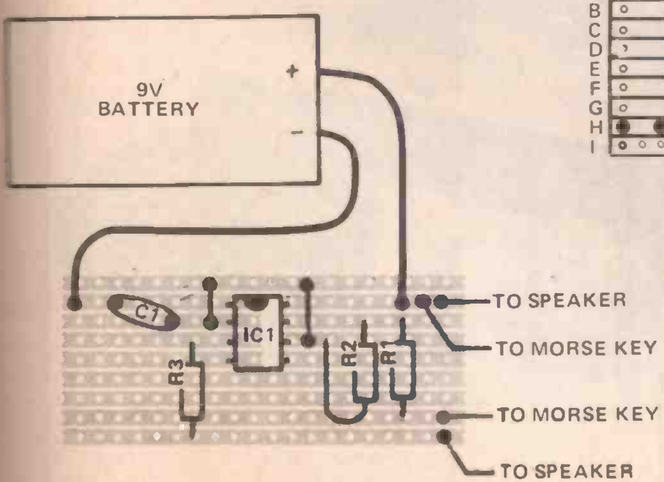
**ETI 555/2**

| | |
|---|---|
| **Resistors all ½W 5%** | |
| R1 | 47 k |
| R2 | 100 k |
| R3 | 22R |
| **Capacitor** | |
| C1 | 47 n polyester |
| **Semiconductor** | |
| IC1 | NE 555 |
| **Miscellaneous** | |
| PC Board ETI 555 (or Veroboard) | |
| Battery nine volt plus clip | |
| Morse key | |

Component overlay for the printed circuit version.




*Note:*

One 'dah' should be equal to three 'dits' in length.

The space between parts of the same letter should be equal to one 'dit'.

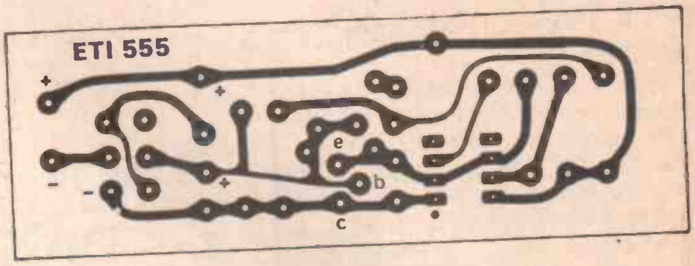
The space between two letters should be equal to three 'dits' (or one 'dah).

The space between two words should be equal to six 'dits'.

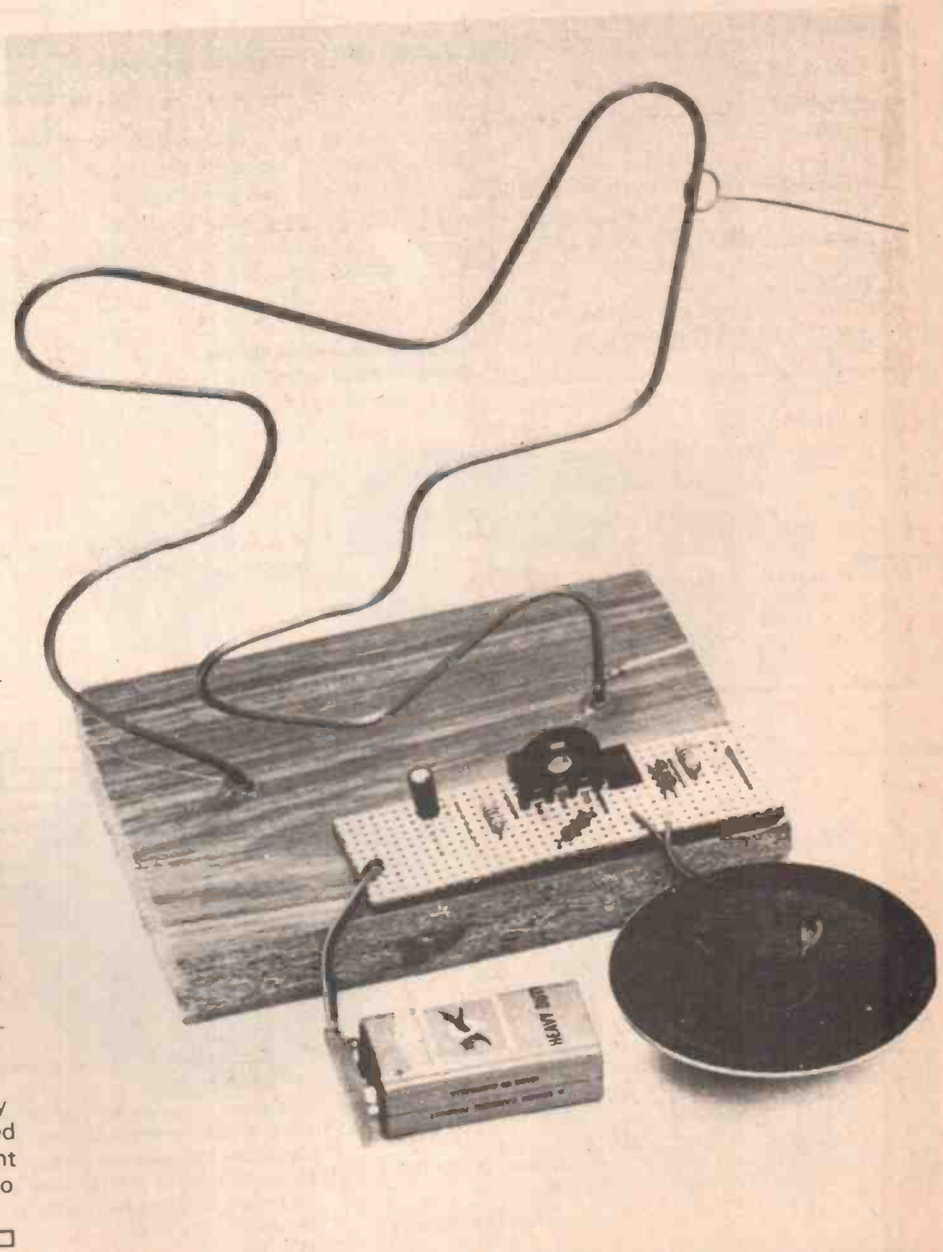
### THE MORSE CODE

| | |
|---|---|
| A | di-dah |
| B | dah-di-di-dit |
| C | dah-di-dah-dit |
| D | dah-di-dit |
| E | dit |
| F | di-di-dah-dit |
| G | dah-dah-dit |
| H | di-di-di-dit |
| I | di-dit |
| J | di-dah-dah-dah |
| K | dah-di-dah |
| L | di-dah-di -dit |
| M | dah-dah |
| N | dah-dit |
| O | dah-dah-dah |
| P | di-dah-dah-dit |
| Q | dah-dah-di-dah |
| R | di-dah-dit |
| S | di-di-dit |
| T | dah |
| U | di-di-dah |
| V | di-di-di-dah |
| W | di-dah-dah |
| X | dah-di-di-dah |
| Y | dah-di-dah-dah |
| Z | dah-dah-di-dit |
| 1 | di-dah-dah-dah-dah |
| 2 | di-di-dah-dah-dah |
| 3 | di-di-di-dah-dah |
| 4 | di-di-di-di-dah |
| 5 | di-di-di-di-dit |
| 6 | dah-di-di-di-dit |
| 7 | dah-dah-di-di-dit |
| 8 | dah-dah-dah-di-dit |
| 9 | dah-dah-dah-dah-dit |
| 0 | a long dah, or dah-dah-dah-dah-dah |

# BUZZ BOARD




**Test your steadiness of hand with this updated version of an old game.**



THIS PROJECT is a sophisticated version of a simple game in which the player attempts to pass a small metallic loop along a bent wire path without making contact with that wire.

In its simplest form there are no electronics at all: the 'circuit' consisting primarily of a battery and buzzer. The simple version works quite well but there is no facility for varying the difficulty of the game, short of bending the metal contacting loop.

The version shown here has a time delay built-in. This is adjustable so that the 'buzzer' will sound only if the loop contacts the wire for longer than the set time – and this time is adjustable from zero to a little less than one second.

## CONSTRUCTION

As with most circuits described in this series the unit may be built up on Veroboard or the printed circuit board shown here. The external wire path should be made of heavy gauge bare wire – fencing wire or a straightened out coat-hanger for example. This path can be as long as you reasonably like – certainly several hundred metres if you want to make the game really tough!

The metallic sensing loop again should be made of heavy gauge wire or tubing. Unlike the simpler form of this game a low resistance contact between the loop and the wire is not essential – so it doesn't matter too much if either becomes a little tarnished.

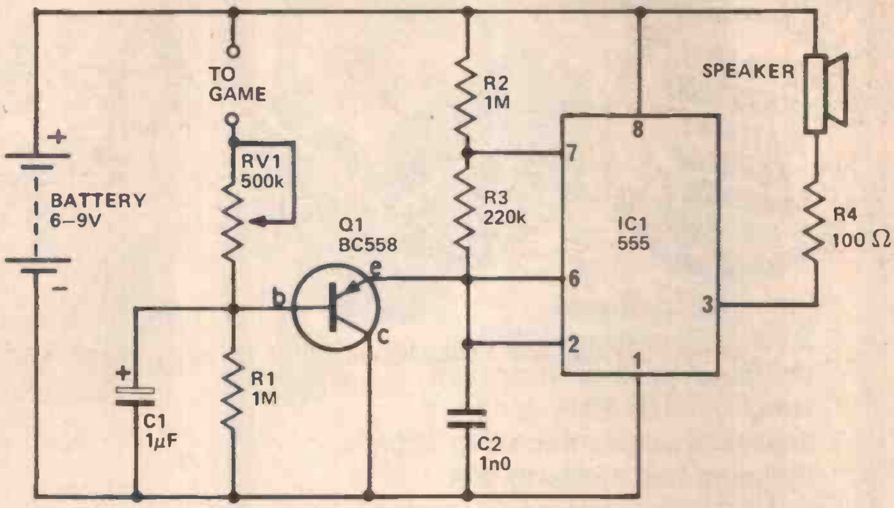
If required potentiometer RV1 may be removed from the board and located in any convenient manner. In this event it will probably be more satisfactory to replace it by a conventional ½ watt rotary potentiometer. □

## HOW IT WORKS

### ETI 555/3

Transistor Q1 holds the voltage on pins 2 and 6 of the 555 IC below 2/3rds of the battery voltage whilst the game contacts are not made. This action prevents the 555 IC from oscillating.

If the game contacts are made, capacitor C1 charges up via the potentiometer RV1. After a period (determined by the setting of RV1) the charge on C1 becomes high enough to bias Q1 to cut off. This action allows the 555 to commence oscillating thus producing a tone in the loudspeaker.




## PARTS LIST

### ETI 555/3

Resistors all ½ W 5%

| | |
|---|---|
| R1,2 | 1 M |
| R3 | 220 k |
| R4 | 100 R |

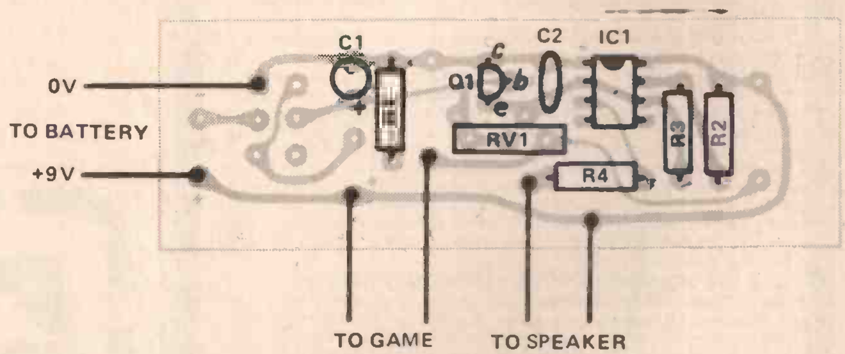
RV1 Trimpot 500 k

Capacitors

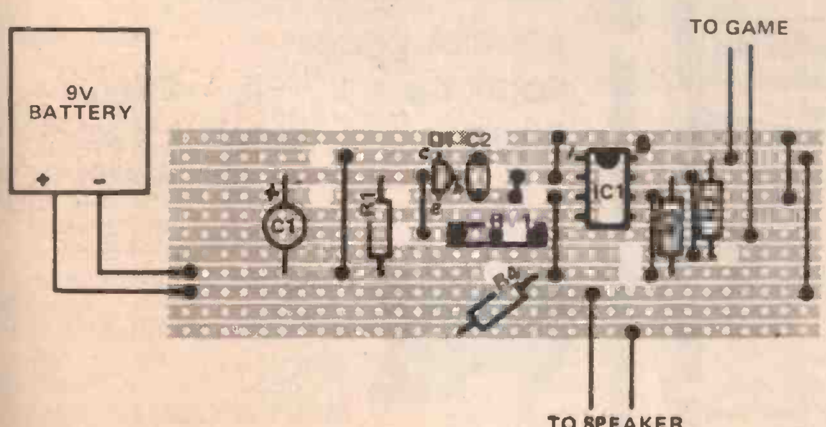
| | |
|---|---|
| C1 | 1 μF 16 V electrolytic |
| C2 | 1n0 polyester |

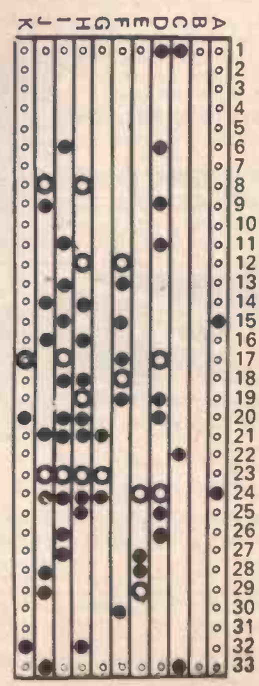
Q1 Transistor BC 558 or similar
IC1 Integrated circuit 555

Speaker 8-15 ohms any size
Printed circuit board ETI or ETI 555
Veroboard
Nine volt battery and clip.




**Here's how the components are located in the printed circuit board version of the game.**

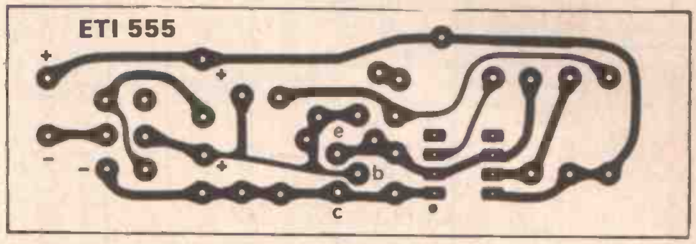


Cisco

# TEMPERATURE ALARM

**Find out if it's cold outside or inside with the last, but not least, of our straightforward project series.**




THIS IS A SIMPLE BUT VERY versatile temperature monitor which can be used in two different ways:
1. To warn if temperature exceeds a preset level.
2. To warn if temperature falls below a preset level.

The unit may be used to monitor temperature in fish tanks, laboratory ovens and/or water baths, incubators, cooking vessels, etc.

The temperature at which an alarm is given is adjustable over a range pre-determined by the combined values of the components RV1 and R1. RV1 is a potentiometer which is used to adjust the final 'set point' (the temperature at which the alarm is given).

Actual temperature sensing is done by a device called a 'thermistor'. This is basically a resistor in which the resistance value varies with changes in temperature. Thermistors are obtainable in innumerable shapes, sizes and temperature ranges.

The unit may be built so that a small loudspeaker provides an audible warning when the set limit is reached.

The unit may be constructed so that the warning takes place as temperature exceeds the set limit — or so that the warning takes place as temperature falls *below* the preset level.

All that is required to convert either unit from one mode of operation to the other is as follows: both the printed circuit board and Veroboard layouts show alternative positions for R1 and the thermistor leads. Each alternative is marked appropriately. Thus to use the circuit in the 'over-temperature' mode just insert R1 into the position marked 'over-alarm' and connect the thermistor to the 'over-alarm' positions. Naturally only one R1 is required.


Figure 1 shows the unit with loud-speaker set up to warm if the temperature exceeds the limit preset by RV1.

## Building the unit

Constructional method is not at all critical — we show the unit made up on Veroboard and also on a printed circuit board for those who wish to use this simpler and more elegant method.

The thermistor should be mounted in the end of a short length of thin-walled glass tube and sealed with epoxy resin. Thermistors can actually be ▷

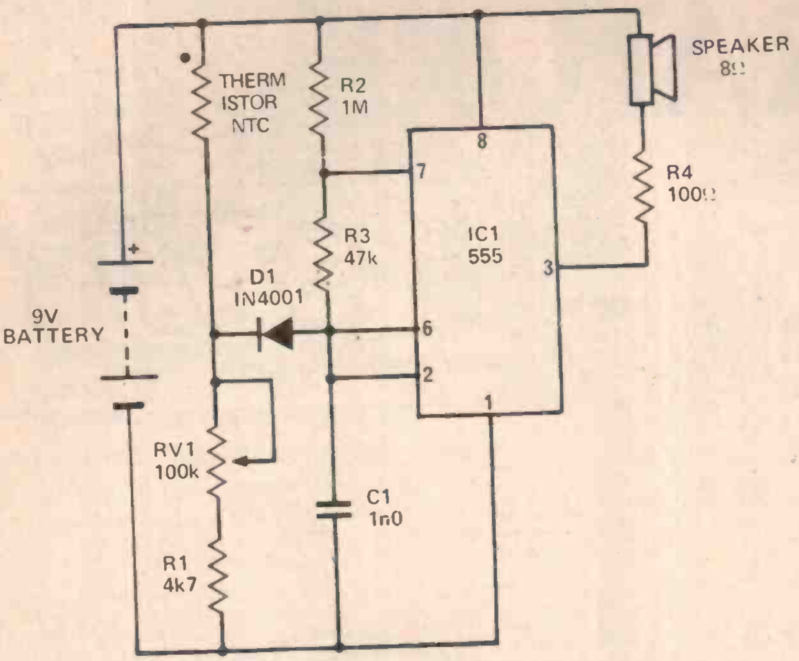



**Fig. 1. Basic circuit provides audible warning if temperature exceeds set point adjusted by RV1. See text if opposite operation is required.**

## PARTS LIST

**ETI 555/4**

**Resistors all ½ W 5%**

| | |
|---|---|
| R1 | 4k7 |
| R2 | 1 M |
| R3 | 47 k |
| R4 | 100 ohms |
| RV1 | 100 k Preset |

**Capacitor**

| | |
|---|---|
| C1 | 1n0 polyester |

**Semiconductors**

| | |
|---|---|
| D1 | 1N4001 |
| IC1 | NE555 |

**Miscellaneous**

Speaker 8 ohms
PC Board ETI 555 or Veroboard 3.3 x 1.1"
9 V battery
Thermistor 47 k (25°C) Philips type 642 11473 (available from A. Marshall (London) Ltd.)

bought commercially already mounted in this way — but they're expensive.

There are two reasons for sealing the thermistor in the manner described above. Firstly, if the thermistor is not sealed electrolytic action will very quickly dissolve the thermistor leads — our first one lasted just one day! Secondly, if the thermistor is used to monitor the temperature of an open element such as a heating jug there is a very real danger of the thermistor or its leads contacting mains voltage. If the thermistor is used solely for monitoring air temperatures then no sealing is of course required.

As outlined above, the combined values of R1 and RV1 determine the temperature at which the unit triggers. Table 1 shows roughly what the combined resistance should be for various triggering temperatures. Thus for the unit to operate at high temperatures the 100 k potentiometer and the 4k7 resistor specified will enable the set point to be adjusted from about 20°C to about 82°C.

If finer control is required then the 100 k potentiometer could be replaced by a 25 k potentiometer and R1 increased from 4k7 to 75 k. □

## HOW IT WORKS

**ETI 555/4**

Temperature is sensed via a thermistor. This is a resistor which varies its resistance as temperature changes. The one chosen for this application is a NTC (negative temperature coefficient) type in which resistance falls as temperature rises. The resistance at 25 °C is about 47 k falling to about 3 k at 100 °C. This thermistor forms a voltage divider with RV1 and R1.

The familiar 555 IC is the basis of the unit. The IC will oscillate if pins 2 and 6 are allowed to exceed approximately 2/3rds of the supply voltage, however the voltage divider along with diode D1 can prevent this and while it does so the alarm will be off.

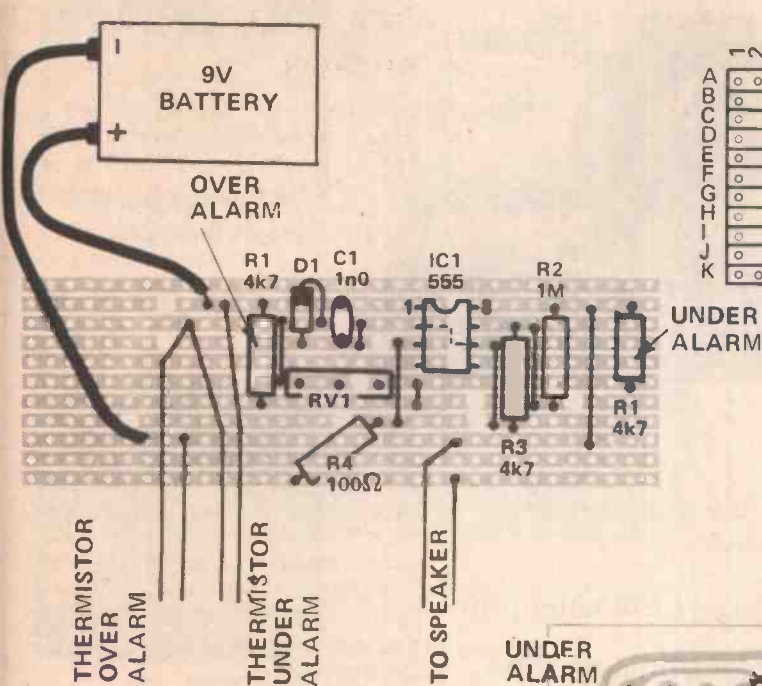
As temperature increases thermistor resistance falls and the voltage begins to rise at the junction of D1, the thermistor and R1. When the voltage reaches 2/3 $V_S$ – 0.6 V the 555 begins to oscillate and causes the loudspeaker to sound (at about 1.2 kHz). If an 8 ohm speaker is available then R4 must be included. However if an 80 ohm speaker is available then R4 may be left out — the sound will then be much louder.

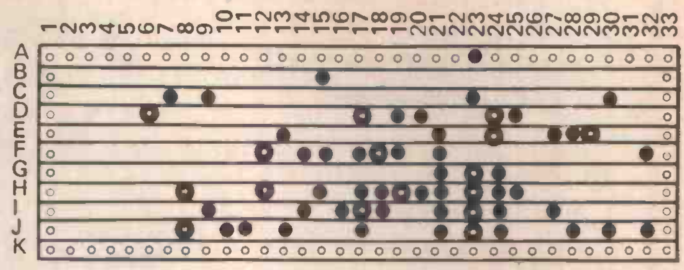
Figure 1 shows the unit set up to sound an alarm as temperature exceeds the set point. If an alarm is required as temperature falls below the set point then the position of the thermistor, and the combination of RV1 and R1 should be reversed — i.e., so that the thermistor is connected to the negative supply rail.

**TABLE 1**

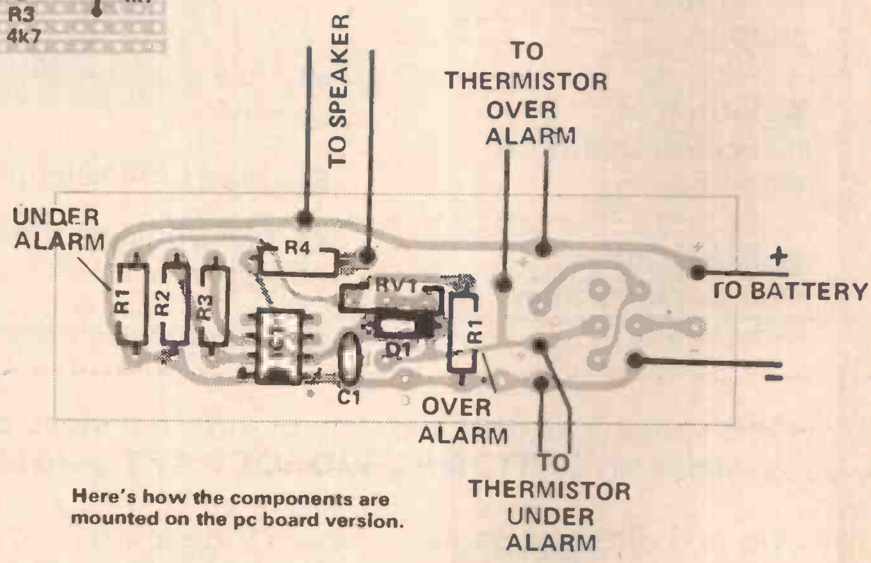
**APPROXIMATE VALUES FOR R1 + RV1 FOR VARIOUS TEMPERATURES**

| Temp °C | Over Alarm | Under Alarm |
|---|---|---|
| 25 | 75 k | 22 k |
| 35 | 50 k | 15 k |
| 45 | 30 k | 10 k |
| 55 | 18 k | 7k5 |
| 65 | 10 k | 5k2 |
| 75 | 6k5 | 3k8 |
| 85 | 4 k | 2k7 |
| 95 | 2k5 | 2k |



This is how the components are mounted on the Veroboard version. Note particularly that two alternative positions are shown for resistor R1 — the position chosen depends upon whether 'under alarm' or 'over alarm' operation is required. Similar comments apply to the pc board version shown on the right.




Here's how the components are mounted on the pc board version.

# PROBLEMS?

SUFFIXES 'k', 'm', 'M' etc after component values indicate a numerical multiplier or divider — thus

Multipliers

k = X 1000
M = X 1000 000
G = X 1000 000 000

Dividers

u = ÷ 1000 000
n = ÷ 1000 000 000
p = ÷ 1000 000 000 000

Where the numerical value includes a decimal point the traditional way of showing it was, for example, 4.7k. Experience showed that printing errors occurred due to accidental marks being mistaken for decimal points. The Standard now calls for the ex-suffix to be used in place of the decimal point. Thus a 4.7 k resistor is now shown as 4k7. A 2.2 uF capacitor is now shown as 2u2 etc.

Some confusion still exists with capacitor markings. Capacitors used to be marked with multiples or sub-multiples of microfarads — thus 0.001 uF, 470 uF etc. Markings are now generally in sub-multiples of a Farad. Thus —

1 microfarad (1u) = $1 \times 10^{-6}$ F
1 nanofarad (1n) = $1 \times 10^{-9}$ F
1 picofarad (1p) = $1 \times 10^{-12}$ F

OV on our circuits in this series means the same as —ve (an abbreviation for 'negative'.

Unless otherwise specified all components in our drawings are shown as seen from above — note however that component manufacturers often show them as seen looking *into* the pins.

Pin numbering of ICs — with the IC held so that the pins are facing away from you and with the small cut-out downwards pins are numbered anti-clockwise starting with pin number 1 at bottom right.

The thin line on a battery schematic drawing is positive (+ve or just +).

If a circuit won't work the most probable causes of trouble in the most probable order of occurrence are:—

(a) Components inserted the wrong way round or in the wrong places.
(b) Faulty soldering.
(c) Bridges of solder between tracks (particularly with Veroboard) — breaks in Veroboard omitted — and/or whiskers of material bridging across Veroboard breaks.
(d) Faulty components.

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- Time limit selection
- Electronic sound effects
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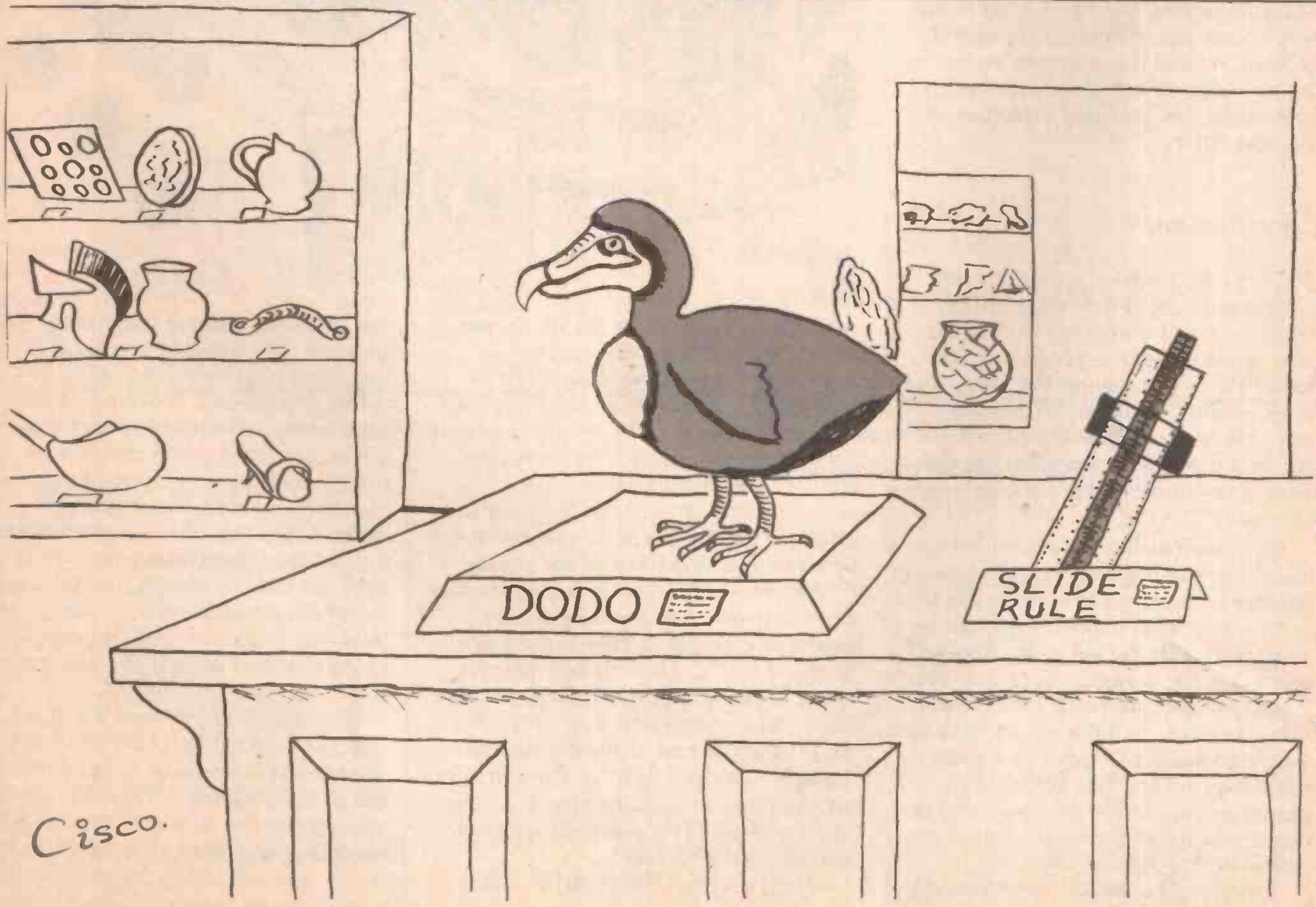


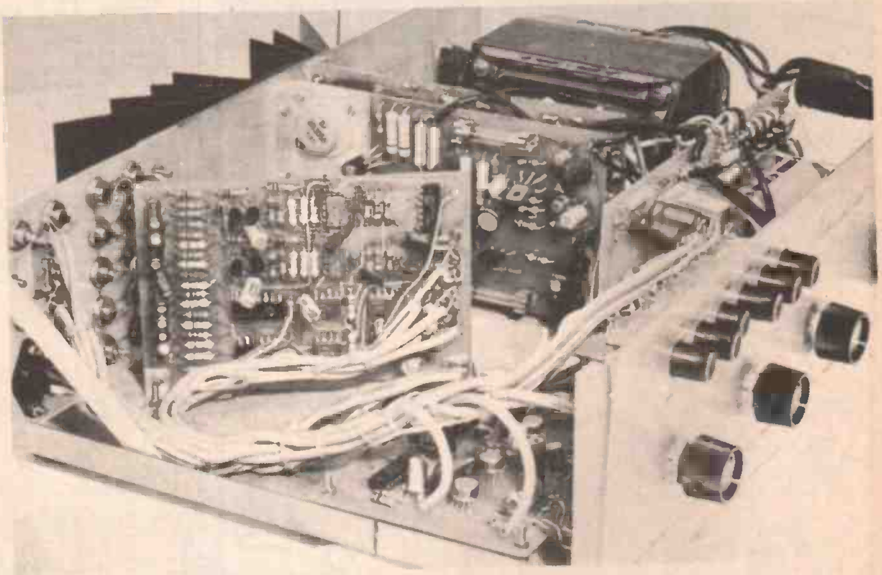
DODO
SLIDE RULE
Cisco.

# CMOS SWITCHED PREAMPLIFIER

## A versatile unit designed with our 480 power amplifier modules in mind

THE PREAMPLIFIER incorporates rumble and scratch filters, and something new in audio amplifiers, at least in magazine projects in solid-state switching of the audio inputs and filters. This simplifies wiring, as the only wires connected to the selector switches are control wires — not shielded cables as before.

In this design we have used a bank of push-buttons, but there is no reason why touch sensitive circuitry cannot be used. Indeed it is a simple matter to use a remote switch bank with multi-core cable, for armchair selection of input or filter.



### Construction.

The ETI 480 power amplifiers are described in detail in the March 1977 edition of ETI complete with a suitable power supply — if you are unfortunate in not having this issue do not despair! Xerox copies are available, see box on opposite page. Of course commercial modules can be used, but will probably work out more expensive.

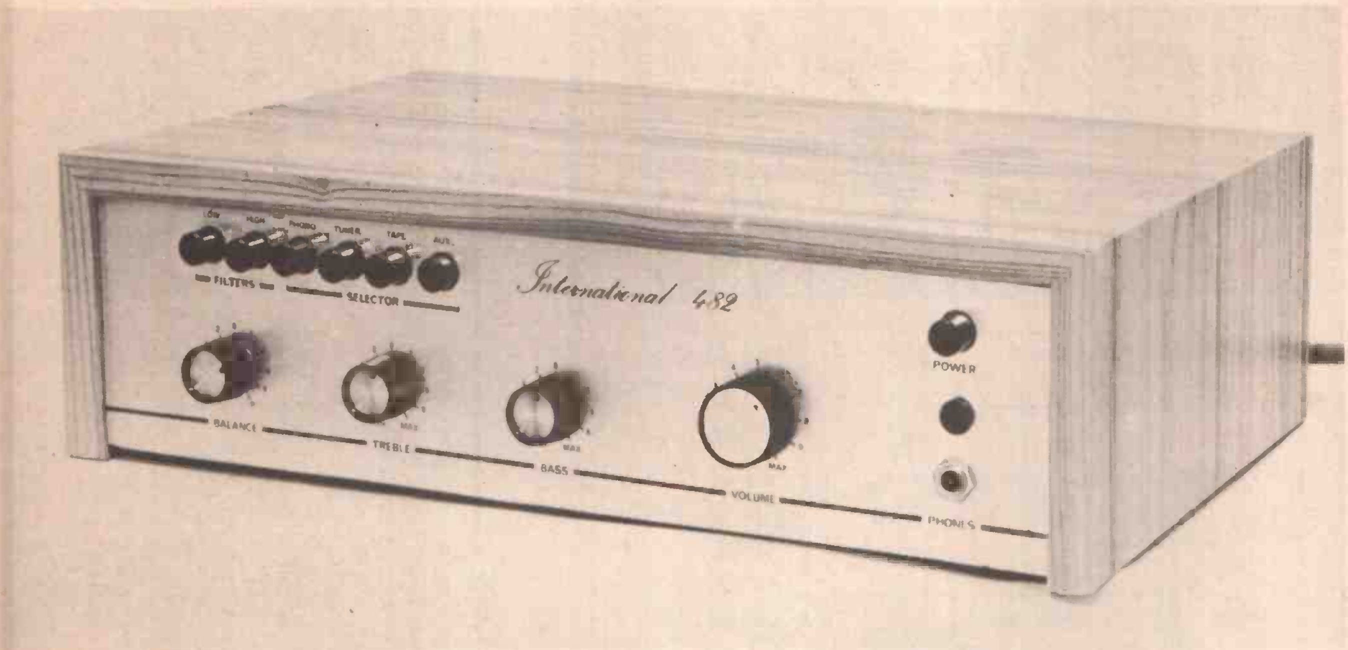
The preamplifier is built on two boards, one being the 'mag' preamp and selector board; the other being the tone control and filter board. These can be assembled with the aid of the appropriate overlay drawing. Note that the mag preamp board has tracks on both sides and must be soldered on both sides where applicable. If you use a small soldering iron and fine solder, this should not prove any problem. Use pc board pins for all external wires as this makes wiring much easier later.

Commence assembly of the chassis with the 12mm spacers for the selector switches and the power switch. Although the switches should not be fitted yet, the countersunk screws used to mount them are covered by the front panel and these will not be accessible later. The potentiometer and tone control board can now be installed and interconnected. The small rear panel can be assembled and fixed to the chassis.

Add wires about 40 mm long to each of the 10 inputs to the mag preamp board (it is neater if these are soldered to the rear of the board) and connect them to the appropriate phono sockets. Also add an earth link from this board to a lug under one of the phono input sockets. Connection of all the commons of the phono input sockets is via the chassis itself. The preamplifier board can now be installed.

Before fitting the amplifier modules they should have the bias current adjusted. While this can be set later, if anything is wrong it is easier to fix before installation. Provided no load is connected, no heatsink is required at this stage. The module can now be fitted, along with the heatsink on the rear of the chassis. The chassis goes between the modules and the heatsink, but the heat loss is not great. While the heatsink used in the 480 modules is not the only one which can be used, it must be about this size — and be capable of being clamped against the rear panel, to ensure adequate cooling.

The power supply board and the selector switches can now be added and the complete amplifier wired with the aid of the diagram in Figure 4. We left the transformer out until this stage to keep the weight down. It can now be added and the wiring completed. □




## SPECIFICATION

| | |
|---|---|
| **Output power** | 50 watts into 8 ohms |
| **Frequency response** 20Hz–20kHz | ± 0.5 dB |
| **Signal to noise ratio with 50 W output** | |
| Tape, tuner and aux inputs | --79 dB |
| Disc input (re 10mV) | –63 dB |
| **Input sensitivity** | |
| Tuner and aux inputs | 180 mV into 100k |
| Tape input | 180 mV into 47k |
| Disc input | 2.5 mV into 47k |
| Main amp input | 500 mV into 10k |

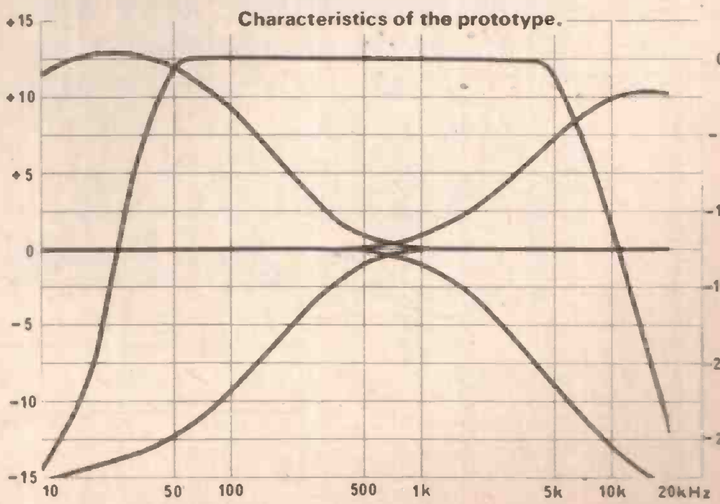
| | |
|---|---|
| **Total harmonic distortion at 1 kHz.** at 1 kHz | |
| 50 watts out | 0.3% |
| 10 watts out | 0.08% |
| 1 watt out | 0.08% |
| Tone controls | see graph |
| Filters | see graph |
| Damping factor | 25 |
| Channel separation | 45 dB |

**ETI 480 Power Amplifier**

Xerox copies of the ETI 480 article are available for 50p inclusive from:

ETI 480,
ETI Magazine,
25-27, Oxford Street,
London. W1R 1RF.

Please make cheques or postal orders payable to ETI Magazine and write your name and address on the back.



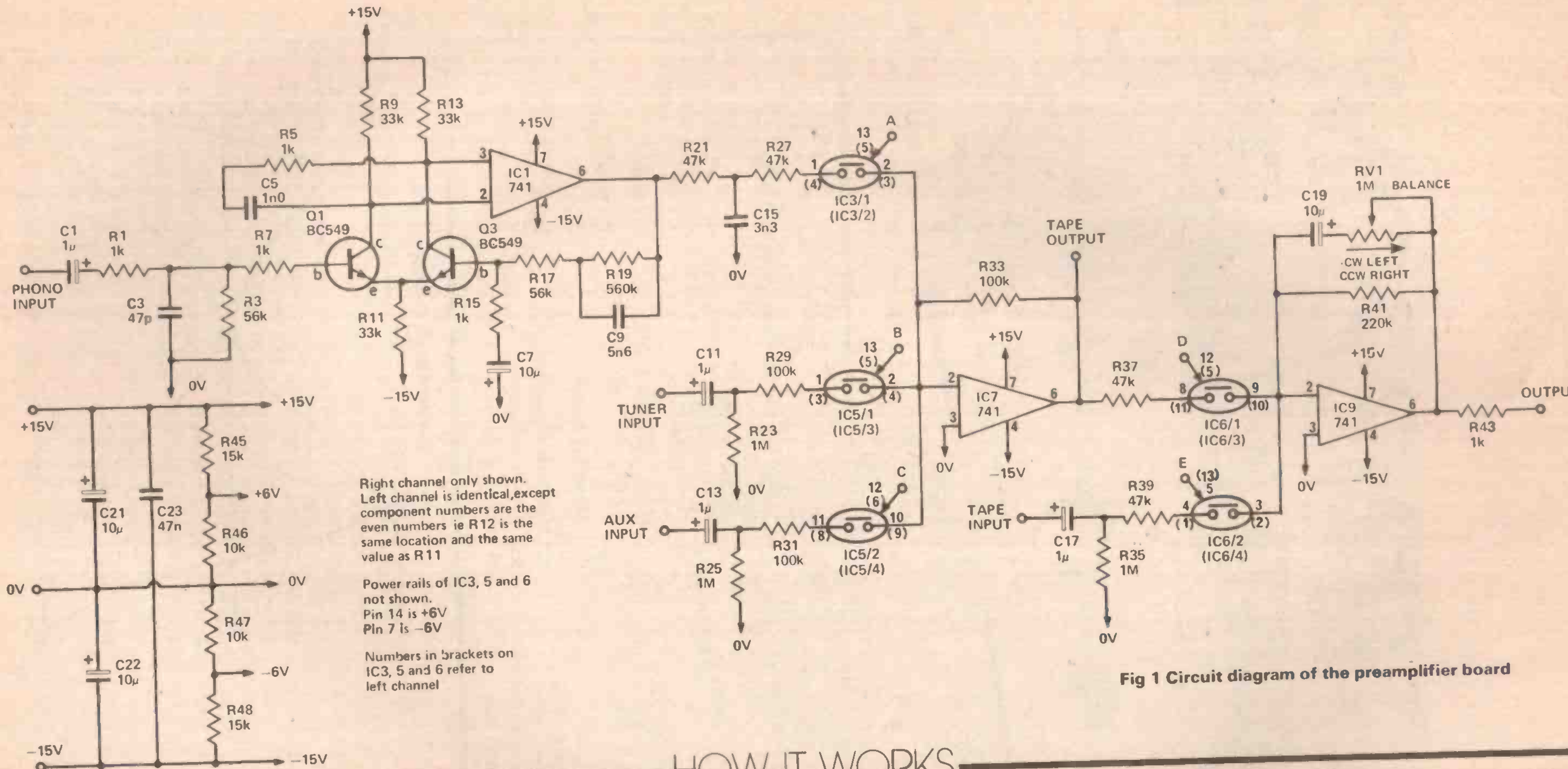



Fig 1 Circuit diagram of the preamplifier board

## HOW IT WORKS

### ETI 482

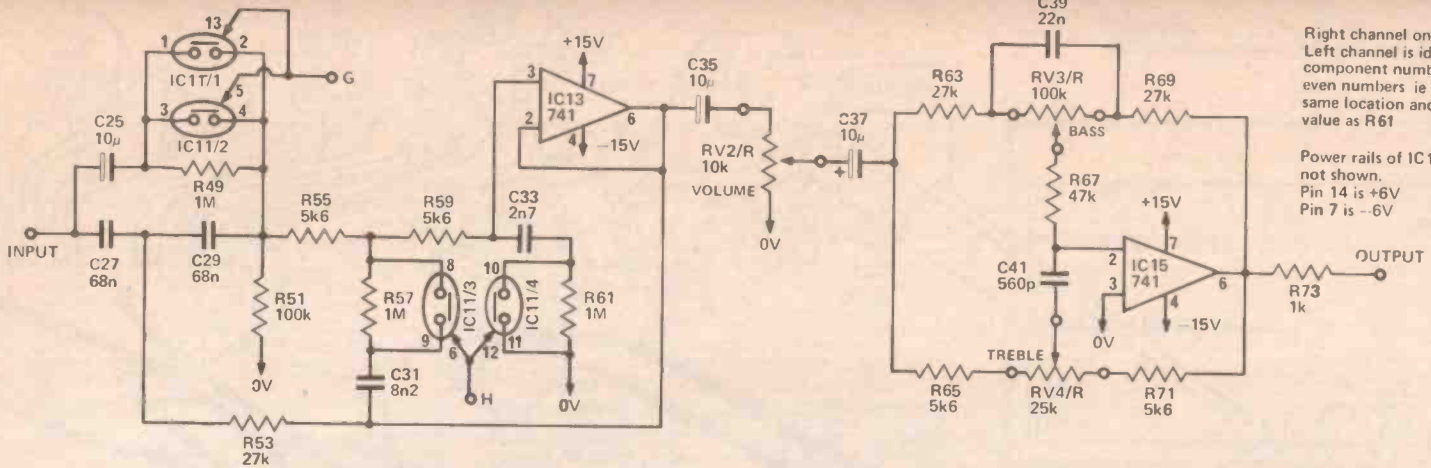
The output from a magnetic pickup has to be amplified and equalised before it can be used. This is achieved using Q1, 3 and IC1 to provide a gain of about 40 dB at 1 kHz and using C9 and C15 to provide the equalisation required to meet the RIAA curve. The transistors are used to reduce the noise of the 741 amplifier to acceptable levels.

Selection of the inputs is done by IC3, 5 and 6, which are CMOS anologue switches. If the control input to these devices is high (+6V) the switch appears as a 300 ohm resistor and if it is low (-6V), it appears as an open circuit. Therefore, IC3/1, IC5/1 and IC5/2 can select phono, tuner or aux inputs and IC7 buffers the one selected.

The output of IC7 is used as tape output for recording purposes. The tape input is fed with a second buffer, IC9, and IC6/1 disconnects IC7 when this is to allow monitoring (when recording) and this is selected by depressing both the tape button and the input required. The gain of the second buffer, IC9, is variable by means of RV1, which is the balance control. The two channels are wired to the opposite way around on RV1, so that increasing gain on one channel decreases the gain on the other.

The filters used are two-pole active type and CMOS switches are used to enable or inhibit the circuits. C27 and C29 determining the low filter cutoff frequency and the valus can be varied to suit your requirements. The values given give a cutoff at about 50 Hz and increasing the capacitance decreases the cutoff frequency, and vice versa. In the high cut filter C31 and C33 determining the frequency and these values can also be varied if required. The approximate ratio between these capacitons should be maintained.

The tone controls are conventional and we used the same values as in the 440 amplifier (they have a better range than those in the original 422). To reduce the effective noise level, the volume control is wired between the filter section and the tone control stage. This does mean, however, that the input levels are more critical than they would be if the control was further back in the circuit. Input levels should be kept below about 2 volts.



Right channel only shown. Left channel is identical, except component numbers are the even numbers ie R62 is the same location and the same value as R61

Power rails of IC11 not shown. Pin 14 is +6V Pin 7 is −6V

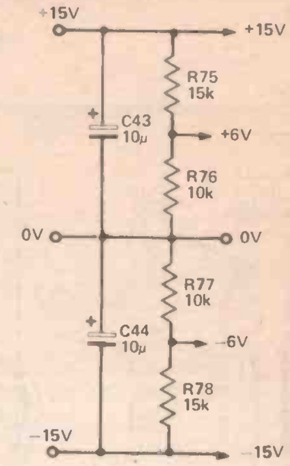


Fig 2 Circuit diagram of the filter and tone control board

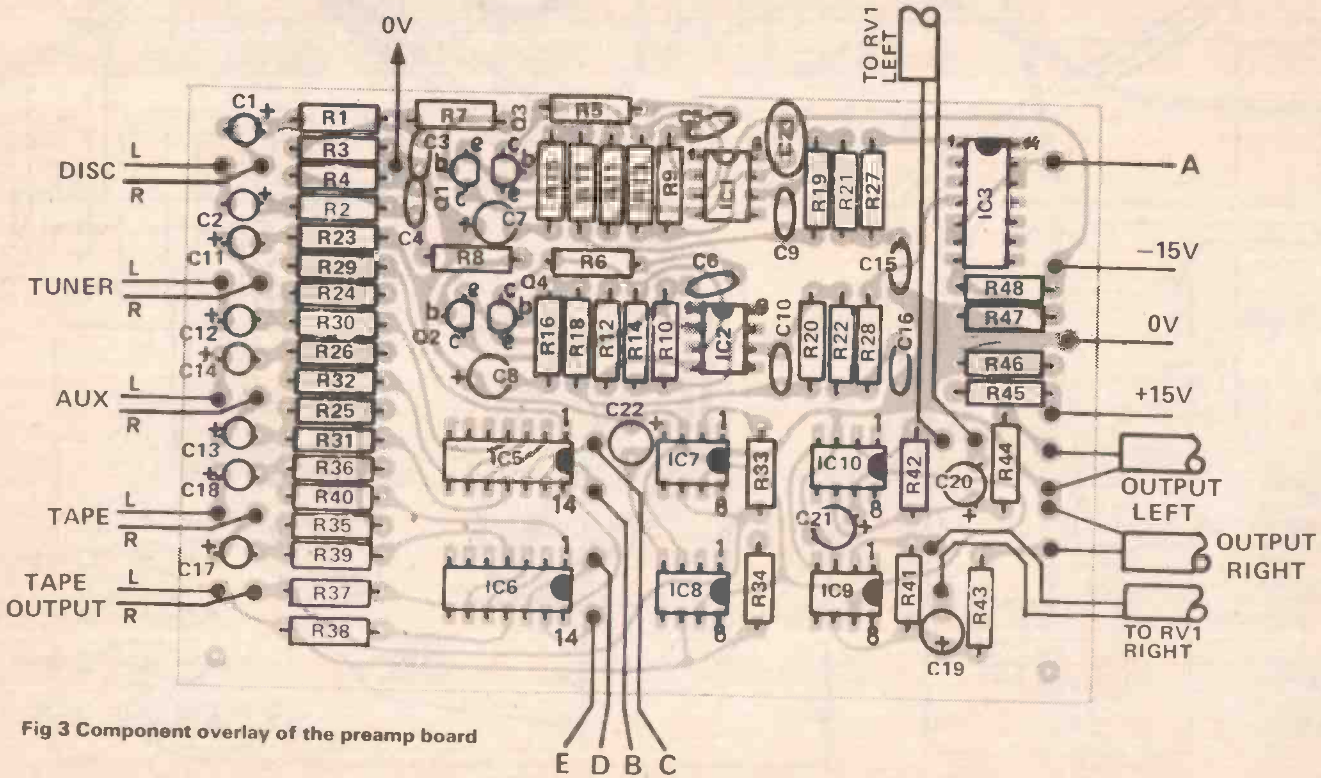


Fig 3 Component overlay of the preamp board

## PARTS LIST

### ETI 482A

| | |
|---|---|
| **Resistors** ½w 5% | |
| R1,2,5-8,15,16,43,44 | 1 k |
| R3,4,17,18 | 56 k |
| R9-14 | 33 k |
| R19-20 | 560 k |
| R21,22 | 47 k |
| R23-26,35,36 | 1M |
| R29-34,37-40 | 100 k |
| R41,42 | 220 k |
| R45,48 | 15 k |
| R46-47 | 10 k |
| **Capacitors** | |
| C1,2, | 1 µ 35 V Tantalum |
| C3,4 | 47p ceramic |
| C5,6 | 1n polyester |
| C7,8,19-22 | 10 µ 16 V electrolytic |
| C9,10 | 5n6 polyester |
| C11-14, 17,18 | 1 µ 35 V electrolytic |
| C15,16 | 3n3 polyester |
| C23 | 47n polyester |
| **Semiconductors** | |
| Q1,Q2 | Transistor BC549 |
| IC1, 2 | Integrated Circuit 741 |
| *IC3,5,6 | Integrated Circuit 4016 |
| IC7-IC10 | Intergrated Circuit 741 |
| *The number IC4 is not used | |
| PC Board | ETI 482A |

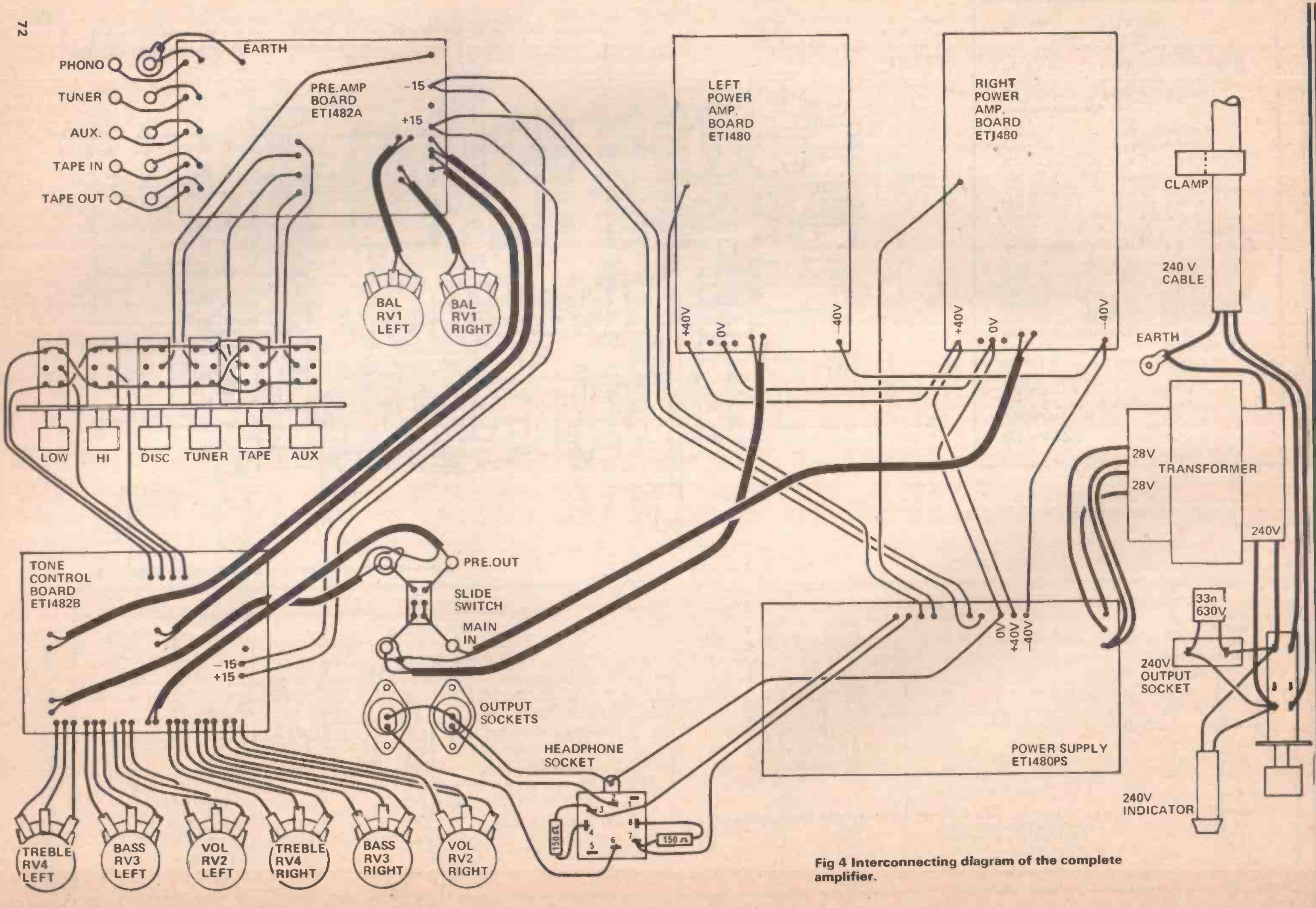
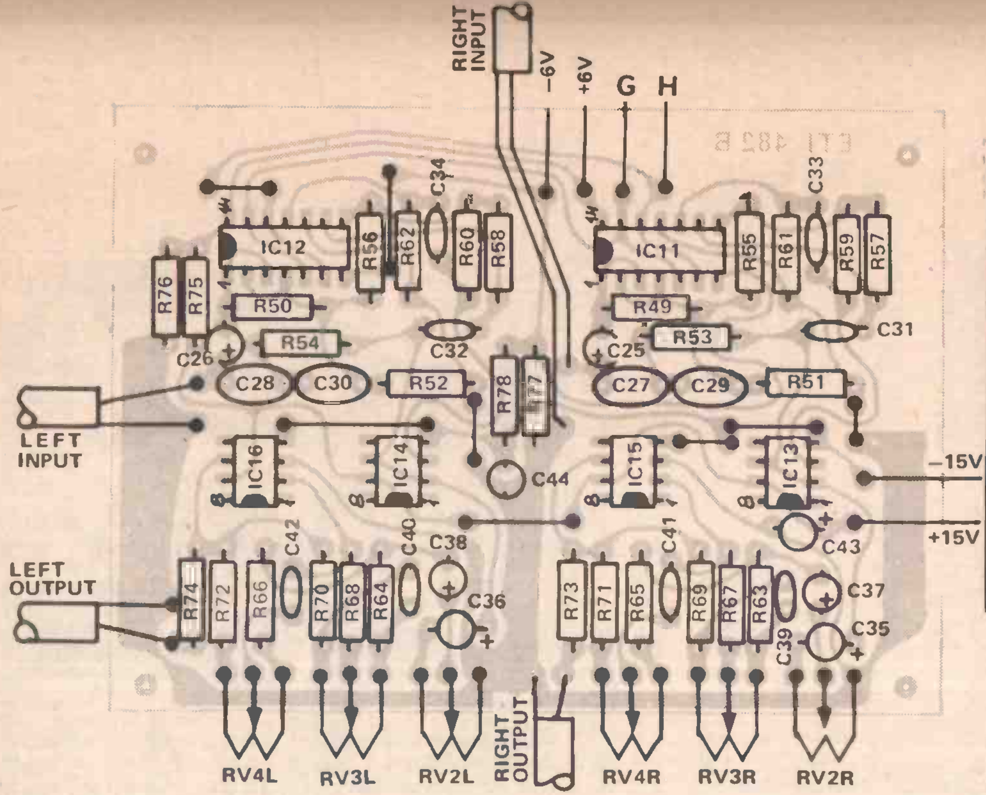



**Fig 4 Interconnecting diagram of the complete amplifier.**




## PARTS LIST

### ETI 482B

**Resistors all ½ W 5%**

| | |
|---|---|
| R49,50,57,58,61,62 | 1 M |
| R51,52 | 100 k |
| R53,54,63,64,69,70 | 27 k |
| R55,56,59,60,65,66,71,72 | 5 k 6 |
| R67,68 | 47 k |
| R73,74 | 1 k |
| R75,78 | 15 k |
| R76,77 | 10 k |

**Potentiometers**

| | |
|---|---|
| RV2 | 10 k log dual rotary |
| RV3 | 100 k lin dual rotary |
| RV4 | 25 k lin dual rotary |

**Capacitors**

| | |
|---|---|
| C25,26,35-38, 43,44 | 10 μ 16 V electro |
| C27-C30 | 68 n polyester |
| C31,32 | 8n2 polyester |
| C33,34 | 2n7 polyester |
| C39,40 | 22 n polyester |
| C41,42 | 560 p ceramic |

**Integrated Circuits**

| | |
|---|---|
| IC11,12 | 4016 or 4066 |
| IC13-IC16 | 741 |
| PC board | ETI 482 B |

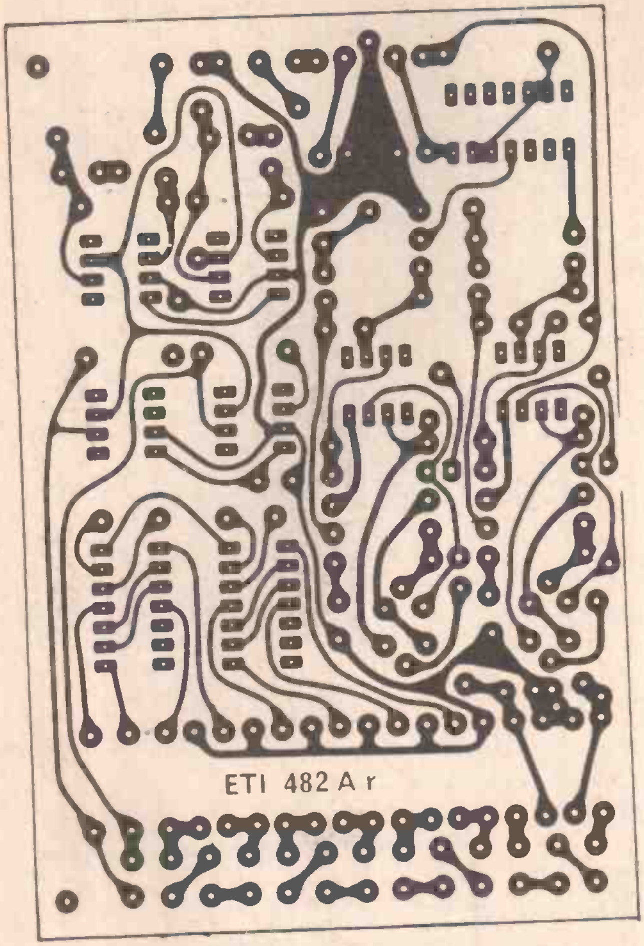
## PARTS LIST

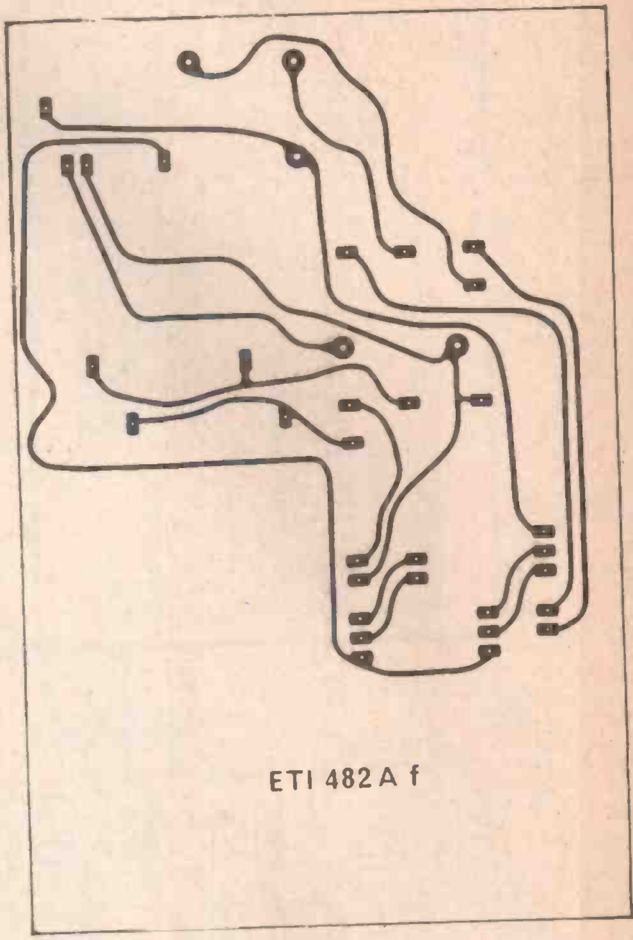
### ETI 482 GENERAL

2 50 W ETI 480 Amplifier modules
1 ETI 480 P Power supply module

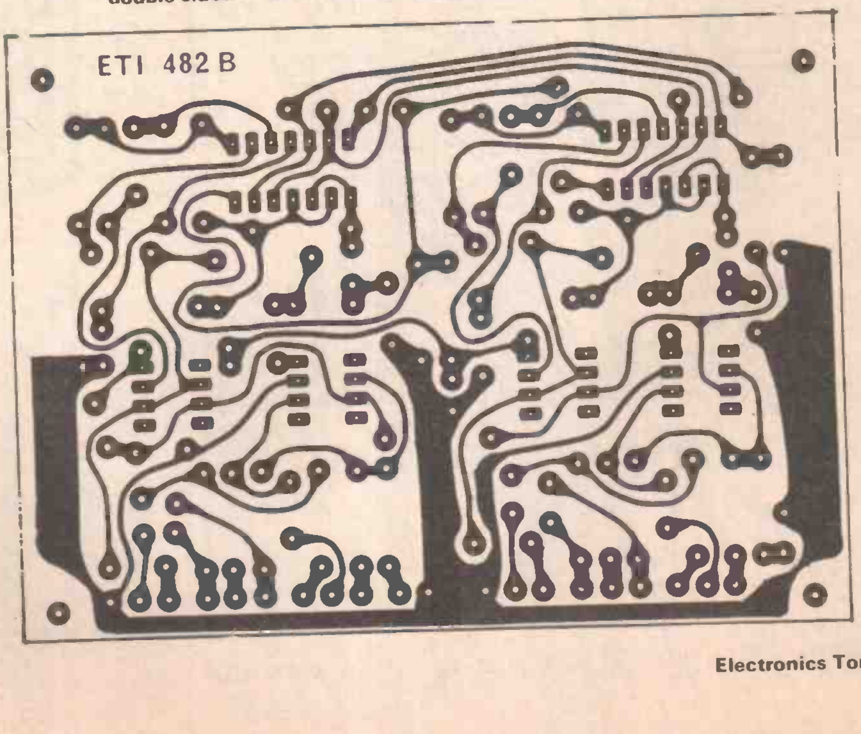
chassis
cover
Front panel
Heatsink
Rear panel
5 brackets
4 knobs
1 Selector switch bank
1 Power switch
1 2 pin power socket
1 33 n 630 V capacitor

1 240 V power indicator
1 Power cord, grommet and clamp
1 Stereo headphone socket
14 Single phono sockets
1 Small double pole slide switch
2 2 pin DIN socket
8 12mm spacers
nuts, bolts, washers etc.




Foil patterns for the printed circuit boards. Note that 482A is double sided — all artwork is correct size.



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Because the Chess Challenger serves as your chess partner, it is ready to play whenever you are, day or night. And it eliminates the age-old problem of chess players — finding someone who wants to play chess! This is especially important for beginning players, who may be too embarrassed by their lack of skill to challenge a better player. By practising with the Chess Challenger, a novice quickly learns to plan upcoming moves and cover the board positions.

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If you know the basic chess moves, which can be learned in ten minutes, you can take on the Chess Challenger a few minutes after reading its simple directions.

Set up both sides of the chess board with the included wood pieces (you can play white or black) and make your first move. Enter your move into the Chess Challenger mini-computer by touching a couple of keys on the Control Center.

Seconds later, Chess Challenger responds with its move, which is displayed in standard chess alpha-numeric notation in the FROM and TO windows on the Control Center. You can move the Chess Challenger's piece on the board to match the display. Make your next move, enter it, take a note of the Chess Challengers response and move its piece to the appropriate square on the chess board. That's all there is to it!!

### BUT CAN YOU BEAT THE CHALLENGER!!

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You control Chess Challenger's level of play. Turn on Chess Challenger and it plays Chess Level I, an average game. If level I is too easy, press the CL (clear) button and call up level II, a tougher game. If you master Level II, you can play Level III, an extremely difficult chess game. These varying games make Chess Challenger an ideal opponent and a perfect teacher for aspiring chess masters.


— CONTROL CENTER —

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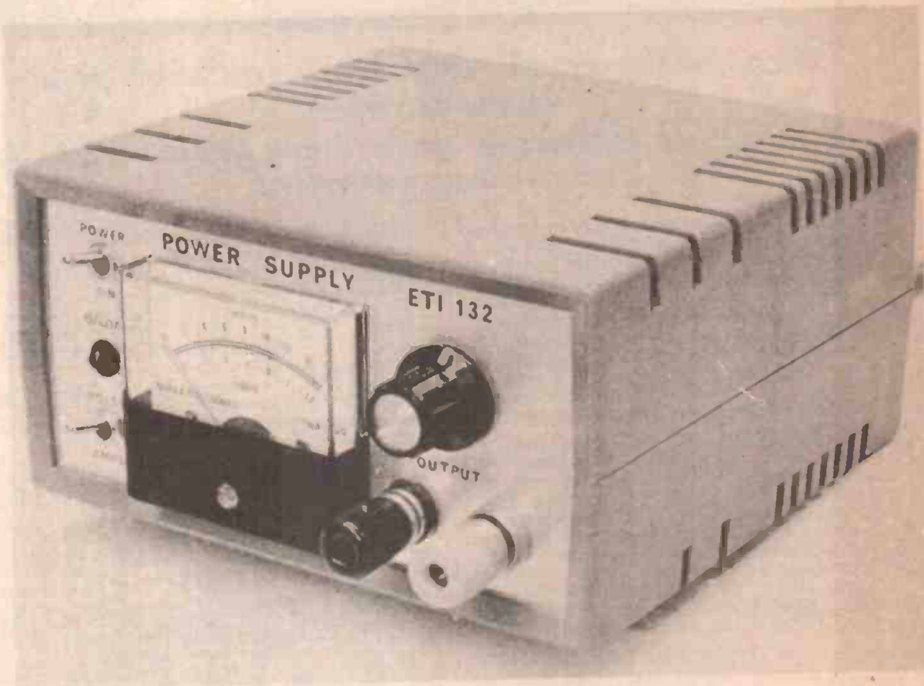
# EXPERIMENTERS' POWER SUPPLY

**Versatile, two version bench supply — no workshop is complete without one!**

THIS ECONOMICAL POWER SUPPLY gives the full range 0 to 15 V. In addition this supply features metering (or you can use the calibrated scale on the second version if you don't have a spare meter) to enable accurate setting of voltage or current.




## Construction

Commence by assembling the pc board with the aid of the component overlay diagram. The main filter capacitor C1 is normally a chassis-mounting type, but we mounted this satisfactorily by passing the lugs through the large holes in the pc board, bending them flush with the copper and soldering. Check the polarity of the capacitor before fitting, as it cannot be seen later. The transistor Q3 is fitted, along with its heatsink, with the two mounting screws. No insulation is used between the transistor and the heatsink but pass a small piece of tubing over the base and emitter leads where they go through the heatsink, to prevent shorting. If the meter is not required RV3, RV4 and R10 are not used.

The front and rear panels can now be drilled. Note that the mounting bracket of the transformer has to be cut back about 12 mm on one end to allow it to fit easily.

Assemble the front and rear panels and wire the unit according to Fig 3.

The wires to and from the power switch can pass the pc board via the chamfer on the lower left hand side. Other wires from the pc board to the front panel can be connected onto the copper side of the board.

## SPECIFICATION

| | |
|---|---|
| Output Voltage | 0-15 V variable |
| Output Current | 0-1 A |
| Current Limit | approx 1.2 A |
| Load regulation | 35 mV 0 to 1 A load |
| Line regulation | 20 mV 220 to 260 V input |
| LED indication of current overload | |

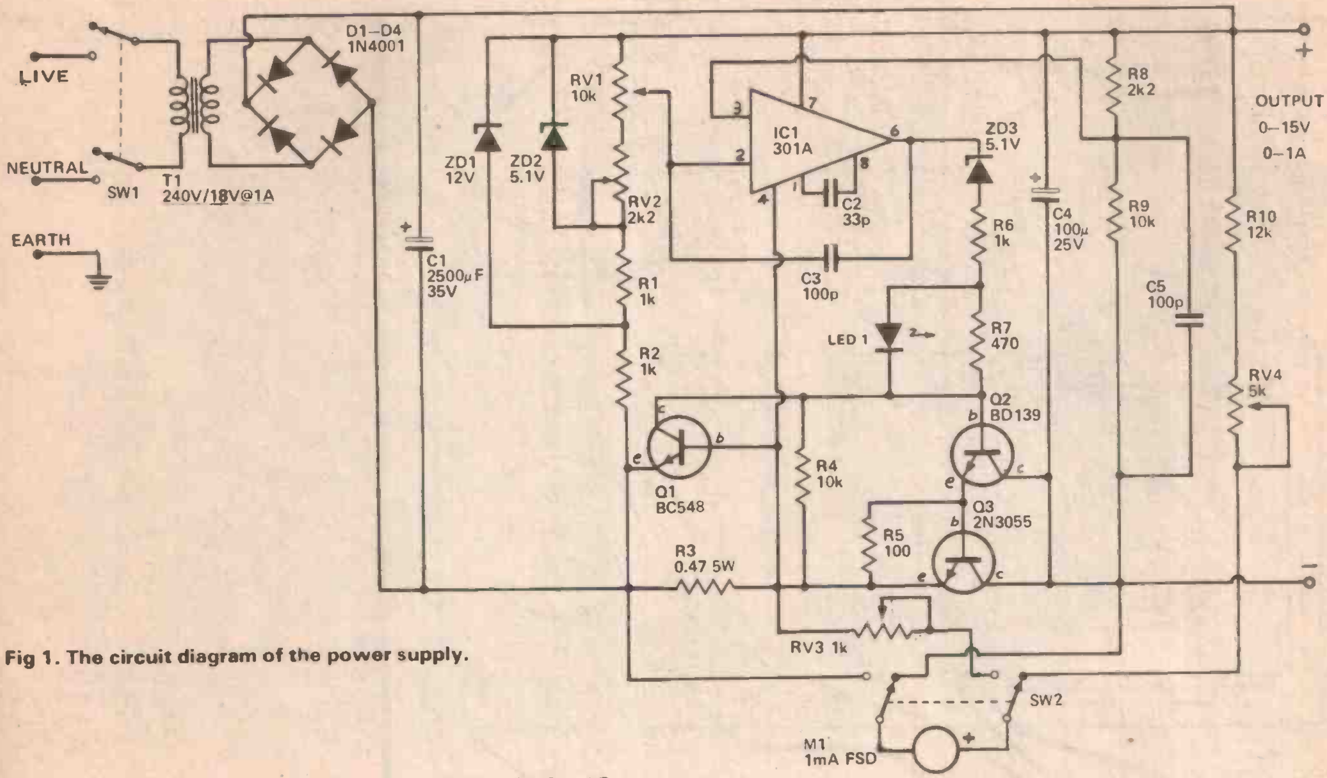



Fig 1. The circuit diagram of the power supply.

## HOW IT WORKS

The 240 V mains is reduced to 18 V in T1. This 18 V ac is then rectified by D1-D4 and filtered by C1 to give about 25 volts dc (on no load). The voltage reference for the supply is ZD2, which gives about 5 V dc. However, due to the large variation in voltage across C1 (caused by load changes) additional regulation is used, incorporating ZD1, and the two circuits give the stability required.

The regulator is a 'series-pass' type with the positive rail common and the negative rail variable. We have done it this way to achieve outputs down to 0 V. The comparator IC (LM301) cannot work with its input less than about 2 volts above the negative rail, but it can work with the inputs at the positive supply rail. However this will not work with all types of op amp — so do not substitute the 301 with a 741 or similar.

The output of ICI controls the output transistors, Q2 and Q3. A level-shifting zener ZD3 is used in the output of IC1 as its output cannot swing low enough. The output voltage is divided by R8 and R9 and is taken to IC1 which compares it to that set on RV1. IC1 then adjusts the drive to the output stage until the two voltages are the same. RV2 is used to compensate for variations in the voltage of ZD2.

In the event of an overload the voltage drop across R3 will forward-bias Q1, which will bypass current away from the output transistors. This causes the output voltage to fall, the comparator sees this error, and the output of IC1 goes to the positive supply rail (trying to compensate). Q1 however will continue to bypass any extra current, holding the output current constant at about 1.2 A. However, the additional current out of IC1 will forward bias LED 1 and it will indicate the overload.

With such high gain in the circuit additional frequency stability is needed and C3 and C5 provide this. For metering, we simply use a 1 mA movement meter and measure the voltage across the output (via R10 and RV4) and across R3 (current).

### Setting Up

1. Without Meter — With this version we rely on the potentiometer to be linear. In practice it is not linear at the two ends of its travel. Calibration is done by adjusting the knob position and RV2.

Set the output to one volt and position the knob to read one volt. Now turn the knob to 15 V and adjust RV2 to give 15 V output. Recheck the 1 V setting and repeat the procedure, if necessary.

2. With Meter — Connect the output to an accurate voltmeter and turn the pot to maximum. Adjust RV2 to give 16 V. Adjust RV4 until the meter reads 16 V (with RV2 switched to volts). Now connect a load and an ammeter. Set 1A on the ammeter and then adjust RV3 until the power supply meter reads 1 A. ▷

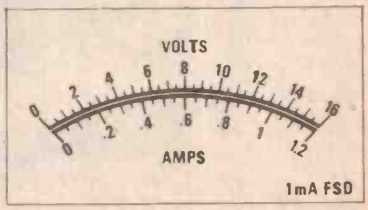



Fig 2. The meter scale used.

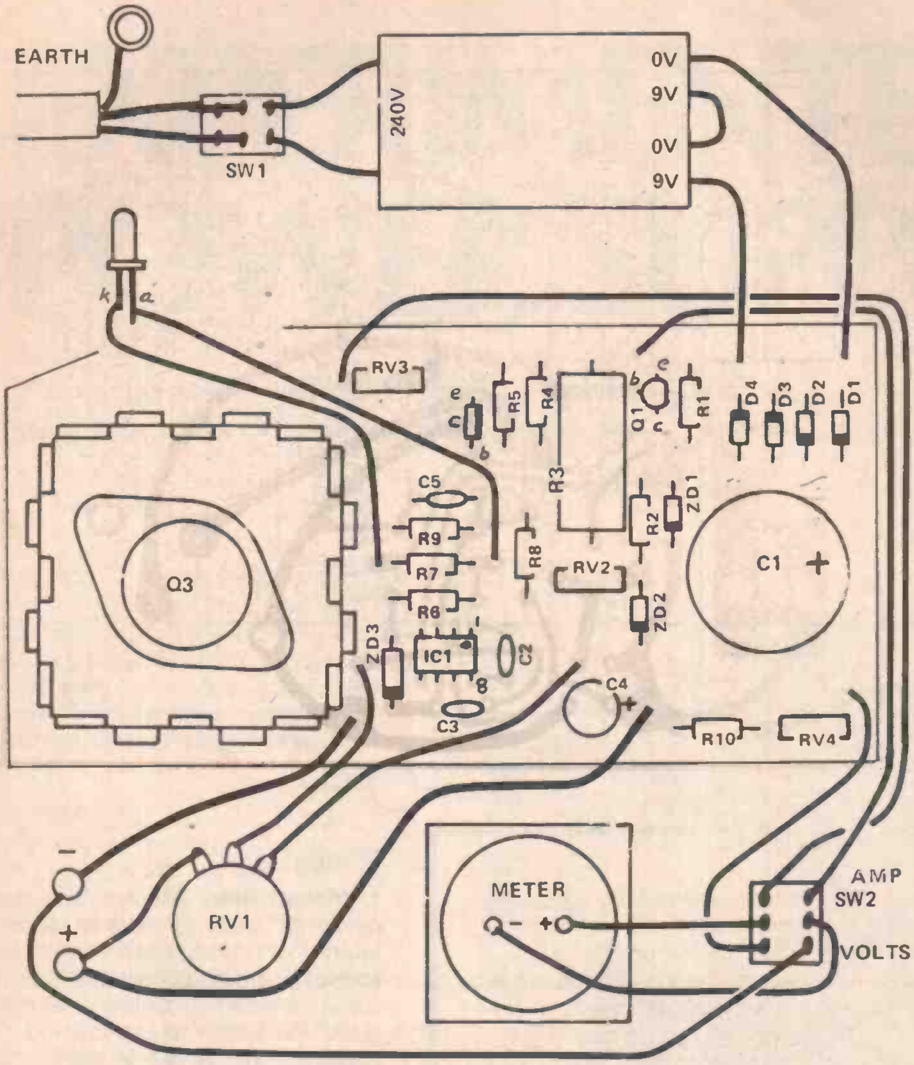



Fig 3. The component overlay and interconnection diagram.


## PARTS LIST

**Resistors**

| | | |
|---|---|---|
| R1,2,6 | 1 k | ½ W 5% |
| R3 | 0R47 | 5 W 5% |
| R4,9 | 10 k | ½ W 5% |
| R5 | 100 | " " |
| R7 | 470 | " " |
| R8 | 2k2 | " " |
| R10 * | 12 k | " " |
| RV1 | 10 k lin rotary | |
| RV2 | 2k2 Trim | |
| RV3 * | 1 k " | |
| RV4 * | 5k " | |

**Capacitors**

| | |
|---|---|
| C1 | 2500 µ electrolytic |
| C2 | 33 p ceramic |
| C3,5 | 100 p " |
| C4 | 100 µ 25 V electro lytic |

**Semiconductors**

| | |
|---|---|
| D1-D4 | Diodes 1N4001 |
| ZD1 | Zener 12 V 400 mW |
| ZD2,3 | Zener 5.1 V 400 mW |
| LED1 | TIL 209 with clip |

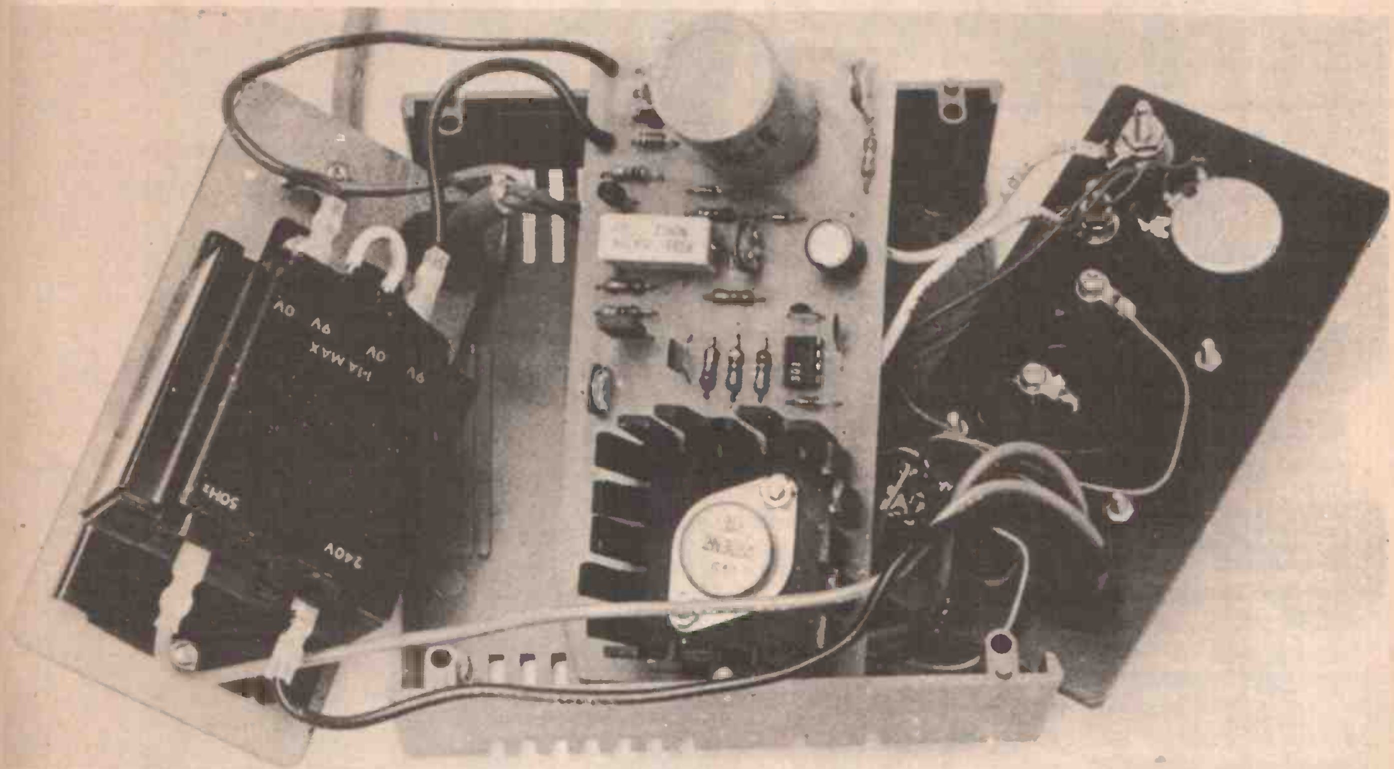
| | | |
|---|---|---|
| Q1 | Transistor | BC548 |
| Q2 | " | BD139 |
| Q3 | " | 2N3055 |
| IC1 | Integrated circuit LM301 | |

**Miscellaneous**

PCB ETI 132
Transformer 240 V — 18 V 2A

Case
Power cord and clamp
Heat sink
Two 2 pole 2 position 240 V Toggle switches
Two terminals
Meter 1 mA FSD *
Knob

*If meter is not required delete RV3, RV4, R10, the meter and one switch



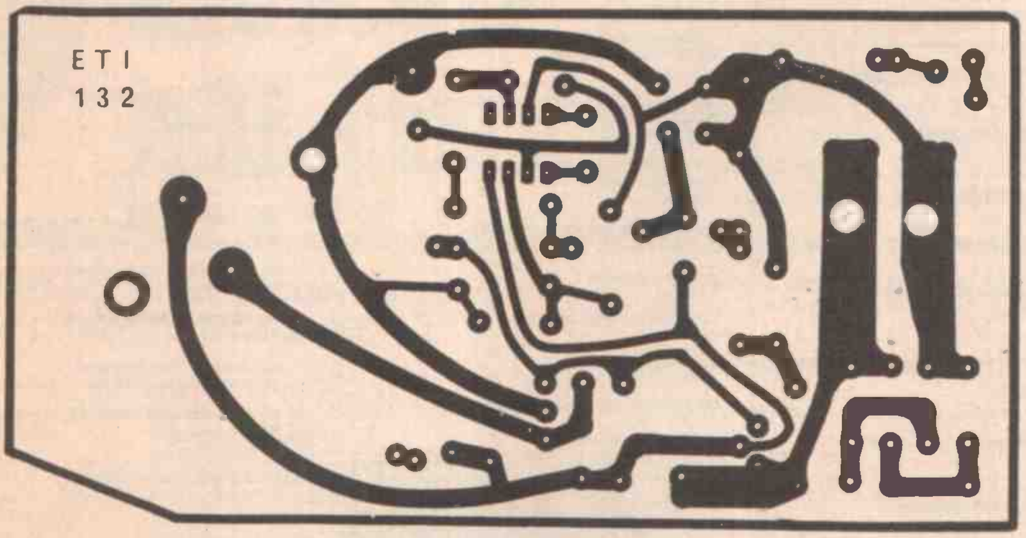



Fig 4. Printed circuit layout Full size 132 x 66 mm.

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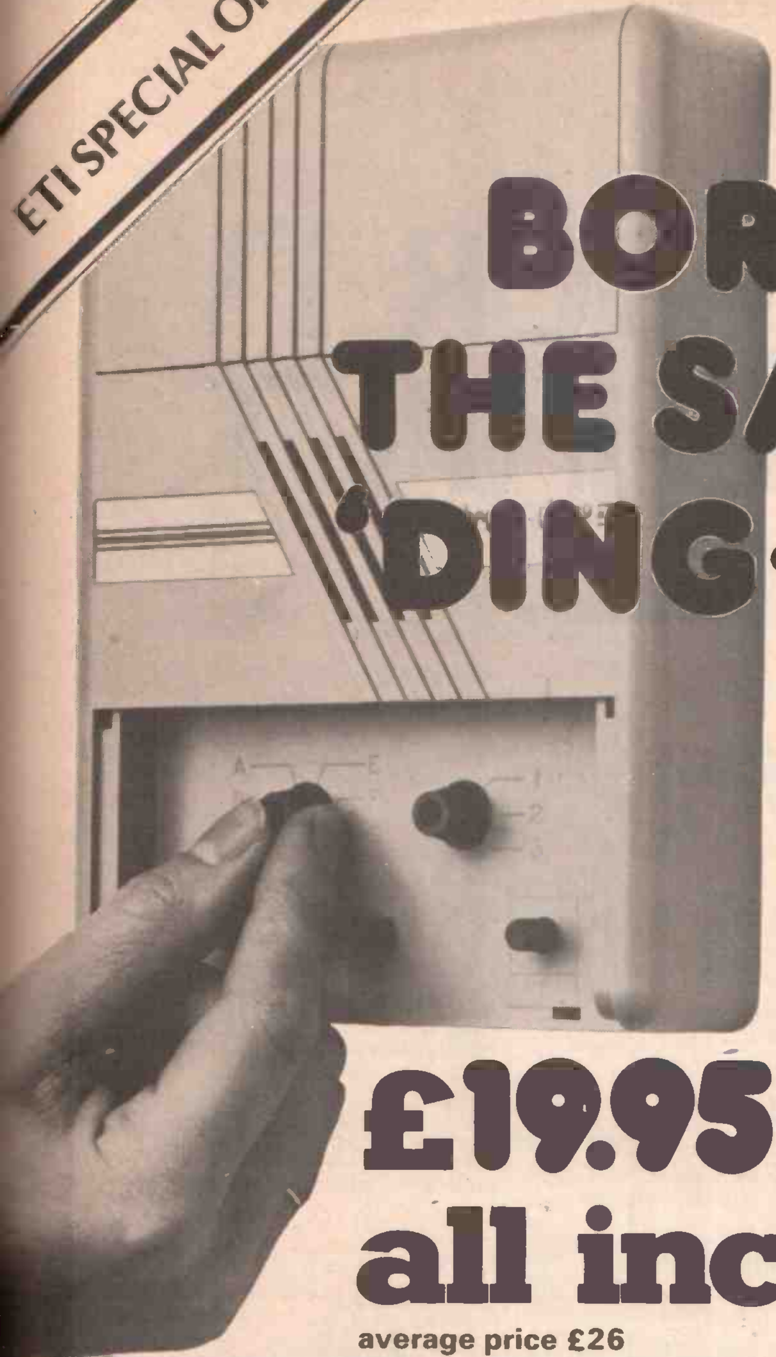

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# MODIFY YOUR TV FOR VIDEO INPUT

**How to turn your isolated TV into an MPU terminal**

THIS ARTICLE GIVES SOME HINTS on how to modify a normal television receiver so that a signal can be fed directly into the video circuit. This enables you to use your TV for video games or other video displays without needing to use an RF modulator.

Besides the obvious reduction of cost and complexity, the use of a direct video connection has the advantage of higher resolution. A good RF modulator is quite a complex device and because of the UHF signals it must handle, it calls for special construction techniques.

Once modified for external video input, the receiver can be used for a variety of experiments. It can be used with the VDU section of the microcomputer terminal that has recently appeared in ETI, or as a simple video monitor for black and white TV cameras. (For colour TV use much more elaborate circuitry would be required to ensure the required bandwidth and phase characteristics).

## Normal Receiver Operation

Figure 1 is a block diagram of the signal processing section of a normal TV set.

The signal from the antenna is a low level UHF signal of a few microvolts amplitude. The tuner outputs a signal at the receiver's intermediate frequency, which is amplified by the IF stages to give an RF signal of about 1·2 volts peak to peak amplitude. The detector rectifies the output of the IF amplifier, usually by means of a diode, in much the same way as a crystal set. The result is a composite video waveform — that is

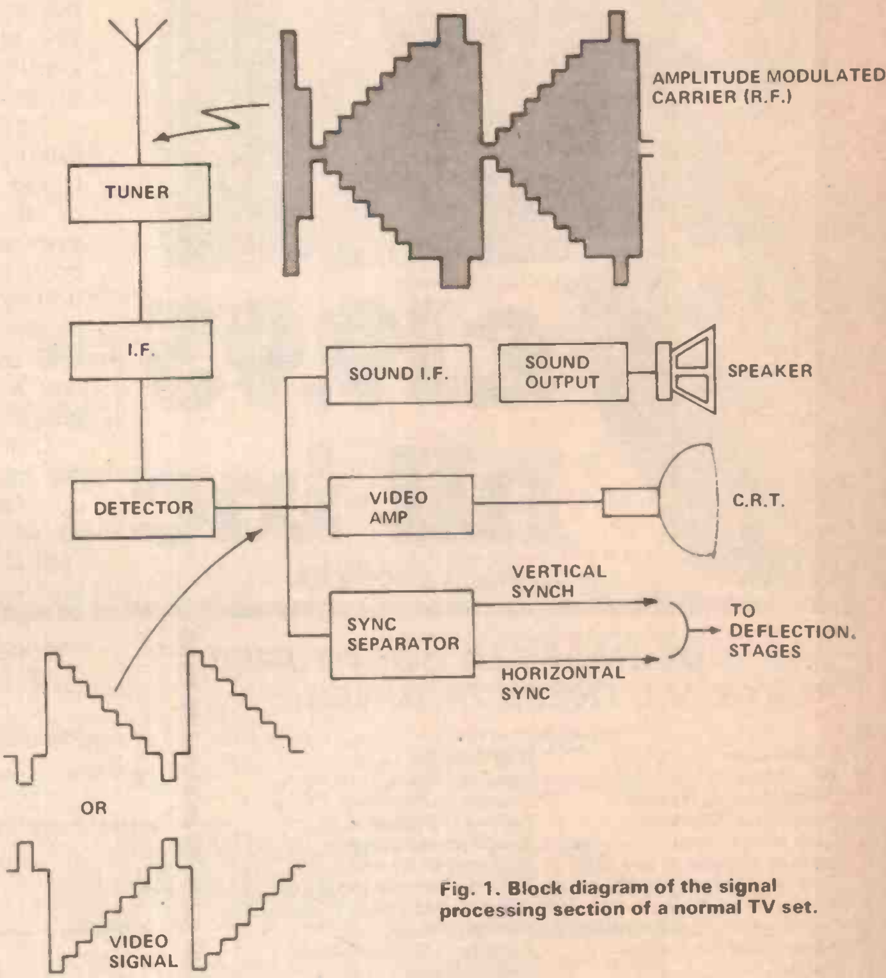



**Fig. 1. Block diagram of the signal processing section of a normal TV set.**

a waveform containing both picture and synchronising information. In addition, the 5.5 MHz sound carrier is usually extracted at the video detector.

This waveform would result from reception of a "staircase" test signal, which consists of a number of vertical bars ranging in greyscale from white to black. The output from the detector looks something like the waveform shown in Fig. 2(b). In this example it is assumed that the detector diode is configured so as to produce a more positive output with an increase in carrier amplitude.

The video amplifier provides a signal of sufficient amplitude for modulating the brightness of the dot displayed by the CRT.

The sync separator detects when the video signal reaches its maximum excursion, which corresponds to sync level. The horizontal and vertical sync pulses are then extracted from this composite sync signal and fed to the deflection circuitry.

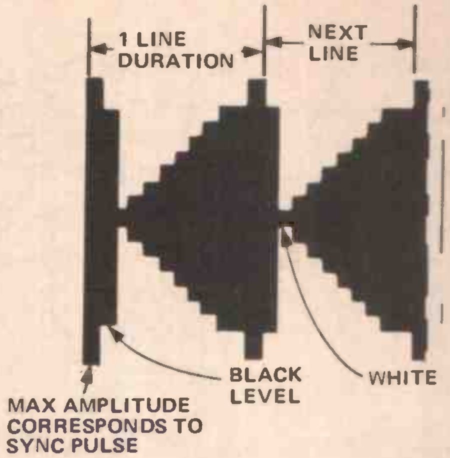



Fig. 2a. R.F. envelope before detection.

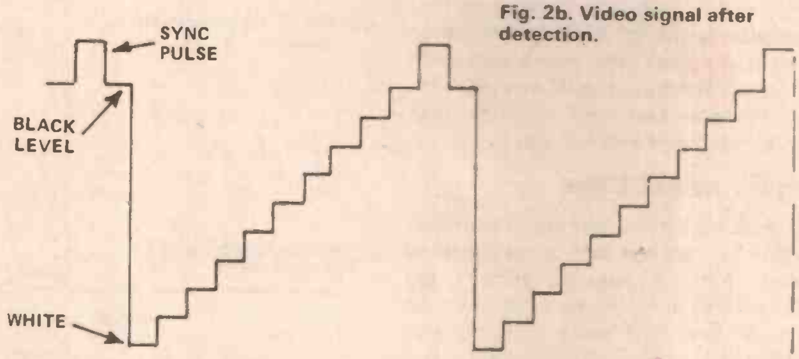



Fig. 2b. Video signal after detection.

## Format

In England the vision information is put onto the radio wave at the TV transmitter using negative amplitude modulation. This means that the brighter the picture element is, the less the carrier amplitude. Maximum carrier amplitude corresponds to the sync pulses, minimum corresponds to white, and black level lies somewhere in between. The signal at the output of the IF amplifier therefore looks something like Fig. 2(a).

## Requirements

The universally adopted standard for "line level" video is 1 volt peak-to-peak into 75 ohms positive-going (more positive means greater brightness). Most video games and the Video Display Unit in the ETI microcomputer terminal project provide such a video output suitable for feeding directly into a monitor or modified receiver. Alternatively an RF modulator can be used to generate a signal suitable for feeding into the TV set via the antenna terminals for viewing on a vacant TV channel. This latter alternative means that the video signal is modulated and then demodulated which can degrade the picture quality unless the modulator is carefully designed.

In many cases it is simpler to modify the TV set than build a modulator. The receiver can be fitted with a changeover switch which can be used to return it to normal reception when required, or an old black and white set can be butchered specifically for the job. In view of the low cost of second hand black and white sets it may be preferable to persue the latter course rather than strain family relationships by dissecting the new telly.

The modification involves feeding in the video signal where the detector normally goes. The input should be via a 75 ohm coaxial connector and it must present a 75 ohm terminating impedance to the source. In most cases a certain amount of additional circuitry will be required to match the 75 ohm, 1 V positive input to the impedance, amplitude and polarity required by the video stages of the receiver.

## Before You Start

There are several important factors to consider before attempting the modification. Before you start check these points:

1 The TV must not be of the "hot chassis" type. These receivers do not use a transformer to isolate the works from the mains. In many cases one side of the mains connects directly to the chassis of the set. Check that the chassis is securely grounded via the power cord and that the power supply section does not use an isolating transformer. "Hot chassis" sets are not suitable for modifications. Moreover they are potentially lethal and should be left alone.

2 Unless you are sure about what's in your TV set you will need a circuit diagram of the chassis. These can be obtained from the manufacturers or their service departments.

3 Don't attempt the modification unless you are quite confident you know what you are doing. This is not meant to discourage the adventurous hobbyist spirit, but if you rush in without sufficient knowledge you could wind up with a smouldering wreckage where once your TV stood (or where you yourself stood).

## Finding The Right Spot

The first task is to locate the video detector stage. This will often be ▷

labelled on the circuit diagram, but if it is not it can be found by following the circuit starting from the tuner. There will be a couple of stages of IF amplification followed by a detector in the form of a diode or, in more recent sets, part of an integrated circuit. Figure 3 shows a simplified diode detector stage. With the diode this way around, the recovered video waveform will be positive going, as shown. If the diode were reversed, an inverted video waveform would be present.

In some receivers the video detection and pre-amplification are accomplished by an integrated circuit. If the sync separator is internal to the IC you should look for a different receiver to modify as it may not be possible to find a suitable point to feed in the video signal. If the sync separator occurs after the IC you can treat the IC as a glorified diode detector and feed the video into the first transistor video stage.

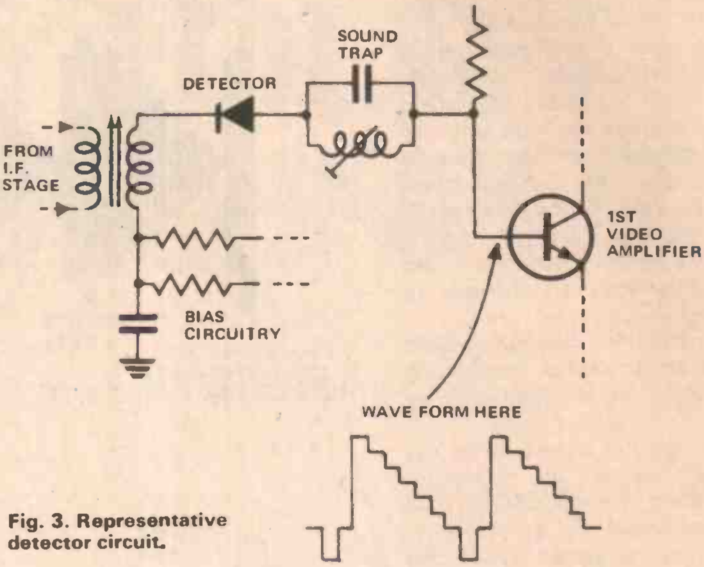



**Fig. 3. Representative detector circuit.**

## The Simplest Case

If you are lucky the first video amplifier in your TV receiver will be designed to operate with a negative-going video signal of about 1 volt peak to peak. In this case very little extra circuitry will be required to modify the set. The simple arrangement shown in Fig. 4 will probably suffice.

The change-over switch SW1 selects an internal or external source of video for the 1st video amplifier transistor. When switched to *external* base bias for Q1 is provided by RV1 and R1. RV1 provides a large range of adjustment so that the DC level at the base of Q1 can be matched to the level present when the receiver is operating normally. Capacitor C1 provides DC isolation and R2 presents the required 75 ohm impedance to the coaxial video input.

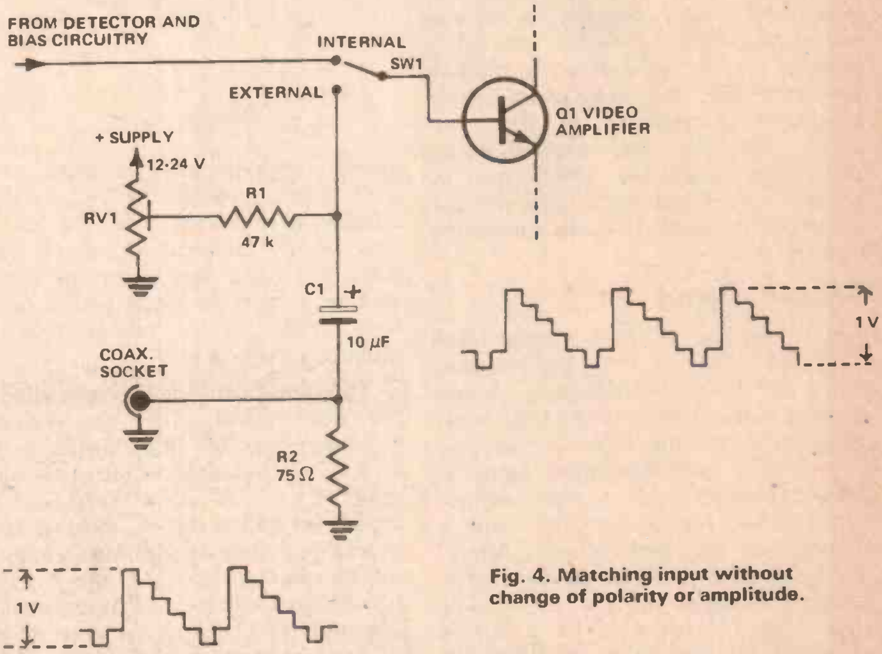



**Fig. 4. Matching input without change of polarity or amplitude.**

## Input Buffering

In some cases the 1 volt video input will not be of sufficient amplitude to drive the video stages fully. Figure 5 shows the circuit of a simple non-inverting amplifier which will bring the input amplitude up to a suitable level.

Q1 is wired in common-base configuration which provides the low impedance input required and does not invert the signal. RV1 allows adjustment of the amplitude from 1 volt to 3 volts P-P. Once again, RV2 is provided for bias adjustment. The polarity of C2 will be determined by the relative settings of RV1 and RV2.

## Inverting Buffer

If the receiver requires a positive-going video input, means must be provided for inverting the external video input. Depending on the exact requirements of the particular TV receiver in question, it may also be necessary to provide some gain as well.

Figure 6 shows a simple circuit which fulfills these requirements.

The gain is adjustable from 1 to 3 by means of VR2. VR1 adjusts the bias on the following stage of video amplification.

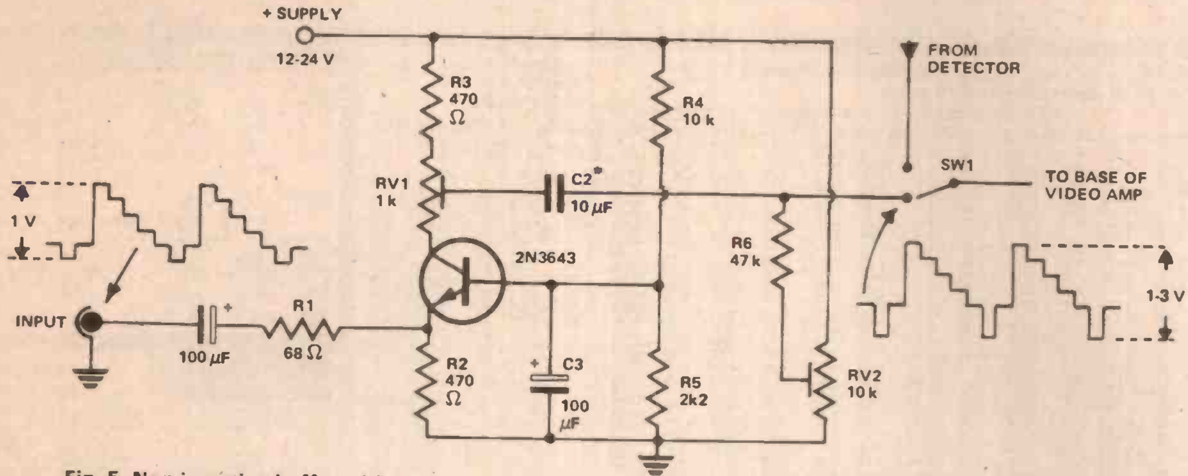



Fig. 5. Non-inverting buffer with gain.

*10uF is electrolytic — polarity is determined by setting of RVI

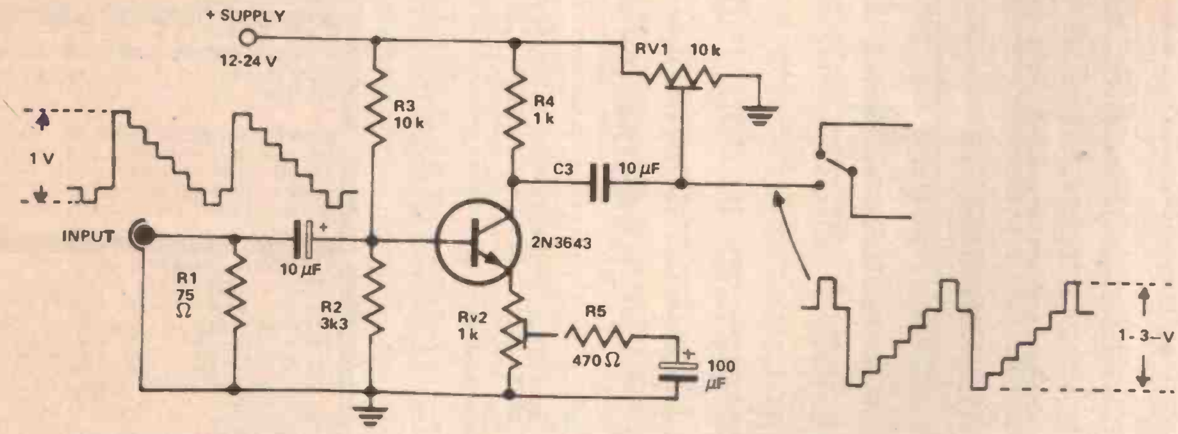
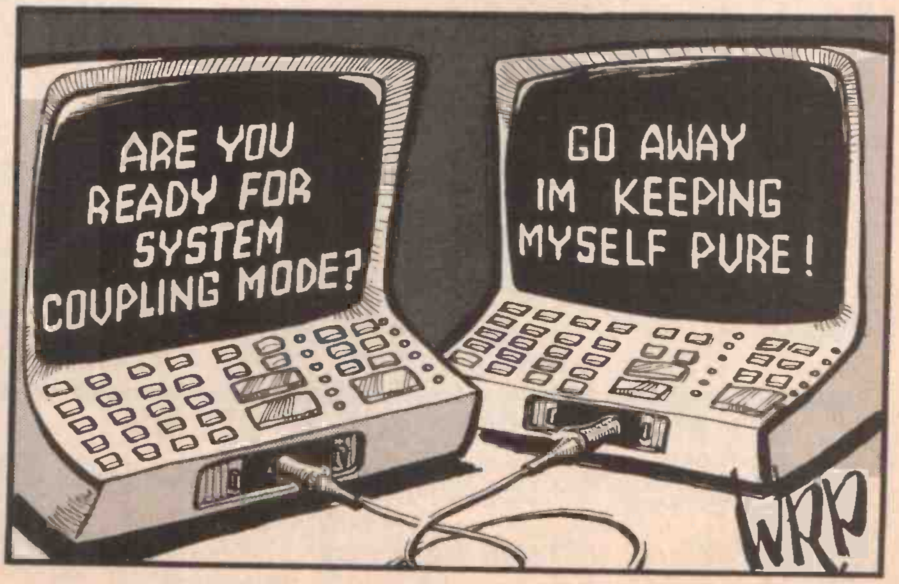



Fig. 6. Inverting buffer with gain.

## Finishing Off

With a little experimentation a suitable circuit can be developed using the above hints as guidelines. Keep the wiring to the switch as short as possible. Mount a coaxial connector on the rear panel of the TV set for the external input.

The modern standard for video connectors is the "BNC" type, although there is still a lot of equipment using the more cumbersome "VHF" type (also known as a PL-259). A much cheaper alternative is the "Belling and Lee" coaxial connector commonly used at the antenna input connection of colour TV sets. □



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| 2N698 | 0.62 | 2N3705 | 0.15 | 40362 | 0.55 | BC161 | 0.35 | BD132 | 0.54 | BFX88 | 0.30 |
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| 2N706A | 0.28 | 2N3708 | 0.13 | 40407 | 0.52 | BC169 | 0.12 | BD137 | 0.38 | BFY51 | 0.25 |
| 2N708 | 0.28 | 2N3709 | 0.15 | 40408 | 0.75 | BC170 | 0.18 | BD138 | 0.38 | BFY52 | 0.30 |
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| 2N2222 | 0.25 | 2N4058 | 0.20 | AF125 | 0.65 | BC251 | 0.16 | BF166 | 0.40 | MJE3055 | 0.95 |
| 2N2222A | 0.25 | 2N4059 | 0.15 | AF126 | 0.65 | BC253 | 0.22 | BF167 | 0.35 | MP8111 | 0.35 |
| 2N2368 | 0.25 | 2N4060 | 0.20 | AF139 | 0.69 | BC257A | 0.17 | BF173 | 0.35 | MP8112 | 0.40 |
| 2N2369 | 0.25 | 2N4061 | 0.17 | AF186 | 0.50 | BC258A | 0.17 | BF177 | 0.25 | MP8113 | 0.45 |
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| CA3030 | 1.35 | LM1828 | 1.75 | TAA661B | 1.50 |
| CA3030A | 2.00 | LM3301N | 0.85 | TAA700 | 3.91 |
| CA3045 | 1.40 | LM3302N | 1.40 | TAA930A | 1.30 |
| CA3046 | 0.89 | LM3401 | 0.70 | TAA930B | 1.30 |
| CA3048 | 2.23 | LM3900 | 0.75 | TAD100 | 1.95 |
| CA3049 | 1.80 | LM3905 | 1.60 | TBA120 | 0.75 |
| CA3050 | 2.42 | LM3909 | 0.68 | TBA400 | 2.00 |
| CA3053 | 1.62 | MC1035 | 1.75 | TBA500 | 2.21 |
| CA3080 | 0.75 | MC1303 | 1.03 | TBA500Q | 2.30 |
| CA3080A | 1.88 | MC1304 | 1.40 | TBA510 | 2.21 |
| CA3086 | 0.60 | MC1305 | 1.40 | TBA510Q | 2.30 |
| CA3088 | 1.70 | MC1310 | 1.91 | TBA520 | 2.21 |
| CA3089 | 2.52 | MC1327 | 1.54 | TBA520Q | 2.30 |
| CA3090 | 4.00 | MC1330 | 1.00 | TBA530 | 1.98 |
| CA3130 | 0.98 | MC1350 | 0.90 | TBA530Q | 2.07 |
| LM301A | 0.67 | MC1351 | 1.20 | TBA540 | 2.21 |
| LM301N | 0.40 | MC1352 | 1.10 | TBA540Q | 2.30 |
| LM304 | 2.45 | MC1458 | 0.91 | TBA550 | 3.13 |
| LM307N | 0.65 | NE555 | 0.40 | TBA550Q | 3.22 |
| LM308C | 1.82 | NE556 | 1.10 | TBA560Q | 3.22 |
| LM308N | 0.85 | NE565 | 1.30 | TBA570 | 1.29 |
| LM309K | 1.85 | NE566 | 1.65 | TBA570Q | 1.38 |
| LM317K | 3.00 | NE567 | 1.80 | TBA641B | 2.70 |
| LM318N | 2.26 | SAS560 | 2.50 | TBA651 | 2.20 |
| LM323K | 6.46 | SAS570 | 2.50 | TBA700 | 1.52 |
| LM339N | 1.40 | S042P | 1.25 | TBA700Q | 1.61 |
| LM348N | 1.50 | 76001N | 1.30 | TBA720Q | 2.30 |
| LM360N | 2.75 | 76003N | 2.20 | TBA750 | 1.98 |
| LM370N | 2.50 | 76008K | 1.50 | TBA750Q | 2.07 |
| LM371N | 1.70 | 76013N | 1.50 | TBA800 | 1.25 |
| LM372N | 1.70 | 76013ND | 1.30 | TBA810 | 1.25 |
| LM373N | 2.80 | 76018K | 1.50 | TBA820 | 1.25 |
| LM374N | 3.10 | 76023N | 1.45 | TBA920 | 2.90 |
| LM377N | 1.75 | 76023ND | 1.26 | TBA920Q | 2.99 |
| LM378N | 2.25 | 76033N | 2.20 | TBA940 | 1.62 |
| LM379S | 3.95 | 76110N | 1.18 | TCA160C | 1.85 |
| LM380-8 | 0.90 | 76115N | 1.51 | TCA160B | 1.61 |
| LM380N | 0.98 | 76116N | 1.66 | TCA270 | 2.25 |
| LM381A | 2.45 | 76131N | 1.20 | TCA280A | 1.30 |
| LM381N | 1.60 | 76226N | 1.56 | TCA290A | 3.13 |
| LM382N | 1.25 | 76227N | 1.20 | TCA420A | 1.84 |
| LM384N | 1.45 | 76228N | 1.41 | TCA730 | 3.22 |
| LM386N | 0.80 | 76530N | 0.75 | TCA740 | 2.76 |
| LM387N | 1.05 | 76532N | 1.40 | TCA750 | 2.30 |
| LM388N | 0.90 | 76533N | 1.20 | TCA760 | 1.38 |
| LM389N | 1.00 | 76544N | 1.44 | TCA800 | 3.13 |
| LM702C | 0.75 | 76545N | 1.65 | UAA170 | 2.00 |
| LM709C | 0.65 | 76546N | 1.44 | UAA180 | 2.00 |
| LM709N | 0.45 | 76550N | 0.35 | OIL | |
| LM710C | 0.60 | 76552N | 0.52 | SOCKETS | |
| LM710N | 0.60 | 76570N | 1.65 | 8 PIN | 0.15 |
| LM723C | 0.85 | 76620N | 0.90 | 14 PIN | 0.16 |
| LM723N | 0.75 | 76650N | 1.10 | 16 PIN | 0.18 |
| LM741C | 0.65 | 76660N | 0.60 | 22 PIN | 0.30 |
| LM741N | 0.40 | 76666N | 0.92 | 24 PIN | 0.35 |
| LM741-8 | 0.40 | TAA320A | 1.00 | 28 PIN | 0.45 |
| LM747N | 0.90 | TAA350A | 2.48 | 40 PIN | 0.55 |

## MICROPROCESSOR COMPONENTS

**RAMS**

| | |
|---|---|
| 2101-2N | 3.00 |
| 2102-2N | 2.10 |
| 2111-2N | 3.00 |
| 2112-2N | 3.00 |
| 74C920D | 12.57 |

**TRISTATE BUFFERS**

| | |
|---|---|
| DM81LS95 | 1.45 |
| DM81LS96 | 1.45 |
| DM81LS97 | 1.45 |
| DM81LS98 | 1.45 |

**2102.2N RAM** £1.93 for 25 pcs

**ROMS**

| | |
|---|---|
| MM5214 | 26.95 |

**PROMS**

| | |
|---|---|
| 74S287 | 5.33 |
| MM5204 | 10.50 |
| 1702AQ | 10.80 |
| 2708Q | 35.00 |

**SC/MP**

**8080A 8 BIT MICROPROCESSOR FAMILY**

| | | |
|---|---|---|
| INS8080A | N Channel 40 Pin | £23.45 |
| DP8224N | Clock Generator | £6.16 |
| DP8228D | System Controller | £7.30 |
| DP8212N | 8 Bit Port | £3.08 |
| 1SP-8A/500D | SC/MP CPU chip | £12.00 |
| 1SP-8A/600N | N-channel CPU chip | £10.00 |


## CLOCK MODULES DIGITAL

Built and tested — requires only switches and transformer to complete. 12 or 24hr alarm modules

| | |
|---|---|
| MA1002F 12hr. 5" display | £10.90 |
| MA1002H 24hr. 5" display | £10.90 |
| MA1010E 12hr. 84" display | £14.50 |
| MA1010G 24hr. 84" display | £14.50 |

**CAR CLOCK MODULE**

MA1003 Built and tested 12v supply and four-digit module. Crystal controlled £17.00
Data Sheet 5p + SAE

NATIONAL

"What is a microprocessor?" — a complete teach yourself course with cassettes + brochure £9.95 incl. VAT & p&p

**NEW SC/MP RETROFIT KIT**
Now available from stock this new SC/MP/II Retrofit which enables existing SC/MP Intro Kit users to evaluate the new SC/MP/II Microprocessor £18.40 excl. VAT p&p 75p.

**TRIACS** Plastic pack 400V

| | | | |
|---|---|---|---|
| 6 amp | 0.70 | 16 amp | 1.10 |
| 8 amp | 0.75 | 20 amp | 1.70 |
| 12 amp | 0.85 | 25 amp | 2.00 |

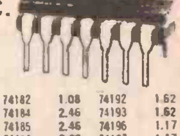
**THYRISTORS** Plastic C106/116

| | | | | | |
|---|---|---|---|---|---|
| 4 amp 100V | 0.35 | 8 amp 100V | 0.43 | 12 amp 100V | 0.57 |
| 4 amp 200V | 0.40 | 8 amp 200V | 0.49 | 12 amp 200V | 0.65 |
| 4 amp 400V | 0.49 | 8 amp 400V | 0.62 | 12 amp 400V | 0.81 |

**VOLTAGE REGULATORS**

| | |
|---|---|
| 500MA TO202 positive 5, 12, 15, 24V | 1.10 |
| 500MA TO202 negative 5, 12, 15, 24V | 1.05 |
| 1 amp TO220 positive 5, 12, 15, 24V | 1.35 |
| 1 amp TO220 negative 5, 12, 15, 24V | 2.85 |

## TTL FROM NATIONAL, ITT, TEXAS, SIGNETICS, ETC.



| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7400 | 0.16 | 7412 | 0.21 | 7438 | 0.55 | 7460 | 0.21 | 7485 | 1.85 | 74118 | 0.90 | 74160 | 1.41 | | | | |
| 7401 | 0.16 | 7413 | 0.51 | 7440 | 0.21 | 7470 | 0.46 | 7486 | 0.41 | 74119 | 1.80 | 74161 | 1.41 | | | | |
| 7402 | 0.16 | 7414 | 1.80 | 7441 | 1.03 | 7472 | 0.38 | 7490 | 0.61 | 74121 | 0.49 | 74162 | 1.41 | | | | |
| 7403 | 0.16 | 7416 | 0.61 | 7442 | 0.78 | 7473 | 0.43 | 7491 | 0.98 | 74122 | 0.45 | 74163 | 1.41 | | | | |
| 7404 | 0.26 | 7417 | 0.61 | 7445 | 1.35 | 7474 | 0.43 | 7492 | 0.61 | 74123 | 0.58 | 74164 | 1.23 | | | | |
| 7405 | 0.26 | 7420 | 0.21 | 7446 | 1.23 | 7475 | 0.58 | 7493 | 0.61 | 74141 | 1.03 | 74165 | 1.23 | 74182 | 1.08 | 74192 | 1.62 |
| 7406 | 0.74 | 7423 | 0.39 | 7447 | 1.17 | 7476 | 0.51 | 7494 | 0.74 | 74145 | 1.06 | 74167 | 3.70 | 74184 | 2.46 | 74193 | 1.62 |
| 7407 | 0.74 | 7425 | 0.39 | 7448 | 1.17 | 7480 | 0.45 | 7495 | 0.78 | 74151 | 1.11 | 74174 | 1.52 | 74185 | 2.46 | 74196 | 1.17 |
| 7408 | 0.29 | 7427 | 0.39 | 7450 | 0.29 | 7481 | 1.10 | 7496 | 1.03 | 74153 | 1.11 | 74175 | 1.35 | 74188 | 2.00 | 74197 | 1 17 |
| 7409 | 0.29 | 7430 | 0.21 | 7451 | 0.21 | 7482 | 0.67 | 7497 | 4.60 | 74154 | 1.85 | 74176 | 1.23 | 74189 | 3.99 | 74198 | 2.93 |
| 7410 | 0.21 | 7432 | 0.39 | 7453 | 0.21 | 7483 | 1.33 | 74100 | 1.15 | 74155 | 1.11 | 74180 | 1.77 | 74190 | 1.91 | 74199 | 2.93 |
| 7411 | 0.29 | 7437 | 0.55 | 7454 | 0.21 | 7484 | 0.85 | 74107 | 0.43 | 74157 | 0.98 | 74181 | 3.70 | 74191 | 1.91 | | |

**OPTO ELECTRONICS**
Full range of Opto devices in our New Catalogue
LEDS TIL209 0.12 100 + pcs
3mm Red 0.18 Green 0.25 Yellow 0.25
5mm Red 0.21 Green 0.26 Yellow 0.25
Many more types — listed in our new catalogue — Solar cells, light switches, etc.

**DISPLAYS** 7 Segment

| | Single | Double | Display |
|---|---|---|---|
| DL704 | 2.00 | 3.00 | .3" Red |
| DL707 | 2.00 | 3.00 | .3" Red |
| DL747 | 2.50 | 3.40 | .5" Red |
| DL750 | 2.50 | 3.40 | .5" Red |

**CMOS & LOW POWER SCHOTTKY**

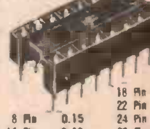
| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CD4000 | 0.24 | CD4018 | 1.15 | CD4041 | 0.96 | CD4059 | 5.45 | CD4081 | 0.25 | 74LS02 | 0.24 | 74LS138 | 1.27 |
| CD4001 | 0.24 | CD4019 | 0.70 | CD4042 | 0.96 | CD4060 | 1.27 | CD4082 | 0.25 | 74LS04 | 0.27 | 74LS151 | 1.13 |
| CD4002 | 0.24 | CD4020 | 1.27 | CD4043 | 1.15 | CD4063 | 1.25 | CD4085 | 0.81 | 74LS08 | 0.24 | 74LS157 | 1.17 |
| CD4006 | 1.34 | CD4021 | 1.15 | CD4044 | 1.06 | CD4066 | 0.80 | CD4086 | 0.81 | 74LS10 | 0.24 | 74LS160 | 1.40 |
| CD4007 | 0.24 | CD4022 | 1.10 | CD4045 | 1.59 | CD4067 | 4.25 | CD4089 | 1.77 | 74LS13 | 0.65 | 74LS161 | 1.50 |
| CD4008 | 1.10 | CD4023 | 0.24 | CD4046 | 1.52 | CD4068 | 0.25 | CD4093 | 0.91 | 74LS32 | 0.25 | 74LS162 | 1.50 |
| CD4009 | 0.64 | CD4024 | 0.84 | CD4047 | 1.15 | CD4069 | 0.25 | CD4094 | 2.13 | 74LS42 | 1.01 | 74LS163 | 1.50 |
| CD4010 | 0.64 | CD4025 | 0.24 | CD4049 | 0.64 | CD4070 | 0.66 | CD4095 | 1.19 | 74LS74 | 0.48 | 74LS164 | 1.52 |
| CD4011 | 0.24 | CD4027 | 0.64 | CD4050 | 0.64 | CD4071 | 0.25 | CD4096 | 1.19 | 74LS75 | 0.60 | 74LS173 | 2.35 |
| CD4012 | 0.24 | CD4028 | 1.02 | CD4051 | 1.06 | CD4072 | 0.25 | CD4510 | 2.00 | 74LS76 | 0.40 | 74LS174 | 1.20 |
| CD4013 | 0.60 | CD4029 | 1.30 | CD4052 | 1.06 | CD4073 | 0.25 | CD4511 | 2.30 | 74LS85 | 1.45 | 74LS175 | 1.20 |
| CD4014 | 1.15 | CD4030 | 0.64 | CD4053 | 1.06 | CD4075 | 0.25 | CD4516 | 2.00 | 74LS86 | 0.48 | | |
| CD4015 | 1.15 | CD4031 | 2.53 | CD4054 | 1.32 | CD4076 | 1.17 | CD4518 | 2.00 | 74LS90 | 1.00 | | |
| CD4016 | 0.64 | CD4035 | 1.34 | CD4055 | 1.50 | CD4077 | 0.66 | CD4520 | 2.00 | 74LS92 | 0.90 | | |
| CD4017 | 1.15 | CD4037 | 1.10 | CD4056 | 1.50 | CD4078 | 0.26 | 74LS00 | 0.24 | 74LS107 | 0.44 | | |

**74LS**

**74C MOS**

| | | | |
|---|---|---|---|
| 74C00 | .26 | 74C85 | 1.90 |
| 74C02 | .26 | 74C86 | .68 |
| 74C04 | .26 | 74C90 | .91 |
| 74C08 | .26 | 74C107 | 1.30 |
| 74C10 | .26 | 74C151 | 2.62 |
| 74C20 | .26 | 74C157 | 2.35 |
| 74C30 | .26 | 74C160 | 1.18 |
| 74C32 | .26 | 74C161 | 1.18 |
| 74C42 | .92 | 74C162 | 1.18 |
| 74C48 | 2.30 | 74C163 | 1.18 |
| 74C73 | .58 | 74C164 | 1.04 |
| 74C74 | .59 | 74C173 | .95 |
| 74C76 | .58 | 74C174 | .95 |

**LOW PROFILE SKTS**



| | | | |
|---|---|---|---|
| | | 18 Pin | .27 |
| | | 22 Pin | .30 |
| 8 Pin | 0.15 | 24 Pin | .35 |
| 14 Pin | 0.16 | 28 Pin | .45 |
| 16 Pin | 0.18 | 40 Pin | .55 |

Telephone orders with credit cards — £10 minimum

## MICROPROCESSOR SYSTEMS

**SC/MP INTROKIT** £68.61 exc. VAT
Budget introduction to SC/MP microprocessing — Board, CPU, Memories, Crystal, etc. Built-in debugging. Complete with explanatory data and applications — National Semiconductors.

**KEYBOARD KIT** £65.84 exc. VAT
Budget VDU for Teletype substitute, the calculator type keyboard provides manual I/O commands to Introkit. Full instruction and data supplied with each kit. Complete kit easily mates with cassette recorder.

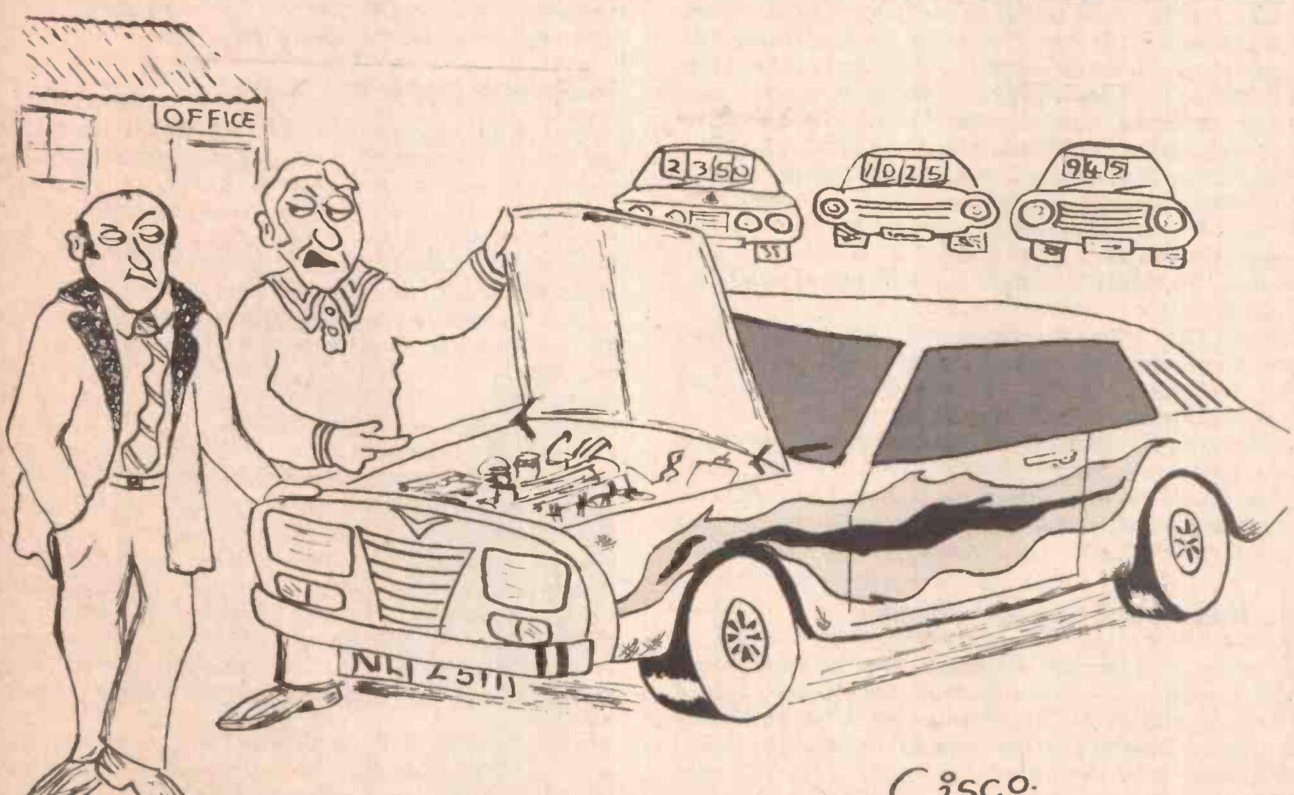
**SC/MP**

DATA PACK £1.50
46 instruction set
8 bit tristate bus I/O
12 bit tristate address
512 bytes rom
256 bytes ram

**NEW FROM MOTOROLA 6800**

A build-it-yourself microcomputer designed around the Motorola M6800 Family.
Kit contains CPU (MC6800), 256 x 8 RAM (2 x MCM6810 AP), 2 x P.I.A. (MC6820), 1 x ACIA (MC6850), Hex-Keyboard, Hex-display interface to audio cassette, plus all additional components. Easily expanded. Single 5V supply needed. 72 basic instructions.

**D2 KIT** £190 +VAT




"So the little old lady, who used it once a week to go to Church, built the transistor ignition then?"

# ELECTRONICS

**John Miller-Kirkpatrick reminisces about Electronics Tomorrow, and puts his crystal MPU on line**

It all started when the phone rang and ETI gave me the the news about this publication you are reading. "Thought you might like to write a couple of pages for it", said the voice, "sort of look through the back issues and do a review or something?" This is the sort of opportunity no author can afford to miss, being asked to write a two page review of your own work.

As a regular feature article 'Electronics Tomorrow' has been quite an innovator of new ideas, some of which have since become products, others which may still be a little difficult to see as your next Christmas present. Some of the ideas rubbed off onto ETI itself — one example being the first of the now regular special offers in ETI Aug 73. That was for a pair of LED lamps, one green and one red at £1.10. It may not sound like much of an offer at today's prices but it was the first of a range of special offers which has subsequently resulted in some special issues with 20 or more offers per issue.

The policy statement made in that first Electronics Tomorrow still stands, "It is intended to be more than a product review in as much as we hope to give short constructional examples of some of the products, this approach gives a better insight to the capabilities of the product than one gets with just a data sheet." Since then we have reviewed many new products and put forward some rather mind bending applications and ideas while hopefully making the article amusing and educational.

In 1974 some of the subjects were—

January: The 556 dual timer, then a very new device, now commonplace.

February: The MM5371 alarm clock chip and new 0.6" LED display.

March: CT6002 liquid crystal drive CMOS clock chip, the first of the digital watch chips.

April: A battery charger using a 555 and the new LM3900 quad Amp.

July: How to use a calculator as an MPU, now its how to use a calculator *with* an MPU!

October: What to do during those long winter nights.

November: Variable speech control and an upside-down calculator problem.

## The Inebriated Reporter Saga

We started 1975 with a futuristic horror story about super-automation with computers which were capable of building and controlling themselves. A bit far fetched perhaps, but not impossible. March 75 brought digital FM tuners, done the hard way — with TTL. This was followed by complex counter chips, 'Time on TV' display chips, a cassette recording system, a few stopwatch chips, and a self controlling hair curler. My favourite article during 1975 must be the October 'Tank Fight', not so much from the obvious literary talent displayed but more from the joy of sinking several pints whilst collecting data for the article — my thanks to the landlord for ignoring the hysterical laughter coming from the corner with the TV tank game.

The new year brought forth the 'Black Watch kit', an add-on calculator programmer, the first low cost clock module and the start of two sagas. The first saga was the seven segment to BCD conversion problem for which I received and am still receiving lots of clever solutions, one obvious solution was to input data into an MPU as seven segment data and let the MPU do the conversion. The second saga started in May 1976 with the idea of including an MPU in a Teletext system (or vice-versa), I understand that Texas Instruments now have a version of TIFAX for just that application!

A similar saga also started about that time, the problem of getting your MPU to use a calculator chip, the latest device is the MM57109 — a calculator chip specifically designed to do the job.

## More and More and More

It is a little obvious that 1976 was the year that I became very interested in microprocessors with the year ending up with more teletext plus MPU plus cassettes plus calculators plus low cost direct-access devices. This must have started some brains ticking because ever since then I have been receiving letters with comments, ideas and tales of resultant systems.

It is my experience from letters like these and from past experience that there was a lot of interest in calculators at £80 in 1974, in 1975 it was in £100+ digital watches, 1976 saw £200 VDU systems and teletext interest and 1977 has seen a lot of interest in £500 MPU systems. In each of the first three examples the products became almost household items with corresponding price drops to give the £5 calculator, £20 watch and £150 Teletext decoder. This should mean that 1978 will bring us the home computer for games, household accounts, diary, etc for about £200. Already several manufacturers are producing MPU systems for business use at £3,000 odd with a very small simple version at about £1,000, with an MPU kit on sale at under £50 in November 1977 what will prices be like in 1978?

Having started a forecast for 1978 in the amateur and consumer electronics market perhaps I should continue in the same vein. Having had several lucky guesses committed to print in Electronics Tomorrow I

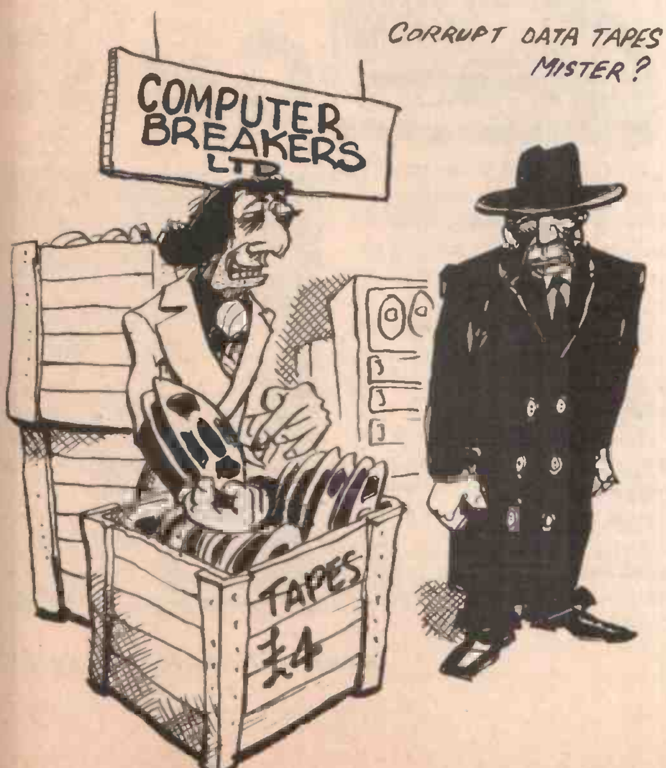
# YESTERDAY

feel that a few more suggestions might also work out in the same way.

First of all obviously, microcomputers. By Christmas 78 you should be able to buy a unit consisting of a typewriter keyboard, MPU plus memory, interface to TV and cassette recorder for under £200. It will talk to you in BASIC, one of the simplest possible programming languages and will allow you to play very complex games far into the night — goodbye 'Monopoly', hello 'Star Trek'.

Of course this is not the only form in which you can use MPUs for fun, already there are several MPU based board games for sale at Christmas 77, the first of these use a calculator style MPU to control games similar to 'Battleships', 'Campaign' and other 'strategy' rather than luck games. This type of unit will also see a new industry spring up in the form of a 'Game of the Month Club', supplying new programs for old board games. With all of these board and TV games around you are going to have to start talking to your neighbours again, if TV was the death of the art of conversation perhaps MPUs can cause the rebirth.

The use of MPU chips in games applications leads on to their use in teaching, training and overcoming disabilities. The MPU can cover the same training ground repetitively at any time of day or night and can be programmed to lead a student at the correct rate and in the right direction. If it doesn't sound too harsh, MPUs could be used as a substitute for 'electric shock' training or correction techniques. First you catches your rat, then you teach it BASIC insert, and then let it solve mazes the easy way!




The new style of MPU controlled cooker will be able to cook a complete Sunday meal, you just tell it the weight of your Sunday joint and vegetables, which cooking units they are on or in and what time you want to eat. It calculates the cooking time of each unit with any temperature changes necessary and works out what time to start each unit. The super de-luxe version also keeps a record of your favourite recipes and any changes you make to them. When this type of computer becomes commonplace (198?) it might also order your groceries from the supermarket computer thus allowing advance programming of a week's meals based on diet, seasonal availability and personal preferences. With the advent of little vacuum cleaners programmed to clean rooms whilst you are out, MPU based tomato watering systems and computer controlled dish and clothes washers you are going to need the MPU games to have something to do other than eat!

## Shops for Everything

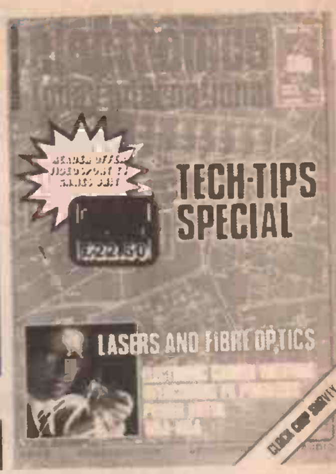
Electronic products are now finding a place in most homes, cars, offices and factories, within the next couple of years the consumer market will be flooded with more electronic gadgets, some useful and others useless. Many more people are now becoming interested in the various fringes of electronics as you do not have to have a knowledge of radio receivers to use TTL logic or MPUs or vice-versa. This decentralisation of electronics as a hobby is confirmed by the growth of specialist suppliers who tend to only stock components within their own specialisation. With the high rate of new technology on the whole electronics front this approach allows the supplier to hold large stocks of the specials without committing money and effort into another field of electronics. To the constructor it means that the supplier will probably be able to give a better and more detailed service than before. Your local electronics component shop will continue to supply basic standard components, kits and accessories for most constructional projects whereas the specialist supplier will stock components for the larger more complex projects.

If you are not a regular reader of ETI I hope that this article has given you some idea of what you are missing in just a couple of pages each month, just think what you are missing in the other 80 or so pages of ETI each month.

Electronics Tomorrow is put together each month with help from lots of people, I would like to take this opportunity of passing on my thanks for support. To my wife for patience and coffee, to manufacturers like National and GIM for new data and products, to Halvor and Co for editing and publishing, to readers and personal friends for ideas and inspiration, and to Bywood for the time.

□






# Gaps?




# Gaps?



# Gaps?

# Gaps?

It can be a nuisance can't it, going from newsagent to newsagent? "Sorry squire, don't have it - next one should be out soon."

Although ETI is monthly, it's very rare to find it available after the first week. If it is available, the newsagent's going to be sure to cut his order for the next issue - but we're glad to say it doesn't happen very often.

Do yourself, your newagent and us a favour. Place a regular order for ETI; your newsagent will almost certainly be delighted. If not, you can take out a postal subscription so there's nothing for you to remember - we'll do it for you.

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# THE SINCLAIR STORY

**Steve Braidwood and Halvor Moorshead travelled to Cambridge for this exclusive Electronics Tomorrow interview.**

**You may be surprised to learn that Clive Sinclair never went to university. When he left school he got a job as an editorial assistant on an electronics magazine, so from our common starting point he explained to us how he got where he is today (we couldn't understand why anyone would want to leave the fun world of electronics magazines . . . but apparently not all magazines are as much fun as ETI). We asked Clive why he didn't continue formal education after school:**

Because I'd already been writing articles on electronics when I was at school — electronics was my prime interest then — and I decided that a university degree wouldn't teach me what I wanted to know at the sort of rate I wanted to learn it. Primarily universities then, and still many today, taught electrical engineering rather than electronics.

**Clive learned by studying on his own, but it wasn't long before he was in business:** The company started by selling transistors — individual transistors which I bought from Plessey and tested (they were rejects). They were rejected because they didn't meet the computer-type specs, but they were perfectly satisfactory . . . **Are these the ones that you put your own number on?** Yes, that's right — MAT101s . . .

**That was 1961 and Clive was operating his mail-order business from his room in London. He was 21.**

Then I did a radio kit, a thing called the Slimline. That was the first one. **Was that the one in a full-page ad in PW?** Yes.

Then there was a very tiny little amplifier module, a thing called the Microamp. **A single-ended thing with a power transistor?** No, that came later. There was one even before that. But that's right, there was something called the TR750 — by that time though the company employed two people, three including myself.

## Biscuit Tin Amplifiers

**And then you went into the audio field?** Into hi-fi modules. **Wasn't there a device called the X10 that caused you some problems?** In the early days we had some problems with the transistors blowing up so we did a revised design, the X20, which was much more satisfactory.

But there was the problem, fundamentally, that they tended to radiate. If you kept them in a biscuit tin they weren't too bad, but otherwise they were a bit of a problem.

**In the early days the products were designed completely by Clive himself, there was no one else around. The X10 was a design that Clive got from another company, but when it caused problems he designed the X20 himself. After the X20 the company set about producing conventional amplifiers (the X10 and X20 were pulse-width modulation designs) starting with the Z12, a class-B design.**

We had just done the Z12 when we moved to Cambridge and then in Cambridge we started to widen the range of hi-fi modules. And from that we went into built hi-fi units. We started with the Neoteric 60 amplifier — it was black on the top with a rosewood front and gold or silver knobs.

## Enthusiastic Markets

**Sinclair is no longer in the hi-fi market. But he hasn't given up the electronics hobby-kit market, it is too closely associated with the way Clive thinks. Of Sinclair Radionics he says:** We're not basically very much in the business of the hobbyist these days. Sinclair Radionics are concerned with supplying the public in general on one hand, and specialists with instruments, on the other. **But a large part of Sinclair's market is comprised of hobbyists because, as Clive says,** we tend to make products that are interesting technically because I'm personally interested in the technology. I hope our products will always be of interest to electronics enthusiasts because they're of interest to me, but they won't always be aimed at that market any more than the pocket television which, although interesting to an electronics engineer or amateur electronics enthusiast, is of use to anybody.

**We asked Clive if he considered himself to be an enthusiast:** Yes, very much so. Not in the sense of wielding a soldering iron, because I have never particularly been interested in that aspect anyway. I'm much too interested in the theoretical side.

**It is the way that Clive involves himself personally in the development of the company's products that makes the company so exciting — to us and to Clive. But some people in the business world thought that Clive ought to be spending more time managing the company and taking fewer or lesser risks. But before looking at the state of Sinclair today, we'll return to the history of Sinclair Radionics.**

## The Amazing Executive

**The Sinclair Executive calculator was launched in 1972. It was the world's first truly hand-held electronic calculator and it was surprisingly easy for Sinclair to get into production, thanks to one very clever idea.** That was not a product that had been a long time in development — it was only about six months. One of the fastest developments we ever did!

I had always wanted to make calculators and it was the development of the single-chip that made it possible for us. And we did everything possible to get hold of it at the earliest possible time, then we moved rapidly into production.

**Was it the first single-chip calculator?** Yes. We weren't the first people to make one — a firm in the States made the calculator at the same time as us, or a bit earlier, using the same chip. What we did was to make a pocket calculator. Whereas theirs was a hand held calculator, ours was a pocket one. Because we had this power-saving circuitry: it cut the power consumption by about twenty times.

**How did you manage that?** We switched the chip on and off; off most of the time. The charges on the capacitors on the chip held the data. That's a technique we developed.

**So you discovered this when you got the chip into your lab?** No we didn't discover it . . . I had anticipated that this would be theoretically possible, and so I devised a circuit to do it which worked. And so we were able to make a very slim machine.

**But that was before the calculator boom. Then there was no demand.** It boomed because we caused it to boom. It wasn't there when we started and it was there when we advertised.

**And what about production probems?** It was horrendously difficult to make this product. We were making it ourselves and there were so many parts in such a small space.

**How many staff did you have at that time?** I'd say about sixty.

**From these beginnings Sinclair have become world-famous as calculator manufacturers: today the Cambridge programmable outsells all programmables and all scientifics.** ▷

## Measuring the Instrument Market

**Sinclair is also in the instrument field; he has been selling the DM2 digital multimeter for six years and is now the largest manufacturer of multimeters in Europe. In October he launched another digital multimeter, the PDM35. Clive expects that by the middle of 1978 his company will be the largest manufacturer (by number of units sold) of digital multimeters in the world (but there are more meters to be released this winter).**

**We asked John Nicholls, head of Sinclair's instrument division, if there were any other companies competing with Sinclair in the cheap digital multimeter market:** In America there are a number of meters at a hundred dollars, in the UK we have the field virtually to ourselves, in other European countries there is a certain amount of low-cost Far-East meters but their penetration is very small.

**Before the DM2 Sinclair wasn't making any instruments, but after selling 25 000 units it's hardly surprising that he's going into business seriously with a new range — including, we're told, an auto-ranging 4½-digit model priced at around £100 (but this wasn't released at the time of the interview).**

**One of the factors that accounts for the success of Sinclair in the early days was the sub-contracting of production. Sinclair would buy the components, send them out to another company to be assembled, and then check the quality of the products in his own factory before sending them out into the marketplace. He then concentrated on research and development, free from the hassles (financially and managerially) of production. But there was a danger that he might be let down by one of his contractors, with disastrous results.**

## The Black Watch Disaster

**This happened in 1976 when he lost £355 600 thanks to the suppliers of the chip for his Black Watch. We asked Clive if technical problems played any part in the disaster.** No, the chip we got worked beautifully. We had some early snags but so does everybody in watches — they're just teething troubles. It was a great shame because the chip was miles ahead of anyone else's — way ahead of the Americans.

And the chip was a Sinclair design? Yes, entirely. **Was it the first production $I^2L$ chip in the world?** Yes, we were ahead of TI on it. **But $I^2L$ was developed by Philips and IBM, how come Sinclair used it first?** They invented it and we spotted that this looked like an ideal technology for watches — way ahead of anyone else. Indeed, we did all the work to make it a technology for watches, you couldn't just use conventional circuits.

Steve Braidwood and Halvor Moorshead caught in mid-interview with Clive Sinclair, at Sinclairs Cambridge headquarters.

**We remember quite a lot of problems when the watch first came out, do you regret launching it as early as you did?** There were problems with everybody else's. I just think that something as new as that can't do without having some problems.

What went wrong was one of those things that happens now and again and it was tough luck.

**That was your only venture (so far) into watches?**

Yes. We did then make a version of the Black Watch using CMOS chips but only to fulfil obligations of supply, because we couldn't then be particularly competitive.

The watch business has been a particularly bad business for everybody who's been in it, really, because there's been such absurd competition and price cutting. Even if we hadn't had the problem with the supply of the chips we would probably have seen some other problems.

**But the same applies to the calculator field, to some extent, where you certainly have been able to hold your head above water?** That's right, and so we would have done in the watch field, had we had the chance. So we much regret that the chips weren't available.

**As a company you're quite remarkable as innovators. But you've been hit down a bit — with**

**the PWM amplifier and the $I^2L$ watch. Has that made you a bit more cautious?**

No, not a bit. In both cases the technology was right and something else was wrong. In the case of the PWM, we were a much smaller company then and we didn't do our homework properly. We didn't test it thoroughly enough before we launched it, but we soon put that right.

In the case of the $I^2L$ watch, again the snag there was the people who were making the chip who suddenly found themselves with a processing problem which had nothing to do with the fact that it was that chip.

**Haven't you become just a bit more conservative?** No, I don't think I have. The television is a massive risk by any standard. **But you did go to the NEB.** That was of necessity. The risk was such a damn big one. Generally, large companies are not prepared to take big risks, but I personally am.

**Since the misfortunes of 1976 Sinclair has been helped out by the National Enterprise Board with cash and a 43% shareholding, and by the NRDC with £700 000 for further development of the pocket television.**

## Satisfaction Guaranteed

**One nice thing about Sinclair is that from the start, before the law came in to protect the consumer, he offered an unconditional money-back guarantee to his customers. So when innovatory new techniques caused problems you didn't need to be one of Clive's guinea-pigs if you didn't want to be, but it was so much fun to be at the forefront of technology that most hobbyists didn't mind coping with teething troubles themselves. Clive's views on the money-back deal are double-edged:** In mail-order it was likely to succeed in helping sales; it was also quite a genuine policy. We stuck to it and meant it. We didn't want a situation where customers weren't happy — at the end of the day. It was very deliberate. It is a genuine policy we've stuck to ever since: we don't argue with customers, we do replace products.

**We asked Clive if he had got over the bad name he once had — in the hi-fi days it was commonly rumoured that he had a 20% failure rate on some of his products.** True. The quality control wasn't as good as it should have been, there's no doubt about it. The reason was that we sub-contracted production and really didn't have enough experience of quality control in those days.

Our quality is superb now.

**And the bad name?** There was indeed, yes. I think that's behind us now. We don't seem to get that at all now — we did until a year or two ago. Our reputation with the big stores, who have got very quality-control-conscious themselves (and do their own goods-inwards checks), is excellent.

## Exporting Success

**What percentage of your products do you export?** Seventy per cent overall, now, I think. **Mainly the USA?** No, it's only recently. We haven't been very big in the USA, although we've got our own company there, but just this year it's suddenly taking off there. For two reasons: the television is the obvious one, but the multimeter is pushing out very heavily in the USA, hitherto it's been mostly Europe.

**The pocket television was obviously designed with the export market in mind — the switches on the front allow you to select UHF or VHF, US, UK or European standards. The marketing effort has so far been concentrated in the US, with the result that most of the 1977 sets have been sold there. Marketing in Europe (except for the UK, where the set was available from the start) starts at the beginning of 1978. Now 40% of the turnover is attributable to the TV (20% to multimeters and 40% to calculators) but the production of the TV (and consequently the sales) will double between October and December 1977. Clive Sinclair is confident that the television is a success, but with twelve years of research and development behind it and massive investments, let's hope that he doesn't get let down by his suppliers (he has only a single source for the two-inch picture-tube) or be price-cut into bankruptcy by Japanese competition. But at £200+VAT I can't see many being sold in the UK until the price does come down.**

### Researching for the Future

**Clive has about a dozen people working in research (as opposed to development) but he says he isn't about to enter any new areas in the immediate future. We asked him about the electric vehicle research:** The electric vehicle side have done work over quite a long period and are still doing work on the motor side, but it's not a 'product development' area, it's a 'research' area.

**If you were fifteen years younger what area would you now go into, if you had the same starting point you had in 1962?**

Personal computers, probably, in the constructor field, if you have to be in the constructor field. I only did so in the first place because that's an area where it's possible to start small.

**We would have expected to see you in personal computers by now.** Well, I'm waiting to see what happens. I think the programmable calculator is, in a way, a venture in that direction. Evolutions of that type of product might meet that demand. It's hard to see which way it's going at the moment.

We've spent an awful lot of time looking into this problem and we're still not definite which way we'll go. But I suspect it'll be from calculators upwards to computers.

**Do people buy calculators to play with, or to use?** There's certainly a market sector, the calcaholics, God bless them. It's quite an important one, but it's not that big.

**What about innovations in calculators, like bigger memory?**

We offer a service to our customers whereby we'll write programs for our calculators, for them. When we did our first programmable, to 50% of those who wrote in we had to say I'm sorry but our programmable won't do it. On the present machine only two of the many hundreds who've written in did we have to say that to, and one of those couldn't be done on a programmable anyway. So, basically, we're offering a machine, which, much to our surprise, already meets the overwhelming majority of people's current needs.

**How long will it be before you are using bubble memories?** The problem today is that there aren't enough suppliers for there to be competition; there's TI and nobody else. Intel are coming out, and if the competition builds up things could happen quickly. Charge-coupled devices might come in faster.

### Over the Horizon

**Is there anything on the horizon that will make a significant change in our life-style, do you think the home computer will:** I think there's not much use for the computer in the home. I think what will change our lives much more is robots. This is the thing that intrigues me — looking quite a long way ahead — the electronics is becoming available to make simple robots practical.

Uncle Clive holding his world stunning pocket TV, you too can hold one for the sum of £200 plus VAT!

I don't know why, for example, we can't already buy mowing machines that mow the lawn and learn where the trees are and where the humps are. There's nothing in the technology preventing them appearing now. Nor is there anything in the technology preventing, say, a robotic vacuum cleaner that could learn the layout of a house and busily set about cleaning the house every day and plugging itself into the mains at night to recharge itself. And so on. The first robots will not be made by the traditional companies, they'll be made by new companies. Then the large companies may take it up.

**Are you researching this at the moment?** No. **It's too early?** It's too early in the sense it's something that evolves out of general computer work. It's too early to put everything together today.

**What will you be selling in 1984?** What we're selling now, but lots more of them.

**Did you know seven years ago what you'd be selling today?** Yes I did, very much so.

In 1984 we'll be more into computers than we are now. We see ourselves as on the beginning of computers with the programmable. I'm sure that will have gone a lot further by them.

If you look at the areas that we are in — television, instruments and calculators — you'll see that there are some common factors that could lead to some interesting product areas. I won't say more than that.

**Things like a two-inch pocket scope?** Scopes are an example, yes. There are a lot of others. **A miniature VDU?** Yes, things just like that.

**Well, thank you for a most enjoyable afternoon, Electronics Tomorrow readers may be the founders of Robotic companies after reading this interview.** They could well be, it has been a pleasure talking to you. □


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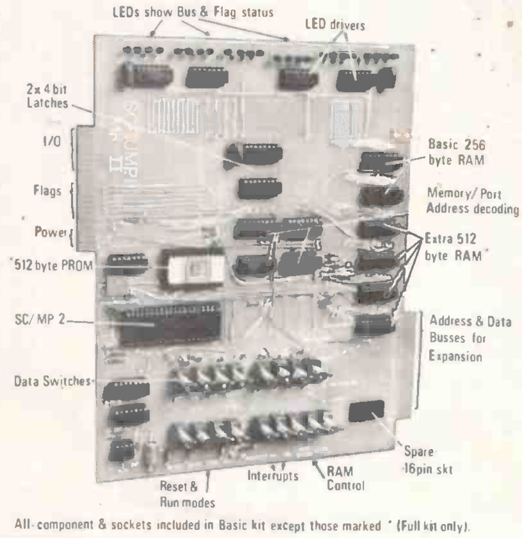


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## CLOCK CHIPS & KITS

| TYPE | SPECIAL FEATURES | £CHIP | £KIT |
|---|---|---|---|
| MM5309 | 7 seg + BCD, RESET ZERO | 8.53 | 12.50 |
| MM5311 | 7 seg + BCD | 4.26 | 8.00 |
| MM5312 | 7 seg + BCD 4 DIGIT ONLY | 5.65 | |
| MM5313 | 7 seg + BCD | 6.50 | |
| MM5314 | 7 seg + BASIC CLOCK | 4.26 | 7.00 |
| MM5315 | 7 seg + BCD RESET ZERO | 6.50 | |
| MM5316 | Non-mpx ALARM | 7.50 | |
| MM5318 | 7 seg + BCD External digit select | 4.93 | 8.00 |
| MM5371 | ALARM, 50 Hz | 12.19 | |
| MM5378 | CAR Clock, Crystal control, LED | 9.86 | 14.00 |
| MM5379 | CAR Clock, Crystal control, Gas discharge | 9.86 | |
| MK5025 | ALARM, SNOOZE | 5.60 | 9.00 |
| MK50395 | UP/DOWN Counter — 6 Decade | 12.10 | 15.10 |
| MK50396 | UP/DOWN Counter — HHMMSS | 12.10 | 15.10 |
| MK50397 | UP/DOWN Counter — MMSS.99 | 12.10 | 15.10 |
| FCM7001 | ALARM, SNZ, CALENDAR, 7 seg | 9.00 | 12.50 |
| FCM7002 | ALARM, SNZ, CALENDAR, BCD | 9.00 | |
| CT7003 | ALARM, SNZ, CALENDAR, Gas discharge | 9.00 | |
| FCM7004 | ALARM, SNZ, CALENDAR, 7 seg | 9.00 | 12.50 |
| AY5 1202 | 7 seg, 4 digit | 4.76 | |
| AY5 1230 | 7 seg, ON and OFF ALARM | 5.25 | TBA |

All above clock kits include clock PC board, clock chip, socket and CA3081 driver IC. MH15378 also includes crystal and trimmers. When ordering kit, please use prefix MHI, e.g. MHI 5309.

## DISPLAYS

| | |
|---|---|
| DL707, 704, 701 0.3" | 1.70 |
| DL727, 728, 721 0.5" (2 dig.) | 4.31 |
| DL747, 750, 746 0.6" | 2.82 |

Litronix class 2 product

| | |
|---|---|
| DL707E | 0.85 |
| DL727E (2 dig.) | 2.00 |
| DL747E | 1.80 |

## MHI DISPLAY KITS

| | | | |
|---|---|---|---|
| MHI707/4 digit 0.3" | 7.60 | MHI707E/4 | 4.30 |
| MHI707/6 | 11.00 | MHI707E/6 | 5.70 |
| MHI727/4 0.5" | 9.70 | MHI727E/4 | 5.30 |
| MHI727/6 | 13.80 | MHI727E/6 | 7.20 |
| MHI747/4 0.6" | 11.40 | MHI747E/4 | 7.20 |
| MHI747/6 | 17.30 | MHI747E/6 | 9.90 |

Any one or two of the above MHI display kits will interface directly with any of the MHI clock kits

## CASES (with perspex screen)

| | |
|---|---|
| VERO 1. 8" x 5½" x 3" | 3.00 |
| VERO 2. 6" x 3¼" x 2¼" | 3.00 |

## SOCKETS

| | |
|---|---|
| 24, 28 or 40 pin | 0.60 |
| Soldercon strip skts. 50 pins | 0.30 |

## BITS & BYTES

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| 74C00 Quad NAND | 0.25 |
| 74C04 Hex Inverter | 0.25 |
| 74C10 Triple NAND | 0.25 |
| 74C42 BCD Decoder | 0.95 |
| 74C157 Quad Selector | 2.25 |
| 74C163 4 bit counter | 1.15 |
| 74C164 PISO register | 1.15 |
| 74C165 SIPO register | 1.15 |
| 74C173 3S Quad latch | 0.95 |
| 74LS139 Dual 2-4 Dec | 1.50 |
| DM8095 3S Hex buffer | 1.75 |
| DM8096 Inv 8095 | 1.75 |
| DM81LS95 3S 8 bit buff | 1.45 |
| DM81LS96 Inv 95 | 1.45 |
| DM81LS97 3S 4+4 buffer | 1.45 |
| DM81LS98 Inv 97 | 1.45 |

| | |
|---|---|
| MM2102-2 1Kx1 RAM | 2.11 |
| MM2112-2 256x4 RAM | 3.08 |
| MM74C920 256x4 CMOS RAM | 11.83 |
| XX2114 1Kx4 RAM | 24.00 |
| MM1702Q 256x8 EPROM | 11.90 |
| MM5204Q 512x8 EPROM | 10.95 |
| MM2708Q 1024x8 EPROM | 31.15 |

EPROM prices for blank devices

| | |
|---|---|
| ER3401 1024 x 4 EAROM | 28.85 |
| MM5307AA Baud Rate Gen | 12.68 |
| MM5303 (AY-5-1013) UART | 6.34 |
| Xtal for 5307 | TBA |
| DM8678 Char Gen | 15.20 |

(both CAB & BWF avail.)

## CLOCK MODULES

| | |
|---|---|
| LT601 Alarm Clock Module, similar to MA1002 | 6.00 |
| MTX1001 Transformer | 0.90 |

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