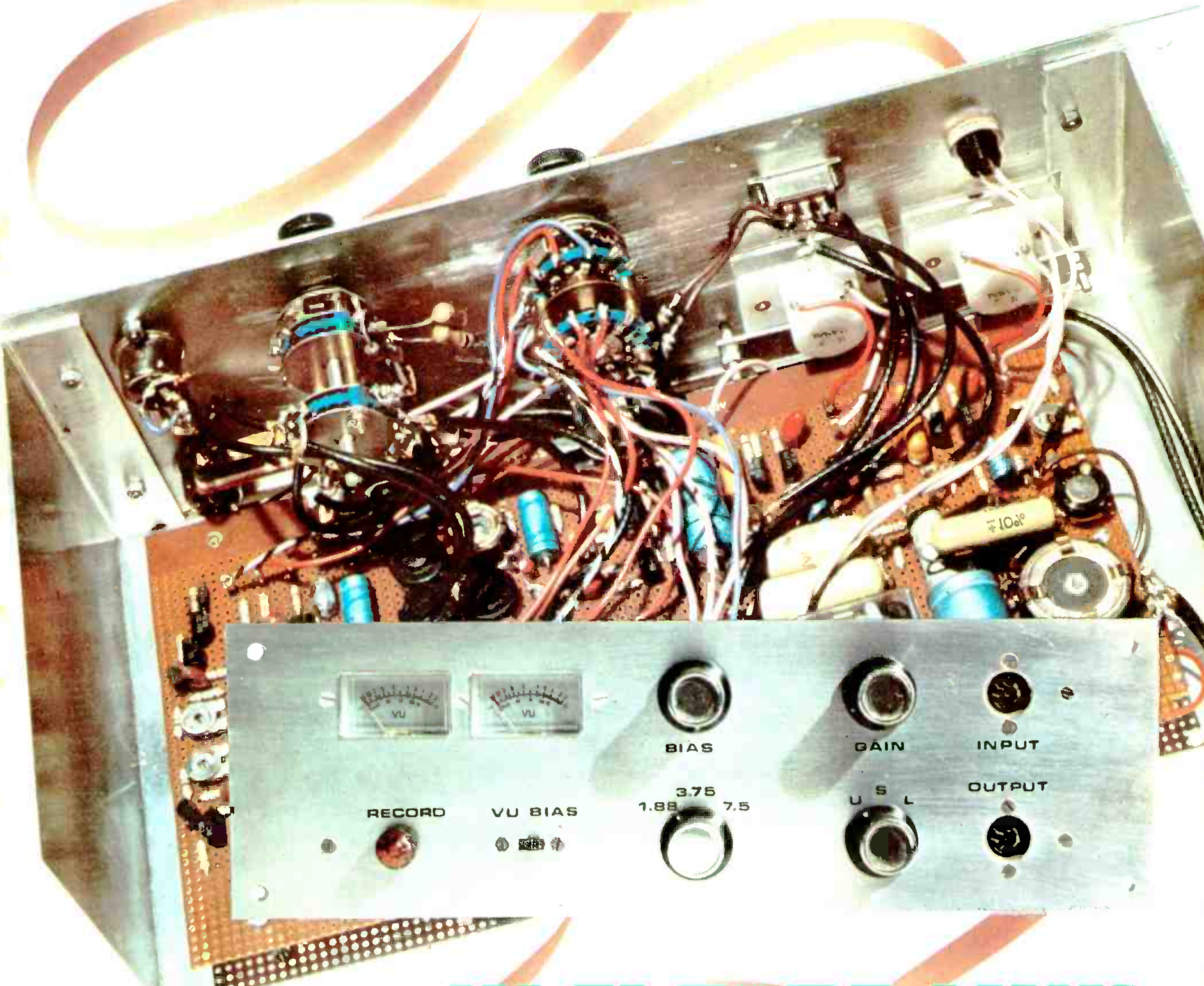
PRACTICAL

# ELECTRONICS

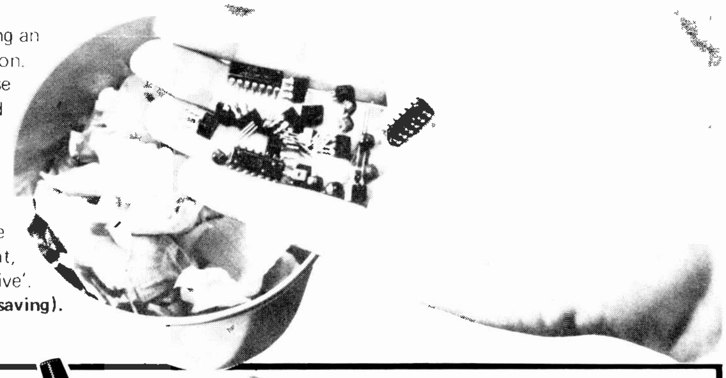
MARCH 1973

20p

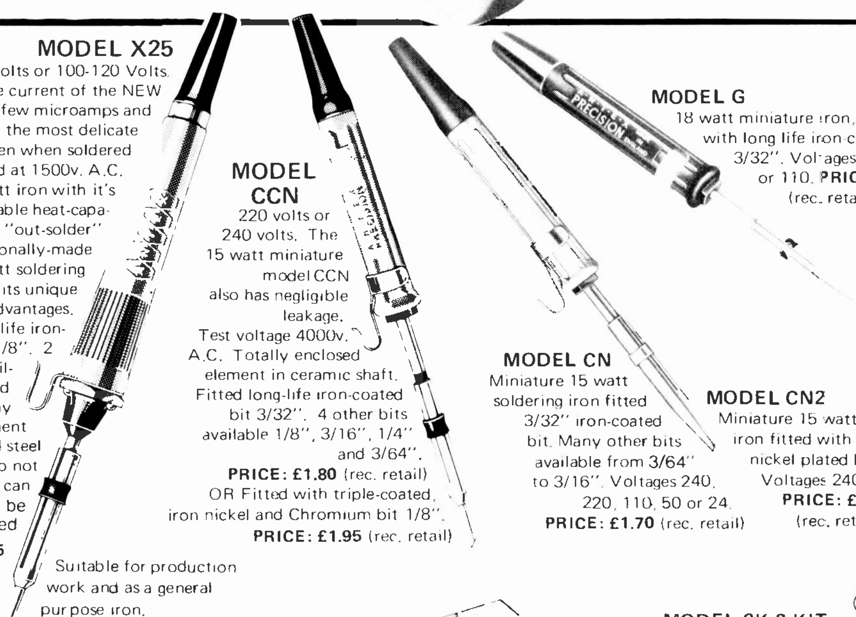



# HI FI TAPE LINK

# is this the price you pay?



Probably, if you're still using an ordinary soldering iron. Ordinary soldering irons can cause damage to transistors and integrated circuits — damage which wastes time and costs money. Now, with the unique ANTEX X25 and CCN low leakage soldering irons no harm can come to the most delicate equipment, even when soldered 'Live'.
**(You could be making quite a saving).**




## MODEL X25

220-240 Volts or 100-120 Volts. The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live". Tested at 1500v. A.C. This 25 watt iron with it's truly remarkable heat-capacity will easily "out-solder" any conventionally-made 40 and 60 watt soldering irons, due to its unique construction advantages. Fitted long-life iron-coated bit 1/8". 2 other bits available 3/32" and 3/16". Totally enclosed element ceramic and steel shaft. Bits do not "freeze" and can easily be removed

**PRICE: £1.75** (rec. retail)

Suitable for production work and as a general purpose iron.

## MODEL CCN

220 volts or 240 volts. The 15 watt miniature model CCN also has negligible leakage. Test voltage 4000v. A.C. Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32". 4 other bits available 1/8", 3/16", 1/4" and 3/64".
**PRICE: £1.80** (rec. retail)
OR Fitted with triple-coated, iron nickel and Chromium bit 1/8".
**PRICE: £1.95** (rec. retail)

## MODEL G

18 watt miniature iron, fitted with long life iron coated bit 3/32". Voltages 240,220 or 110. **PRICE: £1.83** (rec. retail).

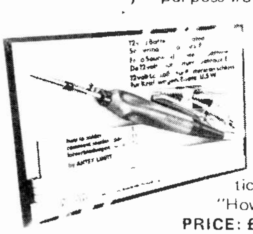
## MODEL CN

Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 3/64" to 3/16". Voltages 240, 220, 110, 50 or 24.
**PRICE: £1.70** (rec. retail)

## MODEL CN2

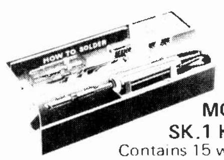
Miniature 15 watt soldeing iron fitted with nickel plated bit 3/32". Voltages 240 or 220.
**PRICE: £1.70** (rec. retail)

as selected for the DESIGN CENTRE



## MODEL MES.KIT

Battery-operated 12v 25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet with booklet "How to Solder"
**PRICE: £1.95** (rec. retail)

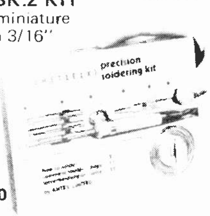



## MODEL SK.1 KIT

Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.
**PRICE: £2.75** (rec. retail)

## MODEL SK.2 KIT

Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32" heat sink, solder, stand and "How to Solder" booklet.
**PRICE: £2.40** (rec. retail)

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PRACTICAL
# ELECTRONICS
VOLUME 9 No. 3 MARCH 1973

## CONSTRUCTIONAL PROJECTS



## GENERAL FEATURES



## NEWS AND COMMENT



**Our April issue will be published on Friday, March 9, 1973**

# MUSIC MAKERS

## UNISOUND FOR THE NEW SOUND

**AT £25**

The whole system is complete *including superb cabinets in simulated teak*—just simply screw together the components and you save pounds!
Amplifier is based on the famous Mullard Unilex system. Garrard 2025TC turntable complete with stereo ceramic cartridge, teak simulated plinth and tinted acrylic cover. Plus the big 13in. × 8in. EMI Twin-cone speakers ready for mounting in their elegant cabinets, which simply need screwing and gluing together. All glue and screws supplied.
Easy to follow step-by-step instructions guide you quickly and effortlessly to taking the wraps off truly realistic stereo sound.
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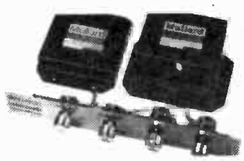
No soldering, just simply screw together with screwdriver supplied. Their overall specification is the same as shown for the complete Unisound console, using the high efficient I.C. monolithic power chips to ensure very low distortion at all power levels, correct operation in all ambient temperatures, full power over the audio spectrum.



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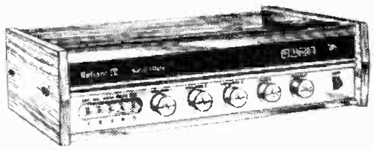
Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulised IF stages which are pre-aligned before despatch. As well as electronic components, this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.

The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles. It covers the full medium and long wave bands. Four push-buttons for medium wave, one for long wave. It is permeability tuned and sturdily constructed. Output is a full 2·5 watts into an 8 ohm speaker. But the Tourist PB will operate into any loudspeaker from 8 to 15 ohms. Power consumption is less than 1 amp.
The Tourist PB can be mounted in any standard size dash panel and it has an illuminated tuning scale for easy reading at night. Approx. chassis size is: 7in wide, 2in. high and 4 11/16 in. deep (excluding front panel, etc.).
★ Circuit diagram and comprehensive instructions 50p, free with parts.
★ Fully retractable lockable car aerial £1·25 post paid.
**PRICE ONLY £7 + p & p 50p**
**Speaker with baffle and fixing strips £1·50 + 25p p & p, post free if brought with the kit.**
Send for illustrated leaflet

**If you can solder on printed circuit board, you can build this push-button car radio kit. It's simple—just follow the step-by-step instructions.**

**ONLY £7.00**

## RELIANT MK.IV



★ 5 Electronically Mixed Inputs. ★ 3 Individual Mixing Controls. ★ Separate bass and treble controls common to all 5 inputs. ★ Mixer employing F.E.T. (Field Effect Transistor). ★ Solid State Circuitry. ★ Attractive Styling. ★ Sides finished in solid teak.

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**CONTROLS:**—3 Volume controls. Bass control range: 13dB @ 60Hz. Treble control range: ± 12dB @ 15KHz. Separate ON/OFF Switch. Neon indicator. **POWER OUTPUT:**—12 Watts R.M.S. into 3 to 4 ohms speaker. **SIGNAL NOISE:**—Better than −60dB on inputs 3, 4 and 5 & −50dB on 1 & 2. **SUPPLY:**—220-250 A.C. Mains. **SIZE:**—12½in. × 6in. × 3¼in. **NEW VERSION: 20 watts into 8 ohms £13·50 + 60p p & p**

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**JUST ANNOUNCED** The new 20 watt (into 8 ohms) version for just £3 extra. All other specifications as above. **plus p & p 60p** **£13·50**

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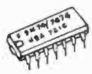
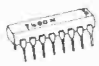
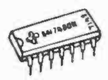

| Type | 1/11 p | 12/24 p | 25/99 p |
|---|---|---|---|
| SN7400 | 0·20 | 0·18 | 0·16 |
| SN7401 | 0·20 | 0·18 | 0·16 |
| SN7402 | 0·20 | 0·18 | 0·16 |
| SN7403 | 0·20 | 0·18 | 0·16 |
| SN7404 | 0·20 | 0·18 | 0·16 |
| SN7405 | 0·20 | 0·18 | 0·16 |
| SN7406 | 0·30 | 0·27 | 0·25 |
| SN7407 | 0·30 | 0·27 | 0·25 |
| SN7408 | 0·20 | 0·19 | 0·18 |
| SN7409 | 0·45 | 0·42 | 0·35 |
| SN7410 | 0·20 | 0·18 | 0·16 |
| SN7411 | 0·23 | 0·22 | 0·20 |
| SN7412 | 0·42 | 0·40 | 0·35 |
| SN7413 | 0·30 | 0·27 | 0·25 |
| SN7416 | 0·30 | 0·27 | 0·25 |
| SN7417 | 0·30 | 0·27 | 0·25 |
| SN7420 | 0·20 | 0·18 | 0·16 |
| SN7422 | 0·48 | 0·44 | 0·40 |
| SN7423 | 0·48 | 0·44 | 0·40 |
| SN7425 | 0·48 | 0·40 | 0·35 |
| SN7427 | 0·42 | 0·39 | 0·35 |
| SN7428 | 0·50 | 0·45 | 0·42 |
| SN7430 | 0·20 | 0·18 | 0·16 |
| SN7432 | 0·42 | 0·39 | 0·35 |
| SN7433 | 0·70 | 0·61 | 0·44 |
| SN7437 | 0·65 | 0·60 | 0·50 |
| SN7438 | 0·65 | 0·60 | 0·50 |
| SN7440 | 0·20 | 0·18 | 0·16 |
| SN7441AN | 0·75 | 0·72 | 0·70 |
| SN7442 | 0·75 | 0·72 | 0·70 |
| SN7443 | 1·00 | 0·95 | 0·90 |
| SN7445 | 2·00 | 1·75 | 1·60 |
| SN7446 | 2·00 | 1·75 | 1·60 |
| SN7447 | 1·75 | 1·60 | 1·45 |
| SN7448 | 1·75 | 1·60 | 1·45 |

| Type | 1/11 p | 12/24 p | 25/99 p |
|---|---|---|---|
| SN7450 | 0·20 | 0·18 | 0·16 |
| SN7451 | 0·20 | 0·18 | 0·16 |
| SN7453 | 0·20 | 0·18 | 0·16 |
| SN7454 | 0·20 | 0·18 | 0·16 |
| SN7460 | 0·20 | 0·18 | 0·16 |
| SN7470 | 0·30 | 0·27 | 0·25 |
| SN7472 | 0·30 | 0·27 | 0·25 |
| SN7473 | 0·40 | 0·37 | 0·35 |
| SN7474 | 0·40 | 0·37 | 0·35 |
| SN7475 | 0·55 | 0·52 | 0·50 |
| SN7476 | 0·45 | 0·42 | 0·39 |
| SN7480 | 0·80 | 0·75 | 0·67 |
| SN7481 | 1·25 | 1·15 | 1·10 |
| SN7482 | 0·87 | 0·80 | 0·70 |
| SN7483 | 1·00 | 0·90 | 0·85 |
| SN7484 | 0·90 | 0·85 | 0·80 |
| SN7486 | 0·45 | 0·41 | 0·38 |
| SN7490 | 0·75 | 0·70 | 0·65 |
| SN7491AN | 1·00 | 0·95 | 0·90 |
| SN7492 | 0·75 | 0·70 | 0·65 |
| SN7493 | 0·75 | 0·70 | 0·65 |
| SN7494 | 0·80 | 0·75 | 0·70 |
| SN7495 | 0·80 | 0·75 | 0·70 |
| SN7496 | 1·00 | 0·97 | 0·95 |
| SN7497 | 6·25 | 5·50 | 5·00 |
| SN74100 | 2·50 | 2·30 | 2·00 |
| SN74104 | 1·45 | 1·35 | 1·20 |
| SN74105 | 1·45 | 1·35 | 1·20 |
| SN74107 | 0·50 | 0·45 | 0·40 |
| SN74110 | 0·80 | 0·70 | 0·60 |
| SN74118 | 1·00 | 0·95 | 0·90 |
| SN74119 | 1·90 | 1·78 | 1·65 |
| SN74121 | 0·60 | 0·55 | 0·50 |
| SN74122 | 1·35 | 1·25 | 1·10 |
| SN74123 | 2·70 | 2·55 | 2·47 |
| SN74141 | 1·00 | 0·95 | 0·90 |

| Type | 1/11 p | 12/24 p | 25/99 p |
|---|---|---|---|
| SN74145 | 1·50 | 1·40 | 1·30 |
| SN74150 | 3·35 | 2·95 | 2·15 |
| SN74151 | 1·10 | 0·95 | 0·90 |
| SN74153 | 1·35 | 1·27 | 1·20 |
| SN74154 | 2·00 | 1·75 | 1·55 |
| SN74155 | 1·55 | 1·47 | 1·35 |
| SN74156 | 1·55 | 1·47 | 1·35 |
| SN74157 | 1·80 | 1·70 | 1·50 |
| SN74160 | 2·60 | 2·40 | 2·25 |
| SN74161 | 2·60 | 2·40 | 2·25 |
| SN74162 | 3·40 | 3·25 | 2·70 |
| SN74163 | 3·40 | 3·25 | 2·70 |
| SN74164 | 2·75 | 2·30 | 2·10 |
| SN74165 | 4·00 | 3·50 | 3·00 |
| SN74166 | 4·00 | 3·50 | 3·00 |
| SN74167 | 6·25 | 5·60 | 5·10 |
| SN74170 | 4·10 | 3·55 | 3·05 |
| SN74174 | 2·00 | 1·75 | 1·30 |
| SN74175 | 1·35 | 1·27 | 1·15 |
| SN74176 | 1·60 | 1·35 | 1·20 |
| SN74177 | 1·60 | 1·35 | 1·20 |
| SN74180 | 1·55 | 1·30 | 1·20 |
| SN74181 | 7·00 | 6·00 | 5·50 |
| SN74182 | 2·00 | 1·80 | 1·60 |
| SN74184 | 2·40 | 2·00 | 1·80 |
| SN74185A | 2·40 | 2·00 | 1·80 |
| SN74190 | 1·95 | 1·85 | 1·75 |
| SN74191 | 1·95 | 1·85 | 1·75 |
| SN74192 | 2·00 | 1·90 | 1·80 |
| SN74193 | 2·00 | 1·90 | 1·80 |
| SN74194 | 2·50 | 2·25 | 1·90 |
| SN74195 | 1·85 | 1·70 | 1·60 |
| SN74196 | 1·50 | 1·40 | 1·30 |
| SN74197 | 1·50 | 1·40 | 1·30 |
| SN74198 | 4·60 | 3·70 | 3·35 |
| SN74199 | 4·60 | 3·70 | 3·35 |

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| AC187 | 25p | BCY43 | 25p | GET880 | 45p | OC140 | 55p | ZTX503 | 17p | 2N3705 | 10p |
| AC188 | 25p | BCY55 | 2·50 | LM309K (T03) | 1·87 | OC170 | 25p | 2G301 | 30p | 2N3714 | 1·80 |
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| AD149 | 50p | BD124 | 80p | MJE3055 | 75p | OCP71 | 1·25 | 2N930 | 20p | 2N3866 | 85p |
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| AF117 | 20p | BF115 | 25p | NKT216 | 40p | P346A | 20p | 2N1132 | 25p | 2N4061 | 12p |
| AF118 | 50p | BF167 | 25p | NKT217 | 40p | RA8310AF | 45p | 2N1302 | 18p | 2N4062 | 12p |
| AF124 | 25p | BF173 | 25p | NKT403 | 70p | RA8508AF | 55p | 2N1304 | 22p | 2N4126 | 15p |
| AF139 | 30p | BF179 | 30p | NKT404 | 50p | TAA263 | 75p | 2N1305 | 22p | 2N4871 | 35p |
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| AF239 | 40p | BF194 | 15p | OA10 | 35p | TIP29A | 50p | 2N1308 | 25p | 2N5777 | 55p |
| ASY27 | 30p | BF195 | 15p | OA81 | 10p | TIP30A | 60p | 2N1613 | 20p | 2S001 | 1·00 |
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| BAX16 | 7p | BFX88 | 20p | OC23 | 85p | TIP36A | 3·00 | 2N2222A | 25p | 2S324 | 95p |
| BC107 | 10p | BFY50 | 20p | OC25 | 40p | TIP41A | 75p | 2N2369A | 15p | 40250 | 50p |
| BC108 | 10p | BFY51 | 20p | OC28 | 65p | TIP42A | 85p | 2N2906 | 20p | 40360 | 40p |
| BC109 | 10p | BFY52 | 20p | OC35 | 50p | | | 2N2926 (all cols) | 10p | 40361 | 40p |
| BC109C | 12p | BFY64 | 50p | OC36 | 65p | | | 2N3053 | 20p | 40362 | 50p |
| BC113 | 15p | BFY90 | 59p | OC42 | 40p | | | 2N3054 | 50p | 40408 | 50p |
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500 + 35p
1000 + 30p

**2N3055 55p**
25 + 50p
100 + 45p
500 + 38p
1000 + 33p

## ZENER DIODES

400 M/W 5% Miniature
**BZY 88 Range**
All voltages 3·3 – 33 Volt
10p each.

| | |
|---|---|
| 25+ | 9p |
| 100+ | 8p |
| 500+ | 6·5p |
| 1000+ | 5p |

Any one type.

1¼ Watt 5% Wire Ends Metal Case
All voltages 6·8 – 100 Volts
20p each

| | |
|---|---|
| 25+ | 18p |
| 100+ | 16p |
| 500+ | 12p |
| 1000+ | 10p |

Any one type.

3 Watt Plastic Wire Ends 5%
3EZ Range
All voltages 6·8 – 100 Volts
30p each.

### SILICON RECTIFIERS WIRE ENDED PLASTIC

| Type | P.I.V. | 1-11 |
|---|---|---|
| 1 amp miniature | | |
| IN4001 | 50 | 6 |
| IN4002 | 100 | 7 |
| IN4003 | 200 | 8 |
| IN4004 | 400 | 8 |
| IN4005 | 600 | 10 |
| IN4006 | 800 | 12 |
| IN4007 | 1000 | 15 |
| 1·5 amp miniature | | |
| PL4001 | 50 | 8 |
| PL4002 | 100 | 9 |
| PL4003 | 200 | 10 |
| PL4004 | 400 | 10 |
| PL4005 | 600 | 12 |
| PL4006 | 800 | 15 |
| PL4007 | 1000 | 16 |

## LINEAR (O/P AMPS)

| | | |
|---|---|---|
| 702C | TO5 | 75p |
| 709C | TO99 | 35p |
| 709C | D.I.L. | 35p |
| 723C | TO99 | £1·00 |
| 723C | D.I.L. | 95p |
| 725C | TO99 | £4·50 |
| 741C | TO99 | 55p |
| 741C | D.I.L. | 55p |
| 747C | TO99 | £1·10 |
| 747C | D.I.L. | £1·10 |
| 72741P | D.I.L. | 60p |
| 72748P | D.I.L. | 60p |

SINCLAIR 1C12 £1·80
TOSHIBA TH9013P
20 WATT AMP £4·47 POST PAID
TH9014P Pre Amp £1·50

DATA AND CIRCUITS REF. 42 10p
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**3 Watt Amplifier SL403 D**
Complete with 8-page booklet, circuits and data

**£1.50 each**

## TRIACS

### STUD WITH ACCESSORIES

| Type | Volts P.I.V. | Price 1-11 |
|---|---|---|
| **3 AMP RANGE** | | |
| SC35A | 100 | 75p |
| SC35B | 200 | 79p |
| SC35D | 400 | 85p |
| **6 AMP RANGE (TO48)** | | |
| SC40A | 100 | 85p |
| SC40B | 200 | 90p |
| SC40D | 400 | £1·00 |
| SC40E | 500 | £1·20 |
| **10 AMP RANGE (TO48)** | | |
| SC45A | 100 | 95p |
| SC45B | 200 | £1·00 |
| SC45D | 400 | £1·25 |
| SC45E | 500 | £1·45 |
| **15 AMP RANGE (TO48)** | | |
| SC50A | 100 | £1·25 |
| SC50B | 200 | £1·35 |
| SC50D | 400 | £1·65 |
| SC50E | 500 | £1·85 |

DIAC D32 25p

TRIACS—Additional Types

| | | |
|---|---|---|
| 40430 | (TO66) | 85p |
| 40669 | (Plastic) | £1·00 |
| 40486 | (TO5) | 80p |


3 Amp T048

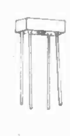

15 Amp T048

## NEW BRIDGE RECTIFIERS

### SMALL SIZE AND LOW COST

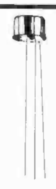
| Type | Volts P.I.V. | Price 1-11 |
|---|---|---|
| **HALF AMP** | | |
| BO5/05 | 50 | 20p |
| BO5/10 | 100 | 25p |
| **ONE AMP ½ × ⅜ H TUBULAR** | | |
| B1/05 | 50 | 25p |
| B1/10 | 100 | 25p |
| B1/20 | 200 | 30p |
| B1/60 | 600 | 35p |
| **ONE AMP (G.I.) TUBULAR** | | |
| W005 | 50 | 30p |
| W01 | 100 | 35p |
| W02 | 200 | 40p |
| W06 | 600 | 45p |
| **TWO AMPS ¼ H × ¼ L × ⅛** | | |
| B2/05 | 50 | 35p |
| B2/100 | 100 | 40p |
| B2/200 | 200 | 45p |
| B2/600 | 600 | 50p |
| B2/1000 | 1000 | 60p |
| **FOUR AMPS ¼H × ¼L × ⅛** | | |
| B4/100 | 100 | 60p |
| B4/200 | 200 | 65p |
| B4/400 | 400 | 70p |
| B4/600 | 600 | 75p |
| B4/800 | 800 | £1·00 |
| **SIX AMPS ¼H × ¼L × ⅛** | | |
| B6/100 | 100 | 70p |
| B6/200 | 200 | 75p |
| B6/400 | 400 | 90p |
| B6/600 | 600 | £1·00 |





### SILICON CONTROLLED RECTIFIERS

| Type | Volts P.I.V. | Price 1-11 |
|---|---|---|
| **ONE AMP** | | |
| CRS 1/05 | 50 | 25p |
| CRS 1/10 | 100 | 30p |
| CRS 1/20 | 200 | 30p |
| CRS 1/40 | 400 | 35p |
| CRS 1/60 | 600 | 45p |
| **THREE AMP (TO48)** | | |
| CRS 3/05 | 50 | 30p |
| CRS 3/10 | 100 | 30p |
| CRS 3/20 | 200 | 35p |
| CRS 3/40 | 400 | 45p |
| CRS 3/60 | 600 | 55p |
| **FIVE AMP (TO66)** | | |
| CRS 5/400 | 400 | 60p |
| **SEVEN AMP (TO48)** | | |
| CRS 7/100 | 100 | 60p |
| CRS 7/200 | 200 | 65p |
| CRS 7/400 | 400 | 70p |
| CRS 7/600 | 600 | 95p |
| **SIXTEEN AMP** | | |
| SCR 16/100 | 100 | 65p |
| SCR 16/200 | 200 | 70p |
| SCR 16/400 | 400 | 80p |
| SCR 16/600 | 600 | £1·00 |


1 Amp T05


3 Amp T048

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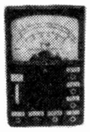
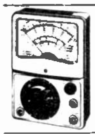
# MULTIMETERS *for EVERY purpose!*



**TS60 POCKET MULTIMETER** High-precision at low-cost. Ranges: D.c. 15V, 150V, 1,000V (10,000 O.P.V.). A.c. 15V, 150V, 100V (1,000 O.P.V.). D.c. Current 150mA. Resistance 100k ohms. **£1·85.** Post 15p.

**MODEL 1092 Testmeter.** 5,000 O.P.V. 0/3/15/150/300/1,200V d.c. 0/6/30/300/600V a.c. 0/300μA/300MA 0/10K/1 meg Ω Decibels −10 to +16 dB **£2·75 each.** Post 15p.



**HIOKI MODEL 720X** 20,000 O.P.V. Overload protection 5/25/100/500/1,000V d.c. 10/50/250/1,000V a.c. 50μA/250mA. 20K/2 meg. ohm. −5 to +62dB. **£4·97.** Post 15p.

**HIOKI MODEL 730X** 30,000 O.P.V. Overload protection. 6/30/60/300/600/1,200V d.c. 12/60/120/600/1,200V a.c. 60μA/30mA/300 mA. 2K/200K/2 meg-ohm. −10 to +63 dB. **£6·50.** Post 15p.

**MODEL TE-12** 20,000 O.P.V. 0/0·6/6/30/120/600/1,200/3,000/6,000V d.c. 0/6/30/120/600/1,200V a.c. 0/60μA/6/60/600mA. 0/6K/600K/6Meg./60 Meg. Ω 50pF. 0·2mFd. **£5·97.** Post 17p.

**MODEL TE-200** 20,000 O.P.V. Mirror scale, overload protection. 0/5/25/125/1,000V d.c. 0/10/50/250/1,000V a.c. 0/50μA/250mA. 0/60K/6 meg Ω. −20 to +62dB. **£3·95.** Post 15p.

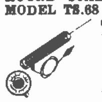
**MODEL 500 30,000 O.P.V. with overload protection mirror scale** 0/0·5/2·5/10/25/100/250/500/1,000V d.c. 0/2·5/10/25/100/250/500/1,000V a.c. 0/50μA/5/50/500mA. 12 amp. d.c. 0/60/K/6 Meg./60 MegΩ. **£8·87.** Post paid.

**HIOKI MODEL 750X** 50,000 O.P.V. 43 ranges 0-0·3 to 1,200V d.c. 0-3 to 1,200V a.c. 0-30μA/300mA. 0-3K/30 meg ohms. −10 to +17dB. **£8·97.** Post 20p.

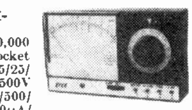
**HT100B4 MULTI-METER Features a.c. current ranges. 100,000 O.P.V. Mirror Scale, Overload protection.** 0/0·5/2·5/10/50/250/500/1,000V d.c. 0/2·5/10/50/250/500/1,000V a.c. 0/10/250μA/2·5/25/250MA/10 amp. d.c. 10 amp. a.c. 0/20K/200K/2MEG/20 MEG. −20 +62dB. **£12·50.** Post 25p.

**370 WTR MULTIMETER Features a.c. current ranges.** 20,000 O.P.V. 0/0·5/2·5/10/50/250/500/1,000V d.c. 0/2·5/10/50/250/500/1,000V a.c. 0/50μA/1/10/100mA/1/10 amp. d.c. 0/100mA/1/10 amp. a.c. 0/5K/50K/500K/5MEG/50MEG. −20 +62dB. **£15.** Post 25p.

**RUSSIAN 22 RANGE MULTIMETER** Model U437 10,000 O.P.V. A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2·5/10/50/250/500/1,000V d.c. 2·5/10/50/250/500/1,000V a.c. D.c. current 100wA/1/10/100mA/1A. Resistance 300 ohms/3/30/300K/3mΩ. Complete with batteries, test leads, instructions and sturdy steel carrying case. OUR PRICE **£5·97.** Post 25p.



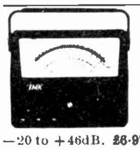
**ROUND SCALE TYPE PENCIL TESTER MODEL TS.68** Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V a.c. and d.c. at 2,000 O.P.V. Resistance 0·20K ohms. ONLY **£1·97.** Post 13p.



**LT 601 MULTI-METER** New style 20,000 O.P.V. pocket multimeter. 5/25/50/250/500/2,500V d.c. 10/50/100/500/1,000V a.c. 50μA/250A. 6K/6 meg ohms. −20 to +22 dB. **£3·75.** Post 20p.

**MODEL TH-12** 20,000 O.P.V. Overload protection. Slide switch selector. 0/0·25/2·5/10/50/250/1,000V d.c. 0/10/50/250/1,000V a.c. 0/50μA/25/250mA d.c. 0/3K/30K/300K/3 meg. −20 to +50dB. **£4·97.** Post 15p.

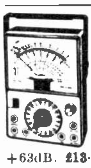
**MODEL TE-300.** 30,000 O.P.V. Mirror scale, overload protection 0/0·6/3/15/60/300/1,200V d.c. 0/6/30/120/600/1,200V a.c. 0/30μA/6mA/60mA/300mA/600mA. 0/8K/80K/800K/8 meg. ohm −20 to −63dB. **£5·97.** Post 15p.



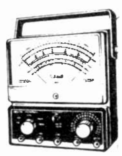
**MODEL PL436** 20kΩ/V d.c. 8kΩ/V a.c. Mirror scale. 0·6/3/12/30/120/600V d.c. 3/30/120/600V a.c. 50/600μA/60/600mA. 10/100K/1 Meg/10 MegΩ. −20 to +46dB. **£6·97,** Post 12p.

**TMK MODEL TW-50K** 46 ranges, mirror scale, 50K/V d.c. 5K/V a.c. D.c.: Volts 0·125, 0·25, 1·25, 2·5, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.c. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.c. Current: 25, 50μA, 2·5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance: 10K, 100K, 1 MEG, 10 MEG Ω. Decibels: −20 to +81·5 dB. **£8·50.** Post 17p.

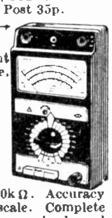
**MODEL K228A** Taut band suspension. Overload protection. Polarity reversing switch. 30,000 O.P.V. 0/0·5/2·5/15/50/250/500/1,000/2,500V d.c. 0/15/50/150/500/1,000V a.c. 0/50μA/5/50/150/500mA/5A d.c. 0/3K/300K/3meg. **£8·95.** Post 20p.



**HIOKI MODEL 700X** 100,000 O.P.V. Overload protection. Mirror scale. 0·3/0·6/1·2/1·5/3/6/12/30/60/120/300/600/1,200V d.c. 1·5/3/6/12/30/60/150/300/600/1,200V a.c. 15/30μA/3/6/30/60/150/300mA 6/12 amp. d.c. 2K/200K/2 Meg/20 Meg ohm −20 to +63dB. **£13·50.** Post 20p.

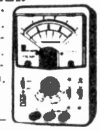


**MODEL C-7080 EN** Giant 6in mirror scale. 20,000 O.P.V. 0/0·25/1/2·5/10/50/250/1,000/5,000V d.c. 0/2·5/10/50/250/1,000/5,000V a.c. 0/50μA/1/10/100/500mA/10 amp. d.c. 0/2K/200K/20 meg. −20 to +50dB. **£13·95.** Post 35p.



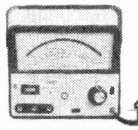
**U4312 MULTIMETER** Extremely sturdy instrument for general electrical use. 667 O.P.V. 0/0·3/1·5/7·5/30/60/150/300/600/900V d.c. and 75mV. 0/0·3/1·5/7·5/30/60/150/300/600/900V a.c. 0/300μA/1·5/6/15/60/150/600MA/1·5/6 amp. d.c. 0/1·5/6/15/60/150/600MA/1·5/6 amp. a.c. 0/200Ω/3k/30kΩ. Accuracy Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. **£9·50.** Post 25p.

# Selected TEST EQUIPMENT



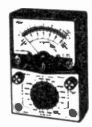
**PTC-401 TRANSISTOR TESTER** Full capabilities for measuring A, B and ICO. *npn* or *pnp*. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads. **£7·50.** Post 20p.

**Model S-100TR MULTIMETER/TRANSISTOR TESTER.** 100,000 O.P.V. mirror scale/overload protection. 0/0·12/0·6/3/12/30/120/600V d.c. 0/6/30/120/600V a.c. 0/12/600μA/12/300mA/12 amp. d.c. 0/10 K/1 MEG/100 MEG. −20 to +50dB. 0·01–2 MFD. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. **£13·50.** Post 25p.

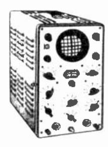


**MODEL 449A IN CIRCUIT TRANSISTOR TESTER** Checks true a.c. beta in/out. Checks Icbo. Checks diodes in/out. Checks SCR, etc. Beta HI 10—500 LO 2—50 Icbo 0-5000μA. 220/240V a.c. operation. **£17·50.** Post 25p.

**TE-20D RF SIGNAL GENERATOR** Accurate wide range signal generator covering 120 kHz-500 MHz on 6 bands. Directly calibrated Variable R.F. attenuator, audio output, Xtal socket for calibration. 220/240V a.c. Brand new with instructions. **£15.** Carr. 37p. Size 140mm × 215mm × 170mm.



**MODEL L-55 FET V.O.M.** Input impedance 10 meg ohms. 0/0·3/1·2/6/30/120/600V d.c. 0/3/12/60/120/600V a.c. 0/120μA/120mA d.c. 0/1K/100K/10 meg/100 meg ohms. **£15·97.** Post 25p.

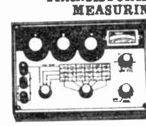


**CI-5 PULSE OSCILLOSCOPE** For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth 10MHz. Sensitivity at 100kHz V RMS/mm. 0·1-25; HOR. AMP. Bandwidth 500kHz. Sensitivity at 100kHz, V RMS/mm. 0 3-25; Pre-set triggered sweep 1-3,000μsec.; free running 20-200,000Hz in nine ranges. Calibrator pips. 220mm × 360mm × 430mm. 115-230V a.c. operation. **£39.** Carr paid.

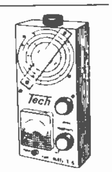
**TO-3 PORTABLE OSCILLOSCOPE** 3in tube, Y amp. Sensitivity 0·1V p-p/CM. Bandwidth 1·5cps-1·5MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9V. p-p/CM. Bandwidth 1·5cps-800kHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10cps-300kHz. Synchronisation. Internal/external. Illuminated scale 140mm × 215mm × 330mm. Weight 15¼lb. 220/240V a.c. Supplied brand new with handbook. **£40·00.** Carr. 50p.

**RUSSIAN CI-16 DOUBLE BEAM OSCILLOSCOPE** 5MHz Pass Band. Separate Y1 and Y2 amplifiers. Rectangular 5in × 4in C.R.T. Calibrated triggered sweep from 0·2u/sec to 100 milli-sec per cm. Free running time base 50 Hz-1MHz. Built-in time base calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manual. **£87.** Carr. paid.

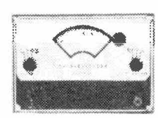
**TE-16A Transistorised Signal Generator.** 5 ranges 400kHz—30MHz. An inexpensive instrument for the handyman. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. 5¼in × 5¼in × 3¼in. Complete with instructions and leads. **£7·97.** Post 25p.



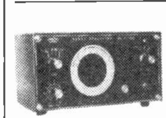
**TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE** A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω-11·1 megΩ 6 Ranges ±1%. L.1 μH — 111 HENRYS 6 Ranges −2%. C. 10pF ± 1110 mFd. 6 Ranges +2%. TURNS RATIO 1:1/1000-1:11100. 6 Ranges +1%. Bridge voltage at 1,000cps. Operated from 9V 100μA. Meter indication. Attractive 2 tone metal case. Size 7¾in × 5in × 2in. **£20.** Post 25p.



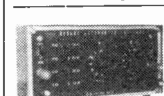
**MODEL TE15 GRID DIP METER** Transistorised. Operates as Grid Dip, Oscillator, Absorption Wave Meter and Oscillating Detector. Frequency range 440kHz-280MHz in 6 coils. 500μA meter. 9V battery operation. Size 180mm × 80mm × 40mm. **£12·50.** Post 20p.



**BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR** Sine 18-200,000 Hz; Square 18-50,000 Hz. Output max. +10dB (10 K ohms) Operation internal batteries. Attractive 2-tone case 7¼in × 5in × 2in. Price **£17·50.** Carr. 17p.



**MODEL MG-100 SINE SQUARE WAVE AUDIO GENERATOR** Range 19-220,000 Hz. Sine Wave 19 — 100,000Hz. Square Wave. Output Sine or Square wave 10V. P. to P. Size 180mm × 90mm × 90mm. Operation 220/240V a.c. **£17·50.** Post 37p.



**MODEL AT201 DECADE ATTENUATOR** Frequency range 0-200kHz. Attenuator 0-111dB, 0·1dB step. Impedance 600 ohms. Max. input power 30dBm. Size 180mm × 90mm × 55mm. **£12·50.** Post 37p.

**TE-65 VALVE VOLTMETER** 28 ranges. D.c. volts 1·5–1,500V a.c. volts 1·5–1,500V. Resistance up to 1,000 megohms. 200/240V a.c. operation. Complete with probe and instructions. **£17·50.** Post 30p. Additional probes available: R.F. **£2·12**; H.V. **£2·50.**

**MODEL U4311 SUB-STANDARD MULTI-RANGE VOLT AMMETER** Sensitivity 330 ohms/Volt a.c. and d.c. Accuracy 0·5% d.c. 1% a.c. Scale length 165mm. 0/300/750μA/1·5/3/7·5/15/30/75/150/300/750mA/1·5/3/7·5 amp. d.c. 0/3/7·5/15/30/75/150/300/750mA/1·5/3/7·5 amp. a.c. 0/75/150/300/750mV/1·5/3/7·5/15/30/75/150/300/750V d.c. 0/750mV/1·5/3/7·5/15/30/75/150/300/750V a.c. Automatic cut out. Supplied complete with test leads, manual and test certificates. **£49.** Post 50p.

**G. W. SMITH & CO. (RADIO) LTD.**

Also see opposite page and next two pages

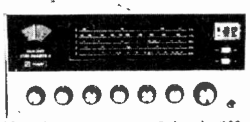
**UR-30 RECEIVER**

4 Bands covering 550kHz-30MHz. BFO. Built-in Speaker 220/240V a.c. Brand new with instructions. £15·75. Carr. 37p.

**UR-1A SOLID STATE COMMUNICATION RECEIVER**

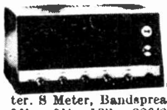
4 Bands covering 550kHz-30MHz. FET. S Meter. Variable BFO for SSB, Built-in Speaker, Bandspread, Sensitivity Control. 220/240V a.c. or 12V d.c. 12½in × 4½in × 7in. Brand new with instructions. £25. Carr. 37p.

**SKYWOOD CX203 COMMUNICATION RECEIVER**



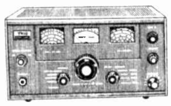
Solid state. Coverage on 5 bands 200–420 kHz and 0·55 to 30MHz. Illuminated slide rule dial. Bandspread. Aerial tuning. BFO, AVC, ANL, "S" meter. AM/CW/SSB. Integrated speaker and phone socket. Operation 220/240V a.c. or 12V d.c. Size 325 × 266 × 150 mm. Complete with instructions and circuit. £28·50. Carr. 50p.

**LAFAYETTE HA-600 SOLID STATE RECEIVER**



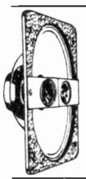
General coverage 150–400kHz, 550 kHz–30MHz. FET front end. 2 mech. filters, product detector, variable BFO, noise limiter. S Meter, Bandspread. RF Gain. 15in × 9⅛in × 8½in. 18lbs. 220/240V a.c. or 12V d.c. Brand new with instructions. £50. Carr. 50p.

**TRIO 9R59DS COMMUNICATION RECEIVER**



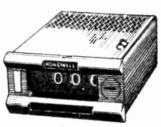
4 band covering 550kHz–30MHz continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW. ANL. Variable BFO. S meter. Sep. bandspread dial. IF frequency 455kHz. Audio output 1·5W. Variable RF and AF gain controls 115/250V a.c. Size 7in × 13in × 10in with instruction manual. £49·50. Carr. paid.

**EMI LOUDSPEAKERS**



Model 350. 13in × 8in with single tweeter/crossover, 20–20,000Hz. 15W RMS. Available 8 or 15 ohms. £7·25 each. Post 37p.
Model 450. 13in × 8in with twin tweeter/crossover. 55–13,000Hz. 8W RMS. Available 8 or 15 ohms. £3·62 each. Post 25p.

**HONEYWELL DIGITAL VOLTMETER VT.100**



Can be panel or bench mounted. Basic meter measures 1V d.c. but can be used to measure a wide range of a.c. and d.c. volt, current and ohms with optional plug in cards. Specification: Accuracy: ±0·2, ±1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999). Input Impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100V d.c. Input: Fully floating (3 poles). Input power: 110–230V a.c. 50/60 cycles. Overall size: 5⅛in × 2⅞in × 8⅝in. AVAILABLE BRAND NEW AND FULLY GUARANTEED. £35·50. Carr. 50p.

# SINCLAIR IC-12

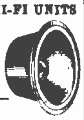
List Price £2·98
OUR PRICE £1·80
P. & P. 10p.

**SINCLAIR EQUIPMENT**

Project 60 Package offers.

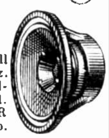
2 × Z30 amplifier, stereo 60 pre-amp, PZ5 power supply. £15·95. Carr. 37p. Or with PZ6 power supply. £18·00. Carr. 37p. 2 × Z50 amplifier, stereo 60 pre-amp, PZ8 power supply. £20·25. Carr. 37p. Transformer for PZ8. £2·97 extra. Add to any of the above £4·45 for active filter unit and £13·00 for pair of Q16 speakers. All other Sinclair products in stock. 2000 amp. £21·95. Carr. 37p.; 3000 amp. £28·50. Carr. 37p.: Neoteric Amp. £43·95. Carr. 37p. IC12. £1·80. P. & P. 10p. NEW PROJECT 605—£20·97. Carr. 37p.

**WHARFEDALE MID-RANGE HI-FI UNITS**



As used in world famous system. 5in dia. Impedance 4/8 ohms. High flux ceramic magnet. 20W RMS. Brand new £1·50. Carr. 37p.

**SPECIAL OFFER! GOODMANS AXIOM 301**



Hi-Fi 12in 20W twin cone full range speaker. 30–16,000Hz. 16,500 gauss. 8 ohm impedance. Brand new and boxed. (List price £21·72). OUR PRICE £12·50 each. Carr. 50p.

**HA-10 STEREO HEADPHONE AMPLIFIER**

All silicon transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. Inputs 5MΩ/100MΩ. Output 50MW. £5·97. Post 15p.

## SPECIAL PURCHASE !

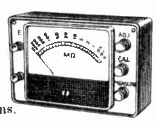
**NEAT G30J STATIC BALANCE PICK-UP ARMS**

Identical specification to NEAT G30 arm but with two-tone chrome and black finish. Complete with head shell, pick-up rest and plug in phono leads. BRAND NEW—FULLY GUARANTEED. ONLY £8·95. Post 25p.

**KAMODEN HM-350 TRANSISTOR TESTER**

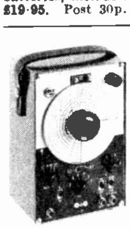
High quality instrument to test Reverse Leak current and D.C. current. Amplification factor of NPN, PNP, transistors, diodes, SCR's, etc. 4" × 4½" clear scale meter. Operates from internal batteries. Complete with instructions, leads and carrying handle. £12·50. Post 30p.

**KAMODEN HMG-500 INSULATION RESISTANCE TESTER**



Range 0–1,000 Megohms, 500 Volt. Battery operated. Wide range clear meter 4½" × 4". Complete with deluxe carrying case, batteries, instructions. £19·95. Post 30p.

**ARF-300 AF/RF SIGNAL GENERATOR**



All transistorised, compact, fully portable. AF sine wave 18 Hz to 220 KHz. AF square wave 18 Hz to 100 KHz. Output sine/square 10v. P-P. RF 100 KHz to 200 MHz. Output 1v. maximum. Operation 220/240v. AC. Complete with instructions and leads. £29·95. Post 50p.

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- X5000 Tape Rec. .. £99·95
- GX370 Tape Deck .. £259·95
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- 4000DS Dust Cover .. £4·75
- X201D Tape Deck .. £132·95
- X221D Tape Deck .. £169·95
- GX220D Tape Deck .. £148·50
- GX280D Tape Deck .. £249·40
- X1810D Tape/8 track Deck .. £169·95
- GX1900D Tape/Cass. Deck .. £177·95
- X2000SD Tape/Cas/8 Rec. .. £223·30
- CR80DSS 8 track .. £122·50
- CR81 8 track Rec. .. £80·95
- CR81D 8 track Rec. .. £65·95
- CR81T 8 track/Receiver .. £118·90
- CR80SS 8 track system .. £145·00
- GXC40 Cassette Rec. .. £82·25
- GXC40D Cassette Deck .. £66·95
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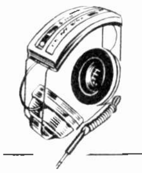
Carriage 50p extra (recorders and decks 75p).

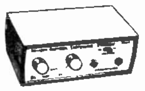
## GENUINE BARGAIN!

**KOSS SP.3XC STEREO HEADPHONES**



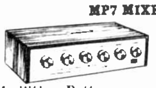
Response 10–15,000Hz. Impedance 4–16 ohms. Brand new. Boxed and fully g'teed (List £9·50). OUR PRICE £6·50. Post 25p.

**1021 STEREO LISTENING STATION**



For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. 2 gain controls, speaker on-off slide switch, stereo headphone sockets. 6in × 4in × 2½in. £2·25. Post 15p.

**MP7 MIXER PREAMPLIFIER**



5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9½in × 5in × 3in. Inputs Mics: 3 × 3mV 50K: 2 × 3mV 600 ohm. Phono mag. 4mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K. £8·97. Post 20p.

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Features unique mechanical 2 way units and fitted adjustable level. controls. 8 ohm impedance 20–20,000cps Complete with spring lead & stereo jack plug £7·97. Post 12p.

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**HOSIDEN DHO-2S STEREO HEADPHONES**

Wonderful value and excellent performance combined. Adjustable head-band. 8 ohm impedance. 20–12,000 cps. Complete with lead and plug. ONLY £2·37. Post 12p.

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Top quality Hi-Fi Low Noise in Library cases.

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| C90 | 3 for £1·05 | 10 for £3·30 |
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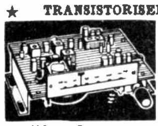
Self-contained, transistorised, battery operated. Simply plug in microphone, guitar, etc., and output into your amplifier. Volume control, depth of reverberation control. Beautiful walnut cabinet. 7¼in × 3in × 4½in. £5·97. Post 15p.

**★ TRANSISTORISED FM TUNER ★**



6 TRANSISTOR HIGH QUALITY TUNER, SIZE ONLY 6in × 4in × 2½in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88–108MHz. Ready built ready for use. Fantastic value for money. £8·37. Post 12p Stereo multiplex adaptors £4·97.

**TE 1018 DE-LUXE MONO HIGH IMPEDANCE HEADSET**

Sensitive, soft earpads, adjustable headband. Magnetic, impedance 2,600 ohms. £1·97. Post 15p.

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Also see previous pages and opposite page

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With remote control microphone.

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THE ONE STEP FORWARD EVERYONE HAS WAITED FOR! **NOW** a superb de-luxe portable **BATTERY/MAINS** tape recorder and player—and incredible **Shopertunities** bring it to you for ONLY £12·49! Due to our cut price we cannot name first-class makers—**but rest assured you're getting one of the BEST!** Expensive **"PIANO KEYBOARD" CONTROL PANEL (or latest MASTER SWITCH control) AND AUTOMATIC LEVEL CONTROL.** No fiddling with awkward tape and reels, **just "slap-in" a cassette and off you go!** (Takes 30, 60, or 90 minute standard cassette tapes obtainable everywhere). **Amazing** performance ensures perfect tapings and superb reproduction! Remote control microphone. Rapid Rewind! Fast forward! Beautiful tone from a whisper to a roar! Completely self contained—**record anywhere**, indoors or out! **Runs on standard batteries AND 220/240V AC mains.** Separate jacks for remote control microphone, etc. Size 9½in 5in 2½in approx. Design can vary slightly. With carry handle. WRITTEN GUARANTEE and full instructions. **ONLY £12·49 post, etc., 31p.** ★ Refund if you don't agree we could charge up to £26·97! **BONUS OFFER** (one per customer)—**Cassette tape, set of standard batteries AND microphone stand all for 50p extra, if required. Send quickly, after receiving goods test 7 days—refund if not delighted. Or call.**

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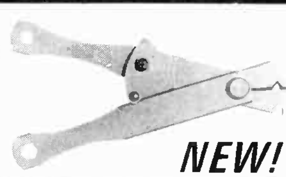
**Size 5** (Savbit) 18swg, 18p (illustrated)

**Size 19A** (60/40 alloy) 18swg. 18p

**Size 15** (60/40 alloy) 22swg. 22p

## BIB WIRE STRIPPER AND CUTTER



**NEW!**

**Model 3A.** Strips insulation from cable or flex without nicking wire. 4 different settings, 4&6 BA spanner ends, ground cutting edges Price 32p. Also available, de luxe Model 8. Price 58p.

From Electrical and Hardware Shops. If unobtainable, write to: **Multicore Solders Ltd.,** Hemel Hempstead, Herts. HP2 7EP

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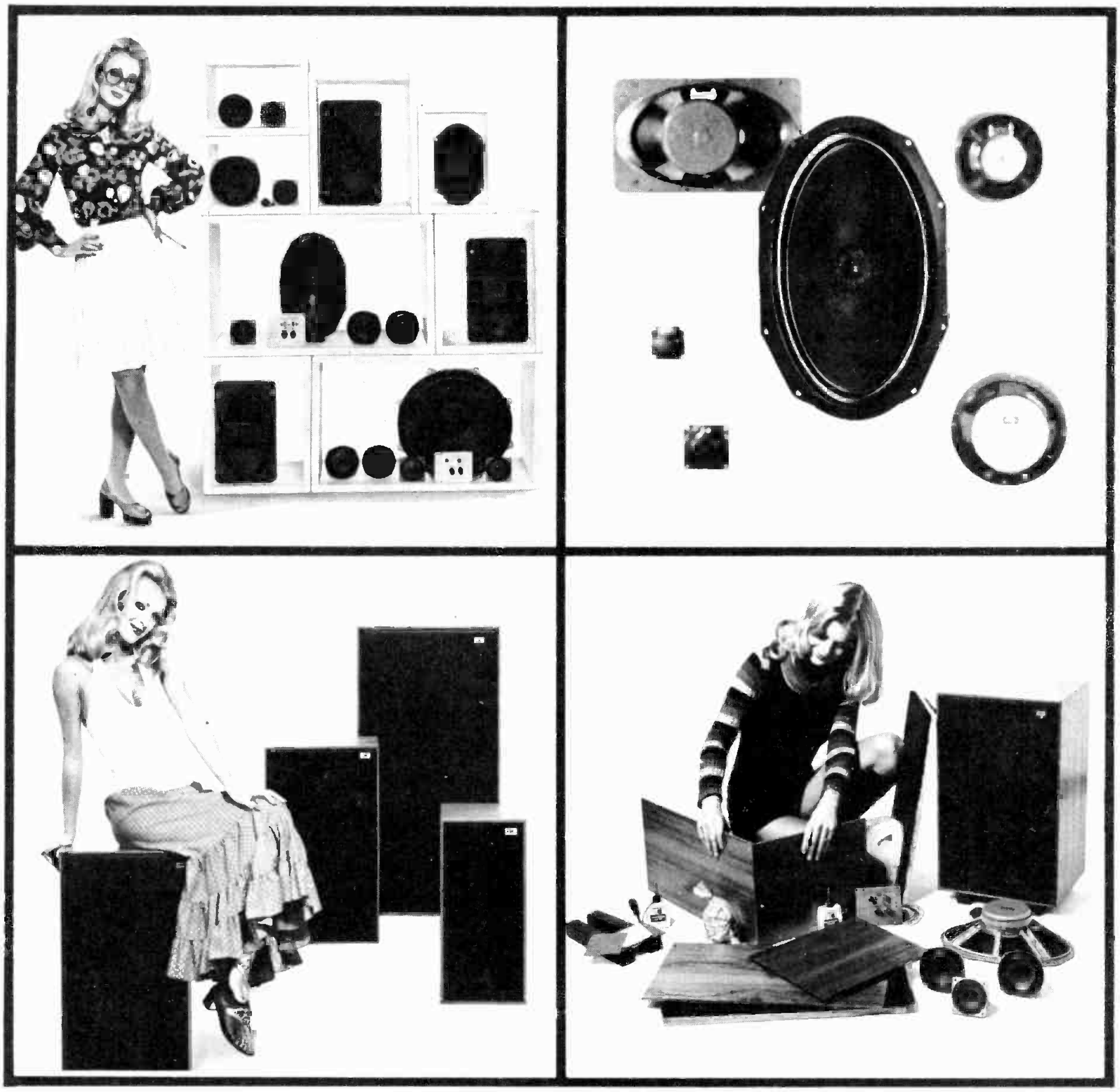

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# THIS IS THE FIRST PAGE OF THE GREAT BI-PAK SECTION

## BRAND NEW FULLY GUARANTEED DEVICES

*Cut these 3 pages out and keep for reference*

| Type | Price |
|---|---|
| AC107 | 0·20 |
| AC113 | 0·20 |
| AC115 | 0·23 |
| AC117K | 0·20 |
| AC122 | 0·12 |
| AC125 | 0·17 |
| AC126 | 0·17 |
| AC127 | 0·17 |
| AC128 | 0·17 |
| AC132 | 0·14 |
| AC134 | 0·14 |
| AC137 | 0·14 |
| AC141 | 0·14 |
| AC141K | 0·17 |
| AC142 | 0·14 |
| AC142K | 0·17 |
| AC151 | 0·15 |
| AC154 | 0·20 |
| AC155 | 0·20 |
| AC156 | 0·20 |
| AC157 | 0·24 |
| AC165 | 0·20 |
| AC166 | 0·20 |
| AC167 | 0·20 |
| AC168 | 0·24 |
| AC169 | 0·14 |
| AC176 | 0·20 |
| AC177 | 0·24 |
| AC178 | 0·28 |
| AC179 | 0·28 |
| AC180 | 0·17 |
| AC180K | 0·20 |
| AC181 | 0·17 |
| AC181K | 0·20 |
| AC187 | 0·22 |
| AC187K | 0·20 |
| AC188 | 0·22 |
| AC188K | 0·20 |
| ACY17 | 0·25 |
| ACY18 | 0·20 |
| ACY19 | 0·20 |
| ACY20 | 0·20 |
| ACY21 | 0·20 |
| ACY22 | 0·16 |
| ACY27 | 0·18 |
| ACY28 | 0·19 |
| ACY29 | 0·35 |
| ACY30 | 0·28 |
| ACY31 | 0·28 |
| ACY34 | 0·21 |
| ACY35 | 0·21 |
| ACY36 | 0·28 |
| ACY40 | 0·17 |
| ACY41 | 0·18 |
| ACY44 | 0·35 |
| AD130 | 0·38 |
| AD140 | 0·48 |
| AD142 | 0·48 |
| AD143 | 0·38 |
| AD149 | 0·50 |
| AD161 | 0·33 |

| Type | Price |
|---|---|
| AD162 | 0·33 |
| AD161 & AD162 (MP) | 0·55 |
| ADT140 | 0·50 |
| AF114 | 0·24 |
| AF115 | 0·24 |
| AF116 | 0·24 |
| AF117 | 0·24 |
| AF118 | 0·35 |
| AF124 | 0·30 |
| AF125 | 0·25 |
| AF126 | 0·28 |
| AF127 | 0·28 |
| AF139 | 0·30 |
| AF178 | 0·50 |
| AF179 | 0·50 |
| AF180 | 0·50 |
| AF181 | 0·45 |
| AF186 | 0·45 |
| AF239 | 0·37 |
| AL102 | 0·65 |
| AL103 | 0·65 |
| ASY26 | 0·25 |
| ASY27 | 0·30 |
| ASY28 | 0·25 |
| ASY29 | 0·25 |
| ASY50 | 0·25 |
| ASY51 | 0·25 |
| ASY52 | 0·25 |
| ASY54 | 0·25 |
| ASY55 | 0·25 |
| ASY56 | 0·25 |
| ASY57 | 0·25 |
| ASY58 | 0·25 |
| ASZ21 | 0·40 |
| BC107 | 0·09 |
| BC108 | 0·09 |
| BC109 | 0·10 |
| BC113 | 0·10 |
| BC114 | 0·15 |
| BC115 | 0·15 |
| BC116 | 0·15 |
| BC117 | 0·15 |
| BC118 | 0·10 |
| BC119 | 0·30 |
| BC120 | 0·80 |
| BC125 | 0·12 |
| BC126 | 0·18 |
| BC132 | 0·12 |
| BC134 | 0·18 |
| BC135 | 0·12 |
| BC136 | 0·15 |
| BC137 | 0·15 |
| BC139 | 0·40 |
| BC140 | 0·30 |
| BC141 | 0·30 |
| BC142 | 0·30 |
| BC143 | 0·30 |
| BC145 | 0·45 |
| BC147 | 0·10 |

| Type | Price |
|---|---|
| BC148 | 0·10 |
| BC149 | 0·12 |
| BC150 | 0·18 |
| BC151 | 0·20 |
| BC152 | 0·17 |
| BC153 | 0·28 |
| BC154 | 0·30 |
| BC157 | 0·18 |
| BC158 | 0·12 |
| BC159 | 0·12 |
| BC160 | 0·45 |
| BC161 | 0·50 |
| BC167 | 0·12 |
| BC168 | 0·12 |
| BC169 | 0·12 |
| BC170 | 0·12 |
| BC171 | 0·14 |
| BC172 | 0·14 |
| BC173 | 0·14 |
| BC174 | 0·14 |
| BC175 | 0·22 |
| BC177 | 0·19 |
| BC178 | 0·19 |
| BC179 | 0·19 |
| BC180 | 0·24 |
| BC181 | 0·24 |
| BC182 | 0·10 |
| BC182L | 0·10 |
| BC183 | 0·10 |
| BC183L | 0·10 |
| BC184 | 0·12 |
| BC184L | 0·12 |
| BC186 | 0·28 |
| BC187 | 0·28 |
| BC207 | 0·11 |
| BC208 | 0·11 |
| BC209 | 0·12 |
| BC212L | 0·11 |
| BC213L | 0·11 |
| BC214L | 0·14 |
| BC225 | 0·25 |
| BC226 | 0·35 |
| BCY30 | 0·24 |
| BCY31 | 0·26 |
| BCY32 | 0·30 |
| BCY33 | 0·22 |
| BCY34 | 0·25 |
| BCY70 | 0·14 |
| BCY71 | 0·18 |
| BCY72 | 0·14 |
| BCZ10 | 0·20 |
| BCZ11 | 0·25 |
| BCZ12 | 0·25 |
| BD121 | 0·60 |
| BD123 | 0·65 |
| BD124 | 0·60 |
| BD131 | 0·50 |
| BD132 | 0·60 |
| BD133 | 0·65 |
| BD135 | 0·40 |
| BD136 | 0·40 |

| Type | Price |
|---|---|
| BD137 | 0·45 |
| BD138 | 0·50 |
| BD139 | 0·55 |
| BD140 | 0·60 |
| BD155 | 0·80 |
| BD175 | 0·60 |
| BD176 | 0·60 |
| BD177 | 0·65 |
| BD178 | 0·65 |
| BD179 | 0·70 |
| BD180 | 0·70 |
| BD185 | 0·65 |
| BD186 | 0·65 |
| BD187 | 0·70 |
| BD188 | 0·70 |
| BD189 | 0·75 |
| BD190 | 0·75 |
| BD195 | 0·85 |
| BD196 | 0·85 |
| BD197 | 0·90 |
| BD198 | 0·90 |
| BD199 | 0·95 |
| BD200 | 0·95 |
| BD205 | 0·80 |
| BD206 | 0·80 |
| BD207 | 0·95 |
| BD208 | 0·95 |
| BDY20 | 1·00 |
| BF115 | 0·24 |
| BF117 | 0·45 |
| BF118 | 0·70 |
| BF119 | 0·70 |
| BF121 | 0·45 |
| BF123 | 0·50 |
| BF125 | 0·45 |
| BF127 | 0·50 |
| BF152 | 0·55 |
| BF153 | 0·45 |
| BF154 | 0·45 |
| BF155 | 0·70 |
| BF156 | 0·48 |
| BF157 | 0·55 |
| BF158 | 0·55 |
| BF159 | 0·60 |
| BF160 | 0·40 |
| BF162 | 0·40 |
| BF163 | 0·40 |
| BF164 | 0·40 |
| BF165 | 0·40 |
| BF167 | 0·22 |
| BF173 | 0·22 |
| BF176 | 0·35 |
| BF177 | 0·35 |
| BF178 | 0·30 |
| BF179 | 0·30 |
| BF180 | 0·30 |
| BF181 | 0·30 |
| BF182 | 0·40 |
| BF183 | 0·40 |
| BF184 | 0·25 |
| BF185 | 0·30 |

| Type | Price |
|---|---|
| BF188 | 0·40 |
| BF194 | 0·12 |
| BF195 | 0·12 |
| BF196 | 0·14 |
| BF197 | 0·14 |
| BF200 | 0·45 |
| BF222 | 0·95 |
| BF257 | 0·45 |
| BF258 | 0·60 |
| BF259 | 0·85 |
| BF262 | 0·55 |
| BF263 | 0·55 |
| BF270 | 0·35 |
| BF271 | 0·30 |
| BF272 | 0·80 |
| BF273 | 0·35 |
| BF274 | 0·35 |
| BFW10 | 0·60 |
| BFX29 | 0·27 |
| BFX84 | 0·22 |
| BFX85 | 0·30 |
| BFX86 | 0·22 |
| BFX87 | 0·24 |
| BFX88 | 0·22 |
| BFY50 | 0·20 |
| BFY51 | 0·20 |
| BFY52 | 0·20 |
| BFY53 | 0·17 |
| BPX25 | 0·85 |
| BSX19 | 0·15 |
| BSX20 | 0·15 |
| BSY25 | 0·15 |
| BSY26 | 0·15 |
| BSY27 | 0·15 |
| BSY28 | 0·15 |
| BSY29 | 0·15 |
| BSY38 | 0·18 |
| BSY39 | 0·18 |
| BSY40 | 0·28 |
| BSY41 | 0·28 |
| BSY95 | 0·12 |
| BSY95A | 0·12 |
| Bu105 | 2·00 |
| C111E | 0·50 |
| C400 | 0·30 |
| C407 | 0·25 |
| C424 | 0·20 |
| C425 | 0·50 |
| C426 | 0·35 |
| C428 | 0·20 |
| C441 | 0·30 |
| C442 | 0·30 |
| C444 | 0·35 |
| C450 | 0·22 |
| MAT100 | 0·19 |
| MAT101 | 0·20 |
| MAT120 | 0·19 |
| MAT121 | 0·20 |
| MPF102 | 0·42 |
| MPF104 | 0·37 |
| MPF105 | 0·37 |

| Type | Price |
|---|---|
| OC19 | 0·35 |
| OC20 | 0·63 |
| OC22 | 0·38 |
| OC23 | 0·42 |
| OC24 | 0·56 |
| OC25 | 0·38 |
| OC26 | 0·25 |
| OC28 | 0·50 |
| OC29 | 0·50 |
| OC35 | 0·42 |
| OC36 | 0·50 |
| OC41 | 0·20 |
| OC42 | 0·24 |
| OC44 | 0·15 |
| OC45 | 0·12 |
| OC70 | 0·10 |
| OC71 | 0·10 |
| OC72 | 0·14 |
| OC74 | 0·14 |
| OC75 | 0·15 |
| OC76 | 0·15 |
| OC77 | 0·25 |
| OC81 | 0·15 |
| OC81D | 0·15 |
| OC82 | 0·15 |
| OC82D | 0·15 |
| OC83 | 0·20 |
| OC84 | 0·20 |
| OC139 | 0·20 |
| OC140 | 0·20 |
| OC169 | 0·25 |
| OC170 | 0·25 |
| OC171 | 0·25 |
| OC200 | 0·25 |
| OC201 | 0·28 |
| OC202 | 0·28 |
| OC203 | 0·25 |
| OC204 | 0·25 |
| OC205 | 0·35 |
| OC309 | 0·40 |
| P346A | 0·20 |
| P397 | 0·42 |
| OCP71 | 0·43 |
| ORP12 | 0·43 |
| ORP60 | 0·40 |
| ORP61 | 0·40 |
| ST140 | 0·12 |
| ST141 | 0·17 |
| TIS43 | 0·30 |
| UT46 | 0·27 |
| 2G301 | 0·09 |
| 2G302 | 0·19 |
| 2G303 | 0·19 |
| 2G304 | 0·24 |
| 2G306 | 0·40 |
| 2G308 | 0·35 |
| 2G309 | 0·35 |
| 2G339 | 0·20 |
| 2G339A | 0·16 |
| 2G344 | 0·18 |
| 2G345 | 0·16 |

| Type | Price |
|---|---|
| 2G371 | 0·16 |
| 2G371B | 0·12 |
| 2G373 | 0·17 |
| 2G374 | 0·17 |
| 2G377 | 0·30 |
| 2G378 | 0·16 |
| 2G381 | 0·16 |
| 2G382 | 0·16 |
| 2G401 | 0·30 |
| 2G414 | 0·30 |
| 2G417 | 0·25 |
| 2N388 | 0·35 |
| 2N388A | 0·55 |
| 2N404 | 0·20 |
| 2N404A | 0·28 |
| 2N524 | 0·42 |
| 2N527 | 0·49 |
| 2N598 | 0·42 |
| 2N599 | 0·45 |
| 2N696 | 0·12 |
| 2N697 | 0·13 |
| 2N698 | 0·24 |
| 2N699 | 0·35 |
| 2N706 | 0·08 |
| 2N706A | 0·09 |
| 2N708 | 0·12 |
| 2N711 | 0·30 |
| 2N717 | 0·35 |
| 2N718 | 0·24 |
| 2N718A | 0·50 |
| 2N726 | 0·28 |
| 2N727 | 0·28 |
| 2N743 | 0·20 |
| 2N744 | 0·20 |
| 2N914 | 0·14 |
| 2N918 | 0·30 |
| 2N929 | 0·21 |
| 2N930 | 0·21 |
| 2N1131 | 0·20 |
| 2N1132 | 0·22 |
| 2N1302 | 0·14 |
| 2N1303 | 0·14 |
| 2N1304 | 0·17 |
| 2N1305 | 0·17 |
| 2N1306 | 0·21 |
| 2N1307 | 0·21 |
| 2N1308 | 0·23 |
| 2N1309 | 0·23 |
| 2N1613 | 0·20 |
| 2N1711 | 0·20 |
| 2N1889 | 0·32 |
| 2N1890 | 0·45 |
| 2N1893 | 0·37 |
| 2N2147 | 0·72 |
| 2N2148 | 0·57 |
| 2N2160 | 0·60 |
| 2N2192 | 0·35 |
| 2N2193 | 0·35 |
| 2N2194 | 0·35 |
| 2N2217 | 0·22 |
| 2N2218 | 0·20 |

| Type | Price |
|---|---|
| 2N2219 | 0·20 |
| 2N2220 | 0·22 |
| 2N2221 | 0·20 |
| 2N2222 | 0·20 |
| 2N2368 | 0·17 |
| 2N2369 | 0·14 |
| 2N2369A | 0·14 |
| 2N2411 | 0·24 |
| 2N2412 | 0·24 |
| 2N2646 | 0·47 |
| 2N2711 | 0·21 |
| 2N2712 | 0·21 |
| 2N2714 | 0·21 |
| 2N2904 | 0·17 |
| 2N2904A | 0·21 |
| 2N2905 | 0·21 |
| 2N2905A | 0·21 |
| 2N2906 | 0·15 |
| 2N2906A | 0·18 |
| 2N2907 | 0·20 |
| 2N2907A | 0·22 |
| 2N2923 | 0·14 |
| 2N2924 | 0·14 |
| 2N2925 | 0·14 |
| 2N2926 (G) | 0·12 |
| 2N2926 (Y) | 0·11 |
| 2N2926 (O) | 0·10 |
| 2N2926 (R) | 0·10 |
| 2N2926 (B) | 0·10 |
| 2N3010 | 0·70 |
| 2N3011 | 0·14 |
| 2N3053 | 0·17 |

| Type | Price |
|---|---|
| 2N3054 | 0·46 |
| 2N3055 | 0·50 |
| 2N3391 | 0·14 |
| 2N3391A | 0·16 |
| 2N3392 | 0·14 |
| 2N3393 | 0·14 |
| 2N3394 | 0·14 |
| 2N3395 | 0·17 |
| 2N3402 | 0·21 |
| 2N3403 | 0·21 |
| 2N3404 | 0·28 |
| 2N3405 | 0·42 |
| 2N3414 | 0·15 |
| 2N3415 | 0·15 |
| 2N3416 | 0·28 |
| 2N3417 | 0·28 |
| 2N3525 | 0·75 |
| 2N3646 | 0·09 |
| 2N3702 | 0·10 |
| 2N3703 | 0·10 |
| 2N3704 | 0·11 |
| 2N3705 | 0·10 |
| 2N3706 | 0·09 |
| 2N3707 | 0·11 |
| 2N3708 | 0·07 |
| 2N3709 | 0·09 |
| 2N3710 | 0·09 |
| 2N3711 | 0·09 |
| 2N3819 | 0·28 |
| 2N3820 | 0·50 |
| 2N3821 | 0·35 |
| 2N3823 | 0·28 |
| 2N3903 | 0·28 |
| 2N3904 | 0·30 |
| 2N3905 | 0·28 |
| 2N3906 | 0·27 |
| 2N4058 | 0·12 |

| Type | Price |
|---|---|
| 2N4059 | 0·10 |
| 2N4060 | 0·12 |
| 2N4061 | 0·12 |
| 2N4062 | 0·12 |
| 2N4284 | 0·17 |
| 2N4285 | 0·17 |
| 2N4286 | 0·17 |
| 2N4287 | 0·17 |
| 2N4288 | 0·17 |
| 2N4289 | 0·17 |
| 2N4290 | 0·17 |
| 2N4291 | 0·17 |
| 2N4292 | 0·17 |
| 2N4293 | 0·17 |
| 2N5172 | 0·12 |
| 2N5457 | 0·32 |
| 2N5458 | 0·32 |
| 2N5459 | 0·40 |
| 2S301 | 0·50 |
| 2S302A | 0·42 |
| 2S302 | 0·42 |
| 2S303 | 0·55 |
| 2S304 | 0·70 |
| 2S305 | 0·84 |
| 2S306 | 0·84 |
| 2S307 | 0·84 |
| 2S321 | 0·56 |
| 2S322 | 0·42 |
| 2S322A | 0·42 |
| 2S323 | 0·56 |
| 2S324 | 0·70 |
| 2S325 | 0·70 |
| 2S326 | 0·70 |
| 2S327 | 0·70 |
| 2S701 | 0·42 |
| 40361 | 0·40 |
| 40362 | 0·45 |

### DIODES AND RECTIFIERS

| Type | Price |
|---|---|
| AA119 | 0·08 |
| AA120 | 0·08 |
| AA129 | 0·08 |
| AAY30 | 0·09 |
| AAZ13 | 0·10 |
| BA100 | 0·10 |
| BA116 | 0·21 |
| BA126 | 0·22 |
| BA148 | 0·14 |
| BA154 | 0·12 |
| BA155 | 0·14 |
| BA156 | 0·13 |
| BY100 | 0·15 |
| BY101 | 0·12 |
| BY105 | 0·17 |
| BY114 | 0·12 |
| BY126 | 0·14 |
| BY127 | 0·15 |
| BY128 | 0·15 |
| BY130 | 0·16 |

| Type | Price |
|---|---|
| BY133 | 0·21 |
| BY164 | 0·50 |
| BYX38/30 | 0·42 |
| BYZ10 | 0·35 |
| BYZ11 | 0·30 |
| BYZ12 | 0·30 |
| BYZ13 | 0·25 |
| BYZ16 | 0·40 |
| BYZ17 | 0·35 |
| BYZ18 | 0·35 |
| BYZ19 | 0·28 |
| CG62 (Eg) OA91 | 0·05 |
| CG651 (Eq) OA70-OA79 | 0·06 |
| OA5 | 0·35 |
| OA58L | 0·21 |

| Type | Price |
|---|---|
| OA10 | 0·35 |
| OA47 | 0·07 |
| OA70 | 0·07 |
| OA79 | 0·07 |
| OA81 | 0·07 |
| OA85 | 0·09 |
| OA90 | 0·06 |
| OA91 | 0·06 |
| OA95 | 0·07 |
| OA200 | 0·06 |
| OA202 | 0·07 |
| SD10 | 0·05 |
| SD19 | 0·05 |
| IN34 | 0·07 |
| IN34A | 0·07 |
| IN914 | 0·06 |
| IN916 | 0·06 |
| IN4148 | 0·06 |
| IS021 | 0·10 |
| IS951 | 0·06 |

## NEW COMPONENT PAK BARGAINS

| Pack No. | Qty. | Description | Price |
|---|---|---|---|
| C 1 | 250 | Resistors mixed values approx. count by weight | 0·50 |
| C 2 | 200 | Capacitors mixed values approx. count by weight | 0·50 |
| C 3 | 50 | Precision Resistors ·1%, ·01% mixed values | 0·50 |
| C 4 | 75 | ⅛th W Resistors mixed preferred values | 0·50 |
| C 5 | 5 | Pieces assorted Ferrite Rods | 0·50 |
| C 6 | 2 | Tuning Gangs, MW/LW VHF | 0·50 |
| C 7 | 1 | Pack Wire 50 metres assorted colours | 0·50 |
| C 8 | 10 | Reed Switches | 0·50 |
| C 9 | 3 | Micro Switches | 0·50 |
| C10 | 15 | Assorted Pots & Pre-Sets | 0·50 |
| C11 | 5 | Jack Sockets 3 × 3·5m 2 × Standard Switch Types | 0·50 |
| C12 | 40 | Paper Condensers preferred types mixed values | 0·50 |
| C13 | 20 | Electrolytics Trans. types | 0·50 |
| C14 | 1 | Pack assorted Hardware—Nuts/Bolts, Grommets etc. | 0·50 |
| C15 | 4 | Mains Toggle Switches, 2 Amp D/P | 0·50 |
| C16 | 20 | Assorted Tag Strips & Panels | 0·50 |
| C17 | 10 | Assorted Control Knobs | 0·50 |
| C18 | 4 | Rotary Wave Change Switches | 0·50 |
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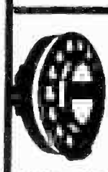

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| 400 | 0·43 | 0·47 | 0·56 | 0·56 | 0·67 | 0·75 | 0·93 | 1·75 |
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| SN74180 | £2·00 | £1·60 | £1·40 |
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| SN74182 | £2·00 | £1·80 | £1·60 |
| SN74184 | £3·50 | £3·25 | £3·00 |
| SN74190 | £1·95 | £1·90 | £1·85 |
| SN74191 | £1·90 | £1·85 | £1·80 |
| SN74192 | £1·95 | £1·90 | £1·85 |
| SN74193 | £2·00 | £1·80 | £1·75 |
| SN74194 | £2·70 | £2·60 | £2·50 |
| SN74195 | £2·00 | £1·90 | £1·80 |
| SN74196 | £1·80 | £1·70 | £1·60 |
| SN74197 | £1·80 | £1·70 | £1·60 |
| SN74198 | £5·50 | £5·00 | £4·50 |
| SN74199 | £5·90 | £5·00 | £4·50 |

### LINEAR I.C.'s—FULL SPEC.

| Type No. | Price 1–24 | 25–99 | 100 up |
|---|---|---|---|
| BP201C—SL201C | 68p | 58p | 45p |
| BP701C—SL701C | 68p | 50p | 45p |
| BP702C—SL702C | 68p | 50p | 45p |
| BP702—72702 | 53p | 45p | 40p |
| BP709—72709 | 36p | 34p | 30p |
| BP709P—μA709C | 36p | 34p | 30p |
| BP710—72710 | 44p | 42p | 40p |
| BP711—μA711 | 45p | 43p | 40p |
| BP741—72741 | 75p | 60p | 50p |
| μA703C—μA703C | 28p | 26p | 24p |
| TAA263— | 70p | 60p | 55p |
| TAA293— | 90p | 75p | 70p |
| TAA350 | 170p | 158p | 150p |
| S.G.S. EA1000 2·63 | | | |

### ROCK BOTTOM PRICES
### LOGIC DTL 930 Series I.C's

| Type No. | Price 1–24 | 25–99 | 100 up |
|---|---|---|---|
| BP930 | 12p | 11p | 10p |
| BP932 | 13p | 12p | 11p |
| BP933 | 13p | 12p | 11p |
| BP935 | 13p | 12p | 11p |
| BP936 | 13p | 12p | 11p |
| BP944 | 13p | 12p | 11p |
| BP945 | 25p | 24p | 22p |
| RP946 | 12p | 11p | 10p |
| BP948 | 25p | 24p | 22p |
| BP951 | 65p | 60p | 55p |
| BP962 | 12p | 11p | 10p |
| BP9093 | 40p | 38p | 35p |
| BP9094 | 40p | 38p | 35p |
| BP9097 | 40p | 38p | 35p |
| BP9099 | 40p | 38p | 35p |

Devices may be mixed to qualify for quantity price. Larger quantity prices on application. (DTL 930 Series only).

## NUMERICAL INDICATOR TUBES

| MODEL | CD66 | GR116 | 3015F Minitron |
|---|---|---|---|
| Anode voltage (Vdc) | 170min | 175min | 5 |
| Cathode Current (mA) | 2·3 | 14 | 8 |
| Numerical Height (mm) | 16 | 13 | 9 |
| Tube Height (mm) | 47 | 32 | 22 |
| Tube Diameter (mm) | 19 | 13 | 12 wide |
| I.C. Driver Rec. | BP41 or 141 | BP41 or 141 | BP47 |
| PRICE EACH | £1·70 | £1·55 | £1·90 |

All indicators 0·9 + Decimal point. All side viewing. Full data for all types available on request.

### RTL MICROLOGIC CIRCUITS

| Epoxy TO-5 case | Price each 1–24 | 25–99 | 100 up |
|---|---|---|---|
| uL900 Buffer | 35p | 33p | 27p |
| uL914 Dual 2i/p gate | 35p | 33p | 27p |
| uL923 J-K flip-flop | 50p | 47p | 45p |

Date and Circuits Booklet for IC's Price 7p.

### DUAL IN LINE SOCKETS.

14 & 16 Lead Sockets for use with DUAL-IN-LINE I.C's. TWO Ranges PROFESSIONAL & NEW LOW COST.

| PROF. TYPE No. | 1–24 | 25–99 | 100up. |
|---|---|---|---|
| TSO 14 pin type | 30p | 27p | 25p |
| TSO 16 ,, ,, | 35p | 32p | 30p |
| LOW COST No. | | | |
| BPS 14 | 15p | 13p | 11p |
| BPS 16 | 16p | 14p | 12p |

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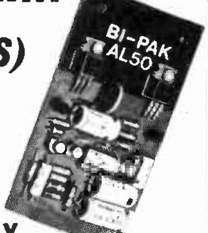



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## THE AL50

★ Frequency Response 15Hz to 100,000—1dB.

★ Load—3, 4, 8 or 16 ohms.

★ Distortion—better than ·1% at 1KHz.

★ Signal to noise ratio 80dB.

**ONLY £3.25p each**

★ Supply voltage 10–35 Volts.

★ Overall size 63mm × 105mm × 13mm.

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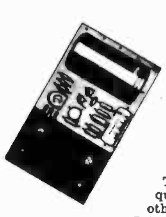
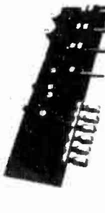


AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm. These units enable you to build Audio Systems of the highest quality at a bitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available, 10p **PRICE £2·95**

**TRANSFORMER BMT80 £1·95 p. & p. 25p.**

## STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit tecnniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.



**SPECIFICATION**

| | |
|---|---|
| Frequency Response | 20Hz – 20KHz ± 1dB |
| Harmonic Distortion | better than 0·1% |
| Inputs : 1. Tape Head | 1·25 mV into 50K Ω |
| 2. Radio, Tuner | 35 mV into 50K Ω |
| 3. Magnetic P.U. | 1·5 mV into 50K Ω |

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.

| | |
|---|---|
| Bass Control | ± 15dB at 20Hz |
| Treble Control | ± 15dB at 20KHz |
| Filters : Rumble (High Pass) | 100Hz |
| Scratch (Low Pass) | 8KHz |
| Signal/Noise Ratio | better than – 65dB |
| Input overload | + 26dB |
| Supply | + 35 volts at 20mA |
| Dimensions | 292mm × 82mm × 35mm |

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**Primary 200-250 Volts Secondary 240 Volts Centre Tapped (120V) and Earth Shielded**

**ALSO AVAILABLE WITH 115/120V SEC. WINDING**

| Ref. No. | VA (Watts) | Weight lb | oz | Size cm. | £ | P & P p |
|---|---|---|---|---|---|---|
| 07 | 20 | 1 | 11 | 7·0 × 6·0 × 6·5 | 1·61 | 30 |
| 100 | 60 | 3 | 8 | 8·9 × 8·0 × 7·7 | 2·39 | 36 |
| 61 | 100 | 5 | 12 | 10·2 × 8·9 × 8·3 | 2·62 | 52 |
| 30 | 200 | 9 | 8 | 12·0 × 10·3 × 10·0 | 4·39 | 52 |
| 62 | 250 | 12 | 4 | 9·5 × 12·7 × 11·4 | 5·80 | 67 |
| 55 | 350 | 15 | 0 | 14·0 × 10·8 × 12·4 | 7·77 | 82 |
| 63 | 500 | 27 | 0 | 17·1 × 11·4 × 15·9 | 11·20 | * |
| 92 | 1000 | 40 | 0 | 17·8 × 17·1 × 21·6 | 20·63 | * |
| 128 | 2000 | 63 | 0 | 24·1 × 21·6 × 15·2 | 34·10 | * |

## AUTO SERIES (NOT ISOLATED)

| Ref. No. | VA (Watts) | Weight lb | oz | Size cm. | Auto Taps | £ | P & P p |
|---|---|---|---|---|---|---|---|
| 113 | 20 | | 11 | 7·3 × 4·3 × 4·4 | 0-115-210-240 | 0·85 | 22 |
| 64 | 75 | 1 | 14 | 7·0 × 6·4 × 6·0 | 0-115-210-240 | 1·66 | 30 |
| 4 | 150 | 3 | 0 | 8·9 × 6·4 × 7·6 | 0-115-200-220-240 | 2·00 | 36 |
| 66 | 300 | 6 | 0 | 10·2 × 10·2 × 9·5 | ,, ,, | 3·89 | 52 |
| 67 | 500 | 12 | 8 | 14·0 × 10·2 × 11·4 | ,, ,, | 5·78 | 67 |
| 84 | 1000 | 16 | 0 | 11·4 × 14·0 × 14·0 | ,, ,, | 10·49 | 82 |
| 93 | 1500 | 28 | 9 | 13·5 × 14·9 × 16·5 | ,, ,, | 15·20 | * |
| 95 | 2000 | 40 | 0 | 17·8 × 16·5 × 21·6 | ,, ,, | 19·84 | * |
| 73 | 3000 | 45 | 8 | 17·4 × 18·1 × 21·3 | ,, ,, | 26·99 | * |

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Also available a 20 Watt version. £1·67. P & P 22p.

## LOW VOLTAGE SERIES (ISOLATED)

**PRIMARY 200-250 VOLTS 12 AND/OR 24 VOLT RANGE**

| Ref. No. | Amps. 12V | 24V | Weight lb | oz | Size cm. | Secondary Windings | £ | P & P p |
|---|---|---|---|---|---|---|---|---|
| 111 | 0·5 | 0·25 | | 12 | 7·6 × 5·7 × 4·4 | 0-12V at 0·25A × 2 | 0·85 | 22 |
| 213 | 1·0 | 0·5 | 1 | 0 | 8·3 × 5·1 × 5·1 | 0-12V at 0·5A × 2 | 1·01 | 22 |
| 71 | 2 | 1 | 1 | 0 | 7·0 × 6·4 × 5·7 | 0-12V at 1A × 2 | 1·33 | 22 |
| 18 | 4 | 2 | 2 | 4 | 8·3 × 7·0 × 7·0 | 0-12V at 2A × 2 | 1·86 | 36 |
| 70 | 6 | 3 | 3 | 12 | 10·2 × 7·6 × 8·6 | 0-12V at 3A × 2 | 2·24 | 42 |
| 108 | 8 | 4 | 5 | 4 | 10·0 × 8·3 × 8·2 | 0-12V at 4A × 2 | 2·48 | 52 |
| 72 | 10 | 5 | 6 | 3 | 7·9 × 10·8 × 10·2 | 0-12V at 5A × 2 | 2·94 | 52 |
| 17 | 16 | 8 | 7 | 8 | 12·1 × 9·5 × 10·2 | 0-12V at 8A × 2 | 4·54 | 52 |
| 115 | 20 | 10 | 11 | 13 | 12·1 × 11·4 × 10·2 | 0-12V at 10A × 2 | 5·78 | 67 |
| 187 | 30 | 15 | 16 | 12 | 13·3 × 12·1 × 12·1 | 0-12V at 15A × 2 | 10·67 | 82 |
| 226 | 60 | 30 | 34 | 0 | 17·0 × 14·5 × 12·5 | 0-12V at 30A × 2 | 19·61 | * |

## 30 VOLT RANGE

| Ref. No. | Amps. | Weight lb | oz | Size cm. | Secondary Taps | £ | P & P p |
|---|---|---|---|---|---|---|---|
| 112 | 0·5 | 1 | 4 | 8·3 × 3·7 × 4·9 | 0-12-15-20-24-30V | 1·01 | 22 |
| 79 | 1·0 | 2 | 0 | 7·0 × 6·4 × 6·0 | ,, ,, | 1·35 | 36 |
| 3 | 2·0 | 3 | 2 | 8·9 × 7·0 × 7·6 | ,, ,, | 2·01 | 36 |
| 20 | 3·0 | 4 | 6 | 10·2 × 8·9 × 8·6 | ,, ,, | 2·48 | 42 |
| 21 | 4·0 | 6 | 0 | 10·2 × 10·0 × 8·6 | ,, ,, | 2·94 | 52 |
| 51 | 5·0 | 6 | 8 | 12·1 × 10·0 × 8·6 | ,, ,, | 3·66 | 52 |
| 117 | 6·0 | 7 | 8 | 12·1 × 10·0 × 10·2 | ,, ,, | 4·36 | 52 |
| 88 | 8·0 | 10 | 0 | 14·0 × 11·7 × 10·0 | ,, ,, | 5·64 | 67 |
| 89 | 10·0 | 12 | 2 | 14·0 × 10·2 × 11·4 | ,, ,, | 7·14 | 67 |

## 50 VOLT RANGE

| Ref. No. | Amps. | Weight lb | oz | Size cm. | Secondary Taps | £ | P & P p |
|---|---|---|---|---|---|---|---|
| 102 | 0·5 | 1 | 11 | 7·0 × 7·0 × 5·7 | 0-19-25-33-40-50V | 1·33 | 30 |
| 103 | 1·0 | 2 | 10 | 8·3 × 7·3 × 7·0 | ,, ,, | 1·94 | 36 |
| 104 | 2·0 | 5 | 0 | 10·2 × 8·9 × 8·6 | ,, ,, | 2·69 | 42 |
| 105 | 3·0 | 6 | 0 | 10·2 × 10·2 × 8·3 | ,, ,, | 3·65 | 52 |
| 106 | 4·0 | 9 | 4 | 12·1 × 11·4 × 10·2 | ,, ,, | 4·83 | 52 |
| 107 | 6·0 | 12 | 4 | 12·1 × 11·1 × 13·3 | ,, ,, | 7·14 | 67 |
| 118 | 8·0 | 18 | 9 | 13·3 × 13·3 × 12·1 | ,, ,, | 9·32 | 97 |
| 119 | 10·0 | 19 | 12 | 16·5 × 11·4 × 15·9 | ,, ,, | 11·68 | 97 |

## 60 VOLT RANGE

| Ref. No. | Amps. | Weight lb | oz | Size cm. | Secondary Taps | £ | P & P p |
|---|---|---|---|---|---|---|---|
| 124 | 0·5 | 2 | 4 | 8·3 × 9·5 × 6·7 | 0-24-30-40-48-60V | 1·35 | 36 |
| 126 | 1·0 | 3 | 0 | 8·9 × 7·6 × 7·6 | ,, ,, | 1·88 | 36 |
| 127 | 2·0 | 5 | 6 | 10·2 × 8·9 × 8·6 | ,, ,, | 2·94 | 42 |
| 125 | 3·0 | 8 | 8 | 11·9 × 9·5 × 10·0 | ,, ,, | 4·48 | 52 |
| 123 | 4·0 | 10 | 6 | 11·4 × 9·5 × 11·4 | ,, ,, | 5·78 | 67 |
| 120 | 6·0 | 16 | 12 | 13·3 × 12·1 × 12·1 | ,, ,, | 8·37 | 82 |
| 122 | 10·0 | 23 | 2 | 16·5 × 12·7 × 16·5 | ,, ,, | 13·85 | * |

## LEAD ACID BATTERY CHARGER TYPES

| Ref. No. | Amps. | Weight lb | oz | Size cm. | | £ | P & P p |
|---|---|---|---|---|---|---|---|
| 45 | 1·5 | 1 | 9 | 7·0 × 6·0 × 6·0 | Please note, these units do not include rectifiers | 1·34 | 30 |
| 5 | 4·0 | 3 | 11 | 10·2 × 7·0 × 8·3 | | 2·03 | 42 |
| 86 | 6·0 | 5 | 12 | 10·2 × 8·9 × 8·3 | | 3·07 | 52 |
| 146 | 8·0 | 6 | 4 | 8·9 × 10·2 × 10·2 | | 3·49 | 52 |
| 50 | 12·5 | 11 | 14 | 13·3 × 10·8 × 12·1 | | 5·20 | 67 |

All ratings are continuous. Standard construction: open with solder tags and wax impregnation. Enclosed styles to order.

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| BC107/108/109 9·0p each | 2N 3055 68p each + mica and bushes | AD 161/162 60p pair + mica and bushes |
|---|---|---|
| 25+ 7p | 25+ 55p | 25+ 55p |
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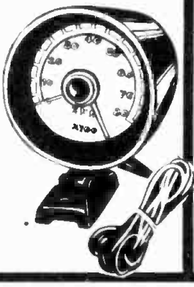
## SOLID STATE TACHOMETER



Functionally styled for under or over dashboard installation, this electronic tachometer fits all 4-cycle, 4-cylinder, or 2-cycle, 2-cylinder 12V vehicles. Negative or positive earth. Calibrated white on black 0–8,000 r.p.m. in 100 r.p.m. divisions together with setable "danger" line, simple installation—2 screws, 4 wires. 80mm (3in) diameter dial, 50mm deep. On adjustable angle bracket. Sealed black crackle finish.

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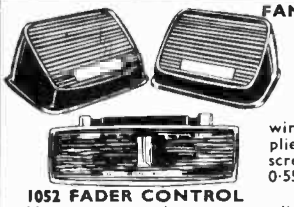
### AUTO BURGLAR ALARM PLUS "POP-OUT" CIGARETTE LIGHTER


Designed for easy installation on any car (whether 6V or 12V) this device activates the horn when a theft is attempted of equipment or personal belongings. This neat unit reacts when the vehicle is disturbed or rocked and continues its warning for 15 seconds after tampering. The sensitivity of the device is adjustable and controlled by a separate ON/OFF panel which can be located wherever convenient. Supplied with connecting wires and screws in attractive bubble pack, containing installation instructions and diagrams. 150 × 65 × 20mm plus panel 65 × 45 × 20mm.

**£2·10 FOR BOTH**

## FANTAVOX STEREO LOUDSPEAKER SYSTEM



These high quality speaker enclosures are made of tough black moulded plastic and have been designed for fitting on to almost any vehicle surface. The smart louvred fronts are silver trimmed and house heavy duty 5in (125mm) ceramic loudspeakers rated at 3/5 watts. 8 ohms impedance. Already wired with generous length connecting leads and supplied in packs of speaker pairs complete with fixing screws. Each cabinet measures 190 × 105 × 165mm; 0·55kg.

### 1052 FADER CONTROL

Neat, custom-made appearance slide fader control for balance of front and rear speaker volume. Simulated wood finish panel which can be quickly fitted below car dash. Supplied with generous connecting cable and fitting screws. Will suit 4, 8, 16 ohm installations. 100 × 38 × 30mm (including knob but excluding fitting bracket).

**All for £4·70**

## 420ES MICROSCOPE

An extremely modestly priced yet efficient microscope capable of magnification up to 750 times with clear sharp images. This model is of the self-illuminating type and incorporates an easily rotable four-position turret magnifying lens with rack and pinion focusing. The crackle black metal body houses the batteries for adjustable illumination. Packed in carton with built-in carrying handle and full notes for user. A sample slide also provided. 105mm at base; 180mm high; 0·40kg.

**£4·95**

## G5555 PROFESSIONAL STEREO HEADPHONE

Lightweight materials are skilfully used in the construction of this model in black crackle moulding and kid-soft leathercloth with contrasting bright metal. Each ear pad houses a highly efficient 60mm reproducer unit and features ear muffs removable for cleaning. 10 self-coiled lead plugs fitted.

*Freq. Response*: 20–20,000Hz. *Impedance*: 4–16 ohms. *Sensitivity*: 110dB. *Power*: 0·5W. *Weight*: 0·39kg.

**£9·25**

## "SPRITE" LIGHTWEIGHT STEREO HEADPHONE

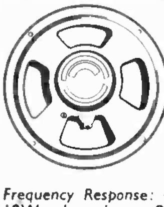
An outstanding achievement following lengthy development by one of the world's leading audio manufacturers, the T.T.C. "Sprite" offers the following specification:

- Extreme lightness (only 150 grammes—5oz);
- Instant wearing adjustment with sliding earpieces and flexible headband;
- Highly efficient Mylar reproducer units;
- Removable, washable foam padded ear muffs;
- 3 metre lightweight lead with stereo plug fitted

*Frequency Response*: 30–13,000Hz. *Sensitivity*: 105dB. *Impedance*: 4–16 ohms. *Power*: 0·2W. *Weight*: 0·15kg.

**£2·25**

## ADASTRA "HI-TEN" 10in LOUDSPEAKER



The British made "Hi-Ten" unit has also had minor improvements of late including an extended top response and a new matt black chassis finish. This full range 10in. loudspeaker handles up to 10 watts with convincing all round performance and total reliability. A high flux ceramic moulded magnet keeps the unit compact. An ideal unit for all full range music, audio and monitoring purposes and particularly suitable for column enclosures. Available in 8 or 15 ohm versions.

**£2·70**

*Frequency Response*: 40–13,000Hz. *Bass Resonance*: 70Hz. *Power Handling*: 10W. *Impedance*: 8 and 15 ohms. *Flux Density*: 10,000 lines. *Voice Coil*: 25mm (1in.). *Baffle Aperture*: 228mm (9in). *Fixing Centres*: 244·5 × 6·4mm. *Dimensions*: 255·8 × 91·9mm. *Weight*: 0·91kg (2lb).

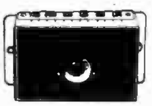
## K2006 HORN CONE TWEETER

Neat 3in (75mm) pressure driven tweeter with spun metal cone giving excellent H.F. response with up to 10 watts load. Designed for fitting into a rebate (80mm dia.) with fitting by four corner holes on outer flange. Screws provided. Polarised connections. 8 or 15/16 ohms, impedance matching.

**£1·65**

*Freq. Resp.*: 1,500–16,000Hz. *Crossover Freq.*: 3,000Hz. *Sensitivity*: 104dB. *Size*: 85 × 85 × 80mm. *Weight*: 0·30kg. *Impedance*: 8 or 16 ohm versions.

## K4004 VARIABLE CROSSOVER



Continuously variable from 2,500Hz to infinity and matching any Bass/H.F. unit combination this variable crossover is housed in a two-colour metal case with marked and polarised connections. 102 × 66 × 55mm.

**£1·05 ALL THREE FOR £5·20**

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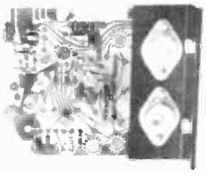
LOW-PRICED AUDIO MODULES FOR DOMESTIC and COMMERCIAL USE



THESE THREE MODULES HAVE ENJOYED UNPARALLELED SUCCESS DURING THE FIRST FEW MONTHS OF THEIR BEING MADE AVAILABLE TO THE GENERAL PUBLIC. WE ARE PLEASED TO ANNOUNCE THAT WE CAN NOW OFFER FAST DISPATCH ON MOST OF OUR ADVERTISED ITEMS, INCLUDING THESE THREE MODULES.

**SA25 £2·95** carr. free
25 WATTS R.M.S. 7 transistors, 7 diodes

**SA35 £4·45** carr. free
35 WATTS R.M.S. 7 transistors, 7 diodes

**SA100 £10·90** carr. free
100 WATTS R.M.S. 11 transistors, 6 diodes

ALL THREE MODULES HAVE OPEN AND SHORT CIRCUIT PROTECTION, AND THE SA100 IS PROOF AGAINST OVER-DISSIPATION AND FAULTY INDUCTIVE LOADS.

ONLY ADVANCED DESIGN TECHNIQUES MAKE THESE EXTRAORDINARILY LOW PRICES POSSIBLE.

### BRIEF SPEC. FOR ALL THREE MODULES

| | |
|---|---|
| Freq. response | 20–40,000Hz ± 1dB |
| Distortion | 0·2% at 1kHz |
| Loads | 4 to 16 ohms |
| Quiescent current | 15mA |
| Noise | Better than −75dB |
| Supply voltage | 25–45V, SA25/35<br>40–70V, SA100 |
| Size | 4½in × 4in × 1in (SA100)<br>4in × 3in × 1in (SA25, SA35) |

Circuits, connecting instructions and application data are supplied free with all modules.

### POWER SUPPLIES FOR THE SA25/35 and SA100 AUDIO MODULES

| | |
|---|---|
| **PU45** | Unstabilised supply for 2 SA25/35's, **£4·90.** |
| **PU70** | Unstabilised supply for one or two SA100's, **£7·75**, carr. 40p |
| **MT45** | Transformer for above, heavy duty, **£2·85**, carr. 20p |
| **PS45** | Stabilised module for 2 SA25's or two SA35's, **£3·50**, carr. free |
| **MT70** | Transformer for PS70, **£4·90**, carr. 40p |
| **PS70** | Stabilised supply module for one or two SA100's, **£4·90**, carr. free |

ALL MODULES ARE BUILT ON GLASS FIBRE P.C. BOARD

## OTHER SAXON PRODUCTS . . .

### 120 WATT HEAVY DUTY MODULE

**£13·90+20p carr. or with supply £18·95+40p carr.**

Featuring a rugged class A driver stage, this module will run from all our mixers etc., and most other makes of mixer. It delivers 120W into an eight ohm load and employs 4 TO3 can (115W) output transistors.

**SPECIFICATION**

| | |
|---|---|
| Power output | 120W into 8 ohms |
| Freq. response | 20–20,000Hz ± 2dB |
| Input sensitivity | 200mV into 10K |
| Construction | Fibreglass board |
| Size | 8in × 4in × 4in (5in with supply) |

Low distortion parallel push-pull output stage.

**NEW:** 160 Watt version & supply **£27·90**

### SINGLE CHANNEL SOUND/LIGHT CONVERTER

This compact and reliable unit operates from amplifiers with outputs from 5–100W. Does not impose a heavy load on the amplifier, or, if connected in the wrong polarity, cause any damage, as with some units.


Operation is simplicity itself and the unit is fully fused. The unit is supplied to function from bass notes but may easily be converted to respond only to treble or mid-range notes by the addition of components costing less than 5p.

**£8·90** carr. free


### THREE CHANNEL SOUND TO LIGHT UNIT

Handling the total of 3,000W (3kW) this unit is unique for its price in that not only bass middle and treble but also master controls are provided. Two amplifier sockets eliminate the need for split leads, etc. Supplied in tough white steel case with a blue hooded cover. Fully guaranteed.

**£19·75** carr. 30p

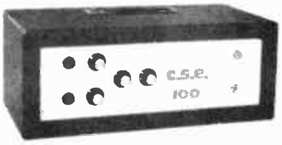
MONO VERSION **£6·50**, carr. 20p
(As illustrated below. S.A.E. details. 9V operation)
OUTPUTS UP TO 1V RMS

**£15·80** carr. 30p
**SAXON STEREO CONTROL UNIT**


Two decks, and full headphone monitoring. The unit is mains operated and measures 17½in × 3in × 4in deep and is finished with a smart white on black facia. The controls are: Left/Right deck fader, volume, bass, treble, headphone selector and volume, microphone volume, bass, treble, mains on/off. **THIS IS A MUST FOR THE HOME BUILT HIGH QUALITY DISCOTHEQUE AND IS COMPARABLE TO UNITS AT OVER TWICE THE PRICE.**

### COMPLETE AMPLIFIERS

**THE CS 100. £34·90** carr. free




This versatile unit is now available in a black vynide case and so represents even better value than ever, delivering speech and music powers of up to 100W R.M.S. and continuous signal outputs of 70W.

Two individually controlled inputs with wide range bass and treble controls. Ideal for small groups, D.J's, etc


**The SAXON 100. £48·50**, carr. free.
With an R.M.S. output of 120W speech and music, 100W continuous power, four individually controlled F.E.T. input stages and wide range bass and treble controls, this amplifier has established itself as a unit offering quality and reliability at low cost.

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D1000C 24 ct. gold plate r.r.p. £37, our price **£32** post free.

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# PE

## OUR TRANSISTOR

THIS seems a good time to reveal our own secret suspicions concerning the origin of the transistor. We admit that for long we have had an irresistible feeling that this device was in fact conceived with the private constructor expressly in mind. Yes indeed, and plenty of evidence points this way—other important users and impressive applications notwithstanding.

Forget, for a moment or two, those epic moon journeys monitored on colour television. Forget (if you can) those ubiquitous transistor radios. Forget those prodigious computers—and those in-vogue status setting personal appurtenances like pocket calculators and solid state wristwatches. Instead, reflect upon what the transistor has meant to us as private constructors and experimenters. For we as much as any other body of individuals have cause to be jubilant and grateful in respect of that revolutionary technological breakthrough a quarter century ago.

We suggest that if the trio of research physicists at Bell Labs had been working to a specification drawn up with the private constructor's interests foremost in mind, they could hardly have done better. Those readers able to cast their minds back to the pre-transistor days when the valve ruled the roost will certainly be appreciative of the transformation set in train by the solid state amplifying device. It ushered in an era of expansive amateur activities, by bringing within the private individual's reach, literally to his table top, previously undreamed of electronic techniques.

By comparison with the thermionic devices it was going to replace, the transistor when it made its debut seemed so ridiculously simple to handle, so small and undistinguished in appearance, so undemanding in power, as not to be true. Not that there were no headaches for the average constructor and experimenter initially, when trying to get to grips with strange new concepts involving solid state physics, with a little chemistry and metallography thrown in. It was rather a traumatic experience trying to adjust to the transistor's idiosyncrasies. (An h.t. line of minus 6 volts—what nonsense was this? Though we got our potentials right once again when the *npn* version arrived.) First attempts to make practical use of the strange component were accompanied with trepidation, for burnt-out transistors weren't uncommon in those pioneering days.

Seen now in retrospect, these were but little teething troubles. The advantages and rewards arising from the solid state device were soon made apparent. Without the transistor and its descendants amateur activity would never have reached the advanced technical stage, nor have been able to embrace such wide and diverse applications as it does today. Undoubtedly the basic simplicity of construction is the great single factor which has stirred up popular interest in solid state electronics. It is now an ideal sparetime hobby which can be pursued without difficulty in the home.

Yes, constructors and enthusiasts all, there is cause to be exuberant. And don't forget, without the transistor there could hardly be PRACTICAL ELECTRONICS. So we all owe a vote of thanks to Messrs. Bardeen, Brattain, and Shockley. And surely no true enthusiast will dare deny that our suspicions are well founded.—F.E.B.

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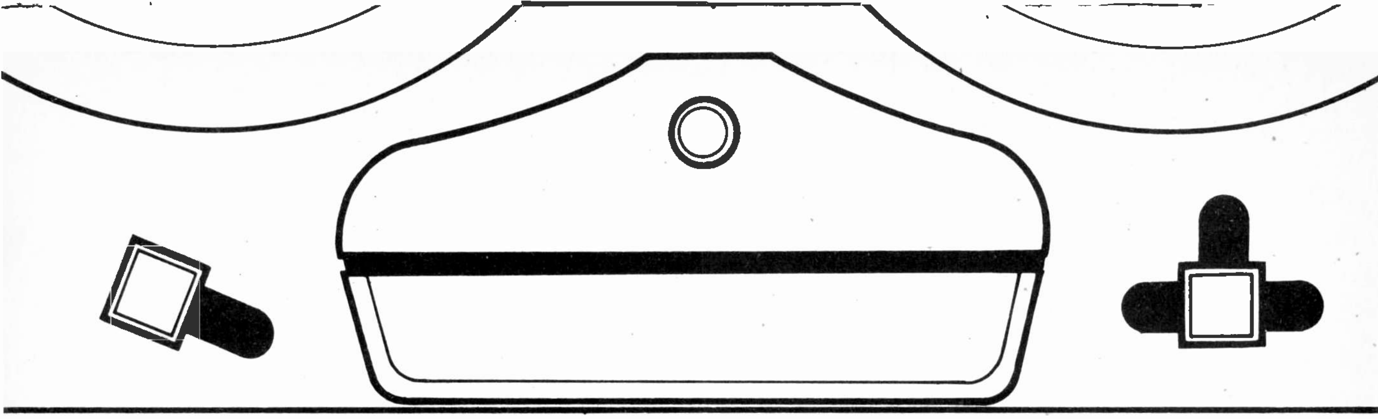
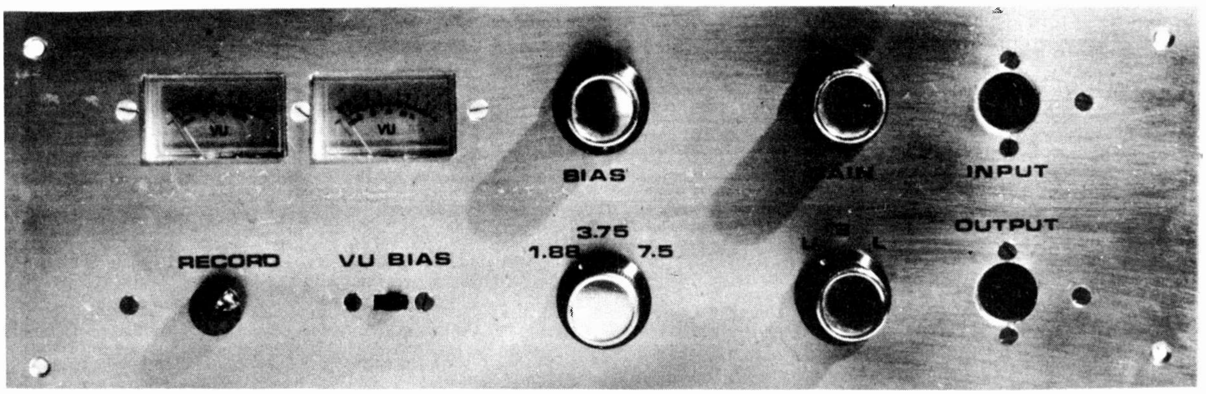





# Hi-Fi Tape Link

By P. S. EWER

THERE must be many readers who possess a tape recorder whose quality does not match that of the rest of their hi-fi system and who would like to improve it to save the expense of buying a completely new deck.

This article describes how to convert a reasonable quality deck to hi-fi by renewing the electronics and the heads whilst retaining the original tape transport system. All that is required is a tape deck of reasonable quality, the author using a Collaro Studio. Full constructional details relating to the deck will be given.

Since it is assumed that the constructor will already possess a high quality amplifier, this will not be described. Microphone facilities are not included because in the author's opinion these are best provided by a comprehensive mixer.

## OVERALL SYSTEM

A block diagram of the overall system is shown in Fig. 1. A six-pole three-way switch is used to select either upper track, lower track, or stereo operation (S3). A relay (RLA) is used to control record and playback modes. The relay itself is controlled by an external switch normally fitted to the tape deck. This switch is also used to control the supply to the bias and erase oscillator, which is on in the record position and off in the playback.

A ganged potentiometer (VR6, VR106) controls the gain of the record amplifier which is fed from the input signal via a DIN socket. The output of the record amplifier is fed via a resistor and the relay contacts to the record/replay heads. It is also fed to the meter circuit which can also be used to read the bias voltage.

The resistor between the record amplifier and the head is used to achieve constant current drive.

In the record mode the relay contacts connect the heads to the record amplifier. The bias oscillator is on and feeds the erase heads. Two 50 kilohm potentiometers (VR7 and VR107) are used to control the bias. When only single track operation is selected then the unused output of the bias oscillator is grounded via a 10 kilohm resistor (R42).

In the playback mode the output of the heads is fed directly to the playback amplifier and then out via another DIN socket.

## HEAD REQUIREMENTS

A tape recorder is only as good as its heads and to achieve the required performance heads of very high calibre are essential.

The characteristics required for the record/replay head are

1. Low eddy current loss at high frequency so that a high bias frequency can be used both to avoid interference (this being particularly important when recording stereo radio transmissions with its attendant sub-carrier output problems), and to enable the minimum pre-emphasis to be employed.

# SPECIFICATION . . .

**System**
Quarter track stereo tape link intended for use in conjunction with a high fidelity system. Features include two level indicators, adjustable metered bias, and single track mono operation

**Overall Frequency Response**
7½ i.p.s. 30Hz–17kHz ±1dB
3¾ i.p.s. 40Hz–11·5kHz +1, −1·5dB
1⅞ i.p.s. 40Hz–6·5kHz ±2dB

**Replay Characteristic**
CCIR
7½ i.p.s. 70µS
3¾ i.p.s. 140µS
1⅞ i.p.s. 280µS

**Distortion**
1% at 0VU

**Signal to noise ratio**
60dB weighted according to the CCIF characteristic and using low noise tape

**Crosstalk**
45dB

**Input**
55mV r.m.s. to infinity at 10 kilohm

**Output**
1 volt r.m.s. from near zero source impedance. Protected against accidental short circuit

2. A well-engineered gap which is as close as possible to the mechanical gap width. This results in minimal gap losses at short wavelengths.
3. The magnetic core should have a low coercivity to prevent magnetic saturation occurring which would reduce the signal-to-noise ratio and cause second harmonic distortion. This is particularly important at low tape speeds or when using low noise tapes.

On the playback side the important characteristics are:

4. Low source impedance consistent with a high output, which is required to enhance the signal-to-noise ratio.
5. A narrow gap width and a small gap depth.
6. A ripple free response at low frequencies.

The erase head should be very efficient, requiring a low input power and so causing minimal damping of the oscillator tuned circuit.

The heads specified for the recorder fulfil these requirements and are manufactured by Wolfgang Bogen of West Berlin. They are obtainable in the U.K. from Cole Electronics Ltd., the sole agents (see Components List for the address).

## RECORD AMPLIFIER REQUIREMENTS

A recording amplifier raises the level of the input signal to an amplitude suitable for driving the head. It must incorporate pre-emphasis to compensate for the high frequency fall-off inherent in the head to tape characteristic, and provide a constant current output to the head.

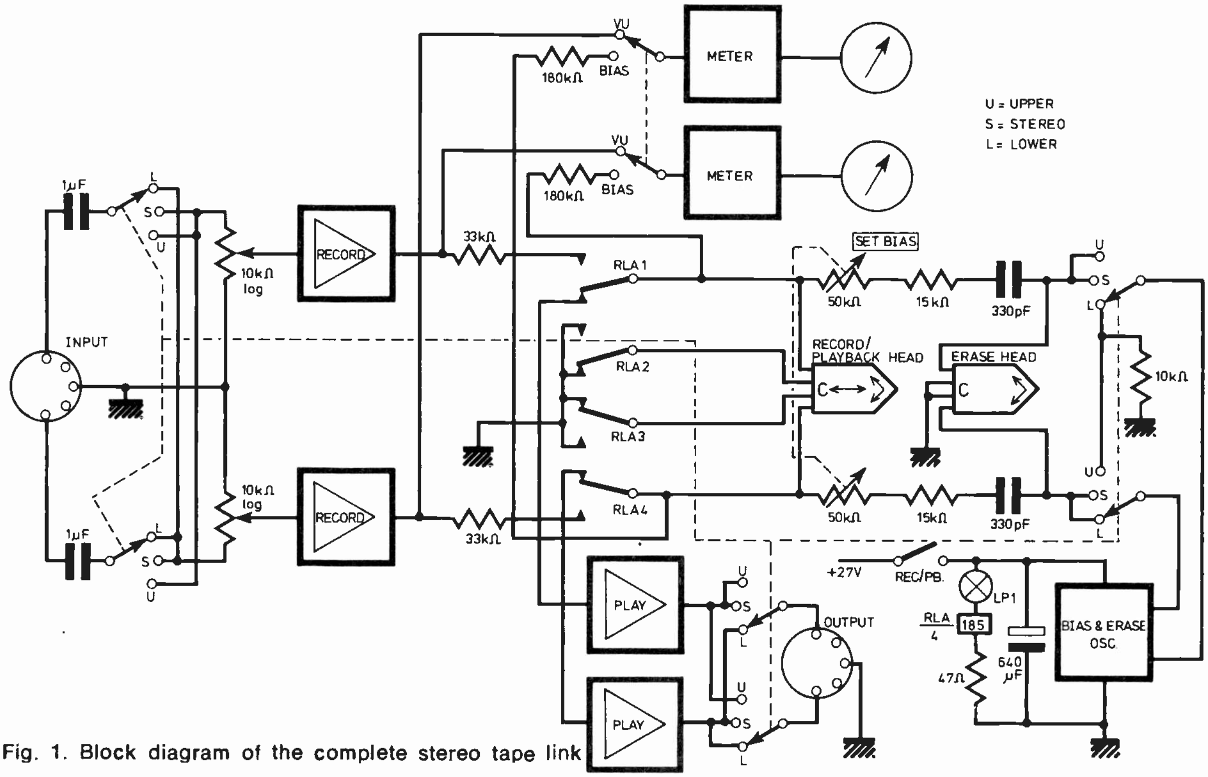



Fig. 1. Block diagram of the complete stereo tape link

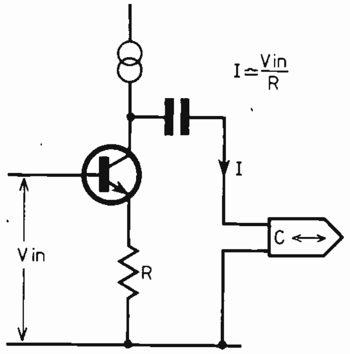



Fig. 2a. Constant current drive using the high output impedance of a transistor collector

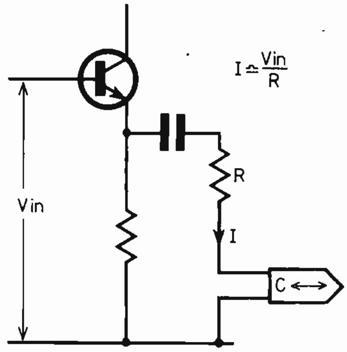



Fig. 2b. Constant current drive using the head in the feedback loop

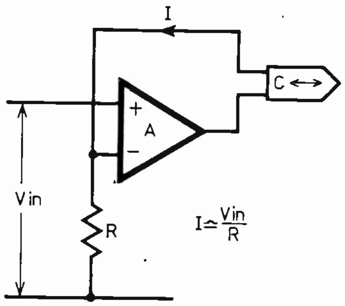



Fig. 2c. Actual method used which uses a series resistor to provide the constant current

Furthermore, even allowing for the full pre-emphasis required, there should be no overload, and the general distortion figure should be low.

## CONSTANT CURRENT DRIVE

Because the record/replay head is an inductor its impedance rises with frequency. Therefore to induce a constant magnetic flux in the tape head the head should be driven from a constant current source. (This is the opposite of the constant voltage drive which requires a low output impedance from the amplifier.)

A high impedance in comparison with that of the head is thus required and there are many ways of achieving this in practice.

Use can be made of the intrinsically high collector impedance of a transistor, or the head may be included in the feedback loop of an amplifier as shown in Figs. 2a and 2b. Both these approaches give an excellent approximation to the ideal current drive requirements.

However, both systems have the disadvantage of bias rejection problems and the consequent need for tuned circuits in series with the head. As this is considered to be a major drawback, the author has adopted a different method of obtaining this constant current.

## METHOD USED

The basic recording amplifier has a very low output impedance and the record signal is fed to the head via a resistor of a value which is large in comparison with that of the head over the frequency range under consideration.

The bias signal is now attenuated by the resistor and the output impedance of the amplifier (see Fig. 2c).

The penalties to be paid for this solution are: firstly, the departure from accurate current drive (the source impedance is now no longer negligible in comparison with the head impedance); and secondly, the need for a high rail voltage if a reasonable value of series resistor is to be used.

The impedance of the specified Bogen head varies from 170 ohms to a maximum of 10 kilohms. At even the highest tape speed under consideration, the output from the head begins to drop at three kilohertz. Departure from constant current above this frequency can thus be compensated for in the recording pre-emphasis.

A value of 33 kilohms was chosen for the series resistor. Between 20Hz and 3kHz the variation in the record current is truly negligible, and even up to 18kHz the drop in current is only 3·7 per cent.

## RECORD AMPLIFIER CIRCUIT

The output required from the amplifier is 10·8 volts peak-to-peak for full modulation of the tape. Allowing for the full pre-emphasis to be utilised and for the saturation losses in the amplifier transistors, a rail voltage of at least 48 volts is required. In fact 55 volts are available thus allowing for a small overload.

Referring to the circuit diagram (Fig. 3), it will be seen that the circuit is similar in conception to that commonly employed in audio power amplifier design.

Transistor TR1 forms a low noise input stage and has a gain of 4·5 times. TR2 is the workhorse of the amplifier. It has a boot-strapped collector load for high gain with low distortion due to the limited modulation index of the collector current, and forms the driver for the output stage.

Transistors TR3 and TR4 comprise the output stage which operates in class A, a requirement for low distortion when a large output is required.

The amplifier has good linearity even before feedback, and this, coupled with the high gain and hence large amount of allowable feedback, serves to reduce distortion to a very low level.

The overall loop gain at d.c. is unity giving exceptional stability of the mid-rail voltage. Components R5, R6, and C9 provide a.c. feedback, and the frequency response for the different speeds is shaped by L1 in conjunction with C5, C6, or C7, the frequency of maximum treble boost being switched according to the speed in use, and the amount being preset by the series resistors VR1 to VR3.

The nominal gain is approximately 70 and this gives an input sensitivity in the region of 55mV. C11 is a phase shifting capacitor required to give stability by preventing high frequency oscillation.

## METERING CIRCUIT

It is the author's opinion that average reading meters of the volume unit (VU) variety allow short duration overloads to occur without any indication. The recording meters in this recorder are therefore of the peak reading kind having a fast attack, and a slow decay time of about 2·5 seconds.

This reduces the effect of meter movement inertia, for the pointer generally has less far to travel to

# COMPONENTS . . .

**Resistors**

| | | | |
|---|---|---|---|
| R1, R101 | 390kΩ | R26, R126 | 1kΩ |
| R2, R102 | 180kΩ | R27 | 5·6kΩ |
| R3, R103 | 100kΩ | R28 | 1·2kΩ |
| R4, R104 | 6·8kΩ | R29, R129 | 1MΩ |
| R5, R105 | 100kΩ | R30, R130 | 15kΩ |
| R6, R106 | 10kΩ | R31, R131 | 10kΩ |
| R7, R107 | 150Ω | R32, R132 | 2·2kΩ |
| R8, R108 | 10kΩ | R33, R133 | 56Ω |
| R9, R109 | 39kΩ | R34, R134 | 8·2kΩ |
| R10, R110 | 6·8kΩ | R35, R135 | 10MΩ |
| R11, R111 | 220Ω | R36 | 270Ω |
| R12, R112 | 220kΩ | R37, R137 | 39kΩ |
| R13, R113 | 220Ω | R38, R138 | 82kΩ |
| R14, R114 | 33kΩ | R39, R139 | 150kΩ |
| R15, R115 | 180kΩ | R40, R140 | 10MΩ |
| R16, R116 | 100kΩ | R41, R141 | 10kΩ |
| R17, R117 | 33kΩ | R42 | 10kΩ |
| R18, R118 | 39kΩ | R43, R143 | 15kΩ ½W 5% |
| R19, R119 | 3·3kΩ | R44 | 10Ω ½W 2% |
| R20, R120 | 3·3kΩ | R45 | 3·3kΩ |
| R21 | 220Ω | R46 | 3·3kΩ |
| R22, R122 | 560kΩ | R47 | 10Ω ½W 2% |
| R23, R123 | 22kΩ | R48 | 22Ω 5W 5% wirewound |
| R24, R124 | 18kΩ | R49 | 47Ω ½W 10% |
| R25, R125 | 4·7kΩ | | |

All ¼W 5% carbon film histab unless otherwise stated, 2 off of each except R21, R27, R28, R42 and R44–R49

**Capacitors**

| | |
|---|---|
| C1, C101 | 560pF polystyrene |
| C2, C102 | 2·2μF 25V Tantalum |
| C3, C103 | 10μF 25V Tantalum |
| C4, C104 | 100μF 64V elect. |
| C5, C105 | 0·15μF 5% polyester |
| C6, C106 | 0·068μF 5% polyester |
| C7, C107 | 0·027μF 5% polyester (use 0·022μF and 0·005μF in parallel) |
| C8, C108 | 50μF 25V elect. |
| C9, C109 | 2·2μF 25V Tantalum |
| C10, C110 | 16μF 40V elect. |
| C11, C111 | 47pF 10% polystyrene |
| C12, C112 | 0·47μF polyester |
| C13, C113 | 0·33μF polyester |
| C14, C114 | 10μF 10V Tantalum |
| C15, C115 | 5μF 10V Tantalum |
| C16, C116 | 50μF 16V Tantalum |
| C17, C117 | 2·2μF 16V Tantalum |
| C18, C118 | 0·1μF polyester |
| C19, C119 | 1,800pF 2% polystyrene |
| C20, C120 | 50μF 25V elect. |
| C21 | 50μF 40V elect. |
| C22, C122 | 1μF polyester |
| C23, C24 | 2,500μF 40V elect. |
| C25, C125 | 330pF ceramic |
| C26 | 0·022μF 10% polyester |
| C27 | 0·22μF 10% polyester |
| C28 | 0·022μF 10% polyester |
| C29 | 640μF 25V elect. |

2 off each except C21 and C26–C29

**Potentiometers**

| | |
|---|---|
| VR1, VR101; VR2, VR102; VR3, VR103 | 100Ω preset (R.S. Mouldtrim) (6 off) |
| VR4, VR104 | 1kΩ submin skeleton preset (2 off) |
| VR5, VR105 | 4·7kΩ submin skeleton preset (2 off) |
| VR6, VR106 | 10kΩ + 10kΩ log ganged pot |
| VR7, VR107 | 50kΩ + 50kΩ lin ganged pot |

**Inductors**

| | |
|---|---|
| T1 | 20V–0–20V ½A (R.S. 20V Rectifier) |
| T2 | Bias transformer (see next month for details) |
| L1, L101 | 4mH (2 off) (see next month for details) |

**Heads**

| | |
|---|---|
| EH1 | Bogen erase head type UL296 |
| RPH1 | Bogen universal head type UK207E |

(These are available from Cole Electronics Ltd., 7-15 Lansdowne Road, Croydon CR9 2HB and Brenell Engineering Co. Ltd., 231/5 Liverpool Road, London, N.1 who also market a tape deck incorporating these heads).

**Transistors**

| | |
|---|---|
| TR1, TR101 | BC159 |
| TR2, TR102 | BC147 |
| TR3, TR103 | BC157 |
| TR4, TR104 | BC147 |
| TR5, TR105 | BC148 |
| TR6, TR106 | BC157 |
| TR7, TR107 | BC149 |
| TR8 | BC158 |
| TR9, TR109 | 2N3823 |
| TR10, TR110 | BC159 |
| TR11, TR12 | BFY50 |

All 2 off except TR8

**Diodes**

| | |
|---|---|
| D1, D101 | OA47 (2 off) |
| D2 | BZY88C 27V 400mW Zener |
| D3 | BZY88C 20V 400mW Zener |
| D4, D5 | BA145 (2 off) |
| D6 | 12V 1·5W Zener |
| D7–D10 | BA148 *or* 1N4002 (4 off) |

**Integrated Circuit**

IC1, IC101 SN72741P *or* 741OPA (2 off)

**Relay**

RLA 12V 185Ω 4 changeover contacts (ITT)

**Meters**

ME1, ME101 VU meters. Sensitivity 1·228V a.c. for 0dB (300μA) (2 off)

**Switches**

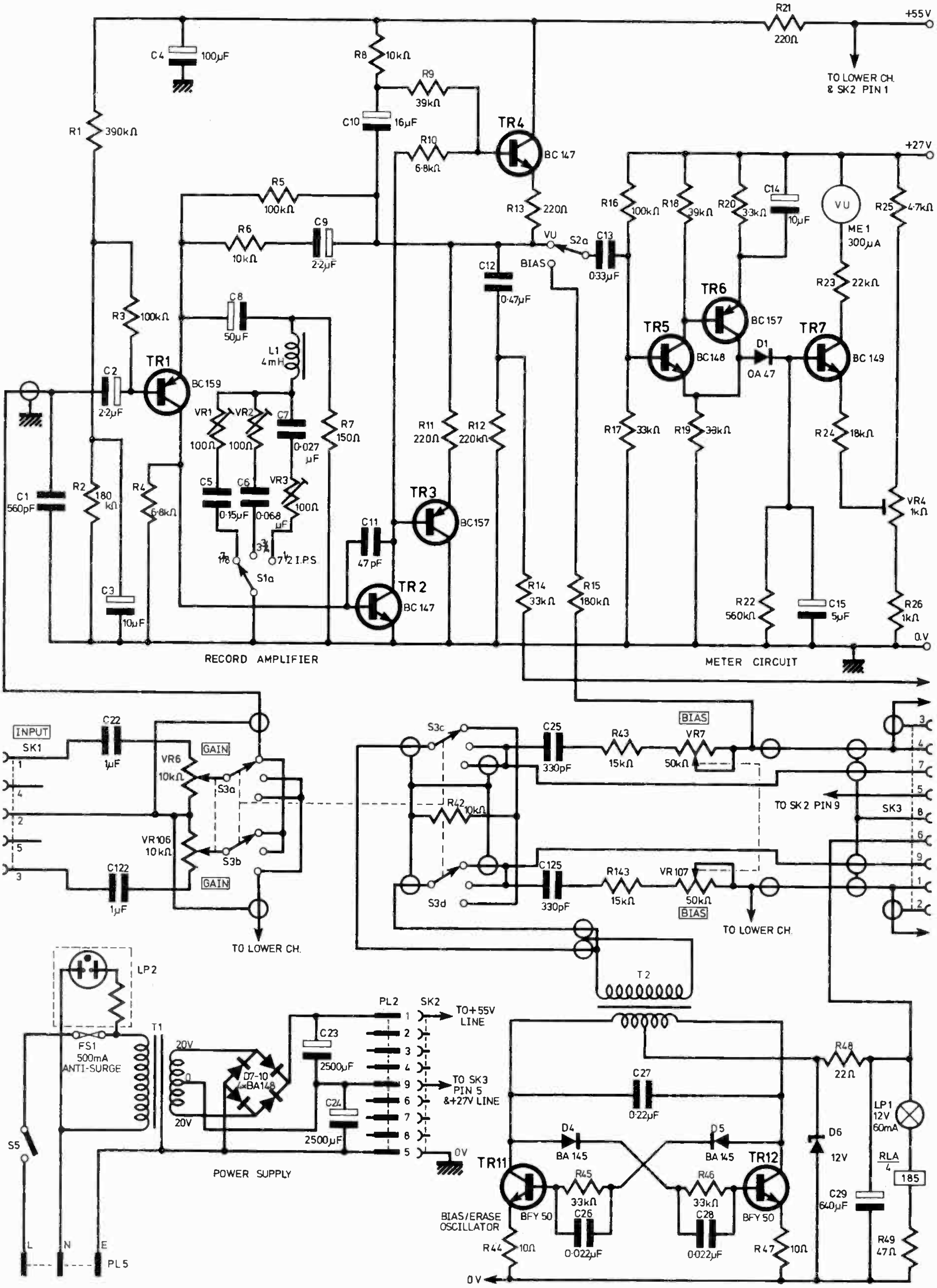
| | |
|---|---|
| S1 | 4 pole 3 way (R.S. miniature Maka-switch) |
| S2 | 2 pole changeover miniature slide |
| S3 | 6 pole 3 way (R.S. miniature Maka-switch) |
| S4 | see text |

**Miscellaneous**

| | |
|---|---|
| SK1 | 5 pin 180° DIN socket |
| SK2, SK3 | B9A valveholder (2 off) |
| SK4 | 5 pin 180° DIN socket |
| PL2, PL3 | B9A plug (2 off) |
| PL4 | Mains plug Bulgin type P429 |
| LP1 | 12V 0·75W lamp and holder |
| LP2 | Mains neon with integral resistor |

9½in × 5in 0·1in matrix plain Veroboard

16 s.w.g. aluminium for chassis (see Pt. 2 for dimensions), TO5 clip-on heatsinks (2 off), plastic cable clips (2 off), capacitor clips (2 off), 21, 30 and 34 s.w.g. enamelled copper wire



+55V
R21 220Ω
TO LOWER CH. & SK2 PIN 1
C4 100μF
R8 10kΩ
R9 39kΩ
C10 16μF
R10 6·8kΩ
TR4 BC 147
R1 390kΩ
R5 100kΩ
R6 10kΩ
C9 2·2μF
R13 220Ω
VU
S2a
BIAS
C13 0·33μF
C12 0·47μF
+27V
R16 100kΩ
R18 39kΩ
R20 3·3kΩ
C14 10μF
VU
ME 1 300μA
R25 4·7kΩ
R23 22kΩ
TR6 BC 157
TR5 BC148
TR7 BC 149
D1 OA 47
R3 100kΩ
C8 50μF
L1 4mH
TR1 BC159
C2 2·2μF
VR1 100Ω
VR2 100Ω
C7 0·027 μF
R7 150Ω
R11 220Ω
R12 220kΩ
R17 33kΩ
R19 33kΩ
R24 18kΩ
C1 560pF
R2 180 kΩ
R4 6·8kΩ
C5 0·15μF
C6 0·068 μF
VR3 100Ω
TR3 BC157
VR4 1kΩ
C11 47 pF
7½ I.P.S.
S1a
TR 2 BC 147
C3 10μF
R14 33kΩ
R15 180kΩ
R22 560kΩ
C15 5μF
R26 1kΩ
0.V
RECORD AMPLIFIER
METER CIRCUIT
INPUT
SK1
C22 1μF
GAIN
VR6 10kΩ
S3a
VR106 10kΩ
S3b
C122 1μF
GAIN
TO LOWER CH.
S3c
C25 330pF
R43 15kΩ
BIAS
VR7 50kΩ
R42 10kΩ
C125 330pF
R143 15kΩ
VR 107 50kΩ
BIAS
S3d
TO LOWER CH.
TO SK2 PIN 9
SK3
T2
LP2
FS1 500mA ANTI-SURGE
T1
20V
0
20V
D7-10 4xBA148
C23 2500μF
C24 2500μF
PL2
SK2
TO +55V LINE
TO SK3 PIN 5 &+27V LINE
0V
POWER SUPPLY
S5
L N E
PL5
C27 0·22μF
R48 22Ω
D4 BA 145
D5 BA 145
TR11 BFY 50
TR12 BFY 50
R45 33kΩ
R46 33kΩ
C26 0·022μF
C28 0·022μF
BIAS/ERASE OSCILLATOR
R44 10Ω
R47 10Ω
0V
D6 12V
LP1 12V 60mA
RLA 4/185
C29 640μF
R49 47Ω

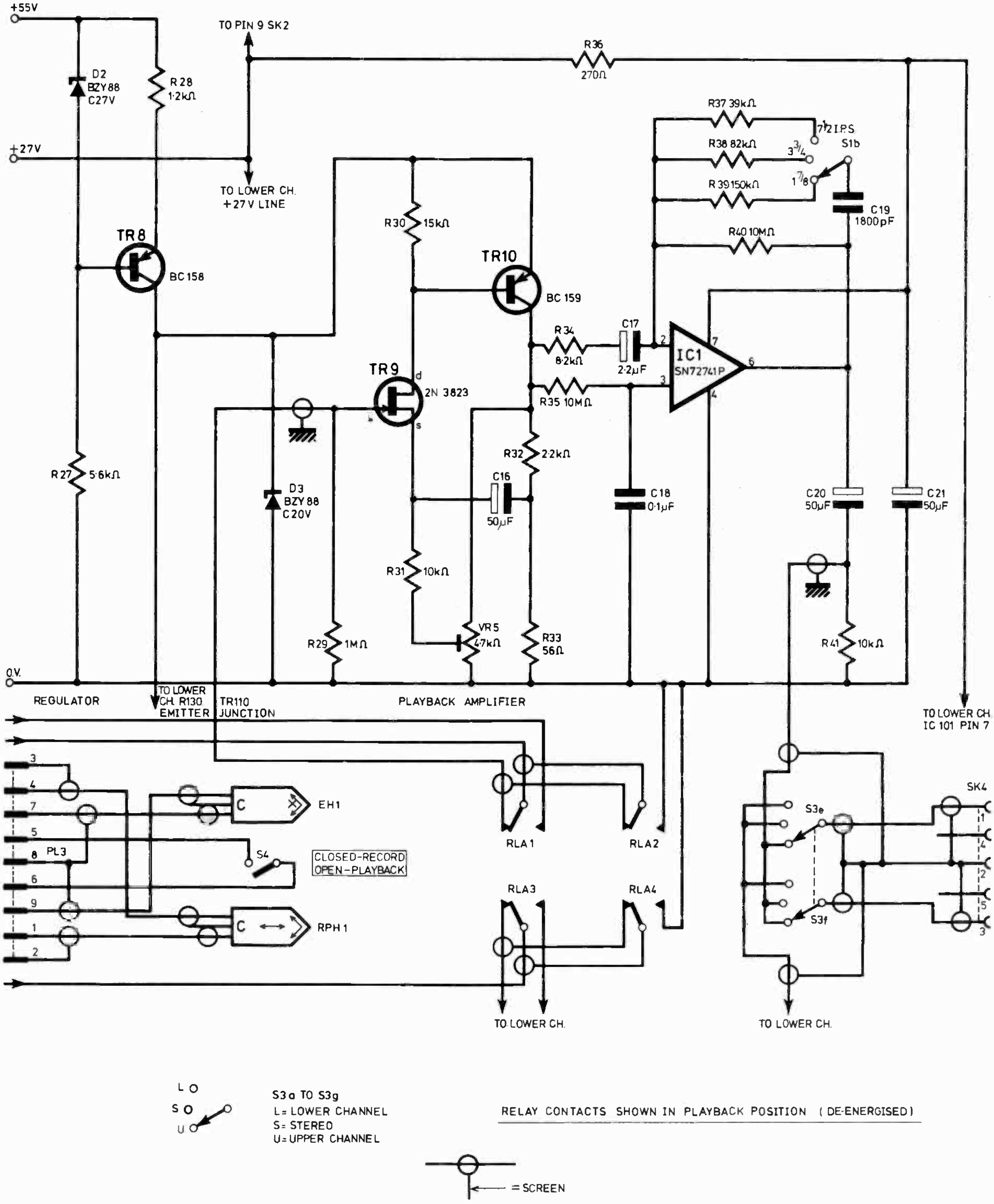



Fig. 3. Full circuit diagram of the stereo tape link. Only the upper channel has been shown; the lower channel electronics being identical to the upper channel. Components numbers of the lower channel are upper channel numbers plus 100

indicate a transient, and is easier for the eye to follow.

Referring now to the circuit diagram, transistors TR5 and TR6 comprise a unity gain voltage follower having a very low output impedance.

The metering signal is rectified by diode D1 and stored in C15. Because of the low impedance of the voltage follower the major limitation on the charging time of C15 is the forward resistance of the diode which is a gold-bonded germanium type.

The discharge time is governed by the combination of the reverse resistance of the diode, R22 and the input impedance of TR7.

In the absence of an input signal the base of TR7 is at 6·7 volts. Preset VR4 is set so that TR7 is just cut off and hence no current flows through the meter. As the signal input increases the charge on C15 increases positively hence forward biasing TR7. Resistor R23 provides the meter with overload protection.

## BIAS AND ERASE OSCILLATOR

A very pure bias waveform is needed if the full dynamic range of the tape is to be realised. Also, due to the dependence of frequency response, output level, distortion and modulation noise on the bias amplitude, the oscillator amplitude should be drift free.

Push-pull operation is used to minimise even harmonic distortion and the rail voltage is regulated to ensure amplitude stability of the waveform.

So that adequate filtering of the oscillator harmonic output is assured, the tuned circuit must have a high working *Q*. This is achieved by the employment of a low impedance tuned circuit wound with thick wire on a low loss high permeability pot core. The tuning capacitor should have low dielectric losses as well.

The transistors are protected against reverse breakdown of their base emitter junctions by diodes D4 and D5. Although this breakdown does not interfere with the operation of the oscillator, it can, after a period of time, cause reduction in the current gain of the transistors.

Zener diode D6 regulates the voltage supplied to 12 volts. The bias is arranged to decay slowly by discharging C29 when switching off from record. This is essential if magnetisation of the heads is to be avoided.

In practice, the oscillator works well. The output rises by 0·25dB over the first minute of operation and is thereafter stable. The waveform is good, as indicated by the inaudible change in the tape noise after virgin tape has been passed by the erase head. It is important when performing this test to pull the tape *away* from the record head as this will record modulation noise. Modulation noise is inherent in all biased recorders and can be reduced only by the use of low noise tapes and careful design of the heads.

## REPLAY AMPLIFIER

The output of the record/replay head when playing a tape rises at the rate of 6dB per octave (i.e. it doubles for every doubling of frequency) up to the point at which high frequency fall-off occurs.

The replay amplifier compensates for this characteristic, and provides a high level output signal suitable for feeding long screened cables.

When considering the connection of the head to the amplifier it is important that no appreciable direct current flows through it, as this would result in magnetisation of the head, and a consequent increase in the background hiss of the tape. It is thus inadvisable to couple the head via a capacitor as the charging current for it will pass through the head.

## F.E.T. INPUT STAGE

The use of a field effect transistor as an input device allows direct connection of the head. Because of the very high input impedance of the f.e.t. it requires only a miniscule bias current (about 2nA) which is insufficient to affect the head. Compared to a bipolar transistor the f.e.t. also possesses a generally lower noise and distortion level.

The f.e.t. and TR10 comprise a complementary feedback pair operating at a gain of 50 from an input signal of 2·7mV at 1kHz and at 7½ inches per second. This stage has a flat frequency response. The f.e.t. has a considerable spread in the gate to source bias voltage for a given drain current, being anywhere from 0·5 to 7·5 volts. It is not easy to design away this variation, and a preset resistor (VR5) has therefore been provided for setting-up.

## SUPPLY RIPPLE REDUCTION

An interesting feature of the input stage is the method of supply ripple reduction. Transistor TR8 is biased as a current source. Zener diode D2 maintains the base-emitter potential constant in the presence of ripple on the 55 volt line, reducing modulation of the collector current.

The high source impedance of the current combined with the low slope resistance of the Zener diode D3 attenuates the ripple to a negligible level.

## EQUALISATION

The function of equalisation is left to the last stage, thus resulting in lower noise levels, and greater accuracy of equalisation which, if carried out earlier could cause variations in the input impedance.

The general purpose operational amplifier type 741 is the equaliser and output stage and is eminently suitable for this application. Because of its high gain and low output impedance it is capable of producing very accurate equalisation. It has its own internal frequency compensation for stability and its output is short circuit protected.

The d.c. source impedances of the inverting and non-inverting inputs are similar and the d.c. gain of the stage is set to unity to minimise drift of the quiescent output voltage with temperature.

The equalisation components R37-39 and C19 are selected according to the speed in use and set to the CCIR standards of 70, 140 and 280 microseconds.

## POWER SUPPLY

The power supply is quite simple, providing two outputs of 55 volts and 27 volts. Full wave rectification and large value reservoir capacitors are employed to produce good supply regulation and low output ripple.

**In the second part of this article, next month, construction of the Hi-Fi Tape Link will be described**

## ARE WE ALONE?

From time to time the question of other living entities, whether they be elementary forms or whether equivalent to homo sapiens or better, is revived. Over the past year or so the climate of acceptability has improved in these matters and there are less sceptics each year.

While all science fiction has been treated as having license in this direction, examination tends to show that in our galaxy, at least, the chances of bug-eyed monsters or intelligent vegetations being our companions is losing ground. In general all the findings so far point to a cycle of emergence to the present level of homo sapiens as the most likely, though minor variations could occur.

At the present state of knowledge the evidence is in favour of similar forms of life to that which exists now. This being the case the field is narrowed quite considerably and statistically it is known that there is a high possibility of life existing elsewhere, but the possibility of communication presents a major problem.

From several sources recently there have come new suggestions for contacting other intelligences. Some are based on the concept that if there are fundamental laws governing the matter, they would be the same for all. The use of mathematical constants and the geometric forms regarded as fundamental, is a natural step.

## ECHOES FROM SPACE?

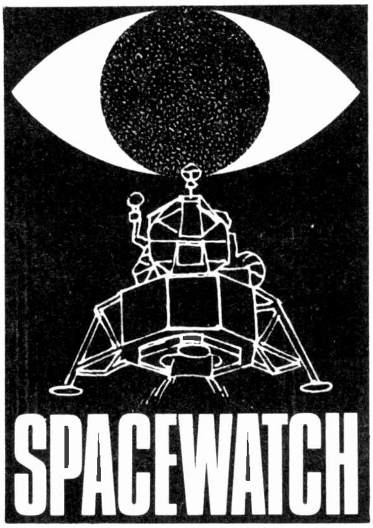
There have been two recent suggestions, one which relates to a cyclic condition of the movements of heavenly bodies and one which is based on the problem of long time echoes of known broadcasts.

The first of these suggestions involves the possibility of near approaches to the solar system by stars which might have a planetary system. Statistics show that there is a quite frequent approach to within 50 light years of the solar system.

A second line put forward is based on the phenomenon of echoes, first noted by Störmer and Van der Pol in 1928. While they appeared to be curious and puzzling at that time this is not really the case now.

However, renewed interest has been aroused by D. Lunan, who has studied available data over a long period and has offered certain suggestions as to the reason for the echoes.

One of the suggestions is that the echoes behave as though they were reflected from a point at or near the orbit of the moon. He has constructed maps which are very similar to the star maps of the northern hemisphere and suggests that the star Epsilon Boötes might




BY FRANK W. HYDE

be the source from which a probe has been dispatched.

The probe may be in orbit and attempting to make earth beings aware of its existence by re-transmitting broadcasts. It is also suggested that the probe may have arrived in the solar system about 11,000 years ago.

Perhaps all the evidence has not been released but the matter was given considerable discussion at a meeting of the Interplanetary Society.

The echoes are both long-time, that is years, and short-time, that is 3 to 15 seconds and it is the latter that Lunan has investigated.

It is easier to offer an alternative for this suggestion because the periods are short enough to avoid the complication of dissipation of power. A short time of three seconds could be a direct reflection from the earth's other moon that has so frequently been postulated or even from the moon itself over a long path.

However, for both of the extremes of timing there is a simple answer which involves the model of the ionosphere that was considered satisfactory for a long time. This was a layer type model like the successive skins of an onion.

The ionosphere in fact is not a bit like that and not only are there now many doubts about propagation theories that have been held for so long, but the layer theory disappeared with the advent of *Sputnik 1*. In this connection there is much evidence that indicates that there is no homogenity about these layers at all.

Moreover, there is considerable variation in the density of the northern and southern hemispheres. This variation of density in the layers has a considerable effect on the length of reflection paths. It is, therefore, possible for a signal to go round the earth several times before emerging at a particular angle that could be recorded as an echo.

It would be possible to expand on the Lunan theory, but suffice to say that the answer to the appearance of regular patterns can only come from a specific attempt to make a practical test of Lunan's work. It is in fact an experiment that could be undertaken by amateurs and perhaps here is an opportunity for UFO supporters to produce some practical answers to their claims.

## USSR RESEARCH

As a result of finding amino acids in the Murchison meteorite the Russians have been carrying out further experiments on meteorites that have fallen in the past. They concluded — so state academicians Vinogradov and Vdovykin — that there is evidence for the chemical evolution of life.

They also state that it is not necessary for there to be special fortuitous circumstances for this to come about; in short, life could evolve anywhere where there is a dust accretion in the galaxy. This has been deduced from an examination of the Mighei meteorite which fell in the Ukraine in 1889.

The Murchison meteorite revealed amino acids and the Mighei meteorite shows an acid which is similar to *DNA* but has a spiral which is symmetrical. From this fact they conclude that it is not of biological derivation.

## CRAB NEBULA AGAIN

The crab nebula has been much in the news of late. The original noting of this supanova by the Chinese astronomer Yang Wei-Tek was on July 4, 1054. Little other record of this occurrence is found in literature though it must have been an event of considerable note.

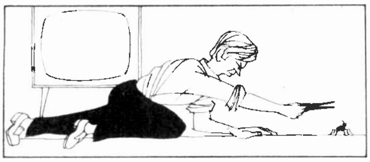
However, in 1955 W. C. Miller discovered evidence that the North American Indians had recorded the event. Pictures were found showing the crescent moon with the nova nearby. This was thought to be a unique record and the date was confirmed as July 5, 1054.

Recently another discovery was made at Fern Cave in California. This cave was occupied at the time of the event in 1054 and so could be depicting an event during the formation of the settlement. The timing has been checked by four investigators and though no absolute claim for identification is made it seems unlikely that it records any other event.

The fact that the nova was more brilliant than Venus must have made it an outstanding sight.

Gerry Brown . . .

# ON THE FRINGE



## SENSE OF SMELL

Apropos of our discussion some months back, relating to "sniffing", it seems that someone else has latched on to the idea of recruiting bugs to serve as extensions to our probosci. This time it's some form (goodness knows what) of marine bacteria which come as a package-deal for detecting the smells associated with just about anything from bombs to pineapples.

These wonderful little "critters" can, I gather, be trained (presumably in the good old Pavlovian way) to glow whenever they sense or come in contact with a material of one's choosing. It is then simply a matter of detecting this light with a photocell (photomultiplier?) to identify the type of smell. Unlike previous attempts to make bugs useful in the role of an olfactory sense, this way would appear to be far more flexible.

The particular application to which this artificial nose might show some real worth ultimately is tele-olfaction. Using this new way to sense smell at a distance ought not to be too difficult, but may be complicated by the fact that odours do not seem to be represented to us in the same way that, say, colour is; to wit, it is not simply a question of discovering primary odours then combining them to produce "hues" (or phews!).

No doubt, the limitation would be on the number of trained bacteria packages one could incorporate in a transducer, since each package would only respond to a particular smell. Assuming a compromise could be accepted at around one hundred or so packages, that is one package for each of the more common smells, then by fanning air over the device, sequential interrogation of the bacterias' photocells would classify both type and amplitude of odour.

This, though, is only part way to the ultimate in communication. There still needs to be a method for reproducing the "pong" from the transducer output waveform. This should be a simpler job because, following receipt of this signal, it might then be decoded within the receiver and the resultant employed to address a corresponding set of control valves, so releasing the correct aromatic. As an alternative, heaters could be arranged to vapourise the material.

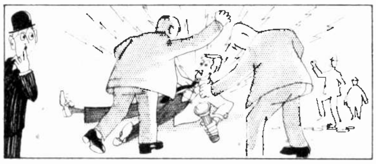
Whether there should be a delay between different signals is a moot point; naturally, it would not be the best of schemes to follow one smell by another when the chance existed that they might clash or produce some offensive "mixture".

Honestly, imagine one of these things going wrong. There is little doubt that TV servicemen would suddenly find new uses for the humble pair of bull-nosed pliers!

## SHOCK THE VILLAINS

Mugging, and the crop of pensioner-bashing cases we have witnessed lately must be distasteful to anyone with a sense of respect for their fellows. For a while now I have considered a number of possibilities for beating this, very real, public menace, but it is not something to be easily reckoned with.

Anyhow, having contacted the Chief Constable for my area and



discovered that, "no, you were not permitted to use portable high-voltage equipment with a view to shocking the villians into submission", the only effective alternative seemed to be a notion based on the word "shock". The best deterrent thus appeared to be one that could attract a lot of attention to one's predicament by others in the vicinity of the incident.

An electronic device to meet our requirements generally needs to have quite bulky proportions, so probably the best "noise-maker" would be a small klaxon employing a miniature electric motor, this driving a coarse-pitch gear pinion bearing directly against a piece of bent metal (certainly noisier than any loudspeaker of twice the size). The metal "noise-maker" could be carved out of the lower part of a hand-held lamp case the upper portion being utilised for photo-flash attention lamps.

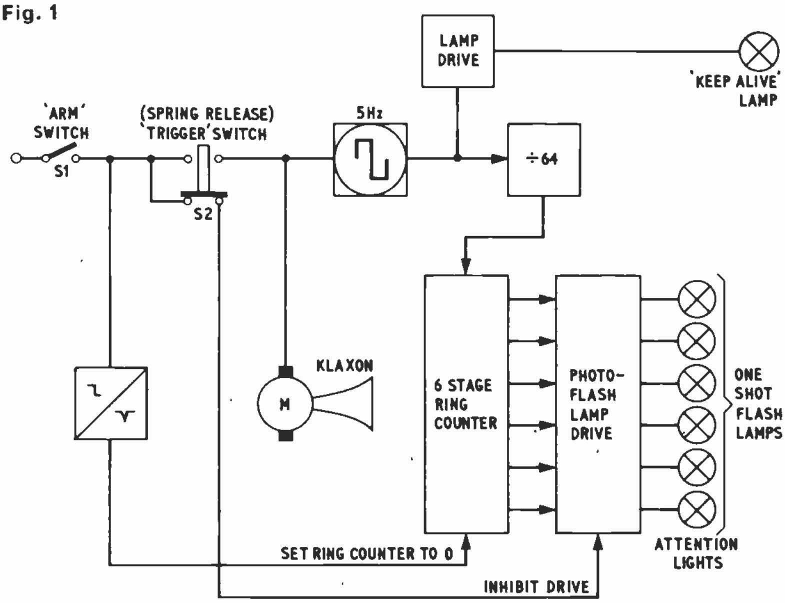
This kind of alternative, at least, should come within the limits of the law and Fig. 1 gives the general picture of how such a set-up would function.

Two switches control the device. The "arm" switch (preferably concealed) connects a supply battery preparatory to possible operation. Simultaneously, photo-flash lamp drive is inhibited while a "set" pulse is fed to a six-stage ring counter whose outputs all go to logical "0".

Release of the spring-return "trigger" switch starts the klaxon and also causes the clock generator to run. In turn, a (deliberately over-run) "keep-alive" lamp rapidly flashes while the divider counts down the signal from the clock. Thus, every 13 or so seconds, the ring counter will be advanced one step and so fire (one at a time) the photo-flash lamps.

Naturally, the device ought not to be too inelegant physically, but should be of sufficient size to prevent any feeble-minded body-vandal shoving it in a convenient Gladstone bag!

Fig. 1



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| 2N335 | 0·75 |
| 2N351 | 0·95 |
| 2N376 | 1·00 |
| 2N384 | 0·93 |
| 2N388A | 0·40 |
| 2N404 | 0·43 |
| 2N456 | 0·75 |
| 2N456A | 0·75 |
| 2N457A | 0·80 |
| 2N491 | 8·25 |
| 2N584 | 0·26 |
| 2N591 | 0·34 |
| 2N696 | 0·15 |
| 2N697 | 0·15 |
| 2N698 | 0·25 |
| 2N699 | 0·29 |
| 2N706 | 0·10 |
| 2N706A | 0·12 |
| 2N708 | 0·13 |
| 2N709 | 0·38 |
| 2N711 | 0·30 |
| 2N718 | 0·21 |
| 2N718A | 0·30 |
| 2N720 | 0·50 |
| 2N721 | 0·55 |
| 2N914 | 0·15 |
| 2N916 | 0·17 |
| 2N918 | 0·80 |
| 2N919 | 0·20 |
| 2N929 | 0·14 |
| 2N930 | 0·14 |

Only a few examples of our stocks can be shown here

| | |
|---|---|
| 2N1090 | 0·23 |
| 2N1091 | 0·24 |
| 2N1131 | 0·20 |
| 2N1132 | 0·20 |
| 2N1184 | 1·27 |
| 2N1302 | 0·16 |
| 2N1303 | 0·16 |
| 2N1304 | 0·20 |
| 2N1305 | 0·20 |
| 2N1306 | 0·22 |
| 2N1307 | 0·22 |
| 2N1308 | 0·25 |
| 2N1309 | 0·25 |
| 2N1483 | 0·90 |
| 2N1507 | 0·24 |
| 2N1613 | 0·20 |
| 2N1631 | 0·35 |
| 2N1637 | 0·30 |
| 2N1638 | 0·27 |
| 2N1671 | 1·00 |
| 2N1701 | 1·10 |
| 2N1702 | 2·15 |
| 2N1711 | 0·17 |
| 2N1893 | 0·34 |
| 2N2102 | 0·30 |
| 2N2147 | 0·70 |
| 2N2148 | 0·60 |
| 2N2192 | 0·40 |
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| 2N2193 | 0·40 |
| 2N2193A | 0·42 |
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| 2N2194A | 0·30 |
| 2N2195 | 0·37 |
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| 2N2219 | 0·20 |
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| 2N2220 | 0·20 |
| 2N2221 | 0·20 |
| 2N2221A | 0·22 |
| 2N2222 | 0·20 |
| 2N2222A | 0·25 |
| 2N2368 | 0·11 |
| 2N2369 | 0·12 |
| 2N2369A | 0·15 |
| 2N2646 | 0·41 |
| 2N2647 | 1·20 |
| 2N2711 | 0·12 |
| 2N2712 | 0·12 |
| 2N2713 | 0·17 |
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| 2N2907A | 0·25 |
| 2N2913 | 0·75 |
| 2N2923 | 0·12 |
| 2N2924 | 0·12 |
| 2N2925 | 0·12 |
| 2N2926 | |
| Green | 0·10 |
| Yellow | 0·10 |
| Orange | 0·10 |

| | |
|---|---|
| 2N3053 | 0·31 |
| 2N3054 | 0·47 |
| 2N3054 | 0·46 |
| 2N3055 | 0·50 |
| 2N3390 | 0·20 |
| 2N3391 | 0·20 |
| 2N3391A | 0·22 |
| 2N3392 | 0·13 |
| 2N3393 | 0·12 |
| 2N3394 | 0·12 |
| 2N3402 | 0·17 |
| 2N3403 | 0·19 |
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| 2N3405 | 0·27 |
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| 2N3415 | 0·10 |
| 2N3416 | 0·15 |
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| 2N3570 | 1·25 |
| 2N3571 | 1·12 |
| 2N3572 | 0·97 |
| 2N3702 | 0·10 |
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| 2N3704 | 0·10 |
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| 2N3706 | 0·90 |
| 2N3707 | 0·10 |
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| 2N3774 | 3·33 |
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| 2N3859A | 0·16 |
| 2N3860 | 0·16 |
| 2N3866 | 0·70 |
| 2N3877 | 0·25 |
| 2N3877A | 0·26 |
| 2N3878 | 1·22 |
| 2N3879 | 1·91 |
| 2N3900 | 0·20 |
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| 2N4928 | 1·80 |
| 2N4929 | 2·23 |
| 2N4930 | 2·25 |
| 2N4931 | 2·70 |
| 2N5172 | 0·08 |
| 2N5174 | 0·22 |
| 2N5175 | 0·26 |

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| 2N5245 | 0·43 |
| 2N5190 | 0·92 |
| 2N5191 | 0·96 |
| 2N5192 | 1·24 |
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| 3N128 | 0·63 |
| 3N138 | 1·37 |
| 3N199 | 1·36 |
| 3N140 | 0·76 |
| 3N141 | 0·69 |
| 3N142 | 0·54 |
| 3N143 | 0·64 |
| 3N152 | 0·79 |
| 3N153 | 0·74 |
| 3N154 | 0·74 |
| 3N159 | 1·00 |
| 3N200 | 2·07 |
| 3N201 | 1·05 |
| LM741CN (d.i.l.) | 0·70 |
| L741C (TO5) | 0·40 |
| 40050 | 0·78 |
| 40251 | 0·81 |
| 40309 | 0·33 |
| 40310 | 0·50 |
| 40313 | 0·92 |
| 40316 | 0·50 |
| 40318 | 0·92 |
| 40322 | 0·92 |
| 40360 | 0·46 |
| 40361 | 0·48 |
| 40362 | 0·44 |
| 40363 | 0·88 |
| 40389 | 0·46 |
| 40394 | 0·56 |
| 40395 | 0·50 |
| 40406 | 0·44 |
| 40407 | 0·33 |
| 40408 | 0·50 |
| 40409 | 0·52 |
| 40410 | 0·53 |
| 40411 | 2·00 |
| 40414 | 3·55 |
| 40438 | 1·44 |
| 40467A | 0·69 |
| 40468A | 0·44 |
| 40600 | 0·69 |
| 40601 | 0·67 |
| 40602 | 0·46 |
| 40603 | 0·58 |
| 40604 | 0·56 |
| 40636 | 1·10 |
| 40673 | 0·56 |
| AC107 | 0·35 |
| AC113 | 0·16 |
| AC115 | 0·16 |
| AC117 | 0·20 |
| AC121 | 0·13 |
| AC126 | 0·20 |
| AC127 | 0·20 |
| AC128 | 0·20 |
| AC141K | 0·30 |
| AC142K | 0·25 |
| AC151V | 0·14 |
| AC152V | 0·17 |
| AC153 | 0·22 |
| AC153K | 0·25 |
| AC154 | 0·20 |
| AC176 | 0·18 |
| AC176K | 0·20 |
| AC187K | 0·20 |
| AC188K | 0·26 |
| ACY17 | 0·25 |
| ACY18 | 0·15 |
| ACY19 | 0·20 |
| ACY20 | 0·20 |
| ACY21 | 0·18 |
| ACY22 | 0·13 |
| ACY28 | 0·18 |
| ACY30 | 0·42 |
| ACY39 | 0·55 |
| ACY40 | 0·17 |
| ACY41 | 0·15 |
| ACY44 | 0·23 |
| AD136V | 0·94 |
| AD140 | 0·50 |
| AD140 | 0·55 |
| AD142 | 0·50 |
| AD143 | 0·45 |
| AC149V | 0·66 |
| AD149V | 1·26 |
| AD150 | 0·63 |
| ADZ11 | 1·50 |
| ADZ12 | 1·75 |
| AF106 | 0·27 |
| AF109R | 0·40 |
| AF114 | 0·25 |
| AF115 | 0·24 |
| AF116 | 0·25 |
| AF117 | 0·20 |
| AF118 | 0·50 |

| | |
|---|---|
| AF121 | 0·22 |
| AF124 | 0·24 |
| AF125 | 0·20 |
| AF126 | 0·19 |
| AF127 | 0·20 |
| AF139 | 0·38 |
| AF170 | 0·25 |
| AF172 | 0·25 |
| AF178 | 0·55 |
| AF179 | 0·65 |
| AF180 | 0·50 |
| AF186 | 0·40 |
| AF200 | 0·35 |
| AF239 | 0·41 |
| AF240 | 0·72 |
| AF279 | 0·54 |
| AF280 | 0·54 |
| AFY42 | 0·74 |
| AF211 | 0·55 |
| AL102 | 0·75 |
| AL103 | 0·70 |
| ASY26 | 0·30 |
| ASY27 | 0·36 |
| ASY28 | 0·28 |
| ASY29 | 0·30 |
| ASY50 | 0·20 |
| ASY55 | 0·35 |
| ASZ21 | 0·55 |
| AU103 | [illegible] |
| BC107 | [illegible] |
| BC108 | [illegible] |
| BC109 | [illegible] |
| BC113 | 0·10 |
| BC114 | 0·12 |
| BC115 | 0·15 |
| BC116 | 0·15 |
| BC116A | 0·18 |
| BC117 | 0·20 |
| BC118 | 0·11 |
| BC119 | 0·27 |
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| BC123 | 0·25 |
| BC125 | 0·15 |
| BC126 | 0·20 |
| BC132 | 0·30 |
| BC134 | 0·11 |
| BC135 | 0·11 |
| BC136 | 0·15 |
| BC137 | 0·15 |
| BC138 | 0·20 |
| BC140 | 0·30 |
| BC141 | 0·34 |
| BC142 | 0·18 |
| BC143 | 0·21 |
| BC144 | 0·24 |
| BC145 | 0·21 |
| BC147 | 0·10 |
| BC148 | 0·09 |
| BC149 | 0·10 |
| BC153 | 0·10 |
| BC154 | 0·11 |
| BC157 | 0·09 |
| BC158 | 0·10 |
| BC159 | 0·10 |
| BC150 | 0·37 |
| BC167B | 0·11 |
| BC168B | 0·10 |
| BC168C | 0·10 |
| BC169B | 0·11 |
| BC169C | 0·11 |
| BC170 | 0·11 |
| BC171 | 0·13 |
| BC172 | 0·11 |
| BC182 | 0·10 |
| BC182L | 0·10 |
| BC183 | 0·09 |
| BC183L | 0·09 |
| BC184 | 0·11 |
| BC184L | 0·11 |
| BC186 | 0·25 |
| BC187 | 0·25 |
| BC204 | 0·11 |
| BC205 | 0·10 |
| BC206 | 0·11 |
| BC207 | 0·10 |
| BC268 | 0·09 |
| BC209 | 0·10 |
| BC211 | 0·30 |
| BC212K | 0·10 |
| BC212L | 0·12 |
| BC214L | 0·14 |
| BC236 | 0·16 |
| BC237 | 0·08 |
| BC238 | 0·08 |
| BC239 | 0·08 |
| BC251 | 0·20 |
| BC252 | 0·18 |
| BC253 | 0·23 |
| BC257 | 0·08 |
| BC258 | 0·08 |
| BC259 | 0·11 |
| BC261 | 0·20 |
| BC262 | 0·18 |
| BC263 | 0·23 |
| BC300 | 0·42 |
| BC301 | 0·34 |
| BC302 | 0·27 |
| BC303 | 0·50 |
| BC304 | 0·43 |
| BC307 | 0·09 |

| | |
|---|---|
| BC307A | 0·09 |
| BC307V1 | 0·09 |
| BC308 | 0·08 |
| BC308A | 0·08 |
| BC308B | 0·08 |
| BC309 | 0·09 |
| BC309A | 0·09 |
| BC309B | 0·09 |
| BC313 | 0·30 |
| BC327 | 0·21 |
| BC328 | 0·19 |
| BC337 | 0·17 |
| BC338 | 0·17 |
| BCY30 | 0·27 |
| BCY31 | 0·30 |
| BCY32 | 0·50 |
| BCY33 | 0·25 |
| BCY34 | 0·30 |
| BCY38 | 0·40 |
| BCY39 | 0·60 |
| BCY40 | 0·50 |
| BCY42 | 0·15 |
| BCY43 | 0·15 |
| BCY58 | 0·18 |
| BCY59 | 0·19 |
| BCY66 | 0·58 |
| BCY67 | 0·82 |
| BCY70 | 0·15 |
| BCY71 | 0·20 |
| BCY72 | 0·13 |
| BCY87 | 3·47 |
| BCY88 | 2·40 |
| BCY89 | 0·80 |
| BCZ10 | 0·27 |
| BCZ11 | 0·40 |
| BD115 | 0·75 |
| BD116 | 0·75 |
| BD121 | 0·65 |
| BD123 | 0·80 |
| BD124 | 0·60 |
| BD130 | 0·50 |
| BD131 | 0·75 |
| BD132 | 0·75 |
| BD135 | 0·38 |
| BD136 | 0·44 |
| BD137 | 0·47 |
| BD138 | 0·55 |
| BD139 | 0·62 |
| BD140 | 0·73 |
| BDY10 | 1·25 |
| BDY11 | 1·50 |
| BDY17 | 1·50 |
| BDY18 | 1·75 |
| BDY19 | 1·97 |
| BDY20 | 0·92 |
| BDY38 | 0·65 |
| BDY60 | 0·90 |
| BDY61 | 0·85 |
| BDY62 | 0·75 |
| BF115 | 0·23 |
| BF117 | 0·43 |
| BF119 | 0·58 |
| BF121 | 0·25 |
| BF123 | 0·27 |
| BF125 | 0·25 |
| BF127 | 0·27 |
| BF152 | 0·20 |
| BF153 | 0·29 |
| BF154 | 0·16 |
| BF158 | 0·15 |
| BF159 | 0·27 |
| BF160 | 0·23 |
| BF161 | 0·35 |
| BF163 | 0·20 |
| BF166 | 0·35 |
| BF167 | 0·18 |
| BF173 | 0·19 |
| BF177 | 0·25 |
| BF178 | 0·25 |
| BF179 | 0·30 |
| BF180 | 0·35 |
| BF181 | 0·32 |
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| BF183 | 0·40 |
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| BF185 | 0·17 |
| BF194 | 0·14 |
| BF195 | 0·15 |
| BF196 | 0·15 |
| BF197 | 0·15 |
| BF198 | 0·15 |
| BF199 | 0·18 |
| BF200 | 0·35 |
| BF224J | 0·14 |
| BF225J | 0·19 |
| BF237 | 0·22 |
| BF238 | 0·22 |
| BF244 | 0·16 |
| BF245 | 0·33 |
| BF246 | 0·43 |
| BF247 | 0·49 |
| BF254 | 0·14 |
| BF255 | 0·15 |
| BF257 | 0·41 |
| BF258 | 0·46 |
| BF259 | 0·48 |
| BF261 | 0·23 |
| BF264 | 1·45 |
| BF270 | 0·25 |
| BF271 | 0·21 |

| | |
|---|---|
| BF272 | 0·53 |
| BF273 | 0·25 |
| BF274 | 0·28 |
| BF457 | 0·46 |
| BF458 | 0·57 |
| BF459 | 0·57 |
| BF821 | 2·10 |
| BF821A | 2·30 |
| BF828 | 0·92 |
| BF861 | 0·27 |
| BF898 | 0·28 |
| BFW10 | 0·61 |
| BFW11 | 0·61 |
| BFW15 | 0·35 |
| BFX13 | 0·23 |
| BFX29 | 0·25 |
| BFX30 | 0·25 |
| BFX37 | 0·30 |
| BFX44 | 0·33 |
| BFX63 | 2·48 |
| BFX68 | 0·30 |
| BFX84 | 0·24 |
| BFX85 | 0·29 |
| BFX86 | 0·24 |
| BFX87 | 0·25 |
| BFX88 | 0·20 |
| BFX89 | 0·45 |
| BFY10 | 0·35 |
| BFY11 | 0·45 |
| BFY17 | 0·90 |
| BFY18 | 0·25 |
| BFY19 | 0·25 |
| BFY20 | 0·50 |
| BFY29 | 0·40 |
| BFY37 | 0·20 |
| BFY41 | 0·43 |
| BFY43 | 0·62 |
| BFY50 | 0·16 |
| BFY51 | 0·16 |
| BFY52 | 0·16 |
| BFY53 | 0·15 |
| BFY56 | 0·34 |
| BFY64 | 0·41 |
| BFY75 | 0·40 |
| BFY76 | 0·22 |
| BFY77 | 0·24 |
| BFY78 | 0·36 |
| BFY90 | 0·55 |
| BRY39 | 0·30 |
| BSX19 | 0·13 |
| BSX20 | 0·14 |
| BSX21 | 0·20 |
| BSX26 | 0·34 |
| BSX27 | 0·34 |
| BSX28 | 0·25 |
| BSX29 | 0·47 |
| BSX30 | 0·68 |
| BSX59 | 0·78 |
| BSX60 | 0·54 |
| BSX61 | 0·42 |
| BSX76 | 0·15 |
| BSX77 | 0·20 |
| BSX78 | 0·25 |
| BSW70 | 0·28 |
| BSY24 | 0·20 |
| BSY25 | 0·15 |
| BSY26 | 0·20 |
| BSY27 | 0·15 |
| BSY28 | 0·15 |
| BSY38 | 0·1[illegible] |
| BSY39 | [illegible] |
| BSY51 | [illegible] |
| BSY52 | [illegible] |
| BSY53 | [illegible] |
| BSY54 | 0·30 |
| BSY56 | 0·79 |
| BSY65 | 0·15 |
| BSY78 | 0·40 |
| BSY79 | 0·40 |
| BSY790 | 0·45 |
| BSY95A | 0·09 |
| BU104 | 1·42 |
| BU105 | 2·25 |
| C111 | 0·53 |
| C407 | 0·18 |
| C424 | 0·15 |
| C425 | 0·36 |
| C426 | 0·25 |
| C428 | 0·25 |
| C444 | 0·26 |
| D40N3 | 0·62 |
| GET111 | 0·45 |
| GET113 | 0·25 |
| GET114 | 0·20 |
| GET115 | 0·50 |
| GET119 | 0·35 |
| GET120 | 0·40 |
| GET535 | 0·20 |
| GET536 | 0·20 |
| GET538 | 0·20 |
| GET873 | 0·15 |
| GET880 | 0·30 |
| GET883 | 0·20 |
| GET887 | 0·20 |
| GET890 | 0·22 |
| GET895 | 0·25 |
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| SN7417 | 0·30 | 0·40 | SN7452 | 0·20 | 0·18 | SN7491 | 1·00 | 0·94 |
| SN7420 | 0·20 | 0·18 | SN7453 | 0·20 | 0·18 | SN7492 | 0·75 | 0·70 |
| SN7423 | 0·52 | 0·45 | | | | SN7493 | 0·75 | 0·70 |
| SN7425 | 0·48 | 0·42 | SN7454 | 0·20 | 0·18 | SN7494 | 0·84 | 0·80 |
| SN7426 | 0·32 | 0·28 | SN7460 | 0·20 | 0·18 | SN7495 | 0·80 | 0·74 |
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| 3A | 15p | 17p | 20p | 22½p | 25p | 27p | 30p | 35p |
| 6A | — | — | 25p | 30p | 32½p | 35p | — | — |
| 10A | 30p | 35p | 40p | 47p | 56p | 66p | 75p | — |
| 15A | 36p | 45p | 48p | 55p | 65p | 75p | 87p | — |
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1 amp and 3 amp are plastic encapsulation.

## DIODES & RECTIFIERS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| IN34A | 10p | AA119 | 7p | BAX16 | 12½p | FST3/4 | 22½p |
| IN914 | 7p | AA129 | 15p | BAY18 | 17½p | OA5 | 17p |
| IN916 | 7p | AAZ13 | 12p | BAY31 | 7p | OA10 | 20p |
| IN4007 | 20p | AAZ15 | 12p | BAY38 | 25p | OA9 | 10p |
| IS44 | 7p | AAZ17 | 10p | BY100 | 15p | OA47 | 8p |
| IS113 | 15p | BA100 | 15p | BY103 | 22p | OA70 | 7p |
| IS120 | 12p | BA102 | 25p | BY122 | 47½p | OA73 | 10p |
| IS121 | 14p | BA110 | 25p | BY124 | 15p | OA79 | 7p |
| IS130 | 8p | BA114 | 15p | BY126 | 15p | OA81 | 8p |
| IS131 | 10p | BA115 | 7p | BY127 | 17p | OA82 | 10p |
| IS132 | 12p | BA141 | 17p | BY164 | 57p | OA90 | 7p |
| IS920 | 7p | BA142 | 17p | BYX10 | 22p | OA91 | 7p |
| | | BA144 | 12p | BYZ10 | 35p | OA95 | 7p |
| IS922 | 8p | BA145 | 17p | BYZ11 | 32p | OA2000 | 7p |
| IS923 | 12p | BA154 | 12p | BYZ12 | 30p | OA202 | 10p |
| IS940 | 5p | BAX13 | 5p | BYZ13 | 25p | TIV307 | 50p |

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|---|---|
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| 0·68 | 11p |
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| | | |
|---|---|---|
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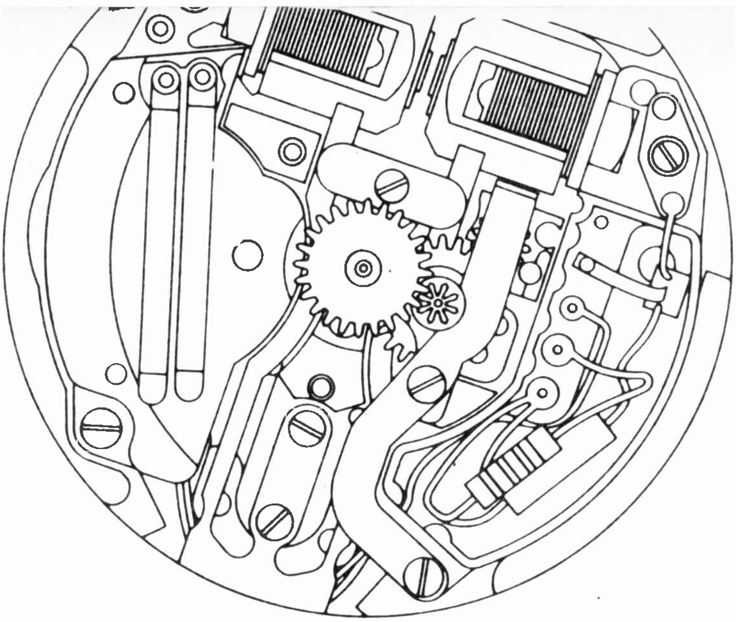
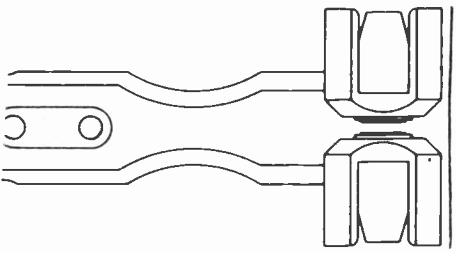




# ELECTRONIC TIMEPIECES

## By JB DANCE M.sc.

Most watches and small clocks being manufactured at the present time still employ a mainspring as the source of power and a balance wheel plus hair spring as the timing mechanism. The basic design of such timepieces has remained essentially unaltered since Huygens developed the balance wheel mechanism in the 17th Century.

### RECENT PROGRESS

The first battery powered wrist watch was marketed in 1952, but recent developments in micro-miniature integrated circuits have enabled high quality electronic watches to be produced which are much more accurate than the more common types of watch. Most of the quartz crystal controlled watches show an accuracy of about one minute per year.

Electronic watches do not have a spring which requires winding periodically, but their miniature battery must be replaced about once per year. Smaller movements suitable for ladies' watches are becoming available, but considerable problems arise in designing watches which can be powered by miniature mercury cells which must have the minimum acceptable life of one year.

### TYPES

Some of the main types of electronic watches can be classified in the following way. Many variations of these main types are available.

*First generation watches* employ a conventional balance wheel and hair spring as the timing mechanism, but they are powered by a battery instead of a main spring. They have the advantage that they do not have to be wound, but their accuracy is not generally so much greater than that of a conventional watch.

*Second generation watches* employ a tuning fork mechanism operating at about 300–500Hz as the timing device; a transistor circuit drives the tuning fork. Such watches have an accuracy of about one minute per month, this being considerably better than that of an ordinary watch. Tuning fork watches do not tick, but emit a slight hum.

*Third generation watches* employ a quartz crystal oscillator which normally operates at a frequency of between about 8kHz and 33kHz; most types have an accuracy of about one minute per year. The pulses from the quartz crystal are used to control the speed of a motor which drives the hands of the watch. Various techniques are employed to accomplish this.

*Fourth generation watches* do not employ hands to indicate the time, but incorporate a digital display which shows the time in actual figures. These watches have no moving parts and are completely electronic. They employ a quartz crystal oscillator and have an accuracy of about one minute per year. They are only just becoming available.

### PRICES

Unfortunately the price of electronic watches is still quite high. The price of many watches is increased because a gold case is employed.

In the case of stainless steel cased watches, one finds tuning fork models ranging from just under

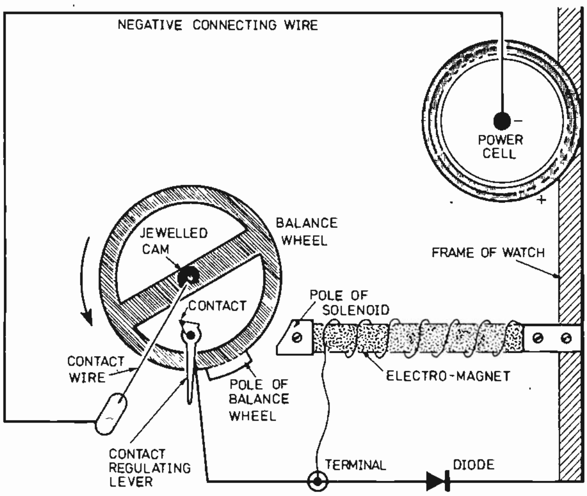



Fig. 1. The circuit diagram of the first electric watch

£40 upwards, with the smaller ladies' watches rather more expensive. The quartz crystal controlled watches are generally priced from about £100 upwards, but some of the watches providing a digital display are not so much more expensive than other quartz crystal controlled watches.

It seems fairly certain that the prices of electronic watches will fall during the next few years. The components of all electronic digital watches can be mass produced and assembled by relatively unskilled personnel. This will effect a great saving in labour costs at a time when the general trend is for labour costs to rise rapidly and integrated circuit production costs to fall—especially if large numbers are produced. Thus it seems we are experiencing a revolution in watch design.

Although one has the annual cost of the power cell replacement (typically £1), most electronic watches do not require servicing so frequently as ordinary watches. The forces in the transmission gearing are usually less than in conventional watches and therefore satisfactory functioning is almost independent of the increase of viscosity of the oil with time. In general the regular cleaning and preventative maintenance recommended for balance wheel watches are unnecessary with most electronic types; one only has the watch attended to if it stops or does not keep time with its normal accuracy.

## CLOCKS

Electronic clocks are also available with either a digital display or with the analogue display provided by ordinary hands. Many electronic clocks are quartz crystal controlled and provide an accuracy of about one minute per year. Both battery powered and mains types are available.

Some of the main types of electronic timepieces will now be considered in reasonable detail. The development of electronic clocks has followed a rather similar pattern to that of watches (although the problems of size are not nearly so acute) and therefore clocks and watches will be discussed together

## THE FIRST ELECTRIC WRIST WATCH

The first battery driven wrist watch was developed by the French Company LIP in collaboration with the Elgin Company of the U.S.A. This watch was introduced into the LIP range on 15th March 1952, but the same type of movement is still being produced by this Company. The Hamilton Company introduced a similar type of movement very shortly after the LIP watch became available.

Although this type of watch is electric rather than electronic, it will nevertheless be discussed, since it led to the development of some electronic types and has been described as the greatest advance in watch design for some centuries. The same basic principle has also been used in clocks manufactured by the Hamilton, Vedette, Bayard and Odo Companies.

## PRINCIPLE OF OPERATION

The principle of operation of the LIP type R.148 movement is shown in Fig. 1. The R.184 is similar, but it also indicates the date.

As the balance wheel rotates in an anticlockwise direction, the jewelled cam on the balance wheel pivot pushes the contact wire onto the contact. A current then flows from the power cell through the electro-magnet and the contacts and back to the cell. The energising of the electro-magnet at the instant the pole of the balance wheel is approaching the pole of the magnet causes the two poles to be attracted together so that the balance wheel is given an impulse.

The balance wheel continues to rotate after the contact has been made and the wire returns to its normal position. When the balance wheel swings in the opposite direction, the cam merely pushes the contact wire away from the contact and the magnet is not energised. The electro-magnet passes a current which increases to about 1mA over a period of 3 milliseconds and then the current falls rapidly to zero. The current pulses occur every 0·4s. For simplicity a magnetic shunt employed in this type of watch is not shown in Fig. 1.

## SPARK SUPPRESSION DIODE

A diode is connected in parallel with the electro-magnet. When the contacts are joined little current flows through this diode, since the potential across the electro-magnet reverse biases the diode. When the contacts break, however, the current ceases to flow through the electro-magnet and a back e.m.f. is developed across the latter, owing to its inductance. The diode shorts out this back e.m.f. and thus prevents damage to the delicate contacts by sparking.

The cam illustrated in Fig. 1 consists of a jewel. The amplitude of the balance wheel oscillations can be controlled by adjusting the contact regulating lever; the latter rotates the contact arm on its axis.

The amplitude of the oscillations of the balance wheel remains fairly constant and this results in the watch keeping more accurate time than many watches which are powered by a main spring. There is some negative feedback, since if the amplitude of oscillation decreases, the contact time is increased and this provides more power which helps to stabilise the amplitude of oscillation.

The mean current taken from the 1·55V cell is normally 5$\mu$A, but does not exceed 7$\mu$A. A 100mA-hour battery therefore has a life of some 15 to 18 months.

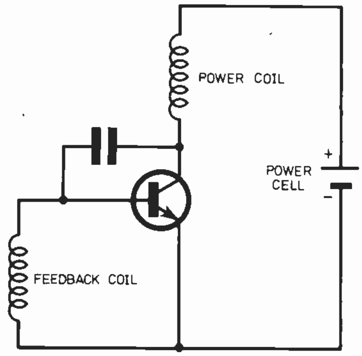
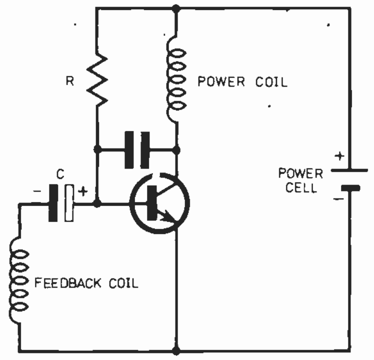



Fig. 2 (left). A circuit which can be used to drive the balance wheel of a watch

Fig. 3 (right). A circuit used in some self-starting watches and clocks for driving the balance wheel




## ELECTRONIC WATCHES WITH A BALANCE WHEEL

The main problem with the type of electric watch just described is that the contacts must be very carefully designed and positioned if they are to have a reasonable life. In any case, the contact life tends to be limited.

The work of Marius Lovet of France has led to the development of electronic watches with balance wheels in which the switching is carried out by a transistor.

The balance wheel of such electronic timepieces carries small permanent magnets which move near to two coils—a feedback coil and a power coil. The currents induced in the feedback coil by the movement of the balance wheel magnets drive the transistor into conduction so that the power coil receives a pulse. The magnetic field developed by this coil acts on the magnets to give the balance wheel a driving pulse.

## CIRCUIT

The type of circuit shown in Fig. 2 may be used in timepieces which employ an electronically driven balance wheel. If the latter is stationary, the base and emitter are at the same potential and therefore the collector current is extremely small.

When a magnet of the balance wheel moves past the feedback coil, however, the voltage induced in this coil causes the transistor to conduct. A current therefore flows in the power coil and an impulse is produced which powers the balance wheel. The pulse duration is typically 10 milliseconds. Spurious oscillations of the circuit can be suppressed by connecting a capacitor between the base and collector of the transistor. The resistance of the coils may be a few hundred to a few thousand ohms.

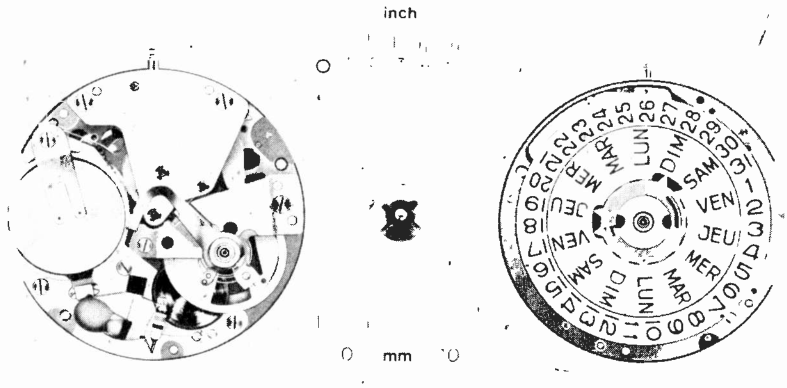
One of the disadvantages of this type of circuit is that the balance wheel does not commence to oscillate automatically. The watch must be rotated to start it. This difficulty can be avoided by connecting a resistor of about 100 to 200 kilohms in the base circuit (as shown in Fig. 3) so that a very small current flows in the base and collector circuit even when the balance wheel is stationary.

The current flowing through the power coil interacts with the magnets of the balance wheel and causes the latter to move. The minute oscillations are built up by transistor action until the normal amplitude of vibration is reached.

Although a current flows through the circuit continuously, this current can be eliminated by connecting an electrolytic capacitor in series with the feedback coil (as shown in Fig. 3).

Contactless circuits of this general type are widely employed in some of the more economical types of electronic watch. For example, the LIP movement type RE.50 (introduced in 1970) was the first electronic watch for ladies available anywhere in the world. Much of the internal volume is occupied by the 1·55V, 60mA-hour cell which is 7·9mm in diameter. One finds similar circuits in the 9154 "Dynotron" movement produced by Ebauches S.A.

The Swissonic 10 electronically driven balance wheel movement. The magnets can be seen fixed to the balance wheel and the power coil under the balance wheel. The first three letters of the days of the week are shown in French

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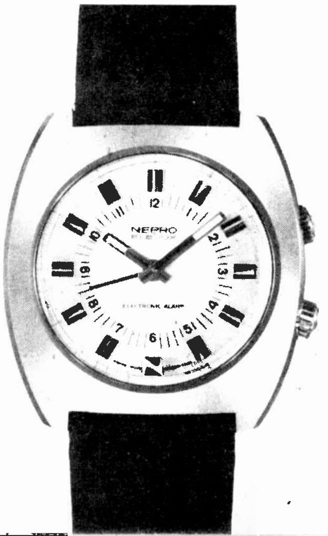
The Nepro Elevox watch which incorporates an electronic alarm



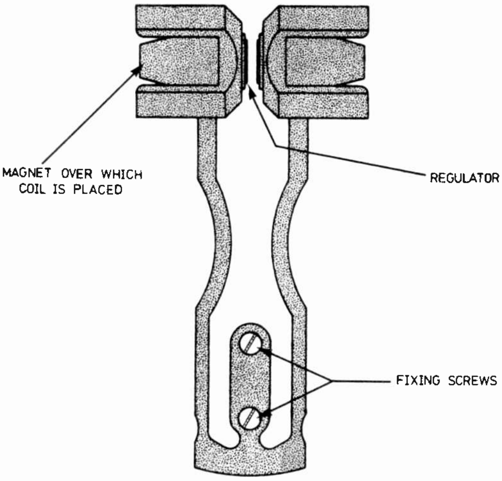



Fig. 4. The miniature tuning fork used in the Bulova 214 series of "Accutron" models

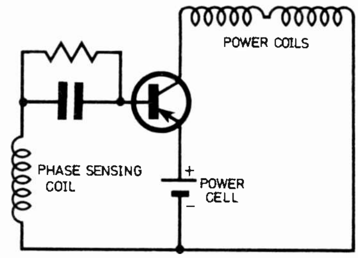



Fig. 5. The circuit of the Bulova 214 series of "Accutron" watches

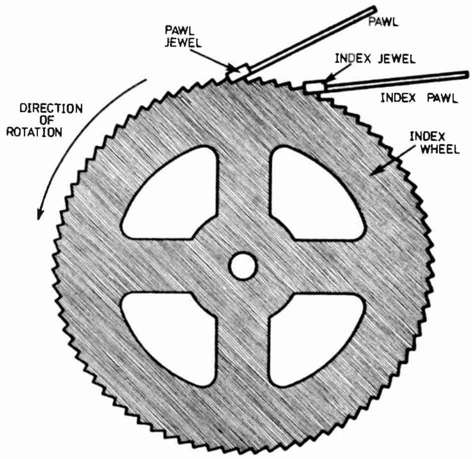



Fig. 6. The pawl mechanism used in the Bulova "Accutron" watches for converting the tuning fork vibrations into a rotary motion

(a large group of Swiss watch manufacturers), in the Junghans 600.12 self starting wrist watch produced in Germany, etc.

Electronic clocks employing this type of movement are produced by Junghans (type ATO-MAT-WERK 726); the mean current consumption is less than 160μA at 1·4V or a total of less than 1·5A-hour per year. Similar types of clock are produced by the Jaz Company.

## ELECTRONIC ALARMS

The first wrist watches with electronic alarm systems were introduced by the Nepro Company of Switzerland in 1972 after five years of development work. Although watches which have an alarm powered by a spring are available, the stored energy is rather small and this results in the intensity of sound being low and the duration limited. In addition, the alarm spring must be wound each time the alarm is used.

The Nepro watches employ a 1·5V battery of 40mA-hour capacity to power their wrist watch alarms. The current is about 8 to 12mA and the battery has a life of about a year with normal use. The alarms of these watches sound for five minutes unless cancelled by a push button.

## ALARM MODELS

One type of wrist watch with an alarm produced by Nepro is the "Memotron". A vibrating membrane generates the sound in the MB 500 alarm system contained in this watch. This is the smallest electronic alarm in production, having a volume of only 0·8 cubic centimetres.

Watches using this type of alarm can be used to remind a person of appointments throughout the day and can therefore be used for many purposes for which normal alarm clocks are unsuitable. The Nepro Company also produce a range of very small alarm clocks with battery powered alarms.

## TUNING FORK WATCHES

The first tuning fork movement was announced by the Bulova Company on 25th October 1960. This watch, which was the result of six years of research by Dr Hezel of Bulova, represented a real revolution in watch design. It was the first watch to employ an electronic mechanism and the first to use a timing mechanism not based on the balance wheel. In addition, it was the first watch to be delivered to the purchaser with a written guarantee of its time keeping accuracy; this is ±1 minute per month.

The frequency of operation of the tuning fork watches made by Bulova for men is 360Hz. The mechanical loss of energy has been reduced to a very low level and this enables the low power consumption of about 8μW to be obtained. The tuning fork mechanism is relatively insensitive to shock.

The tuning fork employed in the Bulova 214 series is shown in Fig. 4. It is made of a special alloy which is little affected by changes of temperature. A strong conical magnet and a magnetic cup are fitted to each prong of the tuning fork.

A coil is fitted over each magnet. The coils must be fixed in position so that they are very close to the vibrating magnets but never touch them. The coils have a total of about 16,000 turns, comprising about 200 metres of insulated copper wire of diameter 0·015mm. About one quarter of the number of turns on the one coil is used for feedback purposes.

## CIRCUIT

The circuit of the 214 series of Bulova watches is shown in Fig. 5. It consists of a simple transistor oscillator with a feedback coil (or "phase sensing

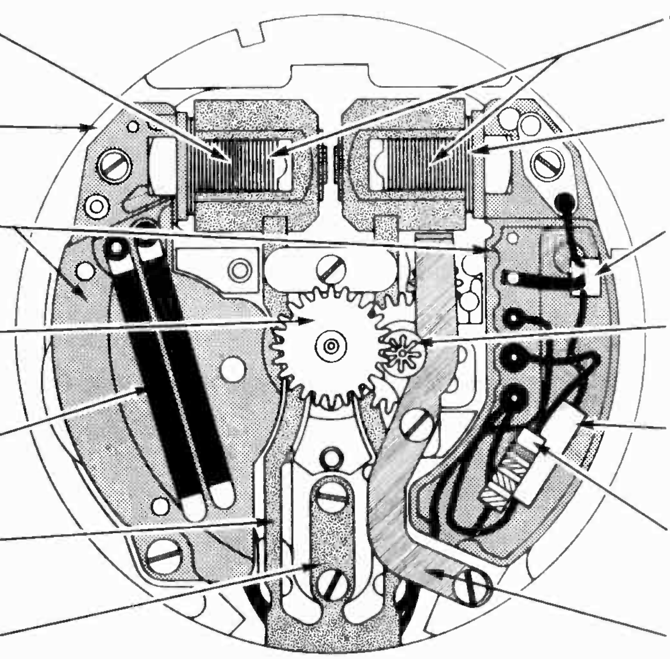



Fig. 7. The inside of a Bulova 214 series "Accutron" watch

coil") and two power coils. Indeed, it is basically very similar to the circuits of Figs. 2 and 3 which drive balance wheel watches.

The alternating voltages induced in the phase sensing coil are applied (via the battery and capacitor) to the base-emitter junction of the transistor. This diode junction rectifies these voltages and the capacitor is charged with such a polarity that the voltage across it opposes the power cell voltage.

The resistor in parallel with the capacitor allows the charge of the latter to leak away slowly so that a small pulse of current flows each time the voltage across the phase sensing coil is near to its maximum value and at a time when the polarity of the voltage induced in the power coils opposes that of the power cell.

If the total voltage induced in the power coils at the instant the transistor conducts were exactly equal to the cell voltage, no current would flow through them. At the correct amplitude of vibration, the voltage induced across the power coils at a time when the transistor conducts is about 10 per cent less than the cell voltage. A 10 per cent increase in the amplitude of vibration would therefore result in the current pulses to the power coils becoming zero and the amplitude would then quickly fall to its correct value. Similarly, a 10 per cent decrease in the amplitude would raise the current through the power coils to double its normal value and return the amplitude quickly to normal.

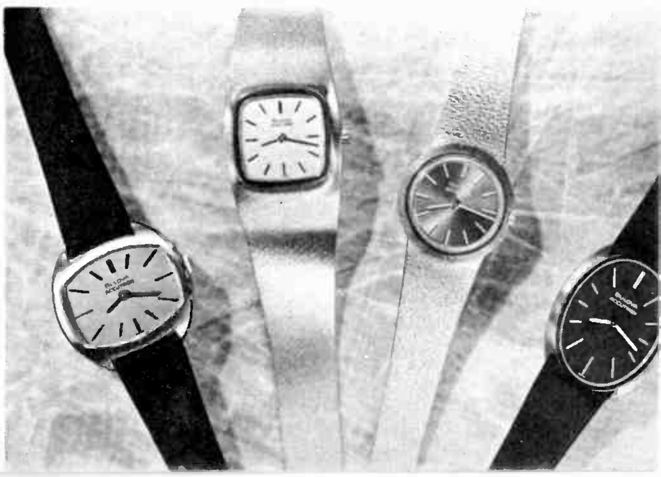
## TRANSLATING THE VIBRATIONS

The vibrations of the tuning fork are converted into rotary motion by means of the rachet and pawl mechanism shown in Fig. 6. Attached to one arm of the tuning fork is a straight spring (the "index") tipped with a tiny jewel which engages ratchet teeth on an index wheel. The wheel advances one tooth for each complete vibration of the tuning fork. A pawl holds the index wheel in position during the return stroke of the index jewel. Although the index wheel is only 2·4mm in diameter and 0·04mm in thickness, it has 300 teeth spaced at 0·025mm intervals. The index wheel drives a gear train which turns the hands of the watch.

The rate of rotation of the index wheel is unaffected by any normal changes in the amplitude of vibration of the tuning fork. The index wheel will move one tooth per vibration of the tuning fork when the index jewel moves any distance between just over one and just under three times the distance between adjacent teeth. If the index wheel moves a distance just over the distance between successive teeth, the pawl jewel will push it back during the time the index jewel returns; the net movement is then one tooth.

*continued on page 231*

Four small Accutron watches for ladies, using a tuning fork movement



# INDUSTRY NOTEBOOK

By Nexus

## YEAR OF THE HYBRID

This could be the year of the hybrid microcircuit. Thick film technology has made enormous strides through development of special inks for printing resistive networks, plenty of chip capacitors and active devices are available and potting techniques have also had their share of improvement. The result is a neat module of high reliability which has become extremely attractive to equipment manufacturers.

The manager of the very active hybrid microcircuit division of Welwyn Electric, Brian Attwood, tells me that although Welwyn started research on thin films some seven years ago and reached a high degree of perfection, the less expensive thick film technology has now reached the stage where it can do all the jobs of thin film. Welwyn are now fully concentrated in the thick film area with a plant capacity capable of handling £1 million worth of circuits a year, although he admits that actual production has not yet reached this figure.

Welwyn is engaged in the high technology end of the business with as many as a couple of dozen components in a single package. At any one time some 60 different circuits are going through the plant and some 500 types of circuits, all custom built by Welwyn, are in field service.

Also bidding for a big share of the hybrid market but in the higher volume area is Newmarket Transistors Ltd., a member of the Pye Group.

Two recently announced products are a low level audio amplifier, the performance of which can be adjusted as required by external components or links, and a self-contained hearing aid amplifier.

The company states that thick film hybrids have now reached a stage where costs are becoming appreciably lower than discrete assemblies. So confident is Newmarket that they are inviting users of circuits using discrete components to send details to the Newmarket design team who will then evaluate it in hybrid terms free of charge and submit a quotation for supplies.

Yet another firm spreading its wings with hybrids is Coutant Electronics, best known as a supplier of power supply units. Coutant started a thick film facility for in-house use manufacturing mainly encapsulated voltage regulators and over voltage protection units. Now the company is offering a full design and manufacturing service to allcomers.

## POLLUTION MEASUREMENT

The big investment in design of pollution measurement equipment by Plessey looks as if it may be starting to pay off. The company's water quality monitoring equipment came through a four-month evaluation at the Water Pollution Research Laboratory, Stevenage, with flying colours and installations are now operating with the Sussex, Lancashire and Trent River Authorities. Orders have been taken from similar authorities in Sweden, Italy and France, the forerunners of a profitable export trade.

Another notable order, although valued only at £20,000 is for an environmental monitoring system at Lovisa, Finland, where that country's first nuclear power station is scheduled to come into operation in 1975. The Plessey installation measures meteorological, hydrographic and water quality data at the outfall of the station's water cooling system. A total of 38 separate parameters are automatically monitored and the resulting data should prove extremely valuable even before the station comes into operation.

## PROFESSIONAL COMPONENTS FOR THE AMATEUR

SDS Components at Portsmouth have opened a retail shop for the home constructor at their premises at Gunstore Road, Hilsea Trading Estate. This is not the first time a wholly professional supplier has turned to the amateur market for extra revenue and it will be interesting to see if the project fares better than some earlier attempts elsewhere which, in the end, proved uneconomic.

Many famous names are listed in the product list which can be obtained by sending 20p to SDS Components Ltd. Tim Curtis, managing director of SDS, says that he intends to break down the barriers between the amateur fraternity and industrial manufacturers.

## NEW OUTLET FOR EVR

Electronic Video Recording — EVR — has been slow in market development but good business could result from its use at sea. Most ships now have TV for the use of the crew when in port and in coastal waters. In fact Marconi Marine has supplied more than 4,000 multi-standard receivers to vessels of all types.

Ships' crews are just like their shore-based counterparts and like to have TV on tap all the time. Hence the interest in EVR which will allow the TV to keep entertaining from video telecartridges when out of normal reception range.

Marconi Marine has entered an agreement with Telmar Programme Service for the supply of recorded programmes on the EVR film cartridge system which is manufactured at Basildon, Essex. The cartridges each give two 30-minute monochrome programmes or one 30-minute colour programme.

Many thousands of recorded programmes are available and ships will be able to exchange programmes at ports throughout the world. The playing units are manufactured by a number of companies under licence from the EVR partnership of ICI and CIBA-GEIGY.

## RACAL AND THE YOUNGER MAN

Chairman and managing director of Racal Electronics, Ernest Harrison, believes in youth. He likes to spot likely managers early in life and then give them the opportunity to show what they can do.

Some recent promotions prove the point. Keith Thrower who heads up a newly-formed Advanced Development Team has made big progress on the engineering side. He now has a top job at the age of 38. David Elsbury, 36, has climbed the ladder to become managing director of Racal Mobilcal Ltd., one of the most profitable of all Racal companies and the one that recently booked the largest ever contract for the company valued at £1·8 million.

Two other youngsters who now have top jobs are Gerry Smith, heading up Racal's Singapore office, and Jim Diggins, who joined Racal at the age of 25 and is now managing director of Racal Communications Ltd.

Harrison told me that in general successful people need to be "well seen" before they are 30 years old. Very few good people, he says, ever leave the company because promotion prospects are good.

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| 3·3mf | 63V | 6p | 150mf | 25V | 6p |
| 4·7mf | 63V | 6p | 220mf | 25V | 11p |
| 6·8mf | 63V | 6p | 470mf | 25V | 13p |
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mf: 0·22, **price 7p.**
mf: 0·33, **price 10p.**
mf: 0·47, **price 13p.**
160V d.c.
mf: 0·1, 0·15, **price 4p**; 0·22, **price 5p**; 0·33, **price 6p**; 0·47, **price 7p**; 0·68, **price 10p**; 1·0, **price 13p.**
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mf: 0·068, 0·1, 0·15, **price 4p.**
mf: 0·22, 0·33, **price 5p.**
mf: 0·47, **price 7p**; 0·68, **price 10p**; 1·0, **price 11p.**

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Single 10K, 25K, 50K, 100K, log or linear, **31p.**
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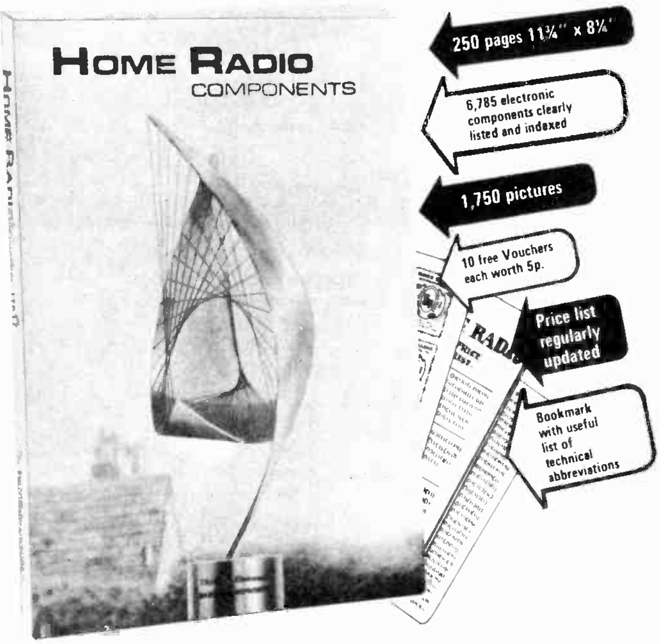


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# 25 YEARS SILVER JUBILEE ...THE FIRST TRANSISTOR

## THE TEAM

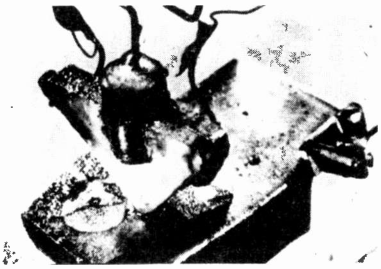
THE original transistor device was demonstrated in public for the first time on June 30, 1948, at Bell Telephone Laboratories' New York premises. This was the point-contact transistor, invented by two physicists, John Bardeen and Walter Brattain, who had been researching into solid state materials. They formed part of a Bell Laboratories team led by William Shockley.

A few months following the successful experiment that resulted in the first practical solid state amplifying device, Shockley set out to formulate a theory to explain transistor action. He proposed, in fact, the junction transistor structure. This theory was later developed in practice and the junction transistor became the very successful successor to the point-contact transistor and the latter was obsolete by about 1956.

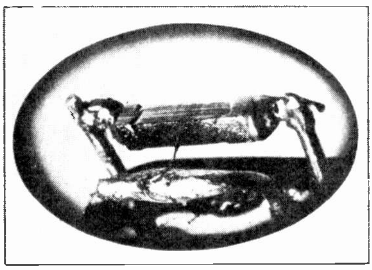
A whole new field of semiconduction technology sprang from the exploitation of the *pn* junction, as originally proposed by Shockley. An amazing range of devices have been developed through the application of the *pn* junction principle, where conduction is performed through minority as well as majority current carriers—holes and electrons.

William Shockley was also responsible for proposing the four layer *pnpn* device, which led to the silicon controlled rectifier (thyristor); and also for a different class of unipolar devices, based upon the field effect. These inventions followed within a few years of the junction transistor.

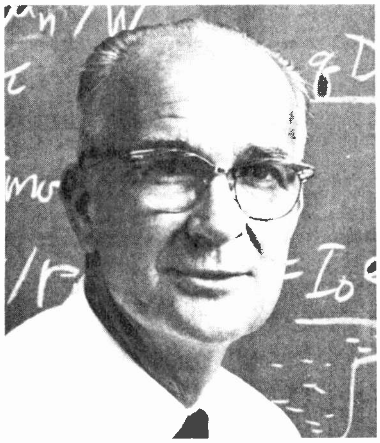
For their outstanding contributions to transistor physics, John Bardeen, Walter Brattain, and William Shockley were awarded the 1956 Nobel Prize in Physics.



**One of the first experimental point-contact transistors.**



**An early version of a junction transistor.**



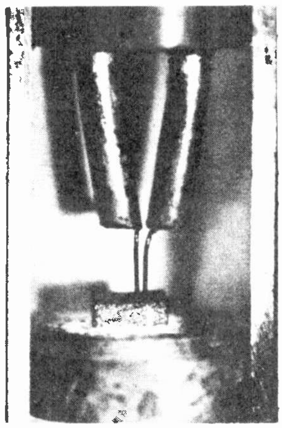
**DR WILLIAM SHOCKLEY**

Dr W. Shockley was born in London of American parents on February 13, 1910. Reared in California, he received his B.Sc. degree at the California Institute of Technology in 1932 and his Ph.D at the Massachusetts Institute of Technology in 1936. He joined Bell Telephone Laboratories in 1936. During the war he served as Director of Research for the U.S. Navy. Afterwards he returned to Bell and became director of the solid state physics research programme which saw the development of early junction transistors.

In 1963 Dr Shockley was named the first Alexander M. Poniatoff Professor of Engineering Science at Stamford University. He has received numerous awards for scientific achievement and public service, and serves on many top level Advisory Committees in the United States. Dr Shockley has contributed over one hundred articles to scientific journals, and more than 70 U.S. Patents have been granted for his inventions.

★Dr William Shockley is to lecture at the I.E.E. in London on February 14.

**An early production version of the point-contact transistor.**



### IERE and IEE

The IERE is marking the 25th anniversary of the invention of the transistor by devoting a specially enlarged issue of its Journal—*The Radio and Electronic Engineer*—to a unique collection of nearly 20 papers on semiconducting subjects contributed by leading British scientists and engineers who have worked in this field during the past quarter of a century.

This Transistor Issue of the *Radio and Electronic Engineer* which is dated January–February 1973, may be obtained from the IERE Publications Sales Department, 9 Bedford Square, London WC1B 3RG, price £2·00 per copy, post free.

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To celebrate this silver Jubilee, the Institute of Electrical Engineers, in conjunction with the Institution of Electronic and Radio Engineers, has arranged a number of events which will take place between the 12 and 16 February 1973.

**12th-16th February 1973**
An exhibition at the Institution of Electrical Engineers demonstrating the evolution from the point-contact transistor to complex integrated circuits.

**13th February 1973 10.00 a.m.**
A colloquium "The 25th anniversary of the Transistor" at the Royal Society.

**14th February 1973 5.30 p.m.**
A lecture by Dr William Shockley "The invention of the transistor: an example of creative-failure methodology" at the IEE.

**15th February 1973 10.30 a.m.**
A half-day discussion meeting "What next in semiconductors" at the IEE.

**3.00 p.m.**
A lecture by Dr W. E. J. Farvis "The influence of the transistor in our society and economy" at the IEE.

# 25 YEARS Transistor Trail

## FROM RECTIFYING CONTACTS TO PN JUNCTIONS

A STARTINGLY new and revolutionary technical device rarely appears simply out of the blue. The invention or discovery is generally a culminant achievement by a research worker who has followed in the train of a number of earlier researchers and experimenters.

Experience suggests that requisite conditions for a momentous breakthrough are (1) a sufficiently advanced state of theoretical knowledge, (2) a large demand or potential need for a particular kind of device and (3) a sufficiently sophisticated technology capable of undertaking development and then quantity production of some innovation.

Amplification of electric currents is an essential part of electronics. The idea of a solid state amplifier had been a vision in the minds of many scientists and experimenters for many years before the triumph of 25 years ago.

As beneficiaries of the electronic wonder of the century, it is appropriate for us to look back and try to pick out some of those stepping stones that formed a path, no matter how faint and discontinuous, which led to the ultimate success of Messrs. Bardeen, Bratain, and Shockley.

### EARLY INVESTIGATIONS

With some justification we can identify the commencement of the trail to the transistor with Michael Faraday, who in 1833 recorded the non-linear characteristics of certain conductors of electricity. He found that silver sulphide had a negative temperature coefficient.

In 1873 Willoughby Smith discovered that light affected the resistance of crystalline selenium.

In 1876 Adams and Day observed non-linear conduction phenomena on light-sensitive selenium cells.

(A fascinating light beam wireless communication system was created by the American experimenter and inventor Alexander Graham Bell (1847-1922). Speech was transmitted some distance in space by modulating a light beam and then received upon a selenium element, which produced an electrical output corresponding to the speech input.)

The earliest detailed investigation of the rectifying effect of dis-similar materials in contact, was carried out by the Austrian physicist Braun around 1874. Braun explored a variety of crystals, but mainly lead and ferrous sulphide, and used a base electrode and wire as a point-contact. He observed that the resistance was dependent upon the polarity of the applied voltage, as well as on the nature and condition of the contact surfaces. Braun likened this phenomena to the conduction between closely spaced electrodes in a gas.

Braun also appears to have been the first to observe the rectification effect produced by selenium.

Like many pioneers, Braun had his critics and his discoveries did not gain immediate recognition.

### POINT-CONTACT RECTIFIERS

Point-contact rectifiers were first put to practical use as signal detectors in the early days of wireless, around 1904. Natural lead sulphide was commonly used. During the mid-1920's the crystal detector was finally ousted from radio receivers by the thermionic valve.

### PLATE RECTIFIERS

Plate or "metal" rectifiers consist of thin semiconducting layers with metallic electrodes on either side. Cuprous oxide and selenium are the two most important materials that have been widely used.

The rectification effect of contacts between metals and cuprous oxide was already known to Braun. The first useful device appears to have been made by Grondahl in 1920.

The cuprous oxide rectifier was used on a large scale for power rectification and for use in measuring instruments, from the mid-1920's to the late 1930's. Then it began to be replaced by the selenium rectifier which offered many advantages.

The selenium photocell was widely used during the period 1930-40.

### NEW CONCEPTS

Investigation into the properties of semiconducting materials appears to have received a great impetus in the 1930's. One important new concept was the "hole", introduced by A. H. Wilson in 1931 when formulating the transport theory of semiconductors based on the band theory of solids.

But the mechanism by which the widely used metal-semiconductor rectifiers ("metal" rectifiers) operated was not clearly understood. One theory that received general acceptance was based on the Schottky effect (1938), a concept similar to the ideas put forward to explain thermionic emission. According to Schottky, cold emission or field emission is produced by the application of a few volts across a thin film of semiconducting material (the copper-oxide coating); and this is due to stable space charges in the semiconductor alone, without the presence of a chemical layer.

Also during the same period N. F. Mott offered a theory for swept-out metal semiconductor contacts which is known as the Mott Barrier.

In 1938 Helsch and Pohl published an account of a solid-state amplifier. This consisted of a single crystal of potassium bromide with a single wire of platinum providing control of current through the crystal. No practical developments resulted.

### WAR-TIME ADVANCES

The invention of radar just before the second World War stimulated a new interest in the solid state rectifier as a detector of microwaves. And so the silicon point-contact detector was developed.

During the 1940's the technique of crystal "doping" was introduced. Boron added to highly purified silicon was found to result in highly sensitive crystals. This arose from experiment and the theory behind this effect could not then be explained.

This was a very significant period for the future of solid state. For one thing, the requirement for improved detectors for operation at centimetric wavelengths led to an intensive search for new materials. The discovery of germanium was one direct result of this activity.

## POINT-CONTACT TRANSISTOR

Shortly after the war, Bardeen, Brattain, and Shockley were involved in research on copper oxide rectifiers. Bardeen showed that a Schottky barrier layer could exist at the free surface of a semiconductor. This layer makes the contact properties independent of thermionic work functions. Following upon this, Bardeen and Brattain initiated the series of experiments that led to the invention of the point-contact transistor.

They placed two point-contacts close together on the surface of a crystal. It was found that a current flowing through one could influence the current flowing through the second circuit. The first practical solid state amplifying device had arrived. This was December 1947.

In working out the basic mechanism involved in point-contact transistors, Bardeen discovered the carrier-injection phenomena. This injection of extra current carriers into the semiconductor in the region of contact when forward bias voltage is applied produces the "transistor" action.

Later, Shockley carried out a research experiment to diagnose the surface phenomena of the original transistor. In the process, he found he had devised a new type of transistor. This was patented as the junction transistor. An account of this important discovery was published in 1949. Within a few years the *pn* junction device was to prove vastly superior to the point-contact device, both from manufacturing and application view points.

It is of interest to note that around the mid 1930's Shockley had instigated some research into copper oxide rectifiers in an attempt to invent a solid state amplifying device. The results were negative.

## DIFFERENT MECHANISMS

The rectifying properties of metal-semiconductor contacts are due to a different mechanism to that now understood to be responsible in the case of *pn* junctions.

During the last decade, the metal-semiconductor type of contact has returned to favour, albeit with new materials, and it has assumed a new prominence in special devices such as field effect or metal oxide semiconductor transistors (m.o.s.t.), and Schottky barrier diodes used for microwave purposes. The m.o.s. technique is extensively used in integrated circuit manufacture.

Thus it seems the circle has been completed. Development of the *pn* junction has stimulated further widespread research into solid state physics over these last 25 years, and a new interest has arisen in the rectifying phenomena which was the starting point of this "trail to the transistor". And so more devices seem likely to be developed in the future which make use of both mechanisms of current transport.

# *ELECTRONIC TIMEPIECES*

*continued from page 225*


The Omega f300 watch. A balanced tuning fork movement is used

Regulation of the watch is effected by moving either of the small regulator plates which are attached to the ends of each side of the tuning fork. This makes an extremely minute change in the effective length of the fork. An adjustment of half a second per day can be made.

An interior view of the mechanism of the Bulova 214 series watches is shown in Fig. 7.

## MODELS

The Bulova tuning fork watches are known by the name "Accutron", a word derived from "accuracy" and "electronics". In 1970 this Company introduced the first Accutron watches for ladies (series 230). These employ a power cell of the same size as that used in Accutron watches for men, but the frequency of the electronically driven tuning fork is 480Hz so that the movement can be made far smaller. The shape and construction of the tuning fork is different from that in the models for men, but the current consumption remains at 8–10$\mu$A.

A few other companies now offer tuning fork watches. Longines offer the Ebauches caliber 6312 "Mosaba" movement in their "Ultronic" watches. (Mosaba is a word derived from "Movement sans balance"). Baume and Mercier have given the name "Tronosonic" to their tuning fork watches, whilst Omega refers to such watches as "f300". Bulova also produce clocks with tuning fork mechanisms.

## GRAVITATIONAL EFFECTS

The frequency of some types of tuning fork watches is dependent on their position owing to the pull of gravity on the prongs of the fork. When the prongs (or "tines") point downwards, the watch may run a few seconds per day faster than when the prongs are horizontal.

This disadvantage has been almost eliminated in the balanced Mosaba movement designed by Ebauches S.A. It operates at 300Hz and is marketed as the Swissonic 100 range by Longines in their "Ultronic". The Omega "f300" range also employs a balanced tuning fork movement.

**Next month the final article will look at, among other things, quartz, cybernetic and digital watches.**

# PE Sound Synthesiser 2

# STABILISED POWER SUPPLY

By G. D. SHAW

If the modular concept outlined last month, is to be followed in its entirety, this implies that not only must each circuit be entirely self contained but also that each circuit, complete with its various controls, should be capable of operating as a separate entity either within, or external to, the framework of the synthesiser as a whole.

These factors, coupled with the experience gained in building the prototype, contributed towards a decision to redesign the instrument into a fully modular form based on one of the many commercially available racking systems.

This month modifications to a standard racking system will be described together with constructional details of the twin stabilised power unit that will supply the various synthesiser card modules.

### CHOICE OF RACKING SYSTEM

It was believed that, in the interests of economy, the Card Frame System 1 by Vero offered the greatest value. Utilisation of this particular system, however, means that the constructor will be obliged to manufacture his own modular inserts which may perhaps be a deterrent to those not having the facilities or experience to tackle sheet metal fabrication. In this case the modular racking system type 3E also by Vero has the advantage that it covers a range of components which may be easily assembled into modular inserts.

This latter system is extremely well designed and the component parts of the assemblies are precision made, these factors, naturally enough, being reflected in the price of the 3E System which is several times greater than that of System 1.

Fig. 2.1 shows a general view of the assembly of the card frame to be used as the mainframe of the synthesiser chassis. The aluminium end plates are already pre-drilled to suit the standard Vero components normally used in the assembly of a System 1 Card Frame. It will be necessary, however, to provide additional holes to allow for modifications to the standard assembly and to provide mounting facilities for a number of components. Drilling details are shown.

### MAINTAINING A TIGHT ASSEMBLY

The slotted card support sections are made of plastic and are secured to the end plates by means of self tapping screws. Repeated removal and replacement of these screws will result in wearing of the threads which will, in turn, make the assembly sloppy. It is suggested therefore that assembly of the mainframe is only attempted when all necessary drillings, etc. have been completed, and that, once assembled, it is left so. If the constructor wishes, for any reason, to have the facility of stripping the assembly down repeatedly he would be well advised to redrill the securing screw holes and tap them to take a suitably sized metallic thread insert.

## COMPONENTS . . .

**RACKING SYSTEM**

**Card Frame**

Kit of parts for a System 1 Card Frame with a pair of guide mouldings to suit (Part No. CFMN/1)

| | |
|---|---|
| SK7–SK13 | 8 pin McMurdo sockets (Part No. RS8) (7 off) |
| PL1–PL7 | 8 pin McMurdo plugs (Part No. RP8) (7 off) |

Frame parts above available from Vero Electronics Ltd., Industrial Estate, Chandler's Ford, Eastleigh, Hants., SO5 3ZR

### MODULE FRONT PANELS

Fig. 2.2 shows the composite front panel layout with dimensions. It will be seen that the panel is divided vertically into eight separate sections. These sections represent the front panels of individual modular units and, with the exception of the strip on the extreme right of the panel, can be removed from the mainframe complete with their respective card supports and circuitry.

The right hand strip is permanently fixed to the mainframe by two small aluminium brackets.

The left-hand panel is slightly wider than the remainder mainly to act as "fill-in" on the full width of the front panel.

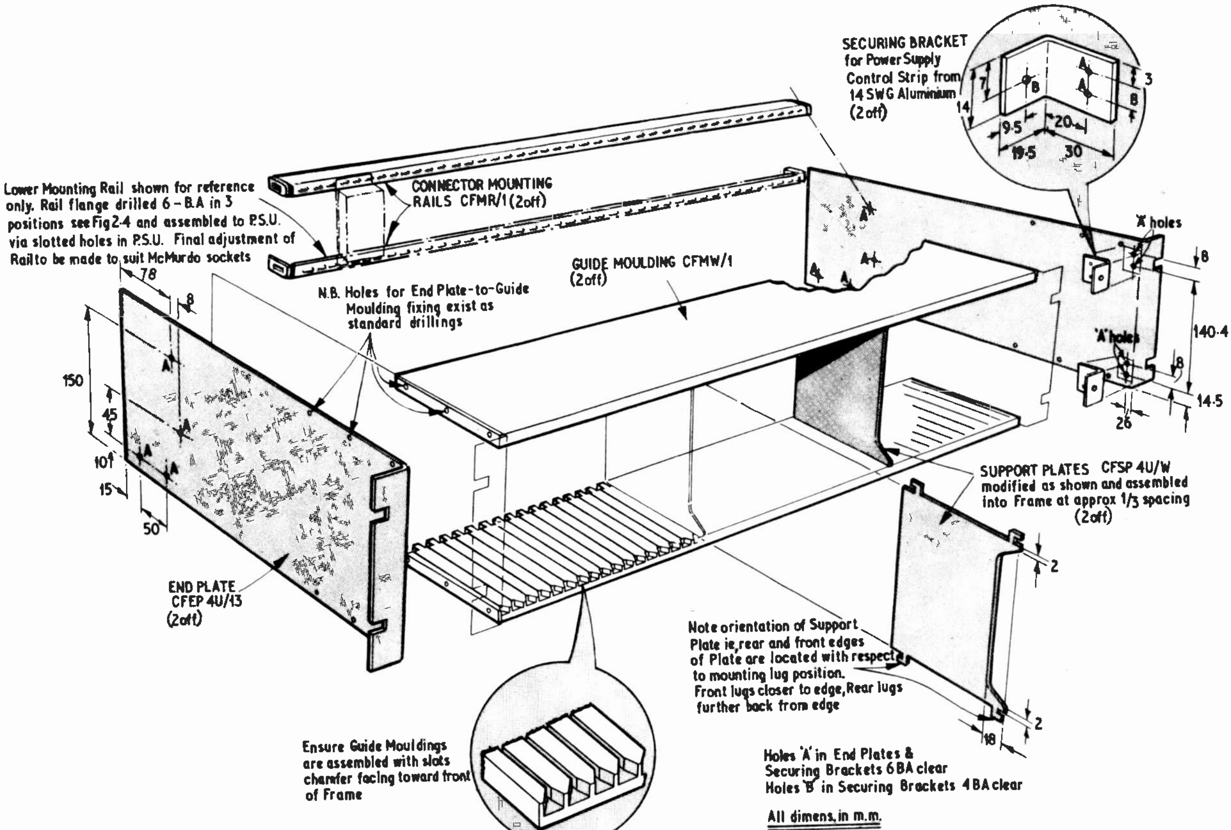



Fig. 2.1. Perspective view of the Card Frame System 1. The end slots on the upper mounting rail require to be elongated for future adjustment of McMurdo sockets

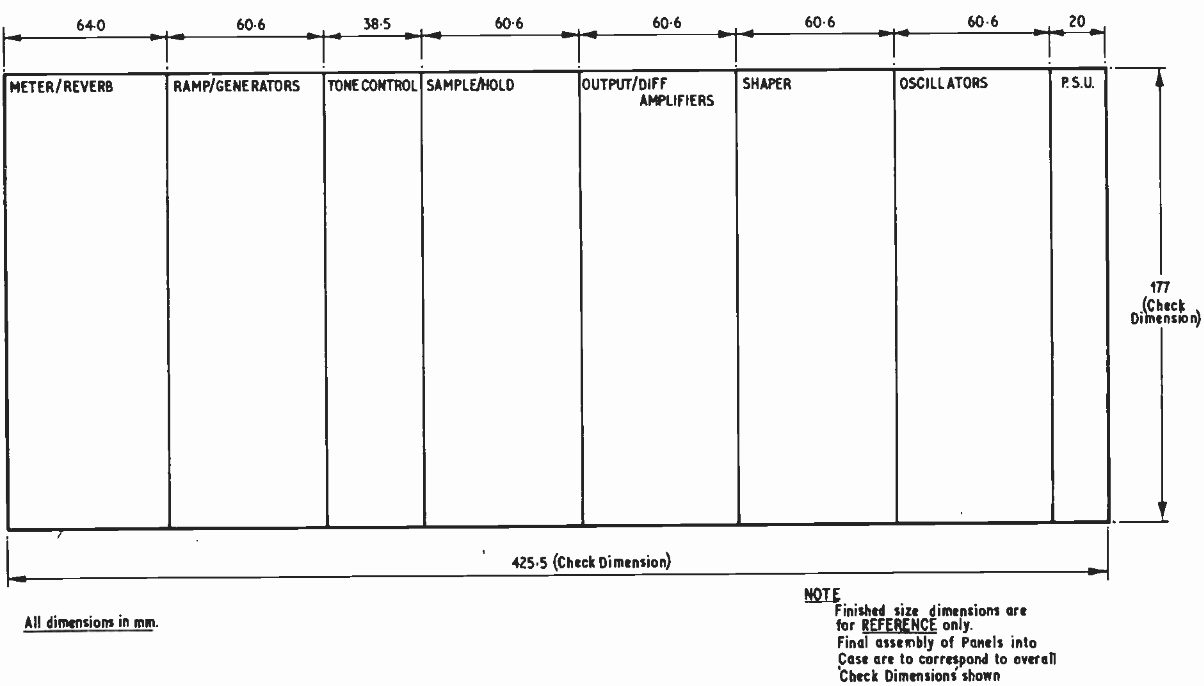
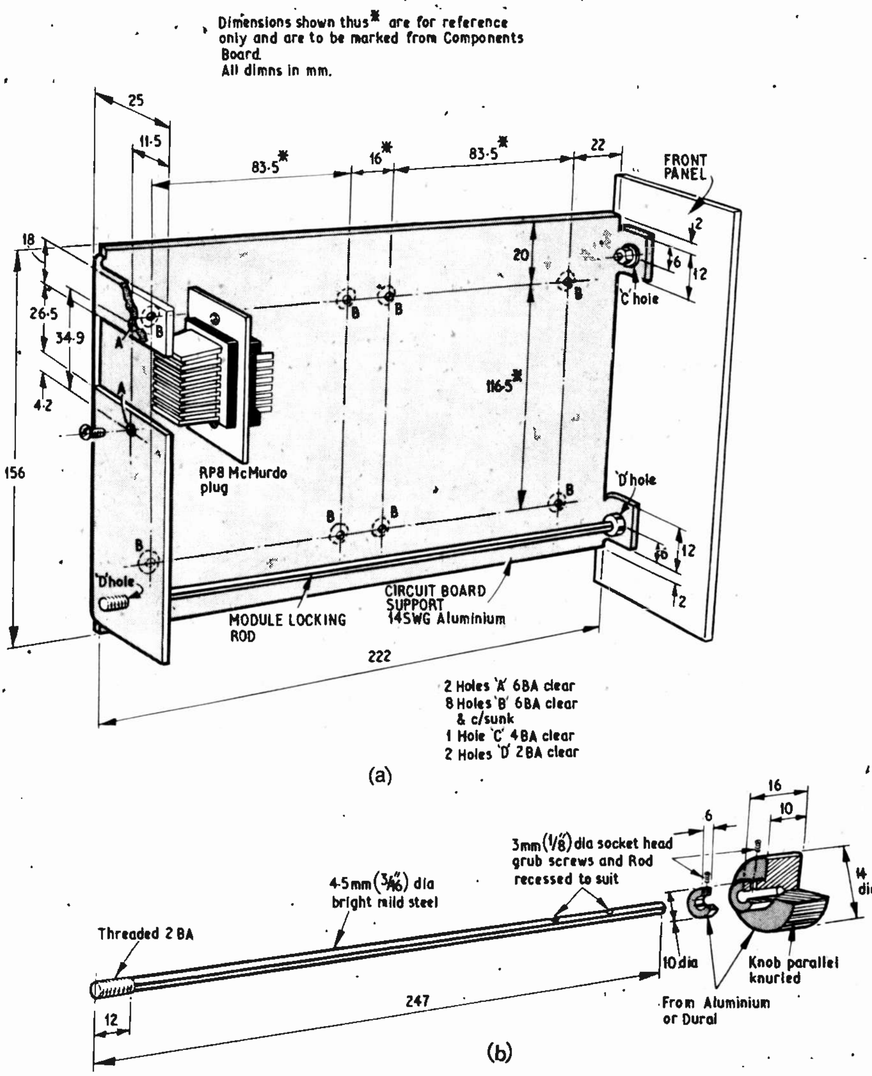



Fig. 2.2. Composite front panel. These sections represent the front panels of individual modular units as indicated

Fig. 2.3a. Drilling and bending details for circuit board support plate and McMurdo plug (b) details of retaining rod




## MODULE SUPPORT PLATE

Circuit boards are supported on a plate to one end of which is attached the module front panel and to the other end a plug which mates with a socket at the rear of the mainframe assembly. Fig. 2.3a shows details of this support plate. Care should be taken in bending this item and the bends should be made as tightly as possible. Lack of attention to this point will mean that the overall depth of the plate is greater than specified with the result that the front panel, when attached, will not be flush with the card support moulding in the main frame.

Modules are retained in the main frame by means of a $\frac{3}{16}$in (4·5mm) rod, Fig. 2.3b, screwed 2B.A. at one end, which passes through the front panel and engages with a Rosan bush, or similar, in the power supply sub-frame. This arrangement also provides a means whereby the module may be withdrawn from the main frame and, for this purpose, a locking collar is provided to abut the lower lug on the circuit board support plate.

## P.S.U. SUB-FRAME ASSEMBLY

Fig. 2.4 shows the bending and drilling details of the power supply sub-frame. As with the circuit board support plate care should be taken that the clamping and bending is carried out as shown and that the bends are made as tightly as possible. Details have not been provided about the positioning of holes for Rosan bushes or components within the sub-frame.

## POWER SUPPLY UNIT

In a project of this kind the predictability of circuit performance depends largely on the ability of the power supply to maintain its voltage rails within relatively close limits. This is particularly true where the oscillators and hold circuits are concerned since quite small variations in supply rail voltage can cause significant changes in the low frequency and "droop" characteristics respectively.

The power supply unit is based on one of the latest regulator i.c.s to appear from Fairchild, the $\mu$A7815. This particular device is capable of passing up to 1·5 amps without the necessity of external series regulating transistors, thus it is operating well within its maximum capability. Output ripple and noise is around 500 microvolts or less while load regulation from zero to 400mA is better than 1 per cent. (Total current requirement for the basic synthesiser is 400mA per rail.)

The output voltage of the i.c. is specified as being plus or minus 5 per cent of its nominal rated voltage thus the constructor may find up to 1·5 volts variation across the two power supply rails. This is not necessarily a disadvantage since all the voltage dividers in the synthesiser which require an accurately set voltage are fitted with presets.

## CIRCUIT

The circuit diagram of the power supply unit is shown in Fig. 2.5.

Construction is perfectly straightforward (see Fig. 2.6) the only recommendation being that the leads from the transformer to the bridge rectifiers be routed to avoid passing directly over the regulators and that they be twisted together in the interests of hum reduction.

Wires carrying a.c. to the power supply control strip on the front panel should pass through holes drilled in the rear of the sub-frame and fitted with rubber grommets. These leads should be 10in (254mm) in length measured from the rear face of the sub-frame.

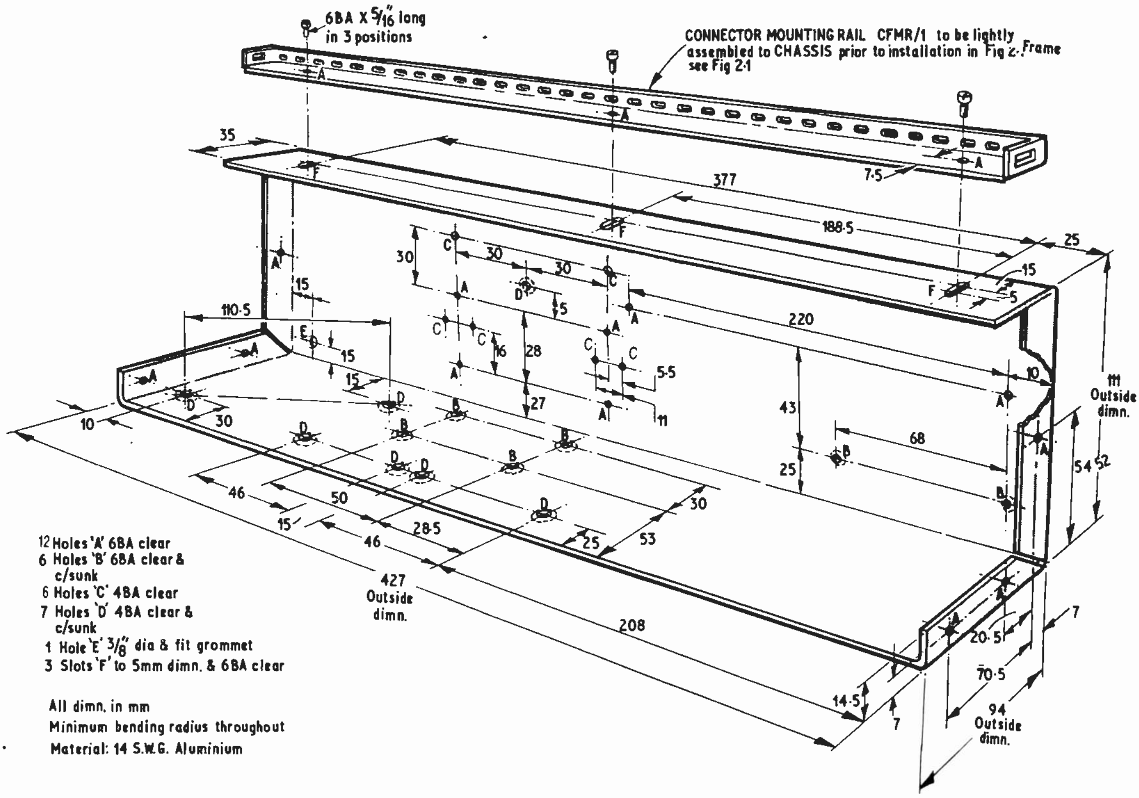



Fig. 2.4. Bending and drilling details of the p.s.u. sub-frame

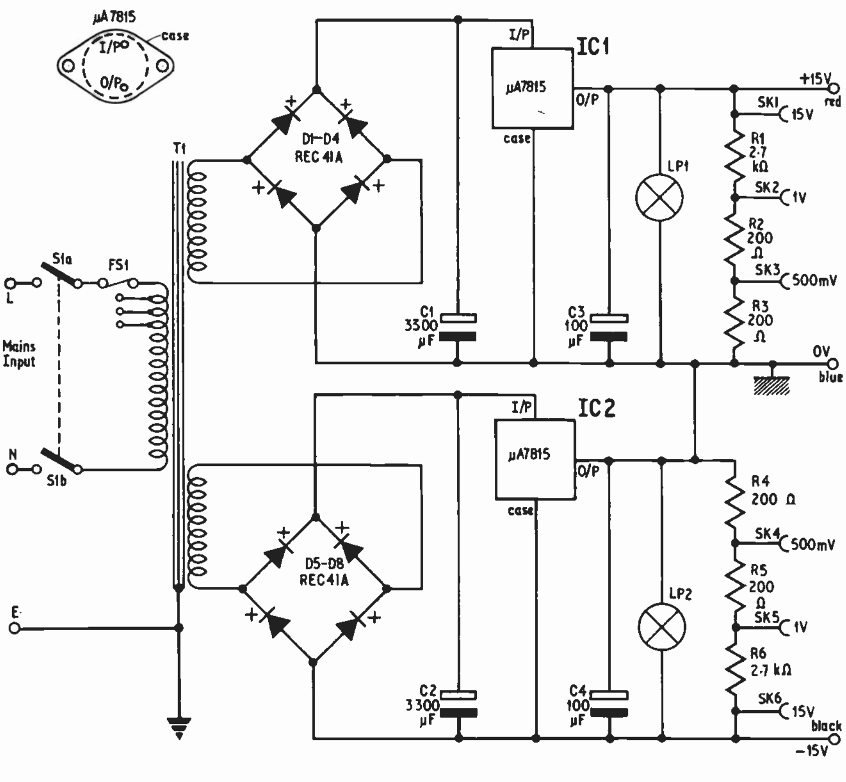



Fig. 2.5. Circuit diagram of twin stabilised p.s.u.

## COMPONENTS . . .

### TWIN STABILISED P.S.U.

**Resistors**

R1 2·7kΩ R2–R5 200Ω (2 off)
R6 2·7kΩ
All 2% ½ watt metal oxide

**Capacitors**

C1–C2 3,300μF 63V
High ripple elect. (2 off)
C3–C4 100μF 25V elect. (2 off)

**Bridge Rectifiers**

D1–D8 REc 41A (2 off)

**Integrated Circuits**

IC1–IC2 μA 7815 (Fairchild)
Macro Marketing Ltd.,
396 Bath Rd., Slough, Bucks.

**Transformer**

T1—Main transformer,
primary 240V;
secondary 30–0–30V at 1·5A

**Miscellaneous**

S1—Miniature double pole, single throw on/off switch
LP1–LP2 miniature 28V filament lamps,
FS1—500mA fuse,
SK1–SK6 1mm miniature sockets (6 off)
14 s.w.g. aluminium as required

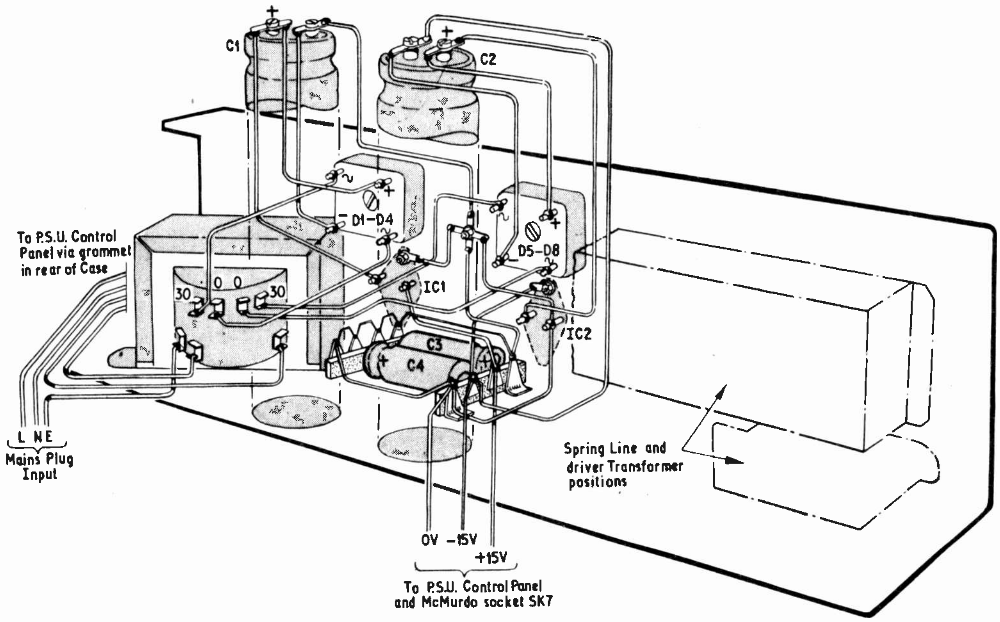



Fig. 2.6. Mounting and wiring details of p.s.u. components

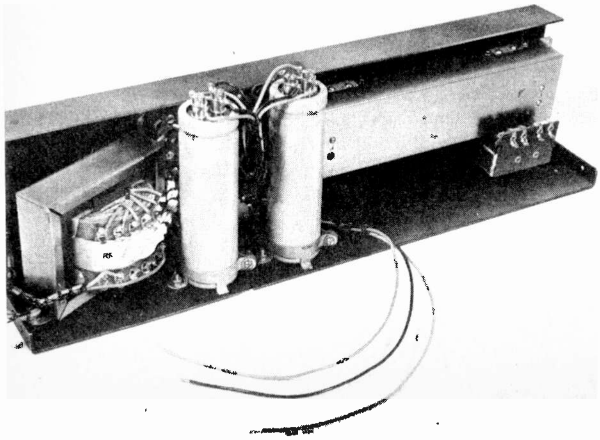
Smoothed d.c. supplying the indicator lamps and calibrating voltage points is taken from the d.c. busbars coupling the McMurdo Red-Range sockets and thus may pass over the top of the sub-frame.

When the power supply unit has been wired up, with the exception of the d.c. to the indicators and calibrating voltage sockets, the mainframe assembly may be commenced.

## ARRANGEMENT OF PANEL UNITS

Referring for a moment to Fig. 2.2, the constructor should decide at this stage the actual arrangement or order in which he wishes the panel units to be placed relative to one another. The arrangement shown need not be adhered to with the exception of the meter and reverberation unit and the power supply control strip, which have to be sited as shown at the extreme left- and right-hand sides of the front panel respectively.

This decision is necessary at this time in order that the support plates may be correctly placed between the slotted mouldings. Viewed from the front of the assembly, the correct position of these plates is in the slot immediately to the right of the one occupied by a circuit-board support plate.



Since component placement on all front panels offers very little clearance at the left-hand side of the panel it is necessary to cut out the front face of the support plates as shown in Fig. 2.1. The 18mm depth of the cut-out is adequate to clear potentiometers and sockets on all front panels except that of the output amplifiers which will be fitted with ganged "pan-pots".

The optimum position for the support plates is approximately one third of the distance in from the end plates, the exact point, of course, depending upon the module arrangement chosen by the constructor.

## MAIN FRAME ASSEMBLY

Assembly of the main frame should be started by loosely securing the bottom slotted moulding between the end plates. The support plates may then be dropped into their respective slots and the upper slotted moulding placed over the lugs on the top edge of the panels and loosely secured between the end plates. Ensure that the chamfered edge of the slots in the mouldings are towards the front face of the assembly and that the vertical panels are in the same respective slot in both mouldings.

This being so, the securing screws may be fully tightened and lugs on the vertical panels twisted through 45 degrees where they protrude through the upper and lower faces of the mouldings.

## SECURING THE P.S.U.

The power supply sub-frame may now be secured to the rear of the end plates. The lower socket support should be drilled to mate with the slotted holes in the power supply sub-frame (Fig. 2.4) and loosely secured in position. Similarly the upper socket support should be placed loosely in position.

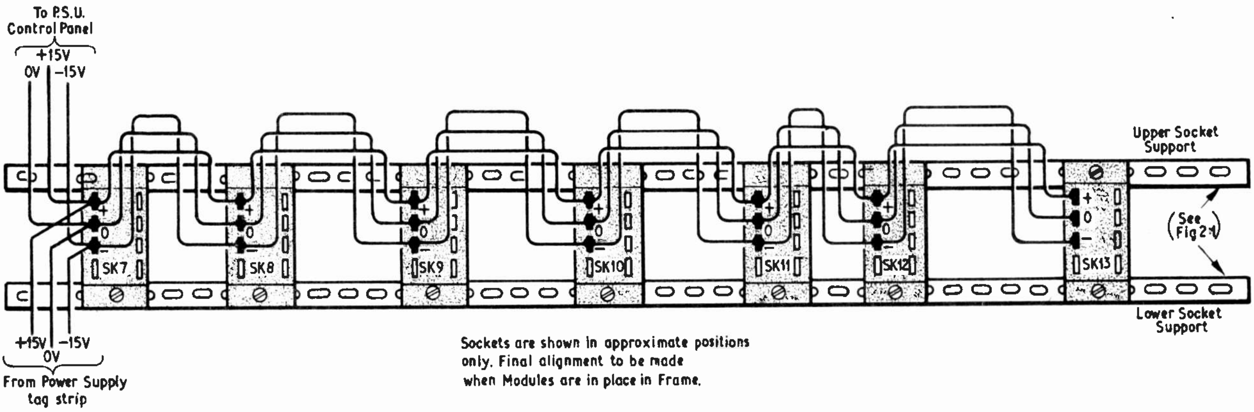



Fig. 2.7. Socket arrangement and wiring on connector mounting rails

## POSITIONING THE SOCKET SUPPORTS

The final position of these latter supports is determined by inserting an assembled circuit support plate, complete with plug, into the slotted mouldings until the front panel is flush with the face of the mouldings.

A socket is now placed over the plug so that its securing lugs abut the supports at the rear face and the supports adjusted so that they align with the socket lugs and are parallel with the front face of the mouldings. The socket supports can now be secured firmly at this point and the socket placed in position for the first of the modules to be incorporated into the assembly.

Ideally all the sockets should be placed in position at this time; but if this is not possible the first socket to be positioned should be immediately adjacent to the power supply control module so that its terminals can provide a convenient jumping off point for the leads supplying d.c. to this latter assembly.

The arrangement for supplying power to the individual sockets is illustrated in Fig. 2.7, while Fig. 2.8 illustrates the arrangement for wiring up the rear of the power supply control strip.

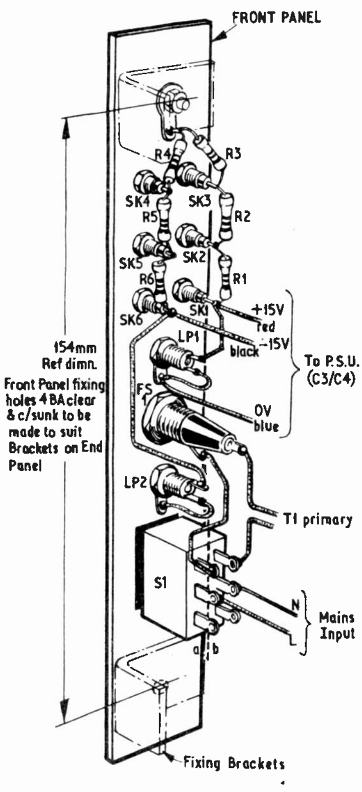



Fig. 2.8. Wiring details for rear of p.s.u. control strip

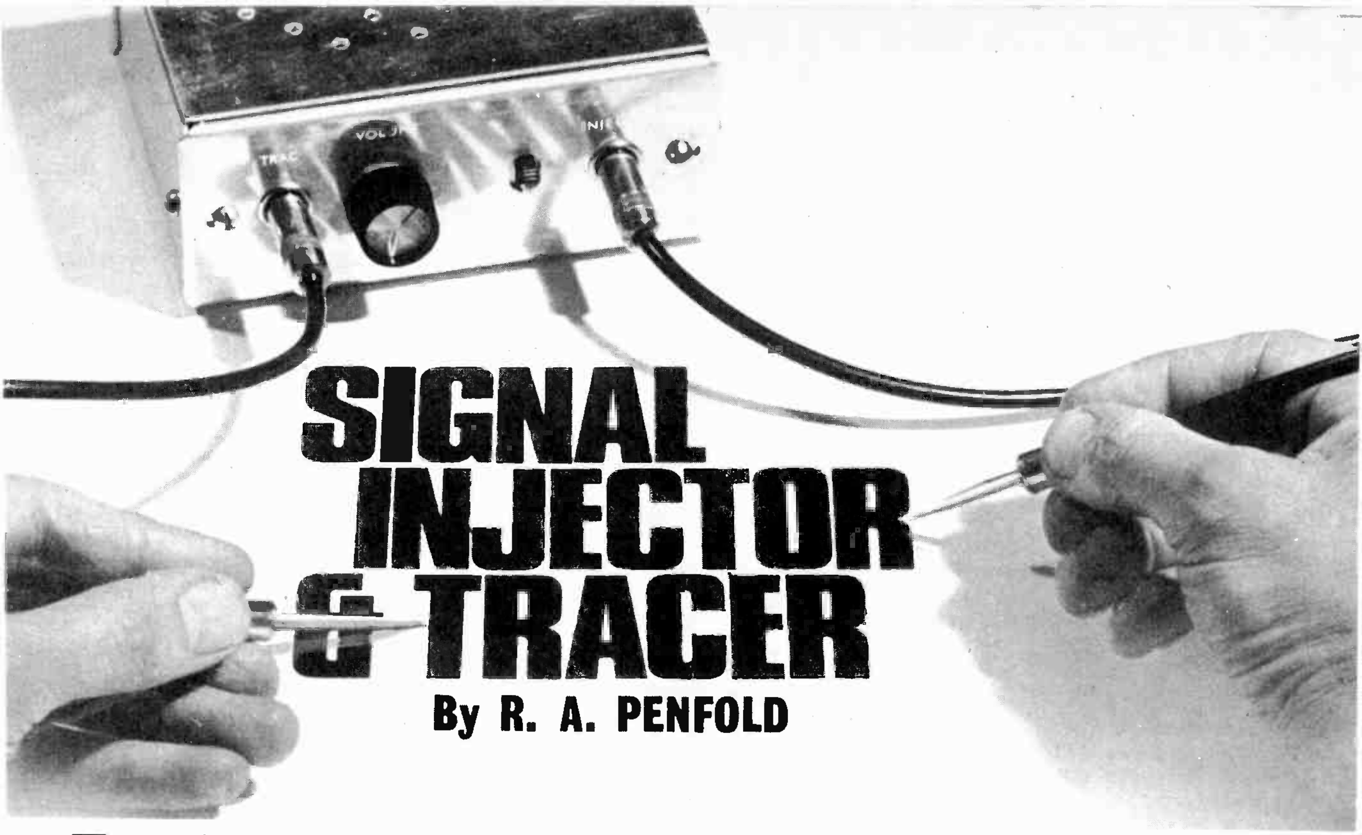
## TESTING THE P.S.U.

The power supply may be tested on completion of assembly and wiring up the main frame. The main purpose of testing is to establish whether the ripple and noise and output voltage levels of each regulator are within their rated specification. Load regulation may also be checked by coupling a 30 ohm 10 watt wirewound resistor across each power rail and observing the change in output voltage on the oscilloscope. If the offset on the scope is not sufficient to enable the trace to be observed at a sufficient degree of sensitivity, a high resistance voltmeter should be used.

The level of change of output voltage at the moment of connecting the resistor across the power rails is likely to be of the order of 150 millivolts or less. Note that the resistor will be dissipating about 7·5 watts and is likely to get uncomfortably hot after a few moments across the power rails. It is best therefore to incorporate a switch in series with the resistor.

The main frame assembly is designed to be accommodated in a standard 19in case in the Vero range. A later article will include details of the types of cases which may be used and modifications necessary in order to fit a.c., d.c., and keyboard sockets to the rear of the case.

**Next month: The operation and construction of the voltage controlled oscillators and voltage inverter will be given.**



# SIGNAL INJECTOR & TRACER

**By R. A. PENFOLD**

THIS project uses a single, inexpensive, TTL integrated circuit, type SN7402, and a few discrete components.

The SN7402 i.c. is a quad, two-input, positive, NOR gate, intended for switching rather than linear applications. However, this device is available for less than the price of many single transistors.

Although when used as a gate its usefulness to the home constructor is rather limited, with a little ingenuity it can be adapted to perform other functions.

## THE SN7402 INTEGRATED CIRCUIT

Internal connections to the pins of the SN7402 are shown in Fig. 1.

It is housed in a dual-in-line 14 pin package. As will be seen from looking at Fig. 1, each gate has two inputs, and a single output. The output voltage of the gate will be high only if all the input voltages are low. The output potential will be low, if any of the inputs are at a high potential. Therefore, if one of the inputs is connected to earth, the input will be controlled by the remaining input alone.

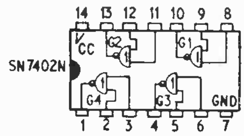
The gate may now be biased into a linear operating condition, by connecting this input to earth through a suitable resistor. The value of this resistor must be such that the voltage at the output is approximately half the supply voltage.

## INJECTOR CIRCUIT

The function of the gate under the conditions described above is that of a Class A amplifier. The input and the output are 180 degrees out of phase, and the stage thus has very similar characteristics to a single stage transistor amplifier.

By capacitively coupling two gates together, with each output connected to the input of the other gate,

Fig. 1. The internal circuit of the SN7402N quad two input positive NOR gate



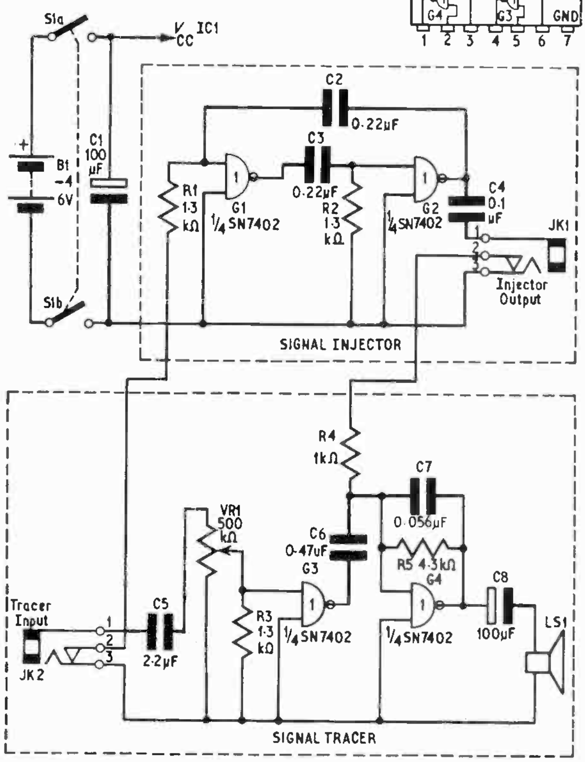




Fig. 2. Circuit diagram of the complete signal injector and tracer unit

a circuit similar to that of a free-running, or astable multivibrator, is obtained. A circuit diagram showing two gates connected in this fashion is shown in the upper half of Fig. 2.

The circuit operates as follows. When the supply is connected, the voltages at the outputs will begin to rise, and due to slight variations in component tolerances in the circuit, one will start to rise more quickly than the other.

For example, assume that the output voltage of gate 1 rises most quickly. This rise in voltage will be coupled by C3 to the input of gate 2. This will cause the output voltage of gate 2 to fall, this fall in voltage being coupled by C2 to the input of gate 1.

A further rise in the voltage at gate 1 output will occur, and this regenerative process will continue until this voltage is at its highest level, and gate 2 output is at its lowest level.

Capacitor C2 will now begin to charge through gate 1, and the voltage at gate 1 input will begin to rise, causing the output voltage to fall. This fall in voltage is coupled to gate 2, causing its output voltage to swing to a slightly higher level.

A regenerative action will again take place, until gate 1 output is very low, and gate 2 output is very high. C3 will now begin to charge through gate 2, and the opposite will occur. The circuit will thus begin to oscillate continuously, the actual frequency of oscillation being determined by the value given to C3 and C2.

The output is taken through the isolating capacitor, C4, to the output socket. The output wave shape will be almost square, and harmonics of the fundamental frequency will thus be available up to frequencies of many megahertz.

## TRACER CIRCUIT

The signal tracer circuit consists of the remaining two gates suitably biased, and coupled by a capacitor, C6. The circuit of the tracer is shown in the lower half of Fig. 2.

There is enough output available to drive a 25 ohm impedance loudspeaker. This should preferably have a fairly high efficiency, as the output is not very large, although perfectly adequate for this function.

Capacitor C7 is used to limit the high frequency response of the amplifier, which is otherwise so good, that instability arises.

Resistors R4, and R5 bias the output stage, and as R5 is connected to the output, it also introduces a certain amount of negative feedback to the amplifier.

The input to the amplifier is taken through C5, and the potentiometer which is the sensitivity control.

## COMPONENTS . . .

### INJECTOR AND TRACER

**Resistors**

| | |
|---|---|
| R1, R2, R3 | 1·3kΩ (3 off) |
| R4 | 1kΩ |
| R5 | 4·3kΩ |

All ±5%, $\frac{1}{8}$W carbon

**Potentiometer**

VR1 500kΩ logarithmic

**Capacitors**

| | |
|---|---|
| C1 | 100μF 6·4V elect. |
| C2, C3 | 0·22μF (2 off) |
| C4 | 0·1μF disc ceramic |
| C5 | 2·2μF non elect. |
| C6 | 0·47μF |
| C7 | 0·056μF |
| C8 | 100μF 6·4V elect. |

**Integrated Circuit**

IC1 SN7402N positive NOR gate

**Miscellaneous**

| | |
|---|---|
| S1 | Double pole single throw slider |
| JK1, JK2 | 3·5mm jack sockets with break contact |
| PL1, PL2 | 3·5mm jack plugs |
| LS1 | 15 to 30Ω, 2½ to 3½in speaker |

1·6in × 2in 0·1in matrix Veroboard

Universal Chassis members: 4in × 2in side panels (2 off); 5in × 2in side panels (2 off); 5in × 4in plates (2 off) (Home Radio type CU51A, CU52A and CU156 respectively) 1½V batteries type U7 (4 off) and battery holder

## RADIO FREQUENCY DETECTOR

If the tracer is to be used with r.f. signals, a detector must be added at the input of the amplifier. This could be made an integral part of the unit, but in the prototype a separate r.f. probe was used. The circuit of this probe is shown in Fig. 3.

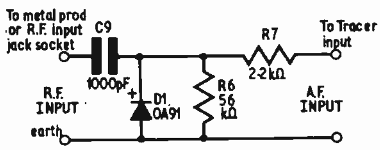



Fig. 3. The circuit of a simple detector which can be built into a small metal tube to enable the tracer to be used with radio frequencies

## COMPONENTS . . .

### R.F. DETECTOR

**Resistors**

R6 56kΩ    R7 2·2kΩ

**Capacitors**

C9 1,000pF

**Diode**

D1 OA91

**Miscellaneous**

Metal tube for case plus metal for prod


Photograph of the completed signal injector and tracer unit showing the layout of the front panel. The box is built using universal chassis members

The casing, and metal prod for the probe will both have to be home made. They can be constructed from whatever suitable materials are at hand. Pen cases, pen light torch cases, and 35mm film containers are popular for housing this type of probe.

The metal prod can be a long bolt, or something similar. The hardware used for the prototype probe consists of a disused penlight torch case, some rubber grommets, and a steel knitting needle for the metal prod. The output should be taken through a screened lead to a 3·5mm jack plug. The components can be mounted on a small piece of 0·1in matrix Veroboard.

If the detector is to be an integral part of the unit, an extra jack socket will have to be mounted on the front panel. The break contact of this should be wired in parallel with that of the other input socket. The detector is wired between these two sockets.

## CIRCUIT ISOLATION

Due to breakthrough between the trace and injector circuits, these cannot both be run at the same time. The internal wiring of the i.c. is such, that the power supply must be connected to all, or none of the gates.

The circuit has, therefore, to be arranged so that when the plug is inserted into the tracer input socket, the break contact of the jack disconnects one of the biasing resistors of the injector, thus disabling it. When the injector lead is plugged in, the result is the same, except that it is the tracer, output stage biasing which is removed.

The unit requires 6V at about 20 to 25mA, and this is supplied by four batteries wired in series. A supply of no more than 7V may be used, or the i.c. will be destroyed.

## CONSTRUCTION

The circuit is built on a piece of 0·1in matrix Veroboard, measuring 2in × 1·6in. A diagram giving the layout of this board is given in Fig. 4.

When completed this board is bolted to the rear right-hand side of the case and must be insulated from the case. This may be achieved by placing a piece of expanded polystyrene between the board and the case. C1 is not mounted on the board, but is mounted on switch S1.

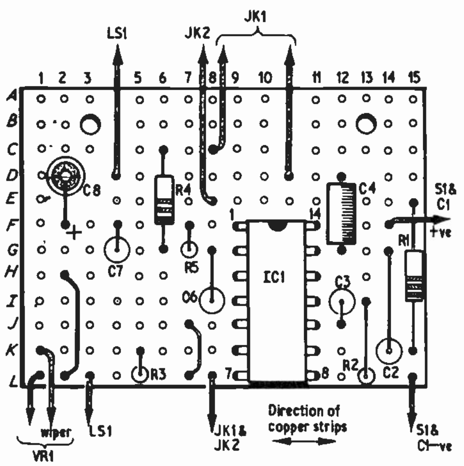
## ALUMINIUM CASE

An aluminium case is constructed using Home Radio Universal Chassis Members, and measures 5in × 4in × 2in.

The front, back, and side panels are bolted together using eight 2BA bolts, the holes for which are already drilled in the panels.

The base plate is fixed in place by four 6BA bolts.

Break copper strips at 9D, 10F, 10G, 10I, 10J and 10K



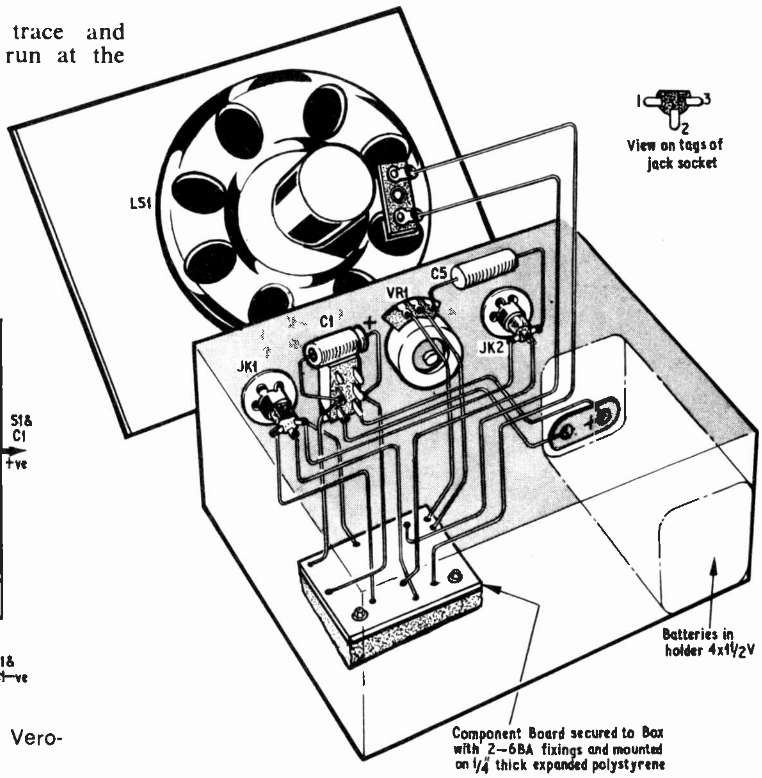
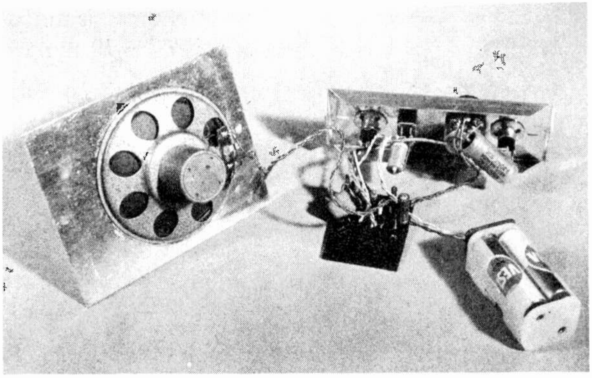




Fig. 4. Layout of the components on the Veroboard panel and interwiring details



Two 4BA self-tapping screws are required to hold the lid in place. The holes for these should be drilled centrally on the flanges of the side panels, using a No. 31 twist drill.

A drill of the same size may be used to drill the holes for the 6BA bolts. A No. 24 twist drill is used to make the mounting holes in the lid. The speaker should be mounted on the lid at any convenient place.

Details of the front panel can be seen in the photograph. The exact size of the mounting holes will vary according to the type of switch, or jack socket used, but the positioning of the holes will of course remain the same.

The batteries are positioned to the rear, and at the left-hand side of the case, opposite the main component board. They should be mounted in a battery holder of the type specified in the components list. Battery clips of the type used with PP3, or PP6 batteries are used to make the connection to the holder.

### USING THE UNIT

Switch S1 is the main supply on-off switch.

As described earlier, the function of inject, or trace is obtained by merely inserting the appropriate test lead.

When using the injector, the first test would be to the speaker of the radio, or amplifier under test. Tests should then be made at the inputs of the earlier stages, working forwards towards the r.f. stages, or the amplifier input.

When a test is made, and no output comes from the speaker, the faulty stage has been located. It is the stage which lies between the last, and the penultimate one to be tested. Because the output of the injector is so rich in harmonics, it may be used to test the a.f., r.f., and i.f. stages.

### USING THE TRACER

To use the tracer, the same procedure is used, except in reverse, with the first test being made at the input of the amplifier, and then working towards the speaker.

A signal of some kind must be connected at the input and when this signal is not received by the tracer the faulty stage has been located. It is again the one that lies between where this last test, and the previous one were made.

When testing i.f., or r.f. stages of a receiver, the r.f. probe must be substituted for the ordinary test leads. ★

# NEWS BRIEFS

## Tidal Monitoring System

The task of monitoring tidal conditions and wave height along the coast of Spain presents enormous difficulties using conventional monitoring techniques. To overcome this problem Plessey Environmental Systems have supplied pressure sensors and a digital logging system to the Spanish maritime authorities to provide precise information at 25 of the harbours around Spain's coastline, which is one of the longest in Europe.

The pressure sensors are accurate to ±0·3 per cent of full scale and this measured pressure is encoded into a frequency modulated analogue signal which is transmitted to a central data collection unit in Madrid where it is stored on magnetic tape for subsequent analysis by computer.

## New Radar Testing Equipment for Europe's MRCA

Europe's new multi-role combat aircraft (MRCA) uses a highly sophisticated radar system and efficient testing is vital for such a system. EMI Electronics' Systems & Weapons Division have just announced that they are supplying radar testing equipment to assist in-flight testing.

Unlike conventional airborne radar testing methods which limit thorough evaluation of the radar to the period that the aircraft is in flight, the EMI systems will enable the radar's performance to be examined in detail on the ground.

When fitted to the aircraft, the equipment will continuously record the video signal from the radars onto magnetic video tape which can later be replayed on ground equipment.

The new technique is expected to yield far more information from each test than was previously possible.

## UK Tops Europe in Data Transmission

The number of terminals sending and receiving computer data in the Post Office's Datel services has grown by more than a quarter over the last year.

Datel terminals in service reached a new peak of 22,214, a growth of 27 per cent. Although the UK has only a quarter of Europe's computers, there are more data-transmission terminals in Britain than in the rest of Europe combined.

# POINTS ARISING

**I.C. LINEAR OHMMETER** *(January 1973)*

This article was the work of Charles Griffiths B.Sc (Eng). We apologise for the fact that an incorrect initial was attached to our author's name.

**BIOLOGICAL AMPLIFIER** *(January 1973)*

In Fig. 3, page 34, the value of resistor R5 should be 5·6kΩ. In the last paragraph under the side heading Alphaphone on page 38 reference to C10 should read C11.

Fig. 5, page 39, the pin numbers 9 and 10 should be transposed in both the circuit diagram and case interwiring. In the case interwiring pin 12 should be 11. These corrections bring Fig. 5 into agreement with the circuit diagram Fig. 3.

# By R.W. COLES PART 9

## PROGRAMME BOARD

THE BULK of the Digi-Cal logic has now been described. Throughout the articles covering the logic boards from DISPLAY to ADDER, readers will constantly have encountered a variety of signals attributed to a mysterious PROGRAMME BOARD.

The far-reaching influences of this board thus having been established, the time has arrived to delve into the method of deriving the plethora of programme output signals, a most important aspect of the calculator.

### DIGI-CAL PROGRAMME

The requirements of Digi-Cal are humble, re-programming not being required in the normal run of things and the tasks for which a programme is necessary, namely the four arithmetic functions of addition, subtraction, multiplication and division can be carried out with only a few programme steps and without recourse to any high level language facilities other than the press of an appropriate key.

Programming then is carried out at the basic level of logic gates and flip-flops, and the Digi-Cal philosophy is retained by making the programmes variable by wiring in diodes where required in a matrix arrangement.

The separate jobs to be controlled by the programme include shifts, transfers, register and counter clearing, routing and clock pulse initiation, all of which must be carried out in a strict sequence.

### PRINCIPLES OF PROGRAMME GENERATION

The programmes for Digi-Cal are formed in a diode matrix in the form of a Read Only Memory or R.O.M. "Memory" because a number of separate addressable locations are provided, and "Read Only" because the instruction data in each address location is fixed at the wiring-up level and is not altered by the operator.

In the present system the R.O.M. array is addressed sequentially by means of a counter. In this way each location in the memory is addressed in turn starting each time at address "1" and continuing to the final address of each R.O.M. in an incremental fashion.

It is not possible to jump back or forward in the sequence and random addressing of a particular location is likewise impossible.

Pausing during a sequence for an indefinite length of time is possible, as is aborting the sequence by clearing the address counter and stopping the clock.

### BASIC CIRCUIT

The incremental ADDRESS COUNTER/R.O.M. programme system is best understood initially by means of a simplified circuit without any trimmings (Fig. 9.1).

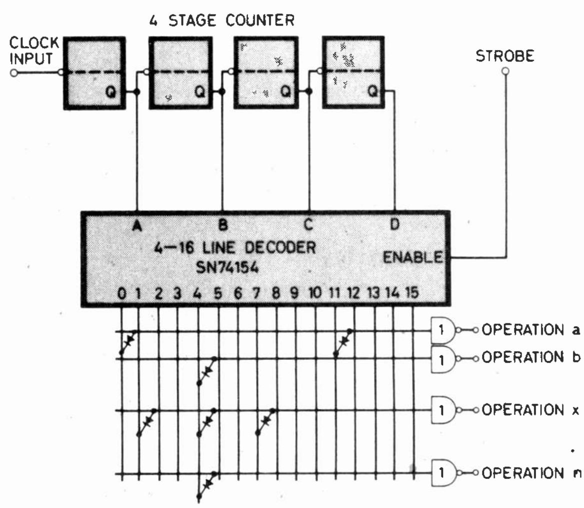



Fig. 9.1. Principles of Read Only Memory Programme generation

Here, a four stage binary counter with 16 possible states is driven continuously by a clock pulse train. The system states of the counter are individually decoded by gates which produce an active low output when inputs are in the appropriate states.

These gates are in the form of an SN74154 TTL M.S.I. decoder which has extra facilities to generate the complement versions of the four inputs required by the decoder gates and a common overriding enable, or strobe input which can be used to inhibit all outputs.

The pin connections of the SN74154 is shown in Fig. 9.2. Referring again to Fig. 9.1 with Fig. 9.2 in mind, it can be seen that, as the counter steps through the sequence, each output from the decoder is enabled in turn for one clock period, thus establishing the programme steps.

The number of operations to be controlled by the programme depends on the requirements of the machine controlled, and can be few or many as required only four being shown in the basic circuit.

All that remains to perform a particular operation in a particular programme step, is to connect a diode across the appropriate intersection where the step line crosses the operation line.

## DIODE MATRIX

Inverters are used at the output end of the operation lines to act as what could be described as "sense amplifiers" in traditional memory terms. Another way of looking at the operation lines and inverters is as multi-input NOR gates with the number of inputs to each gate being determined by the number of times that an operation is used.

Note that each operation can be used any number of times and also that any number of different operations can be activated simultaneously.

The basic circuit has no facilities for stopping or starting the sequence which therefore runs continuously. Also only one programme is catered for and, because of the ripple-through counter circuit propagation delays combine to give spurious pulses of a few nanoseconds width on some of the step lines.

All of these disadvantages have to be overcome in the Digi-Cal circuit, which is shown in Fig. 9.3.

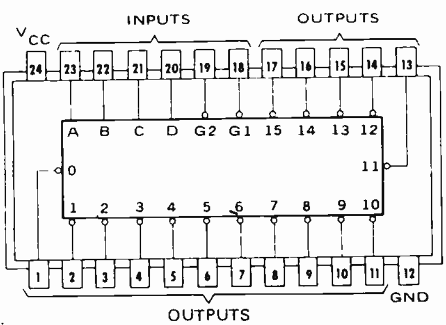



Fig. 9.2. The pin connections of the SN74154 four line to 16 line decoder

## FULL CIRCUIT

The full circuit looks very much more complicated at first sight but the R.O.M. arrays can be easily identified, and the rest of the tangle breaks up into sections with specific jobs.

First out of the way are IC108, 109 and 110 which are simply there to divide the master (ungated) clock signal from board CB by a factor of a thousand, to allow the programme circuits to operate at slow speed.

This eases reflection and decoding problems while keeping the operation of the calculator logic tied to a master synchronising clock signal. The only special thing about these dividers is the fact that the three SN7490 are connected in the ÷10 mode which gives a 1 : 1 mark space output from the final stage.

This is arranged by connecting the A stage of the circuit after the B, C, D stage.

## STOPPING AND STARTING

An SN7493 (IC112) is used as the programme counter, and it is made to stop or start counting by means of a gate in its clock line. Gate G1 itself is controlled by a latch flip-flop which is SET by a pulse from the EQUALS key monostable in the keyboard logic and RESET by the programmes themselves.

Setting the latch is accomplished by using the clock input with a permanent "1" on the D input and clearing is achieved by using the programme STOP PROGRAMME operation to energise the CLEAR input of the first flip-flop via a monostable formed from the other flip-flop and a couple of inverters.

This method of forming a monostable was described in the article covering the CLOCK BOARD, Fig. 7.5, a monostable being necessary in this case to prevent "race" conditions removing the RESET input before the latch was properly cleared.

## PROGRAMME SELECTION

Three separate programmes are required in Digi-Cal; three rather than four because the sequences for ADDITION and SUBTRACTION are identical, the distinction being drawn by the fact that the ADDER BOARD operates either as a subtractor or an adder depending on the FUNCTION CODE which is produced directly by keyboard depressions.

The ADD/SUBTRACT programme is quite simple as might be expected and requires only a few steps. Seven steps are, however, provided to allow reprogramming if any "frills" such as round-off or true negative answer are considered possible later.

The MULTIPLY and DIVIDE programmes are separate and have a possible 15 steps each, to allow for the increased complexity of these operations. Some spare steps are also left in these operations, and can be employed as required.

The selection of the required programme is accomplished by utilising the G1/G2 ENABLE inputs on the SN74154 decoders providing the MULTIPLY and DIVIDE sequences, and by using the D input for the same purpose on the SN7442 of the shorter ADD/SUBTRACT sequence.

Using the D input as an enable is possible with the SN7442 because if the D input is high, the output selected must be greater than seven and since only outputs one to seven are used, a high D input means all programme steps are disabled even though they may be addressed by the A, B and C counter outputs.

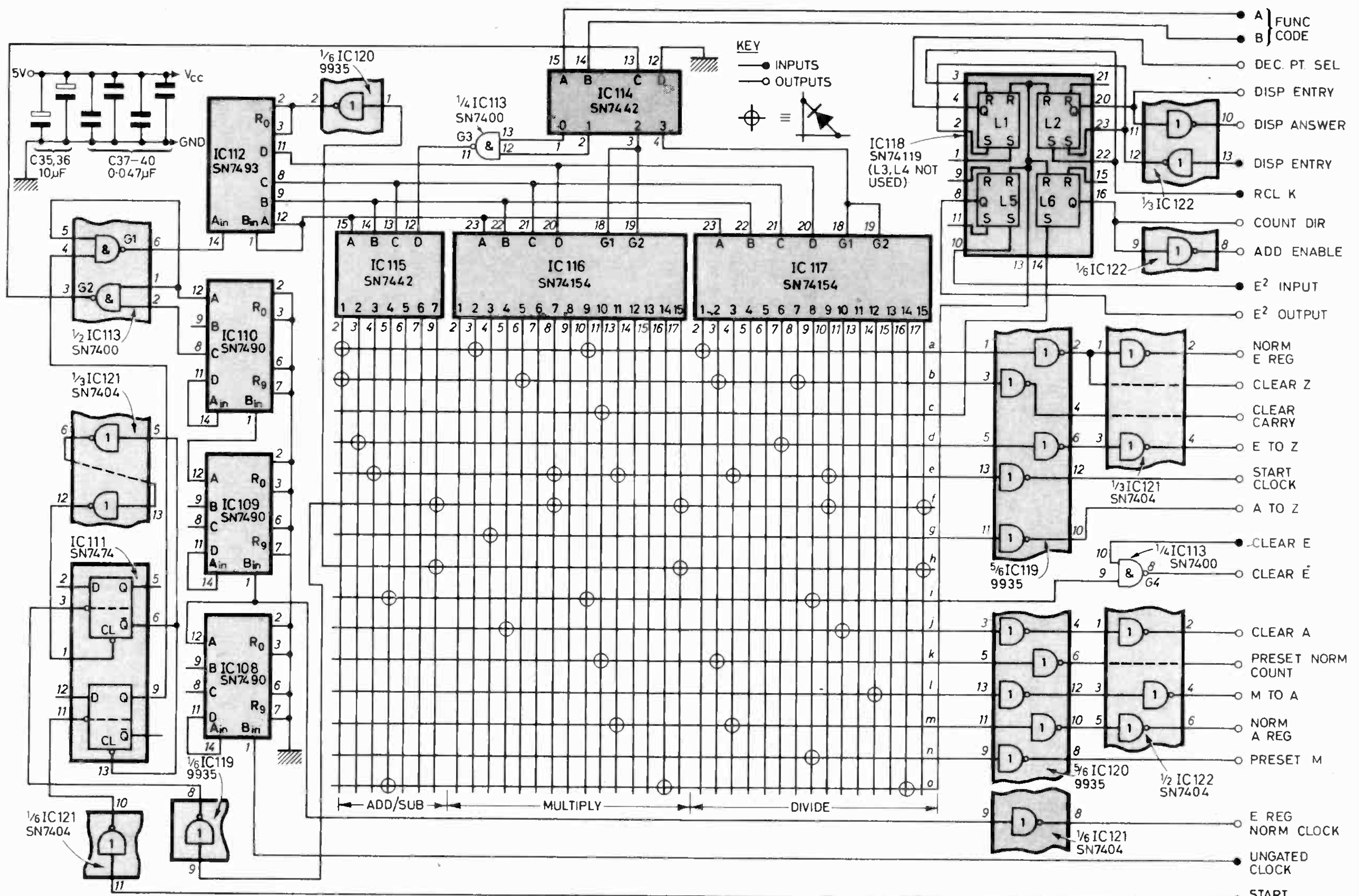



Fig. 9.3. The full circuit diagram of the PROGRAMME BOARD. Power supply connections to the SN74154 and SN74119 are shown in Figs. 9.2 and 9.6. All others have $V_{CC}$ to pin 14 and GND to pin 7 except the SN7490 and SN7493 which has $V_{CC}$ to pin 5 and GND to pin 10, and SN7442 which has $V_{CC}$ to pin 16 and GND to pin 8

## COMPONENTS . . .

**Capacitors**
C35, C36 10μF 15V elect. (2 off)
C37–C40 0·047μF (4 off)

**Diodes**
D104–D142 West Hyde type "red" (or any small silicon diode) (39 off)

**Integrated Circuits**
IC108–IC110 SN7490 (3 off)
IC111 SN7474
IC112 SN7493
IC113 SN7400
IC114, IC115 SN7442 (2 off)
IC116, IC117 SN74154 (2 off)
IC118 SN74119
IC119, IC120 DTL9935 (2 off)
IC121, IC122 SN7404 (2 off)

**Printed Circuit Board**
0·1in Veroboard (8·2in × 3·4in)

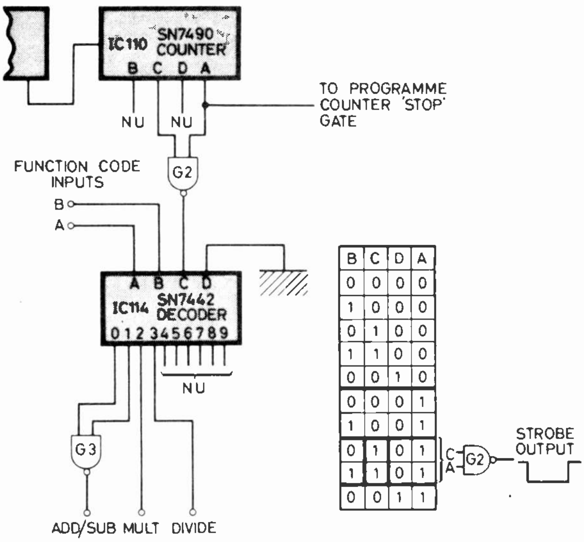
**Edge Connector**
32 way 0·1in pitch edge connector (optional)

### STROBE SYSTEM

Enabling the appropriate programme decoder is not done in a d.c. manner, with a constant input throughout a particular sequence but in an a.c. manner by routing enabling or "strobe" pulses to the selected decoder which occur in the centre of each addressing period.

This scheme is used to kill two birds with one stone, since by enabling decoder outputs only in the middle of each address period the problem of spurious outputs or "glitches" is overcome.

By the time the enable pulse arrives the address counter is resting in a particular state and propagation delay problems are overcome.




| B | C | D | A |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 |
| 1 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 |

Fig. 9.4. Gate G2 is used to generate a strobe pulse by detecting simultaneous C and A outputs during the clock period as shown in the truth table. The decoder is used to select the appropriate part of the programme according to the FUNCTION CODE inputs

This selection system involves IC114, G2 and G3 and to make the principle clearer it is redrawn in an integrated way as Fig. 9.4. Two states of the final divider (IC110), count sequence are detected by gate G2 which gives a negative strobe pulse near the end of the run (see Truth Table).

The strobe pulse is applied to the C input of IC114 which is being under-used in this application as a two to four line decoder with strobe input.

One of the outputs zero to three is addressed by the two line FUNCTION CODE generated by the KEYBOARD in response to the arithmetic selection made by the operator.

The selected output will remain high however, until the strobe pulse takes the C input low. The result of all this is that a continuous stream of strobe pulses is delivered, via the logic described, to the STROBE or ENABLE input of the selected programme decoder. Gate G3 is used as a negative logic NOR gate to ENABLE the single ADD/SUBTRACT programme whether addition or subtraction is called.

### PROGRAMME OUTPUTS

Fifteen programme operations are possible on this board, and although more of these would be useful, board space is a limiting factor for the layout of the R.O.M. matrix.

Because of this limited number of available lines, some outputs do two or more jobs which seem to be unconnected. For example, line A is responsible for normalising the entry register, clearing the Z REGISTER, and clearing the EQUALS LATCH on the M COUNTER boards.

#### PROGRAMME OPERATION CODE ASSIGNATIONS

**a** Normalise Entry Register
Clear Z Register
Clear M Counter Equals Latch

**b** Clear Carry Store
Clear M Counter (to 000000)

**c** Set latch, changing clock count to DOWN and disabling A inputs to ADDER

**d** Transfer the contents of the E register to the Z register

**e** Start Arithmetic Clock

**f** Stop programme sequence

**g** Transfer the contents of the A register to the Z register

**h** Clear the Programme Counter

**i** Clear E register

**j** Clear A register

**k** Preset NORM code from the thumbwheel into the clock counter

**l** Transfer contents of M counter to A register

**m** A register NORM in progress

**n** Preset M counter to 999999

**o** Clear latch array/select A register for display with point position determined by thumbwheel

These operations are not related and are grouped together because they do not interfere with each other if performed at the same time.

It must be remembered, however, that if a CLEAR Z signal is required by a programme, the other signals are also produced which may or may not be important if a "home-made" programme sequence is employed.

Programme outputs are arranged to be either "active high" or "active low" depending on the requirements of the logic they drive, and for this reason either one or two inverters are placed at the end of the operation lines.

The inverters connected directly to the R.O.M. lines are from the DTL family and are type 935 which do not have input diodes (Fig. 9.5). This enables the R.O.M. diodes to be used as an integral part of the circuit without reducing noise immunity.

## LATCH ARRAY

The latch array performs a variety of jobs which are related to the programme, one of the most obvious of which is to stretch programme operations over a number of steps.

"Stretching" is achieved by using the programme to SET a latch in a particular step, and to RESET it in another. The latch output is then used to control a particular operation which must be continued for longer than one step.

Latch L6 is used in this way to control the CLOCK COUNTER direction and ADDER ENABLE during A REGISTER NORMALISATION in the MULTIPLY sequence. Latch L5 is used to control routing logic during an $E^2$ operation, being SET by pressing the $E^2$ key and RESET by the CLEAR LATCH ARRAY programme operation at the end of each sequence.

Latches L3 and L4 are not used, but are available if required, and L1 and L2 operate together to control the display selection.

Latch L1 controls the decimal point selection (fixed or floating) and L2 controls the register selection (A or E).

The i.c. used in this position is the very versatile SN74119, which like the SN74154 decoders is housed in a 24 pin dual-in-line package. The logic of this device is simply that of six cross-coupled gate latches with a common clear line, and is shown in Fig. 9.6.

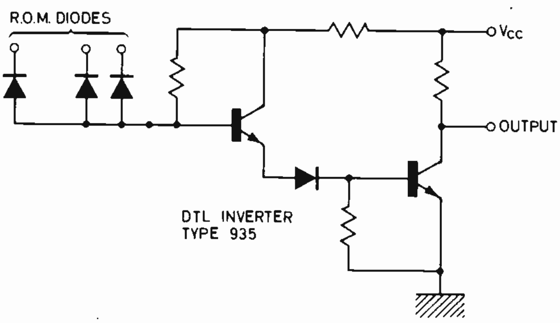



Fig. 9.5. This diagram shows how the R.O.M. diodes and the DTL inverters are used to form NOR gates

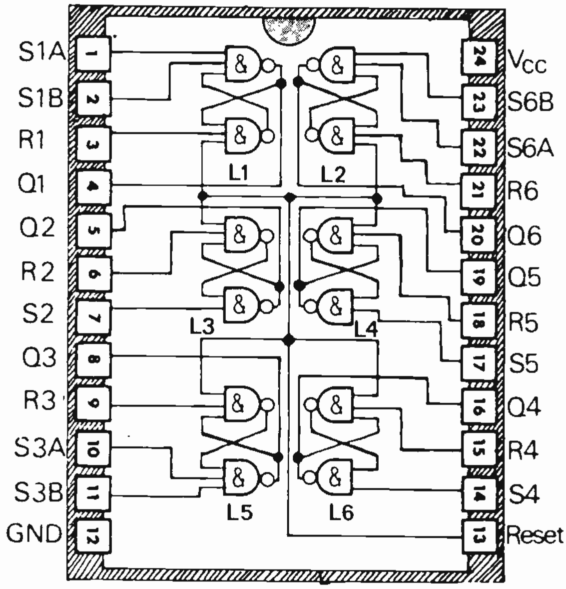



Fig. 9.6. Internal logic of the SN74119 hex SET/RESET LATCH

## CLOCK AND CLEAR

There are only a couple of items left on the full circuit to be mentioned, the first of these being G4 which is used to NOR the CLEAR E output from the programme and the CLEAR E input from the CE key to give a combined signal.

Next, the E REGISTER normalising clock output is taken as a tapping from the divider-chain so that although much faster than the final programme clock, the normalising clock is slower than the arithmetic clock to prevent difficulties with the long line lengths used.

## PROGRAMMING

The programmes used in the prototype are shown in Fig. 9.7, which presents the sequences as flow diagrams.

The operations inside the shaded boxes in the MULTIPLICATION and DIVISION programmes show the conditional branching operation carried out by the CLOCK GENERATING BOARD, and are included in the flow diagram for completeness.

Each of the square boxes corresponds to the programme step with which it is numbered, several operations being possible at each step. The spare steps do not give rise to any outputs from the board, but may be used to advantage if the basic programme is expanded or re-arranged.

Re-programming does not require any particular skill other than commonsense and a knowledge of the way the circuits operate.

The writer has had very little time to consider just what improvements could be programmed into the calculator, but with a little ingenuity and perhaps modification, true negative answers (as opposed to complement versions as the machine stands) should be possible.

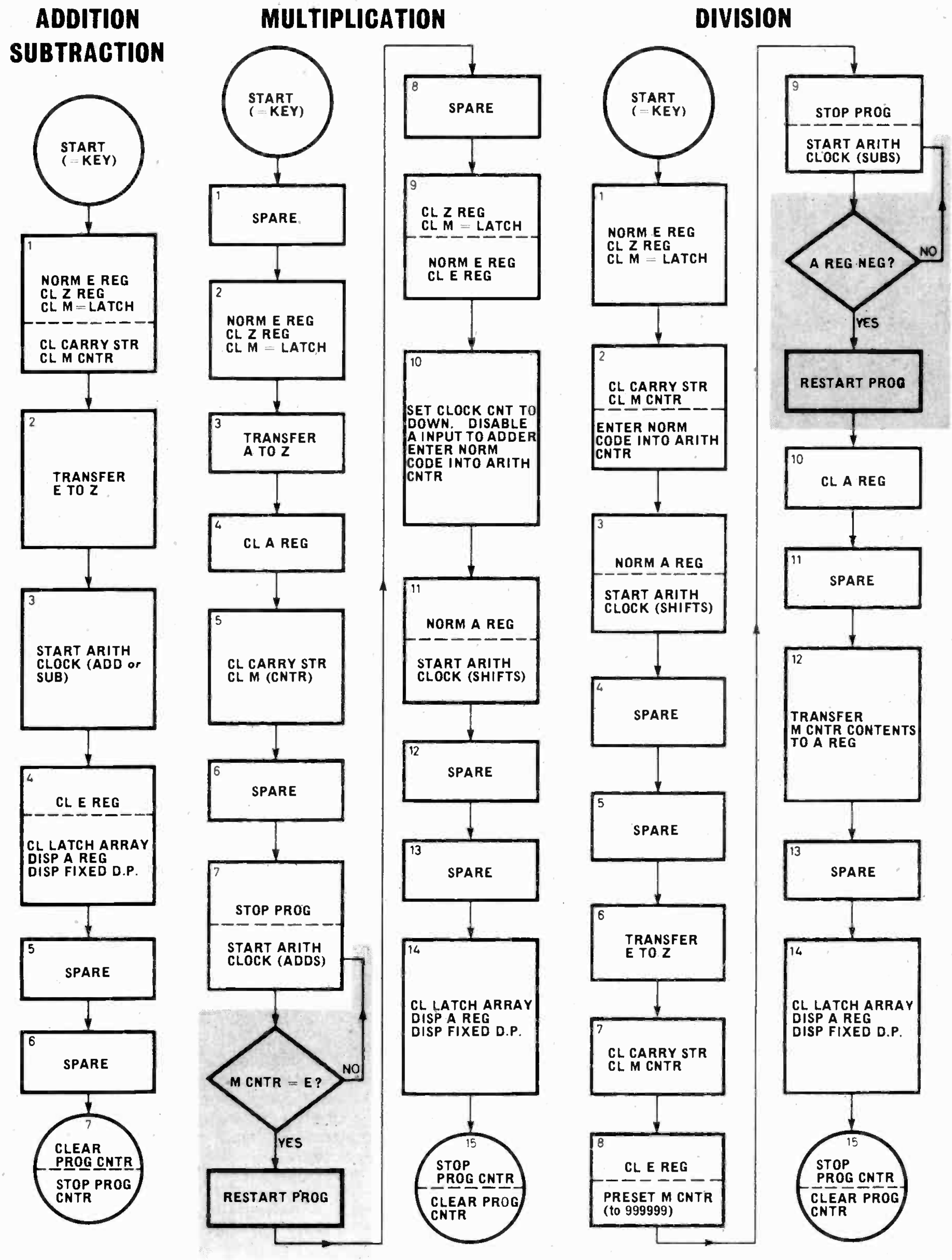



Fig. 9.7. This flow diagram shows the three programmes used on the PROGRAMME BOARD. The same programme is used for addition and subtraction as mentioned in the text

# PROGRAMME BOARD

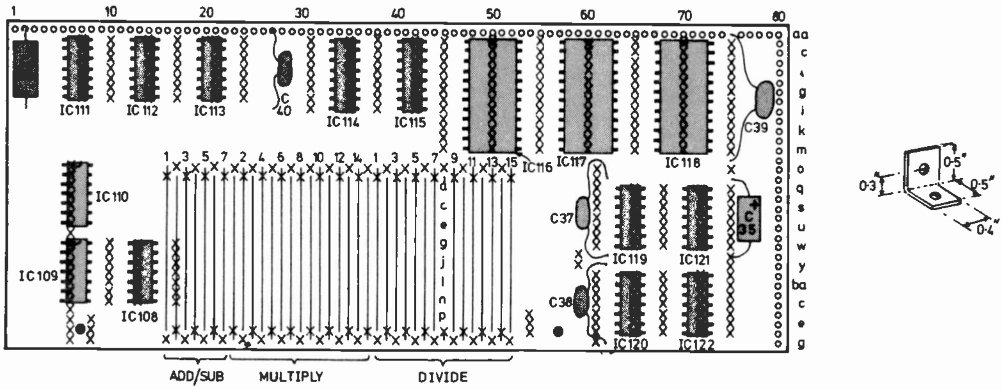
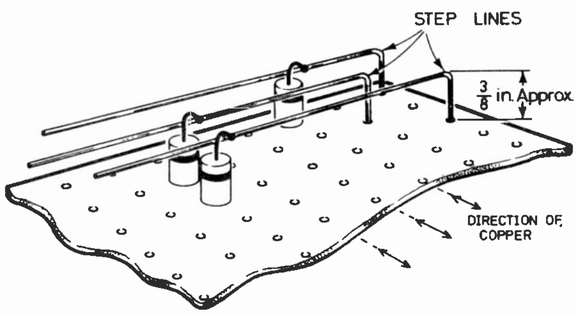



Fig. 9.8. The layout of the components on the Veroboard panel. Crosses show breaks in copper strips




Diode matrix construction

**PROGRAMME BOARD WIRING DESTINATIONS**

| | |
|---|---|
| aa | not used |
| ab | START PROG (fr kbd) |
| ac | RECALL K (fr kbd) |
| ad | UNGATED CLK IN (fr CB/43) |
| ae | FUNC CODE A (fr kbd) |
| af | DISP E (to disp) |
| ag | $E^2$ (fr kbd) |
| ah | DISP E (fr kbd) |
| ai | FUNC CODE B (fr kbd) |
| aj | CNT DIR'N (to CB/28) |
| ak | CLEAR E (to ED/2) |
| al | CLEAR E (fr kbd) |
| am | not used |
| an | GND |
| ao | $E^3$ (to $E^2$ logic) |
| ap | +5V |
| aq | CLEAR Z REG etc (to Z2/43, kbd (NORM) and M1/19) |
| ar | CLEAR CARRY etc (to AD/23, M1/20, M2/20) |
| as | DISP A (to DISP) |
| at | START CLK (to CB/44) |
| au | not used |
| av | DEC PT SEL'N (to kbd) |
| aw | TRANSFER E TO Z (to Z1/24) |
| ax | E REG NORM CLK (to kbd) |
| ay | ADD ENABLE (to AD/37) |
| az | NORM A REG (to CB/37) |
| ba | PRESET NORM CNT (to CB/27) |
| bb | TRANSFER M TO A (to CB/39) |
| bc | not used |
| bd | PRESET M (to M1/21, M2/21) |
| be | CLEAR A REG (to A1/44, A2/44) |
| bf | TRANSFER A TO Z (to Z2/24) |

## CONSTRUCTION

This circuit is built on a Veroboard panel (Fig. 9.8) and carries a good deal of wiring on both sides. The R.O.M. operation lines are formed by the printed tracks on the board, but the step lines are formed from bare tinned copper wire running at right-angles to the tracks.

These are spaced from the board by about $\frac{3}{8}$in so that diodes may be soldered-in where required. Note that the diodes are inserted with their red ends uppermost, connected to the step lines.

Wiring is congested but not critical, thanks to the low programme speed, and both sides of the board carry wire interconnections.

An edge connector of 32 or more ways is recommended for use with this board, but it is not essential; connections can be soldered directly to the printed tracks if desired. If an edge connector is used it is necessary to clean the track ends thoroughly with fine emery paper and then coat them with a tarnish preventer and cleaner such as Electrolube.

## TESTING

Programme selection and step sequences can be easily checked after construction by using a large value capacitor on the CLOCK BOARD to give a very slow programme sequence. Steps can then be followed with a multimeter set to a low voltage range.

Operational testing can be carried out only with the ADD/SUBTRACT programme until the M COUNTER boards and $E^2$ logic are constructed, but when this is working, little trouble should be experienced with the other programmes.

**Note:** In Fig. 6.10 (Dec. 72) Z1/22, Z1/43, Z2/22, and Z2/43 go to Z2/44 not CB/13. Z1/21, Z2/21 go to CB/23. A1/42, A2/42 go to CB/40. A1/43, A2/43 go to CB/38. In Fig. 7.7 (Jan. 73) CB/40 should go to A1/42, A2/42.

**Next month: M Counter Boards**

# Designing with Integrated circuits

BY A. FOORD

## 6 Simple Memory Circuits

THIS month we will show how simple memory circuits may be constructed from gates and how the master-slave bistable is developed. In the way that a transistor bistable can be made from two cross-coupled inverting stages, a bistable can also be made from two inverting gates. This is shown in Fig. 6.1 for NAND gates, although a similar NOR circuit is also possible.

If the clear and set inputs are at 1, and so have no effect, then for either gate a 1 at its input would produce a 0 at its output, and vice versa. Since the output of one gate is the input of the other, the two outputs must be in opposite states. If Q is 1 then $\overline{Q}$ must be 0, and vice versa.

If the clear input is 0 and the set input is 1, then $\overline{Q}$ becomes 1 and Q becomes 0. If the set input is 0 and the clear input is 1 then the opposite state is set up with Q equal to 1 and $\overline{Q}$ equal to 0.

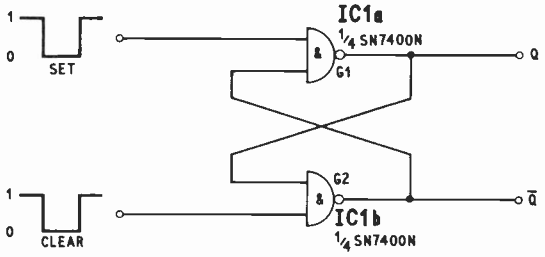
If a momentary 0 input is applied to either the set or clear input the corresponding output will become a 1 and will remain in this state until a 0 is applied to the other input. The circuit can therefore act as a memory and can be used to eliminate the effects that are obtained from contact bounce on a mechanical switch. This could be checked as an experiment (Fig. 6.2).

From the truth table it can be seen that, if 0 levels are applied to both inputs, then both the Q and $\overline{Q}$ outputs will be 1. For a true bistable circuit this condition would be avoided.

### GATED MEMORY

When input gates are added to the basic memory in Fig. 6.1, it can be made to respond to input levels only during a specific clock time interval, as shown in Fig. 6.3. While the clock input is at 0, gates 1 and 2 have a 1 at their outputs and the set and clear inputs are locked out of the memory. New information can only reach the memory when the clock input is at 1.

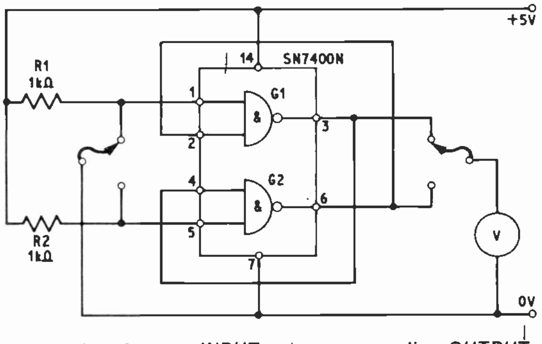
A 1 at the set input with a 0 at the clear input will give a 0 input to gate 3 and a 1 input to gate 4, then Q will be a 1. The other possible states are shown in the truth table.




TRUTH TABLE

| INPUT | | OUTPUTS | |
|---|---|---|---|
| CLEAR | SET | Q | $\overline{Q}$ |
| 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 |
| 0 | 0 | 1 | 1 |
| 1 (last 0) | 1 | 0 | 1 |
| 1 | 1 (last 0) | 1 | 0 |

Fig. 6.1. The basic bistable circuit




momentary 0 on an INPUT sets corresponding OUTPUT to 1

Fig. 6.2. The basic bistable circuit used to eliminate the effects of switch contact bounce

If both set and clear inputs are at 0 when the clock goes high the inputs to the memory remain at 1 and the output does not change from its previous state. In the truth table $T_n$ represents the time during the clock pulse while $T_{n+1}$ represents the time after the clock pulse. Similarly $Q_n$ represent the state of the memory at the time of the clock pulse. (These are common terms used in manufacturers' data on digital i.c.s.)

When the sampling interval is over and the clock returns to 0, further changes in set and reset can have no effect until the next clock pulse. The memory is said to have "clocked", because the sampling point can be timed to occur when the required data is at the set and clear inputs, and data outside this time will be ignored. For this circuit the set and clear levels need not be pulses because input pulsing is provided by the clock.

## DATA LATCH

The previous circuit had three useful conditions, $Q_n$, 0, and 1. In some applications the data latch

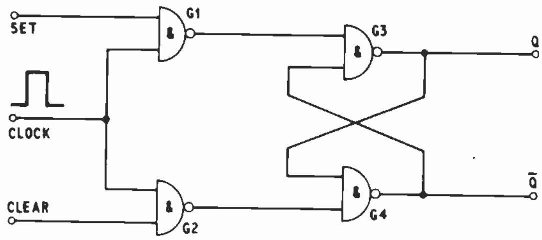
## GLOSSARY

***BISTABLE CIRCUIT*** A circuit in which the output has two stable states.

***NAND GATE*** A logic circuit where all inputs must have 1 level signals to produce a 0 level output.

***NOR GATE*** Any one input or more than one input having a 1 level signal will produce a 0 level output.

***TRUTH TABLE*** A chart which tabulates all the combinations of possible states of the inputs and outputs of a circuit.




TRUTH TABLE

| INPUTS $T_n$ | | OUTPUT $T_{n+1}$ |
|---|---|---|
| CLEAR | SET | Q |
| 0 | 0 | $Q_n$(Q at $T_n$) |
| 0 | 1 | 1 |
| 1 | 0 | 0 |
| 1 | 1 | INDETERMINATE |

Fig. 6.3. The gated memory with SET and CLEAR inputs

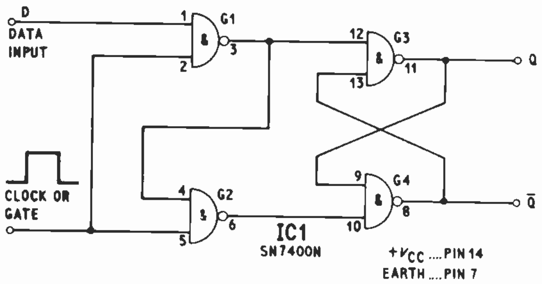
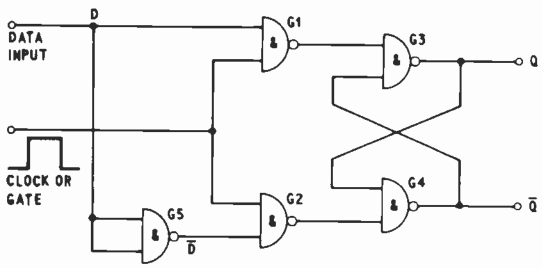
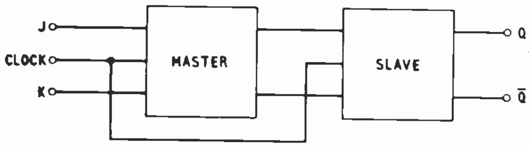



Fig. 6.5. The gated memory with a single data input and the minimum number of gates. It can be realised with an SN7400N




| INPUT | OUTPUT |
|---|---|
| D | Q |
| 0 | 0 |
| 1 | 1 |

Fig. 6.4. The gated memory with a single data input




TRUTH TABLE

| INPUTS | | OUTPUT $T_{n+1}$ |
|---|---|---|
| J | K | Q |
| 0 | 0 | Q at $T_n$ |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | $\bar{Q}$ at $T_n$ |


1 Isolate slave from master

2 Enter information to master

3 Disenable inputs

4 Transfer information from master to slave

Fig. 6.6. The basic action of a master-slave bistable circuit

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|---|---|
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| 1N23 | 0·20 |
| 1N85 | 0·88 |
| 1N253 | 0·50 |
| 1N256 | 0·50 |
| 1N645 | 0·25 |
| 1N725A | 0·20 |
| 1N914 | 0·07 |
| 1N4007 | 0·20 |
| 1S113 | 0·15 |
| 1S130 | 0·18 |
| 1S131 | 0·18 |
| 1S202 | 0·23 |
| 2G371 | 0·22 |
| 2G381 | 0·25 |
| 2G414 | 0·30 |
| 2G417 | 0·22 |
| 2N404 | 0·20 |
| 2N697 | 0·15 |
| 2N698 | 0·40 |
| 2N706 | 0·10 |
| 2N706A | 0·12 |
| 2N708 | 0·15 |
| 2N709 | 0·63 |
| 2N1091 | 0·33 |
| 2N1131 | 0·25 |
| 2N1132 | 0·25 |
| 2N1302 | 0·18 |
| 2N1303 | 0·18 |
| 2N1304 | 0·22 |
| 2N1305 | 0·22 |
| 2N1306 | 0·25 |
| 2N1307 | 0·25 |
| 2N1308 | 0·25 |
| 2N2147 | 0·75 |
| 2N2148 | 0·60 |
| 2N2160 | 0·60 |
| 2N2218 | 0·20 |
| 2N2219 | 0·20 |
| 2N2369A | 0·15 |
| 2N2444 | 1·99 |
| 2N2613 | 0·28 |
| 2N2646 | 0·45 |
| 2N2904 | 0·20 |
| 2N2904A | 0·25 |
| 2N2906 | 0·20 |
| 2N2907 | 0·23 |
| 2N2924 | 0·23 |
| 2N2925 | 0·15 |
| 2N2926 | 0·10 |
| 2N3054 | 0·50 |
| 2N3055 | 0·75 |
| 2N3702 | 0·10 |
| 2N3705 | 0·10 |
| 2N3706 | 0·23 |
| 2N3707 | 0·12 |
| 2N3709 | 0·10 |
| 2N3710 | 0·10 |
| 2N3711 | 0·10 |
| 2N3819 | 0·35 |
| 2N5027 | 0·53 |
| 2N5088 | 0·33 |
| 2S301 | 0·50 |
| 2S304 | 0·75 |
| 2S501 | 0·37 |
| 2S702 | 0·62 |
| AA129 | 0·20 |
| AAZ12 | 0·30 |
| AAZ13 | 0·12 |
| AC107 | 0·37 |
| AC126 | 0·20 |
| AC127 | 0·25 |
| AC128 | 0·20 |
| AC187 | 0·25 |
| AC188 | 0·25 |
| ACY17 | 0·30 |
| ACY18 | 0·25 |
| ACY19 | 0·25 |
| ACY20 | 0·20 |
| ACY21 | 0·20 |
| ACY22 | 0·10 |
| ACY27 | 0·25 |
| ACY28 | 0·17 |
| ACY39 | 0·50 |
| ACY40 | 0·15 |
| ACY41 | 0·15 |
| ACY44 | 0·25 |
| AD140 | 0·50 |
| AD149 | 0·50 |
| AD161 | 0·37 |
| AD162 | 0·37 |
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| AF114 | 0·25 |
| AF115 | 0·25 |
| AF116 | 0·25 |
| AF117 | 0·25 |
| AF118 | 0·62 |
| AF119 | 0·20 |
| AF124 | 0·25 |
| AF125 | 0·20 |
| AF126 | 0·17 |
| AF127 | 0·17 |
| AF139 | 0·30 |
| AF178 | 0·55 |
| AF179 | 0·65 |
| AF180 | 0·52 |
| AF181 | 0·42 |
| AF186 | 0·40 |
| AFY19 | 1·18 |
| AFZ11 | 0·60 |

| Type | £p |
|---|---|
| AFZ12 | 1·00 |
| ASY26 | 0·25 |
| ASY27 | 0·32 |
| ASY28 | 0·25 |
| ASY29 | 0·30 |
| ASY36 | 0·25 |
| ASY50 | 0·17 |
| ASY51 | 0·40 |
| ASY53 | 0·20 |
| ASY55 | 0·20 |
| ASY62 | 0·25 |
| ASY86 | 0·33 |
| ASZ21 | 0·42 |
| ASZ23 | 0·75 |
| AUY10 | 0·98 |
| AU101 | 1·50 |
| BC107 | 0·10 |
| BC108 | 0·10 |
| BC109 | 0·10 |
| BC113 | 0·15 |
| BC115 | 0·20 |
| BC116 | 0·25 |
| BC116A | 0·30 |
| BC118 | 0·25 |
| BC121 | 0·20 |
| BC122 | 0·20 |
| BC125 | 0·68 |
| BC126 | 0·65 |
| BC140 | 0·55 |
| BC147 | 0·15 |
| BC148 | 0·13 |
| BC149 | 0·15 |
| BC157 | 0·15 |
| BC158 | 0·12 |
| BC160 | 0·68 |
| BC169 | 0·13 |
| BCY31 | 0·35 |
| BCY32 | 0·55 |
| BCY33 | 0·25 |
| BCY34 | 0·30 |
| BCY38 | 0·40 |
| BCY39 | 1·00 |
| BCY40 | 0·50 |
| BCY42 | 0·25 |
| BCY70 | 0·15 |
| BCY71 | 0·20 |
| BCZ10 | 0·35 |
| BCZ11 | 0·50 |
| BD121 | 0·65 |
| BD123 | 0·80 |
| BD124 | 0·75 |
| BDY11 | 1·62 |
| BF115 | 0·25 |
| BF117 | 0·50 |
| BF167 | 0·25 |
| BF173 | 0·25 |
| BF181 | 0·35 |
| BF184 | 0·20 |
| BF185 | 0·20 |
| BF194 | 0·17 |
| BF195 | 0·15 |
| BF196 | 0·15 |
| BF197 | 0·15 |
| BF861 | 0·28 |
| BF898 | 0·28 |
| BFX12 | 0·20 |
| BFX13 | 0·25 |
| BFX29 | 0·25 |
| BFX30 | 0·25 |
| BFX35 | 0·98 |
| BFX63 | 0·50 |
| BFX84 | 0·25 |
| BFX85 | 0·30 |
| BFX86 | 0·25 |
| BFX87 | 0·25 |
| BFX88 | 0·20 |
| BFY10 | 1·00 |
| BFY11 | 1·25 |
| BFY17 | 0·25 |
| BYF18 | 0·25 |
| BFY19 | 0·25 |
| BFY24 | 0·45 |
| BFY44 | 1·00 |
| BFY50 | 0·22 |
| BFY51 | 0·20 |
| BFY52 | 0·22 |
| BFY53 | 0·17 |
| BFY64 | 0·42 |
| BFY90 | 0·65 |
| BSX27 | 0·50 |
| BSX60 | 0·93 |
| BSX76 | 0·15 |
| BSY26 | 0·18 |
| BSY27 | 0·17 |
| BSY51 | 0·50 |
| BSY95A | 0·12 |
| BSY95 | 0·12 |
| BT102/500R | 0·75 |
| BTY42 | 0·92 |
| BTY79/100R | 0·75 |
| BTY79/400R | 1·25 |
| BY100 | 0·15 |
| BY126 | 0·15 |
| BY127 | 0·17 |
| BY182 | 0·85 |
| BY213 | 0·25 |

| Type | £p |
|---|---|
| BYZ10 | 0·35 |
| BYZ11 | 0·32 |
| BYZ12 | 0·30 |
| BYZ13 | 0·25 |
| BYZ15 | 1·00 |
| BYZ16 | 0·62 |
| BYZ88C3V3 | 0·15 |
| C111 | 0·65 |
| CR81/05 | 0·25 |
| CR81/40 | 0·45 |
| CS4B | 2·50 |
| CS10B | 3·18 |
| DD000 | 0·15 |
| DD003 | 0·15 |
| DD006 | 0·18 |
| DD007 | 0·40 |
| DD008 | 0·38 |
| GD3 | 0·33 |
| GD4 | 0·05 |
| GD5 | 0·33 |
| GD8 | 0·25 |
| GD12 | 0·05 |
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| GET114 | 0·15 |
| GET115 | 0·45 |
| GET116 | 0·50 |
| GET120 | 0·25 |
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| GET875 | 0·25 |
| GET880 | 0·37 |
| GET881 | 0·25 |
| GET882 | 0·25 |
| GET885 | 0·25 |
| GEX44 | 0·08 |
| GEX45/1 | 0·10 |
| GEX941 | 0·15 |
| GJ3M | 0·25 |
| GJ4M | 0·38 |
| GJ5M | 0·25 |
| GJ7M | 0·37 |
| HG1005 | 0·50 |
| HS100A | 0·20 |
| MAT100 | 0·25 |
| MAT101 | 0·30 |
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| MJE520 | 0·87 |
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| NKT713 | 0·25 |
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| OAZ210 | 0·32 |

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| OAZ224 | 0·45 |
| OAZ241 | 0·22 |
| OAZ242 | 0·23 |
| OAZ244 | 0·22 |
| OAZ246 | 0·23 |
| OAZ290 | 0·38 |
| OC16 | 0·50 |
| OC16T | 0·38 |
| OC19 | 0·37 |
| OC20 | 0·85 |
| OC22 | 0·50 |
| OC23 | 0·60 |
| OC24 | 0·60 |
| OC25 | 0·37 |
| OC26 | 0·25 |
| OC28 | 0·60 |
| OC29 | 0·60 |
| OC30 | 0·40 |
| OC35 | 0·50 |
| OC36 | 0·60 |
| OC41 | 0·25 |
| OC42 | 0·30 |
| OC43 | 0·40 |
| OC44 | 0·17 |
| OC44M | 0·17 |
| OC45 | 0·12 |
| OC45M | 0·18 |
| OC46 | 0·27 |
| OC57 | 0·60 |
| OC58 | 0·60 |
| OC59 | 0·65 |
| OC66 | 0·50 |
| OC70 | 0·12 |
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| OC72 | 0·20 |
| OC73 | 0·30 |
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| OC76 | 0·25 |
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| OC78 | 0·20 |
| OC79 | 0·22 |
| OC81 | 0·20 |
| OC81D | 0·20 |
| OC81M | 0·20 |
| OC81DM | 0·18 |
| OC81Z | 0·40 |
| OC82 | 0·25 |
| OC82D | 0·20 |
| OC83 | 0·25 |
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| OC200 | 0·40 |
| OC201 | 0·70 |
| OC202 | 0·80 |
| OC203 | 0·40 |
| OC204 | 0·40 |
| OC205 | 0·75 |
| OC206 | 0·90 |
| OC207 | 0·90 |
| OC460 | 0·20 |
| OC470 | 0·30 |
| OCP71 | 0·97 |
| ORP12 | 0·50 |
| ORP60 | 0·40 |
| ORP61 | 0·42 |
| S19T | 0·30 |
| SAC40 | 0·25 |
| SFT308 | 0·38 |
| ST722 | 0·38 |
| ST7231 | 0·63 |
| SX68 | 0·20 |
| SX631 | 0·30 |
| SX635 | 0·40 |
| SX640 | 0·50 |
| SX641 | 0·55 |
| SX642 | 0·60 |
| SX644 | 0·75 |
| SX645 | 0·75 |
| V15/30P | 0·50 |
| V30/201P | 0·75 |
| V60/201 | 0·50 |
| V60/201P | 0·75 |
| XA101 | 0·10 |
| XA102 | 0·18 |
| XA151 | 0·15 |
| XA152 | 0·15 |
| XA161 | 0·25 |
| XA162 | 0·25 |
| XB101 | 0·43 |
| XB102 | 0·10 |
| XB103 | 0·25 |
| XB113 | 0·12 |
| XB121 | 0·43 |
| ZR24 | 0·63 |

| Type | £p |
|---|---|
| ZS170 | 0·10 |
| ZS271 | 0·18 |
| ZT21 | 0·25 |
| ZT43 | 0·25 |
| ZTX107 | 0·15 |
| ZTX108 | 0·12 |
| ZTX300 | 0·12 |
| ZTX304 | 0·25 |
| ZTX500 | 0·16 |
| ZTX503 | 0·17 |
| ZTX531 | 0·25 |
| **INTEGRATED CIRCUITS** | |
| 7400 | 0·20 |
| 7401 | 0·20 |
| 7402 | 0·20 |
| 7403 | 0·20 |
| 7404 | 0·20 |
| 7405 | 0·20 |
| 7406 | 0·30 |
| 7407 | 0·30 |
| 7408 | 0·20 |
| 7409 | 0·45 |
| 7410 | 0·20 |
| 7411 | 0·23 |
| 7412 | 0·42 |
| 7413 | 0·30 |
| 7416 | 0·30 |
| 7417 | 0·30 |
| 7420 | 0·20 |
| 7422 | 0·48 |
| 7423 | 0·48 |
| 7425 | 0·48 |
| 7427 | 0·42 |
| 7428 | 0·50 |
| 7430 | 0·20 |
| 7432 | 0·42 |
| 7433 | 0·70 |
| 7437 | 0·65 |
| 7438 | 0·65 |
| 7440 | 0·20 |
| 7441AN | 0·75 |
| 7442 | 0·75 |
| 7450 | 0·20 |
| 7451 | 0·20 |
| 7453 | 0·20 |
| 7454 | 0·20 |
| 7460 | 0·20 |
| 7470 | 0·30 |
| 7472 | 0·30 |
| 7473 | 0·40 |
| 7474 | 0·40 |
| 7475 | 0·55 |
| 7476 | 0·45 |
| 7480 | 0·80 |
| 7482 | 0·87 |
| 7483 | 1·00 |
| 7484 | 0·90 |
| 7486 | 0·45 |
| 7490 | 0·75 |
| 7491AN | 1·00 |
| 7492 | 0·75 |
| 7493 | 0·75 |
| 7494 | 0·80 |
| 7495 | 0·80 |
| 7496 | 1·00 |
| 7497 | 6·25 |
| 74100 | 2·50 |
| 74107 | 0·50 |
| 74110 | 0·80 |
| 74111 | 1·45 |
| 74118 | 1·00 |
| 74119 | 1·90 |
| 74121 | 0·60 |
| 74122 | 1·35 |
| 74123 | 2·70 |
| 74141 | 1·00 |
| 74145 | 1·50 |
| 74150 | 3·35 |
| 74151 | 1·10 |
| 74154 | 2·00 |
| 74155 | 1·55 |
| 74156 | 1·55 |
| 74157 | 1·80 |
| 74170 | 4·10 |
| 74174 | 2·00 |
| 74175 | 1·35 |
| 74176 | 1·60 |
| 74190 | 1·95 |
| 74191 | 1·95 |
| 74192 | 2·00 |
| 74193 | 2·00 |
| 74194 | 2·50 |
| 74195 | 1·85 |
| 74196 | 1·50 |
| 74197 | 1·50 |
| 74198 | 4·60 |
| 74199 | 4·60 |
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is used for storing the output information in counters or computers until the readout has been achieved. This enables counting to recommence while the readout from a previous phase is still taking place.

If only the two middle entries in the truth table are required (as is usual) then a single data input can be used while the complement is obtained from an inverter, Fig. 6.4. The input data is up-dated during the clock pulse and retained when the clock goes low.

## MINIMISED DATA LATCH

The circuit in Fig. 6.4 required five gates to realise it because the D was obtained by the direct inversion of D. However, D can be obtained from the output of gate 1, because D is only needed at the input to gate 2 when the clock is high; therefore, gate 1 will provide the required information.

The minimised circuit shown in Fig. 6.5 may be realised as an experiment using a single SN7400N. Data D will be entered into the memory while the clock is high and retained when the clock is low.

## LOGIC GATE BISTABLES

In the previous circuits the inputs are coupled to the bistable circuit all the time the clock pulse is high, so that these circuits can only be made to toggle (divide by two) if the inputs are a.c. coupled. However, it is essential in logic circuits to overcome this problem without giving up the advantages of d.c. coupling, so circuits were developed which prevent the output transitions from altering the input information which was present when the leading edge of the clock occurred.

These circuits are usually designed in the form of two gated memories, one holds the output state and one holds the input information read in at the beginning of the clock pulse. Since this information is later transferred to the output memory, such a circuit is called a "master-slave" bistable.

Several different versions are available but they all have the master-slave action shown in Fig. 6.6. Here the operation shown is the J-K function where information is transferred from master to slave on the falling edge of the clock pulse. From the truth table it can be seen that this J-K master-slave bistable will divide by two if J and K are taken to 1, and an input applied to the clock.

## CONCLUSION

We have shown how the simple memory circuit develops into the master-slave bistable, with its many advantages.

**Part 7 will describe counters and displays**



# BOAT SHOW '73

THE Yachtsman's winter break, this year in the setting of a sunny Spanish harbour, the annual International Boat Show provides us with a shop window of marine electronics for small craft.

As in previous years there has been a steady development of the electronic gadgetry available, this year has seen the introduction of the l.e.d. (light emitting diode) to boat electronics, a new type of knotmeter and some advancement in the receiver, transmitter field.

One firm whose name must be to the forefront when we consider this year's innovations is EMI; in fact one could call it their year of innovation, with no less than four completely new instruments available. The most interesting new product is a magnetic log.

The new log operates by the transducer generating an a.c. magnetic field in the water surrounding it. As the boat moves through the water a small e.m.f., dependent on the boat speed, is produced and sensed by the transducer head. This induced signal, fed back through the system, is amplified to give a display of speed and distance. Housed in the normal EMI Electra range case the biggest advantage of this instrument is that there are no moving parts below the water and virtually no projection (only 3mm) below the hull surface.

The other innovations from EMI are an automatic direction finder, an f.m. radio telephone, and a gas detector and alarm. The direction finder is a three band receiver covering the range 175kHz to 3,000kHz. To use it, it is tuned to the required radio beacon and automatically gives an immediate and continuous bearing of the transmitter. The unit has its own internal supply or can be powered from a 12V or 24V ship's supply.

The Electra Gas Alarm uses a solid state imported detection unit and provides both visual and audible alarms of dangerous concentrations of gases.

It is interesting to note that the Electrascan MKII radar has been ordered by the RNLI for use in lifeboats. Whilst on the subject of radar both Decca and Electronic Laboratories have introduced MKII radars and the Decca Super 101 MKII is now sold with a magnifier that increases picture size to 9 inches.

## TECHNICAL INNOVATION

As far as real technical innovation goes, this is the first time that we have found a l.e.d. used in a depth sounder. Produced by Marine Electronics and available for about £39, the sounder works on the same principle as a neon type and probably has a similar accuracy.

Instead of providing a point of light at the depth reading, the l.e.d. is turned on when the pulse is transmitted and off when the pulse is received, thus providing an arc of light showing the depth.

Brookes and Gatehouse—manufacturers of perhaps the most reliable and widely used instruments for the racing yachtsmen—have, we feel, done the sensible thing in offering most of their instruments for use on ship's supply. At last no more fiddling with batteries in a heavy seaway.

Baron Instruments, another contender for the "crack" racers' instrument panel, have redesigned their meter faces and introduced a new range—the Baron Sailboat Console—the meters are lit by l.e.d.'s and are 4½ inches in diameter. Provided the instruments can prove themselves at sea, with the new meters (which were in fact suggested by us last year) we feel that this range is the most likley to rival B. and G. this year.

Finally we think it is a pity to see Smiths Industries cashing in on the boat market with standard Radiomobile car radios and tape units. Without the necessary marinisation we feel that these units will not stand up to marine use—particularly in salt water—and for Smiths to push the standard product for this purpose is surely not good policy.

# PATENTS REVIEW...

## WIRING HARNESSES FOR CARS

The Ford Motor Company patent No. 1 287 074 is concerned mainly with wiring harnesses for cars but most electronic enthusiasts will see far wider applications.

In a vehicle all the various electrics, such as sidelights, headlights, stoplights and wipers are usually connected to a power source by separate power carrying cables. The electrics are controlled by switches (usually located inside the vehicle remote from the devices) in the power cables from one of the supply terminals. The vehicle chassis acts as a common return to complete the circuit to the other supply terminal.

Providing heavy duty power lines for each separate remote electrical function is uneconomical. The Ford system is based on the house "ring main" idea and uses a flat strip power conductor capable of handling the total current load for all the vehicle electrics, see Fig. 1.

The strip conductor is flexible and is coated with flexible insulating material. On the surface of the insulating material a thin conducting layer is deposited and etched away to form a parallel series of thin low current control conductors. Each of these has connecting pads spaced out along its length and Ford suggest that in a practical system 20 to 30 control conductors can be used along with one main power conductor.

The vehicle power source is permanently connected to the power conductor by a pin connector which bites through the insulating material and into the conductor. Similar power connectors can be used to connect the power conductor to any electrical device which requires a permanent supply of power.

Each remote electrical function that requires only a switchable power supply (such as headlights, etc) is connected to the power connector by a gated plug. The gated plugs each house a transistor of which the emitter is permanently connected to the power conductor.

A resistor of around 1,000 ohms is connected between the base and emitter of the transistor and the base of the transistor is also connected to the required control conductor of the wiring harness. The transistor collector is connected externally to whatever electrical function is to be powered, Fig. 2.

The gate is controlled by a trigger signal from the control conductor and will only pass current to its load when a control signal is present.

In Fig. 2, the electrical functions or loads are lamps LP1 and LP2. When manual switches S1 and S2 are "off" the base of transistors TR1 and TR2 are at the same potential as the emitters and neither transistor conducts; thus lamps LP1 and LP2 do not light. If switch S1 is turned "on" the potential of control conductor CC1 falls, transistor TR1 is switched on and current flows through lamp LP1. Similarly if switch S2 is turned on, current flows through lamp LP2. The circuit takes into account the high cold current surges involved in lighting most vehicle lamps.

Although SCR's may be used it is easier and cheaper to use switch resistors R1 and R2 (around 100 ohms each) which, together with the resistances connected between the emitters and bases of the transistors, form potential dividers which hold the base potentials constant at a level to which they fall on closing the switch. Current through the transistor can only increase until the voltage across the low emitter resistance (cable resistance, etc) raises the emitter potential to a similar value to the base potential.

## BP1 287 074

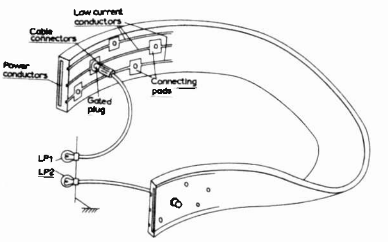



**Fig. 1**

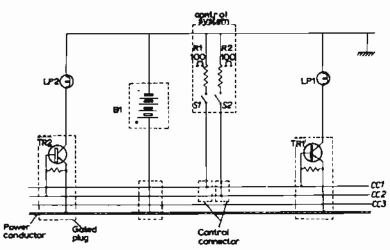



**Fig. 2**

## BIO-NOTES

Readers of Gerry Brown's fascinating column will have noticed his comments in the January 1973 issue concerning "Electrophonic Hearing" and his suggestion that the effect of feeding electric currents direct to the brain should be re-examined as a possible aid to the deaf.

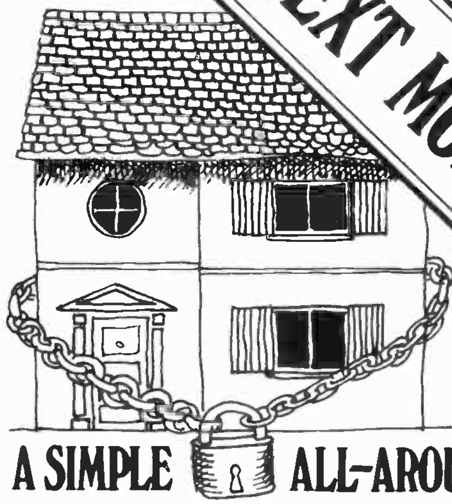
Anyone wishing to follow this line of research will be interested by the content of two British patents Nos. 1 284 158 and 1 286 316 respectively from the ZCM Corporation of USA and Hermann Mengeler of Germany. Both patents were published some while ago but each contains useful technical information on the subject.

The ZCM patent details a method of using an audio signal to pulse a microwave radio signal, the resultant pulses being then fed to electrodes which are capacitively coupled to the subject's skin. This is claimed to produce a brain sensation in some respects equivalent to hearing.

The Mengeler patent claims a comparable system for introducing video information to the brain. In brief, a miniature TV camera produces a scanning voltage which is capacitively coupled to the subject's temples. This supposedly stimulates the optic nerve and produces sensations which the subject may train himself to equate with sight sensations.

Reference to these two patents before experimentation could well save readers wasted time and work—it could also save their subjects unnecessary electric shocks.

# NEXT MONTH



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# MARKET PLACE

**Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned.**

## LOW COST DIGITAL MULTIMETER

A new £49 digital multimeter from **Sinclair Radionics** promises to be a strong contender in the professional quality meter market having as it does a claimed high accuracy, high input impedance, portability, and relative low cost. It is aimed at the replacement market as an economical substitute for analogue multimeters.

Measuring 190 × 130 × 58mm and weighing 1¼lb (0·6kg), the multimeter can easily be held in the hand when making measurements. The leads are fixed to the instrument and wrap around a recess in the lightweight polypropylene case. Simple yet effective finger plate selector switches form an integral part of the case.

The instrument has ranges extending from 1μA up to 1A d.c., 1mV to 1,000V d.c. and a.c., and resistance ranges from 1,000 ohms to 1MΩ full scale. Display is by three Nixies with a carry of one in a single neon. This gives an effective 3½ digits without using a fourth tube.

The measuring technique is such as to reduce current consumption to a minimum, in fact, the manufacturer's specification promises 80 hours of switched-on operation with a current drain of 12mA.

Input impedance is very high at 1,000MΩ compared to analogue meters, as are the accuracy parameters of 0·4 per cent on volts d.c., and 1 per cent on a.c. with an f.s.d. error of ± 2 digits.

An interesting aspect of the circuit is that it is all discrete, with a component count of around 300 (including 100 transistors) all mounted on three p.c.b.s.

In operation all inputs are brought within a 1V range and the incoming signals are analogue-to-digital converted to produce a pulse train the length of which is proportional to the input level. The pulse train is passed to a chain of three cascaded pump circuits. Component values have been so chosen that the incoming pulse is summed in units, tens, and hundreds.

A "ring-of-ten" counter strobes each Nixie numeral terminal in sequence and for each strobe "tops up" the pump circuits. This action is used to time the point in the strobe sequence when the supply is switched onto the relevant Nixie to illuminate the correct numeral.

This instrument is available, by mail order, direct from the makers, Sinclair Radionics Ltd., London Road, St. Ives, Huntingdonshire.

## CASES

Encouraged by the success of their Contil Mod-2 range of instrument cases, **West Hyde Developments** recently launched a new complementary range of cases designated Mod-3 types.

The Mod-3 cases have fixed sides, in scuff resistant p.v.c. coated steel, made of two parts rigidly locked together. A chassis is supplied with the case, this and the panels being made up first and then assembled afterwards in the case.

Interior drilled side flanges allow the chassis plate to be positioned in any convenient position. The side flanges also take the rear and front panel fixing screws.

Case dimensions vary from 3in × 7in to 6in × 11in and further details and price list can be obtained from West Hyde Developments Ltd., Ryefield Crescent, Northwood Hills, Northwood, Middlesex.

## WAFER SWITCHES

The wafer switch is still one of the widest used components in electronics, and **Ultra Electronics (Components) Ltd** are now marketing a range of wafer switch kits.

One of the advantages of the switch kit is its versatility and ease with which the designer can make up prototype switching assemblies and change them on the spot.

The Centralab Switchkits are packaged as separate components; the Series PA 1000 and PA 2000 kit contains, for example, 1,000 clips, 800 eyelets, 925 contacts, stators, rotors, nuts and packing washers, plus 25 index assemblies, 25 adjustable stops, eyeletting pliers and assembly tools and instructions.

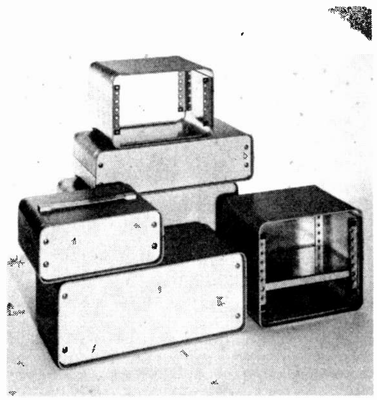
Further information and details of the switch kits can be obtained from Ultra Electronics (Components) Ltd., Fassetts Road, Loudwater, Bucks.

Also available from Ultra Electronics is a free switch wallchart giving typical ratings and configurations.

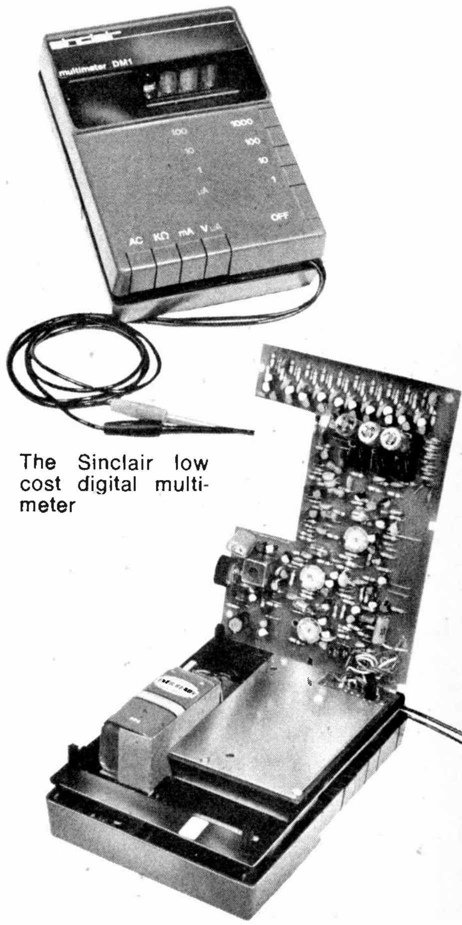
## SPECIAL OFFERS

Here is a chance to stock up with solid state devices at bargain prices. We have been advised by **A. Marshall & Son Ltd.**, that their advertisement next month will list a series of special offers, *available only to readers of this magazine.*

This well-known component supplier will be disposing of a large amount of stock at reduced prices, prior to moving into new premises.



Contil Mod-3 cases from West Hyde Developments

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| Standard Jack Plug | **10p** ,, |
| Screened Standard Jack Plugs | **15p** ,, |
| Stereo Jack Plug | **18p** ,, |
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Solve your communication problems with this **4-Station Transistor Intercom** system (**1 master and 3 Subs**), in de-luxe plastic cabinets for desk or wall mounting. Call/talk/listen from **Master** to **Subs** and **Subs** to **Master.** Ideally suitable for Business, Surgery, Schools, Hospital, Office and Home. Operates on one 9V battery. On/off switch. Volume control. Complete with 3 connecting wires each 66ft. and other accessories. P. & P. 40p.

**MAINS INTERCOM (new model)**

**No batteries—no wires.** Just plug in the mains for instant two-way, loud and clear communication. On/off switch and volume control with lock system. Price **£14·40.** P. & P. 55p extra.

# INTERCOM/BABY ALARM

**£3·35**

Same as 4-Station Intercom for two-way instant communication. Ideal as Baby Alarm and Door Phone. Complete with 66ft. connecting wire. Battery **14p.** P. & P. 25p.

*Transistor* **TELEPHONE AMPLIFIER**

**£2·99**

Why not boost business efficiency with this incredible De-Luxe **Telephone Amplifier.** Take down long telephone messages or converse without holding the handset. A useful office aid. On/off switch. Volume control. Battery **14p** extra. P. & P. 22p. Full price refunded if not satisfied in 7 days.

**WEST LONDON DIRECT SUPPLIES (PE/3)**
**169 KENSINGTON HIGH STREET, LONDON, W.8**

# Would you spend an hour a day to earn more money in Electronics-Television-Radio?

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- ☐ C & G Electrical Installation Work
- ☐ C & G Certificate in Technical Communication Techniques
- ☐ MPT General Certificate in Radio Telegraphy
- ☐ Audio, Radio & TV Engineering & Servicing
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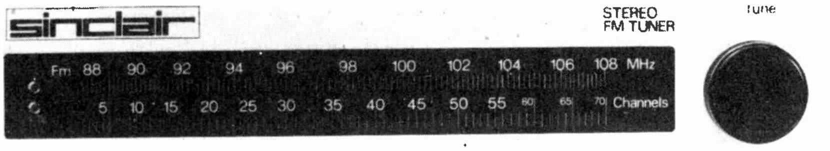
# Sinclair Project 60

## Project 60 Stereo FM Tuner




Built and tested.
Post free.
**£25**

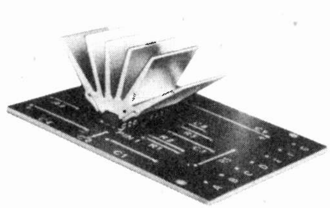
## with phase lock-loop principle

Amongst the many advanced electronic features to be found in this remarkable stereo tuner, use of the phase lock loop principle ensures standards of audio quality better than from any other method of detection yet used. Varicap diode tuning, accurately formed printed circuit coils, an I.C. in the special stereo decoder section and switchable squelch circuit for silent tuning between stations contribute to the unsurpassed performance of this tuner, irrespective of price consideration. But the Project 60 FM Stereo Tuner is far from expensive – indeed, it offers fantastic value for money and will bring the thrill of stereo radio to many who previously may not have been able to afford it. The tuner may be used with any good system as well as Project 60, but if you use it with other Project 60 modules, you will find the matching front panels particularly impressive in appearance as well as function.

**SPECIFICIATIONS**

**Number of transistors:** 16 plus 20 in I.C.
**Tuning range:** 87·5 to 108MHz.
**Sensitivity:** 7μV for lock-in over full deviation.
**Squelch level:** typically 20μV.
**Signal to noise ratio:** ±65dB.
**Audio frequency response:** 10Hz–15Khz (±1dB).
**Total harmonic distortion:** 0·15% for 30% modulation.
**Stereo decoder operating level:** 2μV.
**Cross talk:** 40dB.
**Output voltage:** 2×150mV R.M.S. max. (typically 2×50mV. stereo)
**Operating voltage:** 25–30V DC at 100mA.
**Indicators:** Stereo on · tuning.
**Size:** 93×40×207mm.

## Super IC.12 Integrated circuit high fidelity amplifier



Having introduced Integrated Circuits to hi-fi constructors with the IC.10, the first time an IC had ever been made available for such purposes, we have followed it with an even more efficient version, the Super IC.12, a most exciting advance over our original unit. This needs very few external resistors and capacitors to make an astonishingly good high fidelity amplifier for use with pick-up, F.M. radio or small P.A. set up, etc. The free 40 page manual supplied, details many other applications which this remarkable IC. make possible. It is the equivalent of a 22 transistor circuit contained within a 16 lead DIL package, and the finned heat sink is sufficient for all requirements. The Super IC.12 is compatible with Project 60 modules which would be used with the Z.50 and Z.30 amplifiers. Complete with free manual and printed circuit board.

**SPECIFICATIONS**

**Output power:** 6 watts RMS continuous (12 watts peak). 6–8Ω. **Frequency Response:** 5Hz to 100KHz ± 1dB. **Total Harmonic Distortion:** Less than 1%. (Typical 0·1%) at all output powers and frequencies in the audio band (28V). **Load Impedance:** 3 to 15 ohms. **Input Impedance:** 250 Kohms nominal. **Power Gain:** 90dB (1,000,000,000 times) after feedback. **Supply Voltage:** 6 to 28V. **Quiescent current:** 8mA at 28V. **Size:** 22×45×28mm including pins and heat sink.

*Manual available separately 15p post free.*

With FREE printed circuit board and 40 page manual.
**£2.98** Post free

## Project 605


The easy way to buy and build Project 60

Project 605 is one pack containing: one PZ5, two Z30's, one Stereo 60 and one Masterlink. This new module contains all the input sockets and output components needed together with all necessary leads cut to length and fitted with neat little clips to plug straight on to the modules. Thus all soldering and hunting for the odd part is eliminated. You will be able to add further Project 60 modules as they become available adapted to the Project 605 method of connecting.

Complete Project 605 pack with comprehensive manual, post free **£29.95**

**Everything you need to assemble a superb 30 watt high fidelity stereo amplifier without having to solder.**

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Sinclair Radionics Ltd, London Road, St. Ives, Huntingdonshire PE17 4HJ. Tel: St. Ives 64311

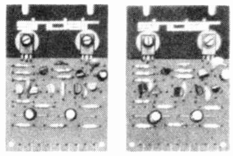
# the world's most advanced high fidelity modules

## Z.30 & Z.50 power amplifiers

*Built, tested and guaranteed with circuits and instructions manual.* **Z.30 £4.48** **Z.50 £5.48**

The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to provide unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at 15w (8Ω) and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and are intended for use principally with other units in the Project 60 range. Their performance and design are such, however, that Z.50s and Z.30 may be used in a far wider range of applications.

**SPECIFICATIONS** ***(Z.50 units are interchangeable with Z.30s in all applications).*** **— Power Outputs:**
**Z.30** 15 watts R.M.S. into 8 ohms using 35 volts : 20 watts R.M.S. into 3 ohms using 30 volts.
**Z.50** 40 watts R.M.S. into 3 ohms using 40 volts 30 watts R.M.S. into 8 ohms using 50 volts.
**Frequency response:** 30 to 300,000Hz ± 1dB. **Distortion:** 0.02% into 8 ohms. **Signal to noise ratio:** better than 70dB unweighted. **Input sensitivity:** 250mV into 100 Kohms (for 15w into 8Ω). For speakers from 3 to 15 ohms impedance. **Size:** 14 x 80 x 57mm.

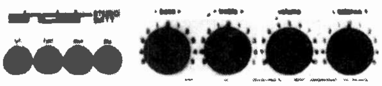


## Stereo 60 Pre-amp/control unit

*Built, tested and guaranteed.* **£9.98**

Designed specifically for use on Project 60 systems, the Stereo 60 is equally suitable for use with any high quality power amplifier. Since silicon epitaxial planar transistors are used throughout, a really high signal-to-noise ratio and excellent tracking between channels is achieved. Input selection is by means of press buttons, with accurate equalisation on all input channels. The Stereo 60 is particularly easy to mount.

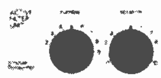
**SPECIFICATIONS—Input sensitivities:** Radio – up to 3mV. Mag. p.u. 3mV: correct to R.I.A.A. curve ±1dB 20 to 25,000 Hz. Ceramic p.u. – up to 3mV Aux – up to 3mV. **Output:** 250mV. **Signal to noise ratio:** better than 70dB. **Channel matching:** within 1dB. **Tone controls:** TREBLE +12 to —12dB at 10KHz: BASS +12 to —12dB at 100Hz **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.



## A.F.U. High & Low Pass Filter Unit

*Built, tested and guaranteed.* **£5.98**

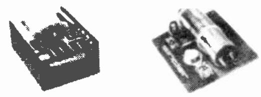
For use between Stereo 60 unit and two Z.30s or Z.50s. The unit is very easily mounted and is unique in that the cut-off frequencies are continuously variable. As attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. There are two filter sections – rumble (high pass) and scratch (low pass). H.F. cut-off (—3dB) variable from 28KHz to 5KHz. L.F. cut-off (—3dB) variable from 25Hz to 100Hz. Distortion at 1KHz (35V. supply) 0.02% at rated output. Operating voltage from 15 to 35V. Current 3mA. **Size:** 66 x 40 x 90mm.



## Power Supply Units

Designed specifically for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ.6 or PZ.8 where a stabilised supply is essential.

**PZ.5** *30 volts unstabilised* **£4.98**
**PZ.6** *35 volts stabilised* **£7.98**
**PZ.8** *45 volts stabilised*
*(less mains transformer)* **£7.98**
**PZ.8** *mains transformer* **£5.98**



**Typical Project 60 applications**

| System | The Units to use | together with | Units cost |
|---|---|---|---|
| Simple battery record player | **Z.30** | Crystal P.U., 12V battery volume control, etc. | **£4.48** |
| Mains powered record player | **Z.30, PZ.5** | Crystal or ceramic P.U. volume control, etc. | **£9.45** |
| 12W. RMS continuous sine wave stereo amp. for average needs | **2 x Z.30s, Stereo 60; PZ.5** | Crystal, ceramic or mag. P.U., F.M. Tuner, etc. | **£23.90** |
| 25W. RMS continuous sine wave stereo amp. using low efficiency (high performance) speakers | **2 x Z.30s, Stereo 60; PZ.6** | High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc. | **£26.90** |
| 80W. (3 ohms) RMS continuous sine wave de luxe stereo amplifier. (60W. RMS into 8 ohms) | **2 x Z.50s, Stereo 60; PZ.8, mains transformer** | As above | **£34.88** |
| Indoor P.A. | **Z.50, PZ.8, mains transformer** | Mic., guitar, speakers, etc., controls | **£19.43** |

F.M. Stereo Tuner **(£25)** & A.F.U. **(£5.98)** may be added as required.

## Guarantee

**If, within 3 months of purchasing any product direct from Sinclair Radionics Ltd., you are dissatisfied with it, your money will be refunded at once. Many Sinclair appointed Stockists also offer this same guarantee in co-operation with Sinclair Radionics Ltd.**

**Each Project 60 module is tested before leaving our factory and is guaranteed to work perfectly. Should any defect arise in normal use, we will service it at once and without any charge to you, if it is returned within two years from the date of purchase. Outside this period of guarantee a small charge (typically £1.00) will be made. No charge is made for postage by surface mail. Air Mail is charged at cost.**

sinclair

**SINCLAIR RADIONICS, ST IVES, HUNTINGDONSHIRE PE17 4HJ**

Please send ____________________
I enclose cash/cheque/money order.

Name ____________________

Address ____________________ PE3/73

## VARIABLE VOLTAGE TRANSFORMERS

**INPUT 230/240V a.c. 50/60 OUTPUT VARIABLE 0–260V**
**All Types from ½ to 50 amp from stock.**

**SHROUDED TYPE**

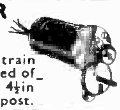
| | |
|---|---|
| 1 amp, £7·00 | 20 amp, £49·00 |
| 2·5 amp, £8·05 | 25 amp, £58·00 |
| 5 amp, £11·75 | 37·5 amp, £82·00 |
| 10 amp, £22·50 | 50 amp, £98·00 |
| 15 amp, £25·00 | |

(Panel Mounting) ½ amp, £4·75. 2·5 amp **OPEN TYPE** 1 amp, £7·00. 2½ amp, £8·05. All carriage paid.

### DOUBLE ENDED MOTOR UNIT

Powerful, continuously rated, 2-speed. Either **6 or 12 volt D.C. operation.** PRICE £2 incl. P. & P.

### 12 VOLT D.C. MOTOR

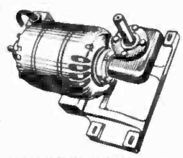


Powerful 1 amp. REVERSIBLE motor. Speed 3,750 r.p.m. complete with external gear train (removable) giving approx. final speed of either 125 r.p.m. or 240 r.p.m. Size: 4½in × 2½in dia. Either type price 95p inc. post.

### REVERSIBLE SPLIT PHASE MOTOR

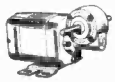
250 r.p.m., 100-115/210-240V A.C., 2in. × 1in. Ideal for rim-drive models, display, etc. Extremely powerful for size, including small capacitor. **75p** post paid.

### PARVALUX TYPE SD19 230/250 VOLT A.C. REVERSIBLE GEARED MOTORS



**30 r.p.m. 40 lb. ins.** Position of drive spindle adjustable to 3 different angles. **Mounted on substantial cast aluminium base.** Ex-equipment. Tested and in first-class running order. A really powerful motor offered at a fraction of maker's price. **£6·80.** Post Paid.

**PARVALUX Type: SD1.S/86896/OJ**



230/250V A.C. 50 r.p.m. 7 lb/in. Continuously rated. Less base. **£6·30.** Post Paid.

**TYPE: SD1.S/89400/OM** 230/250V A.C. 50 r.p.m. 22 lb/in. Continuously rated. Incl. base. **£7·30.** Post Paid.

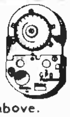
**The above motors are new and unused.**

### PARVALUX TYPE SD2. 200/250 VOLT A.C./D.C. HIGH SPEED MOTOR

Speed 9,000 r.p.m. approx. or 3,200 r.p.m. if used with built-in governor, or variable speed over a wide range if used in conjunction with our Dimmer Switch, illustrated below. PRICE **£2.** Post Paid.

**600 WATT DIMMER SWITCH.** Easily fitted. Fully guaranteed by makers. Will control up to 600W of all lights except fluorescent at mains voltage. Complete with simple instructions. **£3** incl. P. & P.

### VENNER ELECTRIC TIME SWITCH 200/250V Ex. GPO.

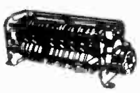


Tested. Manually set 2 on, 2 off every 24h. Override switch: 15A, **£3·45,** 20A, **£3·95.** Post Paid. Also available with solar dial ON dusk, OFF dawn. Price as above.

### 24-HOUR TIMER

Can be adjusted to give a switching delay of between ½ hr. to 24 hrs. Driven by 200/250V A.C. synchronous motor. 15 amp c/o contacts. Mfg. Crater Controls Ltd. Supplied with scale calibrated 0-10 (2 hrs, per division). Brand New. **£2.** Post Paid.

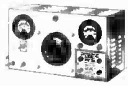
### HONEYWELL PROGRAMME TIMERS



240V. A.C. 5 r.p.m. motor. Each cam operating a c/o micro switch. Cams are individually variable, allowing inumerable combinations. Ideally suited for machinery control, automation, etc. Also in the field of entertainment, for chaser lights, animated displays, etc.
15 cam model **£6.** Post Paid.
10 cam model **£5.** Post Paid
2 cam model with 15 r.p.m. motor **£2.** Post Paid.

**SIMPLE 12 CAM PROGRAMMER** with 4 adjustable cams and 8 that may be profiled to individual requirements, available with 15 or 13 r.p.m. motor, **£3·75.** Post Paid.

### 36V 30 AMP. A.C. or D.C. VARIABLE L.T. SUPPLY UNIT



**INPUT** 220/240V a.c.
**OUTPUT** CONTINUOUSLY VARIABLE 0–36V
Fully isolated. Fitted in robust metal case with Voltmeter. Ammeter Panel Indicator and handles. Input and output fully fused. Ideally suited for Lab. or Industrial use. **£70.** Post Paid.

### MOTOROLA MAC 11/6 PLASTIC TRIAC 400 PIV. 10 AMP

Now available **EX STOCK.** Supplied with full data and applications sheet. Price **£1·12.** Post Paid. Suitable DIAC (RCA 40583) **30p** each.

## STROBE! STROBE! STROBE!

Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250V a.c. operation.

**EXPERIMENTERS' ECONOMY KIT** Speed adjustable 1 to 30 flash per sec. All electronic components including Veroboard S.C.R. Unijunction Xenon Tube and instructions **£6·55.** Post Paid

**NEW INDUSTRIAL KIT** Ideally suitable for schools, laboratories, etc. Roller tin printed circuit. New trigger coil, plastic thyristor. Speed adjustable 1-80 f.p.s. approx. ½ output of Hy-Lyght. Price **£11.** Post Paid.

**HY-LYGHT STROBE MK III** Designed and produced for use in large rooms, halls and the photographic field and utilises a silica tube, printed circuit, also a special trigger coil. Speed adjustable 0-20 f.p.s. Light output approx. greater than many (so called 4 Joule) strobes. **£12·50.** Post Paid.

### *THE 'SUPER' HY-LYGHT KIT*

Approx. four times the light output of our well proven Hy-Lyght strobe. Incorporating:

- Heavy duty power supply.
- Variable speed from 1-13 flash per sec.
- Reactor control circuit producing an intense white light.

Never before a Strobe Kit with so HIGH an output at so LOW a price. ONLY **£20·75.** Post Paid.

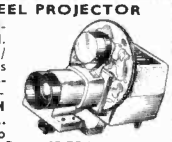
**ATTRACTIVE, ROBUST, FULLY VENTILATED METAL CASE.** Super Hy-Lyght Kit including reflector. **£7·45.** Post Paid.
For Hy-Lyght Kit including reflector. **£4·45.**

**7-inch POLISHED REFLECTOR** Ideally suited for above Strobe kits. Price **66p.** Post Paid.

### RAINBOW STROBE FOUR LIGHT CONTROL MODULE

Will operate four of our Hy-Lyght or Super Hy-Lyght Strobes in either 1, 2, 3, 4 sequence; 2 + 2; or all together. Thoroughly tested and reliable. Complete with full connection instructions. Price: **£18·75.** Post Paid. Send S.A.E. for details.

### COLOUR WHEEL PROJECTOR



Complete with oil-filled colour wheel. 100 watt lamp. 200/240V AC. Features extremely efficient optical system. **£18·50** + 35p. P. & P. **6 INCH COLOUR WHEEL.** As used for Disco lighting effects, etc. Price **£5·75** inc. p. & p.

### BIG BLACK LIGHT

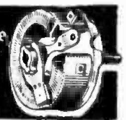
400Watt. Mercury vapour ultra violet lamp. Outer bulb designed to absorb visible light and transmit u.v. rays. Extremely compact and powerful source of u.v. Innumerable industrial applications also ideal for stage, display, discos, etc. P.F. ballast is essential with these bulbs. Price of matched ballast and bulb **£16·50.** Post Paid. Spare bulb **£7·30.** Post Paid.

**BLACK LIGHT FLUORESCENT U.V. TUBES** 4ft. 40 watt. Price **£5·80** incl. P. & P. (For use in standard bi-pin fluorescent fittings). MINI 9 in. 6 watt black light U.V. tube. **£1·45.** Post Paid.

### 50 in 1 ELECTRONIC PROJECT KIT

50 easy to build Projects. No soldering, no special tools required. The kit includes Speaker, Meter, Relay, Transformer, plus a host of other components and a 56-page instruction leaflet. Some examples of the 50 possible Projects are: Sound Level Meter, 2 Transistor Radio, Amplifier, etc. Price **£8·05.** Post Paid.

## Superior Quality Precision Made NEW POWER RHEOSTATS



**100 WATT.** 1 ohm, 10A; 5 ohm, 4·7A; **10** ohm, 3A; **25** ohm, 2A; **50** ohm, 1·4A; **100** ohm, 1A; **250** ohm, 0·7A; **500** ohm, 0·45A; **1** kΩ, 280 mA; **1·5** kΩ, 230mA; **2·5** kΩ, 2A; **3·5**kΩ, **5** kΩ, 140mA. Diameter 3½in Shaft length ⅝in, dia. ¼in. All at **£1·73.** Post Paid.
**50 WATT.** 1/5/10/25/50/100/250/500/1/1·5/2·5/5kΩ. **All at £1·23.** Post Paid.
**25 WATT.** 10/25/50/100/250/300/500/1/1·5/2·5/3·5/5kΩ. **All at 98p.** Post Paid.
**Black Silver Skirted knob** calibrated in Nos. 1-9. 1½ in. dia brass bush. Ideal for above Rheostats, **18p** ea.

## RELAYS SIEMENS, PLESSEY, Etc.

**MINIATURE RELAYS**

Col.(1) Coil ohms; Col. (2) Working d.c. volts; Col. 3 Contracts; Col. (4) Price; HD = Heavy duty; *Incl. Base Post paid.

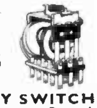
| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 52 | 3–6 | 2 c/o | 63p* |
| 410 | 10–18 | 4 c/o | 73p* |
| 600 | 12–24 | 4 c/o | 78p* |
| 700 | 16–24 | 4M 2B | 63p* |
| 700 | 16–24 | 4 c/o | 78p* |
| 700 | 15–35 | 2 c/o HD | 73p* |
| 700 | 16–24 | 6M | 65p* |
| 700 | 6–12 | 1 c/o HD | 50p* |
| 700 | 20–30 | 6 c/o | 75p |
| 1,250 | 24–36 | 4 c/o | 63p* |
| 2,500 | 36–45 | 6M | 63p* |
| 2,400 | 30–48 | 4 c/o | 50p* |
| 9,000 | 40–70 | 2 c/o | 50p* |
| 15k | 85–110 | 6M | 50p* |

### 12 VOLT D.C. RELAY 140 ohm coil

Type 1: Three sets c/o contacts rated at 5 amps. **78p** incl. P. & P. (Similar to illustration below.)
Type 2: One set of c/o contacts. **60p** incl. P. & P.
Type 3: 4-8 volt, 3 c/o HD, 67 ohm coil. **78p.**

**SPECIAL OFFER** 700 ohm 4 c/o. Ex. new equipment. **£50** per 100 incl. bases (minimum 100).

**'DIAMOND H' 230 VOLT A.C. RELAYS (Unused)**



Three sets c/o contacts rated at 5 amps. PRICE: **60p.** Post Paid. (100 lots **£40** including P. & P.)

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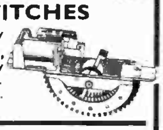
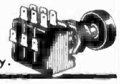


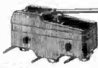
***NEW*** **4 Bank 25 Way** 24V d.c. operation. **£5·88,** P. & P. 25p. **6 Bank 25 Way** 24V d.c. **£6·75.** Post Paid. **8 Bank 25 Way,** 24V d.c. operation. **£7·88.** Post Paid.

### "HONEYWELL" PUSH BUTTON, PANEL MOUNTING MICRO SWITCH ASSEMBLY



Each bank comprises a c/o rated at 10 amps 240V. A.C. Black knob 1 in. Fixing hole ⅜ in. ONE bank **30p;** TWO bank **40p;** THREE bank **55p;** incl. P. & P. Quot. for quantity.

### 'HONEYWELL' LEVER OPERATED MICRO SWITCH



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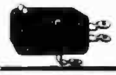

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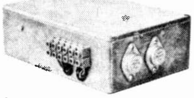

This Capacitor-Discharge Electronic Ignition system was described in the November and December issues of Practical Electronics. It is suitable for incorporating in any 12V ignition system in cars, boats, go-karts, etc., of either pos. or neg. earth and up to six cylinders. The original coil, plugs, points and contact-breaker capacitor fitted in the vehicle are used. No extra or special components are required.
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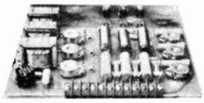
Complete assembly and wiring manual 25p, refundable on purchase of kit. Price: £10·50 plus 50p P. & P.

## PSYCHODELIC LIGHTING UNIT Mk. 3



This unit represents a natural progression from our phenomenally successful Mk. 1 and 2 Units. As before the drive voltage is derived directly from the amplifier output or across the speakers. The unit converts the audio frequency signals into a three-coloured light display; the colour depending on the frequency of the signal and the intensity on the loudness of the audio source.
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160V: 0·01μF, 0·015μF, 0·22μF, 0·033μF, 0·047μF, 0·068μF, **3p**. 0·1μF **3½p**. 0·15μF, **4½p**. 0·22μF, **5p**. 0·33μF, **6p**. 0·47μF, **7½p**. 0·68μF, **11p**. 1·0μF, **13p**.

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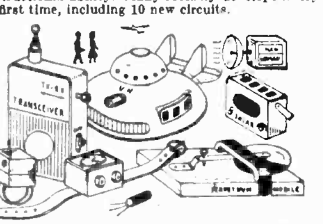

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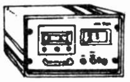

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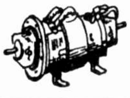

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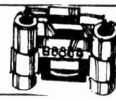

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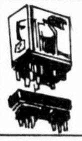
| NKT420 | £1 80 | NKT13429 | 27p | NKT73 | 22p | NKT223 | 25p |
| NKT450 | 30p | NKT16229 | 27p | NKT121 | 21p | NKT224 | 22p |
| NKT603 | 22p | NKT20329 | 29p | NKT124 | 28p | NKT227 | 25p |
| NKT613F | 28p | NKT80111 | 65p | NKT125 | 38p | NKT237 | 29p |
| NKT674 | 30p | NKT80113 | 98p | NKT126 | 35p | NKT238 | 16p |
| NKT677 | 18p | NKT80125 | 80p | NKT127 | 23p | NKT249 | 29p |
| NKT713 | 27p | BC107 | 8p | NKT128 | 18p | NKT261 | 19p |
| NKT734 | 24p | BC108 | 8p | NKT129 | 22p | NKT270 | 18p |
| NKT736 | 30p | BCY70 | 13p | NKT135 | 24p | NKT271 | 16p |
| NKT773 | 23p | BFY51 | 17p | NKT137 | 30p | NKT272 | 15p |
| NKT0216 | 20p | BSY95A | 10p | NKT142 | 48p | NKT273 | 18p |
| NKT3055 | 23p | 2N697 | 13p | NKT143 | 48p | NKT274 | 16p |
| NKT6917 | 27p | 2N706 | 8p | NKT212 | 23p | NKT275 | 21p |
| NKT10339 | 23p | 2N914 | 15p | NKT213 | 23p | NKT278 | 18p |
| NKT10419 | 17p | 2N918 | 28p | NKT214 | 21p | NKT301 | 70p |
| NKT10439 | 25p | 2N930 | 22p | NKT215 | 19p | NKT302 | 85p |
| NKT10519 | 20p | 2N1990 | 22p | NKT217 | 48p | NKT303 | 70p |
| | | | | | | NKT304 | 76p |

**S.T.C. RELAYS—BRAND NEW**

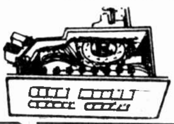


| TYPE | CONTACT FORM | NOMINAL COIL VOLTAGE | COIL RESISTANCE (OHMS) | PRICE EACH |
|---|---|---|---|---|
| 250 ARO | 4 CHANGEOVER | 6V d.c. | 52 | £0 68 |
| 250 ABO | 4 CHANGEOVER | 48V d.c. | 2,500 | £0 68 |

| TYPE | CONTACT FORM | COIL VOLTAGE | SWITCHING CURRENT | PRICE EACH |
|---|---|---|---|---|
| SL7222212 | 3 Pole on/off | 12V a.c. | 10A at 440V a.c. | £1 00 |
| SL7622715 | 2 Pole C/O | 220V a.c. | 10A at 440V a.c. | £0 87 |

| TYPE | CONTACT FORM | COIL VOLTAGE | COIL RESISTANCE | PRICE EACH |
|---|---|---|---|---|
| SP13372 | Single Pole C/O | 6V d.c. | 140 ohm | £0 40 |
| SP13366 | Single Pole C/O | 12V d.c. | 350 ohm | £0 40 |
| 11301D | Single Pole C/O | 18V d.c. | 875 ohm | £0 40 |

**UNISELECTOR SWITCHES**



6 bank 25 way 75 coil 50V d.c. operation. Mounted on Modular Type Chassis with front panel containing 20 illuminated Push Button Switches. Completely wired for operation.
Price £15
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**AUTOMATIC CYCLER UNIT**

This unit generates stepping pulses (50V d.c.) at intervals of 6 pulses per min. to 120 pulses per min.—continuously variable. Can be used for Automatic Stepping of one or more uniselector switches shown above. Price £12 50
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PC1 150mW Audio Amplifier Price £1 00 each P. & P. £0 10
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**POLYESTER CAPACITORS MULLARD C280 250V**
μF: 0·01, 0·015, 0·022, 0·033, 0·047, 3p each; 0·068, 0·1, 0·15, 4p each; 0·22, 5p; 0·33, 7p; 0·47, 8p; 0·68, 10p; 1·0, 13p; 1·5, 20p; 2·2, 23p.

**MULLARD POLYESTER CAPACITORS C296 SERIES**
160V: (μF) 0·01, 0·015, 0·022, 2p; 0·047, 0·068, 3p; 0·15, 0·22, 4p; 0·33, 5p; 0·47, 6p; 0·68, 1·0, 10p.
400V: (μF) 0·001, 0·0015, 0·0022, 0·0033, 0·01, 2p; 0·015, 0·033, 3p; 0·068, 4p.

**MINIATURE ELECTROLYTIC MULLARD C426 SERIES (5p each)**
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**ELECTROLYTIC CAPACITORS. Tubular and large can**
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**CARBON FILM RESISTORS** ¼W 5%, 10 ohms—2·2M, ½W 5%, 22 ohms—1M, 1p each or 100 for 55p; 1,000 for £4.
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| 2½ × 3¾in | 23p | 17p |
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| 3¾ × 3¾in | 25p | 25p |
| 2½ × 1in 2 for | 12p | 12p |
| 2½ × 5in (plain) | — | 12p |
| 2½ × 3¾in (plain) | — | 11p |
| 5 × 3¾in (plain) | — | 20p |
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| Track cutter | 40p | 40p |
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| | |
|---|---|
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| IN4002 | 7p |
| IN4003 | 8p |
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| IN914 | 6p |
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| OC75 | 15p |
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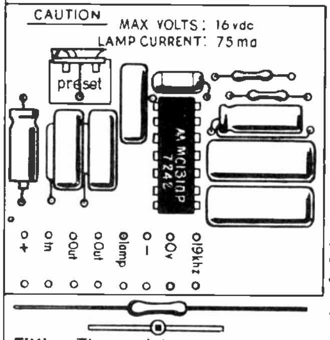
# Stereo radio from your existing tuner.




A complete set of parts from Jermyn to build a stereo decoder module that will convert your existing mono tuner for stereo reception whilst maintaining a high standard of reproduction.

The distortion is very low (typically 0.3% at 560 mV RMS composite input signal) with 40dB channel separation.

The stereo switching is automatic and there is a light emitting diode which acts as a stereo beacon.

The kit requires no coil and there are no alignment problems.

**Fitting.** The module requires a 10-16 volt power supply which can normally be tapped off the existing tuner. The signal input is taken off before the de-emphasis circuit which in practice means disconnecting one, or at the most, two capacitors. Any radio engineer will be able to spot these capacitors, but if you're really stuck send the circuit with a SAE to us and one of our engineers will indicate the output point. (This is the full extent of our involvement, no hardware please).

Of course, if you have a modern mono tuner with a multiplex output our module simply plugs in.

The outputs go via a screened twin cable to the tuner inputs of your stereo amplifier.

And the cost? £4.90 for the Kit with 100% tested integrated circuit. Also available assembled and aligned, checked and ready for use at £6.90 (includes 12 month guarantee). Beat that!

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Sevenoaks
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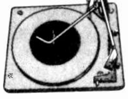
Please rush me ☐ Kit(s). ☐ made up Stereo decoders.
I enclose cheque/postal order for £
Name
Address

Block Capitals Please

# BSR LATEST SUPERSLIM STEREO & MONO



Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200/250V Size 13¾ × 11¼in. Above motor board 3⅛in. below motor board 2¼in. with STEREO and MONO XTAL **£8·75** Post 25p.

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Heavy duty 4-speed motor with separate pick-up arm fitted LP/78 turnover mono cartridge **£4·50** Post 25p

# E.M.I. WOOFER AND TWEETER KIT £5·75

Available separately Post 25p.
Woofer £4·25 Tweeter £1·90
Comprising a fine example of a Woofer 10¾ × 6¼in. with a massive Ceramic Magnet, 44oz. Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter 3¼in. square has a special lightweight paper cone and magnet flux 10,000 lines. Crossover condenser and full instructions supplied.

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| Impedance Standard | 8 ohms |
| Maximum Power | 12 watts |
| Useful Response | 35 to 18,000 c/s |
| Base Resonance | 45 c/s |

SUITABLE ENCLOSURE 20 x 13 x 9in. MODERN DESIGN. TEAK WOOD FINISH **£9** Post 25p

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Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 15p. D.P. 25p. STEREO L/S 55p. D.P. 75p. Edge 5K.S.P. Transistor 25p.

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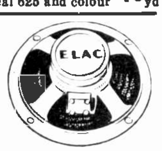
# 8in. or 10in. ELAC HI-FI SPEAKER



Dual cone plasticised roll surround. Large ceramic magnet. 50–60,000 c/s. Bass resonance 55 c/s 8 ohm impedance, 8in 10 watts, 10in 12 watts music power. **£3·75**

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With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45-60 c/s. Flux 10,000 gauss. State 3 or 8 or 15 ohm. **£2·25** Post 25p

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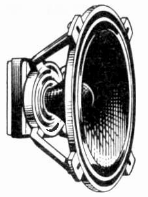
# WHARFEDALE SUPER 10" HI-FI SPEAKER



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OUR PRICE **£5·50**

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| 16/450V | 15p | 1000/50V | 47p | 32+32/450V | 33p |
| 32/450V | 20p | 8+8/450V | 18p | 350+50/325V | 50p |
| 25/25V | 10p | 8+16/450V | 20p | 32+32+32/350V | 43p |
| 50/50V | 10p | 16+16/450V | 25p | 32+32/350V | |
| 100/25V | 10p | 32+32/350V | 25p | 100+50+50/350V | 48p |

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ALL MODELS "BAKER SPEAKERS" IN STOCK
Hi Fi Enclosure Manual containing 20 plans, designs, crossover data and cubic tables. 42p Post Free

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Module kit, 30-17,000 c/s with tweeter, crossover, baffle and instructions. **£11·50**

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| 'Group 25' | 'Group 35' | 'Group 50' |
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| 12in. 25W **£8** | 12in. 35W **£9** | 15in. 50W **£20** |
| 3 or 8 or 15 ohm | 3 or 8 or 15 ohm | 8 or 15 ohm |

TEAK HI-FI SPEAKER CABINETS. For 12in or 10in dia. speaker 20 × 13 × 9in, £9. Post 25p. For 13 × 8in or 8in speaker 16 × 10 × 9in, £5. Post 25p. For 10 × 6in or 8in speaker 16 × 8 × 6in, £4. Post 25p.
LOUDSPEAKER CABINET WADDING 18in wide, 15p per ft.

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De Luxe Horn Tweeters 2-18kc/s, 15W, 15 ohm £3. TWO-WAY 3,000 c/s. CROSSOVERS 3 or 8 or 15 ohm 95p.
LOUDSPEAKERS P.M. 3 OHMS. 7x4in., £1·25; 6½in., £1·50; 8 × 5in, £1·60; 8 × 2½in, £1·50; 8in, £1·75; 10 × 6in, £1·00.
SPECIAL OFFER: 80 ohm, 2¼in, 2½in; 35 ohm, 2in, 3in, 25 ohm, 2½in dia., 3in dia., 6 × 4in.; 15 ohm, 3½in dia, 6 × 4in, 7 × 4in, 8 × 5in. **£1** EACH TYPE
3 ohm, 2½in, 2¼in, 3½in, 5in dia. 6 × 4in 8 ohms £1·50.
RICHARD ALLAN TWIN CONE LOUDSPEAKERS 8in. diameter 4W; 10in diameter 5W; 12in diameter, 6W; 3 or 8 or 15 ohm models, £2·20 each. Post 15p.
VALVE OUTPUT TRANS. 25p; MIKE TRANS. 50:1 25p.
5 WATT MULTI-RATIO, 3, 8 and 15 ohms 80p.

## MAJOR 100 WATT ALL PURPOSE TRANSISTOR AMPLIFIER


4 inputs speech and music, 4 way mixing. Response 10-30,000 c/s. Matches loudspeakers, 8/15 ohm. A.C. 200/250V. Separate Treble and Bass controls. Guaranteed. Details S.A.E. **£49** Post Free

BARGAIN AM TUNER. Medium Wave. Transistor Superhet, Ferrite aerial. 9 volt. **£4·95**

BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. Add musical highlights and sound effects to recordings.

Will mix Microphone, records, tape and tuner with separate controls into single output. 9V. **£3·95**
STEREO VERSION OF ABOVE £5·95.

BARGAIN FM TUNER 88-108 Mc/s Six Transistor. 9V.

Printed Circuit. Calibrated slide dial tuning. Walnut Cabinet. Size 7 × 5 × 4in. **£14·85**

BARGAIN FM TUNER as above less cabinet **£9·85**

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume control and on/off switch, 9 volt. **£4·50**

COAXIAL PLUG 6p. PANEL SOCKETS 6p. LINE 18p. OUTLET BOXES. SURFACE OR FLUSH 25p.
BALANCED TWIN RIBBON FEEDER 300 ohms. 5p yd.
JACK SOCKET Std. open-circuit 14p, closed circuit 23p; Chrome Lead-Socket 45p. Phono Plugs 5p. Phono Socket 5p.
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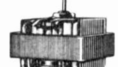
VALVE HOLDERS, 5p; CERAMICS 8p; CANS 5p.



E.M.I. TAPE MOTORS. 120V or 240V A.C. 1,200 r.p.m. 4 pole 135mA. Spindle 0·187x0·75in. Size 3½ × 2¼ × 2¼in (illustrated). Post 15p. **£1·25**
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**£1·29** plus 13p p. & p.

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**Charger**

CT/01 1A—**£1·05** plus 26p p. & p.
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Secondaries—0–5–11–17V.

**Speaker Matching** 3–8–16Ω
Example: 16Ω speaker to 8Ω amplifier. **90p** plus 20p p. & p.

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Zeners—400mW, **15p**; 1·5W, **22½p**
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IN4001—50 P.I.V., 1·0A, **6p**
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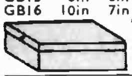
IN4003—200 P.I.V., 1·0A, **8p**
IN4004—400 P.I.V., 1·0A, **9p**
IN4005—600 P.I.V., 1·0A, **12p**

### ALUMINIUM BOXES

with lids and screws

| Type | L. | W. | D. | Price | p. & p. |
|---|---|---|---|---|---|
| GB7 * | 5¼in | 2¾in | 1½in | 38p | 15p |
| GB8 * | 4in | 4in | 1½in | 38p | 15p |
| GB9 * | 4in | 2¾in | 1½in | 38p | 13p |
| GB10* | 5¼in | 4in | 1½in | 44p | 18p |
| GB11 | 4in | 2½in | 2in | 38p | 13p |
| GB12 | 3in | 2in | 1in | 33p | 13p |
| GB13 | 6in | 4in | 2in | 52p | 18p |
| GB14 | 7in | 5in | 2½in | 63p | 19p |
| GB15 | 8in | 6in | 3in | 81p | 26p |
| GB16 | 10in | 7in | 3in | 92p | 26p |

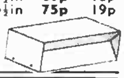


* These sizes fit standard veroboards

### EQUIPMENT CASES in plain aluminium with sloping front panel.

| Type | H. | W. | D. | Price | p. & p. |
|---|---|---|---|---|---|
| SF1 | 2in | 5¾in | 2½in | 45p | 12p |
| SF2 | 2in | 7¾in | 3½in | 60p | 16p |
| SF3 | 2in | 9¾in | 4½in | 75p | 19p |

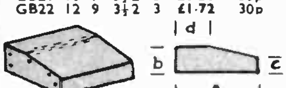
Stove - enamelled silver-grey hammer finished, **25p** extra.



### CONSOLE CASES

in plain aluminium, ideal for mixers, instruments, etc.

| Type | W. in | A in | B in | C in | D in | Price | p. & p. |
|---|---|---|---|---|---|---|---|
| GB20 | 8 | 9 | 3½ | 2 | 3 | £1·42 | 30p |
| GB21 | 10 | 9 | 3½ | 2 | 3 | £1·58 | 30p |
| GB22 | 12 | 9 | 3½ | 2 | 3 | £1·72 | 30p |




### VEROBOARD

| Size | 0·1 matrix | 0·15 matrix |
|---|---|---|
| 2½in × 3¾in | 22p | 16p |
| 2½in × 5in | 24p | 25p |
| 3¾in × 3¾in | 24p | 25p |
| 3¾in × 5in | 27p | 29p |
| 17in × 2½in | 75p | 57p |
| 17in × 3¾in | £1 | 75p |

Pins—either size, packet of 36, 18p

### ELECTROLYTICS

| | | | | | |
|---|---|---|---|---|---|
| 1μF | 450V | 19p | 1,000μF | 25V | 27p |
| 2μF | 450V | 20p | 1,000μF | 50V | 42p |
| 4μF | 350V | 14p | 2,000μF | 25V | 39p |
| 8μF | 450V | 17p | 2,000μF | 50V | 53p |
| 16μF | 450V | 18p | 2,500μF | 25V | 45p |
| 25μF | 25V | 7p | 2,500μF | 50V | 60p |
| 25μF | 50V | 10p | 3,000μF | 25V | 48p |
| 32μF | 450V | 27p | 5,000μF | 25V | 60p |
| 50μF | 50V | 10p | 5,000μF | 50V | £1·10 |
| 100μF | 25V | 10p | 8–8μF | 450V | 18p |
| 100μF | 50V | 11p | 8–16μF | 450V | 20p |
| 250μF | 25V | 14p | 16–16μF | 450V | 27p |
| 250μF | 50V | 17p | 16–32μF | 450V | 63p |
| 500μF | 25V | 18p | 32–32μF | 450V | 49p |
| 500μF | 50V | 25p | 50–50μF | 350V | 38p |

### MINIATURE ELECTROLYTICS

| | | | | | |
|---|---|---|---|---|---|
| 1μF | 63V | 6p | 47μF | 16V | 7p |
| 2·2μF | 63V | 6p | 47μF | 25V | 6p |
| 3·3μF | 63V | 6p | 68μF | 16V | 6p |
| 4·7μF | 63V | 6p | 100μF | 10V | 6p |
| 8μF | 40V | 7p | 220μF | 16V | 7p |
| 10μF | 25V | 6p | 330μF | 16V | 11p |
| 10μF | 64V | 7p | 470μF | 10V | 11p |
| 16μF | 40V | 7p | 1,000μF | 16V | 19p |
| 33μF | 16V | 6p | 1,500μF | 16V | 23p |

### CASSETTE OWNERS!

For Philips and similar cassette recorders.

PU12 Power unit for connection to 12V + or − E car electrical systems, giving 7½V, stabilised output. **£3·25**

PU14 As above but switched for 6V, 7½V or 9V output. **£5·10**

PP75 Mains power supply, output 7½V d.c. **£1·95**

All units are complete with cable and plug.

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Top quality British made, low noise, complete with transparent library cases—
C60—**40p**; C90—**55p**; C120—**70p**

### BATTERY ELIMINATORS

suitable for transistor radios and similar light current equipment
PP6 Input 240V a.c. Output 6V d.c.
PP9 Input 240V a.c. Output 9V d.c.
Price £1·50 plus 12p p. & p.

## ILLUSTRATED CATALOGUE

**Post Free 15p**

### CONTROLS, Log. or Lin.

Single, less switch, **15p**
Single, D.P. switch, **24p**
Tandem, less switch, **40p**
5kΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ

### RESISTORS

**Carbon**
All 5%, high-stability, E12 values. ¼W, **1p**; ½W, **1½p**; 1W, **4p**; 2W, **6p**
**Wire-wound**
5W, **10p**; 10W, **12p**

### SWITCHES

**Toggle switches**, standard size.
SW20—S.P.S.T. **18p**; SW21—D.P.D.T. **23p**.
**Push Button**, miniature, SW1—**13p**.
**Wafer switches** (rotary)—**24p** each.
SW4—1 pole, 12 way. SW5—2 pole, 6 way.
SW6—3 pole, 4 way. SW7—4 pole, 2 way.
SW8—4 pole, 3 way.

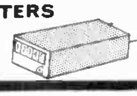
### BONDED ACRYLIC FIBRE

B.A.F. wadding, 18in wide, 1in thick. The ideal lining for speaker enclosures. **30p** per yard. p. & p. one yard 12p; each extra yard 4p.

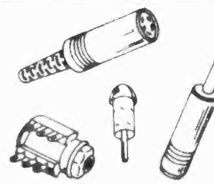
**TYGAN** top quality loudspeaker covering material. Please send 6p for samples, sizes and prices.

### MAGNETIC COUNTERS

Brand new, neat, 48 volt, 5 digit counters. **60p**



### PLUGS



| | |
|---|---|
| Car aerial | 14p |
| Co-axial | 9p |
| D.I.N. 2 pin (speaker) | 10p |
| D.I.N. 3 pin | 13p |
| D.I.N. 4 pin | 14p |
| D.I.N. 5 pin, 180° | 13p |
| D.I.N. 5 pin, 240° | 15p |
| D.I.N. 6 pin | 15p |
| Jack, 2½mm unscreened | 9p |
| Jack, 2½mm screened | 10p |
| Jack, 3½mm unscreened | 8p |
| Jack, 3½mm screened | 12p |
| Jack, ¼in unscreened | 12p |
| Jack, ¼in screened | 20p |
| Jack, stereo, unscreened | 20p |
| Jack, stereo, screened | 35p |
| Phono, plastic top | 5p |
| Phono, plated metal | 12p |
| Wander, red or black | 3p |
| Banana 4mm, red or black | 6p |

### LINE SOCKETS

| | |
|---|---|
| Car aerial | 14p |
| Co-axial | 17p |
| D.I.N. 2 pin (speaker) | 15p |
| D.I.N. 3 pin | 16p |
| D.I.N. 5 pin, 180° | 16p |
| D.I.N. 5 pin, 240° | 16p |
| Jack, 3½mm | 15p |
| Jack, ¼in screened | 49p |
| Jack, stereo, screened | 34p |
| Phono, plated meta' | 14p |

### SOCKETS

| | |
|---|---|
| Car aerial | 8p |
| Co-axial, surface | 8p |
| Co-axial, flush | 9p |
| D.I.N. 2 pin (speaker) | 10p |
| D.I.N. 3 pin | 9p |
| D.I.N. 5 pin, 180° | 9p |
| D.I.N. 5 pin, 240° | 9p |
| Jack, 2½mm | 10p |
| Jack, 3½mm | 10p |
| Jack, ¼in unswitched | 15p |
| Jack, ¼in switched | 17p |
| Jack, stereo, switched | 24p |
| Phono, single | 5p |
| Phono, 2 on a strip | 7p |
| Phono, 3 on a strip | 9p |
| Phono, 4 on a strip | 10p |
| Wander, single, red or black | 5p |
| Wander, twin strip | 7p |
| Banana 4mm red, or black | 6p |

### CAPACITORS

| | | | |
|---|---|---|---|
| 2·2pF | 500V | S/M | 7½p |
| 3·3pF | 500V | S/M | 7½p |
| 5pF | 500V | S/M | 7½p |
| 10pF | 125V | P.S. | 5p |
| 10pF | 500V | S/M | 7½p |
| 15pF | 125V | P.S. | 5p |
| 15pF | 500V | Cer. | 4p |
| 18pF | 500V | S/M | 7½p |
| 22pF | 125V | P.S. | 5p |
| 22pF | 500V | S/M | 7½p |
| 25pF | 500V | S/M | 7½p |
| 27pF | 500V | Cer. | 4p |
| 33pF | 125V | P.S. | 5p |
| 33pF | 500V | S/M | 7½p |
| 39pF | 500V | S/M | 7½p |
| 47pF | 125V | P.S. | 5p |
| 47pF | 500V | Cer. | 4p |
| 50pF | 500V | S/M | 7½p |
| 56pF | 500V | S/M | 7½p |
| 68pF | 125V | P.S. | 5p |
| 68pF | 500V | S/M | 7½p |
| 75pF | 500V | S/M | 7½p |
| 82pF | 500V | S/M | 7½p |
| 100pF | 125V | P.S. | 5p |
| 100pF | 500V | S/M | 7½p |
| 100pF | 500V | Cer. | 5p |
| 120pF | 500V | S/M | 7½p |
| 150pF | 125V | P.S. | 5p |
| 150pF | 500V | S/M | 7½p |
| 150pF | 500V | Cer. | 5p |
| 180pF | 500V | S/M | 7½p |
| 200pF | 500V | S/M | 7½p |
| 220pF | 125V | P.S. | 5p |
| 220pF | 500V | Cer. | 5p |
| 250pF | 500V | S/M | 8p |
| 270pF | 500V | Cer. | 5p |
| 300pF | 500V | S/M | 8p |
| 330pF | 125V | P.S. | 5p |
| 330pF | 500V | S/M | 8p |
| 390pF | 500V | S/M | 8p |
| 470pF | 125V | P.S. | 5p |
| 470pF | 750V | Disc | 5p |
| 500pF | 500V | S/M | 8p |
| 560pF | 500V | S/M | 8p |
| 680pF | 125V | P.S. | 6p |
| 680pF | 500V | S/M | 8p |
| 820pF | 500V | S/M | 8p |
| 0·001μF | 100V | Mylar | 3p |
| 0·001μF | 125V | P.S. | 6p |
| 0·001μF | 400V | Poly. | 3p |
| 0·001μF | 500V | S/M | 10p |
| 0·001μF | 500V | Cer. | 5p |
| 0·001μF | 1,000V | MDC | 6p |
| 0·0015μF | 400V | Poly. | 3p |
| 0·0015μF | 500V | S/M | 10p |
| 0·0015μF | 500V | Cer. | 5p |
| 0·0018μF | 500V | S/M | 10p |
| 0·002μF | 100V | Mylar | 3p |
| 0·002μF | 500V | Cer. | 5p |
| 0·0022μF | 125V | P.S. | 6p |
| 0·0022μF | 500V | S/M | 10p |
| 0·0022μF | 1,000V | MDC | 6p |
| 0·0027μF | 500V | S/M | 15p |
| 0·003μF | 500V | Cer. | 5p |
| 0·0033μF | 125V | P.S. | 6p |
| 0·0033μF | 500V | Poly. | 6p |
| 0·0033μF | 1,000V | MDC | 6p |
| 0·0036μF | 500V | S/M | 15p |
| 0·0047μF | 125V | P.S. | 9p |
| 0·0047μF | 500V | Poly. | 6p |
| 0·0047μF | 500V | S/M | 20p |
| 0·0047μF | 1,000V | MDC | 6p |
| 0·005μF | 100V | Mylar | 3p |
| 0·005μF | 500V | Cer. | 5p |
| 0·0068μF | 125V | P.S. | 10½p |
| 0·0068μF | 500V | S/M | 30p |
| 0·0068μF | 500V | Poly. | 6p |
| 0·0082μF | 125V | P.S. | 10½p |
| 0·0082μF | 500V | S/M | 30p |
| 0·01μF | 18V | Disc | 4p |
| 0·01μF | 125V | P.S. | 10½p |
| 0·01μF | 160V | Poly. | 4p |
| 0·01μF | 250V | M.F. | 3p |
| 0·01μF | 400V | Poly. | 3p |
| 0·01μF | 500V | Cer. | 5p |
| 0·01μF | 500V | S/M | 30p |
| 0·01μF | 600V | MDC | 7p |
| 0·01μF | 1,000V | MDC | 9p |
| 0·015μF | 160V | Poly. | 3p |
| 0·015μF | 400V | Poly. | 3p |
| 0·02μF | 100V | Mylar | 3p |
| 0·022μF | 18V | Disc | 5p |
| 0·022μF | 250V | M.F. | 3p |
| 0·022μF | 400V | Poly. | 3p |
| 0·022μF | 600V | MDC | 7½p |
| 0·022μF | 1,000V | MDC | 10p |
| 0·033μF | 250V | M.F. | 4p |
| 0·033μF | 400V | Poly. | 4p |
| 0·047μF | 12V | Disc | 6p |
| 0·047μF | 160V | Poly. | 3p |
| 0·047μF | 250V | M.F. | 3p |
| 0·047μF | 400V | Poly. | 4p |
| 0·047μF | 600V | MDC | 8p |
| 0·047μF | 1,000V | MDC | 10p |
| 0·1μF | 30V | Disc | 6p |
| 0·1μF | 250V | M.F. | 4p |
| 0·1μF | 400V | Poly. | 5p |
| 0·1μF | 600V | MDC | 10p |
| 0·1μF | 1,000V | MDC | 14p |
| 0·15μF | 250V | M.F. | 5p |
| 0·22μF | 160V | Poly. | 6p |
| 0·22μF | 250V | M.F. | 5p |
| 0·22μF | 400V | Foil | 10p |
| 0·22μF | 1,000V | MDC | 15p |
| 0·33μF | 250V | M.F. | 8p |
| 0·47μF | 250V | M.F. | 8p |
| 0·47μF | 400V | Foil | 15p |
| 0·47μF | 1,000V | MDC | 25p |
| 1·0μF | 250V | M.F. | 15p |

Note:
S/M = silver mica 1% tol.
P.S. = polystyrene 2½% tol.
MDC—a.c. rating = 300V.
M.F. = Mullard min. foil.
Cer. = ceramic.

**MAIL ORDERS:** Some items have a post and packing charge shown against them. Where p. & p. is not shown the charge is 12p for any selection. When both classes of goods are ordered the charge is 12p plus any p. & p. charges shown. (Overseas extra.) Telephone 01-692 4412

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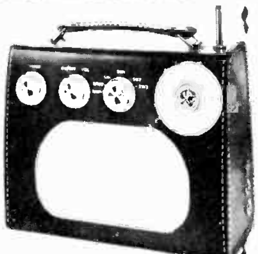
## ROAMER 10 WITH VHF INCLUDING AIRCRAFT

**10 TRANSISTORS. 9 TUNABLE WAVEBANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER BAND, VHF AND LOCAL STATIONS ALSO AIRCRAFT BAND.**

Built-in ferrite rod aerial for MW/LW. Retractable, chrome plated 7 section telescopic aerial, can be angled and rotated for peak short wave and VHF listening. Push-pull output using 600mW transistors. Car Aerial and tape record sockets. 10 transistors plus 3 diodes. Fine tone moving coil speaker. Ganged tuning condenser with VHF section. Separate coil for Aircraft Band. Volume/on/off, wave change and tone controls. Attractive case in black with silver blocking. Size 9in × 7in × 4in.

Easy to follow instructions and diagrams. Parts price list and easy build plans 30p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

TOTAL BUILDING COSTS **£8·50** P.P. & INS. 50p (OVERSEAS P. & P. £1)

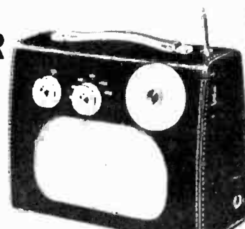


## ROAMER EIGHT Mk. I

*NOW WITH VARIABLE TONE CONTROL*

**7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND.** Built-in ferrite rod aerial for MW and LW. Retractable chrome plated telescopic aerial for short waves. Push-pull output using 600mW transistors. Car aerial and tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9in × 7in × 4in approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 25p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

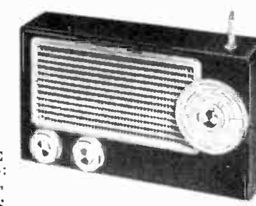
TOTAL BUILDING COSTS **£6·98** P. P. & INS. 45p (OVERSEAS P. & P. £1)



## ROAMER SEVEN Mk. IV

**7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND.** Extra medium waveband provides easier tuning of Radio Luxembourg, etc. Built-in ferrite rod aerial for MW and LW. Retractable 4 section 24in chrome plated telescopic aerial for SW. Socket for car aerial. Powerful push-pull output. 7 transistors and 2 diodes, including micro-alloy R.F. transistors. Fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning and wave change controls. Attractive case with carrying handle. Size 9in × 7in × 4in approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 25p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

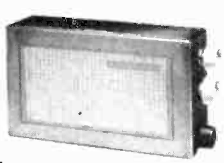
TOTAL BUILDING COSTS **£5·98** P. P. & INS. 45p (OVERSEAS P. & P. £1)



## ROAMER SIX

**6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, TRAWLER BAND PLUS AN EXTRA MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC.** Sensitive ferrite rod aerial and telescopic aerial for short waves. 3in speaker. 8 stages—6 transistors and 2 diodes including micro-alloy R.F. transistors, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9in × 5½in × 2½in approx. Easy build plans and parts price list 25p (FREE with parts).

TOTAL BUILDING COSTS **£3·98** P. P. & INS. 30p (OVERSEAS P. & P. £1)



## POCKET FIVE

**3 TUNABLE WAVEBANDS: MW, LW, TRAWLER BAND WITH EXTENDED MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC.** 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5½in × 1¼in × 3½in. Easy build plans and parts price list 10p (FREE with parts).

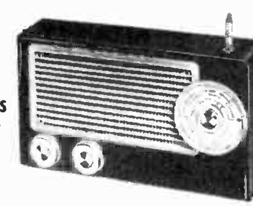
TOTAL BUILDING COSTS **£2·29** P. P. & INS. 23p (OVERSEAS P. & P. 63p)

## TRANSONA FIVE

**5 TRANSISTORS AND 2 DIODES**

**3 TUNABLE WAVE BANDS: MW, LW AND TRAWLER BAND.** 7 stage—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6¼in × 4½in × 1½in. Easy build plans and parts price list 10p (FREE with parts).

TOTAL BUILDING COSTS **£2·50** P. P. & INS. 24p (OVERSEAS P. & P. 63p)



## TRANS EIGHT

**8 TRANSISTORS AND 3 DIODES**

**6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, SW3 AND TRAWLER BAND.** Sensitive ferrite rod aerial for MW and LW. Telescopic aerial for short waves. 3in speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9in × 5½in × 2½in approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans 25p (FREE with parts).

TOTAL BUILDING COSTS **£4·48** P. P. & INS. 32p (OVERSEAS P. & P. £1)

## NEW! "EDU-KIT"

**BUILD RADIOS, AMPLIFIERS, ETC., FROM EASY STAGE DIAGRAMS. FIVE UNITS INCLUDING MASTER UNIT TO CONSTRUCT.** Components include: Tuning Condenser: 2 Volume Controls: 2 Slider Switches: Fine tone moving coil Speaker: Terminal Strip: Ferrite Rod Aerial: 3 Plugs and Sockets: Battery Clips: 4 Tag Boards Balanced Armature Unit: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three ¾in Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction. Parts price list and easy build plans 25p (FREE with parts).

ALL PARTS INCLUDING CASE AND PLANS **£5·50** P. P. & INS. 32p (OVERSEAS P. & P. £1)

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I enclose £ .......... please send items marked

| | | | |
|---|---|---|---|
| ROAMER TEN | ☐ | ROAMER SEVEN | ☐ |
| ROAMER EIGHT | ☐ | TRANS EIGHT | ☐ |
| TRANSONA FIVE | ☐ | ROAMER SIX | ☐ |
| POCKET FIVE | ☐ | EDU-KIT | ☐ |

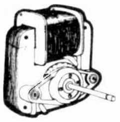
Parts price list and plans for ..........

Name ..........

Address ..........

.......... P.E. 51

## MAINS MOTOR

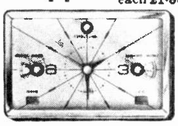


Precision made—as used in record decks and tape recorders—ideal also for extractor fan, blower, heaters, etc. New and perfect. Snip at **65p**. Postage 20p for first one then 10p for each one ordered.

## MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at **20p** each **£1·80** for ten, your assortment.

## 15A ELECTRICAL PROGRAMMER




Learn in your sleep: Have radio playing and kettle boiling as you awake—switch on lights to ward off intruders—have warm house to come home to. All these and many other things you can do if you invest in an electrical programmer Clock by famous maker with 15 amp. on/off switch. Switch on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price **£1·95** + 20p p & p or with glass front chrome bezel **75p** extra.

## RESETTABLE FUSE

How long does it take you to renew a fuse? Time yourself when next one blows. Then reckoning your time at £1 per hour see how quickly our resettable fuse (auto circuit breaker) will pay for itself. Price only **£1** each or **£11** per dozen, specify 5A, 10A or 15A—*simply fit in place of switch.*

## FLUORESCENT CONTROL KIT

Each kit comprises seven items—Choke, 2 tube ends, starter, holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15–20W, **£1**. Kit B—30–40W, **£1**. Kit C—80W, **£1·20**. Kit E—65W, **£1·20**. Kit F for 8ft 125W tube **£1·75**. Kit MF1 is for 6in, 9in and 12in miniature tubes, **£1**. Kit MF2 for 21in 13W miniature tube, **£1**. Postage on Kits A and B 23p for one or two kits then 23p for each two kits ordered. Kits C, D and E 23p on first kit then 18p for each kit ordered. Kit F 33p then 23p for each kit ordered. Kit MF1 18p on first kit then 15p on each two kits ordered.

## SOLDER GUN

A must for every busy man, gives almost instant heat also illuminated job. 100 watt **£2·25** plus post and ins. 20p. BIG JOB 250W model **£4·75** plus post and ins. 40p.

**WATERPROOF HEATING ELEMENT**

26 yards length 70W. Self-regulating temperature control. **50p** post free.

## MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6V, 9V, 12V for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only **£1·00**, plus 20p postage.

## THERMOSTATS

Type "A" 15A for controlling room heaters, greenhouses, airing cupboards. Has spindle for pointer knobs. Quickly adjustable from 30–38 deg. F. **48p**.
Type "B" 10A. This is a 17in long rod type made by the famous Sunvic Co. Spindle adjusts this from 50–550 deg. F. Internal screw alters the setting so this could be adjustable over 30 deg. to 1,000 deg. F. Suitable for controlling furnace, oven, kiln, immersion heater or to make flame-stat or fire alarm, **50p** plus 12½p post and insurance.
Type "C". Simply clamp to tank, pipe, heatsink, casing. Break temperature adjustable by calibrated knob **75p**.
Type "D". We call this the Ice-stat as it cuts in and out at around freezing point, 2/3A. Has many uses, one of which would be to keep the loft pipes from freezing, if a length of our blanket wire (16yd) **50p** is wound round the pipes. **26p**. P. & P. 5p.
Type "E". This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperature. **50p** plus 5p post.

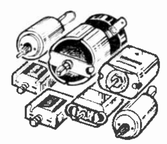
## SPARTAN Portable RADIO

Long and medium wave, 7 transistor, size 6in × 4in × 1½in with larger than usual speaker giving very good tone. Built-in ferrite aerial and telescopic aerial for distant stations. A real bargain complete with leather case, carrying sling, earplug and case **£3·75** plus 25p post and ins.

### THE REMITONE TRANSISTOR

Medium wave pocket loudspeaker radio. Loud and with good tone will make wonderful present. Buy while stocks last. Full money back guarantee. **£1·99** Only.

## BATTERY MOTORS



A bargain parcel of 7 motors for **£1**. Some not as large as a postage stamp and only ⅜in thick, largest is 1¼in × 1¼in dia. Some work off 1½V some as high as 18V. These motors are used in racing cars, power toys, etc. The largest is so powerful that it will drive a Mini drill, model lathe, or similar. This is a 4 pole motor, optimum working 16·5V but very powerful even as low as 4½V. Don't miss this wonderful snip.

## COMPUTER TAPE

2,400ft of the Best-Magnetic Tape money can buy—users claim good results with Video and sound. 1in wide **£1·00** plus 30p post and insurance, with cassette, ½in wide **£1·00** plus 30p post and insurance with cassette. ¼in wide **85p** plus 25p post and insurance with cassette. Spare spools and cassettes—1in **75p**, ½in **75p** each plus 20p post and insurance.

## TANGENTIAL HEATER UNITS

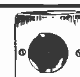
This heater unit is the very latest type, most efficient and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, 2kW element and 1kW element allowing switching 1 2 and 3kW and with thermal safety cut-out. Can be fitted into any metal lin, case or cabinet. Only need control switch, **£3·50**. 2kW. Model as above except 2 kilowatts **£2·50**. Don't miss this. Control Switch **35p**. P. & P. 40p.

## THIS MONTH'S SNIP

### 5 AMP VARIAC for £3

This heading is not quite accurate because it is not a variable transformer that we are offering but a solid state device which serves the same purpose in almost all applications and, of course, much smaller. Made by Ultra Electronics, can be fitted into ordinary switch box. Engrave a circle on the front plate, mark this off in divisions, fit a pointer knob, calibrate with your voltmeter (you will find the scale almost linear) you now have a power controller equal to a 5 amp variac costing £12 or more.

## THYRISTOR LIGHT DIMMER

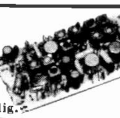


For any lamp up to 1kW. Mounted on switch plate to fit in place of standard switch. Virtually no radio interference. Price **£2·95**, plus 20p post and insurance.

## MULLARD UNILEX

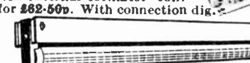
This D.I.Y. Stereo Amplifier is still available complete at **£7** for the four Mullard Modules, or Modules can be bought separately as follows:
4W amp module (2 required) Mullard Ref. No. E.P.9000—**£1·65 each.**
Pre-amp module Mullard Ref. No. E.P.9001—**£1·60 each.**
Power module—Mullard Ref. No. E.P.9002—**£2·10 each.**
In addition and made to Mullard Specification we offer:
Standard Control Unit with escutcheon—**£2·50**
Knobs—Set of 4—**50p.**

## MULLARD I.F. MODULE



This is a fully screened intermediate frequency module for amplification and detection of f.m. signals at 10·7MHz and a.m. signals at 470kHz. The first stage is used as an i.f. amplifier for f.m. and a self-oscillating mixer for a.m. operation, in conjunction with external oscillator coil. **85p** each. 10 for **£7·85**. 100 for **£62·50p**. With connection dig.

## ATLAS TWENTYLITE



Fluorescent lighting units with polyester choke and finished white enamel. 2ft model, ideal kitchen, bedroom, hallway, porch, loft, etc. With tube assembled ready to instal, **£1·99**, plus P. & P. 30p and insurance.

## STANDARD WAFER SWITCHES

Standard size 1½in wafer—silver-plated 5-amp contact. standard ¼in spindle 2in long—with locking washer and nut

| No. of Poles | 2 way | 3 way | 4 way | 5 way | 6 way | 8 way | 9 way | 10 way | 12 way |
|---|---|---|---|---|---|---|---|---|---|
| 1 pole | 40p | 40p | 40p | 40p | 40p | 40p | 40p | 40p | 40p |
| 2 poles | 40p | 40p | 40p | 40p | 40p | 40p | 40p | 70p | 70p |
| 3 poles | 40p | 40p | 40p | 40p | 70p | 70p | 70p | 95p | 95p |
| 4 poles | 40p | 40p | 40p | 70p | 70p | 70p | 70p | £1·20 | £1·20 |
| 5 poles | 40p | 40p | 70p | 70p | 95p | 95p | 95p | £1·45 | £1·45 |
| 6 poles | 40p | 70p | 70p | 70p | 95p | 95p | 95p | £1·70 | £1·70 |
| 7 poles | 70p | 70p | 70p | 95p | £1·20 | £1·20 | £1·20 | £1·95 | £1·95 |
| 8 poles | 70p | 70p | 70p | 95p | £1·20 | £1·20 | £1·20 | £2·20 | £2·20 |
| 9 poles | 70p | 70p | 95p | 95p | £1·45 | £1·45 | £1·45 | £2·45 | £2·45 |
| 10 poles | 70p | 70p | 95p | £1·20 | £1·45 | £1·45 | £1·45 | £2·70 | £2·70 |
| 11 poles | 70p | 95p | 95p | £1·20 | £1·70 | £1·70 | £1·70 | £2·95 | £2·95 |
| 12 poles | 70p | 95p | 95p | £1·20 | £1·70 | £1·70 | £1·70 | £3·20 | £3·20 |

## POCKET BLEEPERS

These work on quite a low frequency, are carried in the pocket, and are mainly used in large buildings or areas so that key personnel may be contacted quickly. These contain two encapsulated circuits to energise the relay and cause the bleep as well as rechargeable nickel cadmium cells. Quite costly things to buy. The ones we have are not new, but believed to be in good working order and sold on the understanding that if they are not, they will be replaced free. The size of the case, which is intended for carrying in top pocket, is approx. 4½in long, 2in wide and ⅝in thick. Limited quantity at **£2** each.

## 9 VOLT BATTERY ELIMINATOR

**£1·00**

## PRESSURE SWITCH

We recently received a delivery of a very fine pressure switch made by Bailey & Mackey. Their type no. 108R. This is an elaborate switch and is adjustable to 16 p.s.i. but is set at 8 p.s.i. It has a reset button and is of very superior construction with a heavy brass body. We understand that the regular price of this is £12 and we have limited stocks offered at **£4·50** each.

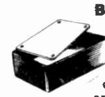
## POCKET CIRCUIT TESTER

Test continuity of any low resistance circuit, house wiring, car electrics. Tests polarity of diodes and rectifiers. Also ideal size for conversion to signal injector (circuit supplied). **30p** or 2 for **50p** post paid.

## AMPLIFIER IN CASE WITH SPEAKER

Marketed by British Relay under the name Luxistor. This is in a very neat looking cabinet and is ideal around the home or in the workshop for trouble shooting or for testing out a quick lash up. Size approx. 9½in × 6½in × 3½in deep. Input is via a matching transformer and volume control and amplifier may be powered by an internal 9V battery or an external 110V source. Speaker is an R-A elliptical 6in × 3½in 10,000 gauss. The amplifier proper is a Newmarket model ref. P.C.4. Price **£3·50** each, 10 for **£31·50.** Post and insurance 20p.

## BAKELITE INSTRUMENT CASE



Size approx. 6½in × 3½in × 2in deep with brass inserts in four corners. This is a very strong case suitable to house instruments and special rigs, etc. Price **45p** each, paxlid 10p extra.

## TELEPHONES

**Complete as illustrated.** Save your legs, time and temper, simply by putting in some telephones. Ex. G.P.O. not new—but guaranteed in good condition and serviceable. Supplied with diagram and instructions showing how to connect. Price **75p each** + 50p post or 2 for **£2** post paid. Also available separately, dials and handsets **50p each** + 20p post.

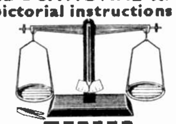
## ROCKER SWITCH

13A self-fixing into an oblong hole. size approximately 1in × ⅝in **6p** each. 10 for **72p.**

## SLIDE SWITCHES

**Slide Switch.** 2-pole changeover pane mounting by two 6B.A. screws. Size approx. 1in × ⅜in rated 250V lamp. **6p** each. 10 for **54p**, 100 for **£5·10**, 500 for **£24.** Ditto as above but for printed circuit **5p** each, 10 for **45p**, 100 for **£4·25.** **Sub Miniature Slide Switch.** DPDT 19mm (⅜in approx.) between fixing centres. **18p** each or 10 for **£1·08.** SP Change over spring return 250V 1A. **10p.**

## EDUCATIONAL KITS—all with pictorial instructions



THIS BALANCE KIT **FREE** Eagle educational kits. Japanese made these are excellent value for money. We do not expect to be able to repeat this offer once stocks are sold. Brief description of each kit is given below and with 3 kits or more we give FREE an accurate 11 piece balance kit. Price of kits **40p each** post paid. Special price for all 8 kits **£3** with free balance kit.

**KA2 Lens Kit.** Eleven parts, including candle, one concave lens, one convex lens, stage and slit frame, etc. Watch light rays bend as they pass through different lenses.

**KA3 Water Pump Kit.** Thirteen parts. Top of pump is transparent so that operating parts may be observed. Small parts are brightly coloured to be seen easily while working. Three types of pump may be made: Lift pump, Force Pump and Force Pump with reservoir and nozzle.

**KA4 Buzzer Kit.** Eleven parts. Transparent covers allow the operation of buzzer to be seen. Illustrates and teaches how electromagnetism with an automatic switch results in an operating buzzer.

**KA6—2-Pole Motor Kit.** Twenty-four parts including enamel wire, armature and pole piece, etc. Motor operates from 1½V battery. Illustrates and teaches how electro-magnetism operates a motor.

**KA7 Electro-Magnet Kit.** Fifteen parts, includes compass. Makes two electro-magnets, one with one layer of wire and one with several layers of wire. Picks up tacks, nails and any small parts showing how magnetism works.

**KA8 Current and Resistance Kit.** Twenty-nine parts, including bench and light bulb. Conduct interesting and educational projects to learn the application of "OHMS LAW" and see the difference in current and resistance with different types and lengths of wire.

**KA9 Bell Kit.** Eight parts, including bell and push button switch. Build a complete electric bell and see how the hammer is triggered to make the bell ring.

**KA10 Morse Key Buzzer and Bell Kit.** Twenty-five part kit, easy to construct, simple to operate.

Where postage is not stated then orders over £5 are post free. Below £5 add 20p. Semi-conductors add 5p post. Over £1 post free S.A.E. with enquiries please.

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Many others. Please send for lists. Post free unless indicated.
**KILRIMONT BOOKS** (D), **Kilrimont House, London Road, Braintree, Essex**

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**DIGITAL COMPUTER** Logic and Electronics. A four volume Self-instructional course, **£2·99** post free. Money back assurance. CAMBRIDGE LEARNING, 8a Rose Crescent, Cambridge.

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Popular T.V. and Radio types
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**SERVICE SHEETS** for Televisions, Radios, Transistors, Tape Recorders, Record Players, etc., from **5p** with free Fault-Finding Guide. S.A.E. orders/inquiries. Catalogue **15p.** HAMILTON RADIO, 47 Bohemia Road, St. Leonards, Sussex. Telephone Hastings 29066.

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## EDUCATIONAL

## RECEIVERS AND COMPONENTS

**DRY REED INSERTS**

Overall length 1.85" (Body length 1.1"), Diameter 0.14" to switch up to 500 mA at up to 250v D.C. Gold clad contacts. 62½p per doz.; £3·75 per 100; £27·50 per 1,000; £250 per 10,000. All carriage paid.
**G.W.M. RADIO, LTD.**
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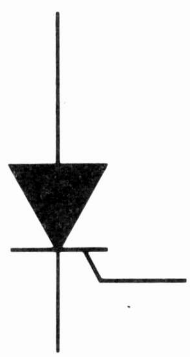

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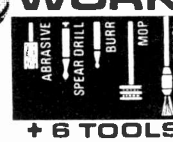


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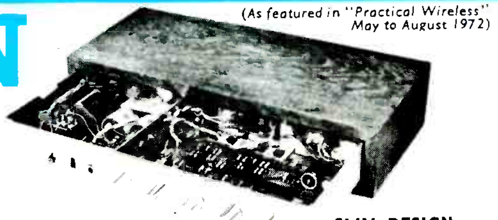

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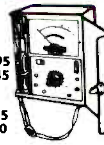

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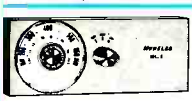

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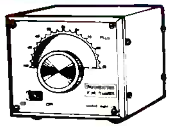

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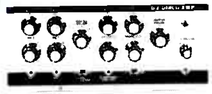

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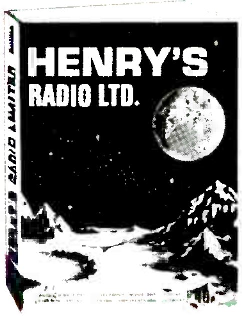


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