PRACTICAL

ELECTRONICS

MAY 1973

PUSHBUTTON VARICAP STEREO TUNER

FREE INSIDE... DISPLAY DEVICE IDENTICHART

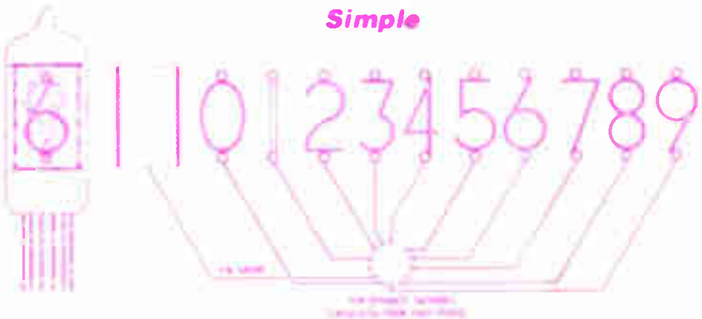
PE

DISPLAY DEVICE ID

PRESENTED FREE WITH PRACTICAL EL

FORMATS

Simple



This format consists of discrete display characters. The character set takes the form of shaped wire cathodes.

Seven Segment

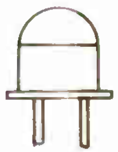
Simplest bar matrix display based on a stylised figure of eight made from seven individually illuminated bars.

Th for 4 × be a

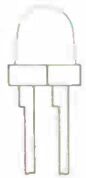
SINGLE LAMP

Neon

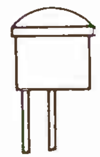
Manufacturer	Various
Voltage	>70V
Current	1mA
Brightness	Low
Colour	Orange



Manufacturer	Monsanto	
Type	MV1	MV2
Voltage	2V	4V
Current	50mA	50mA
Brightness	500ft-L	300ft-L
Colour	Amber	Green



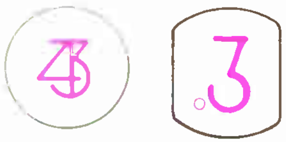
Manufacturer	Monsanto
Type	MV5080
Voltage	1·6V
Current	20mA
Brightness	300ft-L
Colour	Red



Manufacturer	Texas
Type	TIL 209
Voltage	1·6V
Current	20mA
Brightness	High
Colour	Red

Manufac
Type
Voltage
Current
Brightne
Colour

E DIGIT

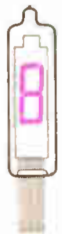


Neon

Filament Indicator

Type	Minitron 3015F
Voltage	10V (max), 5V (typ)

Luminescent Phosphor Indicator



Type	Ise Itron DG12H

Incandescent Digital Indicator

Type	Atron DA-133

Liquid C

Type

VICE IDENTICHART

ITH PRACTICAL ELECTRONICS MAY 1973

PE

ment

56789
JLPU

y based on a stylised
m seven individually

Hexadecimal

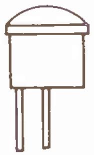
0123456 7
890

This represents the hexadecimal characters for the decimal numbers 0 through to 15 on a 4 × 7 dot matrix. This kind of format can also be achieved using a bar matrix.

Complete Alpha-numeric Matrixes

ABCDEFGHIJKL
MNOPQRSTUVWX
YZ1234567890

36 alpha-numeric characters available in the A.S.C.I.I. (American Standard Code for Information Interface) code are shown. The characters are made up from a 7 × 5 dot matrix.

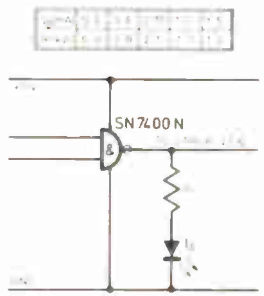


turer	Texas
	TIL 209
	1·6V
	20mA
ss	High
	Red

Manufacturer	Texas
Type	TIL 207
Voltage	1·65V
Current	20mA
Brightness	750ft-L
Colour	Red

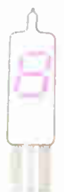
Manufacturer	Hewlett Packard
Type	5082-4480
Voltage	1·6V
Current	20mA
Brightness	High
Colour	Red

APPLICATIONS DATA



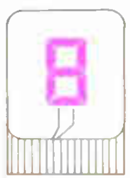
Using an L.E.D. to monitor the output of a TTL integrated circuit

escent Digital Indicator



Atron DA-133

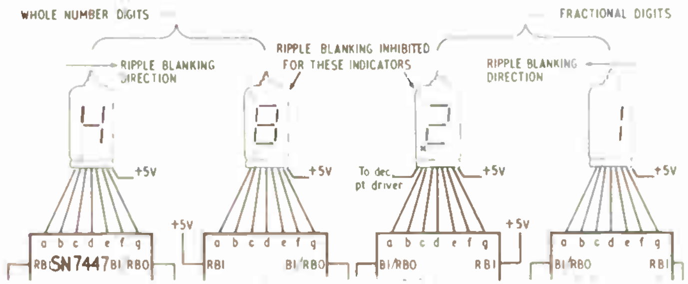
Liquid Crystal Digital Indicator



Type RCA TA8032

Incandescent Bulb Display

Type Spektra-Tek Series 2500



SINGLE DI[GIT]

Type	Mullard ZM1164. ZM1020
Voltage	170V
Current	2·5mA
Character height	15·5mm
Package	Tube
Format	Simple

Type	Minitron 3015F
Voltage	10V (max), 5V (typ)
Current	13mA/bar (max)
Character height	9mm
Brightness	200ft-L
Colour	Orange
Package	Suit 16 pin D.I.L. socket
Format	7-segment

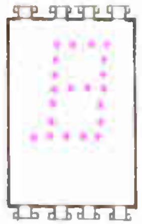
Type	Ise Itron DG12H
Voltage/segment	20V
Filament power	0·68W
Character height	12·2mm
Brightness	80ft-L
Colour	Green
Format	7-segment

Type	Atron DA-133
Voltage	3·5–5V
Power	0·1–0·12W/segment
Character height	12mm
Brightness	5000ft-L
Colour	Coloured filters available
Format	7-segment

Type	
Voltage	
Current	
Character	
Format	
Applicatio[n]	

SINGLE DIGIT L.E.D.s

L.E.D. Display

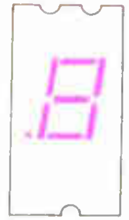


Type	Hewlett Packard 5082-7300
Voltage	5V
Current	94mA
Colour	Red
Character height	7·3mm
Format	4 × 7 dot matrix

Digital Display with logic

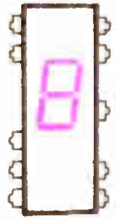
Type	Texas TIL 306
Voltage	5V
Current (total)	170mA
Colour	Red
Brightness	High
Character height	6·8mm
Format	7-segment
Package	16 pin D.I.L.

Alpha-Numeric Display



Type	Monsanto MAN 1
Voltage/segment	3·4V
Current/segment	20mA
Brightness	350ft-L
Character height	6·8mm
Format	7-segment

Alpha-Numeric L.E.D. Display



Type	Monsanto MAN 4
Voltage/segment	1·7V
Current/segment	10mA
Brightness	400ft-L
Character height	4·8mm
Format	7-segment
Colour	Red

Alpha Nu[meric]

Type	
Voltage/se[gment]	
Current/se[gment]	
Brightness	
Character	
Format	
Colour	

MULTI DIGIT

Horizontal L.E.D. Display

Type	Litronix DL34
Voltage	1·7V
Current/segment	5mA
Colour	Red
Brightness	200ft-L
Character height	3·17mm
Format	7-segment

Multidigit L.E.D. Display

Type	Texas TIL 360
Voltage segment	1·65V
Current	10mA
Colour	Red
Brightness	High
Character height	2·54mm
Format	7-segment

Horizontal Neon Display

Type	Sperry Rand SP-730
Current/segment	200μA
Voltage	200V
Colour	Orange
Brightness	225ft-L
Character height	8·4mm
Format	7-segment

Dot Matrix Tube Assembly

Type	Mullard ZM1250
Voltage	140V
Current/each cathode	0·3mA
Colour	Orange
Character height	9·8mm
Format	7 × 5 dot matrix

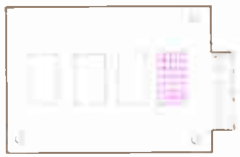
4 D[igit]

Type	
Voltage	
Current	
Character	
Format	

	Atron DA-133
ge	3·5–5V
r	0·1–0·12W/segment
acter height	12mm
tness	5000ft-L
ur	Coloured filters available
at	7-segment

a-Numeric L.E.D.
Display

	Monsanto MAN 4
ge/segment	1·7V
ent/segment	10mA
tness	400ft-L
acter height	4·8mm
at	7-segment
ur	Red



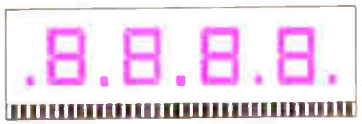
Dot Matrix Tube Assembly

	Mullard ZM1250
ge	140V
ent/each cathode	0·3mA
ur	Orange
acter height	9·8mm
at	7 x 5 dot matrix

Type	RCA TA8032
Voltage	12V pulsed
Current	35μA
Character height	19mm
Format	7-segment
Application	Transmissive type for back or edge lit readout

Alpha Numeric L.E.D.
Display

Type	Monsanto MAN 3
Voltage/segment	1·7V
Current/segment	10mA
Brightness	400ft-L
Character height	2·9mm
Format	7-segment
Colour	Red



4 Digit Liquid Crystal Cells

Type	R.C.A. TA8040
Voltage	8–50V
Current	100μA
Character height	15·2mm
Format	7-segment

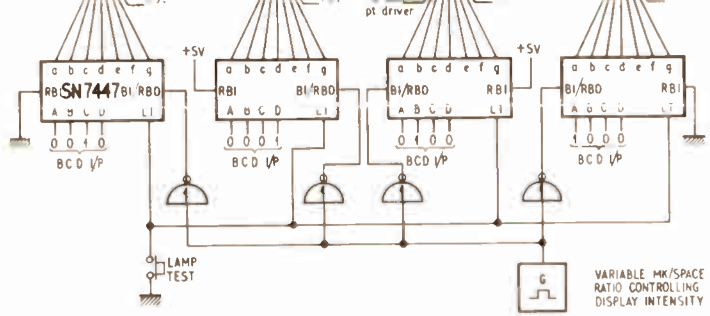
Type	Spektra-Tek Series 2500
Bulb voltage	12V
Bulb current	36mA
Character height	25mm
Brightness	Variable
Colour	Coloured filters available
Format	7-segment

Alpha-Numeric L.E.D.
Display

Type	Monsanto MAN 2
Voltage/diode	1·7V
Total current	400mA
Brightness	300ft-L
Character height	8·9mm
Format	5 x 7 dot matrix
Colour	Red

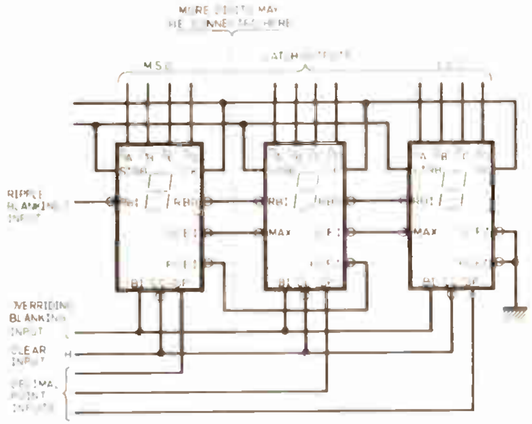
Pandicon 14 Digit Indicator Tube

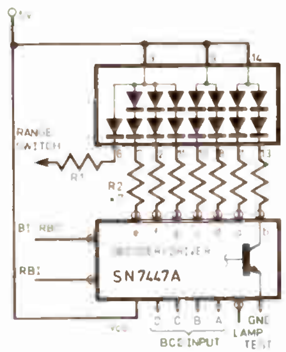
Type	Mullard ZM1200
Voltage	200V
Current	8mA
Colour	Orange
Character height	10mm
Format	Simple



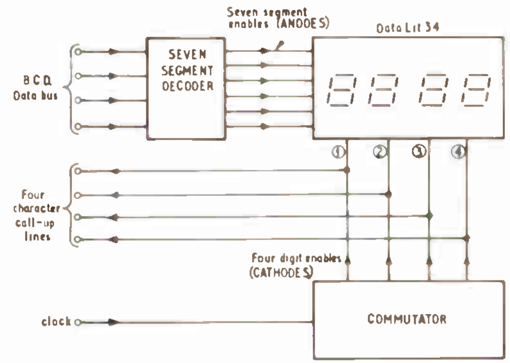
Using single digit filament indicators to give a decimal output

L.E.D. displays with integral logic greatly simplify digital circuits as shown in this circuit where three Texas devices are used to make a self-contained counter





Using single digit L.E.D. indicators to convert a binary coded decimal number into decimal

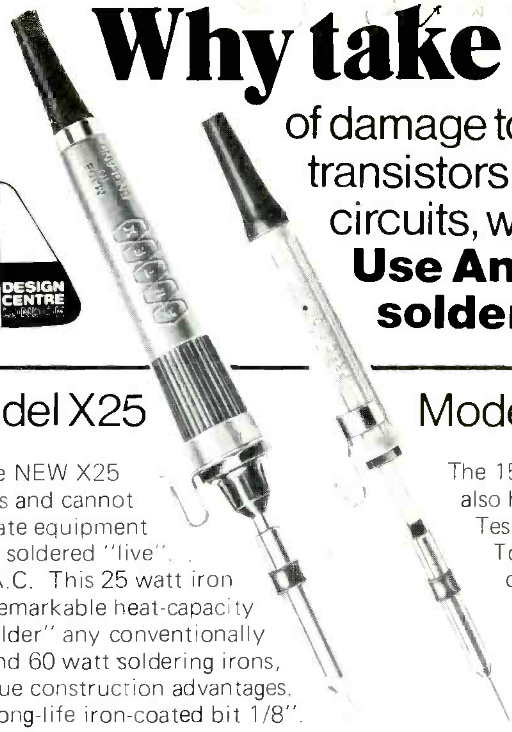


Multidigit L.E.D. displays must be used in a time sharing or multiplex mode where only one digit at a time is activated.

Why take the risk?

of damage to expensive transistors and integrated circuits, when soldering?

Use Antex low-leakage soldering irons



as selected for the DESIGN CENTRE

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 in 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"

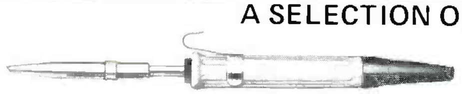
4 other bits available 1/8", 3/16" 1/4" and 1/16"

PRICE: £1.80 (rec. retail)

OR Fitted with triple-coated, (iron, nickel and Chromium) bit 1/8"

PRICE: £1.95 (rec. retail)

A SELECTION OF OTHER SOLDERING EQUIPMENT.



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 soldering iron fitted with nickel plated bit 3/32". Voltages 240 or 220.

PRICE. £1.70 (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)

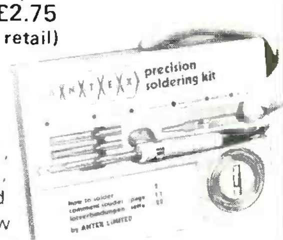
MODEL SK.1 KIT

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.

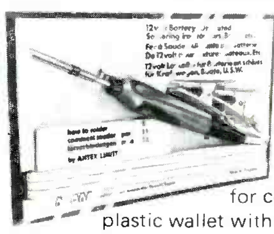
PRICE £2.75 (Rec. retail)

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 and booklet "How to Solder"



PRICE £2.40 (Rec. retail)



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)

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PE5

PRACTICAL
ELECTRONICS
VOLUME 9 No. 5 MAY 1973

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENTS

SPECIAL DATA SHEET

Our June issue will be published on Friday, May 11, 1973

There are 195 other good reasons for buying AMTRON electronic kits

Apart from the five items shown above, there are another 195 kits to choose from in the vast AMTRON range of electronic kits.

A few examples of equipment you can construct from AMTRON kits are:

Power supplies, preamplifiers, amplifiers, L.F. instruments, accessories for musical instruments, amateur and radio control transmitters and receivers, battery chargers, electronic car accessories, psychedelic lighting equipment, measuring instruments, tuners, receivers, I.C. digital equipment.

Only 1st class fully guaranteed components are used—solder is included with every kit.

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MAIL ORDER, CALLERS SATURDAYS ONLY

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High stability, low noise, carbon film resistors. Tubular miniature high power resistors.

Power Watts	Tolerance	Range	Values available	Price 1–99	Price 100+
¼	5%	2·2–2·2M	E12	**1p**	**0·8p**
½	5%	2·2–10M	E12	**1p**	**0·8p**
1	5%	2·2–10M	E12	**2p**	**1·5p**
4	10%	1–10 ohm	E12	**6p**	

Quantity prices available for any selection. Ignore fractions on total order.

CAPACITORS. Electrolytic Gen. Purpose Miniature Axial Lead. 63V, μF: 1, 1·5, 2·2, 3·3, 4·7, 6·8, 10, 15, 22, 47, **6p**; 40V, 100μF, **6p**; 25V, 150μF, **6p**; 25V, 220μF, **11p**; 25V, 470μF, **13p**; 25V, 680μF, **20p**; 25V, 1,000μF, **25p**.

POLYESTER FILM CAPACITORS. Mullard C296 Series
400V d.c., μF: 0·001, 0·0015, 0·0022, 0·0033, 0·0047, 0·0068, 0·01, 0·015, 0·022, **2½p** each; μF: 0·033, 0·047, 0·068, 0·1, **4p** each; μF: 0·15, **6p**; μF: 0·22, **7p**; μF: 0·33, **10p**; μF: 0·47, **13p**.
160V d.c., μF: 0·1, 0·15, **4p**; 0·22, **5p**; 0·33, **6p**; 0·47, **7p**; 0·68, **10p**; 1·0, **13p**.
Mullard C280 Series
400V d.c., μF: 0·01, 0·015, 0·022, **3p** each; 0·033, 0·047, **4p** each.
250V d.c., μF: 0·068, 0·1, 0·15, **4p** each; 0·22, 0·33, **5p** each; 0·47, **7p**; 0·68, **10p**; 1·0, **11p**.

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Stereo screened	**30p**	3·5mm screened	**10p**
Standard socket	**12p**	2·5mm sockets	**7p**
Stereo sockets	**15p**	3·5mm sockets	**7p**

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2 pin, 3 pin, 5 pin (180 or 240), plugs **10p**, sockets **8p**.

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1·5A single pole single throw **15p**. Double pole D/B throw **18p**.
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AC127	**12p**	BC147	**12p**	BFY51	**22p**	OC71	**10p**
AC128	**12p**	BC148	**12p**	OC26	**40p**	OC72	**10p**
AD161	**30p**	BC149	**12p**	OC28	**40p**	2N2926R	**9p**
AD162	**30p**	BD131	**60p**	OC35	**40p**	2N29260	**9p**
AF117	**12p**	BD132	**60p**	OC42	**10p**	2N2926V	**9p**
BC107	**8p**	BF194	**15p**	OC44	**10p**	2N2926G	**10p**
BC108	**8p**	BF195	**15p**	OC45	**10p**	2N3055	**55p**

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741 **32p**
723 **80p**

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OA85 **7p**; OA90 **5p**; OA91 **5p**; IN4001 **6p**; IN4004 **7p**; IN4007 **7p**.
Bridge Rectifier WO1 1A 100V price **35p**.

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Knobs for above. **10p**.

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SINGLE 10K, 25K, 50K, 100K, log or linear price: **35p**.
DUAL GANG 10K + 10K, etc. above values, log or linear price **50p**.
KNOBS for above **10p** each.

VEROBOARD

	0·1 Matrix	0·15 Matrix		0·15 Matrix
2½in × 3¾in	**22p**	**16p**	17in × 5in (plain)	**82p**
2½in × 5in	**24p**	**24p**	17in × 3¾in (plain)	**60p**
3¾in × 3¾in	**24p**	**24p**	17in × 2½in (plain)	**42p**
3¾in × 5in	**27p**	**27p**	PIN INSERTION TOOL	**52p**
17in × 2½in	**75p**	**57p**	SPOT FACE CUTTER	**42p**
Pkt of 50 pins	**20p**	**20p**		

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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**.

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MULLARD C437: (μF/V) 64/64, **9p**; 160/25, **9p**; 160/40, **11p**; 640/6·4, **9p**; 1600/6·4, **14p**.

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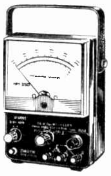

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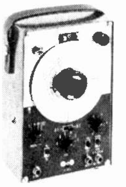

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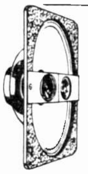

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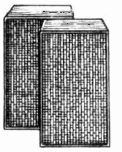

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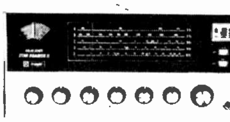

Solid state. Coverage on 5 bands 200–420 kHz and 0·55 to 30MHz. Illuminated slide rule dial. Bandspread. Aerial tuning. BFO, AVC, ANL, "S" meter. AM/CW/SSB. Integrated speaker and phone socket. Operation 220/240V a.c. or 12V d.c. Size 325 × 266 × 150 mm. Complete with instructions and circuit. **£32·50.** Carr. 50p.

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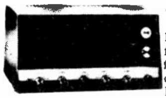
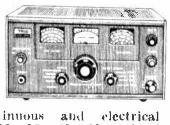


General coverage 150–400kHz, 550 kHz–30MHz. FET front end. 2 mech. filters, product detector, variable BFO, noise limiter. S Meter, Bandspread. RF Gain. 15in × 9¼in × 8½in. 18lbs. 220/240V a.c. or 12V d.c. Brand new with instructions. **£50.** Carr. 50p.



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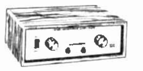

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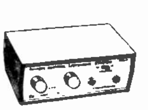
All silicon transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. Inputs 5MV/100MV. Output 50MW. **£5·97.** Post 15p.



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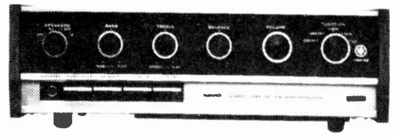

17+17W r.m.s. stereo amplifier with inputs for Magnetic and Crystal phono, Tuner, Tape, Aux and Tape Monitor. Outputs for two pairs of stereo speakers and tape. Stereo headphone socket. Full range of controls including loudness control, scratch filter, etc. Size 13in × 9¼in × 3¾in.

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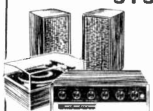
NIKKO TRM 50 SYSTEM



NIKKO TRM50 17+17W rms stereo amplifier, Garrard AP76 plinth and cover, Goldring G800E cartridge, pair of Linton 2 speakers and all leads.

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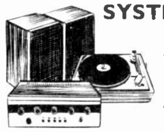
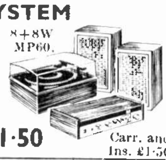
LEAK DELTA 30 SYSTEM



Leak Delta 30 stereo amplifier, Goldring GL75, plinth, cover and G800 cartridge. Pair of Leak 150 speakers and all leads.

OUR PRICE **£109·95** Carr. and Ins. £1·50

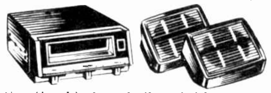
TELETON SAQ206B SYSTEM



Teleton SAQ206B 8+8W amplifier BSR MP60, plinth and cover, Goldring G800 cartridge, pair of Apollo speakers and all leads.

OUR PRICE **£51·50** Carr. and Ins. £1·50

AUDIOTRONIC ACP-8 8-TRACK CAR PLAYER



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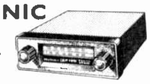

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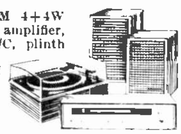

Monotone AM/FM 4+4W stereo tuner amplifier, Garrard 2025 T/C, plinth and cover, stereo cartridge, pair of matching speakers and all leads.

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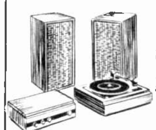

Wharfedale Linton Amplifier, Linton Turntable, pair of Linton 2 speakers and all leads.

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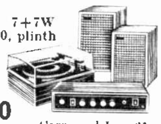

Amstrad 8000 II 7+7W amplifier. BSR MP60, plinth and cover, Goldring G800 cartridge, pair of Apollo speakers and all leads.

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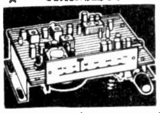

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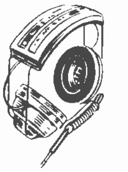

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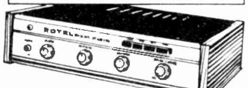

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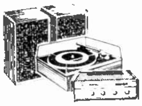

8 + 8 watt amplifier, BSR MP60, plinth and cover, G800 cartridge, pair of Medway T138 speakers and all leads.

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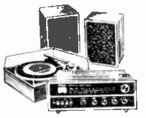

AM/FM 7½ + 7½ watt stereo tuner amplifier, BSR MP60, plinth and cover, G800, pair of Denton 2 speakers and all leads.

OUR PRICE **£76·50** Carr. & Ins. £1·25

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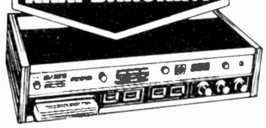

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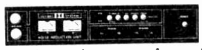

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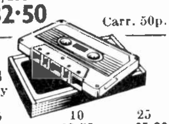

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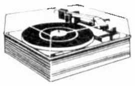

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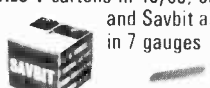

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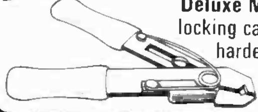

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ACY21	0·20
ACY22	0·10
ACY27	0·25
ACY28	0·17
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ACY40	0·15
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AD140	0·50
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BC157	0·15
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BC160	0·63
BC169	0·13
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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
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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
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GD3	0·33
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GD12	0·05
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GET115	0·45
GET116	0·50
GET120	0·25
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GET875	0·25
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GET881	0·25
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MJE2955	1·37
MJE3055	0·87
NKT128	0·35
NKT129	0·30
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NKT213	0·25
NKT214	0·15
NKT216	0·37
NKT217	0·35
NKT218	1·13
NKT219	0·33
NKT222	0·20
NKT224	0·22
NKT251	0·24
NKT271	0·25
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OA91	0·07
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OA200	0·07
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OC58	0·60
OC59	0·65
OC66	0·50
OC70	0·12
OC71	0·12
OC72	0·20
OC73	0·30
OC74	0·30
OC75	0·25
OC76	0·25
OC77	0·40
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
OC84	0·25
OC114	0·38
OC122	0·60
OC123	0·65
OC139	0·25
OC140	0·35
OC141	0·60
OC169	0·20
OC170	0·25
OC171	0·30
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

	£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	0·85
7438	0·85
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	0·80
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
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74197	1·50
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As a special introductory offer, one of the metal cabinets described below will be supplied with each kit at the additional price of only **70p.** At this fantastic give-away price, stocks of cabinets are certain to disappear fast, so send your order today to avoid being disappointed. Please note that this special offer is not available separately.

METAL CABINETS

These attractive steel cabinets are PVC covered in a range of colours, and offer a really economically-priced unit for the home constructor. The chassis, which has a white PVC finish, provides an easily accessible building area, with an integral fascia panel. The cabinet is supplied complete with rubber feet.
Colours available include Green, Grey, Black, White, Blue and Brown. Every effort will be made to supply a selected colour, but please give alternatives if possible.

Approximate size in inches			Price
l	w	d	
8	6	3	£1·45
11	6½	3	£1·85

Other sizes to special order. Please send S.A.E. for quotation.

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TO3 case. Gives stabilised supply. MVR 5 volt, MVR 12 volt, MVR 15 volt. All priced at **£1·50**

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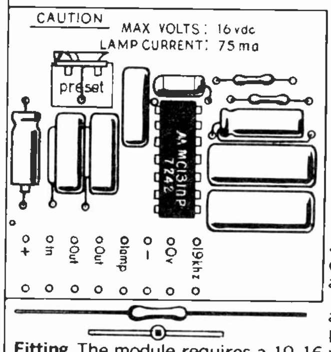
Stereo radio from your existing tuner.



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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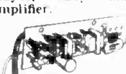
With high IMP input this amplifier will work as a record player, baby alarm, etc., amplifier.



£1·75 plus 13p P. & P.

TRI-VOLT BATTERY ELIMINATOR


Enables you to work your Transistor Radio, Amplifier or Cassette, etc., from the a.c. mains through this compact Eliminator. Just by moving a plug you can select the voltage you require. 6, 7½ or 9 volt. This means all your transistor power pack applications can be handled by this one unit. Approx. size 2¼in 2¼in 3¼in. Our Price **£2·75** plus 10p P. & P. Same model suitably wired for the Philips Cassette £3 plus 10p P. & P.

DIGITAL CLOCK KIT


24-hr. Nixie dig. clock kit. We supply: a complete set of components; a complete set of easy to follow instructions; printed circuits made to make construction as simple as possible; a cabinet and front panel to give a professional finish. All for the price of the components. **£22·50 + 50p P. & P.** Please send S.A.E. if you require more information.

AL20 5 WATT AUDIO AMPLIFIER
A low cost high quality 5 watt audio amplifier designed for use in stereo systems, record players and other audio equipment.

Supply Voltage = 9 to 30 volts.
Frequency = 50 to 25 kHz.
Overall Size = 3in × 2¼in × 1in approx.
Full technical data and diagrams with each module.
All guaranteed and a bargain at **£2·63** plus 5p P. & P.

V.A.T.
From 1st April, 1973, will you please include on your Total (Goods plus Postage and Packing) Value Added Tax at the Standard Stated Rate.

MINIATURE RELAY
6 volt 70 ohm.
Single Pole Changeover = **40p** plus 5p P. & P.
Approx. size = 1¼in × 1in × ¾in.

MAINS TRANSFORMER
Fused Primary 240V. Secondary 220V @ 50mA. 6·3V @ 1A. This transformer is made to a very high standard and is a small size: 2in × 2¼in × 2¼in. **63p** plus 15p P. & P.

S. G. BROWN "DIPLOMAT" MONO/STEREO HEADSET.
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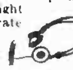
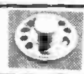


TRI-VOLT CAR SUPPLY
Enables you to work your Transistor Radio, Amplifier or Cassette, etc. from the 12 volt car supply. Positive or negative earth. Approx. size = 2in. × 3¼in. × 1¼in. This converter supplies 6, 7½ or 9 volts and is transistor regulated. A real money saving device for **£2·50** plus 10p P. & P.

MINI LOUDSPEAKERS
2¼in 8 ohm, **50p**; 2¼in 80 ohm, **50p**; 2¼in 40 ohm, **50p**. Please include 5p P. & P. on each L.S.



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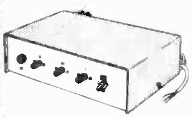
EMI LOUDSPEAKER 450
10W 13in × 8in ± two 2·2¼in tweeters and cross-over. All wired and ready for use. This ever-popular 450 in 3–8–15 ohm imp. **£3·75** plus 38p P. & P. each.

CRESCENT CASSETTES


Top quality cassettes at unbeatable prices (complete with standard storage case): C60 **28p**, C90 **38p**, C120 **48p** plus 5p P. & P.

PSYCHEDELIC LIGHT CONTROL UNIT


Three Channel: Bass—Middle—Treble. Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier, and connect three 250V up to 500W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed) **£18·50** plus 38p P. & P.

If you require more information please send S.A.E.

"CRESCENT" 100 WATT R.M.S. ALL PURPOSE AMPLIFIER U.BUILD.IT
We supply the three modules for you to build this Disco-Group-P.A. amplifier into the cabinet of your choice.

★ **THE POWER AMP MODULE TP100W**
170W r.m.s. sq. wave 300W instantaneous peak into 8 ohm (60W into 16 ohm). **£14·28** carr. 45p

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Four control pre-amp, Vol, Bass, Treble, Middle controls. Designed to drive most amplifiers using F.E.T. first stage. **£3·96** carr. 25p

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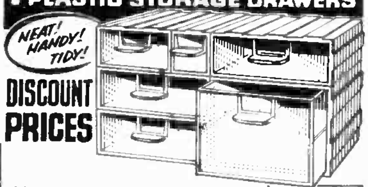
Is supplied complete with the mains transformer. **£9·66** carr. 50p
Complete fixing instructions are supplied and no technical knowledge is required to connect the three ready wired modules.
A fantastic bargain. If you purchase all three modules. **£25** carr. 75p
Send S.A.E. for further details on this or our ready built amplifiers.

7in × 4in LOUDSPEAKER


A top quality speaker ideal where small size is important. Manufactured by E.M.I. for a well-known hi-fi set maker. Size: 7in × 4in. Impedance: 8 ohms. Flux: 38,000. Max. Free range: 90Hz to 12kHz. Power handling: 5W. Unbeatable. Price: **£1·60**. Free postage on this item.

I-N-T-E-R-L-O-C-K-I-N-G PLASTIC STORAGE DRAWERS



Newest, neatest system ever devised for storing small parts and components: resistors, capacitors, diodes, transistors, etc. Rigid plastic units interlock together in vertical and horizontal combinations. Transparent plastic drawers have label slots/removable space dividers. Build up any size cabinet for wall, bench or table top.

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AC115	0·25½
AC117K	0·22
AC122	0·13
AC125	0·18½
AC126	0·18½
AC127	0·18½
AC128	0·18½
AC132	0·15½
AC134	0·15½
AC137	0·15½
AC141	0·15½
AC141K	0·18½
AC142	0·15½
AC142K	0·18½
AC151	0·16½
AC154	0·22
AC155	0·22
AC156	0·22
AC157	0·26½
AC165	0·22
AC166	0·22
AC167	0·22
AC168	0·26½
AC169	0·15½
AC176	0·22
AC177	0·26½
AC178	0·31
AC179	0·31
AC180	0·18½
AC180K	0·22
AC181	0·18½
AC181K	0·22
AC187	0·24
AC187K	0·22
AC188	0·24
AC188K	0·22
ACY17	0·27½
ACY18	0·22
ACY19	0·22
ACY20	0·22
ACY21	0·22
ACY22	0·17½
ACY27	0·19½
ACY28	0·21
ACY29	0·38½
ACY30	0·31
ACY31	0·31
ACY34	0·23
ACY35	0·23
ACY36	0·31
ACY40	0·18½
ACY41	0·19½
ACY44	0·38½
AD130	0·42
AD140	0·53
AD142	0·53
AD143	0·42
AD149	0·55
AD161	0·36½
AD162	0·36½
AD161 & AD162(MP)	0·60½
ADT140	0·55
AF114	0·26½
AF115	0·26½
AF116	0·26½
AF117	0·26½
AF118	0·38½
AF124	0·33
AF125	0·27½
AF126	0·31
AF127	0·31
AF139	0·33
AF178	0·33
AF179	0·55
AF180	0·55
AF181	0·49½
AF186	0·49½
AF239	0·40½
AL102	0·71½
AL103	0·71½
ASY26	0·27½
ASY27	0·33
ASY28	0·27½
ASY29	0·27½
ASY50	0·27½
ASY51	0·27½
ASY52	0·27½
ASY54	0·27½
ASY55	0·27½
ASY56	0·27½
ASY57	0·27½
ASY58	0·27½
ASZ21	0·44
BC107	0·10
BC108	0·10
BC109	0·11
BC113	0·11
BC114	0·16½
BC115	0·16½
BC116	0·16½
BC117	0·16½
BC118	0·11
BC119	0·33
BC120	0·88
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BC159	0·13
BC160	0·49½
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BC172	0·15½
BC173	0·15½
BC174	0·15½
BC175	0·24
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BC178	0·21
BC179	0·21
BC180	0·26½
BC181	0·26½
BC182	0·11
BC182L	0·11
BC183	0·11
BC183L	0·11
BC184	0·13
BC184L	0·13
BC186	0·31
BC187	0·31
BC207	0·12
BC208	0·12
BC209	0·13
BC212L	0·12
BC213L	0·12
BC214L	0·15½
BC225	0·27½
BC226	0·38½
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BCY31	0·28½
BCY32	0·33
BCY33	0·24
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BCY72	0·15½
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BD139	0·60½
BD140	0·66
BD155	0·88
BD175	0·66
BD176	0·66
BD177	0·71½
BD178	0·71½
BD179	0·77
BD180	0·77
BD185	0·71½
BD186	0·71½
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BD188	0·77
BD189	0·82½
BD190	0·82½
BD195	0·93½
BD196	0·93½
BD197	0·99
BD198	0·99
BD199	1·04½
BD200	1·04½
BD205	0·88
BD206	0·88
BD207	1·04½
BD208	1·04½
BDY20	1·10
BF115	0·26½
BF117	0·49½
BF118	0·77
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BF125	0·49½
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BF152	0·60½
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BF160	0·44
BF162	0·44
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BF164	0·44
BF165	0·44
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BF195	0·13
BF196	0·15½
BF197	0·15½
BF200	0·49½
BF222	1·04½
BF257	0·49½
BF258	0·66
BF259	0·93½
BF262	0·60½
BF263	0·60½
BF270	0·38½
BF271	0·33
BF272	0·88
BF273	0·38½
BF274	0·38½
BFW10	0·66
BFX29	0·30
BFX84	0·24
BFX85	0·33
BFX86	0·24
BFX87	0·26½
BFX88	0·24
BFY50	0·22
BFY51	0·22
BFY52	0·22
BFY53	0·18½
BPX25	0·93½
BSX19	0·16½
BSX20	0·16½
BSY25	0·16½
BSY26	0·16½
BSY27	0·16½
BSY28	0·16½
BSY29	0·16½
BSY38	0·20
BSY39	0·20
BSY40	0·31
BSY41	0·31
BSY95	0·14
BSY95A	0·14
Bu105	2·20
C111E	0·55
C400	0·33
C407	0·27½
C424	0·22
C425	0·55
C426	0·38½
C428	0·22
C441	0·33
C442	0·33
C444	0·38½
C450	0·24
MAT100	0·21
MAT101	0·22
MAT120	0·21
MAT121	0·22
MPF102	0·46
MPF104	0·40½
MPF105	0·40½
OC19	0·38½
OC20	0·69½
OC22	0·42
OC23	0·46
OC24	0·61½
OC25	0·42
OC26	0·27½
OC28	0·55
OC29	0·55
OC35	0·46
OC36	0·55
OC41	0·22
OC42	0·26½
OC44	0·16½
OC45	0·14
OC70	0·11
OC71	0·11
OC72	0·15½
OC74	0·15½
OC75	0·16½
OC76	0·16½
OC77	0·27½
OC81	0·16½
OC81D	0·16½
OC82	0·16½
OC82D	0·16½
OC83	0·22
OC84	0·22
OC139	0·22
OC140	0·22
OC169	0·27½
OC170	0·27½
OC171	0·27½
OC200	0·27½
OC201	0·31
OC202	0·31
OC203	0·27½
OC204	0·27½
OC205	0·38½
OC309	0·44
OCP71	0·47½
ORP12	0·47½
ORP60	0·44
ORP61	0·44
P346A	0·22
P397	0·46
ST140	0·14
ST141	0·18½
TI843	0·33
UT46	0·30
2G301	0·21
2G302	0·21
2G303	0·21
2G304	0·26½
2G306	0·44
2G308	0·38½
2G309	0·38½
2G339	0·22
2G339A	0·17½
2G344	0·20
2G345	0·17½
2G371	0·17½
2G371B	0·13
2G373	0·18½
2G374	0·18½
2G377	0·33
2G378	0·17½
2G381	0·17½
2G382	0·17½
2G401	0·33
2G414	0·33
2G417	0·27½
2N388	0·38½
2N388A	0·60½
2N404	0·22
2N404A	0·31
2N524	0·46
2N527	0·54
2N598	0·46
2N599	0·49½
2N696	0·14
2N697	0·14½
2N698	0·26½
2N699	0·38½
2N706	0·09
2N706A	0·10
2N708	0·13
2N711	0·33
2N717	0·38½
2N718	0·26½
2N718A	0·55
2N726	0·31
2N727	0·31
2N743	0·22
2N744	0·22
2N914	0·15½
2N918	0·33
2N929	0·23
2N930	0·23
2N1131	0·22
2N1132	0·24
2N1302	0·15½
2N1303	0·15½
2N1304	0·18½
2N1305	0·18½
2N1306	0·23
2N1307	0·23
2N1308	0·25½
2N1309	0·25½
2N1613	0·22
2N1711	0·22
2N1889	0·35
2N1890	0·49½
2N1893	0·40½
2N2147	0·79
2N2148	0·62½
2N2160	0·66
2N2192	0·38½
2N2193	0·38½
2N2194	0·38½
2N2217	0·24
2N2218	0·22
2N2219	0·22
2N2220	0·24
2N2221	0·22
2N2222	0·22
2N2368	0·18½
2N2369	0·15½
2N2369A	0·15½
2N2411	0·26½
2N2412	0·26½
2N2646	0·51½
2N2711	0·23
2N2712	0·23
2N2714	0·23
2N2904	0·18½
2N2904A	0·23
2N2905	0·23
2N2905A	0·23
2N2906	0·16½
2N2906A	0·20
2N2907	0·22
2N2907A	0·24
2N2923	0·15½
2N2924	0·15½
2N2925	0·15½
2N2926 (G)	0·14
2N2926 (Y)	0·12
2N2926 (O)	0·11
2N2926 (R)	0·11
2N2926 (B)	0·11
2N3010	0·77
2N3011	0·15½
2N3053	0·18½
2N3054	0·50½
2N3055	0·55
2N3391	0·15½
2N3391A	0·17½
2N3392	0·15½
2N3393	0·15½
2N3394	0·15½
2N3395	0·18½
2N3402	0·23
2N3403	0·23
2N3404	0·31
2N3405	0·46
2N3414	0·16½
2N3415	0·16½
2N3416	0·31
2N3417	0·31
2N3525	0·82½
2N3646	0·10
2N3702	0·11
2N3703	0·11
2N3704	0·12
2N3705	0·11
2N3706	0·10
2N3707	0·12
2N3708	0·07½
2N3709	0·10
2N3710	0·10
2N3711	0·10
2N3819	0·31
2N3820	0·55
2N3821	0·38½
2N3823	0·31
2N3903	0·31
2N3904	0·33
2N3905	0·31
2N3906	0·30
2N4058	0·13
2N4059	0·11
2N4060	0·13
2N4061	0·13
2N4062	0·13
2N4284	0·18½
2N4285	0·18½
2N4286	0·18½
2N4287	0·18½
2N4288	0·18½
2N4289	0·18½
2N4290	0·18½
2N4291	0·18½
2N4292	0·18½
2N4293	0·18½
2N5172	0·13
2N5457	0·35
2N5458	0·35
2N5459	0·44
2S301	0·55
2S302A	0·46
2S302	0·46
2S303	0·60½
2S034	0·77
2S305	0·92½
2S306	0·92½
2S307	0·92½
2S321	0·61½
2S322	0·46
2S322A	0·46
2S323	0·61½
2S324	0·77
2S325	0·77
2S326	0·77
2S327	0·77
2S701	0·46
40361	0·44
40362	0·49½

DIODES AND RECTIFIERS

Type	Price
AA119	0·09
AA120	0·09
AA129	0·09
AAY30	0·10
AAZ13	0·11
BA100	0·11
BA116	0·23
BA126	0·24
BA148	0·15½
BA154	0·13
BA155	0·15½
BA156	0·14½
BY100	0·16½
BY101	0·13
BY105	0·18½
BY114	0·13
BY126	0·15½
BY127	0·16½
BY128	0·16½
BY130	0·17½
BY133	0·23
BY164	0·55
BYX38/30	0·46
BYZ10	0·38½
BYZ11	0·33
BYZ12	0·33
BYZ13	0·27½
BYZ16	0·44
BYZ17	0·38½
BYZ18	0·38½
BYZ19	0·31
CG62 (OA91 Eq.)	0·05½
CG651—(OA70–OA79)	0·06½
OA5	0·38½
OA58L	0·23
OA10	0·38½
OA47	0·07½
OA70	0·07½
OA79	0·07½
OA81	0·07½
OA85	0·10
OA90	0·06½
OA91	0·06½
OA95	0·07½
OA200	0·06½
OA202	0·07½
SD10	0·05½
SD19	0·05½
1N34	0·07½
1N34A	0·07½
1N914	0·06½
1N916	0·06½
1N414B	0·06½
1S021	0·11
1S951	0·06½

Cut these 3 pages out and keep for reference

NEW COMPONENT PAK BARGAINS

Pak No.	Qty.	Description	Price
C 1	250	Resistors mixed values approx. (count by weight)	0·55
C 2	200	Capacitors mixed values approx. (count by weight)	0·55
C 3	50	Precision Resistors ·1%, and ·01% mixed values	0·55
C 4	75	⅛th W Resistors mixed preferred values	0·55
C 5	5	Pieces assorted Ferrite Rods	0·55
C 6	2	Tuning Gangs, MW/LW VHF	0·55
C 7	1	Pack Wire 50 meters assorted colours	0·55
C 8	10	Reed Switches	0·55
C 9	3	Micro Switches	0·55
C10	15	Assorted Pots & Pre-Sets	0·55
C11	5	Jack Sockets 3 × 3·5m 2 × Standard Switch Types	0·55
C12	40	Paper Condensers preferred types mixed values	0·55
C13	20	Electrolytics Trans. types	0·55
C14	1	Pack assorted Hardware—Nuts/Bolts, Gromets, etc.	0·55
C15	4	Mains Toggle Switches, 2 Amp D/P	0·55
C16	20	Assorted Tag Strips & Panels	0·55
C17	10	Assorted Control Knobs	0·55
C18	4	Rotary Wave Change Switches	0·55
C19	3	Relays 6—24V Operating	0·55
C20	4	Sheets Copper Laminate approx. 10in × 7in	0·55

Please add 10p post and packing on all component packs, plus a further 10p on pack Nos. C1, C2, C19 and C20.

Component Lists for mail order available on request.

PLUS-MUCH MORE-

SEND NOW FOR THE

BI-PAK *"Component Catalogue"*

5p to cover postage, etc.

JUMBO COMPONENT PAKS

Mixed Electronic Components

Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 3lb in weight. Price including P. & P. £1·65.

EXCEPTIONALLY GOOD VALUE

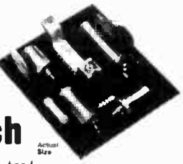
BRAND NEW POST OFFICE TYPE TELE-PHONE DIALS

ONLY 83p each

THE NEW S.G.S. EA 1000 AUDIO AMP MODULE *Guarantee

3 Watts R.M.S.

ONLY £2·89 each



Module Tested and Guaranteed.
Qty. 1—9 **£2·63**; 10—25 **£2·50** Price each. Larger quantities quoted on request. Full hook-up diagrams and complete technical data supplied free with each module or available separately at 10p each.

SYSTEM 12 STEREO

Each Kit contains two Amplifier Modules, 3 watts RMS, two loudspeakers, 15 ohms, the pre-amplifier, transformer, power supply module, front panel and other accessories, as well as an illustrated stage-by-stage instruction booklet designed for the beginner.
Further details available on request.

ONLY £18·64 FREE P. & P.

NOW-TURN OVER FOR MORE FANTASTIC OFFERS

The largest selection

NEW LOW PRICED TESTED S.C.R.'S

	PIV 50	100	200	400	600	800
	£p	£p	£p	£p	£p	£p
1A TO5	0·25½	0·27½	0·38½	0·47½	0·58½	0·69½
3A TO66	0·27½	0·36½	0·40½	0·51½	0·62½	0·77
5A TO66	0·38½	0·51½	0·54	0·61½	0·75	0·88
5A TO64	0·38½	0·51½	0·54	0·61½	0·75	0·88
7A TO48	0·51½	0·55	0·62½	0·73½	0·84½	0·99
10A TO48	0·55	0·64	0·67	0·82½	1·06½	1·32
16A TO48	0·58½	0·69½	0·82½	1·02½	1·37½	1·65
30A TO48	1·26½	1·54	1·76	1·92½	—	4·40

SIL. RECTS. TESTED

PIV	300mA DO7	750mA SO16	1A Plastic	1·5A SO16	3A SO10	10A SO10	30A SO32A
50	0·04	0·05½	0·05½	0·07½	0·15½	0·23	0·66
100	0·04	0·06½	0·05½	0·14½	0·17½	0·25½	0·82½
200	0·05½	0·10	0·06½	0·15½	0·22	0·26½	1·10
400	0·06½	0·14½	0·07½	0·22	0·30	0·40½	1·37½
600	0·07½	0·17½	0·11	0·25½	0·37½	0·49½	2·04½
800	0·11	0·18½	0·12	0·27½	0·40½	0·60½	2·20
1000	0·12	0·27½	0·15½	0·33	0·50½	0·69½	2·75
1200	—	0·36½	—	0·42	0·62½	0·82½	—

TRIACS

VBOM	2A TO-5	6A TO-66	10A TO-48
	£p	£p	£p
100V	33	55	82½
200V	55	66	99
400V	77	82½	1·21

DIACS

FOR USE WITH TRIACS
BR100 (D32) 40½p each

FREE

One 50p Pak of your own choice free with orders valued £4 or over.

BRAND NEW TEXAS GERM. TRANSISTORS

Coded and Guaranteed

Pak No.			EQVT
T1	8	2G3713	OC71
T2	8	D1374	OC75
T3	8	D1216	OC81D
T4	8	2G381T	OC81
T5	8	2G382T	OC82
T6	8	2G344B	OC44
T7	8	2G345B	OC45
T8	8	2G378	OC78
T9	8	2G399A	2N1302
T10	8	2G417	AF117

All 55p each pak

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS. Our price **28p** each.

120 VCB NIXIE DRIVER TRANSISTOR. Sim. BSX21 & C407, 2N1893 **FULLY TESTED AND CODED ND 120.** 1-24 **19p** each. TO-5 N.P.N. 25 up **17p** each.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 5½p each. Any Quantity.

ZENER DIODES

400mW (DO-7 Case), range 2–33V. **14½p** each. 1·5W (Top-Hat), range 2–33V. **20p** each. 10W (SO-10 Stud), range 2–33V, **33p** each.

10 amp POTTED BRIDGE RECTIFIER

on heat sink.
100PIV. 99p each

NEW LINE

Plastic Encapsulated 2 Amp. BRIDGE RECTS.

50V RMS	35p each
100V RMS	40½p each
400V RMS	50½p each

Size 15mm × 6mm.

UNIJUNCTION TRANSISTORS

Direct replacement for TIS43 and BEN3000 also electrically equivalent to 2N2646 Qty.: 1–24 **30p** each. 25–99 **27½p** each. 100+ **22p** each.

CADMIUM CELLS

ORP12 47½p
ORP60, ORP61 44p each

GENERAL PURPOSE NPN SILICON SWITCHING TRANS. TO-18 SIM. TO 2N706/8. BSY-27/28/95A. All usable devices no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

		£p
20	For	0·55
50	For	1·10
100	For	1·92
500	For	8·25
1000	For	14·30

SIL. G.P. DIODES

		£p
300mW	30	0·55
40PIV(Min.)	100	1·65
Sub-Min.	500	5·50
Full Tested	1,000	9·90

Ideal for Organ Builders.

KING OF THE PAKS Unequalled Value and Quality

SUPER PAKS NEW BI-PAK UNTESTED SEMICONDUCTORS

Satisfaction GUARANTEED in Every Pak, or money back.

Pak No.		Description	Price
U 1	120	Glass Sub-Min. General Purpose Germanium Diodes	0·55
U 2	60	Mixed Germanium Transistors AF/RF	0·55
U 3	75	Germanium Gold Bonded Sub-Min. like OA5, OA47	0·55
U 4	40	Germanium Transistors like OC81, AC128	0·55
U 5	60	200mA Sub-Min. Silicon Diodes	0·55
U 6	30	Sil. Planar Trans. NPN like BSY95A, 2N706	0·55
U 7	16	Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000	0·55
U 8	50	Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	0·55
U 9	20	Mixed Voltages, 1 Watt Zener Diodes	0·55
U10	20	BAY50 charge storage Diodes DO-7 Glass	0·55
U11	25	PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904	0·55
U12	12	Silicon Rectifiers Epoxy 500mA up to 800 PIV	0·55
U13	30	PNP-NPN Sil. Transistors OC200 & 2S 104	0·55
U14	150	Mixed Silicon and Germanium Diodes	0·55
U15	25	NPN Sil. Planar Trans. TO-5 like BFY51, 2N697	0·55
U16	10	3 Amp Silicon Rectifiers Stud Type up to 1000PIV	0·55
U17	30	Germanium PNP AF Transistors TO-5 like ACY 17-22	0·55
U18	8	6 Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	0·55
U19	25	Silicon NPN Transistors like BC108	0·55
U20	12	1·5 Amp Silicon Rectifiers Top Hat up to 1000 PIV	0·55
U21	30	AF. Germanium Alloy Transistors 2G300 Series & OC71	0·55
U23	30	MADT's like MHz Series PNP Transistors	0·55
U24	20	Germanium 1 Amp Rectifiers GJM Series up to 300 PIV	0·55
U25	25	300MHz NPN Silicon Transistors 2N708, BSY27	0·55
U26	30	Fast Switching Silicon Diodes like IN914 Micro-Min.	0·55
U27	12	NPN Germanium AF Transistors TO-1 like AC127	0·50
U29	10	1 Amp SCR's TO-5 can, up to 600 PIV CRS1/25-600	1·15
U30	15	Plastic Silicon Planar Trans. NPN 2N2926	0·55
U31	20	Silicon Planar Plastic NPN Trans. Low Noise Amp 2N3707	0·55
U32	25	Zener Diodes 400mW DO-7 case 3–18 volts mixed	0·55
U33	15	Plastic Case 1 Amp Silicon Rectifiers IN4000 Series	0·55
U34	30	Silicon PNP Alloy Trans. TO-5 BCY26 2S302/4	0·55
U35	25	Silicon Planar Transistors PNP TO-18 2N2906	0·55
U36	25	Silicon Planar NPN Transistors TO-5 BFY50/51/52	0·55
U37	30	Silicon Alloy Transistors SO-2 PNP OC200, 2S322	0·55
U38	20	Fast Switching Silicon Trans. NPN 400MHz 2N3011	0·55
U39	30	RF. Germ. PNP Transistors 2N1303/5 TO-5	0·55
U40	10	Dual Transistors 6 lead TO-5 2N2060	0·55
U41	25	RF Germanium Transistors TO-5, OC45, NKT72	0·55
U42	10	VHF Germanium PNP Transistors TO-1 NKT667, AF117	0·55
U43	25	Sil. Trans. Plastic TO-18 A.F. BC113/114	0·55
U44	20	Sil. Trans. Plastic TO-5 BC115/NPN	0·55
U45	7	3A SCR. TO66 up to 600PIV	1·10

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

QUALITY TESTED SEMICONDUCTORS

Pak No.			Price £p
Q 1	20	Red spot transistors *pnp*	0·55
Q 2	16	White spot R.F. transistors *pnp*	0·55
Q 3	4	OC77 type transistors	0·55
Q 4	6	Matched transistors OC44/45/81/81D	0·55
Q 5	4	OC75 transistors	0·55
Q 6	5	OC72 transistors	0·55
Q 7	4	AC128 transistors *pnp* high gain	0·55
Q 8	4	AC126 transistors *pnp*	0·55
Q 9	7	OC81 type transistors	0·55
Q10	7	OC71 type transistors	0·55
Q11	2	AC127/128 Complementary pairs *pnp/npn*	0·55
Q12	3	AF116 type transistors	0·55
Q13	3	AF117 type transistors	0·55
Q14	3	OC171 H.F. type transistors	0·55
Q15	7	2N2926 Sil. Epoxy transistors mixed colours	0·55
Q16	2	GET880 low noise Germanium transistors	0·55
Q17	5	*npn* 2 × ST.141 & 3 × ST.140	0·55
Q18	4	MADT'S 2 × MAT 100 & 2 × MAT 120	0·55
Q19	3	MADT'S 2 × MAT 101 & 1 × MAT 121	0·55
Q20	4	OC44 Germanium transistors A.F.	0·55
Q21	4	AC127 *npn* Germanium transistors	0·55
Q22	20	NKT transistors A.F. R.F. coded	0·55
Q23	10	OA202 Silicon diodes sub-min.	0·55
Q24	8	OA81 diodes	0·55
Q25	15	IN914 Silicon diodes 75PIV 75mA	0·55
Q26	8	OA95 Germanium diodes sub-min IN69	0·55
Q27	2	10A 600 PIV Silicon rectifiers IS425R	0·55
Q28	2	Silicon power rectifiers BYZ13	0·55
Q29	4	Silicon transistors 2 × 2N696, 1 × 2N697, 1 × 2N698	0·55
Q30	7	Silicon switch transistors 2N706 *npn*	0·55
Q31	6	Silicon switch transistors 2N708, *npn*	0·55
Q32	3	*pnp* Silicon transistors 2 × 2N1131, 1 × 2N1132	0·55
Q33	3	Silicon *npn* transistors 2N1711	0·55
Q34	7	Silicon *npn* transistors 2N2369, 500MHz (code P397)	0·55
Q35	3	Silicon *pnp* TO-5. 2 × 2N2904 & 1 × 2N2905	0·55
Q36	7	2N3646 TO-18 plastic 300MHz *npn*	0·55
Q37	3	2N3053 *npn* Silicon transistors	0·55
Q38	7	*pnp* transistors 4 × 2N3703, 3 × 2N3702	0·55

ELECTRONIC SLIDE-RULE

The MK Slide Rule, designed to simplify Electronic calculations features the following scales:— Conversion of Frequency and Wavelength. Calculation of L, C and fo of Tuned Circuits. Reactance and Self Inductance. Area of Circles. Volume of Cylinders. Resistance of Conductors. Weight of Conductors. Decibel Calculations. Angle Functions. Natural Logs and "e" Functions. Multiplication and Division. Squaring, Cubing and Square Roots. Conversion of kW and Hp. A must for every electronic engineer and enthusiast. Size: 2cm × 4cm. Complete with case and instructions. Price each: **£3·68½**

SILICON PHOTO TRANSISTOR. TO-18 Lens end NPN Sim. to BP×25 and P21. BRAND NEW. Full data available. Fully guaranteed.

Qty.	1-24	25-99	100 up
Price each	69p	44p	38p

F.E.T.'S

2N3819	31p	2N5458	35p
2N3820	55p	2N5459	44p
2N3821	38½p	BFW10	66p
2N3823	31p	MPF105	40½p

INTEGRATED CIRCUIT PAKS

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

Pak No.	Contents	Price	Pak No.	Contents	Price	Pak No.	Contents	Price
UIC00	12 × 7400	0·55	UIC46	5 × 7446	0·55	UIC86	5 × 7486	0·55
UIC01	12 × 7401	0·55	UIC47	5 × 7447	0·55	UIC90	5 × 7490	0·55
UIC02	12 × 7402	0·55	UIC48	5 × 7448	0·55	UIC91	5 × 7491	0·55
UIC03	12 × 7403	0·55	UIC50	12 × 7450	0·55	UIC92	5 × 7492	0·55
UIC04	12 × 7404	0·55	UIC51	12 × 7451	0·55	UIC93	5 × 7493	0·55
UIC05	12 × 7405	0·55	UIC53	12 × 7453	0·55	UIC94	5 × 7494	0·55
UIC06	8 × 7406	0·55	UIC54	12 × 7454	0·55	UIC95	5 × 7495	0·55
UIC07	8 × 7407	0·55	UIC60	12 × 7460	0·55	UIC96	5 × 7496	0·55
UIC10	12 × 7410	0·55	UIC70	8 × 7470	0·55	UIC100	5 × 74100	0·55
UIC13	8 × 7413	0·55	UIC72	8 × 7472	0·55	UIC121	5 × 74121	0·55
UIC20	12 × 7420	0·55	UIC73	8 × 7473	0·55	UIC141	5 × 74141	0·55
UIC30	12 × 7430	0·55	UIC74	8 × 7474	0·55	UIC151	5 × 74151	0·55
UIC40	12 × 7440	0·55	UIC75	8 × 7475	0·55	UIC154	5 × 74154	0·55
UIC41	5 × 7441	0·55	UIC76	8 × 7476	0·55	UIC193	5 × 74193	0·55
UIC42	5 × 7442	0·55	UIC80	5 × 7480	0·55	UIC199	5 × 74199	0·55
UIC43	5 × 7443	0·55	UIC81	5 × 7481	0·55			
UIC44	5 × 7444	0·55	UIC82	5 × 7482	0·55	UICX1	25 Assorted 74's	1·65
UIC45	5 × 7445	0·55	UIC83	5 × 7483	0·55			

Paks cannot be split, but 25 assorted pieces (our mix) is available as PAK UIC X1.

POWER TRANS BONANZA!

GENERAL PURPOSE GERM. PNP

Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACE:—OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. T13027-3028, 2N250A, 2N456A-457A-458A, 2N511 A & B. 2G220-222, ETC. VCBO 80V VCEO 50V IC 10A PT. 30 WATTS Hfe 30–170.

PRICE	1–24	25–99	100 up
	47p each	44p each	40p each

SILICON High Voltage 250V NPN TO-3 case. G.P. Switching & Amplifier Applications. Brand new Coded R 2400 VCBO 250/VCEO 100/IC 6A/30 Watts. HFE type 20/fT 5MHZ.
OUR PRICE EACH:

1–24	25–99	100 up
55p	50p	44p

2N3055

115 WATT SIL POWER NPN 55p EACH

NEW 6TH EDITION

TRANSISTOR EQUIVALENTS BOOK. A complete cross reference and equivalents book for European, American and Japanese Transistors. Exclusive to BI-PAK 99p each.

A LARGE RANGE OF TECHNICAL AND DATA BOOKS ARE NOW AVAILABLE EX STOCK. SEND FOR FREE LIST.

AD161/162 *PNP*

M/P COMP GERM TRANS. OUR LOWEST PRICE OF 60p *PER PAIR*

SILICON 50 WATTS MATCHED NPN/PNP
BIP 19 NPN TO-3 Plastic. BIP 20 PNP. Brand new. VCBO 100/VCEO 50/IC 10A. HFE type 100/ft 3mHZ.
OUR PRICE PER PAIR:
1–24 prs: 66p 25–99 prs. 61p 100 prs. 55p

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Send all orders to BI-PAK, P.O. BOX 6, WARE, HERTS.

-the lowest prices!

74 Series T.T.L. I.C's

BI-PAK STILL LOWEST IN PRICE. FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURERS

	1	25	100+
SN7400	0·16½	0·15½	0·13
SN7401	0·16½	0·15½	0·13
SN7402	0·16½	0·15½	0·13
SN7403	0·16½	0·15½	0·13
SN7404	0·16½	0·15½	0·13
SN7405	0·16½	0·15½	0·13
SN7406	0·38½	0·34	0·31
SN7407	0·38½	0·34	0·31
SN7408	0·20	0·18½	0·17½
SN7409	0·20	0·18½	0·17½
SN7410	0·16½	0·15½	0·13
SN7411	0·27½	0·26½	0·25½
SN7412	0·38½	0·34	0·31
SN7413	0·32	0·28½	0·26½
SN7416	0·47½	0·44	0·42
SN7417	0·47½	0·44	0·42
SN7420	0·16½	0·15½	0·13
SN7422	0·55	0·53	0·49½
SN7423	0·55	0·53	0·49½
SN7425	0·55	0·53	0·49½
SN7426	0·49½	0·46	0·44
SN7427	0·49½	0·46	0·44
SN7428	0·77	0·71½	0·66
SN7430	0·16½	0·15½	0·13
SN7432	0·49½	0·46	0·44
SN7433	0·88	0·82½	0·77
SN7437	0·70½	0·68	0·66
SN7438	0·70½	0·68	0·66
SN7440	0·16½	0·15½	0·13
SN7441	0·73½	0·70½	0·64
SN7442	0·73½	0·70½	0·64
SN7443	1·43	1·37½	1·32
SN7444	1·43	1·37½	1·32
SN7445	1·98	1·94½	1·92½
SN7446	1·06½	1·03½	0·97
SN7447	1·10	1·06½	1·04½
SN7448	1·10	1·06½	1·04½
SN7450	0·16½	0·15½	0·13
SN7451	0·16½	0·15½	0·13
SN7453	0·16½	0·15½	0·13
SN7454	0·16½	0·15½	0·13
SN7460	0·16½	0·15½	0·13
SN7470	0·32	0·28½	0·26½
SN7472	0·32	0·28½	0·26½
SN7473	0·40½	0·38½	0·35
SN7474	0·40½	0·38½	0·35
SN7475	0·49½	0·47½	0·46
SN7476	0·44	0·43	0·42½
SN7480	0·73½	0·70½	0·64
SN7481	1·32	1·26½	1·21
SN7482	0·95½	0·94½	0·93½
SN7483	1·21	1·15½	1·04½
SN7484	1·10	1·04½	0·99
SN7485	3·96	3·85	3·74

	1	25	100+
SN7486	0·35	0·34	0·33
SN7489	6·05	5·77½	5·50
SN7490	0·73½	0·70½	0·64
SN7491	1·10	1·04½	0·99
SN7492	0·73½	0·70½	0·64
SN7493	0·73½	0·70½	0·64
SN7494	0·84½	0·81½	0·75
SN7495	0·84½	0·81½	0·75
SN7496	0·95½	0·92½	0·86
SN74100	1·81½	1·76	1·70½
SN74104	1·06½	1·03½	0·97
SN74105	1·06½	1·03½	0·97
SN74107	0·44	0·42	0·39½
SN74110	0·60½	0·58½	0·55
SN74111	1·37½	1·26½	1·21
SN74118	1·10	1·04½	0·99
SN74119	1·48½	1·37½	1·21
SN74121	0·44	0·40½	0·37½
SN74122	1·54	1·43	1·21
SN74123	3·08	2·97	2·86
SN74141	0·73½	0·70½	0·64
SN74145	1·65	1·54	1·43
SN74150	3·30	2·97	2·75
SN74151	1·10	1·04½	0·99
SN74153	1·32	1·21	1·04½
SN74154	1·98	1·87	1·76
SN74155	1·54	1·43	1·32
SN74156	1·54	1·43	1·32
SN74157	2·09	1·98	1·87
SN74160	1·98	1·87	1·76
SN74161	1·98	1·87	1·76
SN74162	4·40	4·12½	3·85
SN74163	4·40	4·12½	3·85
SN74164	2·42	2·36½	2·31
SN74165	2·47½	2·42	2·36½
SN74166	3·85	3·57½	3·30
SN74174	2·53	2·42	2·31
SN74175	1·76	1·65	1·54
SN74176	2·75	2·64	2·53
SN74177	2·75	2·64	2·53
SN74180	2·20	1·76	1·54
SN74181	6·05	5·50	5·22½
SN74182	2·20	1·98	1·76
SN74184	3·85	3·57½	3·30
SN74190	2·14½	2·09	2·03½
SN74191	2·09	2·03½	1·98
SN74192	2·14½	2·09	2·03½
SN74193	2·20	1·98	1·92½
SN74194	2·97	2·86	2·75
SN74195	2·20	2·09	1·98
SN74196	1·98	1·87	1·76
SN74197	1·98	1·87	1·76
SN74198	6·05	5·50	4·95
SN74199	6·05	5·50	4·95

LINEAR I.C.'s—FULL SPEC.

Type No.	Price 1–24	25–99	100+
BP201C—SL201C	0·69½	0·58½	0·49½
BP710C—SL701C	0·69½	0·55	0·49½
BP702C—SL702C	0·69½	0·55	0·49½
BP702—72702	0·58½	0·49½	0·44
BP709—72709	0·39½	0·37½	0·33
BP709P—μA709C	0·39½	0·37½	0·33
BP710—72710	0·48½	0·46	0·44
BP711—μA711	0·49½	0·47½	0·44
BP741—72741	0·55	0·50	0·45
μA703C	0·31	0·28½	0·26½
TAA263	0·77	0·66	0·60½
TAA293	0·99	0·82½	0·77
TAA350	1·87	1·74	1·65
EA1000	2·89½		

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

Type No.	Price 1–24	25–99	100 up
BP930	0·13	0·12	0·11
BP932	0·14	0·13	0·12
BP933	0·14	0·13	0·12
BP935	0·14	0·13	0·12
BP936	0·14	0·13	0·12
BP944	0·14	0·13	0·12
BP945	0·27½	0·26½	0·24
BP946	0·13	0·12	0·11
BP948	0·27½	0·26½	0·24
BP951	0·71½	0·66	0·60½
BP962	0·13	0·12	0·11
BP9093	0·44	0·42	0·38½
BP9094	0·44	0·42	0·38½
BP9097	0·44	0·42	0·38½
BP9099	0·44	0·42	0·38½

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	£1·87	£1·70	£1·09

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
μL900 Buffer	38p	36p	29p
μL914 Dual 2i/p gate	38p	36p	29p
μL923 J-K flip-flop	55p	51p	49p

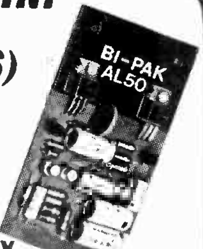
Date and Circuits Booklet for IC's Price 8p.

DUAL IN LINE SOCKETS

(14 & 16 Lead)	1–24	25–99	100+
TSO14	0·33	0·30	0·27½
TSO16 16 pin type	0·38½	0·35	0·33
BPS14 14 pin type (low cost)	0·16½	0·14½	0·12
BPS16 16 pin type (low cost)	0·17½	0·15½	0·13

BI-PAK DO IT AGAIN!

50W pk 25w (RMS)



0·1% DISTORTION!
HI-FI AUDIO AMPLIFIER

THE AL50

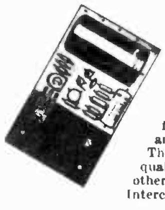
* Frequency Response 15Hz to 100,000—1dB.
* Load—3, 4, 8 or 16 ohms.
* Distortion—better than ·1% at 1KHz.
* Signal to noise ratio 80dB.

ONLY £3·57½ each

* Supply voltage 10–35 Volts.
* Overall size 63mm × 105mm × 13mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and AL50 was conceived to fill the need for all your A.F. amplification needs.
FULLY BUILT—TESTED—GUARANTEED.

STABILISED POWER MODULE SPM80

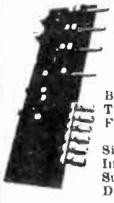


AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 68mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available, 10p **PRICE £3·24½**

TRANSFORMER BMT80 £2·14½ p. & p. 27½p

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 techniques. 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	1·25mV into 50K Ω
2. Radio, Tuner	35mV into 50K Ω
3. Magnetic P.U.	1·5mV 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 × 35m

ONLY £13·14½

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £25·30 FREE p. & p.

All prices quoted in new pence *Giro No. 388-7006*
Please send all orders direct to warehouse and despatch department

BI-PAK

P.O. BOX 6, WARE · HERTS

Postage and packing add 10p. Overseas add extra for airmail. Minimum order 50p. Cash with order please.

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ELECTROVALUE
Electronic Component Specialists

LARGE STOCKS,
ATTRACTIVE DISCOUNTS
DEPENDABLE SERVICE

TRANSISTORS BY SIEMENS AND NEWMARKET

2N3055 *npn* silicon power	**60p**
AC153K *pnp* germanium low power	**25p**
AC176K *npn* germanium low power	**23p**
AD161 *npn* germanium medium power	**42p**
AD162 *pnp* germanium medium power	**40p**
AF139 *pnp* germanium UHF	**33p**

NPN: BC107 **13p**, BC108 **12p**, BC109 **13p**, BC167 **10p**, BC168 **9p**, BC169 **10p**.

PNP: BC177 **15p**, BC178 **14p**, BC179 **15p**, BC257 **9p**, BC258 **8p**, BC259 **9p**.
Standard groupings available.

BD135 *npn* medium power	**26p**
BD136 *pnp* medium power	**27p**

DIODES

OA90, OA91, OA95, **6p** each; OA200, **9p**; OA202, **10p**.

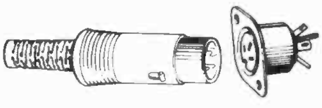
Other semiconductors: AC128, **17p**; AF117, **35p**; BFY51, **19p**. Full lists and technical data will be found in Catalogue No. 6.

SIEMENS' THYRISTORS
0·8A 400V **56p**, 600V **70p**.
3A 400V **60p**, 600V **88p**.

ZENER DIODES full range E24 values: 400mW: 2·7V to 36V, **14p each**; 1W: 6·8V to 82V, **21p** each: 1·5W: 4·7V to 75V, **48p** each. Clip to increase 1·5W rating to 3 watts (type 266F) **4p**.

DIN PLUGS AND SOCKETS

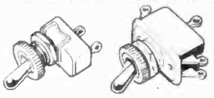
by Hirshmann, 4A rating



2 way L5 —socket **10p**, plug **12p**
3 way scr.—socket **10p**, plug **12p**
5 way scr.—socket **11p**, plug **15p**

TRANSISTOR ACCESSORIES
TO3 cover, **7p**; Heat sinks 1°C/W, type 6W1, undrilled, **60p**.

SWITCHES

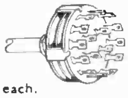


1011 SPST toggle, **20p**; 409 DPDT toggle, **29p** (these are chrome plated, 2·5A rating); 7201 sub-miniature DPDT 250V a.c./2A, **48p**.

ROTARY SWITCHES

Radiospares Miniature Maka-switch (in assembly kit form). Shaft, **48p**. Wafers, MBB-2P5W, 1P11W: BBM1P12W, 2P6W, 3P4W, 4P3W, 6P2W, **6p** each.

WAVECHANGE SWITCHES



1P12W, 2P6W, 3P4W, 4I3W, **32p** each.

ELECTROLYTIC CAPACITORS AXIAL LEAD

Rated voltage: / Capacity μF	3V	6·3V	10V	16V	25V	40V	63V	100V
0·47	—	—	—	—	—	—	7p	7p
1·0	—	—	—	—	—	7p	—	7p
2·2	—	—	—	—	7p	—	7p	7p
4·7	—	—	—	7p	—	7p	7p	7p
10	—	—	7p	—	7p	7p	7p	7p
22	—	—	7p	7p	—	7p	7p	8p
47	7p	—	7p	7p	7p	7p	8p	12p
100	7p	7p	7p	7p	7p	8p	12p	18p
220	7p	7p	7p	8p	9p	10p	17p	26p
470	7p	8p	9p	9p	12p	17p	24p	41p
1,000	9p	12p	12p	17p	20p	23p	40p	—
2,200	14p	16p	22p	25p	36p	40p	—	—
4,700	23p	26p	37p	40p	—	—	—	—
10,000	37p	40p	—	—	—	—	—	—

POLYCARBONATE—5% TOLERANCE
250V up to 0·1μF: 100V, 0·1μF and above.
0·01; 0·012; 0·015; 0·018; 0·022; 0·027; 0·033; 0·047; 0·056; **4p** each. 0·068; 0·082; 0·1; 0·12; 0·15; **4p** each. 0·18; 0·22; **5p** each. 0·27; 0·33, **6p**. 0·39 **7p**. 0·47 **8p**. 0·56 **10p**. 0·68 **11p**. 1μF **13p**.

MINITRON DIGITAL COUNTER
Type 3015F. Seven Filament segment indicators to make 0-9 + decimal point. Compatible with standard logic modules, nett **£2**. Decoder driver type FLL 121T nett **£1·36**. DIL socket, nett **£2**.

RESISTORS – 10%, 5%, 2%

Code	Power	Tolerance	Range	Values available	1 to 9	10 to 99 (see note below)	100 up
C	1/20W	5%	82Ω–220KΩ	E12	**9**	**8**	**7·5**
C	1/8W	5%	4·7Ω–470KΩ	E24	**1**	**0·9**	**0.75 nett**
C	1/4W	10%	4·7Ω–10MΩ	E12	**1**	**0·9**	**0·75 nett**
C	1/2W	5%	4·7Ω–10MΩ	E24	**1·2**	**1**	**0·8 nett**
C	1W	10%	4·7Ω–10MΩ	E12	**2·5**	**2**	**1·6 nett**
MO	1/2W	2%	10Ω–1MΩ	E24	**4**	**3**	**2 nett**
WW	1W	10% ± 1/20Ω	0·22Ω–3·9Ω	E12	**7**	**7**	**6**
WW	3W	5%	1Ω–10KΩ	E12	**7**	**7**	**6**
WW	7W	5%	1Ω–10KΩ	E12	**9**	**9**	**8**

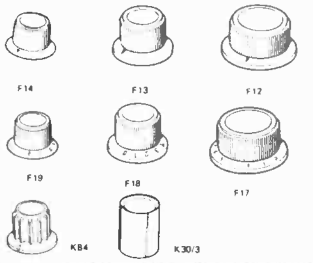
Codes: C = carbon film, high stability, low noise.
MO = metal oxide, Electrosil TR5, ultra low noise.
WW = wire wound, Plessey.
Values:
E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24 denotes series: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

Prices are in pence each for quantities of the same ohmic value and power rating. NOT mixed values. (Ignore fractions on total value of resistor order.)

EVERYTHING BRAND NEW, GUARANTEED TO MAKERS' SPEC. NO SECONDS OR REJECTS

KNOBS

All grub screw fitting for ¼in shafts. Black. For other types—see Catalogue No. 6, p. 54.
F.14 (20mm) pack of 2, **32p**; F.13 (26mm) pack of 2, **38p**; F.12 (33mm) pack of 2, **40p**; F.19 (20mm) pack of 2, **32p**; F.18 (26mm) pack of 2, **38p**; F.17 (33mm) pack of 2, **40p**; KB.4 (20mm) pack of 4, **40p**; K30/3 (17mm) aluminium, **24p** each.



TRANSFORMERS—MAINS

MT3 30V/2A plus 4 taps	**£2·85**
MT103 50V/1A plus 4 taps	**£2·55**
MT104 50V/2A plus 4 taps	**£3·50**
MT127 60V/2A plus 4 taps	**£3·80**
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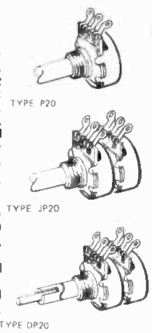

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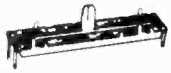

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STEREO RADIO WITHOUT TEARS

THE stereo tuner described this month has a number of interesting features which reflect some of the current approaches to domestic receiver design, as practised by set manufacturers.

In the field of domestic radio receivers, the integrated circuit has yet to make its full contribution. Various subsections of the conventional superheterodyne circuit have been designed and produced in monolithic form, but all these devices require additional discrete components in order to function. Thus the apparent labour- and material-saving advantages of i.c.s are largely nullified. The chief problem is one of inductances and capacitances. This real difficulty associated with monolithic circuits has encouraged further investigation into less conventional receiver designs where there is no dependence on LC tuned circuits. For example, the phase-locked-loop or synchronous detector receiver has been much discussed of late, as a likely future substitute for the classic superhet.

The i.c. has however made a noteworthy contribution to stereo receiver design. Single chip phase-locked decoders have been around for some time, and they represent perhaps the most highly developed integrated circuitry, with the highest component density, found at present in a sound receiver. A less exciting but important function performed by the i.c. is as a power supply regulator—a vital role in v.h.f. receivers incorporating varicapacitance diode (truly electronic) tuning.

The completely integrated high quality receiver will emerge eventually; whether as a single chip, or as a set of two or three i.c.s each covering a major portion of the system, only the i.c. and set designers and manufacturers will have a clue at this moment in time. While awaiting the inevitable, the ultimate in integration, set makers have in recent years been employing several methods. One popular approach is a different form of integration—using pre-adjusted circuit modules, containing conventional discretes. Mass production of complex receivers is thus greatly simplified and the need for critical alignment operations on the assembly line eliminated.

This approach has obvious attractions for the home constructor, especially where a complicated and highly sensitive piece of equipment such as a stereo tuner is concerned. This month's design illustrates the use of modules, i.c.s, and discrete components. Thus as a system it is interesting and instructive. It demonstrates how available circuit devices can be judiciously co-ordinated to produce a "state of the art design" for the modestly equipped home constructor.—F.E.B.

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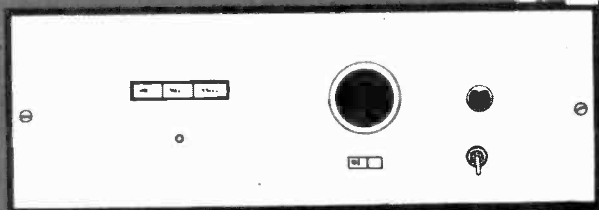
PUSHBUTTON VARICAP STEREO TUNER



By S.R.BEECHING

UP TO recent times the only methods of tuning radios were either the variable capacitor or the variable inductor. Using either system the result was the same, mechanics in the form of pulleys and pointers were needed to physically move either the vanes of the capacitor or the core of the inductor. Any constructor who attempted to build such a radio faced not only these mechanical problems but also the problem of alignment, particularly difficult in v.h.f. radios.

Two new tuner modules recently produced by Mullard go a long way to overcoming all these difficulties; they are pre-aligned and the tuning is electronic, not mechanical, i.e. there are no moving parts.

VARICAP TUNING

The tuner module uses a "varicap" diode for varying the tuning frequency. A varicap diode is one which takes advantage of the fact that the width of the depletion layer in a reverse biased diode varies with the reverse voltage. Thus one is effectively changing the gap between two plates of a capacitor. The capacitances involved are small and thus at the moment varicap tuning is restricted to v.h.f. tuners.

In the Mullard LP1186 module the tuning is carried out by applying a voltage between 2 and 17 volts to its input. Because the tuning is electronic this opens up a whole field of possibilities, in particular that of remote tuning.

THE MODULES

The tuner module type LP1186 has three stages, a tuned aerial and r.f. stage, giving good image and i.f. rejection, a separate oscillator stage for good signal handling, and a mixer stage with a double-tuned i.f. output circuit. The main characteristics of this module are shown in Table 1.

The LP1185 is an f.m.-i.f. amplifier module whose main characteristics are summarised in Table 2. Both modules require a supply voltage of 9V and this is also adequate to cover the broadcast band when applied to the varicap diode.

Cover photo by courtesy of London Electricity

Only a few components are needed around the modules for decoupling and de-emphasis. Automatic frequency control (a.f.c.) is available though this may be removed by shorting to ground when tuning weak stations.

STEREO DECODER

An MC1310P integrated circuit stereo decoder is used to split the output of the LP1185 into right and left channel signals. The integrated circuit has the advantage over some of the earlier types in that it needs no coils. It has automatic stereo switching and an indicator driver capable of driving a 60mA bulb. A light emitting diode (l.e.d.) is shown in the circuit together with a resistor necessary to drop the voltage to the 1·5V needed for an l.e.d.

Table 3 gives some of the data on the i.c. stereo decoder.

CIRCUIT DIAGRAM

The full circuit diagram excluding the tuning unit and the power supply are shown in Fig. 1. The input from the aerial is fed into pin B of the tuner module. The tuning voltage is applied to pin C. Capacitor C1 is only really necessary if there is a large separation between the tuning unit and the tuner and may be omitted. A.F.C. is taken from pin F of the output module and fed back to pin D of the tuner. Switch S1 removes this a.f.c. by shorting to earth.

The signal is then fed into pin 2 of the stereo decoder. D1 is the stereo indicator lamp. VR1 is used to adjust the frequency of voltage controlled oscillator which forms part of the stereo decoder.

Components C9, R4, C10, R5 are de-emphasis components needed to compensate for the pre-emphasis of the high frequency signals which is introduced at the transmission end.

Output is taken to the DIN output socket via C11 and C12.

Table 1: SUMMARY OF THE CHARACTERISTICS OF THE LP1186 F.M. TUNER MODULE

Tuning range	87·4 to 104·5MHz
Tuning voltage	2 to 12V
Bandwidth at −3dB points	300kHz
Aerial impedance	75Ω
Power gain (f_{in} = 95MHz)	30dB
Noise factor (f_{in} = 95MHz)	6·5dB

Table 2: SUMMARY OF THE CHARACTERISTICS OF THE LP1185 F.M.-I.F. AMPLIFIER MODULE

Centre frequency	10·7MHz ± 50kHz
I.F. bandwidth at −3dB points	250kHz
Sensitivity for 40mV output	300μV (min) 60μV (max)
F.M. output at limiting (1mV input)	180mV
Signal-to-noise level with 150μV input	60dB
A.M. rejection	40dB

Table 3: SUMMARY OF THE CHARACTERISTICS OF THE MC1310P STEREO DECODER I.C.

Maximum input signal	500mV r.m.s.
Pilot capture range	±3%
Distortion	<0·3%
Maximum stereo indicator current	70mA

POWER SUPPLY

In a varicap tuner the power supply is very important as the tuning voltage must be very stable and ripple free. The power supply circuit is shown in Fig. 2.

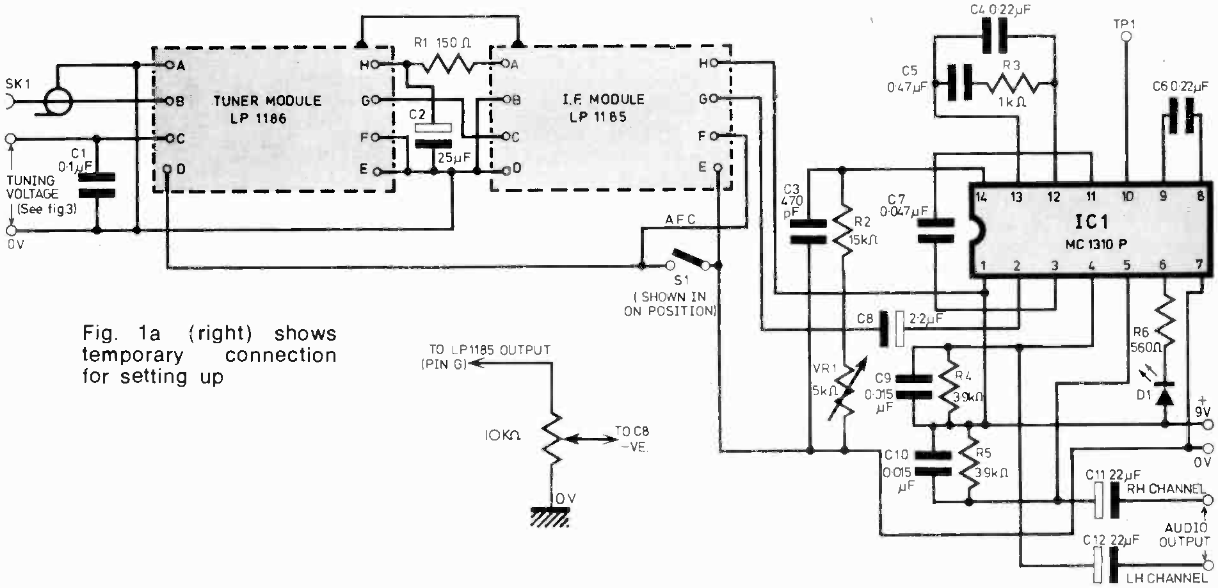


Fig. 1a (right) shows temporary connection for setting up

Fig. 1. Circuit diagram of the stereo tuner. The shaded boxes indicate ready built pre-aligned units. The tuning voltage unit is shown in Fig. 3

Photograph of the complete tuner showing the front panel layout

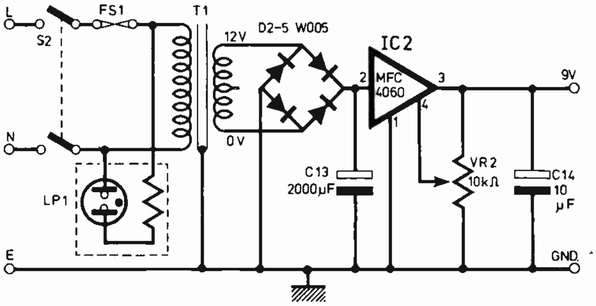


Fig. 2. Circuit diagram of the power supply unit. This not only supplies power to the modules but also provides the stabilised voltage necessary for tuning

The low voltage from the transformer is rectified by the diode bridge D2–5, smoothed by the large capacitor C13 and applied to the input of the integrated circuit regulator IC2. VR2 is used to tap off a fraction of the output voltage to feed back into the input of the i.c. Here it is compared with a reference voltage generated within the i.c. and the output is adjusted to make the two equal. Thus VR2 can be used to accurately set the output voltage.

The i.c. used will keep the output voltage to within 0·2 per cent of the nominal voltage for loads up to 100mA and within 0·03 per cent of nominal for power supply variations, provided that there is more than three volts between input and output. Because this i.c. also supplies the stereo decoder and hence the stereo indicator lamp it is best to keep the lamp current as low as possible hence the use of an l.e.d.

TUNING UNIT

As mentioned earlier, a tuning voltage of between two and nine volts will adequately cover the normal broadcast band. A suggested switching system is shown in Fig. 3. This system gives two preset stations and one manually variable setting. The number of preset stations may be extended *ad infinitum* depending only on the number of push buttons in the unit.

The circuit board shown will accommodate six preset potentiometers. Thus a six-button unit or a six-way rotary switch can be used.

Padding resistors are added at either end of the potentiometers so that fine tuning is easier, although this somewhat restricts the tuning range. Fig. 4 shows the relationship between tuning voltage and frequency and this allows calculations to be carried out on the best settings for each station. The padding resistors are mounted with the potentiometers forming small pillars.

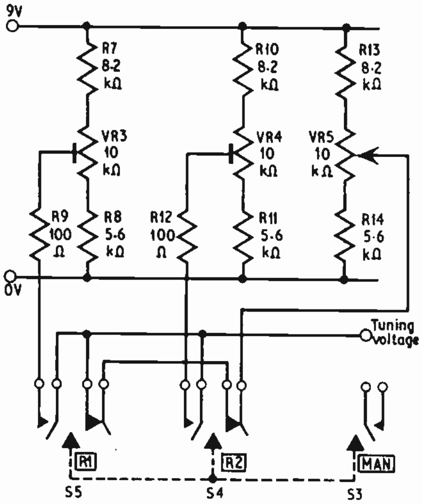


Fig. 3. A suggested tuning unit. This provides two preset voltages with a third manually variable voltage. The number of preset voltages really only depends on the size of the push button unit. There is also no reason why this tuning unit should not be mounted remote from the tuner itself. S3 is simply used to cancel the other two switches

CONSTRUCTION

Construction is simple if the printed circuit board (Fig. 5) or the layout recommended are followed. Note that the orientation of the i.c.s is critical, a small spot indicates pin 1. Assemble the power supply components first (Fig. 6). Set VR2 to midway then switch on and test the output with a voltmeter, adjusting VR2 to give a 9V output.

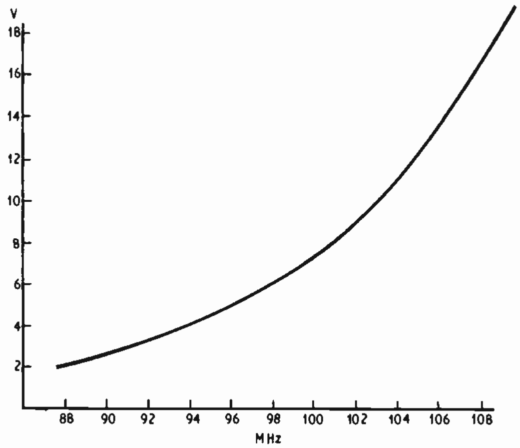


Fig. 4. Relationship between the tuning voltage and the frequency as measured in the prototype

CIRCUIT BOARD

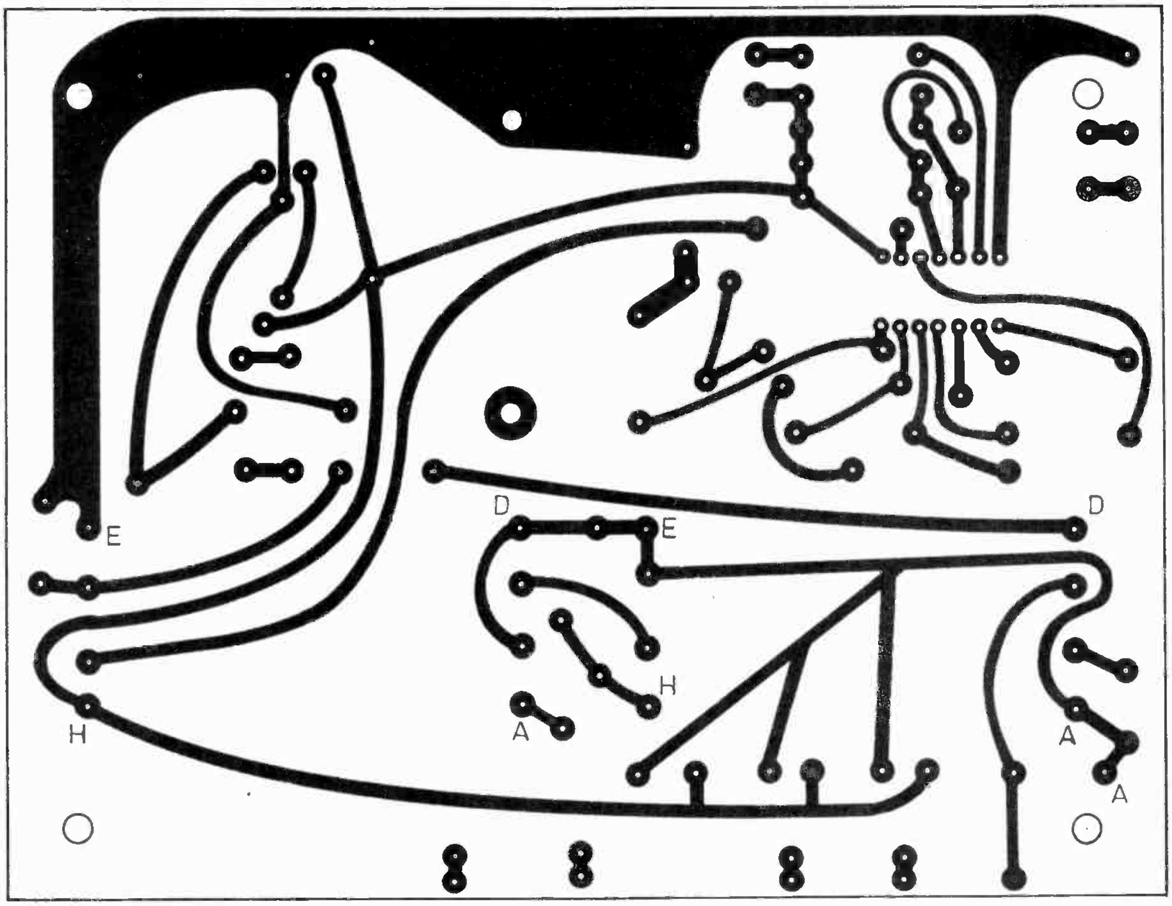


Fig. 5. The underside of the printed circuit board. The black areas indicate copper, the white areas being etched away

COMPONENTS . . .

Resistors

R1	150Ω	R4	3·9kΩ	R7	8·2kΩ	R10, R13	8·2kΩ
R2	15kΩ	R5	3·9kΩ	R8	5·6kΩ	R11, R14	5·6kΩ
R3	1kΩ	R6	560Ω	R9	100Ω	R12	100Ω

All ¼W ± 10% carbon except R2 5%

Potentiometers

VR1 5kΩ skeleton preset
VR2 10kΩ skeleton preset
VR3, VR4 10kΩ skeleton preset (2 off)
VR5 10kΩ carbon linear

Capacitors

C1	0·1μF	C8	2·2μF 64V elect.
C2	25μF 12V elect.	C9	0·015μF
C3	470pF 2%	C10	0·015μF
C4	0·22μF	C11	22μF 25V elect.
C5	0·47μF	C12	22μF 25V elect.
C6	0·22μF	C13	2,000μF 25V elect.
C7	0·047μF	C14	10μF 16V elect.

Diodes

D1 Light emitting diode 1·5V 20mA (West Hyde)
D2–5 W005 or any 50 p.i.v. ½A bridge rectifier

Integrated Circuits

IC1 Motorola MC1310P
IC2 Motorola MFC4060

Transformer

T1 Mains primary, 12V 100mA secondary

Modules

Tuner Module Mullard Type LP1186
I.F. Module Mullard Type LP1185

Switches

S1 Miniature rocker or slide on/off switch
S2 Miniature d.p.d.t. toggle switch
S3–5 3 way pushbutton unit, each switch cancelling the other two

Miscellaneous

FS1 100mA fuse and fuseholder
SK1 Coaxial socket
SK2 5 pin 180° DIN socket, panel mounting
LP1 Mains neon indicator with integral resistor
PL1 Mains panel mounting plug Bulgin type P360
3-way tag strip, printed circuit board, case, 6BA and 8BA nuts and bolts

Printed circuit board and modules can be obtained from B & B Electronics, 64 Manners Road, Balderton, Newark, Notts.

After checking the power supply attach the other components. Note the link between the cases of the two modules. Do not attach C8 at this stage. Push button units vary as to the type of contact arrangement. If you are not sure use a continuity tester, e.g. a battery and bell or lamp to find two contacts which make when the appropriate button is pressed.

As mentioned before there is no reason why the push button units should not be mounted remote from the tuner.

SETTING UP AND TESTING

Prior to testing and final setting up, ensure that a good aerial is available and also an amplifier for monitoring. A v.h.f. aerial will be needed for low noise stereo although a v.h.f. television aerial or a length of wire will suffice for initial checks.

Before setting up is explained, some description of the stereo decoder is useful to understand what is going on. Fig. 7 shows a block diagram of the stereo decoder i.c.

The audio input is buffered and separated from the 19kHz pilot tone which is fed to two modulators which act as phase discriminators; modulator 1 is the input to the phase locking loop and modulator 2 is used as the stereo detector and indicator. Each provide an output which is proportional to the phase difference between the pilot input and the regenerated 19kHz signal (TP1). The output from modulator 1 controls the frequency of a 76kHz oscillator which is then divided by two to give a 38kHz signal necessary for decoding. The regenerated 38kHz is divided by two to give 19kHz which is fed back to the modulators, forming part of the phase locked loop.

If this regenerated 19kHz differs in phase from the 19kHz pilot then the modulator will correct the 76kHz oscillator thus locking it to the pilot tone. The resultant output from modulator 2 triggers a Schmitt trigger which switches on the stereo indicator and feeds the regenerated 38kHz to the decoder. With mono transmissions the audio comes out of the decoder outputs simultaneously, no pilot tone being present.

INTERWIRING

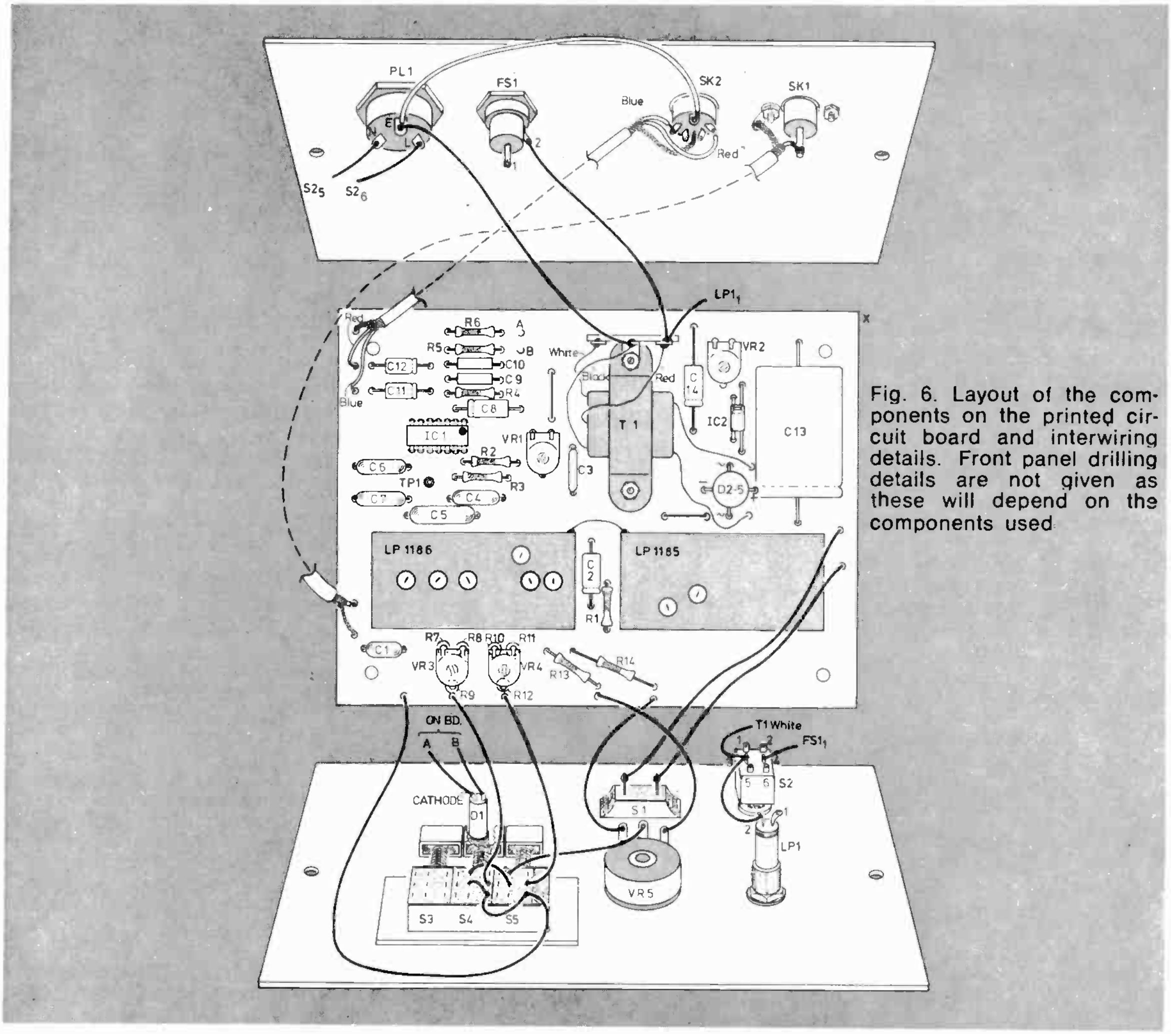


Fig. 6. Layout of the components on the printed circuit board and interwiring details. Front panel drilling details are not given as these will depend on the components used

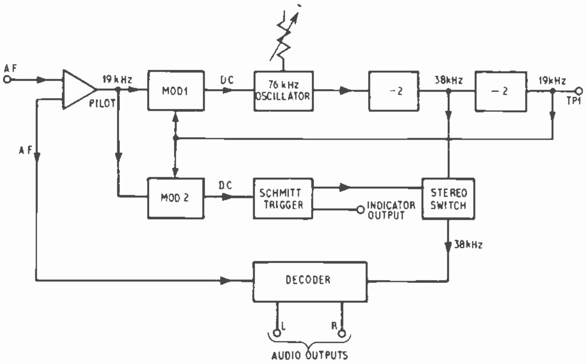


Fig. 7. Block diagram of the MC1310P stereo decoder i.c

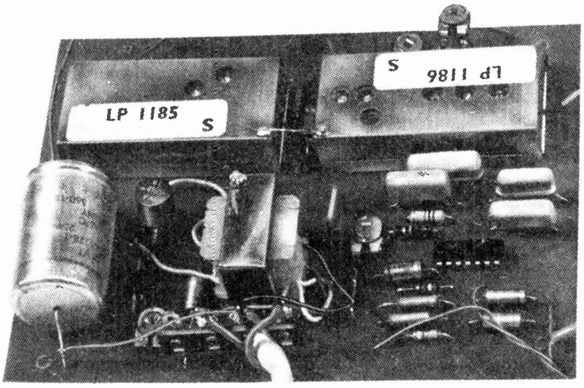
OSCILLATOR ADJUSTMENT

There are two ways to set VR1, the object being to set the oscillator to 76kHz with no pilot or input signal.

Connect the tuner to an aerial and an amplifier with C8 in position on the board, then switch on. It should be possible to tune into a station at least in mono (ignore the indicator lamp if it should come on). Switch off the a.f.c. and tune slightly away from the station, then switch back to a.f.c.; the station should pull in, if the signal is strong. Leave the a.f.c. on and tune to a known stereo broadcast. Rotate VR1 until the stereo indicator just lights and a stereo output is heard. There will probably be a good deal of background noise especially with a poor aerial.

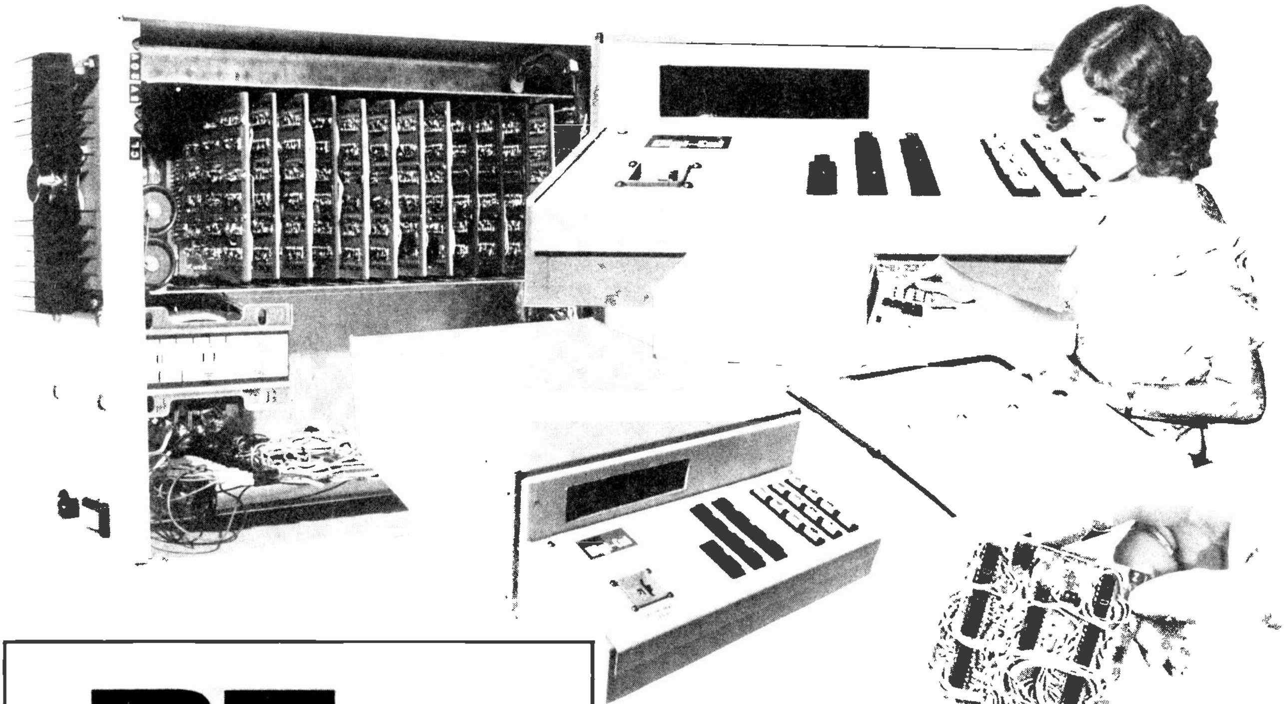
If an oscilloscope is available monitor TP1 with the tuner locked onto a station. Remove the input signal and reset the frequency to this measured value.

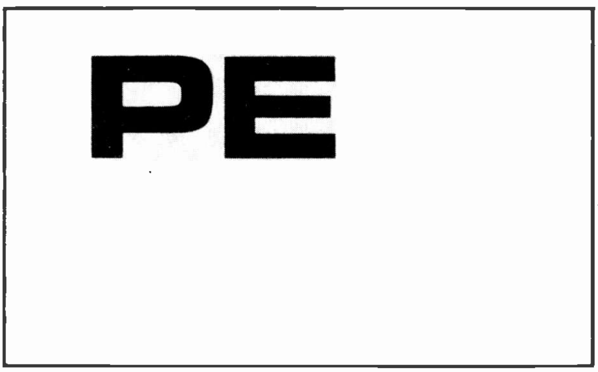
An alternative method of setting up is to reduce the signal level to the decoder thus reducing the range of VR1. Connect the positive end of C8 to the board but connect a 10 kilohm potentiometer between its negative end and the LP1185 output (see Fig. 1a). Switch on and tune to a stereo broadcast then adjust this potentiometer to give maximum audio output. Adjust VR1 until the stereo indicator lights then alternately reduce the output with the potentiometer and adjust VR1 until the setting of VR1 is very sharp or critical, this being the correct setting. ★



Photograph of the internal layout of the tuner

CONCLUDING ARTICLE





By R.W.COLES

PART 11

OVERFLOW LOGIC AND OVF BOARD

This final part of the Digi-Cal series describes the remaining logic housed on the under-chassis overflow (OVF) board, and attempts to knit together the loose ends which have been left dangling in earlier articles. Testing and troubleshooting information is also given.

OVERFLOW (OVF) BOARD

The existence of the OVERFLOW board was established in Part 2, when it was mentioned that this board is mounted copper side uppermost under the chassis, spaced from it by two 6BA nuts on each of the supporting bolts.

The OVF identity was not given to this board in Part 2 but is used here for ease of reference, the majority of the logic housed on this board being concerned with the OVERFLOW circuitry.

The Veroboard panel itself is mounted in the copper up fashion to facilitate the use of this board as an interconnection and power bus medium in addition to its job of housing logic. This mounting method also permits the easy addition of circuitry without access to the underside of the board, the only compromise necessary being that of neatness, since the solder is "on display" together with the components.

INTERCONNECTIONS

The OVF board carries the +5V and ground line power buses, from which the other logic cards are supplied. Any other logic lines which are employed, e.g. the FUNCTION CODE A and B are also allocated a copper strip for bus use to permit a tapping to be made where required.

Programme functions are distributed from the OVF board by means of a series of terminal pins which act as distribution points, the decision as to which functions require this treatment being left to the individual constructor as layouts will undoubtedly vary.

OVERFLOW LOGIC

The OVERFLOW logic is required to detect and indicate any errors resulting from the incorrect operation of the calculator, indication being provided via the red OVF lamp on the keyboard. If this lamp comes on at all during a calculation then an improper operation has been attempted and the only course open is to depress the CLEAR key which also resets the OVF circuits.

There are several ways in which an error condition can occur, an error being a state which would result in an incorrect answer being given. Detection of these states requires a combination of three separate logic groups whose areas of responsibility are as follows:

(a) ENTRY OVERFLOW. If too many digits are entered into the E REGISTER, the most significant data can be destroyed by being shifted out of the end of the register. This condition must be detected.
(b) A REGISTER OVERFLOW. If during a multiplication sequence, the product exceeds the capacity of the A REGISTER then the CARRY STORE will stay set at the end of an addition which is an indication of OVERFLOW.
(c) ANSWER OVERFLOW. The Digi-Cal A REGISTER has a ten digit capacity although only eight digits are displayed, the other two positions in the register being for transient use during programme execution. Should either of these two positions contain other than zeros at the end of a programme sequence then an OVERFLOW has occurred.

This type of OVERFLOW can occur during ADDITION, MULTIPLICATION and when a negative answer is produced in complement form.

OVF CIRCUITS

The active circuitry of the OVF board is shown in Fig. 11.1, where it can be seen that in addition to the OVF logic proper, IC141 and IC146 perform the functions of constant store buffering and E^2 gating respectively.

Bistable BS2 of IC144 acts as the common OVF latch, which is set by an output from any of the three separate OVERFLOW detection circuits, and which controls the OVF lamp driver on the KEYBOARD logic board. The OVF latch is cleared when the CLEAR key is depressed in response to an OVF indication.

The NOR section of IC145 which is a four-wide two-input AND-OR-INVERT gate combines the inputs from three detection circuits to drive the BS2 PRESET input, an output from any of the three resulting in a SET LATCH signal.

ENTRY OVERFLOW LOGIC

IC142 and G1 of IC143 are used to detect E REGISTER overflows. The system used here to monitor the B.C.D. outputs of the most significant digit position of the register with IC142, which, in this application, can be considered as a four-input positive NOR gate with a common disable input.

The output of IC142 is gated with the E CLOCK to generate the OVF output when necessary.

Gate IC142 is in fact waiting for one or more of its inputs to go to a logic 1, indicating that the most significant digit of the E REGISTER contains other than decimal zero.

On the arrival of a further clock pulse an error output is generated to set the latch.

A problem arises here since by using the straightforward E CLOCK an error output would be produced one step too early. What is really needed is an E CLOCK "pre-pulse" which comes and goes before the register itself is clocked. At first sight this is an impossible requirement to meet; however, by using the inherent propagation delays of the gates involved, such an arrangement can be achieved.

What happens is that when a B.C.D. output other than zero appears in the most significant position of the register a 1 input to pin 9 of IC145 results.

Much later, when another number key is pressed the rising E CLOCK on IC145, pin 10 will result in an error output to pin 8, setting the latch. Even before the clock rises on pin 10, the unbuffered E CLOCK operates the common disable input connected to pins 1, 3, 5 and 9 of IC142 removing the 1 input to IC145, pin 9.

The result at the output of IC145 is an extremely narrow pulse which in practice could be too narrow to set the latch BS2. The way to stretch this pulse is to increase the propagation delay through IC142 and G1 of IC143, and this can be conveniently achieved by increasing the capacitive load on the output of IC142.

A capacitor C_x is shown on the diagram and can be added if the error output is found to be too short on test; the value used should be between 200pF and 1,000pF.

No such capacitor was necessary on the prototype.

A REGISTER OVERFLOW LOGIC

The operation of the A REGISTER detection logic is quite straightforward; in this case the task is simply to detect the presence of a stored carry at the end of ten clock pulses during a multiplication or addition.

The rising edge of the END OF TEN output from board CB triggers a monostable made up of BS1 of IC144 and G2 of IC143. The indication that the clock sequence is at an end is gated with the CARRY SENSE output from board AD, in G3.

The output of G3 is gated with an inverted FUNCTION CODE A (which is an indication of the arithmetic operation being performed) in the AND section of IC145 to produce the ERROR output at pin 8.

ANSWER OVERFLOW LOGIC

Detecting an integer in the two most significant A REGISTER positions seems on the face of it to be quite straightforward, but in practice such considerations as lack of space on the A boards to install i.c. gates, and lack of edge contacts on the A boards to allow external i.c. gates pose some problems.

The only practical solution is to construct a special gate using discrete components which operates as a positive logic NOR. This design requires only the installation of four diodes, and the utilisation of only one edge contact on each A board.

The problem of the low logic 1 levels associated with TTL outputs is overcome by clamping the emitter of TR22 of the gate to about $\frac{1}{2}V_{cc}$, and using TR23 to regenerate suitable logic levels to interface with IC145 pin 13.

Pin 1 of IC145 gates the ERROR output from the discrete component gate with what is effectively an END OF PROGRAMME signal (DISPLAY A) so that valid transient outputs from TR23 during programme execution have no effect on the OVF LATCH.

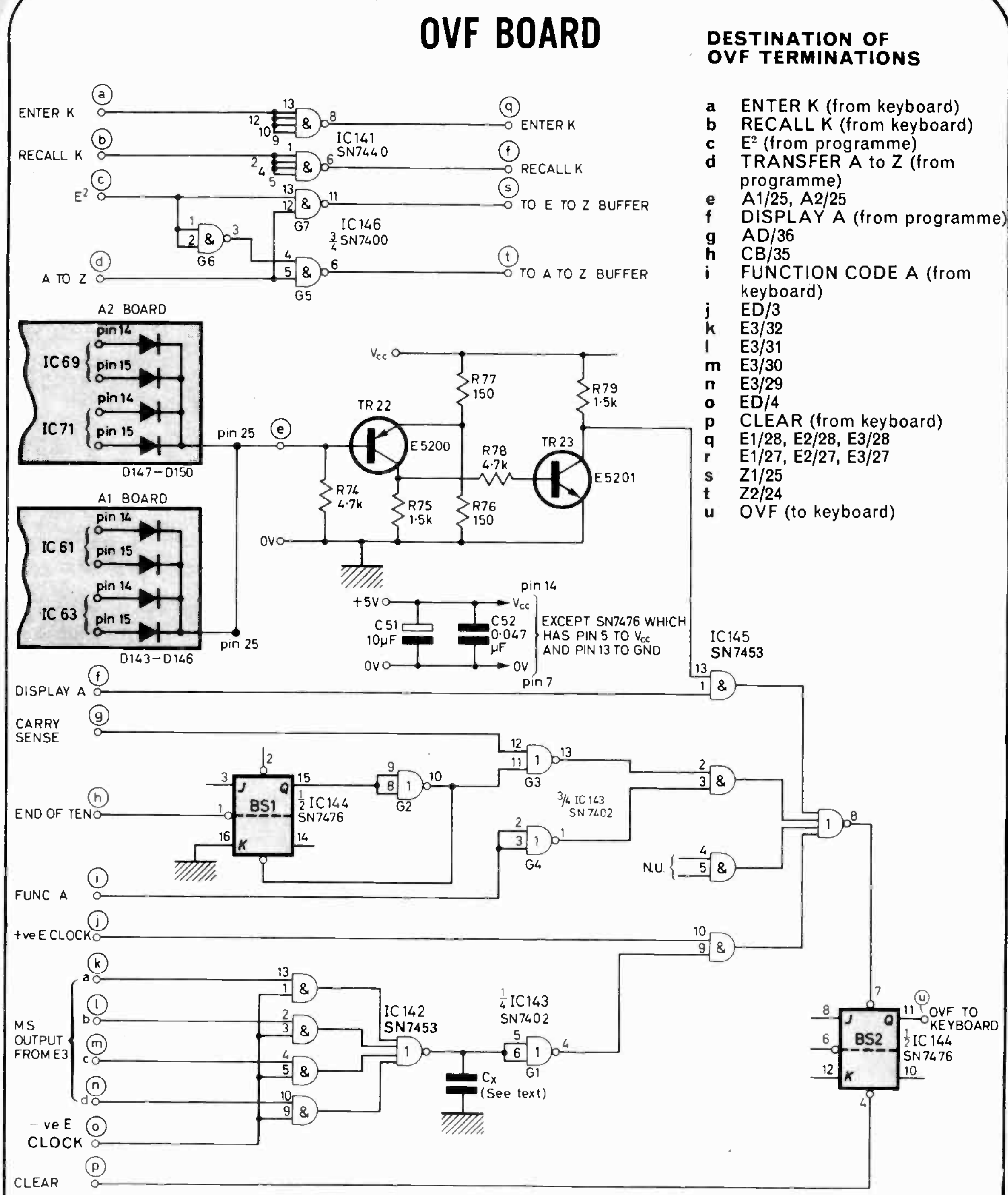


Fig. 11.1. Circuit diagram of the various units contained on the OVF board

DIVIDE OVERFLOW

No logic has been included to show that an OVERFLOW during a DIVISION operation has occurred.

Logic to fulfil this function would be simple to design and could use pins 4 and 5 of IC145 as an access to the OVF LATCH, but this was not carried out on the prototype because a divide overflow is very obvious to the operator by virtue of the fact that no answer is produced on the display.

E SQUARED GATING

It was only after the component location stage of Digi-Cal design that it was realised that the addition of a very few gates could produce an automatic E^2 facility to complement the basic arithmetic functions.

The gating required is so simple that the incorporation on the OVF board is quite straightforward.

The object of the three gates shown in Fig. 11.1 as part of IC146 is to divert the A to Z transfer command from the PROGRAMME to the E to Z buffer gate when the E^2 latch on the PROGRAMME board is set.

This simple operation causes the MULTIPLY programme to multiply the number in the E REGISTER by itself. The normal command to transfer the A REGISTER contents to the Z REGISTER is blocked and the E to Z transfer substituted, resulting in the number E being both multiplier and multiplicand.

CONSTANT STORE BUFFERS

IC141 is an SN7440 buffer gate which is interposed between the KEYBOARD outputs and the constant store to provide the drive and inversion

OVF LOGIC CONSTRUCTION

Although the E^2 logic and the constant store buffers will have to be wired up before the testing stage, it is best to leave the OVF detection logic until the calculator is operating correctly. Connecting up these circuits before proper operation is realised could lead to confusion.

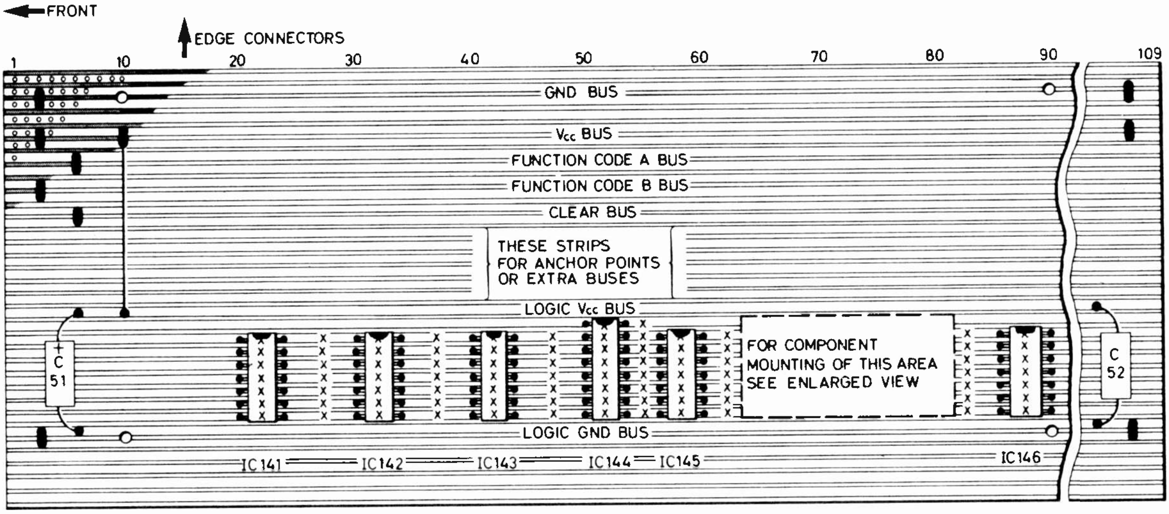
Having both the i.c.s and the wiring on the copper side of the board takes a little getting used to when soldering, but there are no special problems to look out for, and circuit tracing is really much easier. The board layout is shown in Fig. 11.2, and mounting position in Fig. 11.3.

OVERALL TESTING

It would be a very optimistic constructor indeed who wired up the whole Digi-Cal, switched on, and expected it to work perfectly first time.

There will no doubt be wiring errors, perhaps a faulty i.c. (there were three in the prototype), and a dry joint or two.

The policy of piecemeal testing suggested in previous parts will undoubtedly have eliminated most



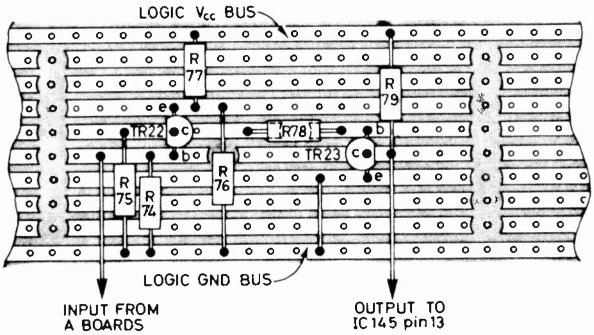


Fig. 11.2. Construction of the OVF board. Note that both the wiring and components are placed on the copper strip side of the Veroboard panel

COMPONENTS . . .

OVF BOARD

Resistors
R74 4·7kΩ
R75 1·5kΩ
R76 150Ω
R77 150Ω
R78 4·7kΩ
R79 1·5kΩ

Capacitors
C51 10μF 15V elect.
C52 0·047μF
C_x (see text)

Diodes
D143–150 West Hyde type "red" or any small silicon diode (8 off)

Transistors
TR22 E5200 } (West Hyde)
TR23 E5201 }

Integrated Circuits
IC141 SN7440
IC142 SN7453
IC143 SN7402
IC144 SN7476
IC145 SN7453
IC146 SN7400

Miscellaneous
11in × 3·6in × 0·1in matrix Veroboard panel

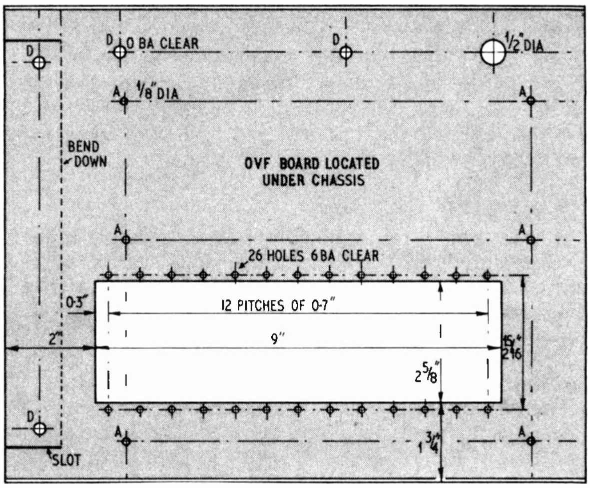


Fig. 11.3. The OVF board is mounted on the underside of the chassis in the four holes marked "A" in the main chassis plate

faults, and certainly the constructor who has reached the final testing stage, which basically involves making the programmes work as required, will be sure that all the boards are fundamentally serviceable.

The first hurdle to be cleared is the correct operation of the ADD/SUBTRACT programme and when this has been achieved (with a slow clock speed if desired) the bulk of the arithmetic section can be given a clean bill of health.

The MULTIPLY and DIVIDE programmes can then be tackeld in turn and if any problems are encountered a thorough understanding of the way the calculator should be operating will soon sort these out.

It cannot be stressed enough that after gathering evidence via a multimeter and display, the best strategy in solving a problem is to sit down with a paper and pencil and ponder the possible causes: aimless probing will get you nowhere.

CLOCK SPEED

The ultimate objective of the testing phase is to increase the clock speed to as high a rate as possible while maintaining correct operation.

In the prototype a speed of over 1MHz was obtained despite the far from ideal underchassis "bird's nest" wiring resulting from prototype modifications.

Constructors should be able to do better than this easily since all improvements have been incorporated in the published designs and any advance achieved in this respect will be rewarded by a shorter maximum multiplication time, important when operating near to the maximum capacity of the machine. ★

Corrections. We apologise for these errors which occurred during the course of Digi-Cal articles.

Part 3, Fig. 3.2. Capacitors C3, C4, C5 and C6 should be connected between +5V and GND, not as shown. The strobe outputs from IC7 are reversed, i.e. pin 12 should be strobe 8 and pin 4 should be strobe 1.

Part 4, Fig. 4.2. Switch S19 is shown twice, the K switch should be S5. S13 is shown twice, the **Decimal Point** switch should be S3. Both are shown correctly on Fig. 4.5. The diode labelled D103 on IC26 should be D101.

Part 5, Fig. 5.8. The K switch should be labelled **Recall K** output.

Part 6, Fig. 6.10. Connection from the Z1 and Z2 sockets to the E1, E2 and E3 boards show the pin numbers incorrectly. Correct destinations can be found by adding 22 to each of the pin numbers associated with the E boards, e.g. Z1/1 should go to E3/31. Also Z1/19 should go to AD/41, and Z1/20 to AD/42. Z2/19 goes to AD/39; Z2/20 to AD/40, not as shown. Z2/44 should go to Z1/42 and Z2/42.

A1/1 should go to AD/27; A1/10 to AD/31; A1/11 to AD/32.

A2/1 should go to AD/25; A2/10 to AD/29; A2/11 to AD/30.

Fig. 6.7. CP in IC77 and 78 should go to pin 3 not 2.

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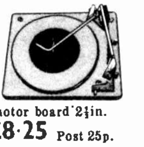

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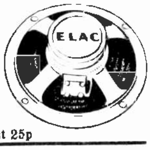

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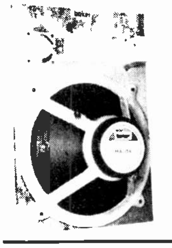

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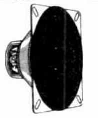

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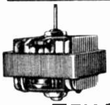

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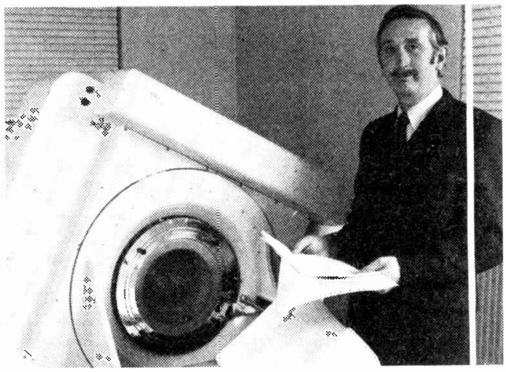
5. The X-ray generating system.

THE BASIC PROBLEM

The conventional X-ray photograph taken of the human body suffers from a serious drawback in that it is attempting to portray a three-dimensional object on a two-dimensional photographic plate. The X-ray picture indicates the X-ray intensity after it has passed through the object being examined. Typically the X-rays will have passed through bone, tissue, fat, blood, etc. and the resulting picture produced will be confused due to the superimposition of the various materials. Frequently the diagnostician is attempting to detect a small variation in the X-ray absorption of tissue (which may indicate some abnormality such as a tumour) when the area of interest is masked by a nearby bone. This situation is shown in Fig. 1.

The human brain poses a considerable problem for radiologists because it is totally enclosed in the protective bone of the skull. In an attempt to overcome some of the limitations of the conventional skull X-ray, several more sophisticated techniques have been developed such as angiography, ventriculography, and radioactive isotope brain scanning. These techniques, while giving some improvement in diagnoses, can cause considerable discomfort to the patient as well as in some cases requiring a team of highly trained staff to perform them. In addition to this the patient may need to be hospitalised after examination.



THE MACROBERT AWARD

For the invention of a new X-ray technique, Mr Godfrey Hounsfield and EMI Limited won the 1972 MacRobert Award.

This Award, often described as the Nobel Prize for engineering, consists of a Gold Medal and £25,000 prize money. It is presented annually, in recognition of the technological innovation contributing most significantly to the prestige and prosperity of the United Kingdom.

It was instituted by the MacRobert Trusts in 1968 and is administered by the council of Engineering Institutes, which is the federal body for 15 chartered engineering institutes.

This is the first time the award has been made in the field of electronics. In his citation for the Award, the Chairman of the MacRobert Award Evaluation Committee said, "One of the medical referees consulted during the evaluation stated that no comparable discovery has been made in this field since Röntgen discovered X-rays in 1895, and we agree with him.

"The EMI-Scanner system developed by Mr Hounsfield within the Central Research Laboratories of EMI is epoch-making, because it breaks away from the photographic techniques for recording X-ray pictures which in principle have remained unchanged since Röntgen's day . . .

"There is another aspect of EMI-Scanner which is remarkable. In these modern days it is rarely that one finds great developments which are the work of one man. The EMI-Scanner is different: the submission for the MacRobert Award was prepared not by the inventor, but by EMI, who stated, 'Mr Hounsfield has been the guiding expert throughout all aspects of the work. The EMI-Scanner was as much a one-man invention as anything can be these days'."

THE NEW TECHNIQUE

The EMI-Scanner offers considerable advantages to both the diagnostician and the patient.

This new system uses X-rays to produce pictures of slices of the head as shown in Fig. 2. The head of the patient rests in a rubber head cap, and a gantry, on which is mounted the X-ray tube and detectors, is able to rotate around the head to perform the scanning sequence shown in Fig. 3. With the gantry in the 0° start position, the X-ray tube and detectors move so as to make a linear pass of the head. The whole gantry then rotates 1° and the X-ray tube and detectors move back to make a further linear pass.

The gantry then rotates a further 1° and this sequence of linear passes and 1° rotations is repeated until a total rotation of 180° has been achieved. Each complete scan does in fact yield results for two contiguous slices of the head as shown in Fig. 4. The thickness of each slice can be adjusted to either 0·8cm or 1·3cm by means of collimators in the X-ray beam. The two pictures from a single patient scan are achieved by using two detectors each with its own associated data processing channel.

The X-ray detectors used are photomultipliers with sodium iodide scintillating crystals. During each linear pass of the head, 160 readings of X-ray intensity are made by each detector so that for each complete scan of 180° a total of 180 × 160 = 28,800 readings are taken. The 160 readings are controlled by means of a glass grating consisting of alternately transparent and opaque sections. This grating moves with the X-ray tube and detectors, and passes between a lamp and photodiode. The output from this photodiode controls the operation of electronic circuits which measure the output of each detector.

For each complete scan the scanning system yields a set of 28,800 readings from each of the two detectors plus an additional set of 28,800 reference readings of the X-ray intensity before passing through the patient's head. These three sets of readings are put into digital form by an analogue to digital converter and stored in the buffer section of a magnetic disc pack. This is illustrated in the block diagram of the system Fig. 5.

DATA PROCESSING

These readings of X-ray intensity now have to be used to solve many thousands of simultaneous equations so that the X-ray absorption value at each point in the slice can be calculated. This operation is performed by a mini-computer, which, by means of a specially written computer program, is able to call-up these readings from the disc store and process them. The computation, which takes about five minutes for each picture, results in 6,400 output values in digital form which are stored in the main storage section of the magnetic disc pack.

PICTURE DISPLAY

The 6,400 digital values can be called-up on command and converted into analogue form where they may be used to build up a picture on the cathode ray tube screen of the Viewing Unit. This picture consists of a matrix of 80 × 80 picture points, the brightness of each point representing the X-ray absorption of the tissue.

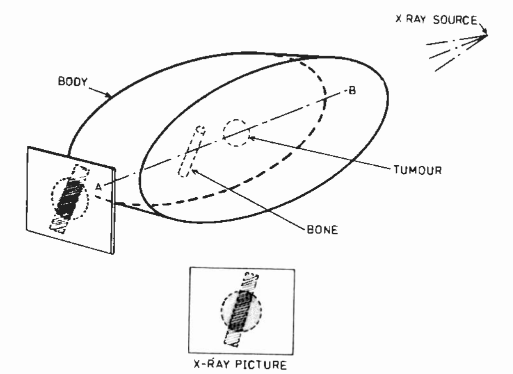


Fig. 1. Conventional X-ray technique

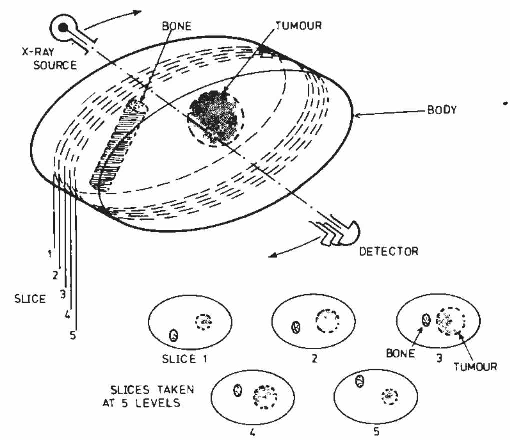


Fig. 2. Computerised transverse axial technique

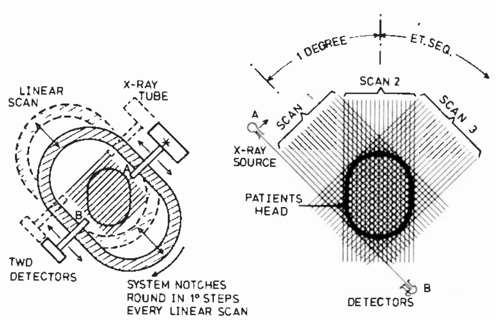


Fig. 3. Motion of scanning frame and detectors for producing two contiguous slices

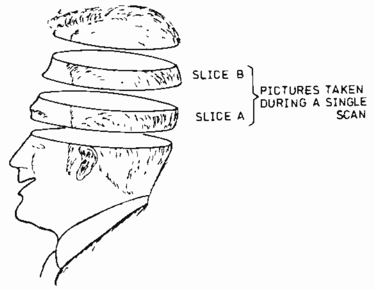


Fig. 4. Two slice planes taken during a single scan

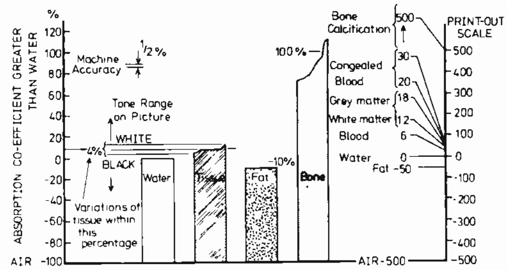


Fig. 6. X-ray absorption chart

An alternative method of displaying the results is to use a line printer which will print out the numerical values of the X-ray absorption coefficient at each point of the 80 × 80 matrix.

The chart shown in Fig. 6 illustrates the range of measurement of the system. The left-hand scale shows the percentage X-ray absorption coefficient greater or less than that of water and the vertical blocks show the coefficients for materials commonly encountered in clinical radiology, i.e. blood, tissue, bone, etc. The right-hand scale on the chart shows the scale actually used on the equipment, with dense bone at +500, water at 0 and air at −500. The system is accurate to within 2½ units on a range 0 to 500.

In order that the diagnostician can select the information which is displayed on the Viewing Unit there are two very important controls—window width and window level.

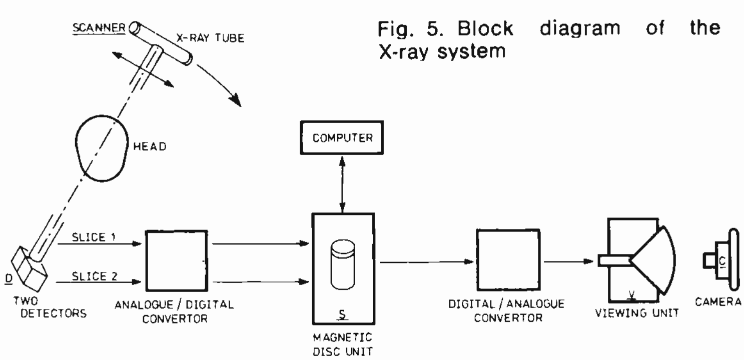
The window width control selects the range of X-ray absorption values which yields black to peak white on the cathode ray tube screen.

The window level control enables this selected band to be moved up or down the scale of absorption values. As an example with the window level control set at +15 (centre of the band) and the window width set at 20 all tissue with X-ray absorption values less than +5 would appear black and all values greater than +25 would appear white. Values between +5 and +25 would appear of different brightness values between black and peak white.

An illustration showing the effect of the window level control is shown in Fig. 8. The top left-hand picture shows the control set at −50; all values less than −60 appear black, all values greater than −40 appear white. The dark ring represents air trapped in the hair of the patient. The top centre picture shows the control set at 0 with the saline fluid-filled ventricles just beginning to show. The top right- and lower left-hand pictures show intermediate settings of the control to show detail of brain tissue at +10 to +20. The lower right-hand picture shows the control set at +50 with the white ring representing the bone of the skull. These pictures clearly show that the diagnostician can select the displayed picture to suit the material under examination.

By switching the window width control to a "measure" position, which yields 1 digit black to peak white on the display, it is possible to measure the X-ray absorption at any chosen point in the picture.

Fig. 5. Block diagram of the computerised X-ray system



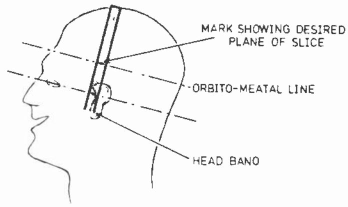


Fig. 7. Marking the slice planes on a headband

The window level control is adjusted until the point under examination is just changing from black to white. The absorption value can then be read off directly from the window level scale.

PATIENT PREPARATION

As each complete scan of the patient yields results on only two 1·3cm thick slices of the head it may be necessary to perform three or four such scans to cover the major part of the brain. If, however, it is desired to locate the examination at a certain point this is done very easily. Firstly an adhesive white tape is fixed over the head of the patient to form a head-band. This is then marked to show the orbito-meatal line, which is an imaginary line drawn between the corner of the eye and the meatus of the ear, used as a reference point. If for example the diagnostician requires to examine a slice 5cm above the orbito-meatal line, then a mark is made at this position on the head-band. This is illustrated in Fig. 7.

At this point the patient's head is inserted in the machine and the rubber head cap is collapsed onto the skull by means of water pressure to expel the air. The patient's head within the head cap is located in a plastic cone on which is printed a scale, and the mark denoting the chosen plane of slice is then read off against this scale. This reading is noted and the patient is then moved either into or out of the machine by means of a hand-wheel beneath the diagnostic table until a pointer and scale indicate the same value as the head cone reading. The patient has then been set in the machine such that a slice either side of the marked plane is examined.

A range of different plastic head cones is available in order to accommodate heads of various sizes and also to allow the head to be tilted for certain special examinations.

Each patient is normally allocated an identifying number which the radiographer can enter into the machine store before each scan by means of thumb-wheel switches on the X-ray Control Unit. This number appears on the pictures and print-outs for that scan and so gives a positive link between the patient and the result.

The computer normally processes each set of readings in serial order from the buffer store. However, should the diagnostician require the results from a certain patient quickly, then the computer can be instructed to give priority processing to a selected picture.

APPLICATIONS

As with any X-ray technique the EMI-Scanner system relies on the fact that the various structures found in the brain must have different X-ray absorption values in order that they can be differentiated. Even though the system is extremely sensitive there may be cases where the use of a contrast medium can be an advantage. Typically a small quantity of an X-ray opaque substance such as iodine can be injected intravenously into the patient.

If for instance there is a lesion which takes up the contrast medium more than the surrounding normal tissue then the diseased area will show up clearly on the picture, and, using the EMI-Scanner system, will continue to do so for several hours. The use of contrast media in this way should be compared with the technique used in angiography where the fluid is injected into the arterial system of the body and the effect lasts for only a few seconds.

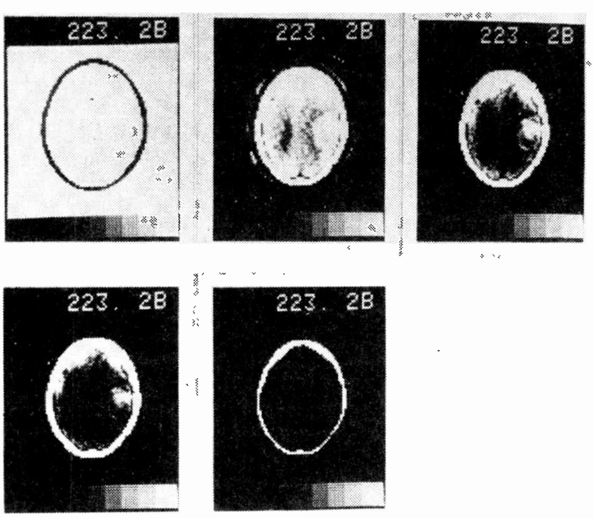
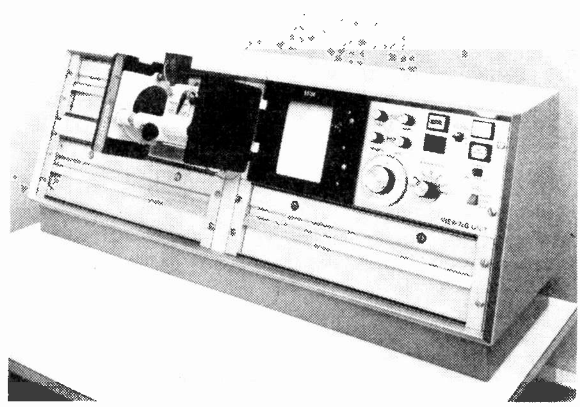


Fig. 8 (left). Effect of the "window level" control

The Viewing Unit

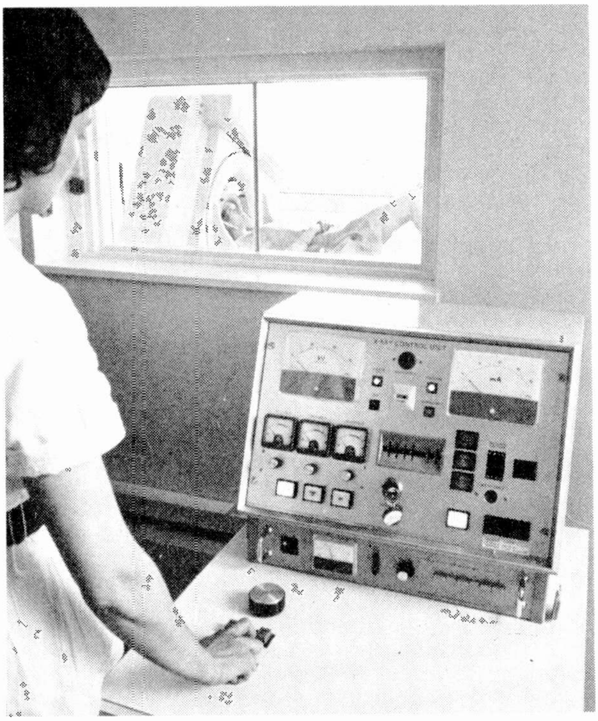


View of a patient in position on the scanning unit

TECHNICAL DETAILS

The circuit techniques used are in general of a conventional nature incorporating both discrete components and integrated circuits mounted on printed circuit boards. Both the Scanning Unit control electronics and the viewing Unit contain a large amount of logic circuitry.

The X-ray Control Unit



A feature of the system is the high degree to which the various controls are interlocked to ensure safe and correct operation by non-technical operators. As an example of this, the scanning sequence cannot be started until four conditions are satisfied:

1. That the scanning gantry is in the start position.
2. That the operator has set the patient's identifying code on the thumbwheel switches.
3. That the computer is ready to receive data into the disc buffer.
4. That the operator has removed the safety key from the Scanning Unit control panel and has inserted it in the X-ray Control Unit.

The status of these interlocks is clearly shown by means of indicating lamps so that the operator can check visually before starting the sequence.

The system for generating the X-rays is designed to give good stability and incorporates regulators for both voltage and current to the X-ray tube. Three-phase a.c. mains is converted to 100V 150Hz by a power conversion unit, which is then fed to the e.h.t. transformer. The output voltage is full wave rectified and smoothed to give an output of up to $\pm$70kV w.r.t. earth for the X-ray tube.

The X-ray tube is a fixed anode type, the cathode being aligned to give a line rather than a spot focus.

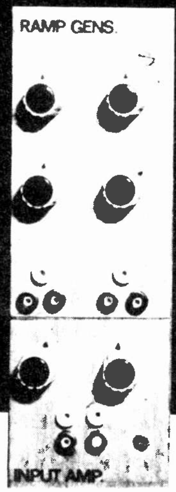
CONCLUSION

This system is being confidently predicted by many radiologists as one which will revolutionise the use of X-rays. The significance of this new technique has already been noted in Great Britain where its inventor, Mr G. N. Hounsfield, of the Central Research Laboratories of EMI Ltd., has recently received the MacRobert Award for outstanding innovation in engineering.

ACKNOWLEDGEMENT

The writer wishes to thank the Directors of EMI Ltd. for permission to publish this article. ★

PE Sound Synthesiser 4
RAMP GENERATORS & INPUT AMPLIFIERS
By G.D. Shaw



THIS month, the operation and construction of the ramp generators and input amplifiers will be described together with guidelines on using the various modules, so far described, in combination.

RAMP GENERATOR

The ramp generator to be described is effectively a sawtooth oscillator capable of working down to very low frequencies. At the low end of its working range the output of the device may be considered to be slowly changing d.c. and, unlike the v.c.o. which produces an output waveform swinging about zero, the output of the ramp generator is single-ended, that is, swinging from zero to about −3·5V.

The reason for this arrangement is that the ramp generator is considered essentially as a device for programming other voltage controlled modules all of which require control voltages of one polarity only. This requirement, incidentally, does not mean that alternating voltages cannot be used for programming and, as will be shown, many interesting effects can be obtained when the control voltages vary about zero.

As with the v.c.o. the principle of operation is that of the linear integrator although the circuit shown in Fig. 4.1 is very much simpler.

IC1 is the integrator which receives its positive control voltage either from VR1, an external source, or from both in combination. IC2 is a comparator which, since single ended operation is required, utilises a reference voltage set by R7-R8 and transistor TR1 to discharge the integrating capacitor C1. The reference voltage also determines the peak ramp output voltage of the circuit.

CIRCUIT OPERATION

The operation of the circuit is as follows. The divider R7/R8 provides −3·5V at the non-inverting input of IC2 and effectively biases TR1 off. Assuming that the R1 input to IC1 is open circuit, a positive voltage derived from VR1 is applied to the inverting input of IC1 via R2 and the integrator begins to ramp negatively at a rate determined essentially by R2/C1.

When the ramp output voltage applied to the inverting input of IC2 is equal to or greater than the reference voltage the comparator switches to its positive saturation state, turns on TR1, and discharges C1 via R6 and R7.

The sawtooth output waveform is taken from the junction of R4 and R5 via VR4 while a pulse output is available from the emitter of TR1. Note that this requires to be a.c. coupled if it is to be used effectively.

CONSTRUCTING THE RAMP GENERATORS

Construction of the ramp generators is perfectly straightforward, the recommended circuit board layout being shown in Fig. 4.2. Note that both ramp generators (RG1/RG2) are built on one circuit board and that power supply decoupling is not required.

The method of construction should generally follow that employed for the v.c.o. module. Components should be mounted to the front panel and prewired before the panel is secured to the circuit board support plate. Note, however, that in this case the main wiring harness from the ramp generators should leave the front panel at the top and pass over the top edge of the circuit boards while the wiring to the input amplifiers should be as short as possible and routed direct to the appropriate circuit board.

A detail of the panel component wiring and board layout is shown in Fig. 4.3. The McMurdo plug should now be prewired and mounted into the support plate.

TESTING

When assembly of one of the ramp generators has been completed make temporary connections to power supply leads and front panel controls and connect a resistor of at least 10 megohms across the integrating capacitor C1. Set VR2 and VR1 to their minimum values, VR3 to its mid-position, and switch on the power supply. Observe the integrator output on the oscilloscope and adjust VR3 for zero offset. Switch off and remove the 10 megohm resistor.

Set VR2 to its mid-position and switch on again. A sawtooth waveform of about 7Hz should now be observed. Gradually reduce the setting of VR2 until the slope of the ramp begins to show slight rippling.

RAMP GENERATORS

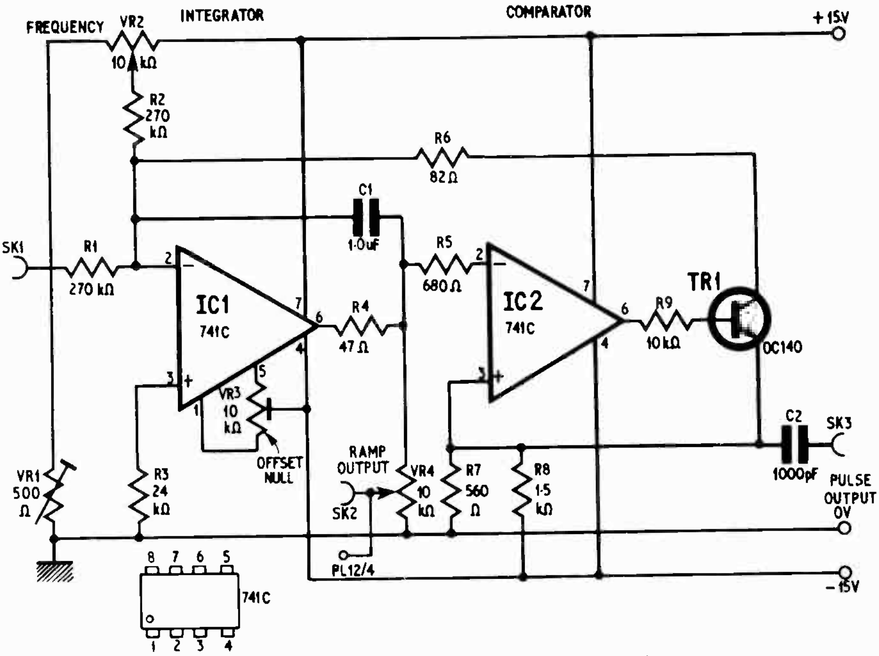


Fig. 4.1. Circuit of a ramp generator

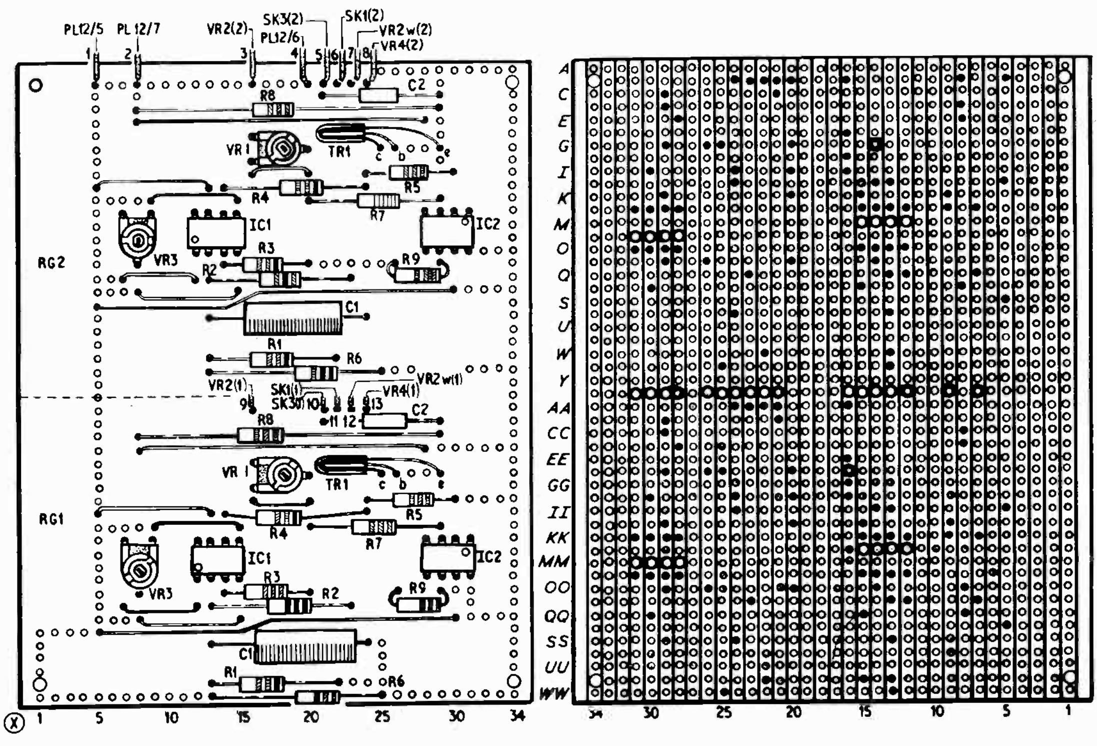


Fig. 4.2. Component layout and wiring of ramp generators

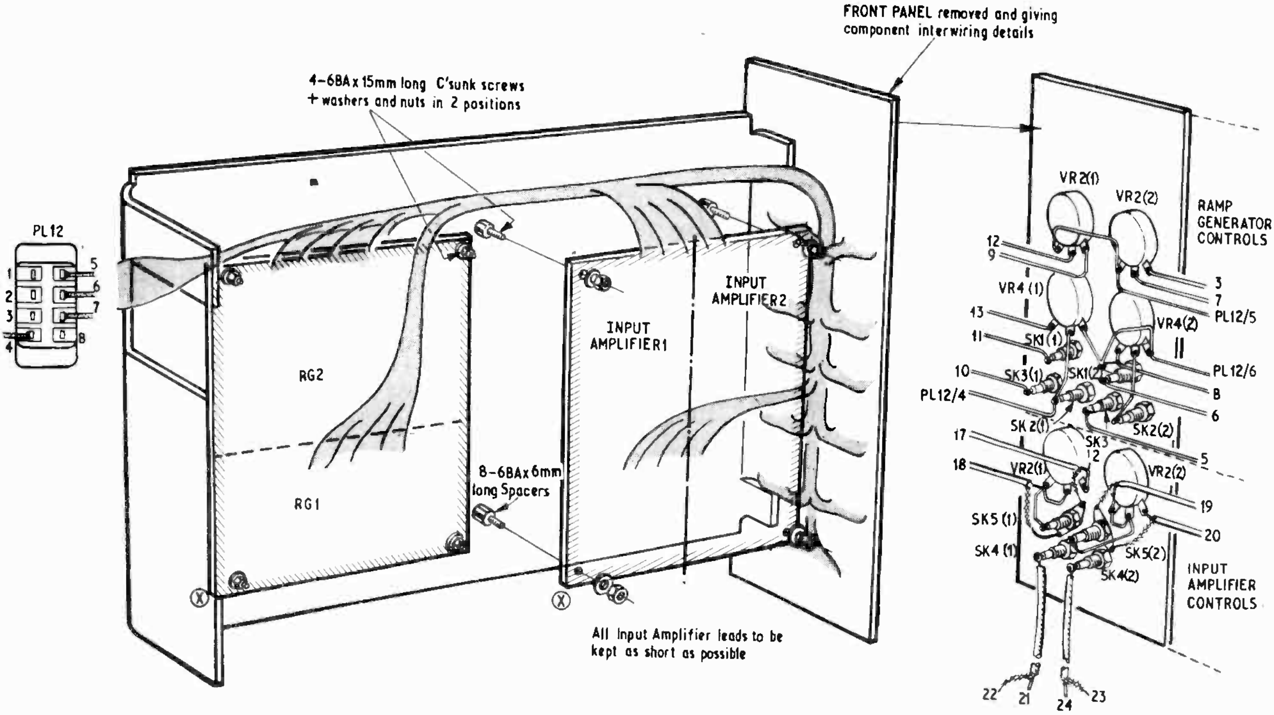


Fig. 4.3. Control panel wiring and board layout of ramp generator module. A lead should be taken from SK2(2) to PL12/8

COMPONENTS . . .

RAMP GENERATOR (2 OFF)

Resistors

R1, R2	270k Ω (2 off)
R3	24k Ω
R4	47 Ω
R5	680 Ω
R6	82 Ω
R7	560 Ω
R8	1·5k Ω
R9	10k Ω

All 2% ½ watt metal oxide

Capacitors

C1 1μF polyester 25V
C2 1,000pF polystyrene

Integrated Circuits

IC1, IC2 741C 8 pin D.I.L. (2 off)

Transistor

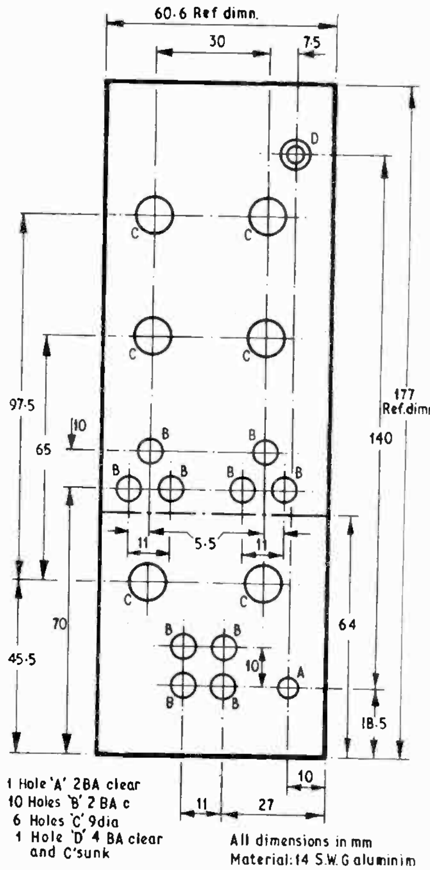
TR1 OC140

Potentiometers

VR1 500 Ω horizontal carbon preset
VR2 10k Ω miniature moulded carbon linear potentiometer
VR3 10k Ω horizontal carbon preset
VR4 10k Ω miniature moulded carbon linear potentiometer

Miscellaneous

SK1–SK3 2mm miniature sockets (3 off), 2 Elma knobs, 34 × 17 way 0·1in matrix Veroboard



INPUT AMPLIFIER

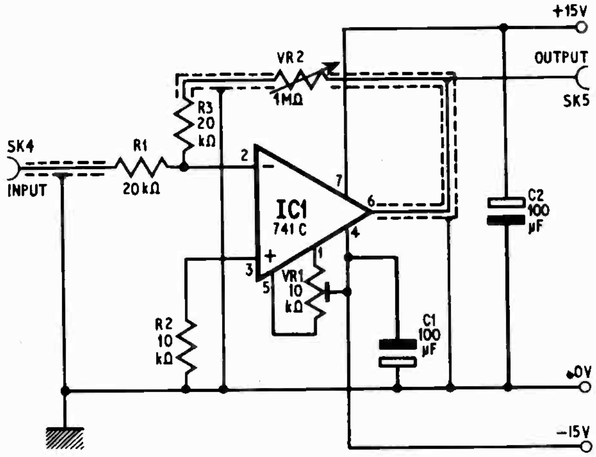


Fig. 4.4. Circuit of an input amplifier

COMPONENTS . . .

INPUT AMPLIFIERS (2 OFF)

Resistors

R1 20k Ω
R2 10k Ω
R3 20k Ω
All 2% ½ watt metal oxide

Capacitors

C1, C2 100μF elect. 25V (2 off)

Potentiometers

VR1 10k Ω horizontal linear preset
VR2 1M Ω linear miniature moulded carbon

Integrated Circuit

IC1 741C 8 pin D.I.L.

Miscellaneous

SK4, SK5 2mm miniature sockets (2 off), 34 × 17 way 0·1in matrix Veroboard, 1 Elma type knob

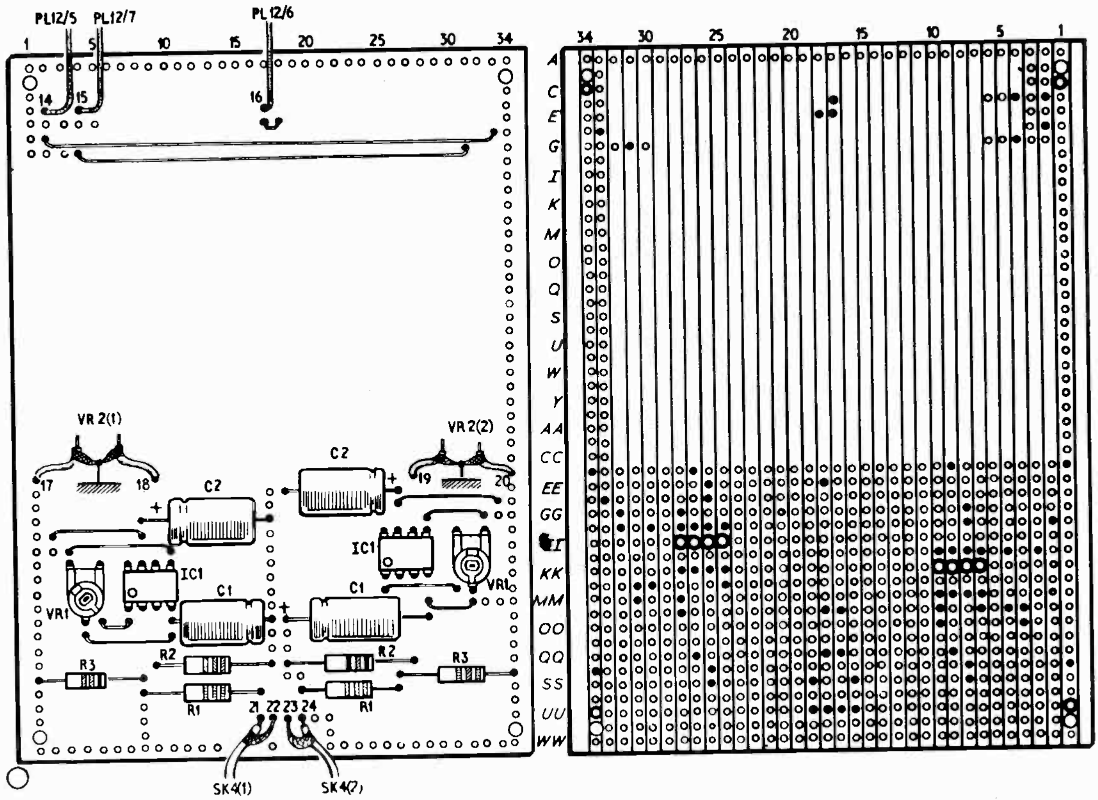


Fig. 4.5. Circuit board layout of input amplifiers

Increase the setting of VR1 until the rippling disappears and make further reductions in the setting of VR2, adjusting VR1 as necessary to keep the slope ripple free. Note that at the minimum setting of VR2 the ripple effect is at very low frequency and shows itself more as a hesitancy in the motion of the oscilloscope trace.

With careful adjustment, and the component values shown, it is possible to achieve a low frequency of 0·01Hz but it is almost impossible to remove ripple entirely at this frequency and generally it is best to set the low end of the range to 0·05Hz to ensure stability. The upper frequency limit with the 1·0μF integrating capacitor is about 15Hz.

In the prototype instrument one ramp generator was built as described and the second was built with an integrating capacitor of 0·47μF thus giving an upper frequency limit of about 30Hz with very little sacrifice to the v.l.f. end of the range. Such a procedure is recommended since the higher frequency is very useful in the production of rapidly changing, complex sound patterns.

When both ramp generators have been built and tested, mount the circuit board on the support plate in the position remote from the front panel (Fig. 4.3).

INPUT AMPLIFIERS

The input amplifier theoretical circuit is shown in Fig. 4.4 and the circuit board layout in Fig. 4.5.

Although very simple in design rather more care is required in the component layout if hum pick-up is to be avoided, this latter problem tending to occur more when the gain control VR1 is at its maximum setting. Note that screened wire is used to connect the input sockets and gain controls to the circuit board. These wires should be trimmed as closely as possible to the required length and led directly to the circuit board without being formed into a harness.

The only setting up required is the adjustment of the offsets. VR2 should be set to maximum, the input grounded and, with the power supply on, adjusted to give an output level of precisely zero.

Reference to block diagram in Part One will show that Oscillator 1 is programmed directly by Ramp Generator 1 through the medium of a prewired interconnection. Accordingly tag 4 on the ramp generator McMurdo socket (SK12) should be connected to tag 1 on the v.c.o. socket (SK8). This direct connection may be over-ridden by inserting either an open circuit or grounded jack plug into the external programming socket of the v.c.o. Alternatively a jack plug coupled to a patch cord may be used to provide programming from another source.

It is recommended that grounded jack plugs are used if precise manual control of v.c.o. frequency is required.

PROGRAMME DATA SHEET

The completion of this module provides the constructor with greater facilities for the production of programming waveforms and some quite complex sound structures. With the addition of the v.c.o. module there are now seven separate circuits and 12 controls to manipulate. There is thus a need for a method of logging control settings and interconnections so that any given sound structure may be repeated at a later date.

Details of a data sheet which will prove ideal for the purpose are given in Fig. 4.6. Control settings would normally be recorded in the circles on the front panel representation while module interconnections would be indicated by a dot in the appropriate square on the grid matrix. Data recorded in the figure relates to the production of a type of bird song which will be described in detail in a later article.

USING THE CONSTRUCTED MODULES

The provision of the input amplifiers allows waveforms from the oscillators and/or ramp generators to be mixed either additively or subtractively when used in combination with the voltage inverter. The permutation of all the possible settings of amplitude and frequency controls implies that an enormous range of sound structures may be produced and, whereas it is beyond the scope of this article to cover all the possibilities, a number of simple experiments are suggested for guidance.

Starting with the ramp generators, Fig. 4.7a shows the type of relationship which may be observed on the oscilloscope when one ramp generator is running at ten times the frequency of the other. With the output of a v.c.o. coupled to a suitable power amplifier and its frequency control at zero, application of either of the waveforms shown will cause the v.c.o. frequency to be swung from the lowermost end of the range to an upper frequency determined by the amplitude of the ramp generator waveform.

Since the upper frequency limit of the v.c.o. is dictated by the saturation level of the differential stage and since the gain of this stage is 10 then a programming waveform amplitude of about 1·4V will drive the v.c.o. to its maximum frequency.

Fig. 4.7b shows the effect of mixing the waveforms shown in Fig. 4.7a additively. To achieve this, route the outputs of the ramp generators to separate input amplifiers which have their gain controls set to zero, i.e. unity gain, and then to the inputs of the voltage inverter. Observation of the output of this latter device reveals the composite waveform.

With the ramp generator output levels adjusted so that the maximum combined level is about 1·4V route the voltage inverter to the input of the v.c.o. The result is an undulating sound the lowermost frequency of which is continuously rising at a rate set by the frequency of the slowest running ramp generator.

SUBTRACTIVE MIXING

Fig. 4.7c shows the effect of subtractive mixing of the ramp generator waveforms. Achievement of the staircase form is as follows.

Set the amplitude of the slowest ramp generator output to 1·4V and route this to the voltage inverter via an input amplifier set to unity gain. Route the second ramp generator to the voltage inverter direct. Since this now sees the inputs from the ramp generators at opposite polarities the result is subtractive mixing which, when the amplitudes are at the correct levels, produces a staircase as shown.

Application of this waveform to the v.c.o. produces a rising, arpeggio-like sound. A falling arpeggio may be produced by reversing the routing of the ramp generators with the slowest direct to the voltage inverter, and fastest to the voltage inverter via the input amplifier. In this latter case the frequency control of the v.c.o. has to be set to its maximum level since the waveform from the voltage inverter is now positive going.

SYNTHESISER PROGRAMME SHEET

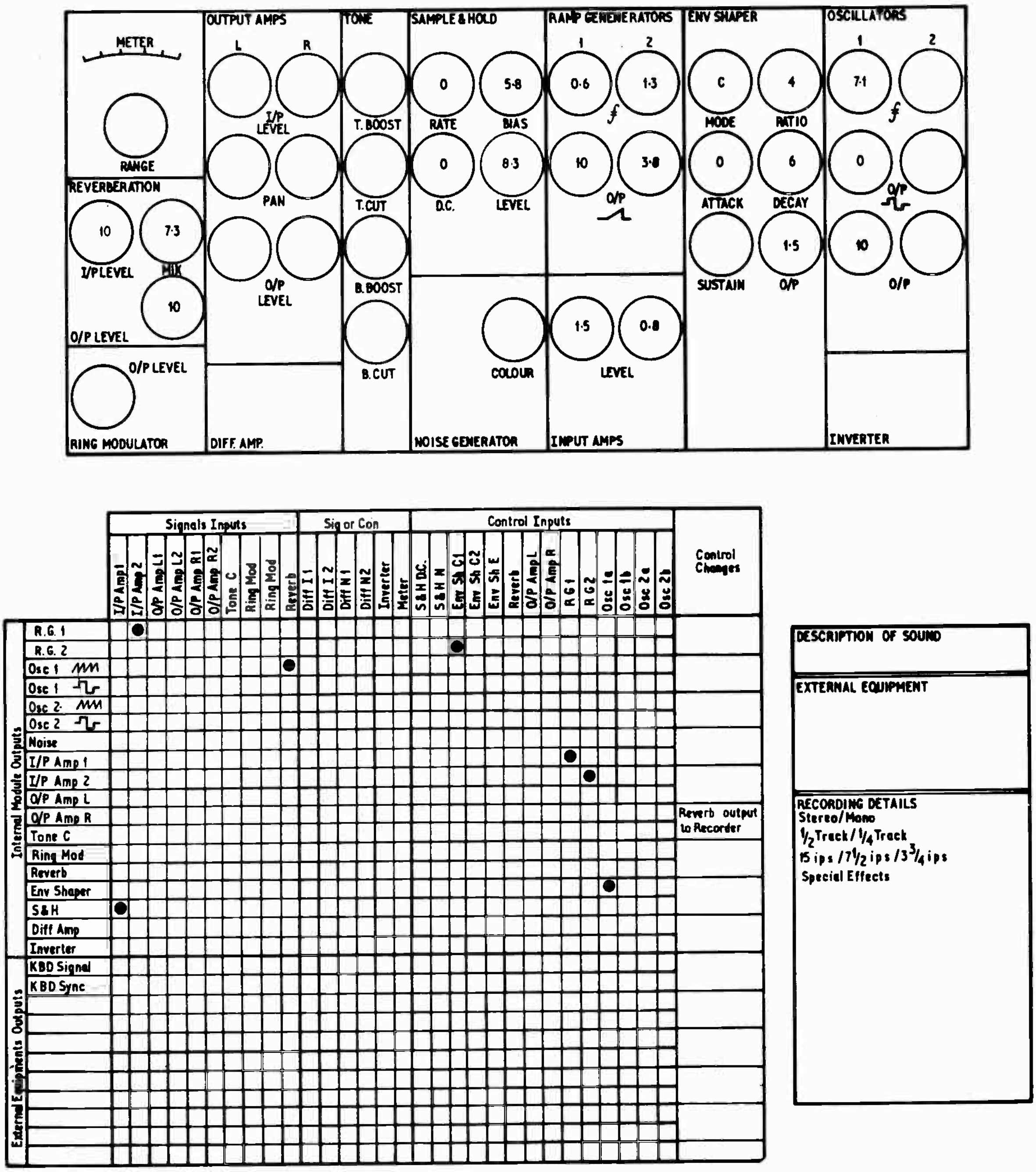


Fig. 4.6. Example of a programme data sheet

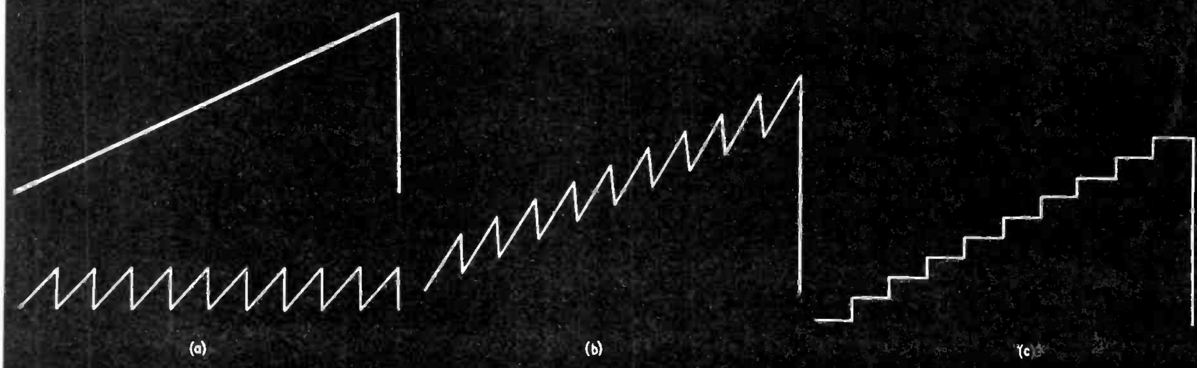


Fig. 4.7. (a) Components for additive mixing; (b) resultant through addition of components; (c) subtractive mixing produces staircase waveform

FIXING THE V.C.O. LIMITS

In these examples the v.c.o. has been programmed through its maximum working range but it is, of course, possible to achieve the same effect within very precise frequency limits. For example, suppose it is wished to provide an arpeggio rising from 130Hz to 520Hz, the frequency control of the v.c.o. is set to give the voltage required to produce 130Hz. The fact that the ramp output will, at times, be zero volts will not affect the l.f. performance limit since the v.c.o.s were originally set up with a link simulating a zero-volt programming input. Thus from Fig. 3.4 in last month's article it will be seen that the initial setting of the v.c.o. will require an input of about 24mV. Also it will be seen that a frequency of 520Hz requires an input of about 42mV and thus the output amplitude of the combined ramp generator signal will have to be (42–24)mV. In a similar manner the manipulation and adjustment of the manual and automatic voltage sources can set the programmed sequence almost anywhere in the working range of the v.c.o.

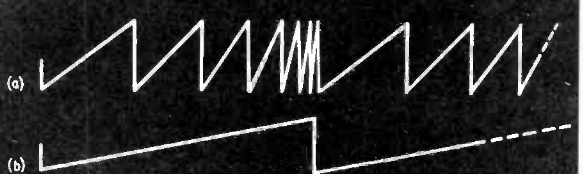


Fig. 4.8(a). Programmed ramp generator output (b) programming waveform

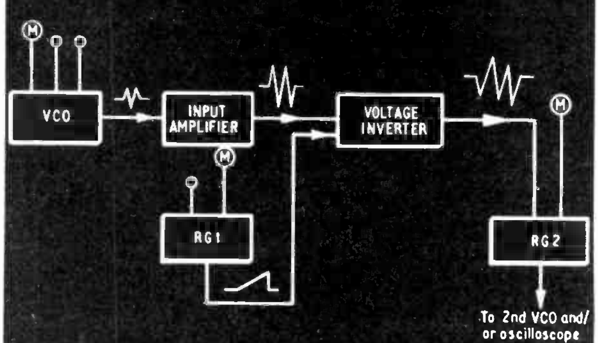


Fig. 4.9. Block diagram for ramp generator programming

PROGRAMMING THE RAMP GENERATORS

The monotonous repetition of the ramp generator output can be considerably varied by application of programming voltages to its own external control input. Fig. 4.8 illustrates the effect of applying a steadily rising voltage to the control input.

The voltage has been derived from the output of the other ramp generator running at a fairly low frequency and routed via one of the input amplifiers set to provide a peak ramp output of positive 14V. The resultant output of the programmed ramp generator consists of a series of ramps gradually increasing in frequency as the programming voltage rises to its peak, the aural effect when used to programme a v.c.o. being a kind of bounce.

For the best effect the programmed ramp generator should be running at about twenty times the frequency of the other.

An extension of the above system is shown in the block diagram Fig. 4.9. In this case one of the v.c.o.s is also providing a programming waveform which is first amplified to provide an output swing of $\pm 7V$. This is then combined, in the voltage inverter, with the output of the programming ramp generator set to its maximum output level. The voltage inverter is then routed to the programmed generator which has been set to run at about 7Hz, the overall result being a bounce which is changing its rate in a pattern depending on the relative frequencies of the programming sources.

EXPERIMENTAL COMBINATION

There are many other combinations of the programming devices all of which result in the production of characteristic sounds. The constructor is encouraged to investigate these as widely as possible noting the control settings and interconnections which produce sounds of particular interest.

It should be noted that even quite small adjustments to amplitude and frequency of programming waveforms can cause relatively great changes in the sound structure. This is particularly the case when amplitudes are adjusted in complex programming waveforms such that the waveform changes potential, i.e. crosses zero. In these cases the v.c.o. will cease to oscillate for as long as the programming waveform remains positive and thus, for a fairly rapidly changing waveform, the long term output of the v.c.o. will resemble a series of tone bursts of varying frequency.

The use of positive going programming waveforms to the v.c.o. should be investigated with care, particularly when the manual frequency control is at or near zero. The sudden application of a large positive input will cause an unpleasant click due to the increase in v.c.o. output voltage as it goes into saturation. Similarly a low potential positive input applied for a prolonged period will, on its removal, give rise to a click when the v.c.o. comes out of saturation.

USING A RECORDER

It is perhaps prudent, at this stage, to mention that a tape recorder is a most necessary adjunct to the Synthesiser if the full potential of the instrument is to be realised. This is essential because, although live performance is possible, it is somewhat limited due to the design of the keyboard which is monophonic. In order to produce complex realisations, it is necessary to employ a recorder in order that multitracking of one form or another may be used to blend or superimpose consecutive series of sound structures into a comprehensive whole.

In a similar manner many sound effects may be enhanced by the addition or superimposition of secondary sounds. This procedure can be particularly useful when complex effects such as storms, battles or woodland birdsong are being synthesised.

Quite apart from the creative aspects of using the tape recorder another important reason for its application with the Synthesiser lies in the establishment of a taped library of sounds.

Many excellent books and articles have been written on this subject but, in the field of creative recording, T. Dwyer's "Composing with Tape Recorders" (Oxford University Press 1971) contains much useful information.

NOTE:
The power supply transformer in Part 2 has 0–30, 0–30V separate secondaries. R1 and R6 should be 5·6kΩ 2% ½ watt metal oxide resistor. IC2 should be insulated from chassis with a mica washer. In Part 3, VR2 is 100kΩ.

Next month: Sample Hold and Noise Generator.

BOOK REVIEWS

ELECTRONIC MUSIC PRODUCTION

By Alan Douglas
Published by Sir Isaac Pitman & Sons Ltd
148 pages 5½in × 8½in. Price £2·75

ELECTRONIC MUSIC PRODUCTION presents a very much "up to the minute" look at the use of electronics in the production of music with special reference to the synthesiser and the applications of voltage control. The book is divided into four main sections. 1—Properties of conventional musical instruments. 2—Musical scales, temperament and tuning; concord and discord. 3—Electronic music generators. 4—Electronic music and the composer. Additionally there are two appendices which provide, in the first, a detailed specification of the Synthi 100, a highly advanced synthesiser designed for interfacing with a computer and, in the second, details of MUSYS documentation standards together with an example drawn from part of a composition programmed on the Synthi 100. Finally there is a comprehensive bibliography and index.

Electronic Music Production is a lucidly written book packed with data much of which will be new to the reader. There are plenty of clear line illustrations and circuit diagrams and there is little doubt that this book will be "required" reading for all students of electronic music—amateur and professional alike.

G.D.S.

LOGIC AND LOGIC DESIGN

By B. Girling and H. G. Moring
Published by International Textbook Company
328 pages, 9in × 6in. Price £5·80

A BASIC understanding of logic is essential for anyone interested in the design of computers and associated logic systems. This book, based on a course of lectures given at The City University, provides an excellent introduction to logic, starting from basic number and set theory. It covers the Computer Science requirements for a B.Sc. degree and each chapter concludes with a bibliography and a set of questions with solutions.

This book is very well written and concepts are explained with the aid of copious clearly drawn diagrams. The book does not deal at all with engineering considerations in logic circuit design, concentrating rather on the logical concepts involved. As well as all the standard aids to logic design many up to date references are quoted so that modern concepts can be understood.

With the increasing interest in Computer Science this book will no doubt find its way into many degree courses as the standard reference work. It is well bound and excellently printed and though the price is rather high it is good value for money.

S.R.L.

POCKET CALCULATOR KIT REVIEW

Supacal Calculator

Obtainable from S.C.S. Components Ltd., P.O. Box 26, Wembley, Middx HA0 1YY.
Price £39 (+ V.A.T.) with special £4 discount to P.E. readers.

IMMEDIATELY upon opening the box containing the SUPACAL calculator kit the decision should be made as to whether one is sufficiently equipped in terms of both tools and experience to undertake the construction of the calculator. *Should there be any doubt in this respect, it is strongly recommended that the services of a more experienced friend or colleague be recruited for this work.* The minimum tools required for building the kit are a good soldering iron of 10 to 25 watts with a bit preferably no more than a sixteenth of an inch diameter, also a pair of side cutters, a pair of long nosed pliers, and a good light.

Many solder joints have to be made in a small area and a certain degree of skill is needed to avoid short circuits and dry joints. Fine solder is provided with the kit and this greatly simplifies the construction.

COMPONENT PACKING

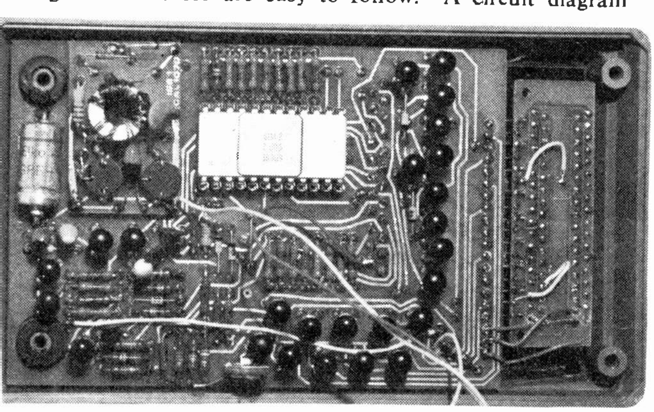
All components come in plastic bags marked with the value of the components contained, but it is as well to check these values against those required as it is always better to be safe than sorry. Because the printed circuit board has tracks both sides many solder joints have to be made on both sides of the board; this is tedious but it is essential to make good connections.

The display board and the inverter board for the 25V i.c. supply come as ready made units and this eases the constructor's task enormously. The keyboard is already fitted into the top half of the case and wiring to the main circuit board is simple, though here again solder joints have to be made top and bottom of the board.

HANDLING PRECAUTIONS

The calculator i.c. comes in a piece of protective conductive foam and the handling precautions in the instructions should be carefully followed. A socket is provided for the i.c. so the usual problems of soldering to an m.o.s. integrated circuit are overcome.

Instructions for the insertion of all components are given and these are easy to follow. A circuit diagram and point-to-point wiring diagram are also supplied. Total construction time for the SUPACAL was three and a half hours in this reviewer's case. Any difficulties will probably be caused by poor soldering and a good light is useful for checking.



The kit suppliers offer a back-up service in the form of a fixed price repair facility and this ensures a fully working calculator no matter how much of a mess you made of the construction. Once the calculator is working then all parts are guaranteed for one year.

CALCULATOR CONSTRUCTION

Now something about the calculator itself. It is housed in a strong plastics case and uses two rechargeable batteries for its power source. A ready built charger is provided with the kit; fully charged batteries give about eight hours working. There is an automatic fade-out facility which switches off the display (which consumes about half the total power) approximately ten seconds after a key has been pressed.

The keyboard uses conductive rubber contacts which give the machine an extremely light touch; in fact the switches are almost too sensitive, some care being needed not to enter a digit unintentionally.

CAPABILITY

The calculator can handle all four arithmetic operations with all calculations being in floating point, with eight digits being displayed. There is a stored constant facility which, unlike most other calculators, can be used with *all* four functions. Another advantage of this calculator is that it will not overflow. Other calculators will ignore any entries over eight digits long; the SUPACAL stores not only the eight digits entered but also stores an exponent up to 10^{79}; the true decimal point position is found by dividing by powers of ten until the point appears on the display. This enables more accurate answers to be found.

INSIDE THE POCKET CALCULATOR

How does the pocket calculator work? The "heart" is the second generation single chip MOS LSI circuit type C500 manufactured by General Instruments Microelectronics. It contains within its 4,000 active devices all the logic necessary for performing eight digit, four function plus constant and floating decimal point, calculations.

The chip contains a read-only-memory (ROM) of 2,000 bits, a random-access-memory (RAM) of 100 bits and associated control logic, dividers and timing circuits for clocking and multiplexing. The chip simply requires a 25V supply and a clock input of 50kHz to 100kHz, a keyboard, display, and circuits to drive the display and it becomes a fully operational calculator.

The display interface is by means of discrete buffer/driver transistors for segment and digit driving. The display is multiplexed, i.e. each digit is only driven for one-ninth of the time, there being nine l.e.d. digits with seven segment format.

BY FRANK W. HYDE

SKYLAB EXPERIMENTS

The number of activities that have been planned for the *Skylab* project are extensive. The work periods are 28 days for the first crew and up to 56 days for the next two crews.

In some experiments the astronauts will be used to study the effect of prolonged weightlessness. So far the longest time in the weightless state has been 18 days. This was by three Russian astronauts during the *Soyus 9* flight.

One of the after effects that became noticeable after the *Soyus* flight was a curious random stumbling which each astronaut suffered but for varying times. All had returned to normal within three weeks.

As the Russians always operate the "shirt sleeve" mode as it were, the *Skylab* experiments will be comparable though, of course, the available area for movement will be greater.

There will be specific exercises which each member of *Skylab* crew will do. These, together with studies of the changes induced in muscles, bones and the blood chemistry will enable a better assessment to be made of the space-induced effects.

Each man will have a special standardised diet to follow. With a special spring balance designed for zero gravity use, the astronauts will measure and record the mass of food they eat.

The spring balance is a coil spring to which is attached the item to be measured. The oscillation of the spring is measured electronically. The period of the oscillation depends upon the mass and on the known properties of the spring. In a similar way the astronauts will check their body weight using a spring chair.

Other experiments to be carried out are the study of crystal growth of metals and alloys together with solidification properties by using an electric furnace. One special study will be that of the possibility of producing doped semiconductors of high chemical uniformity. It is thought that in zero gravity the effects of thermal convection in a gravity field will be avoided.

The changes in flammability which have been noticed in short periods of weightlessness in aircraft will also be studied. On many occasions it has been noted that flames tend to go out when the weightless condition has been reached.

EARTH RESOURCES STUDY

Because the orbit of the space station will be inclined by 50° to the equator something like 75 per cent of the earth's surface will be covered and the station will return every five days over a given area. This provides a unique opportunity to study earth resources. Some 132 experiments originating from about 24 countries will be undertaken.

Observations will be made with cameras both in the visible and the infra-red part of the spectrum, together with the microwave sweeps. The moisture in the soil, the vegetation type and its condition will be determined by comparing the photographs from different spectral areas.

The experiments are varied and the chart below gives some details.

These are but a few of the experiments agreed by NASA and there are many more suggestions involving, in some cases, on-board equipment and in others the use of data collected. NASA accepted 19 experiments from the total of 3,400 proposals sifted by the Science Teachers Association.

The results of the first period will undoubtedly influence the later programmes particularly on the effects of weightlessness.

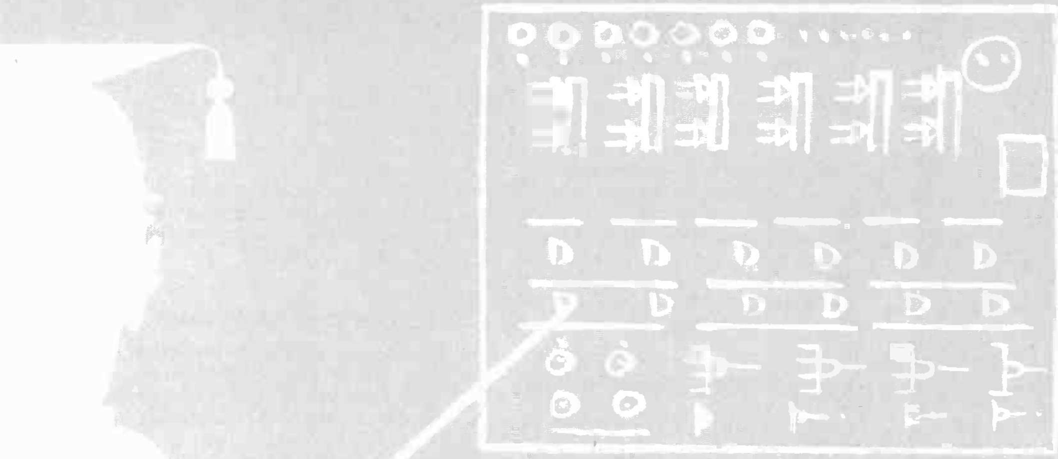
SOLAR OBSERVATION

The experiments involving solar observation are designed to both add to existing data and check the present thinking. Several of the station's telescopes are under automatic control from Earth. This has many advantages since there will be intervals between the change of crews when the station will be unmanned; continuous operation of the selected instruments is important.

The white light coronograph will measure the brightness of the corona and the polarisation. This will be done at distances varying between 1.5 and 6.0 solar radii from the Sun. The instrument has a number of sizes of occulting discs which are controllable and prevent the direct light from the Sun from reaching the objective lens. The scattered light is reduced to 10^{-10} of the mean solar radiance.

CHART 1

Experiment	*Originator*	*Observation*
Ecological	Joseph Otterman	Indentification of land in Israel suitable for wheat and date palms.
Ecological	US Department of Agriculture	Seek infestation areas by pine beetles in South Dakota.
Environment	Japan	Effect of human activities on the environment.
Astronomical	High School Students	Skylab telescopes to look for "cloud moons" thought to be 60° ahead and 60° behind the moon in its orbit.
		Inspection of solar photos for planet between Sun and Mercury.
Biological	High School Students	Radishes grown in weightless conditions to show effect of light and gravity on direction of root and shoot growth.
		Observe spider making web to detect any differences due to gravity.



LOGIC TUTOR

By G. D. Bishop and M. Hughes

To many, the fundamental principles involved in computing are a foreign language. In this article the construction of a comprehensive Logic Tutor is described. Elsewhere in this issue is the first article on using the Tutor providing an introduction to digital logic theory with practical exercises so that at the end of the series a full understanding of computing should be gained.

TUTOR FUNCTIONS

The Logic Tutor is designed to demonstrate the AND, NAND, NOR and OR gates in NAND logic form. Other circuit functions demonstrated are flip-flops, counters and shift registers.

To demonstrate logic theory it is necessary to construct a basic bread board on which exercises can be carried out. This panel can be seen in the photograph with the various symbolic functions marked upon it.

The complete tutor can be made, using entirely bought parts, for about £9. This can, of course, be reduced by judicious shopping.

LOGIC BOARD

In the prototype a 13in × 10in × 4in wooden box was used for housing the Tutor electronics, the logic board forming the lid.

The latter is drilled as in Fig. 1 using a 1·2mm drill for the terminal pin holes. Other holes should be shaped to suit the switches, lamps and digital indicator purchased but at this stage none of these components should be mounted. The logic symbols

COMPONENTS . . .

DISPLAY CIRCUITS

Resistors

R1–R11	100Ω (see text) (11 off)
R12–R17	1kΩ (6 off)
R18	47kΩ
R19–R28	470Ω (10 off)
All 10% ½ watt carbon	

Transistors

TR1–TR32	BC108 or any 300mW n.p.n. silicon planar switching transistor (32 off)

Lamps

LP1–LP10	Round M.E.S. bulbs 1·5V, 0·2A

Cold cathode tube

V1	Hivac GR2M or Mullard ZM1026

LOGIC CIRCUITS

Integrated Circuits

IC1–IC6	945 D.I.L. (6 off)
IC7–IC10	946 D.I.L. (4 off)
IC11–IC12	930 D.I.L. (2 off)
IC13	962 D.I.L.
IC14	933 D.I.L.
IC15	945 D.I.L.

Diodes

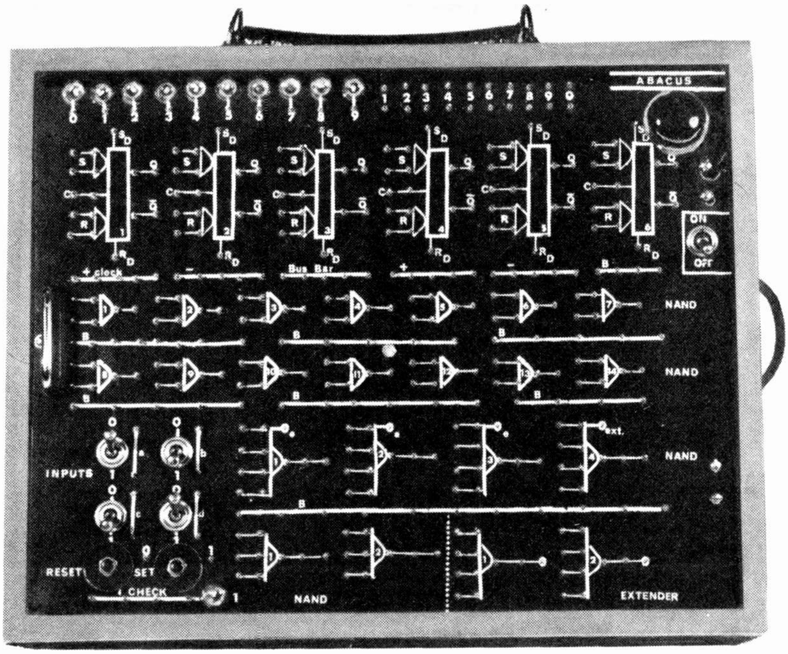
D1–D2	OA91 (2 off)

Capacitors

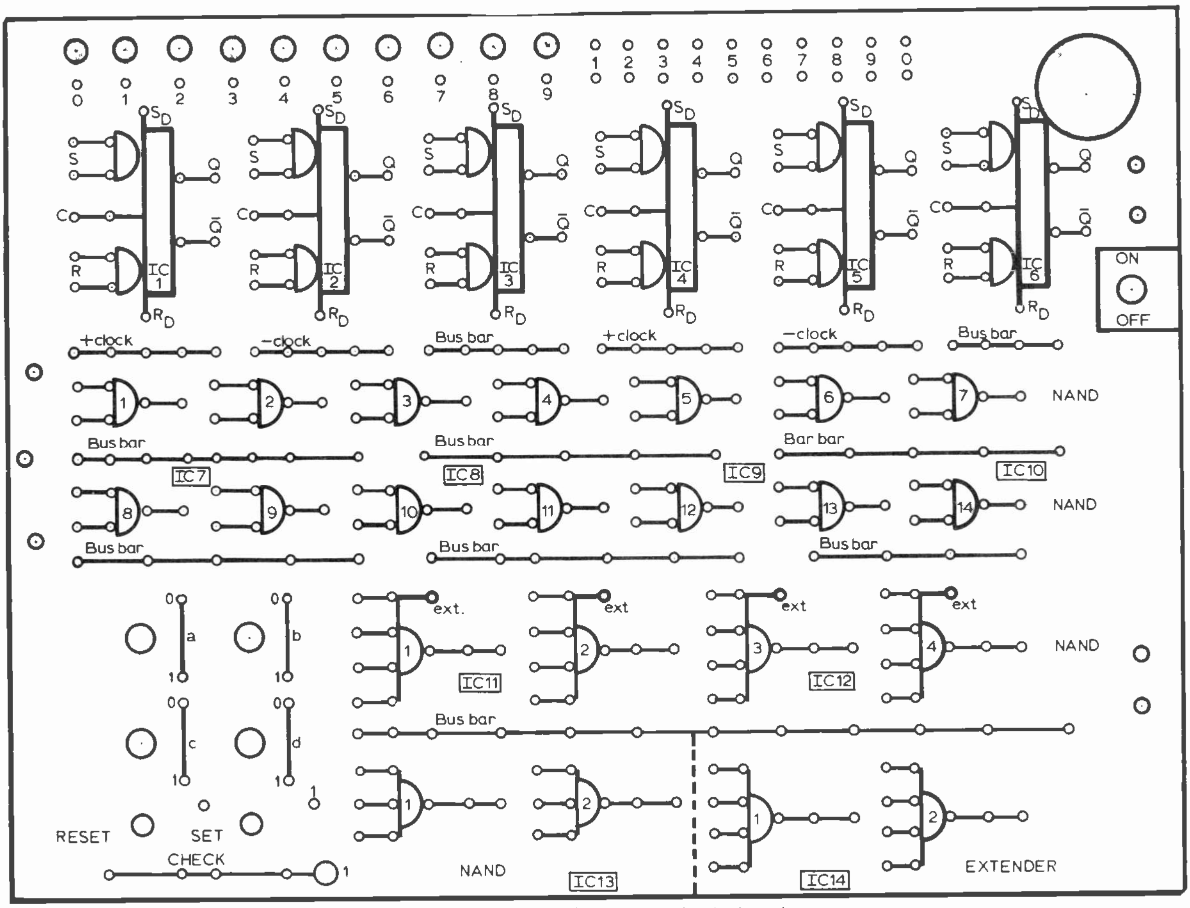
C1–C2	100μF elect. 6V (2 off)

Switches

S1	Mains on/off toggle
S2–S5	Single pole, changeover toggle (4 off)
S6–S7	Miniature push button switches
LP11	Round M.E.S. bulb 1·5V, 0·2A
D.I.P.	Veroboard 6in × 3½in



The completed Logic Tutor showing the front panel layout



All holes shown thus ○ are to be made to suit components available

Veropins to be interwired under the board as indicated by heavy solid lines

Fig. 1. Layout of logic board showing drillings and symbols

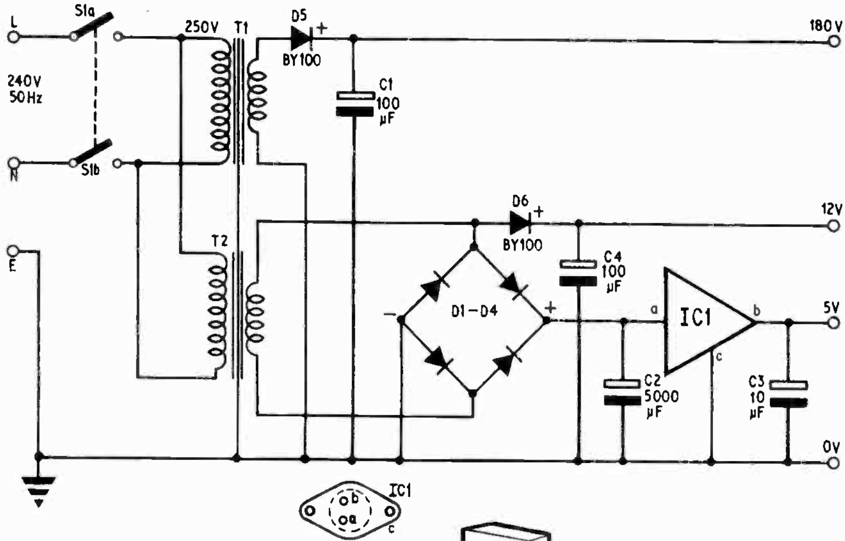
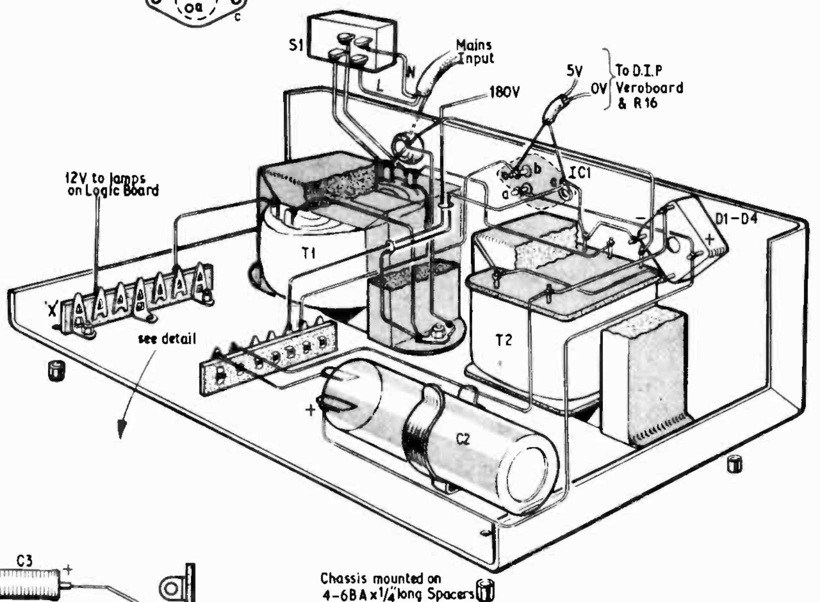


Fig. 2. Circuit diagram of power supply



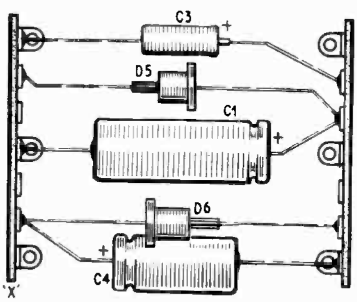


Fig. 3. Component layout and wiring for the power supply unit

COMPONENTS . . .

POWER SUPPLY UNIT

Capacitors

C1 100μF elect. 350V
C2 5,000μF elect. 15V
C3 10μF elect. 15V
C4 100μF elect. 15V

Rectifiers

D1–D4 REC41A Silicon Bridge Rectifier
D5–D6 BY100 (2 off)

Regulator

IC1 5V—600mA monolithic voltage regulator (R.S. type MVR—5V or similar)

Transformers

T1 240V primary; 150V, 10mA secondary
T2 240V primary; 9V, 1A secondary

Miscellaneous

18 s.w.g. aluminium as required, 12 way tag strip, double-sided terminal pins and pick-up tags 1·2mm diameter (R.S. types)

on the board indicate six RS/JK flip-flops, fourteen two-input NAND gates, four four-input NAND gates, two three-input NAND gates and two four-input extenders (AND). Most logic functions can be demonstrated with these.

The logic symbols are marked on the drilled board with paint or Letraset. These should be lacquered for permanent fixing after the double-sided terminal pins are pressed into the 1·2mm holes. These pins have a shoulder to facilitate insertion without risk of pushing the pin right through the board.

POWER SUPPLY

The next item to be tackled is the power supply which feeds the integrated circuits with a stabilised 5 volt, and the output displays.

To observe the logic outputs two alternative displays can be used; lamps to indicate outputs singly or a cold cathode numerical indicator. Although included this item can be dispensed with if costs are to be kept down.

The display supply requirements are 12V for the lamps and 180V for the neon indicator. The circuit diagram in Fig. 2 show how these outputs are derived.

The power supply unit is mounted on an 18 s.w.g. aluminium sub-frame as in Fig. 3, which also gives the interwiring details.

When the wiring is complete the output voltages should be checked with a meter before any loads are connected. If everything is functioning satisfactorily the sub-frame can be screwed to the base of the box.

D.I.P. MOUNTING AND WIRING

The fifteen D.I.P. integrated circuits are mounted on a D.I.P. Veroboard (Fig. 4) in the orientation shown. Pin numberings for the i.c.s are identical as indicated on the key. When the i.c.s are soldered the wire links are added.

The next job is to connect the i.c.s to the logic board. In Fig. 5 the board symbol input and output pins are related directly to the numbered i.c. pins on the Veroboard so that point-to-point wiring can be made. To illustrate this; to wire IC1 to its corresponding logic board symbol, IC1 pins are connected to the underside of the logic board at the corresponding pin numbers (Fig. 5(a)).

Next the two-input NAND gates are wired (IC7–IC10), the four-input (IC11–IC12), the three-input

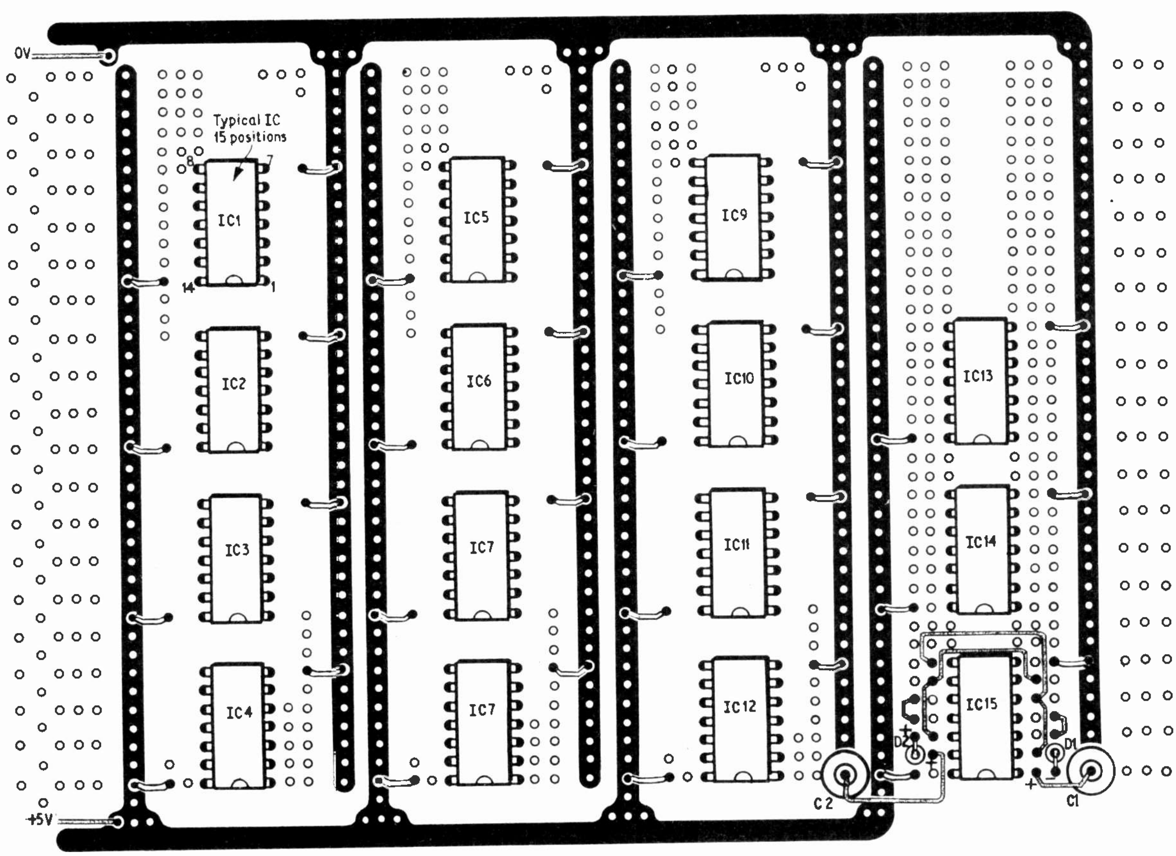


Fig. 4. Wiring and layout of the fifteen D.I.P. integrated circuits on the D.I.P. Veroboard

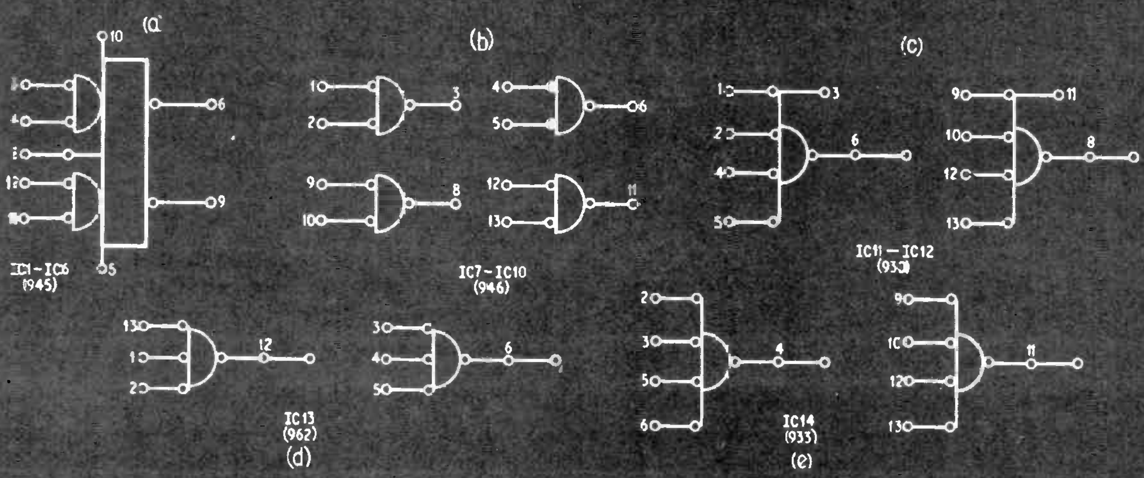


Fig. 5. Identifying the logic symbol Veropins with the i.c. pin numbering

(IC13), and finally the four-input gates (IC14) all being wired according to the relevant gate symbol of Fig. 5. The Veroboard can be fixed finally to the underside of the front panel with nuts, screws and stand off bushes.

LOGIC SWITCHES

Four switches are provided (S2–S5) for logic 0 or 1 inputs to the gates. Here, 0 corresponds to 0 volts and 1 to 5 volts as indicated in Fig. 6. A switch output is taken from either of two Veropins at the switch pole. Wiring for all four switches is given later in Fig. 10.

CLOCK GENERATOR

Most counting circuits can best be demonstrated by applying a clock input of about 2 to 4Hz. This function is provided on the logic board by a 946 i.c. connected as a free running multivibrator (Fig. 7). The timing elements include two 100μF capacitors.

Two outputs are available from this circuit, positive and negative square wave clock pulses. The pins for these are adjacent to the JK flip-flops (Fig. 1). It should be noted that the adjacent "bus-bars" alternatively marked "B" are earth returns to complete signal paths when patching leads. Wiring for the clock generator IC15 is included in Fig. 4.

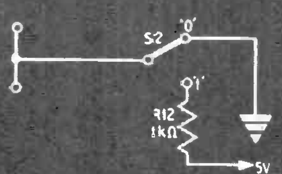


Fig. 6. Input switch circuit

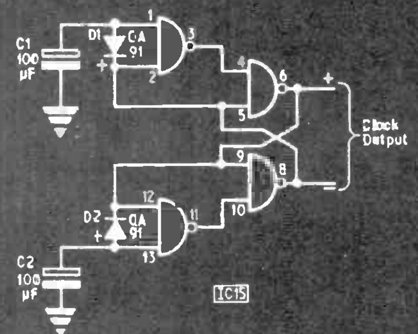


Fig. 7. Circuit diagram of the clock generator

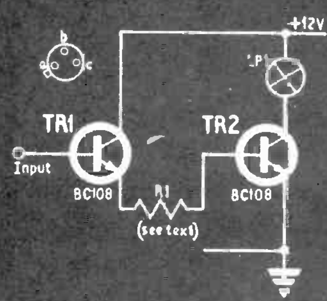
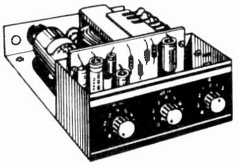


Fig. 8. Lamp driver circuit

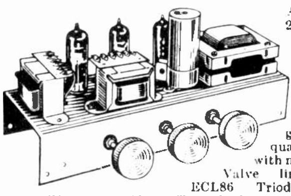
SUPERSOUND 13 HI-FI MONO AMPLIFIER



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

PRICE £10·50 P. & P. 25p.

DE LUXE STEREO AMPLIFIER



A.c. mains 200-240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300mV for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w × 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price £8·92.** P. & P. 45p.

NEW! POWER SUPPLY UNIT

200/240V A.C. input. Four switched fully smoothed D.C. outputs giving 6V and 7½V and 9V and 12V at 1 amp continuous (1½ amp intermittent). Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case, overall size 6" × 3½" × 2½". Suitable for Transistor Radios, Tape Recorders, Amplifiers, etc., etc. Ready built and tested.

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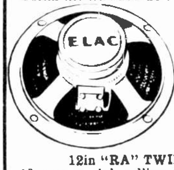

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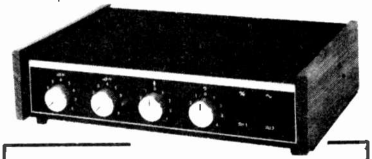

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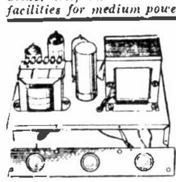

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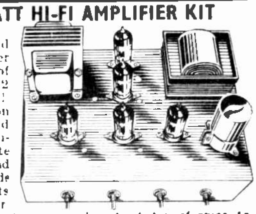

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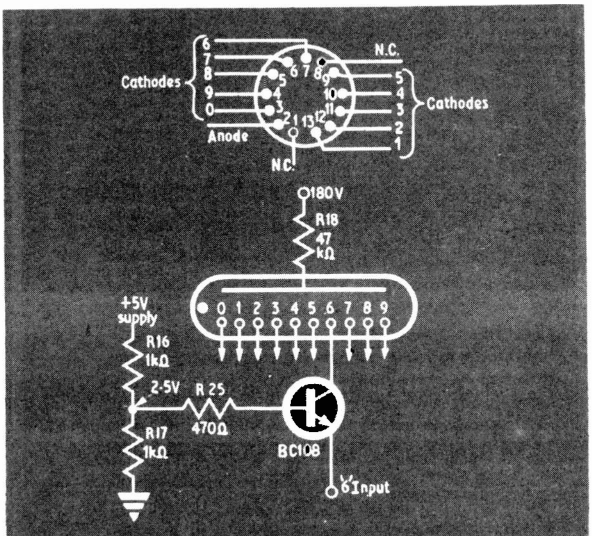


Fig. 9. Transistor switching for the cold cathode tube

WIRING THE INDICATORS

If the lamp bulbs are screw types these can be screwed into the holes provided. The cold cathode tube should be a press fit and glued finally into position.

The lamp driving circuits consist of two transistors and a resistor (Fig. 8) with the inputs connected to adjacent Veropins (0–9). The value of the series resistor may have to be tailored so that the appropriate lamp gives the required light output. The limits to be expected here are 27 ohms to 220 ohms. All drive circuitry is mounted close to each lamp base.

Each cathode of the indicator tube is switched by a transistor (Fig. 9) the emitter of each being connected to board Veropins numbered 1–0. A wiring detail of the transistor drive circuits indicators and switches is given in Fig. 10.

DISPLAY CHECKS

Connections to the indicator tube can be made with the same tags as used for terminating the patching leads, this saves the cost of a special valve base. For a rigid transistor assembly the supply lines and earth returns should be of stiff copper wire.

The first test is with the indicator which should glow as soon as its 180V supply is connected. All the numbers will glow until a particular cathode is grounded when all the current passes via one number which cancels off the others.

If this test is satisfactory connect the 5V supply to the panel and check that the indicator lamps light when the logic inputs are applied to their terminals, remembering that "off" corresponds to 0 and "on" corresponds to 1.

PATCHING LEADS

Some leads can now be terminated with tags for patching exercises. These should be of 12in, 8in, 4in and 2in lengths. More short leads will be required than long leads and it facilitates easy location of a particular length if the lengths are of one given colour.

The Logic Tutor should now be functioning and simple exercises can be performed to get the feel of the instrument. See page 438. ★

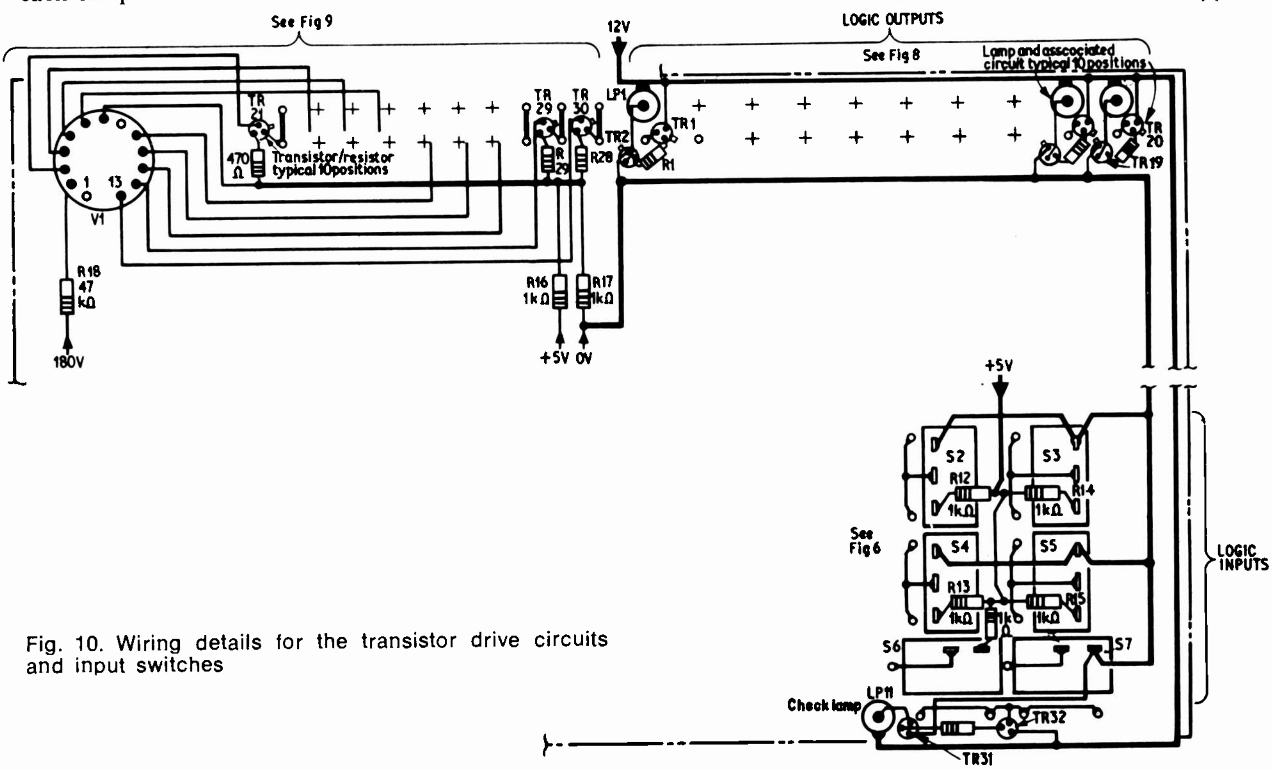
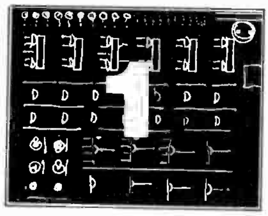


Fig. 10. Wiring details for the transistor drive circuits and input switches

LOGIC TUTOR EXPERIMENTS . .



AND and OR GATES

IN DIGITAL LOGIC there are two states, these are low and high or off and on states. In positive logic, which is the type used in the Logic Tutor, the off or low state is 0V and the on or high state 5V. These two conditions we also know as logical 0 and logical 1 respectively.

The simplest gate which allows or stops a 0 or 1 input is the AND gate formed by an arrangement of diodes as in Fig. 1.1.

TRUTH TABLES

If there is no connection to either input the output will rise to 5V since no current flows through the resistor but if either input is grounded current flows to ground thereby reducing the output to zero volts.

This is logically expressed in logic truth tables and the output sequence is expressed as A.B which is the Boolean Algebra way of representing A AND B. So in the circuit both A AND B must be 1 in order that the output is 1.

PROVING IT

To electrically check the truth table connect the four logic input switches to the inputs of EXTENDER 1 and the output of this to the CHECK lamp. Operating the switches will show that the lamp lights only when all inputs are logical 1.

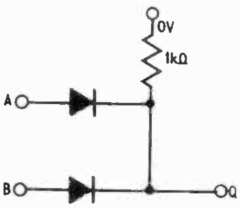
OR GATE

If the diodes of the AND gate are reversed and the supply is changed to 0V an OR gate is formed as in Fig. 1.2. In this gate the output is always 1 if any input is 1, that is, the diodes will conduct if the input goes to 5V but the output return to zero if no input is connected or the inputs are grounded.

It is not possible to demonstrate an OR gate on the tutor since it is seldom used on its own.

The OR function is normally expressed as a combination of NAND functions known as a wired OR functions which will be demonstrated in a later exercise. The OR function is written as A OR B; symbolically this is A + B.

by M. Hughes



A	B	Q
0	0	0
1	0	1
0	1	1
1	1	1

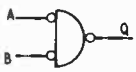
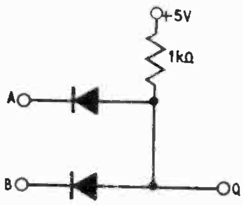


Fig. 1.1. AND gate and truth table



A	B	Q
0	0	0
1	0	0
0	1	0
1	1	1

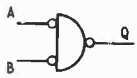


Fig. 1.2. OR gate and truth table

POINTS ARISING

HI FI TAPE LINK *(March, April 1973)*

In Components List, Page 213, R121, 220Ω was omitted. In Fig. 6 page 328, R13 adjacent to C12 should be R12. TR9 and TR109 base diagram, drain and gate connections reversed. On underside wiring collector of TR103 should go directly to R102 not via point marked TO SK2 PIN. In Table 3 TR10 collector voltage is dependent on VR5. First paragraph page 332 should read "collectors of TR10 and TR110 is 12 volts".

P.E. SYNTHESISER

See note on page 427

P.E. TRIFFID I.C. RADIO *(February 1973)*

R7 should be 4·7kΩ not 10kΩ as specified. R17 should be 10Ω not 10kΩ as in the components list. High gain transistors *must* be used for TR2 and TR3. Fig. 7. Transistor TR4 should read c.b.e. not as shown.

A.F. SIGNAL GENERATOR *(November 1972)*

VR2 should be 10kΩ not 1kΩ as shown in Fig. 1 and components list. In Fig. 3 C5 and C7 to S1 have been reversed, i.e. C5 should be where C7 is shown.

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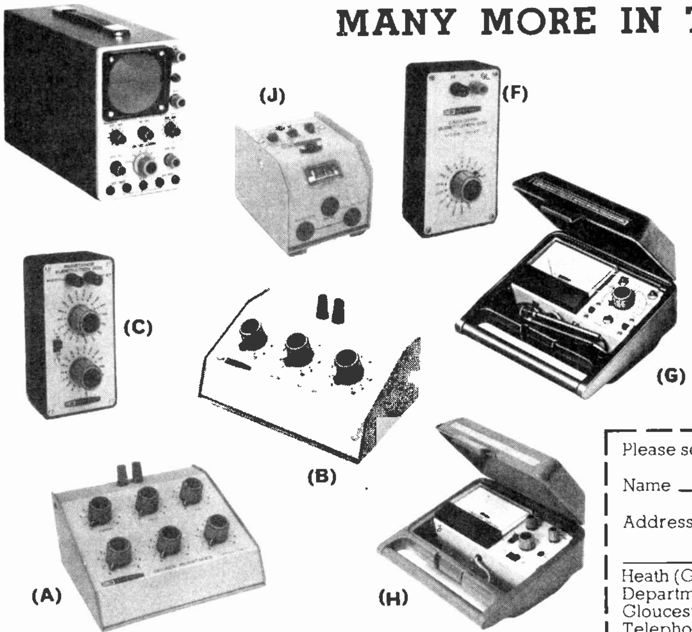

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- **(D)** Service Scope, K/OS-2.
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- **(F)** Capacitor Sub Box, K/IN-47.
- **(G)** Solid-state VVM, K/IM-17U.
- **(H)** Transistor Tester, K/IT-18.
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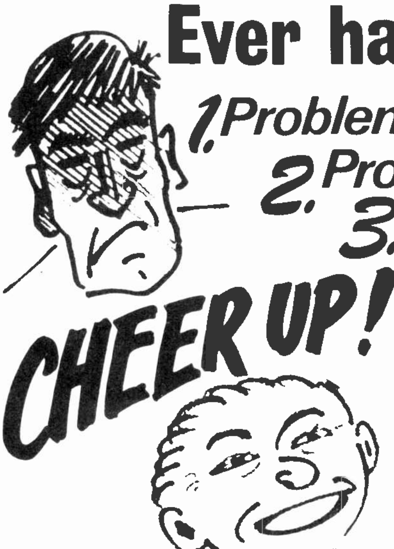

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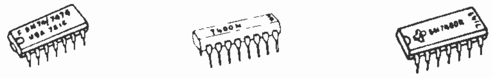

Type	1/11 p	12/24 p	25/99 p	Type	1/11 p	12/24 p	25/99 p	Type	1/11 p	12/24 p	25/99 p
SN7400	0·20	0·18	0·16	SN7450	0·20	0·18	0·16	SN74145	1·50	1·40	1·30
SN7401	0·20	0·18	0·16	SN7451	0·20	0·18	0·16	SN74150	3·35	2·95	2·15
SN7402	0·20	0·18	0·16	SN7453	0·20	0·18	0·16	SN74151	1·10	0·95	0·90
SN7403	0·20	0·18	0·16	SN7454	0·20	0·18	0·16	SN74153	1·35	1·27	1·20
SN7404	0·20	0·18	0·16	SN7460	0·20	0·18	0·16	SN74154	2·00	1·75	1·55
SN7405	0·20	0·18	0·16	SN7470	0·30	0·27	0·25	SN74155	1·55	1·47	1·35
SN7406	0·30	0·27	0·25	SN7472	0·30	0·27	0·25	SN74156	1·55	1·47	1·35
SN7407	0·30	0·27	0·25	SN7473	0·40	0·37	0·35	SN74157	1·80	1·70	1·50
SN7408	0·20	0·19	0·18	SN7474	0·40	0·37	0·35	SN74160	2·60	2·40	2·25
SN7409	0·45	0·42	0·35	SN7475	0·55	0·52	0·50	SN74161	2·60	2·40	2·25
SN7410	0·20	0·18	0·16	SN7476	0·45	0·42	0·39	SN74162	3·40	3·25	2·70
SN7411	0·23	0·22	0·20	SN7480	0·80	0·75	0·67	SN74163	3·40	3·25	2·70
SN7412	0·42	0·40	0·35	SN7481	1·25	1·15	1·10	SN74164	2·75	2·30	2·10
SN7413	0·30	0·27	0·25	SN7482	0·87	0·80	0·70	SN74165	4·00	3·50	3·00
SN7416	0·30	0·27	0·25	SN7483	1·00	0·90	0·85	SN74166	4·00	3·50	3·00
SN7417	0·30	0·27	0·25	SN7484	0·90	0·85	0·80	SN74167	6·25	5·60	5·10
SN7420	0·20	0·18	0·16	SN7486	0·45	0·41	0·38	SN74170	4·10	3·55	3·05
SN7422	0·48	0·44	0·40	SN7490	0·75	0·70	0·65	SN74174	2·00	1·75	1·30
SN7423	0·48	0·44	0·40	SN7491AN	1·00	0·95	0·90	SN74175	1·35	1·27	1·15
SN7425	0·48	0·40	0·35	SN7492	0·75	0·70	0·65	SN74176	1·60	1·35	1·20
SN7427	0·42	0·39	0·35	SN7493	0·75	0·70	0·65	SN74177	1·60	1·35	1·20
SN7428	0·50	0·45	0·42	SN7494	0·80	0·75	0·70	SN74180	1·55	1·30	1·20
SN7430	0·20	0·18	0·16	SN7495	0·80	0·75	0·70	SN74181	7·00	6·00	5·50
SN7432	0·42	0·39	0·35	SN7496	1·00	0·97	0·95	SN74182	2·00	1·80	1·60
SN7433	0·70	0·61	0·44	SN7497	6·25	5·50	5·00	SN74184	2·40	2·00	1·80
SN7437	0·65	0·60	0·50	SN74100	2·50	2·30	2·00	SN74185A	2·40	2·00	1·80
SN7438	0·65	0·60	0·50	SN74104	1·45	1·35	1·20	SN74190	1·95	1·85	1·75
SN7440	0·20	0·18	0·16	SN74105	1·45	1·35	1·20	SN74191	1·95	1·85	1·75
SN7441AN	0·75	0·72	0·70	SN74107	0·50	0·45	0·40	SN74192	2·00	1·90	1·80
SN7442	0·75	0·72	0·70	SN74110	0·80	0·70	0·60	SN74193	2·00	1·90	1·80
SN7443	1·00	0·95	0·90	SN74118	1·00	0·95	0·90	SN74194	2·50	2·25	1·90
SN7445	2·00	1·75	1·60	SN74119	1·90	1·78	1·65	SN74195	1·85	1·70	1·60
SN7446	2·00	1·75	1·60	SN74121	0·60	0·55	0·50	SN74196	1·50	1·40	1·30
SN7447	1·75	1·60	1·45	SN74122	1·35	1·25	1·10	SN74197	1·50	1·40	1·30
SN7448	1·75	1·60	1·45	SN74123	2·70	2·55	2·47	SN74198	4·60	3·70	3·35
				SN74141	1·00	0·95	0·90	SN74199	4·60	3·70	3·35

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AAZ13	10p	BC182	10p	BY126	15p	OC57	50p	ZTX108	12p	2N3442	1·25
AC107	35p	BC214	15p	BY127	15p	OC71	15p	ZTX300	12p	2N3525	75p
AC126	25p	BCY32	75p	BYZ13	35p	OC72	25p	ZTX301	15p	2N3614	59p
AC127	25p	BCY34	35p	C106D	65p	OC77	45p	ZTX302	18p	2N3615	75p
AC128	25p	BCY39	1·00	GET111	55p	OC81	25p	ZTX341	20p	2N3702	10p
AC176	25p	BCY42	30p	GET115	55p	OC83	25p	ZTX500	15p	2N3704	10p
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
ACY17	30p	BCY70	15p	MAT121	25p	OC171	30p	2N404	20p	2N3771	1·75
ACY20	20p	BCY71	20p	MJE340	50p	OC200	45p	2N527	35p	2N3773	2·00
ACY21	20p	BCY72	15p	MJE370	70p	OC201	75p	2N696	15p	2N3790	2·25
ACY39	55p	BCY87	2·99	MJE520	75p	OC202	80p	2N697	15p	2N3819	35p
AD140	50p	BCZ11	50p	MJE2955	1·10	OC203	50p	2N706	10p	2N3820	50p
AD149	50p	BD124	80p	MJE3055	75p	OCP71	1·25	2N930	20p	2N3866	85p
AD161	35p	BD131	75p	MPF105	40p	ORP12	50p	2N987	45p	2N3903	15p
AD162	35p	BD132	80p	NKT214	20p	ORP60	40p	2N1131	25p	2N3906	12p
AF117	20p	BF115	25p	NKT216	40p	P346A	20p	2N1132	25p	2N4061	12p
AF118	50p	BF167	25p	NKT217	40p	RAS310AF	45p	2N1302	18p	2N4062	12p
AF124	25p	BF173	25p	NKT403	70p	RAS508AF	55p	2N1304	22p	2N4126	15p
AF139	30p	BF179	30p	NKT404	50p	TAA263	75p	2N1305	22p	2N4871	35p
AF186	40p	BF180	30p	OA5	50p	TIL209	39p	2N1307	25p	2N5457	30p
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
ASY28	25p	BF861	25p	OA91	7p	TIP31A	60p	2N1671	1·00	2S012	10·00
BA102	30p	BF898	25p	OA200	7p	TIP32A	70p	2N2147	75p	2S018	6·25
BA115	7p	BFX13	25p	OA202	10p	TIP33A	1·00	2N2160	59p	2S026	8·90
BA145	15p	BFX34	75p	OC16	75p	TIP34A	1·50	2N2217	25p	2S301	50p
BAX13	5p	BFX37	30p	OC20	95p	TIP35A	2·50	2N2221	20p	2S303	65p
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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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

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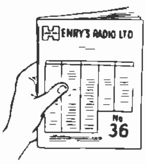

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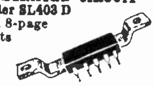

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Type	Volts P.I.V.	Price 1-11
3 AMP RANGE		
SC35A	100	75p
SC35B	200	79p
SC35D	400	85p
6 AMP RANGE (TO48)		
SC40A	100	85p
SC40B	200	90p
SC40D	400	£1·00
SC40E	500	£1·20
10 AMP RANGE (TO48)		
SC45A	100	95p
SC45B	200	£1·00
SC45D	400	£1·25
SC45E	500	£1·45
15 AMP RANGE (TO48)		
SC50A	100	£1·25
SC50B	200	£1·35
SC50D	400	£1·65
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DIAC D32 25p
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40430	(TO66)	85p
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3 Amp T048

15 Amp T048

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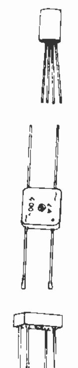
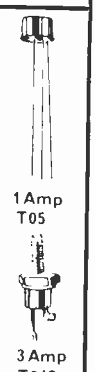
Type	Volts P.I.V.	Price 1-11
HALF AMP		
BO5/05	50	20p
BO5/10	100	25p
ONE AMP ¼ × ⅜ H TUBULAR		
B1/05	50	25p
B1/10	100	25p
B1/20	200	30p
B1/60	600	35p
ONE AMP (G.I.) TUBULAR		
W005	50	30p
W01	100	35p
W02	200	40p
W06	600	45p
TWO AMPS ½ H × ½ L × ⅛		
B2/05	50	35p
B2/100	100	40p
B2/200	200	45p
B2/600	600	50p
B2/1000	1000	60p
FOUR AMPS ⅝H × ⅝L × ⅛		
B4/100	100	60p
B4/200	200	65p
B4/400	400	70p
B4/600	600	75p
B4/800	800	£1·00
SIX AMPS ⅝H × ⅝L × 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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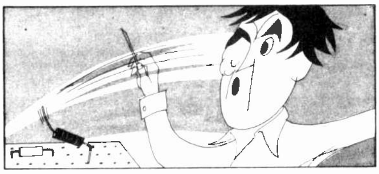
Gerry Brown . . .

ON THE FRINGE



SHEER CUSSEDNESS

The number of times I have heard people justifiably complain about having put a screwdriver down on the floor while adjusting some piece of equipment, only to find, on going to pick it up, that the darned thing had surreptitiously "hopped it". If that didn't happen, one could lay even odds that the four screws, previously lying on your left-hand side, had somehow learned to interpret the structure of the DNA molecule enabling them to grow legs of their own.

Screwdrivers are not, however, exclusive in possessing a mind of their own, oh no. Indeed, the effect is not entirely foreign to the wrong side of hot buttered crumpets, marmalade toast, and (on occasion) the resistor that you've just soldered into position (and for which you are enduring agonies in order to prove that *you* just don't make dry joints) flying off at one end and treating both you and your starboard eye to a good "dollup" of molten solder! Soad's Law, for that is the nice way of putting what this effect has come to be known as, is almost certainly the one which equates with the belief that "If something *can* go wrong, then it *will*".

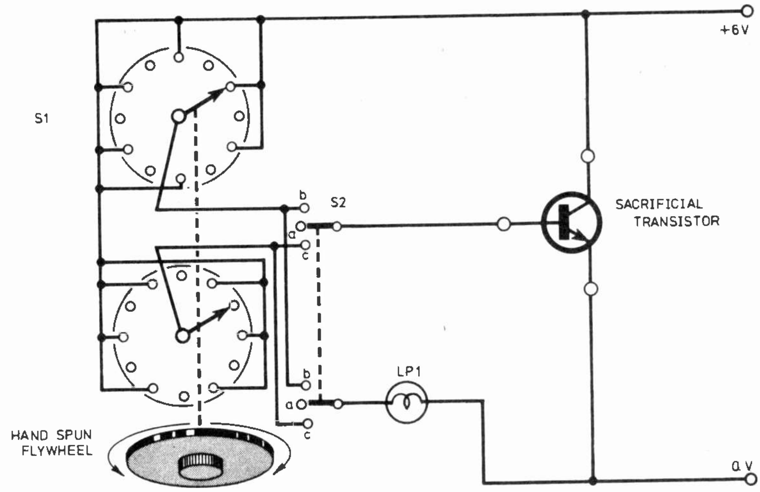


Fig. 1

My old friend Denis has an interesting theory about the effect (also, in ancient literature, referred to as the 4th Law) and has recently put it to the test. He believes, you see, that Soad still exists somewhere, and further that he controls his meddling from either the Moon, or that other satellite which the earth is supposed to have.

The test, which you may have already proved unwittingly, is accomplished by employing a "sacrificial" circuit like the one I've shown in Fig. 1. With such an arrangement one can easily establish how far away this bloody-minded individual is.

First set switch S1 to position "a", then select the most expensive transistor you have, and connect it into circuit. Spin the flywheel-driven rotary switch (the normal wafer type, but with mechanical "click" and "end stops" removed). When it has come to a standstill, decide quite deliberately to yourself whether to operate switch S2 to "b" or "c". This done, now operate the switch quickly to the *opposite* position of your choice; but do it within 2·68 seconds, I implore you.

Provided the decision is made within this time, I'm told it has never been known to "do-in" a transistor. This being so, it looks certain that this ubiquitous enemy of mankind must inhabit a world about a quarter of a million miles from here, composed, for the most part, of dud transistors, brand-new screwdrivers, and fluff-covered "jam-butties".

Judging from his discussion a couple of months back, I have a shrewd suspicion that Frank Hyde knows something of the fella's co-ordinates but is not letting-on!

NEWS BRIEFS

1973 Design Council Awards

Two electronics companies feature prominently among this year's Design Council Awards for consumer goods. Sinclair Radionics win an award for the Sinclair Executive calculator and Rank Radio International win an award for the Wharfedale "Isodynamic" headphones.

The Sinclair Executive pocket calculator was launched in June 1972 and now, nine months later, sales are running at nearly £100,000 per month and profits of £300,000 are forecast for the financial year ending in April this year.

The Wharfedale Isodynamic headphones also introduce some technological advances to achieve a quality of sound previously only reached in headphones costing well over twice as much.

The Wharfedale system combines the best of the electrostatic method with the simplicity and price advantage of the electromagnetic method by using a lightweight diaphragm driven evenly all over its surface by magnetic means.

Launched in London last year, sales for the first year are expected to reach 100,000 units and in fact Wharfedale are having difficulty meeting the demand.

New Electronics Course at Keele University

Among nine new courses announced by Keele University is a new degree course in Electronics. There is great demand for honours Electronics, it being one of the major growth areas in scientific studies. There is particular interest in Electronics where it overlaps with such areas as cybernetics, information theory and "bioelectronics".

Three and four year courses will be on offer, and amongst the permissible combinations of courses over three years will be Electronics and Music.

For further information please contact the Director of Information Services or Professor D. J. E. Ingram, Department of Physics, University of Keele, Keele, Staffordshire ST5 5BG.

INDUSTRY NOTEBOOK

By Nexus

PRICE WAR CONTINUES

A phenomenon of the electronics industry is that while everything else seems to be shooting up in price, many electronic products persist in going down. This is mainly due to the nature of the beast. High technology demands big investment in R and D and, more often than not, a further major investment in production equipment. So new products tend to start their life as high cost items capitalising on improved performance. Then, as production increases, there is the so-called "learning curve" which, when mastered, gives fewer rejects and higher production rates. By this time, other firms are getting into the same market and any monopoly position that may have been attained is soon eroded. Add these factors together and you can see the reason why prices tumble.

No less an authority than Dr Ian Mackintosh, 20 years in the semiconductor business and now a leading consultant, goes as far as to suggest in a recent press interview that aggressive pricing is the key to success. Essentially, he maintains, semiconductors is a volume industry and nobody gets volume without competitive prices. He cites the 1971 price war in TTL devices as nothing new and forecasts a similar war in MOS devices.

Certainly, ready availability of devices and lowered prices are working their way through into products. Look at digital multimeters. The Solartron 4440 is billed in the advertisements as low-cost at £115. Along comes Sinclair with the DM1 at £49. Not to be left out of the act, Advance Electronics introduce the Alpha DMM8 at £55.

It wasn't all that long ago that a digital panel meter was listed at £99. Today you can get one for well under £50. Of course, the products I have mentioned are not all to the same specifications and therefore not directly comparable but the trend is there—downwards in price.

The trend is most obvious in consumer products—in radio, TV, tape recorders, pocket calculators. Look around and shop around—you can see it happening. I find it intriguing that some of my friends in manufacturing industry claim it is often cheaper to buy their employers' products through cut-price retail outlets than through their own staff shops.

The biggest shock, however, comes not through price competition between existing technologies and derivatives thereof, but when a completely new technology threatens to displace the old. Semiconductor memory manufacturers may well spend restless nights following the disclosures that IBM researchers have developed amorphous film bubble memories and got them into experimental use. Moreover, IBM say the new process cuts bubble memory costs ten-fold as well as conferring advantages such as extremenly high density packaging.

EUROCONTROL

It was quite an experience attending the signing of Eurocontrol's latest commercial contracts for the new KARLDAP air traffic control centre at Karlsruhe. The signing was between Plessey Radar, Thomson-CSF and AEG-Telefunken on the one hand, and Eurocontrol officials on the other, and covered the supply of electronic equipment to the value of over £5 million. We had full simultaneous translations of the proceedings which took place in the Eurocontrol Brussels HQ beneath the flags of the member nations.

Plessey Radar's share was worth £1·25 million. Good for Britain, of course, but what was most pleasing was to be in at a ceremony where nations and companies were working amiably together towards a common good.

ERNIE Mk. II

Having never won a penny on Premium Bonds it was interesting to visit the newly installed ERNIE Mk II at Lytham St Annes and see for myself that everything was fair and above board and that my lack of success was nothing more than bad luck.

The original ERNIE, now honourably retired, was built by the Post Office and did a marvellous job. The success of Premium Bonds has been so staggering that Old ERNIE was too sluggish to cope with the draw. It was taking ten working days to generate the prize list. New ERNIE picks out the winners of over 90,000 prizes each month in just three hours. This is remarkable when you remember that each random number generated has to be checked against a master file to see if it has been sold or not.

New ERNIE was designed by Dr Roger Harding of Plessey Telecommunications under a contract worth £250,000. Plessey has also supplied a smaller system to New Zealand who run a similar Bonds scheme. Plessey now have ERNIE on offer world-wide and could secure more orders from governments who wish to run similar savings schemes.

To-date, ERNIE has paid out 10 million winners with nearly £350 million of prizes. Average odds of winning are 10,350 to 1. Don't despair—there will be even more prizes in future.

GROWTH

Several sectors of electronics are now showing good growth. VAT has helped Pitney-Bowes in selling electronic cash registers which have calculating power and produce cash receipts showing the amount of VAT paid. Sales are well up on the forecasts. NCR is another company gearing up to get in on the electronic point-of-sale business.

Over £3·5 million is said to have been invested in getting a production line going at Dundee for the NCR 280 retail terminal and first orders have been taken in the UK. In the United States the order book is reported as being 20,000 units of which 4,500 have been installed. Dundee output is planned to match a sales forecast of over 1,000 units this year rising to over 4,000 units by 1975.

Finally, MDS Data Processing Ltd. report big European sales for the 2400 Key Display System, a key-to-disc data entry system for computers. In 14 months more than 500 systems have been ordered which, together, use 6,000 key-stations.

AEROSPACE EXPORT DRIVE

More than 100 British aerospace companies will be at Paris for this year's air show in June. Electronics companies will be well represented during what promises to be a boom exhibition despite setbacks on the Concorde programme. Last year's exports were in the region of £400 million for the industry as a whole with electronic navaids and guided missiles accounting for a big chunk.

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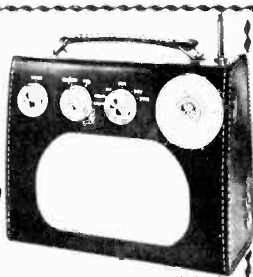

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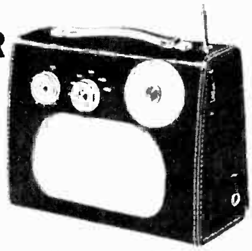
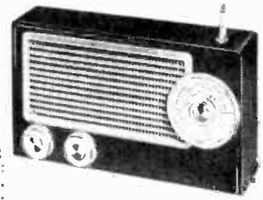
TOTAL BUILDING COSTS **£7·68** P. P. & INS. 47p (OVERSEAS P. & P. £1·05)



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 33p extra.

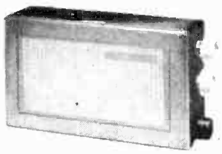
TOTAL BUILDING COSTS **£6·58** P. P. & INS. 47p (OVERSEAS P. & P. £1·05)



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 **£4·38** P. P. & INS. 31p (OVERSEAS P. & P. £1·05)



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).

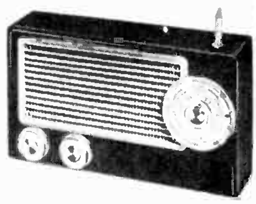
TOTAL BUILDING COSTS **£2·50** P. P. & INS. 24p (OVERSEAS P. & P. 65p)

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 6½in × 4½in × 1½in. Easy build plans and parts price list 10p (FREE with parts).

TOTAL BUILDING COSTS **£2·75** P. P. & INS. 25p (OVERSEAS P. & P. 65p)

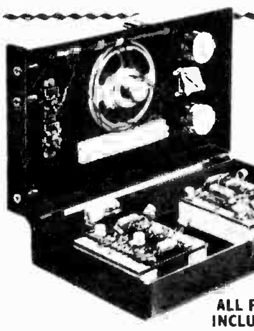


TRANS EIGHT

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 **£4·95** P. P. & INS. 33p (OVERSEAS P. & P. £1·05)



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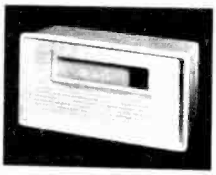
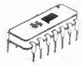
(For complete kit of parts including case.)



This 4 digit 24 hour clock is available to readers at this special price for 1 month only. Parts would normally cost over £25. Kit of parts includes twelve IC's, indicators, and a smart white plastic case.

74 Series TTL



	1	25		1	25		1	25		1	25
SN7400	16p	15p	SN7423	55p	50p	SN7450	16p	15p	SN7489	6·05p	5·85p
SN7401	16p	15p	SN7425	55p	50p	SN7451	16p	15p	SN7490	74p	72p
SN7402	16p	15p	SN7427	49p	46p	SN7453	16p	15p	SN7491	1·10p	1·04p
SN7403	16p	15p	SN7428	77p	72p	SN7454	16p	15p	SN7492	74p	72p
SN7404	16p	15p	SN7430	16p	15p	SN7460	16p	15p	SN7493	74p	72p
SN7405	16p	15p	SN7432	49p	46p	SN7470	33p	29p	SN7494	85p	72p
SN7406	38p	35p	SN7433	94p	82p	SN7472	33p	29p	SN7495	85p	72p
SN7407	38p	35p	SN7437	72p	69p	SN7473	41p	39p	SN7496	95p	92p
SN7408	20p	18p	SN7438	72p	69p	SN7474	41p	38p	SN74100	1·80p	1·75p
SN7409	20p	18p	SN7440	16p	15p	SN7475	50p	47p	SN74104	1·09p	1·06p
SN7410	17p	15p	SN7441	74p	70p	SN7476	44p	43p	SN74105	1·09p	1·06p
SN7411	27p	25p	SN7442	74p	70p	SN7480	73p	70p	SN74107	44p	42p
SN7412	38p	35p	SN7443	1·43p	1·37p	SN7481	1·32p	1·26p	SN74110	61p	59p
SN7413	32p	29p	SN7444	1·43p	1·37p	SN7482	97p	95p	SN74111	1·37p	1·27p
SN7416	47p	43p	SN7445	2·00p	1·92p	SN7403	1·20p	1·15p	SN74118	1·10p	1·05p
SN7417	47p	43p	SN7446	1·07p	1·02p	SN7484	1·10p	1·05p	SN74119	1·47p	1·37p
SN7420	16p	15p	SN7447	1·10p	1·03p	SN7485	3·96p	3·85p	SN74121	44p	41p
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301A	DIL	69p	741c	14 PIN DIL	39p
301A	TO99	69p	741c	TO99	41p
301A	8 PIN DIL	66p	747c	DIL	46p
307	DIL	69p	748c	DIL	39p
307	TO99	69p	748c	TO99	41p
307	8 PIN DIL	66p	1437	DIL	1·27p
308	TO99	6·45p	1458	TO99	1·27p
308A	TO99	6·40p	3046	DIL	84p
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709c	TO99	81p			

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220µF	6½p
330µF	6½p
1000µF	13p
4700µF	29p

6.3 VOLT

33µF	6½p
68µF	6½p
150µF	6½p
470µF	11p
680µF	13p
1500µF	18p
2200µF	18p
3300µF	26p

10 VOLT

22µF	6½p
47µF	6½p
100µF	6½p
220µF	8p
330µF	10p
470µF	10p
1000µF	11p
1500µF	20p
2200µF	24p

16 VOLT

15µF	6½p
33µF	6½p
68µF	6½p
150µF	8p
220µF	9p
680µF	17p
1000µF	17p
1500µF	25p
2000µF	43p

25 VOLT

10µF	6½p
22µF	6½p
47µF	6½p
100µF	8p
150µF	8p
220µF	10p
470µF	13p
680µF	20p
1000µF	22p
2200µF	39p
5000µF	68p

40 VOLT

6·8µF	6½p
15µF	6½p
33µF	6½p

40 VOLT

47µF	6½p
100µF	9p
150µF	10p
220µF	11p
470µF	19p
680µF	25p
1000µF	25p
2200µF	44p

63 VOLT

1µF	6½p
2·2µF	6½p
4·7µF	6½p
6·8µF	6½p
10µF	6½p
22µF	6½p
68µF	10p
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220µF	19p
330µF	22p
470µF	26p
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AC126	14p	BC142	33p	BF329	18p	OC45	14p	1N914	8p
AC127	13p	BC143	33p	BF330	18p	OC70	23p	1N916	8p
AC128	13p	BC144	30p	BF390	37p	OC71	14p	1N4148	8p
AC142K	22p	BC145	26p	BFX84	28p	OC72	14p	1844	10p
AC141K	20p	BC147	9p	BFX85	35p	OC81	14p	1N4007	22p
AC176	15p	BC148	9p	BFX86	22p	OC83	22p	18113	17p
AC187	18p	BC149	9p	BFX87	28p	OC84	28p	18120	17p
AC187K	20p	BC153	16p	BFX88	26p	TIP29A	53p	18121	15p
AC188	13p	BC154	17p	BFY50	21p	TIP30A	64p	18130	9p
AC188K	20p	BC157	13p	BFY51	17p	TIP31A	64p	18131	11p
ACY17	24p	BC158	12p	BFY52	17p	TIP32A	73p	18132	13p
ACY18	21p	BC159	14p	BFY64	89p	TIP33	£1·05	18920	8p
ACY19	25p	BC167	13p	BFY90	72p	TIP34A	£1·54	18922	9p
ACY20	22p	BC168	11p	BSX20	19p	TIP35A	£2·53	18923	13p
ACY21	23p	BC169	11p	C407	22p	TIP36A	£3·19	18940	6p
ACY22	18p	BC177	15p	C426	33p	TIP41A	79p	AA119	11p
ACY39	68p	BC179	15p	C428	31p	TIP42A	91p	AA129	11p
AD140	40p	BC182L	9p	C450	17p	2N706	13p	AAZ13	11p
AD142	44p	BC183L	9p	MP8111	35p	2N930	23p	AAZ15	14p
AD143	39p	BC184L	9p	MP8112	42p	2N1131	22p	AAZ17	14p
AD149	38p	BC186	33p	MP8113	35p	2N1132	28p	BA100	16p
AD150	60p	BC212L	11p	MP8121	33p	2N1613	22p	BA102	25p
AD161	29p	BC213L	11p	MP8122	44p	2N1711	26p	BA115	8p
AD162	29p	BC214L	11p	MP8123	50p	2N2904	40p	BA144	14p
AD M/P	50p	BC258	9p	NKT211	28p	2N2904A	44p	BA145	22p
AF114	14p	BC259	9p	NKT212	28p	2N2905	46p	BA154	14p
AF115	14p	BC267	14p	NKT214	25p	2N2924	18p	BAX13	14p
AF116	14p	BC268	15p	NKT217	55p	2N2926	10p	BAX16	14p
AF117	14p	BC300	40p	NKT261	23p	2N3053	26p	BAY18	19p
AF118	92p	BC301	32p	NKT271	20p	2N3054	55p	BAY31	9p
AF124	27p	BC302	30p	NKT274	20p	2N3055	52p	BY100	19p
AF139	39p	BC303	50p	NKT275	25p	2N3405	44p	BY126	16p
AF239	41p	BC304	40p	NKT403	71p	2N3663	57p	BY127	19p
AL100	77p	BCY70	17p	NKT405	83p	2N3702	9p	BYX10	24p
AL102	66p	BCY71	37p	NKY603F	66p	2N3703	9p	OA5	19p
AL103	55p	BCY72	17p	NKT613G	33p	2N3704	9p	OA9	11p
ASY26	31p	BD123	66p	NKT674	26p	2N3705	9p	OA10	24p
ASY27	40p	BD130	50p	NKT677G	24p	2N3706	9p	OA47	9p
AU103	99p	BD131	68p	NKT713	32p	2N3707	9p	OA70	8p
AU110	£1·10	BD132	90p	NKT773	27p	2N3708	9p	OA73	11p
AU111	77p	BD135	42p	OC19	55p	2N3709	9p	OA79	8p
BC107	9p	BD136	50p	OC20	55p	2N3710	9p	OA81	9p
BC108	9p	BD141	£1·87	OC23	33p	2N3711	9p	OA85	11p
BC109	9p	BD142	50p	OC25	28p	2N3794	17p	OA90	8p
BC113	15½p	BF159	33p	OC28	33p	2N3819	28p	OA91	8p
BC116	16p	BF173	29p	OC29	33p	40361	50p	OA95	8p
BC125	16p	BF177	28p	OC35	38p	40362	50p	OA200	11p
BC126	25p	BF178	29p	OC36	38p	40636	50p		
BC132	16p	BF179	35p	OC41	14p				
BC134	16p	BF194	15p						
BC135	16p	BF195	17p						
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160V: 0·01µF, 0·015µF, 0·22µF, 0·033µF, 0·047µF, 0·068µF, 8p. 0·1µF 3½p. 0·15µF, 4½p. 0·22µF, 5½p. 0·33µF, 6½p. 0·47µF, 8½p. 0·68µF, 12p. 1·0µF, 14½p.

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SINGLE GANGED, LOG or LIN 1k to 1M.
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TWIN GANGED, LOG or LIN 1k to 500k.
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Small high quality type (linear only).
All valves 100-5 meg ohms.
-1 watt 5½p each
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2½in × 5in	28p	28p
3¾in × 3¾in	28p	28p
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Reads 0–9 and decimals
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ONLY £1·50
16 DIL Socket 33p
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100	IN4002 4½p	PL4002 9p
200	IN4003 5½p	PL4003 10p
400	IN4004 6½p	PL4004 10p
600	IN4005 8p	PL4005 13p
800	IN4006 9p	PL4006 15p
1000	1N4007 10p	PL4007 20p

BRIDGE RECTIFIERS

P.I.V.	1 AMP	2 AMP	5 AMP	10 AMP
50	33p	53p	£1·76p	£2·20p
100	35p	57p	—	—
200	37p	60p	£1·98p	£2·31p
400	40p	64p	£2·15p	£2·42p
600	44p	66p	£2·42p	£2·75p
800	49p	—	—	—

THYRISTORS

PIV	50	100	200	300	400
1 Amp	28	25	41	44	53
3 Amps	44	50	60	—	66
7 Amps	—	96	1·01	—	1·24

RESISTORS

¼ watt 5% carbon 1p each
½ watt 10% carbon 1p each
1 watt 10% carbon 2½p each
Range 10 ohms to 4·7 meg.
½ watt m/o 2% 3p each
Range 10–1 meg ohms

PATENTS REVIEW...

CAR WARNING CIRCUIT

A Company which is very active in the field of patents for car safety devices is Joseph Lucas (Industries). Their latest device, BP 1 297 385, triggers an alarm if a driver attempts to leave his vehicle without removing the ignition key.

In the patent circuit, Fig. 1, the car battery has its negative terminal earthed to chassis and its positive terminal connected to one side of a car internal rooflight LP1.

The other side of the light is earthed to chassis via three separate parallel paths. One of these paths contains switch S1 which is operated by the passenger door of the vehicle and closes when the door is open. The second path contains a switch S2 which is manually controlled from within the vehicle.

The third parallel path contains a diode D1 and switch S3 in series. Switch S3 is operated by the driver's door and closes when the door is opened. Closure of any one of the switches S1, S2, S3 energises LP1.

The "live" side of switch S3 is connected to the positive battery terminal via an alarm buzzer or bell in series with a resistor R1.

An *npn* transistor TR1 has its collector-emitter path connected across the alarm and its base connected to the positive battery terminal through resistor R2 and to earth via switch S4. The switch S4 is ganged to the ignition switch and closes when the ignition key is in position.

When the car is being driven, S4 is closed and current flows through R2; no current flows through the alarm or the transistor. When the driver stops the vehicle and removes the ignition key, S4 opens. As the driver gets out of the car the act of opening his door closes S3 and TR1 is turned on by current flow through resistor R1. This short circuits the alarm, which thus cannot sound.

In the event that the driver forgets to remove his ignition key, S4 stays closed and no base current reaches the transistor when S3 closes (as the driver opens his door). In this case the alarm receives current via R1 and sounds the alarm.

The presence of the diode D1 ensures that the alarm cannot be operated when one or both of the switches S1 and S2 are operated.

BP 1 297 385

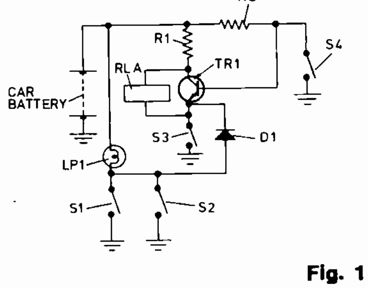


Fig. 1

BUTLER-TYPE OSCILLATOR CIRCUIT

BP 1 282 853

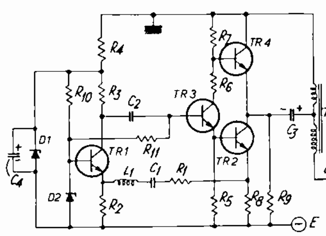


Fig. 1

International Standard Electric Corporation in BP 1 282 853 discloses a Butler-type oscillator circuit of the generally known type in which a first and second transistor have their emitters coupled by a series resonant circuit.

The first transistor has its base biased to a fixed potential and its collector coupled to the base of the second transistor to limit feedback amplitude. The output signal is in the form of a clipped sine wave so in some uses, e.g. in telephony where distortion may cause the faulty operation of receiving equipment, the clipped signal must be corrected by filtering. The filterers necessary can, however, be bulky and costly in comparison with other miniaturised components.

What ISEC suggest is a modified Butler-oscillator with three *npn* transistors TR1, TR2 and TR3 and a buffer output stage formed from an *npn* transistor TR4 mounted in emitter follower configuration.

CIRCUIT PROTECTION

Connecting a car battery into circuit the wrong way round can cause damage, e.g., in the generating and regulating circuits of the vehicle. A diode can be used to block wrong polarity currents but where the circuit carries heavy surges, the diode is at risk.

In BP 1 293 046 Pal-Magneton Narodni Podnik of Czechoslovakia describe three closely related simple ways of connecting circuits which must carry heavy currents and are sensitive to polarity.

The circuit, Fig. 1, shows a relay with its contacts RLA1 in series with a battery and the coil in series with diode D1 and switch S1. The coil, D1 and S1 are connected in parallel with the battery.

The contacts RLA1 are normally open and the diode D1 ensures that current will flow through the relay coil (when S1 is closed) only if the battery is connected with the correct polarity. Incorrect polarity will cause the diode to block current flow through the coil with the result that the contacts stay open and the polarity sensitive load is safeguarded.

The circuit in Fig. 2 shows RLA1 contacts connected as in Fig. 1 but diode D1 is used in parallel with the coil. A resistor R1 is connected in series with the coil and S1.

Again, current flows through the relay coil only if the battery is correctly connected, but in this case if the polarity is wrong the diode D1 will conduct and, in effect, put a short across the relay coil stopping it operating. The resistor R1 prevents the full short circuit current from passing through the diode when the battery is connected incorrectly.

BP 1 293 046

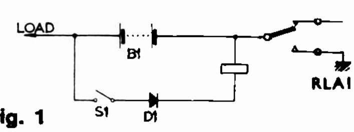


Fig. 1

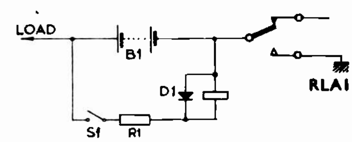


Fig. 2

BOOK REVIEWS

THE RADIO AND ELECTRONIC ENGINEER

(The Journal of the Institution of Electronic and Radio Engineers)
VOL. 43 No. 1/2 January/February 1973.

IT is unusual to review a Journal, but this particular publication is of especial and topical interest to all who are involved in any way with semiconductors. The January/February issue of the *Radio and Electronic Engineer* is almost entirely devoted to special contributions from leading British scientists and engineers who have been associated with semiconductor developments during the past 25 years. Collected together are 18 papers, each written with authority based upon intimate involvement and covering some particular aspect of the design, development, manufacture or application of discrete active devices and integrated circuits.

As a technical record of the first twenty-five years of semiconductors, including their impact and influence upon different specialised fields of application, this issue of the *Radio and Electronic Engineer* warrants a place on the bookshelf of any electronics enthusiast.

Copies may be obtained from the IERE Publications Sales Department, 9 Bedford Square, London, WC1B, price £2·00 per copy, post free.

HANDBOOK OF BASIC ELECTRONIC EQUIPMENT

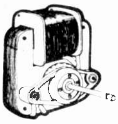
By W. Oliver
Published by Foulsham Technical
102 pages, 5½in × 9in. Price £1·75

THE AUTHOR of this book will be known to all readers of Foulsham-Sams books as the man who translates American into English. The main idea behind this book seems to be that of giving readers some technical background on basic equipment but mainly information on suppliers.

However, if one is going to give technical information it is essential not to give wrong information. The note inside the front cover states that "mathematics . . . have been minimised so that the book will be easily understood by even beginners". After reading the book it makes me wonder whether Mr Oliver knows any maths! For instance, on capacitors: "the total effective capacity of capacitors in series is the sum of the individual capacitors"; or on resistors: "2K and 4K in parallel, then in series with the 3K, gives you roughly 1,333 ohms" (yes, very roughly, in actual fact 4,333 ohms); the term EMF is used where potential drop is meant; a varactor is described as a "very special kind of diode" whereas all diodes exhibit varactor action.

If one is going to present technical information, especially for beginners then one has got to be a little more accurate than this. No, I am afraid I would not recommend this book to any beginner; the suppliers addresses may be useful but as a technical work it leaves very much to be desired.

S.R.L.



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.

MUSIC ON TAPE

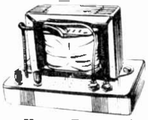
A further buy enables us to offer these at an even lower price—namely **65p** each or 5 for **£2·50.** Send for list of titles. We can't repeat when sold out.

BALANCED ARMATURE UNIT

500 ohm, operates as speaker or microphone, so useful in intercom or similar circuits, **33p** each, **£3·50** doz.

CAR ELECTRIC PLUG

Fits in place of cigarette lighter. Useful method for making a quick connection into the car electrical system, **38p** each or 10 for **£3·42.**



12 VOLT 1½ AMP POWER PACK

This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 m/f/d' smoothing. Price **£2·00,** plus 20p post & packing.

Heavy Duty Mains Power Pack. Output voltage adjustable from 15-40V in steps—maximum load 250W—that is from 6 amp at 40V to 15amp at 15V. This really is a high power heavy duty unit with dozens of workshop uses. Output voltage adjustment is very quick—simply interchange push on leads. Silicon rectifiers and smoothing by 3,000mF. Price **£5·75** plus 65p post.

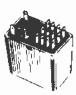
MAINS RELAY BARGAIN

Special this month are some single, double and treble pole changeover relays. Contacts rated at 15 amps. Operating coil wound for 240V A.C. Good British Make. Unused. Size approx. 1½" × 1". Open construction.
Single pole **25p** each 10 for **£2·25.**
Treble pole **35p** each 10 for **£3·15.**

DOOR INTERCOM

Know who is calling and speak to them without leaving bed or chair. Outfit comprises microphone with call push button, connectors and master intercom. Simply plugs together. Originally sold at **£10.** Special snip price **£3·50** plus 20p postage.

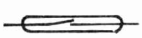
TYPE 25 RELAYS



These are miniature relays. Size approx. 1$\frac{3}{16}$in. high × 1⅛in. wide × ⅞in. deep, 4 changeover silver/gold contacts. Contact rating lamp 100V D.C. Fitted with a plastic cover. Coil operates approx. 250Mv. D.C. Available with the following coils: 28 ohm for 1·2·5v. 45 ohm for 4·7·5v. 52 ohm for 4·9-6v. 90 ohm for 5·5-11·5v. 130 ohm for 10-15v. 530 ohm for 17-36v. 1250 ohm for 27-44v. 2500 ohm for 31-65v. 5800 ohm for 27-44v. **75p** each. **10 for £6·75.** Also one with 16,500 ohm coil but this has only 2 heavy duty changeover gold contacts. Price **85p.**

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.



REED SWITCHES

Glass encased, switches operated by external magnet—gold welded contacts. We can now offer 3 types:

Miniature, 1" long × approximately ⅛" diameter. Will make and break up to ½A up to 300V. Price **13p** each, **£1·20** dozen.

Standard, 2" long × $\frac{3}{16}$" diameter. This will break currents of up to 1A, voltage up to 250V. Price **10p** each, **90p** per dozen.

Flat. Flat type, 2" long, just over $\frac{1}{16}$" thick, flattened out, so that it can be fitted into a smaller space or a larger quantity may be packed into a square solenoid. Rating 1A 200V. Price **30p** each. **£3** per dozen.

Small ceramic magnets to operate these reed switches **9p** each, **90p** dozen.

Dry Reed Relays. Solenoids on moulded bobbins within magnetic shields—printed circuit or panel mounting.

Ref.	*Coil Resistance*	*Reed Switches*	*Price*
71005	2 K	1 normally open	**25p**
81916	5 K	1 normally open 1 normally closed	**75p**
05003	4 K	1 normally open	**25p**
62040	1500 & 500 ohms	1 normally open	**35p**

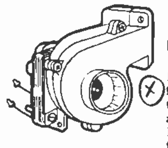
Multiple Reed Relay. Ref. 53001. Contains 13 normally open reeds within a solenoid. Operates on 600 mW. Coil resistance 9K ohms. Price **£1·95** each.

Multiple Reed Relay. Ref. 631. 2 normally open 1 normally closed coil resistance 30 ohms. Price **75p.**

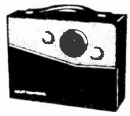
MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied.
Model 1153 500mW power output **85p.**
Model 1172 750mW power output **85p.**
Model EP9000 4 watt power output **£1·65.**
EP9001 twin channel or stereo pre amp. **£1·60.**
10% discount if 10 or more ordered.

CENTRIFUGAL BLOWER



Miniature mains driven blower centrifugal type blower unit by Woods. Powerful but specially built for quiet running—driven by cushioned induction motor with specially built low noise bearings. Overall size 4½" × 4½" × 4". When mounted by flange, air is blown into the equipment but to suck air out, mount it from centre using clamp. Ideal for cooling electrical equipment or fitting into a cooker hood, film drying cabinet or for removing flux smoke when soldering etc. etc. A real bargain at **£1·85.**



GOOD COMPANION I.C. VERSION

We can now offer these again in I.C. version using Ferranti ZN414 and Mullard AF Module 1172. Cabinet size approx. 11in wide × 8in high × 3in deep. Complete assembly instruction—Excellent tone wood cabinet **£5·75.**

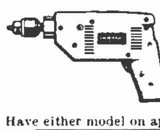
MIGHTY MIDGET

Probably the tiniest possible radio, as described in Practical Wireless, 4 January 73. All electronic parts **£2** post paid.

THIS MONTH'S SNIP

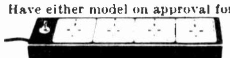
10 AMP DIMMER/CONTROLLER

For the control of lighting of stage or studio or portable equipment in workshops, etc. This has socket outlets each controlled by 5 AMP Solid State regulator. Also fitted with master switch fuse and neon indicator and terminating with 6 feet of flex. Overall length 17in., 3½in. x 1½in. deep. £7·50, plus 25p P. & P.



PORTABLE ELECTRIC DRILL

Very superior quality made by a famous Dutch Toolmaker. Model No. ASM830. 300W—2 speed 2,200/3,000. With ⅜in chuck and chuck key, also separate side handle and hammer facility for dealing with concrete, etc. An equivalent British made drill would cost **£15. £9·95**—similar model but without the hammer attachment **£7·95.** Have either model on approval for 7 days.

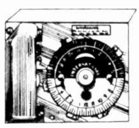


DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 7 feet of heavy cable. Wired up ready to work, **£2·25** plus 20p post and insurance.

CAPACITOR DISCHARGE CAR IGNITION

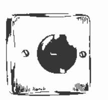
This system which has proved to be amazingly efficient and reliable was first described in the *Wireless World* about a year ago. We can supply kit of parts for an improved and even more efficient version (*Practical Wireless*, June). Price **£5·95** plus 20p post. When ordering please state whether for positive or negative systems. De-luxe model including printed circuit board etc. **£6·95**



24-HOUR TIME SWITCH

Made by Smiths, these are A.C. mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. Two completely adjustable time periods per 24 hours, 5A changeover contacts will switch circuit on or off during these periods. **£2·50** post and ins. 25p. Additional time contacts **50p** pair.

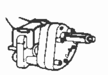
THYRISTOR LIGHT DIMMER



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.
Industrial model 5A **£3.**

BATTERY CONDITION TESTER

Made by Mallory but suitable for all batteries made by Ever Ready and others, most of which are zinc carbon types but also mercury manganese—nicad—silver oxide and alkaline batteries may be tested. The tester puts a dummy load on the battery and the meter scale indicates the condition depending upon which section the pointer rests. The section reads "replace" "weak" or "good". The tester is complete in its case, size 3¾" × 6¼" × 2" with leads and prods. Price **£2·25** plus 20p postage.



SPIT MOTOR

200-250V Induction Motor, driving a Carter gear box with 1½" of output drive shaft running at 5 revs per minute. Intended for roasting chickens also suitable for driving models—windmills, coloured disc lighting effect, etc. etc. **£1·65** plus 20p post and insurance.

DRILL CONTROLLER

NEW IKW MODEL

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£1·50.** Made up model also available. **£2·50.**

MAINS TRANSISTOR POWER PACK

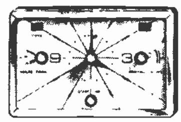
Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor condensers and instructions. Real snip only **£1.**

BURGLAR ALARM

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc.
24in × 18in **£1·40.**
13in × 10in **£1.**

PP3 BATTERY CHARGER

Almost 3 times the life can be obtained from PP3 battery if you re-charge it from the mains—this ready to use charger with instructions only **50p.**



15A ELECTRICAL PROGRAMMER

Learn in your sleep: Have radio playing and kettle boiling as you awake—switch on lights to ward off intruders — have a 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.

BAKELITE INSTRUMENT CASE

Size approx. 6½"×3½"×2" deep with brass inserts in four corners and bakelite panel. This is a very strong case suitable to house instruments and special rigs, etc. Price. **45p** each.
Paxolin lid **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 **£1** each + 50p post or 2 for **£2·50** post paid. Also available separately, dials and handsets **50p** each + 20p p & p

20 WATT INVERTER

Smart and Brown—For van lighting or camping etc. Will light a 2ft. 20 watt standard fluorescent tube from a 12V car battery, current approx. 2A. Very well made unit using die cast chassis. Size 11½" × 2" × 1½". Price **£6·50** complete with lamp holders and tube clips.

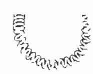
ROCKER SWITCH

13 amp self-fixing into an oblong hole. Size approximately 1" × ½" **8p** each. 10 for **72p.**

SLIDE SWITCHES

Slide Switch. 2-pole changeover panel mounting by two 6B.A. screws. Size approx. 1in × ⅜in rated 250V lamp. **7p** each. 10 for **63p.** Ditto as above but for printed circuit **6p** each 10 for **54p.** **Sub Miniature Slide Switch.** DPDT 19mm (¾in approx.) between fixing centres. **18p** each or 10 for **£1·08.** SP Change over spring return 250V 1 amp. **10p.**

SPRING COIL LEADS



as fitted to telephones, 4 core **15p** each. 10 for **£1·35.** 3 core **10p** each. 10 for **90p.**

**Please add V.A.T.
10% on total orders
after April 1st**

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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AC107	50p
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AC151	20p
AC152	25p
AC153	26p
AC176	20p
AC153/176K	62p
AC187K	17p
AC188K	23p
AC187/188K	40p
ACY17	27p
ACY18	20p
ACY19	20p
ACY20	20p
ACY21	19p
ACY22	10p
AD140	55p
AD149	50p
AD151	49p
AD162	55p
AD161/162	£1·04
AF106	32p
AF114	25p
AF115	25p
AF116	25p
AF117	25p
AF118	44p
AF124	25p
AF125	24p
AF126	17p
AF139	47p
AF186	40p
AF239	50p
AF279	55p
ASY26	25p
ASY27	30p
ASY28	22p
ASY29	30p
BA138	15p
BAX16	8p
BB103	16p
BB104	28p
BB105	32p
BC107	10p
BC107/BC177	24p
BC108	10p
BC108/BC178	23p
BC109	10p
BC109/BC179	24p
BC109C	11p
BC140	30p
BC147	10p
BC148	9p
BC149	10p
BC157	12p
BC158	11p
BC159	12p
BC147/157	22p
BC148/158	20p
BC149/159	22p
BC167	11p
BC168	10p
BC169	11p
BC169C	12p
BC177	14p
BC178	13p
BC179	14p
BC182	10p
BC182L	10p
BC183	9p
BC183L	10p
BC184	13p
BC184L	12p
BC212	12p
BC212L	10p
BC238	10p
BC238/308	29p
BC257	8p
BC258	9p
BC259	9p
BC307	12p
BC308	10p
BCY30	25p
BCY31	48p
BCY32	50p
BCY33	20p
BCY34	25p
BCY38	30p

BCY58	18p
BCY70	15p
BCY71	30p
BCY72	15p
BD124	75p
BD131	75p
BD132	75p
BD131/132	£1·50
BDY20	92p
BF115	23p
BF163	35p
BF167	25p
BF173	39p
BF177	25p
BF178	31p
BF180	35p
BF194	15p
BF195	15p
BF196	15p
BF200	35p
BF254	14p
BF255	15p
BFX13	25p
BFX29	25p
BFX84	25p
BFX85	34p
BFX86	25p
BFX87	30p
BFX88	24p
BFY50	15p
BFY51	15p
BFY52	15p
BFY53	17p
BFY90	£1·05
BP101	75p
BPX66	£1·35
BRY39	40p
BSX19	16p
BSX20	16p
BSX21	20p
BSY27	20p
BSY29	25p
BSY95A	12p
BY100	20p
BY127	22p
BTY79/400R	92p
BT106	£1·20
BZY88C3V3	13p
BZY88C3V6	13p
BZY88C3V9	13p
BZY88C4V3	13p
BZY88C4V7	13p
BZY88C5V1	13p
BZY88C5V6	13p
BZY88C6V2	13p
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BZX61C12V	23p
BZX61C13V	23p
BZX61C15V	23p
BZX61C16V	23p
BZX61C18V	23p
BZX61C20V	23p
BZX61C22V	23p
BZX61C24V	23p
BZX61C27V	23p
BZX61C30V	23p
CA3004	£2·25
CA3005	£1·50
CA3011	92p
CA3013	£1·30
CA3014	£1·52
CA3018	88p
CA3018A	£1·19
CA3020	£1·55
CA3028A	88p
CA3035	£1·52

CA3043	£1·73
CA3044	£1·42
CA3046	86p
CA3048	£2·34
CA3052	£1·80
CA3065	£1·42
CA3088E	£1·38
CA3090Q	£4·70
CD4001AE	54p
CD4009AE	£1·16
CD4011AE	54p
CD4012AE	54p
CD4013AE	£1·11
CD4015AE	£2·92
CD4017AE	£2·92
CD4018AE	£2·92
CD4020AE	£3·25
CD4024AE	£2·09
CR1/051C	45p
CR1/401C	60p
CRS3/05AF	£1·08
CRS3/40AF	£1·53
CZ6	15p
D10 (NTGD10)	40p
IRT84	£2·90
LIC709C/5	42p
LIC709C/8	42p
LIC723C/5	£1·02
LIC723C/14	£1·00
LIC741C/5	45p
LIC741C/8	40p
MC1303L	£1·75
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MFC6030	£1·63
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MFC8040	£1·24
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MJE371	68p
MJE520	65p
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MJE3055	66p
MJ480	97p
MJ481	£1·25
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MJ802/MJ4502	£8·56
MJ900	£1·80
MJ1000	£1·50
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MPF102	37p
MPF103(2N5457)	49p
MPF104(2N5458)	49p
MPF105(2N5459)	46p
NKT0033	96p
NKT211	25p
NKT212	25p
NKT213	25p
NKT216	46p
NKT217	50p
NKT218	25p
NKT223	27p
NKT271	18p
NKT274	18p
NKT275	20p
NKT279A	12p
NKT281	29p
NKT351	75p
NKT401	71p
NKT402	77p
NKT403	65p
NKT404	60p
NKT405	79p
NKT406	62p
NKT713	29p
NKT773	25p
NKT781	29p
NTGD10	40p
OA47	8p
OA79	8p

OA81	8p
OA90	6p
OA91	5p
OA95	5p
OA200	6p
OA202	7p
OC20	97p
OC25	37p
OC28	70p
OC29	76p
OC35	60p
OC36	63p
OC41	40p
OC42	40p
OC44	20p
OC45	20p
OC71	20p
OC72	20p
OC75	25p
OC76	25p
OC77	40p
OC81	20p
OC81D	20p
OC83	23p
OC84	25p
OC139	25p
OC170	25p
OC171	30p
OCP71M	42p
ORP12	50p
ORP60	40p
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VA1040	15p
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W005	30p
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ZTX107	12p
ZTX108	11p
ZTX300	13p
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ZTX303	15p
ZTX304	23p
ZTX314	11p
ZTX320	30p
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ZTX500	14p
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1N914	4p
1N3754	20p
1N4001	7p
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1N4003	10p
1N4004	10p
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1N4148	4p
1N5400	14p
1N5404	18p
1N5408	25p
1S44	4p
1S920	7p
1S940	6p
1S5009	80p
1S5012	80p
1S5015	75p
1S5018	75p
1S5024	75p
1S5047	75p
2N404	23p
2N696	15p
2N697	17p
2N698	30p
2N706	10p
2N706A	12p
2N708	16p
2N911	50p
2N914	20p
2N918	42p
2N929	25p
2N930	28p
2N1131	24p
2N1132	24p
2N1302	17p
2N1303	17p
2N1304	24p
2N1305	24p
2N1306	30p
2N1307	30p
2N1308	34p
2N1309	34p
2N1559 (CR1/401C)	60p
2N1613	15p
2N1711	15p
2N1893	54p
2N2218	33p
2N2218A	44p
2N2219	38p
2N2219A	53p
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74151	£1·10
74153	£1·35
74154	£2·00
74155	£1·55
74156	£1·55
74190	£1·80
74191	£1·80
74192	£1·74
74193	£1·74
74196	£1·50
74197	£1·50
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40309	40p
40310	60p
40311	42p
40312	62p
40320	42p
40360	56p
40361	45p
40362	45p
40406	52p
40407	40p
40408	54p
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1·0	100v	5p	100	25v	6p
2·2	25v	7p	100	40v	7p
2·2	63v	5p	100	63v	10p
4·7	40v	5p	220	25v	8p
10	25v	5p	220	40v	9p
10	63v	6p	470	25v	12p
22	25v	6p	1000	25v	16p
22	40v	6p	2200	25v	30p
47	25v	6p	4700	16v	33p
47	40v	6p			

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UPM075	0·75	5%	10E-1M	E12	1p each
UPM075	0·75	10%	1M-4·7M	E12	1p each
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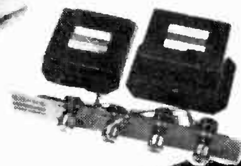

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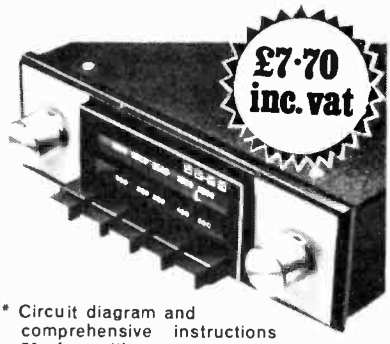

The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles. It covers the full medium and long wave bands. It is permeability tuned and sturdily constructed. Output is a full 2·5 watts into an 8ohms speaker. But the Tourist PB will operate into any loudspeaker from 8 to 15 ohms.
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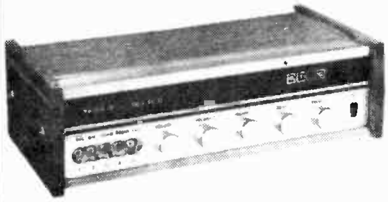

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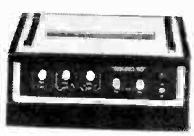

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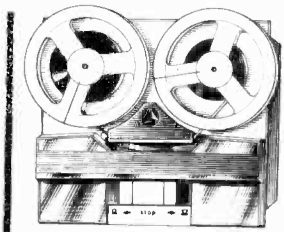

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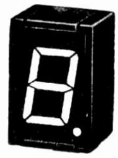

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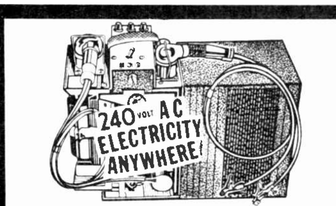

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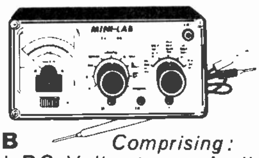

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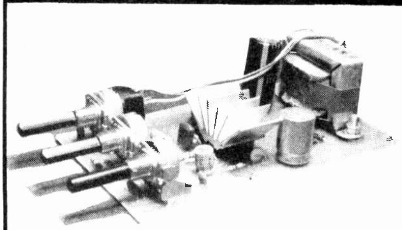

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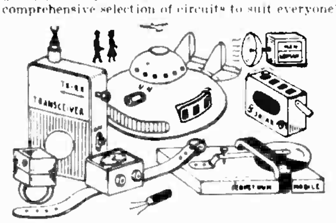

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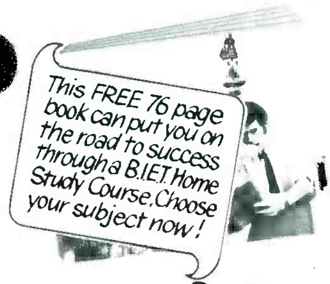

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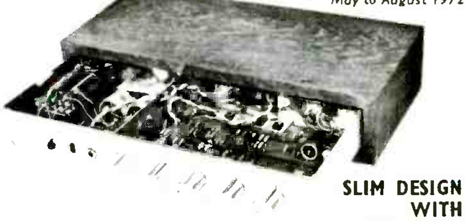

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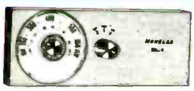

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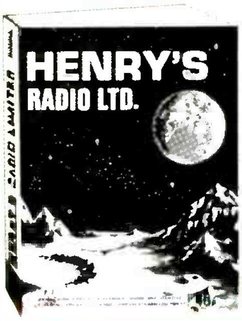

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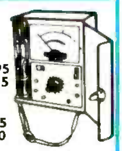

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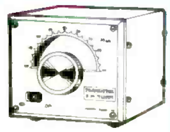

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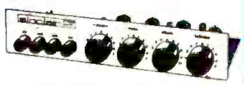

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