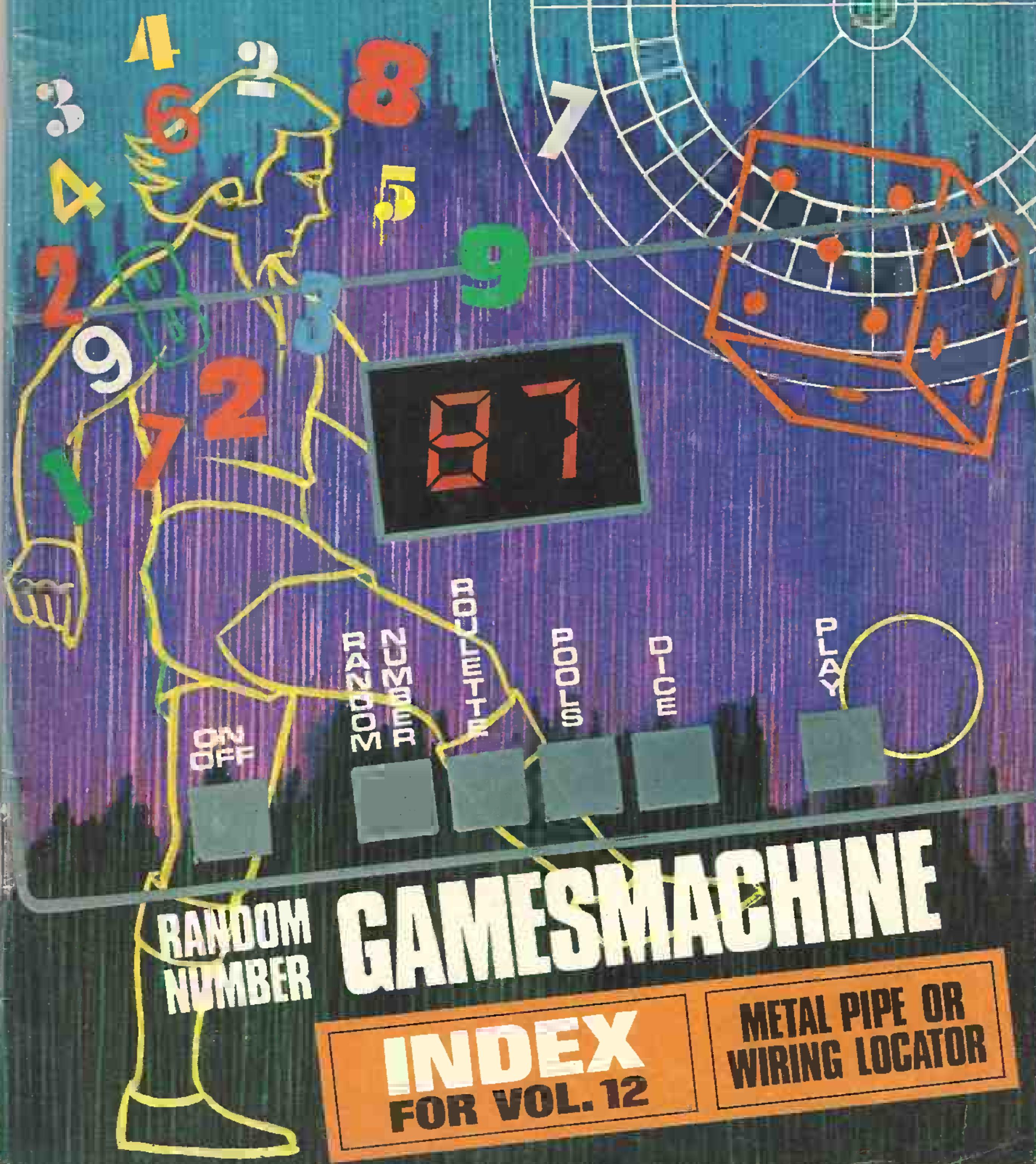
PRACTICAL

ELECTRONICS

DECEMBER 1976

40p



RANDOM NUMBER GAMESMACHINE

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METAL PIPE OR WIRING LOCATOR

PRACTICAL
ELECTRONICS

VOLUME 12 No. 12 DECEMBER 1976

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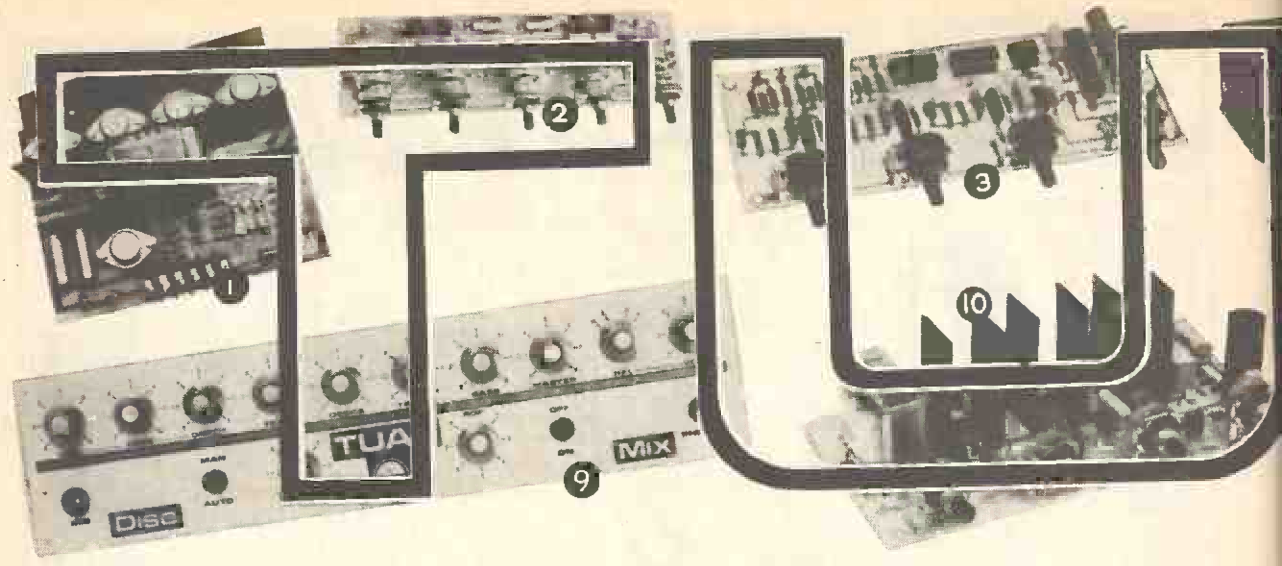
GENERAL FEATURES

NEWS AND COMMENT

Our January issue will be on sale on Friday, December 10, 1976
(for details of contents see page 955)



TRANSISTOR UNIVERSAL AMPLIFICATION Co. Ltd. **PHONE 01-672 3137/672 9080**

9 MONO DISCO MIXER
WITH AUTO FADE

Designed for the discerning D. J. of professional standard. Offering a vast variety of functions. Controls; Mic Vol; Tone, over-ride depth, auto/manual sw; Tape Vol; L & R Deck Faders; Deck Volume; Treble and Bass; H. Phon Vol Selector; Master Vol On/Off sw. Max output 3V RMS.
Specification: Deck inputs—50mV into 1MΩ; Deck Tone Controls—treble total range 36dB at 15kHz—Bass total range 36dB at 50Hz. Mic input—200 ohms upwards 2mV into 22k. Mic Tone Control—Total range 40dB at 15kHz. Tape input—100mV into 200 ohms. Power requirements 20–50 volts d.c. at 50mA. R.I.A.A. comp mag inputs available 75p extra.
PANEL SIZE 18 × 4½in. DEPTH 3in. **£39·75**

THE PIEZO SUPER HORN
has all the features! ***ONLY*** **£10·95**

- NEEDS NO CROSS-OVER NETWORK
- FREQUENCY RESPONSE: 4,000–30,000Hz ± 3dB
- PATENTED MOMENTUM DRIVE PRINCIPLE
- NO VOICE COILS OR MAGNETS
- HIGH INTERNAL IMPEDANCE—ADAPTS TO ANY SYSTEM
- HIGH ACOUSTIC OUTPUT
- MANY CAN BE CONNECTED IN SERIES TO FORM AN ARRAY—INCREASES OUTPUT
- POWER HANDLING CAPACITY 25 volts RMS–see chart
- COMPACT—3⅜ × 3⅜ × 2⅞in.

POWER HANDLING GUIDE

System Impedance	Capacity
2 ohms	312 watts
4 ohms	156 watts
8 ohms	78 watts
16 ohms	39 watts

PRE AMPLIFIERS

VA08
Designed for use with TUAC power amplifier modules. Extensive research has gone into various wide range tone control circuits produces superb sound quality. Thousands are already in use in high quality professional amplification systems.
VA08 Vol. Treb. Mid and Bass controls. HI. IMP. FET. I/P suitable Mid. Guitar, Radio, Crystal/Ceramic P.U. Sensitivity 4mV. Treble + 35dB at 16kHz. Mid + 20 – 15dB at 1kHz. Bass + 20 – 10dB at 40Hz. **£8·50**

VA06 Vol. Treb. and Bass controls. Sensitivity 8mV. Treb. + 28 – 15dB at 12kHz. Bass ± 18dB and 40Hz. **£7·50**

2 SVA08 STEREO PRE AMP Vol. Treb. Mid and Bass controls. I/P suitable, Guitar, Radio, Crystal/Ceramic P.U. Sensitivity 4MV. Treble + 35dB at 16kHz. Mid + 20 – 15dB at 4kHz. Bass + 20 – 10dB at 40Hz. Plus Full Balance Control. Fully I/C operation supply voltage ± 15VDC. **£15·00**

AMPLIFIER MODULES

7 TL30 D.C. COUPLED POWER AMPLIFIER MODULE
- Output power 30 watt R.M.S. continuous sine wave into 8 Ohms
- T.H.D. at full power 0·5%
- Signal to noise ratio—85dB
- Input sensitivity 60mV into 50k ohms
- Frequency response 25Hz–50kHz
- 8 transistors 4 diodes

£12·50

11 TL60 5 × 5 × 3in
- 60 watt R.M.S. continuous sine wave output
- 2 R.C.A. 110 watt 15 amp transistors

£16·75

11 TL100 5 × 5 × 3in
- 100 watt R.M.S. continuous sine wave output
- 2 R.C.A. 150 watt 15 amp transistors

£18·75

1 TP125 7 × 6½ × 3in
- 125 watt R.M.S. continuous sine wave output
- 4 R.C.A. 150 watt 15 amp output transistors

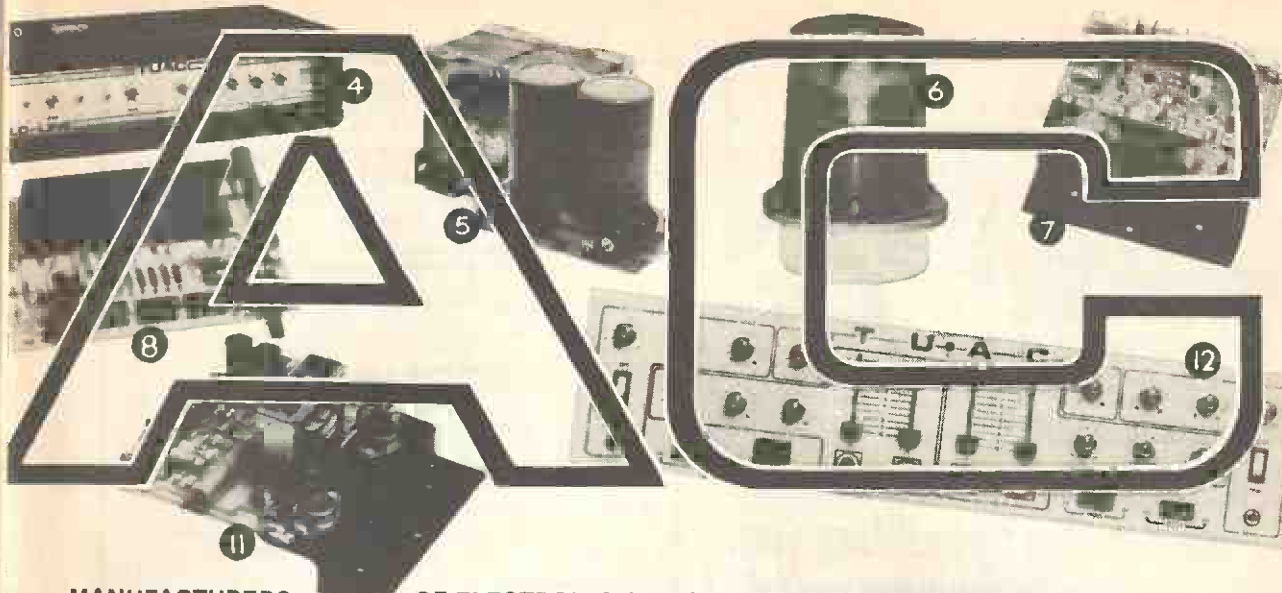
£23·25

Specification on power modules: ● Rugged layer wound driver transforme ● Short—Open—and Thermal overload protection ● Only 6 connections All output power ratings ± 0·5dB. Output impedance 8–15 ohms; THD at fu power 2% typically 1%; Input sensitivity 60mV into 10kΩ; Frequenc response 20Hz–20kHz ± 2dB. Hum and noise better than −70dB.

Suppliers to H.M. Govt. Depts. Manufactured and assembled in Gt. Britain, fully tested and guaranteed.

TO ORDER BY POST
Make cheques/P.O.s payable to TUAC LTD (PE/12) or quote Access/Barclaycard No. and post to TUAC LTD (PE/12). 119 Charlmont Road, London, SW17 9AB. We accept phone orders from Access/Barclaycard holders. Phone 01-672 3137. 9080.

Send large stamped addressed envelope with all enquiries for fully illustrated 12 page catalogue
TRADE & EXPORT ENQUIRIES 01-672 9080



MANUFACTURERS OF ELECTRONIC AND AMPLIFICATION EQUIPMENT

5 POWER SUPPLIES

Vacuum varnish impregnated. Transformers with supply board incorporating pre-amp supply:

PS250 for supplying 2 TP125s	£28·00
PS60/60 for supplying 2 TL60s	£25·50
PS125 ± 45 volts for TP125	£16·75
PS100 ± 43 volts for TL100	£15·50
PS60 ± 38 volts for TL60	£14·50
PS30 ± 25 volts for TL30	£9·75
PSU 2 for supplying disco mixer	£6·50

4 CHANNEL SOUND TO LIGHT SEQUENCE CHASER—4LSMI 8

- RCA 8A Triacs
- 1000W per channel
- Fully suppressed and fused
- Switched master control for sound operation from ¼W to 125W
- Speed control for fixed rate sequence from 8 per minute to 50 per second
- Full logic integrated circuitry with optical isolation for amplifier protection
- Full wave control
- 13 easy connections

Patents applied for **£18·75**

Model 501 500W per channel as above without sound triggering £12·25

10 3 CHANNEL LIGHT MODULATOR

- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 100W
- Full wave control
- 12 easy connections

£18·00

(Single Channel Version 1500 Watts £9·50)

3 ADD SEQUENCE CHASING AND DIMMING EFFECTS TO YOUR TUAC 3 CHANNEL LIGHT MODULATOR

- Speed Control 3 per min. to 10 per sec.
- Full logic integrated circuitry
- Dimmer control to each channel
- 9 easy connections

SEQUENCE DIMMER MODULE—3SDM1 **£13·00**

Factory reorganisation now completed. Assembly line capacity available for long and short runs to clients specification

All prices include VAT
Postage and Packing

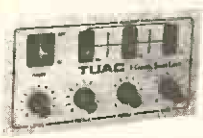
12 STEREO DISCO MIXER

With touch sensitive switching and auto fade

INPUTS: Four identical stereo inputs available with any equalisation. Two magnetic and two flat supplied as standard. High quality slider control on each channel. Volume, treble, and bass controls for each pair of sliders. Sensitivity mag., 3mV (R.I.A.A. comp.). Flat 50MV at 1kHz. Bass controls ± 18dB at 60Hz. Treble controls ± 18dB at 15kHz.
OUTPUT: Up to 3 volts (+12dB) available. Attenuated output for TUAC Power Modules. Rotary master and balance controls. Band width 15Hz–25kHz ± 1dB.
P.F.L.: Output 250mV into 8 ohms. Rotary volume control. Monitoring facility for all 4 channels. Selection via touch sensitive illuminated switches. Switched visual cue indicator.
Miscellaneous Facilities: Two illuminated deck on/off switches. Mains illuminated on/off switches. Auto fade illuminated on/off switch. Mains powered with integral screen and back cover. Complete with full instructions.
Size 25in long × 6in high × 3in deep **£115**

FRONT PANEL FOR LIGHTING EFFECT MODULES

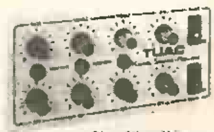
(complete with switches, neons and knobs) as illustrated



Size: 8" × 4¼"

◄ For S1LMB **£6·50**

▲ Size: 6½" × 4¼" For 4LSM1 **£5·50**



Size 9" × 4¼"

◄ For S1LMB combined with 3SDM1 **£7·50**

6 FUZZ LIGHTS

RED GREEN BLUE AMBER

240 volt a.c. Long Life Candle Bulb, Revolving Reflector, adds a new dimension to disco lighting effects.

£21·50

TUAC AMPLIFICATION

Loline 125 watt with sustain	£81
Loline Slave 125 watt	£70
Loline 60 watt with sustain	£65
Combo Twin 60 reverb	£140
Combo 30	£75

STOCKISTS—CALLERS ONLY

Geo Mathews, 85/87 Hurst Street, Birmingham (Tel. 021-622 1941).
Arthur Sallis Ltd., 28 Gardner Street (Tel. Brighton 65806).
Bristol Disco Centre, 25 The Promenade, Gloucester Road (Tel. Bristol 41666).
Soccodi, 9 The Friars (Tel. Canterbury 60948).
Cookies Disco Centre, 132 West Street (Tel. Crewe 4739).
H. B. Electronics, 54 Montagu Street (Tel. Kettering 83922).
Leighton Electronics Centre, 59 North Street (Tel. Leighton Buzzard 2316).
Garland Bros. Ltd., Deptford Broadway, London (Tel. 01-692 4412).
Damon Electronics, 99 Carrington Street (Tel. Nottingham 53880).
Luton Disco Centre, 88 Wellington Street, Luton (Tel. Luton 411733).
Mitchell Electronics, 7 Queen Street (Tel. Salisbury 23689).
Session Music, 163 Mitcham Road Tooting (Tel. 01-672 3413).
Mon–Sat. 9·30 a.m.—5·30 p.m. Half Day Wed. 9·30 a.m.—1 p.m.

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THESE DISCOUNTS APPLY TO TOTAL OF ORDER — SPECIALS INCLUDED

10% OFF ON ORDERS OVER £15
15% OFF ON ORDERS OVER £50

LARGE QUANTITY PRICING AVAILABLE ON REQUEST
PLEASE SPECIFY ITEM AND QUANTITY

TTL

7400	£0-10p	7451	£0-13	74154	-86
7401	11	7453	13	74155	75
7402	11	7454	10	74156	71
7403	11	7460	11	74157	71
7404	13	7464	21	74161	95
7405	13	7465	21	74163	90
7406	22	7472	22	74164	1-10
7407	22	7473	26	74165	1-25
7408	14	7474	26	74166	1-15
7409	14	7475	37	74173	95
7410	10	7476	23	74175	95
7411	16	7483	70	74176	95
7413	29	7485	80	74177	85
7416	22	7486	24	74180	80
7417	22	7489	1-50	74181	2-50
7420	11	7490	40	74182	80
7422	22	7491	71	74184	1-55
7423	22	7492	44	74185	1-30
7425	22	7493	35	74190	95
7426	23	7494	45	74191	95
7427	22	7495	49	74192	90
7430	12	7496	55	74193	85
7432	22	74100	79	74194	95
7437	25	74105	60	74195	72
7438	21	74107	27	74196	1-00
7440	11	74121	28	74197	75
7441	60	74122	50	74198	1-70
7442	55	74123	55	74199	1-70
7443	55	74125	50	74200	3-90
7444	60	74126	50		
7445	75	74141	68	74132	-50
7446	85	74145	75		
7447	73	74150	59		
7448	80	74151	60		
7450	12	74153	56		

LOW POWER

74L00	£0-16	74L51	£0-16	75L90	£0-93
74L02	16	74L55	18	74L91	80
74L03	16	74L71	18	74L93	89
74L04	18	74L72	27	74L95	89
74L06	18	74L73	38	74L98	1-53
74L10	16	74L74	38	74L164	1-53
74L20	16	74L78	44	74L165	1-53
74L30	16	74L85	85		
74L42	89	74L86	38		

LOW POWER SCHOTTKY

74LS00	£-23	74LS32	25	74LS95	1-20
74LS02	23	74LS40	30	74LS107	35
74LS04	23	74LS42	80	74LS164	1-20
74LS08	25	74LS74	40	74LS193	1-30
74LS10	23	74LS90	80	74LS197	1-20
71LS20	23	74LS93	80		

HIGH SPEED

74H00	£0-16	74H22	£0-18	74H61	£0-25
74H01	16	74H30	18	74H62	20
74H04	16	74H40	16	74H74	32
74H08	16	74H50	16	74H101	35
74H10	16	74H52	18	74H102	35
74H11	16	74H53	20	74H103	40
74H20	16	74H55	20	74H106	40
74H21	16	74H60	21	74H108	40

SCHOTTKY

74S00	23	74S08	30	74S22	23
74S02	30	74S10	23	74S32	35
74S03	23	74S20	23	74S74	23
74S04	30				

8000 (SIGNETICS)

8263	3-79	8267	1-79

9000

9002	24	9309	56	9601	62
9301	72	9312	56	9602	56

6 DIGIT CLOCK KIT

1 double sided PC board accommodates clock chip & 6 -.375" displays
Kit contains all necessary components, 3 switches & assembly instruction **£9**

IC SOCKETS

Solder tail - low profile

8 pin	£-11	24 pin	£-25
14 pin	-12	28 pin	-36
16 pin	-13	40 pin	-42
18 pin	-19		

wire wrap - gold plate
14 pin £-30

CMOS

4000A	21	4018A	89	4066A	72
4001A	21	4020A	1-22	4068A	36
4002A	21	4021A	1-13	4069A	36
4006A	1-10	4022A	90	4071A	22
4007A	22	4023A	21	4072A	29
4008A	1-46	4024A	72	4073A	32
4009A	47	4025A	21	4075A	32
4010A	44	4027A	48	4078A	32
4011A	22	4028A	81	4082A	29
4012A	21	4030A	37	4518A	1-69
4013A	37	4035A	1-04	4528A	1-31
4014A	1-22	4040A	99	1585A	1-71
4015A	1-22	4042A	1-21	4901A	31
4016A	46	4049A	48		
4017A	98	4050A	48		

74C00	24	74C74	72	74C162	2-05
74C02	35	74C76	1-07	74C163	2-05
74C04	47	74C107	94	74C164	2-21
74C08	47	74C151	1-83	74C173	1-83
74C10	41	74C154	2-23	74C195	1-90
74C20	41	74C157	1-38	80C95	94
74C42	1-36	74C160	2-05	80C97	94
74C73	98	74C161	2-05		

CALCULATOR CHIPS

CT5002	12 digit, 4 function fixed decimal — battery operation 40 pin	£1-99
CT5005	12 digit, 4 function plus memory, fixed decimal 28 pin	2-06
MM5725	8 digit, 4 function, floating decimal 28 pin	1-37
MM5736	6 digit, 4 function, 9V battery operation 18 pin	2-78
MM5738	8 digit, 5 function plus memory and constant floating decimal, 9V battery operation 24 pin	2-78
MM5739	9 digit, 4 function, 9V battery operation 22 pin	2-78

MEMORIES

1101	256 bit RAM MOS 16 pin	£1-09
1103	1024 bit RAM MOS 18 pin	1-97
1702A	2048 bit static PROM elect. prog. - UV eras. 24 pin	10-50
2102 (2602)	1024 bit static RAM DTL/TTL comp. 1 ms 16 pin	2-00
2101-1	Same as 2101 except 500ns	2-25
5203	2048 bit static PROM elect prog. - UV eras. 24 pin	7-55
5260	1024 bit dynamic RAM MOS 16 pin	1-35
5261	1024 bit dynamic RAM MOS 16 pin	1-35
5262	2048 bit dynamic RAM MOS 22 pin	1-55
7489	64 bit ROM TTL 16 pin	1-79
82S23	256 bit PROM SCHOTTKY 16 pin	2-75
F93410	256 bit RAM bi-polar 16 pin	1-50
74187	1024 bit ROM TTL 16 pin	4-00
74200	256 bit RAM tri-state 16 pin	4-39

TANTALUM CAPACITORS
SOLID-DIPPED ± 20%

.1 mfd	35V	15p	10 mfd	16V	21p
.33 mfd	35V	15p	10 mfd	25V	22p
1 mfd	35V	15p	15 mfd	10V	22p
2.2 mfd	20V	15p	22 mfd	16V	22p
2.2 mfd	35V	15p	33 mfd	10V	25p
4.7 mfd	16V	16p	47 mfd	6V	25p
6.8 mfd	6V	16p	56 mfd	6V	25p
6.8 mfd	50V	21p			

SHIFT REGISTERS

MM5013	1024 bit accum. dyn. 8 pin	£1-20
MM5016	500/512 bit dyn. 8 pin	1-10
SL5-4025	Quad 25 bit	95
2504	1024 bit multiplexed dyn 8 pin	3-40

UNIVERSAL BREADBOARD

Silver plated copper circuit board 3-3/16" x 5-1/16", 2 rows of 27 holes for DIP IC's - space for transistors, resistors & capacitors. Versatile and simple for breadboarding IC circuitry £1

SHIPMENT MADE VIA AIR-POSTAGE PAID
3 DAYS FROM RECEIPT OF ORDER

DECEMBER SPECIALS

MICROPROCESSOR COMPONENTS

8008	8 bit CPU	£17-00
1101	256 bit static RAM	-89
1103	1024 bit dynamic RAM	-79
2102	1024 bit static RAM	1-50
5261	1024 bit dynamic RAM	-79
F93410	256 bit bi-polar RAM	1-19
2513	ROM — character generator	7-00
1702A	2048 bit PROM	5-75
82S23	256 bit PROM	2-50

AUTO CLOCK KIT

£-23

6 digits .375" red led's
Operates from 12V DC or AC
Crystal control for high accuracy
Supplied with case & mounting bracket
Contains internal 9V battery for operation of timing circuit (without display) when removed temporarily from power.
Uses 5314 clock circuit
Supplied with all necessary components and assembly instructions

DVM CHIP 4½ DIGIT

MM 5330 — P channel device provides all logic for 4½ digit volt meter, 16 pin DIP with data £8

7001 CLOCK CHIP

4-6 digit, 12-24 hr. alarm, timer & date circuits with data £4-00

SP-425-09
8 digit display .25" gas discharge hi volt. -89

LINEAR			TTL		CMOS	
301	mDIP	£-15	7406	£-15	4001	£-14
723	DIP	-29	7410	.08	4002	-15
733	TO-5	-35	7430	-09	4009	-29
741	mDIP	-15	7438	-12	4081	-19
1458	mDIP	-29	7490	-29	74C00	-10
75150	DIP	-87	74193	-69	74C73	-59

MISC DEVICES

ULN 2208	FM gain block 14dB mDIP	£1-03
ULN2209	FM gain block 48dB mDIP	1-03
2513	64 x 8 x 5 character generator	7-00
CA 3046	Transistor array 14 pin DIP	55

8038 FUNCTION GENERATOR

Voltage controlled oscillator sine, square, triangular output 16 pin DIP with data £2-50

CLOCK CHIPS

MM5311	6 digit multiplexed BCD, 7 seg 12-24 Hr, 50-60 Hz 28 pin	£3-07
MM5312	4 digit multiplexed BCD, 7 seg 1 pps. 12-23 Hr, 50-60 Hz 24 pin	2-23
MM5313	6 digit multiplexed BCD, 7 seg 1 pps. 12-24 Hr, 50-60 Hz 28 pin	3-07
MM5314	6 digit multiplexed 12-24 Hr, 50-60Hz 24 pin	3-07
MM5316	4 digit, 12-24 Hr, 50-60 Hz, alarm 40 pin	2-78
CT7001	6 digit, 12-24 Hr, 50-60 Hz, alarm, timer and date circuits 28 pin	4-80

LED'S

ME4	Infra-red TO-18	29p
MV50	Mini LED red emitting - axial	10p
NSL100	Mini red LED - point	10p
NSL102	Mini red LED - diffused	10p
XC209-R	Mini red LED - diffused	12p
MV5020	Jumbo red - diffused	12p
MV5020	Jumbo green - diffused	15p
MV5020	Jumbo clear	12p
MV5020	Jumbo amber	12p

LED DISPLAYS

MAN1	Red .27" CA	£1-50
MAN2	Red 5x7 dot matrix .35"	2-95
MAN3A	Red .127" CC	-15
MAN5	Green .27" CA	2-03
MAN6	Red .6" CA	2-93
MAN7	Red .27" CA	-97
MAN8	Yellow .27" CA	2-03
MAN66	Red .6" CA spaced seg	2-03
DL10A	Red .26" CA	2-08
NSN71L	Red .27" CA	-89
FND70	Red .25" CC	-49

MULTIPLE DISPLAYS

NSN33	3 digit .12" red LED	£ -89
HP5082-7405	5 digit .11 red LED	1-80
HP5082-7414	4 digit .11 red LED	1-70
SP-425-09	9 digit .25 gas disch.	1-58

Date sheets on request. Add 20p ea. if item is priced below 50p each.

LINEAR CIRCUITS

300	Pos V Reg (super 723) TO-5	£ 49
301	Hi Perf Op Amp mDIP TO-5	21
302	Volt follower TO-5	49
304	Neg V Reg TO-5	56
305	Pos V Reg TO-5	60
307	Op AMP (super 741) mDIP TO-5	44
308	Micro Pwr Op Amp mDIP TO-5	69
309K	5V 1A regulator TO-3	1-25
310	V Follower Op Amp mDIP	75
311	Hi perf V Comp mDIP TO-5	67
319	Hi Speed Dual Comp DIP	82
320T	Neg Reg 5, 12, TO-220	1-12
320K	Neg Reg 5.2, 12 TO-3	1-32
322	Precision Timer DIP	69
324	Quad Op Amp DIP	1-23
339	Quad Comparator DIP	1-06
340K	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-3	1-48
340T	Pos V reg (5V, 6V, 8V, 12V 15V, 18V, 24V) TO-220	1-23
370	AGC/Squelch AMPL DIP	92
372	AF-IF Strip detector DIP	51
373	AM/FM/SSB Strip TO-5	35
374	Pos V Reg mDIP	38
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382	Lo Noise Dual preamp DIP	1-13
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7524	Dual core memory sense Amp	1-20
7525	Dual core memory sense Amp	92
8038	Voltage contr. osc. DIP	3-68
8864	9 DIG Led Cath Drvr DIP	1-58
75150	Dual Line Driver DIP	1-27
75451	Dual Perepheral Driver mDIP	24
75452	Dual Peripheral Driver mDIP	24
75453	(351) Dual Periph Driver mDIP	24
75491	Quad Seg Driver for LED DIP	58
75492	Hex Digit driver DIP	63

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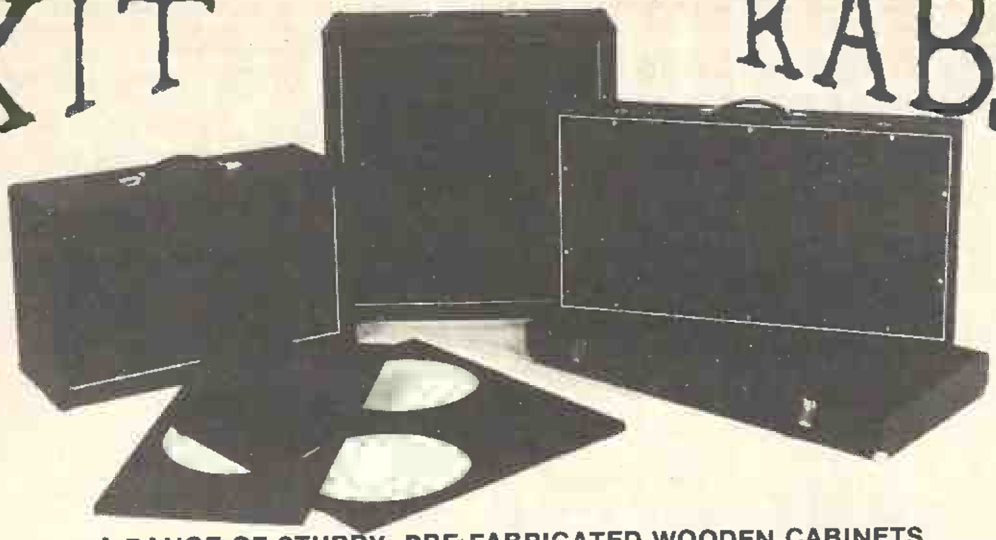

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STEREO PRE-AMP: CP-P1

PRICE £13·30 + £1·66 VAT

Specification

Input	Sensitivity	Signal/Noise	Impedence
Magnetic	3mV	>70dB	47kΩ
Tuner	100mV	>70dB	10kΩ
Tape	100mV	>70dB	10kΩ
Auxiliary	1–100mV	60dB–70dB	200kΩ

Magnetic i/p overload: 33dB;
Distortion: 0·04% at 1kHz;
Output: 1V r.m.s. into 10kΩ;
Supply voltage: ±18V nominal;
Tone controls: Bass ±12dB at 100Hz, Treble ±12dB at 10kHz.

Description: This is a general purpose 2 channel pre-amplifier suitable for use with gramophone, tape, microphone or tuner inputs. It requires no external components other than the potentiometers for the bass, treble, balance and volume controls and the input selector switch. The unit is internally protected against accidental reversed supply connection.

AMPLIFIER: CP2-15-20

PRICE: £12·85 + £1·61 VAT

40W r.m.s. single
20W r.m.s. + 20W r.m.s. stereo

Specification:
Power output:
40W r.m.s. into 8Ω, 1 channel; *or*
30W r.m.s. into 15Ω, 1 channel; *or*
20W r.m.s. + 20W r.m.s. into 4Ω, 2 channel; *or*
15W r.m.s. + 15W r.m.s. into 8Ω, 2 channel.
Input sensitivity: 1V r.m.s.; Frequency response: 20Hz–20kHz, at −3dB. Distortion: 0·04% at 15W; Supply Voltage: ±18V nominal; Size: 5·1 × 4 × 1·25in, (130 × 102 × 32mm).

Description: This module is designed to give either a 20W + 20W stereo amplifier or alternatively a 40W single channel. It has built-in protection against accidental reversed supply connection and it incorporates a thermal shut-down facility to prevent over-dissipation. No external components are required.

FUNCTION GENERATOR: CP-FG1

PRICE: £11·75 + £1·47 VAT

For those requiring a wider range of facilities, this module provides bass and treble filter controls, comprising switchable cut-off frequencies for rumble and hiss reduction. Also included is a stereo separation control. The unit is complete except for the potentiometers and switches.

POWER SUPPLY: CP-PS 18/2D

PRICE: £5·75 + 72p VAT

This is suitable for one 20W + 20W complete system.
For a 40W + 40W system, two power supplies are required.

Full application notes are provided
Post and Packing are free on all orders
All units are guaranteed for 2 years

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★ Solders up to 150 joints per charge.
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★ Only 8in long and weighs just 6 ozs.

OUR PRICE £9·75 + 8%.
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EFFECTS PROJECTOR "150"
No disco should be without our new effects projector, we believe that this is the most versatile machine for projecting coloured images to supplement your music. Spec.: Volts—220/240, a.c., 50 Hz, Lamp—A1/167 150W, Standard Lens—60 mm. A sturdy metal construction and takes a range of lenses and accessories. Comes complete with 6in wheel and ready to use. A bargain at £27 + VAT 8%.

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All built and tested, mounted on a plain aluminium chassis which measures 18 × 9½ × 4in, and which you can mount into a cabinet of your choice.
Four controlled inputs, master volume, treble, middle and bass controls, S/C protected output. 100W clean into 8 ohm L/S. Ideal for disco, music groups, PA. and clubs.
A bargain at £42 + £1 carr. + 8% VAT.

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Ideal tester for everybody interested in electronics. Weighing less than 100 grammes and only 60 × 24 × 90 mm.
Ranges: A.c. volts: 0-10V, 50V, 250V. 1,000V. D.c. volts: 0-10V, 50V, 250V, 1,000V. D.c. current: 0-1mA, 0-100mA. Resistance: 0-150 kohm.
Price £4·75 + 8% VAT.

TIE-CLIP CONDENSER MICROPHONE
Omni-Directional 600 ohm 40–15,000Hz. Extra long lead. Ideal for stage work, conferences, etc.
Price £8·50 + 12½% VAT.

PPI POWER SUPPLY UNIT
Switched 3, 4½, 6, 7½, 9 and 12V at 500 mA. With on/off switch and pilot light.
Size: 130 × 55 × 75 mm
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On/off switch for remote control. Split lead with 2·5 mm and 3·5 mm plugs, standard cassette mics. to suit all types. Complete with desk rest. Please state which impedance required, 200 ohm/50 kohm.
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The perfect hand/stand mic. for stage, group, disco, etc. Finished in matt silver and black. Cardioid dynamic.
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SYNTHESISERS, SOUND EFFECTS AND

COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, etc. are not included but most of these may be bought separately. Fuller details of kits, PCBs and parts are shown in our lists.

CIRCUIT AND LAYOUT DIAGRAMS are supplied free with all PCBs designed by Phonosonics.

PHOTOCOPIES of the P.E. texts for most of the kits are available—prices in our lists.

PHONOSONICS

MAIL ORDER SUPPLIERS OF QUALIT
PRINTED CIRCUIT BOARDS, KITS AN
COMPONENTS TO A WORLD-WID
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P.E. SYNTHESISER
(P.E. Feb. 73 to Feb. 74)
The well acclaimed and highly versatile large-scale mains-operated Sound Synthesiser complete with keyboard circuits. All function circuits may be used independently, or interconnected. The greater the number of circuits, the greater the versatility. Other circuits in our lists may be used with the Synthesiser to good advantage (notably P.E. Minisonic, Phasing Unit, Wind and Rain, Rhythm Generator, Sound Bender, Voltage Controlled Filter, Guitar Effects Pedal).

THE MAIN SYNTHESISER
Stabilised power supply £12·05
Two Linear Voltage Controlled Oscillators and one Inverter—all 3 circuits £17·80
PCB (2 are required) each £1·63
Two Ramp Generators and Two Input Amplifiers
all 4 circuits £5·92
PCB (holds all 4 circuits) £1·51
Sample-Hold and Noise Generator £7·95
PCB (holds both circuits) £1·87
Tone Control £2·68
PCB 88p
Reverberation Amplifier £7·23
Sprine Line unit for Reverb. Amp. £5·50
Ring Modulator £4·24
Peak Level Meter Circuit £1·50
100μA Panel Meter £4·99
PCB to hold Reverb. Ring Mod and Meter Circuits £2·14
Envelope Shaper £6·04
PCB £1·60
Voltage Controlled Amplifier and **Differential Amplifier** £8·69
PCB (holds both circuits) £1·45

THE SYNTHESISER KEYBOARD CIRCUITS
(Can be used without the Main Synthesiser to make an independent musical instrument)
Two Logarithmic Voltage Controlled Oscillators
Component set £15·28
PCB (holds both circuits) £2·86
Divider, 2 Hold Circuits, 2 Modulation Amplifiers, Mixer and 2 Envelope Shapers £21·88
PCB (holds the first 6 circuits) £1·98
PCB for both Envelope Shapers £1·70
Keyboard Stabilised Power Supply £7·61
Printed Circuit Board £1·04

GUITAR EFFECTS PEDAL (P.E. July 75)
Modulates the attack, decay and filter characteristics of an audio signal not only from a guitar but from any audio source, producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range. Circuit does not duplicate effects from the Guitar Overdrive Unit.
Component Set with special foot operated switches £6·79
Alternative component set with panel mounting switches £4·90
Printed Circuit Board £1·43

SOUND BENDER (P.E. May 74)
A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency-doubler.
Component Set for above functions (excl. SWs) £7·24
Printed circuit board £1·74
Optional extra—additional Audio Modulator, the use of which, in conjunction with the above component set, can produce "jungle-drum" rhythms.
Component Set (incl. PCB) £2·76

PHASING UNIT (P.E. Sept. 73)
A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.
Component Set (incl. PCB) £2·85

PHASING CONTROL UNIT (P.E. Oct. 74)
For use with the above Phasing Unit to automatically control the rate of phasing.
Component Set (incl. PCB) £4·25

WAH-WAH UNIT (P.E. Apr. 76)
The Wah-wah effect produced by this unit can be controlled manually or by the integral automatic controller.
Component Set incl. PCB £3·20

P.E. JOANNA (P.E. May/Sept. 75)
A five-octave electronic piano that has switchable alternative voicing of Honky-Tonk piano, ordinary piano, harpsichord, or a mixture of any of the three, together with facilities including fast and slow tremolo, loud and soft pedal switching, and sustain pedal switching. The power amplifier typically delivers 24 watts into 8 ohms. The PCBs have been redesigned by ourselves making improved use of the space available.

Main Power Supply £10·09
Tone Generator and Top C Envelope Shaper £10·61
PCB for Main PSU, Tone Gen & Top C E.S. £2·31
Envelope Shapers for all notes (except Top C) £37·68
Set of PCBs for Envelope Shapers (except Top C) £11·88
Voicing and Pre-Amp Circuits £10·53
PCB for Voicing and Pre-amp £2·80
Power Amplifier (incl. separate Power Supply) £15·06
PCB for Power Amp and PSU 95p

RHYTHM GENERATOR (P.E. Mar./Apr. 74)
Programmable for 64,000 rhythm patterns from 8 effects circuits (high and low bongos, bass and snare drums, long and short brushes, blocks and soft cymbal), and with variable time signatures and rhythm rates. Really fascinating and useful.
Tempo, Timing and Logic circuits £12·68
PCB for above circuits (double-sided) £3·24
Component set for all 8 effects circuits £12·72
PCB for all 8 effects £3·74
Simple mixer (our design) incl. PCB £3·95
Alternative mixer with external volume controls, incl. PCB £10·94
Power Supply for T, T and L, and Effects, Incl. PCB £7·10
(See our list for Power Supplies for Mixers)

REVERBERATION UNIT (P.W. Nov./Dec. 72)
A high quality unit having microphone and line input pre-amps, and providing full control over reverberation level.
Component Set (excl. spring unit) £8·79
Printed Circuit Board £1·93
9 in. Spring Unit £5·50
Panel Meter (50μA) (optional) £4·99

WIND AND RAIN UNIT
A manually controlled unit for producing the above-named sounds.
Component set incl. PCB £3·37

GUITAR OVERDRIVE UNIT (P.E. Aug. 76)
Sophisticated, versatile Fuzz unit, including variable and switchable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering. Does not duplicate the effects from the Guitar Effects Pedal and can be used with it and with other electronic instruments.
Component set using dual slider pot £6·57
Component set using dual rotary pot £5·80
Printed circuit board £1·37

FUZZ UNIT
Simple Fuzz unit based upon P.E. 'Sound Design' circuit.
Component set incl. PCB £1·98

TREMOLO UNIT
Based upon P.E. 'Sound Design' circuit.
Component set incl. PCB £3·19

TREBLE BOOST UNIT (P.E. Apr. 76)
Gives a much shriller quality to audio signals fed through it. The depth of boost is manually adjustable.
Component Set incl. PCB £2·31

25 WATT MONO AMPLIFIER (P.E. Sept. 75)
A good general purpose integrated circuit power amplifier typically delivering 25 watts into 8 ohms. Power bandwidth 20Hz to 20kHz, 3dB, Input impedance 20km. Distortion 0·2%. Suitable for use with any of our sound producing kits.
Component Set incl. power supply £15·06
Printed Circuit Board 95p
For stereo use two sets and PCBs are required.

P.E. MINISONIC MK I
(P.E. Nov. 1974 to March 1975)
A portable, battery or mains operated, miniature so synthesiser, with keyboard circuits. Although havi slightly fewer facilities than the large P.E. Synthesise the functions offered by this design give it great sco and versatility. Like the large Synthesiser it too m be advantageously used with other circuits in our list
Basic component set £41·
Set of PCBs £7·
Full details in our list.

P.E. MINISONIC MK 2
More sophisticated version of the MK I.
Basic component set from £52·
Set of PCBs £9·
Full details in our list.

DISCOSTROBE (P.E. Nov. 76)
4-channel light-show controller giving a choice sequential, random, or full strobe mode of operation.
Basic component set £19·
Printed circuit board £2·

ENVELOPE SHAPERS
Both of the kits below have manual control over the Attack, Decay, Sustain and Release functions. Both ki include PCB (VCA means Voltage Controlled Amplifie
Envelope Shaper and VCA (P.E. Apr. 76) £6·
Envelope Shaper (without VCA) (P.E. Oct. 75) £4·

VOICE OPERATED FADER (P.E. Dec. 73)
For automatically reducing music volume during "ta over"—particularly useful for Disco work or for hom movie shows.
Component Set incl. PCB £3·

VOLTAGE CONTROLLED FILTER (P.E. Oct. 74)
An independently designed VCF that can be used wi the P.E. Synthesiser
Component Set £3·
Printed Circuit Board £1·

P.E. TUNING FORK (P.E. Nov. 75)
Produces 84 switch-selected frequency-accurate ton An LED monitor clearly displays all beat note adju ments. Ideal for tuning acoustic and electronic musi instruments alike.
Main Component Set incl. PCB £14·
Power Supply set incl. PCB [illegible]

P.E. SYNCHRONOME (P.E. Mar. 76)
An accented-beat electronic metronome, providi duple, triple and quadruple times with full control ov the beat rate. Can also be used as a simple drum-be rhythm generator. Includes power supply.
Component Set incl. loudspeaker £10·
Printed Circuit Board £1·

PEAK LEVEL INDICATOR (P.E. Mar. 76)
A twin-channel visual display unit for monitoring peak level of audio signals. Well suited for use w inter-coupling our many sound producing kits to he avoid signal over-loading.
Component Set incl. PCB (as published) £3·

POST AND HANDLING
U.K. orders—under £15 add 25p plus VAT, over £15 add 50p plus VAT.
Optional Insurance for compensation against loss or damage in post, add 35p in addition to above post and handling.
Eire, C.I., B.F.P.O., and other countries are subject to Export postage rates.

DON'T FORGET VAT!
Add 12½% (or current rate if changed) to full total of goods, post and handling. (Does not apply to export orders).

EXPORT ORDERS are welcome, though we advi that a current copy of our list should be obtained befo ordering as it also shows Export postage rates. All pa ments must be cash-with-order, in Sterling and preferab by International Money Order or through an Engli Bank. To obtain list for Europe send 20p, for oth countries send 40p.

PHONOSONICS • DEPT. PE4D • 22 HIGH STREET • SIDCUP • KENT DA14 6EH MAIL ORDER AND C.W.O. ONL SORRY BUT NO CALLERS PLEAS

OTHER PROJECTS

PHOTOGRAPHS in this advertisement show two of our units containing some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.

LIST—Send Stamped Addressed Envelope with all U.K. requests for free list giving fuller details of PCBs, kits, and other components.

OVERSEAS enquiries for list: Europe—send 20p; Other Countries—send 40p.

KEYBOARDS AND CONTACTS

Kimber-Allen Keyboards as required for many published circuits, including the **P.E. Joanna, P.E. Minisonic, and P.E. Synthesiser.** The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C. The keys are plastic, spring-loaded and mounted on a robust aluminium frame.
3 Octave (37 notes) £23·10. 4 Oct (49 notes) £27·45. 5 Oct (61 notes) £32·10.
Contact Assemblies for use with above keyboards: Single-pole change-over (type SP) as for P.E. Joanna and P.E. Minisonic. Two-pole normally open-make-break (type DP) as for P.E. Synthesiser. Special contact assembly (type 4PS) having 4 poles, 3 of which are normally-open make-break contacts and the fourth is a change-over contact—this special assembly enables THE SAME KEYBOARD to be used with the P.E. Synthesiser, P.E. Minisonic and the P.E. Joanna simultaneously thus avoiding the cost of more than one keyboard.

Contact	Each	3 Octave Set	4 Octave Set	5 Octave Set
SP	22p	£8·14	£10·78	£13·42
2P	25p	£9·25	£12·25	£15·25
4PS	50p	£18·50	£24·50	£30·50

PRINTED CIRCUIT BOARDS for use with the above contacts and thus eliminating most of the inter-wiring required, are available. Details in our lists.

SOUND-TO-LIGHT (P.E. Apr./Aug. 71)
The ever-popular **Aurora**—4 or 8 channels each responding to a different sound frequency and controlling its own light. Can be used with most audio systems and lamp intensities. A MUST for any Disco, and a fascinating visual display for the home.

4 Channel Component Set (excl. thyristors)	£14·42
8 Channel Component Set (excl. thyristors)	£25·75
Power Supply Component Set	£5·35
PCB for 4 frequency channels	£3·65
PCB for power supply and 8 lamp drivers	£1·70
1A 400V thyristors (1 per chan. req.) each	75p
Panel meter (1μA) (optional)	£4·99

3-CHANNEL SOUND-TO-LIGHT (P.E. Apr. 76)
A simple but effective sound-to-light controller capable of operating 3 lamps each of approximately 700 watts. Includes power supply, thyristors, and by-pass switches.
Component Set incl. PCB £11·18

BIOLOGICAL AMPLIFIER (P.E. Jan./Feb. 73)
Multi-function circuits that, with the use of other external equipment, can serve as lie-detector, alphaphone, cardiophone etc.

Pre-Amp Module Component Set incl. PCB	£4·11
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Audio Amplifier Module Type PC7	£6·75

TAPE NOISE LIMITER
Very effective circuit for reducing the hiss found in most tape recordings. All kits include PCBs.

Standard Tolerance Set of Components	£2·85
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SINE AND SQUARE WAVE GENERATOR (P.E. July 75)
Suitable for audio, digital, or general purpose. Controllable through 4 decade ranges 10Hz to 100kHz, switched attenuation through 10 ranges from 10V to 1mV peak-to-peak.

Component Set. While stocks last	£9·83
PCB for above components	£1·76
Power Supply	£6·21
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SEMI CONDUCTOR TESTER (P.E. Oct. 73)
Essential test equipment for the enterprising home constructor. While stocks last.

Set of resistors, capacitors, semiconductors, potentiometers, makaswitches and PCB	£8·86
Panel meter (500μA)	£4·99

P.E. MINIMIX 6 (P.E. Nov./Dec. 75)
Each of the 6 input channels has its own gain, volume and panning controls. The volume of the twin channel outputs are fully manually controllable, as are the headphone and pre-fade monitoring facilities. Twin VU meters provide visual display of channel audio levels. Ideal for use with effects and synthesiser kits.
For details see our list. While stocks last.

8-INPUT MIXER
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72710	0·32	0·31	0·28	TAA293	0·93	0·88	0·83	LM380	0·93	0·90	0·88
72741	0·28	0·27	0·26	TAA350	£1·71	£1·67	£1·57	*NE555	0·45	0·43	0·40
72741C	0·26	0·25	0·24	μA703C	0·26	0·24	0·22	*NE556	0·88	0·86	0·83
72741P	0·28	0·27	0·26	μA709C	0·19	0·18	0·17	TBA800	£1·39	£1·34	£1·30
72747	0·79	0·74	0·61	μA711C	0·32	0·31	0·28				
72748P	0·35	0·33	0·31	μA712C	0·32	0·31	0·28				
SL201C	0·46	0·42	0·37	μA723C	0·45	0·43	0·40				

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7401	0·10	0·09	0·08	7450	0·12	0·11	0·10	74123	0·58	0·56	0·54
7402	0·11	0·10	0·09	7451	0·12	0·11	0·10	74141	0·60	0·58	0·56
7403	0·11	0·10	0·09	7453	0·12	0·11	0·10	74145	0·96	0·94	0·92
7404	0·13	0·12	0·11	7454	0·12	0·11	0·10	74150	£1·30	£1·25	£1·20
7405	0·13	0·12	0·11	7460	0·12	0·11	0·10	74151	0·76	0·74	0·72
7406	0·25	0·24	0·23	7470	0·25	0·24	0·23	74153	0·95	0·93	0·91
7407	0·25	0·24	0·23	7472	0·22	0·21	0·20	74154	£1·50	£1·45	£1·40
7408	0·15	0·14	0·13	7473	0·26	0·24	0·22	74155	0·80	0·78	0·76
7409	0·15	0·14	0·13	7474	0·27	0·25	0·23	74156	0·80	0·78	0·76
7410	0·09	0·09	0·08	7475	0·48	0·46	0·44	74157	0·95	0·93	0·91
7411	0·23	0·22	0·21	7476	0·25	0·24	0·23	74160	£1·00	0·98	0·96
7412	0·26	0·25	0·24	7480	0·50	0·48	0·46	74161	£1·00	0·98	0·96
7413	0·28	0·26	0·25	7481	£1·02	£1·00	0·98	74162	£1·00	0·98	0·96
7416	0·28	0·27	0·26	7482	0·83	0·81	0·79	74163	£1·00	0·98	0·96
7417	0·28	0·27	0·26	7483	0·98	0·96	0·94	74164	£1·25	£1·20	£1·15
7420	0·12	0·11	0·10	7484	0·90	0·88	0·86	74165	£1·25	£1·20	£1·15
7422	0·28	0·27	0·26	7485	£1·25	£1·20	£1·15	74166	£1·48	£1·44	£1·39
7423	0·30	0·28	0·26	7486	0·32	0·30	0·28	74174	£1·00	0·95	0·90
7425	0·30	0·28	0·26	7489	£2·90	£2·80	£2·70	74175	0·95	0·93	0·91
7426	0·30	0·28	0·26	7490	0·37	0·35	0·33	74176	£1·10	£1·11	£1·06
7427	0·30	0·28	0·26	7491	0·60	0·58	0·56	74177	£1·10	£1·11	£1·06
7428	0·42	0·38	0·36	7492	0·43	0·42	0·41	74180	£1·10	£1·11	£1·06
7430	0·12	0·11	0·10	7493	0·43	0·42	0·41	74181	£2·00	£1·90	£1·80
7432	0·30	0·28	0·26	7494	0·43	0·42	0·41	74182	0·90	0·88	0·86
7433	0·39	0·37	0·35	7495	0·70	0·68	0·66	74184	£1·67	£1·62	£1·58
7437	0·30	0·28	0·26	7496	0·68	0·66	0·64	74190	£1·50	£1·45	£1·40
7438	0·30	0·28	0·26	74100	£1·00	0·98	0·96	74191	£1·50	£1·45	£1·40
7440	0·12	0·11	0·10	74104	0·40	0·38	0·36	74192	£1·15	£1·10	£1·05
7441	0·64	0·62	0·60	74105	0·40	0·38	0·36	74193	£1·15	£1·10	£1·05
7442	0·65	0·63	0·61	74107	0·36	0·34	0·32	74194	£1·15	£1·10	£1·05
7443	£1·10	£1·05	£1·00	74110	0·56	0·54	0·52	74195	0·80	0·78	0·76
7444	£1·10	£1·05	£1·00	74111	0·83	0·81	0·79	74196	£1·00	0·98	0·96
7445	0·95	0·90	0·85	74118	0·90	0·88	0·86	74197	£1·00	0·98	0·96
7446	£1·10	£1·05	£1·00	74119	£1·25	£1·20	£1·15	74198	£2·10	£2·00	£1·90
7447	0·67	0·65	0·63	74121	0·26	0·28	0·25	74199	£1·95	£1·90	£1·85

Devices may be mixed to qualify for quantity price. (TTL 74 series only). Data is available for the above series of I.C.'s in booklet form. PRICE 35p.

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BP932	0·21	0·20	0·19	BP945	0·34	0·32	0·29	BP9083	0·48	0·46	0·44
BP933	0·21	0·20	0·19	BP946	0·20	0·19	0·18	BP9094	0·48	0·46	0·44
BP935	0·21	0·20	0·19	BP948	0·34	0·32	0·29	BP9097	0·48	0·46	0·44
BP936	0·21	0·20	0·19	BP951	0·71	0·66	0·62	BP9099	0·48	0·46	0·44

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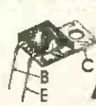

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PE

A DISINGENUOUS FEW

ONE of the most interesting duties performed by the P.E. editorial staff is the examination of circuit ideas offered for publication by readers. It is an important and illuminating task. The ideas offered provide an insight into the multifarious activities of electronics enthusiasts and show how they have solved a problem or achieved some desired effect through their own ingenuity.

This brings us quite naturally to the question of originality. The purpose of Ingenuity Unlimited is to present circuits that are original, if not in whole, at least in significant part. Thus, certain modifications to existing designs can come within this definition. Electronics being what it is, the chances of anyone producing a circuit which in all respects is entirely original are rather remote. The important and essential point is that the individual submitting a design genuinely believes it to be original.

It is our task and responsibility to make judgement upon this point, and many submissions have to be rejected because the idea is already common knowledge. Yet we are not and cannot be infallible in this regard. It is impossible to have complete awareness of all published circuits, at home or elsewhere in the world. Thus it is always possible that an idea published in this magazine may exactly or closely resemble a circuit already published elsewhere. This is unfortunate. It certainly defeats the object of Ingenuity Unlimited, but if the contributor himself was unaware of the pre-existence of the design when submitting his own version, the spirit of Ingenuity Unlimited at least has not been consciously violated.

There is, sad to report, another possibility we must face up to. Evidence has been presented to us on a few occasions over the past years suggesting deliberate attempts to defraud. Certainly we have unwittingly published two circuits, at anyrate, that subsequently proved to be the direct copies of circuits previously published in other magazines. In both instances the evidence was irrefutable. Fortunately the deceptions were detected in time to withhold the customary payments.

One can only marvel at the kind of person who can derive any satisfaction from seeing his or her name appended as originator to a design which has been copied coolly and deliberately from someone else's published work.

Vigilant as we are, there is no guarantee that further abuse of our pages will not occur. But we know such dishonest persons are a tiny minority in the vast electronics fraternity. Ingenuity Unlimited is a continuing record of the undisputed creative abilities of genuine enthusiasts. Financial gain for them is but secondary to the reward of seeing something of their own creation in print. They are entitled to feel a little proud at this credit to their name, and at the realisation that perhaps hundreds or even thousands of their fellow enthusiasts will make some use of their brain child.

We will never knowingly permit these fine traditions to be besmirched by a few pirates and impostors whose actions are completely alien to the spirit of Ingenuity Unlimited.

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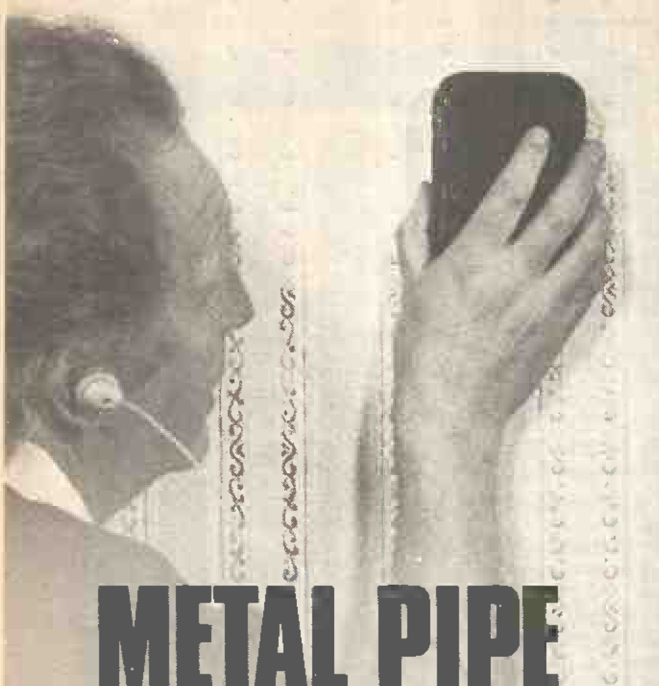


METAL PIPE or WIRING LOCATOR

By C.C. WHITEHEAD

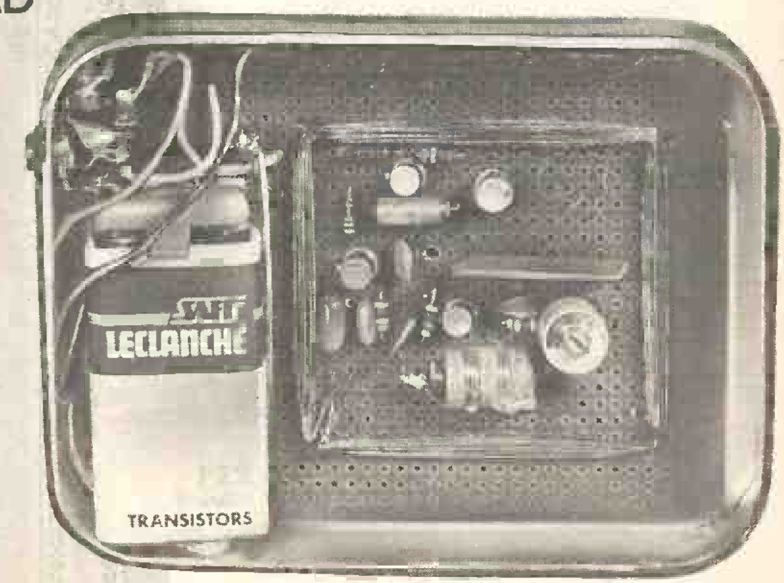
WITH house electric wiring now invariably buried beneath the surface of the plaster on the walls, many forms of d.i.y. activity such as putting up shelves can become potentially dangerous. Even where installation plans are available, these seldom give any reliable indication of the positions of wiring runs. Since the required detection range is a couple of inches at maximum, a sensitive, sophisticated unit is not required, just something small, cheap, simple and handy.

The first design tried was a simple super-regenerative receiver with a pick-up coil a couple of inches square. It worked, but the indications were not sufficiently definite, as a change of two or three decibels in output level is the minimum that can be detected by most people. However, almost anyone (except the tone-deaf) can easily distinguish a change of pitch of a semitone in a clean note. So the solution to the difficulty was a heterodyne oscillator.

CIRCUIT

Basically the instrument (Fig. 1) consists of a reference oscillator (TR3, etc.), the magnetic field of which cannot couple with external metal, and a second oscillator (TR1, etc.) energising the search coil. The latter oscillator, which also acts as a detector, has an unusually low L/C ratio, so that only the magnetic field of the search coil is affected by the approach of metal: other materials therefore have very little effect. The frequencies used are low, about 110kHz, and are adjusted to give a beat note somewhere between 500 and 1,500Hz. Because of the low frequencies used, penetration through non-metallic materials is excellent.

The tone amplifier circuit based on TR2 is the simplest configuration possible. It was added simply to avoid the necessity for very sensitive headphones or earpiece, though sensitivity is not of great importance, since it is pitch, not level, that is the indication. The level varies only slightly and incidentally.



COMPONENTS

There is nothing critical about the components, operating frequencies or layout. Any transistors with characteristics approximating to the BC108 are suitable. The reference oscillator, whose coil is mounted so as to have minimum coupling with external objects, should preferably be higher in frequency than the search oscillator. The whole of the audible heterodyne range is then available when the frequency of the search oscillator is increased by the proximity of metal, causing the pitch of the beat note to fall, passing through zero to rise again when the instrument is very close to a large mass of metal. It is wise to avoid frequencies within 10kHz of 100 or 150kHz on account of the existence on these frequencies of powerful transmitters and their harmonics, though the instrument is adequately shielded and a very poor receiver in this respect.

The prototype instrument was built in a standard two-ounce tobacco tin, which is a convenient shape and size and will also house the required PP3 nine-volt battery. The bottom of the box is cut out and replaced by a piece of perforated board on which the components, including the search coil, are mounted. All components except the battery are within the area of the search coil, the wiring being done on the underneath of the board and covered with a layer of felt or velvet to avoid scratching any surface over which it is moved in close contact.

CONSTRUCTION

Cut out the bottom of the box, leaving a surround of about 6mm ($\frac{1}{4}$in). Trim the perforated board as necessary to fit the box. When the board has been wired and tested, it will be fixed to the bottom of the box by means of a liberal application of Araldite.

All the wiring and coil-winding can be conveniently carried out with 36 s.w.g. enamelled wire, being careful to see that the insulation is not damaged where wires cross. Self-fluxing enamelled wire makes the job easier.

COMPONENTS . . .

Resistors
- R1 3·3kΩ
- R2 2·2kΩ
- R3 5·6kΩ
- R4 470kΩ
- R5 220kΩ
- R6 470kΩ
- All $\frac{1}{8}$ or $\frac{1}{4}$W, 10%

Capacitors
- C1 5,000pF min ceramic
- C2 10μF 10V electrolytic
- C3 10μF 10V electrolytic
- C4 390pF silvered mica
- C5 5·5–65pF min preset, RS Components 125–660
- C6 1,500pF min ceramic
- C7 0·05μF min ceramic
- C8 5,000pF min ceramic
- C9 1,500pF min ceramic

Inductors
- L1 Search coil—see text
- L2 Wound onto L3
- L3 2mH r.f. choke, pie-wound

Transistors
- TR1–TR3 BC108 or any similar *npn* silicon

Miscellaneous

S1 Min slide switch SPST. JK1 Min phone jack. Perforated board, 0·1in pitch, 108 × 76mm approximately to suit case used (see text). 36 s.w.g. enamelled copper wire for coils and board wiring. Earphone, about 1kΩ impedance.

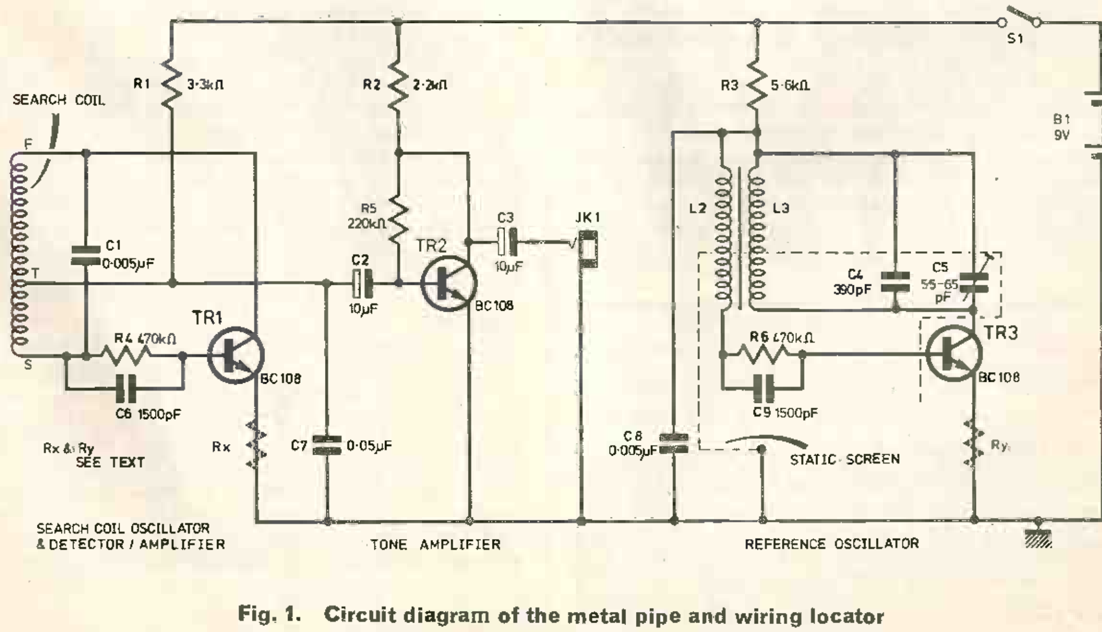


Fig. 1. Circuit diagram of the metal pipe and wiring locator

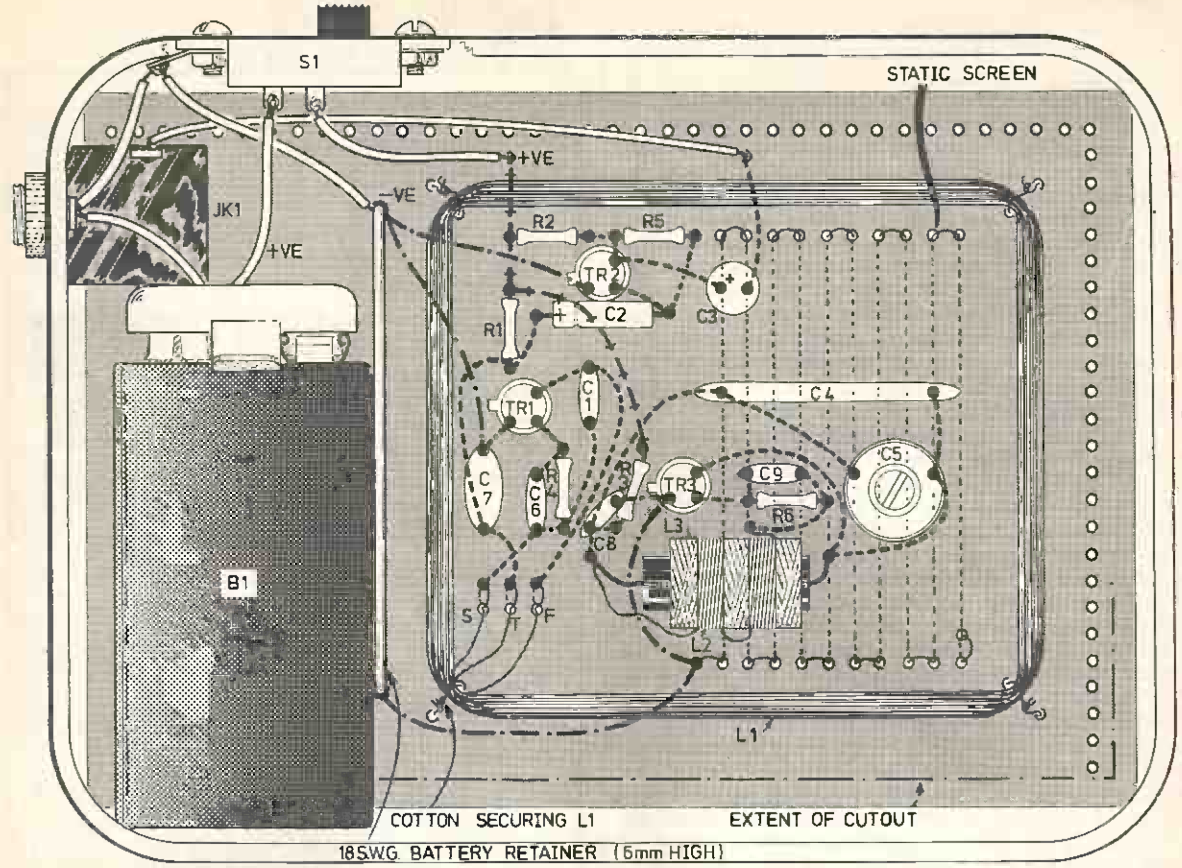


Fig. 2. Component layout and wiring details. All wiring shown in broken line is done on the underside of the board. The static screen is insulated from that wiring by a layer of Sellotape, etc. (see text)

The coils required are both "specials", the search coil being mounted directly on the circuit board, as already mentioned, and the reference oscillator coil being a modified r.f. choke. In the prototype, a Cambion 2mH choke was used, but any pie-wound component of about the same value should be satisfactory. Connect one end of the feedback winding L2 to the starting end of the choke and wind on a total of 78 turns in the spaces between the pies, divided more or less equally between them. Secure the end with a spot of adhesive. This added winding must be in the opposite sense to the choke winding. It is generally not difficult to find the starting and finishing ends of the choke winding or the sense in which it is wound.

To locate the corners of the search coil, four pieces of 18 s.w.g. tinned copper wire about 10mm (⅜in) long should be fitted to the board in the appropriate positions (see Fig. 2). Wind on 12 turns of wire, bring out the tap, then wind on another 48 turns, securing the ends as shown in the drawing. Dope the coil liberally with coil varnish and leave it to set. It should then be fairly securely attached to the board, but to make certain tie each corner to the board with a couple of turns of stout thread. The wire pins at the corners can then be carefully bent inwards and removed, to avoid any possibility of short-circuited turns.

LICENCE

We would like to warn constructors that a Home Office Pipe Finder licence is required for this device, which has been tested and approved for licensing in the United Kingdom. Licence application forms may be obtained on request to Radio Regulatory Department, Waterloo Bridge House, Waterloo Road, London SE1 8UA.

(A licence for 5 years costs £1.20)

TESTING

If you have the means available, check the frequencies of the two oscillators. In any case, find out if it is possible, *with the lid on the box,* to cause them to beat over the whole of the audio frequency range by adjustment of C5. If not, the remedy is to change the value of C4 by a few picofarads. It is important that neither of the oscillators should show any tendency to "squeg". If such is the case, either choose transistors with lower gain or insert suitable resistors (*R*x and/or *R*y) in the emitter leads. In the prototype, these resistors were not necessary, and should not normally be required.

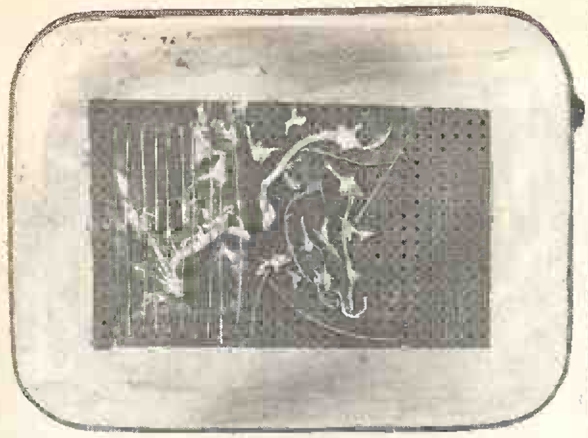


Fig. 3. Underside view of the prototype unit, showing the static screen laid across the board wiring and insulated from it

Once satisfactory results are achieved, the static screen can be added. A layer of insulation, such as p.v.c. tape or Sellotape, should be stuck over the board wiring over the area to be occupied by the screen (see Fig. 2), and a length of 36 s.w.g. enamelled copper wire "stitched" across it as shown, one end being soldered to the nearest convenient earthed point in the wiring. This screen cannot completely eliminate the capacitance effect of objects in contact with the working face, but it does reduce it. This effect is due to the rather high L/C ratio of the reference oscillator circuit. Finally attach the outer covering of felt or velvet, using Cow Gum, etc.

By means of C5, adjust the beat note to a tone somewhere between 500 and 1,000Hz. According to your hearing and the headphones or earpiece used, you may find a certain pitch that is easy to listen to and gives an apparently optimum sensitivity.

To test for sensitivity, the approach of a 10p coin within 50mm (2in) of the working face should result in a change in pitch of at least a semitone. Before trying to locate concealed wiring, leave the instrument on for a few minutes to let the beat note settle down to a reasonably steady value. Concealed metal will be located with certainty up to at least 50mm below the surface, and house wiring or pipes are not usually run at a deeper level. A run of several leads or conduits together can be detected at even greater depths. Lateral location of the wiring depends upon many things, but generally it is possible to fix a run fairly exactly by "straddling" it, judging where the pitch changes equally on either side of the run.

INTERFERENCE

The power of the oscillators, and the frequencies used are such that the instrument cannot possibly interfere with any normal radio equipment, or even be detected by anything other than a very sensitive receiver close by. Very powerful external signals may occasionally be heard faintly, but are unlikely to be mistaken for the normal indications of the instrument. The same applies to its use near unsuppressed electrical equipment.

The instrument's range is deliberately and necessarily limited, and though it will readily find a 50p piece lost beneath a carpet, it will be of no use in searching for Roman coins or World War II relics. ★

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By D.S. GIBBS & I.M. SHAW

THIS final part deals with construction, testing and the simple adjustments required.

PUSH-BUTTON UNIT

The push-button selector mechanism used in the prototype was a type manufactured by Imperial Metal Industries and is available from Ambit International. A similar unit, but with six little plastic pointers to give an approximate indication of frequency, is manufactured by A. B. Metal Products Ltd., and is available from Integrex Ltd. However, both of these units are fairly expensive and many constructors will be able to find a suitable unit on the surplus market at much lower cost. The resistance of each potentiometer should be about 100 kilohm, i.e. 16 kilohm total resistance for a six-position switch.

Alternatively a suitable selector can be built up with a six-position rotary or push-button switch and 100 kilohm preset potentiometers.

No provision has been made for variable tuning as this is of very limited value with six stations to choose from, but it is a simple matter to add a 100 kΩ pot on the front panel.

PRINTED CIRCUIT BOARD

The copper pattern for the printed circuit board is shown in Fig. 2.1 and the component layout in Fig. 2.2. Wiring up the p.c.b. is straightforward and should not present any problems. It is probably best to start by soldering in all the resistors and capacitors, followed by the transistors, diodes and the coil L1, and then the two integrated circuits and the Tuner Head module can be soldered in place.

A socket can be used for the MC1310P (IC2) if desired but it is not advisable to use a socket for the SN76660N (IC1) as the extra lead length and stray capacitance may cause instability. It is not necessary to use heat shunts when soldering any of the semiconductors provided the joints are made quickly with a clean, hot iron.

When all the components have been mounted, flying leads for the external connections can be soldered to the p.c.b. A short length of standard aerial coaxial cable should be used between the p.c.b. and the aerial socket and a piece of single screened (microphone) cable between the tuning voltage input on the p.c.b. and the push-button unit —as this point is rather sensitive to hum pick-up.

MECHANICAL WORK

The box used in the prototype unit was a type G.B.1 from H. M. Electronics, which was chosen to match the Orion Amplifier. But there is no reason why another type of box should not be used provided that the same layout is adhered to. A drilling diagram for the G.B.1. box is shown in Fig. 2.3, but note that some modifications will be necessary if an alternative push-button unit is used. The A. B. Metal Products unit mentioned earlier needs a small window for the six plastic pointers.

The G.B.1 box is supplied with a protective plastic film over the aluminium front panel. This can be used for marking out and should be left in place until all the drilling is complete—when it can be removed and the front panel lettered with Letraset or a similar product.

ASSEMBLY

The l.e.d. indicator lamps are supplied with plastic mounting clips, but these sometimes need a certain amount of persuasion to get them in place. Trimming the moulding "flash" from around the l.e.d. may help in stubborn cases. If desired, slide switches can be used instead of the miniature toggle switches shown, and are somewhat cheaper.

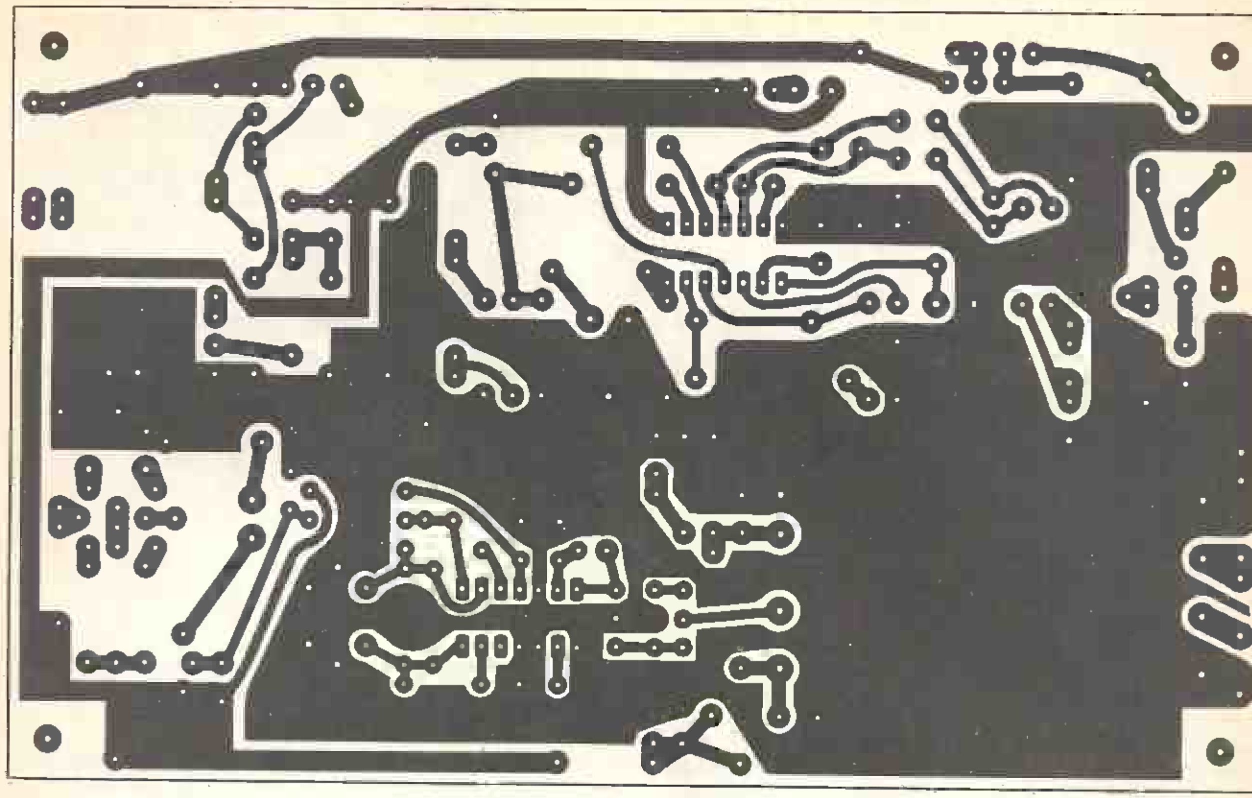


Fig. 2.1. Copper pattern for p.c.b.

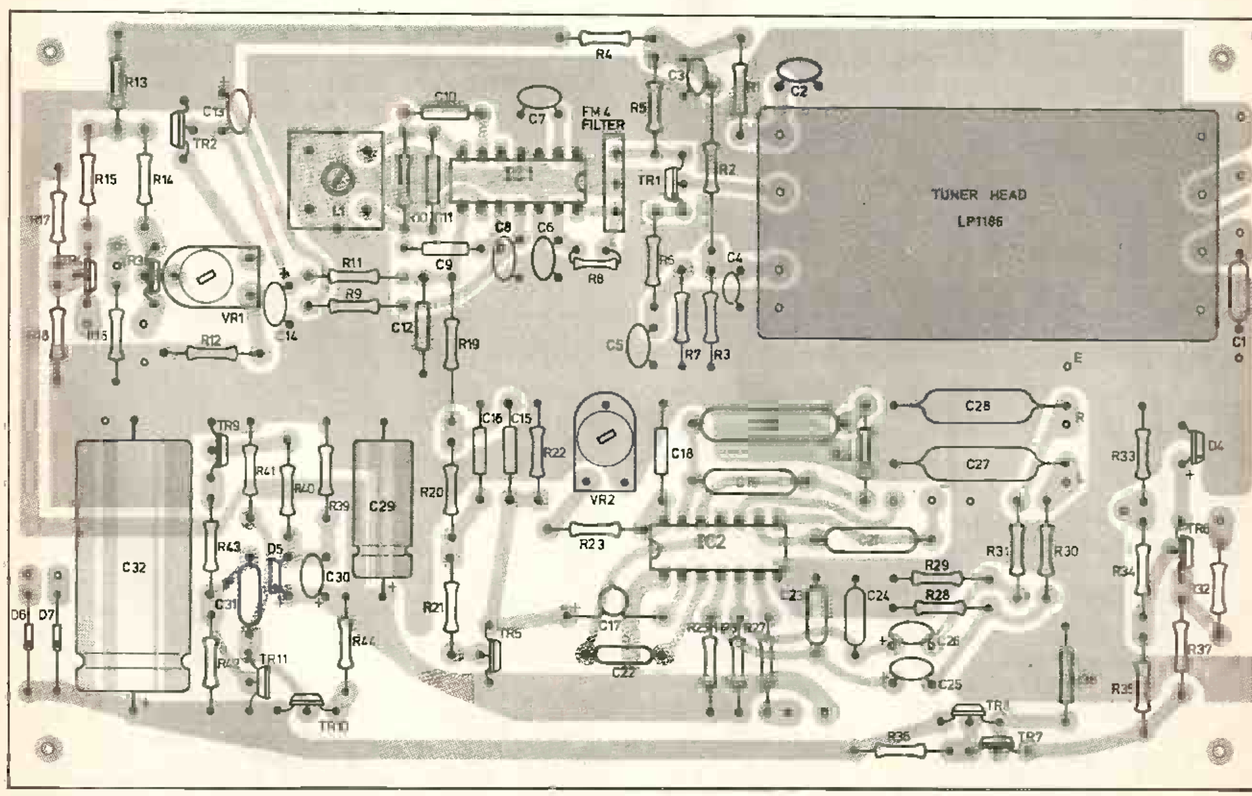


Fig. 2.2. Disposition of components on p.c.b.

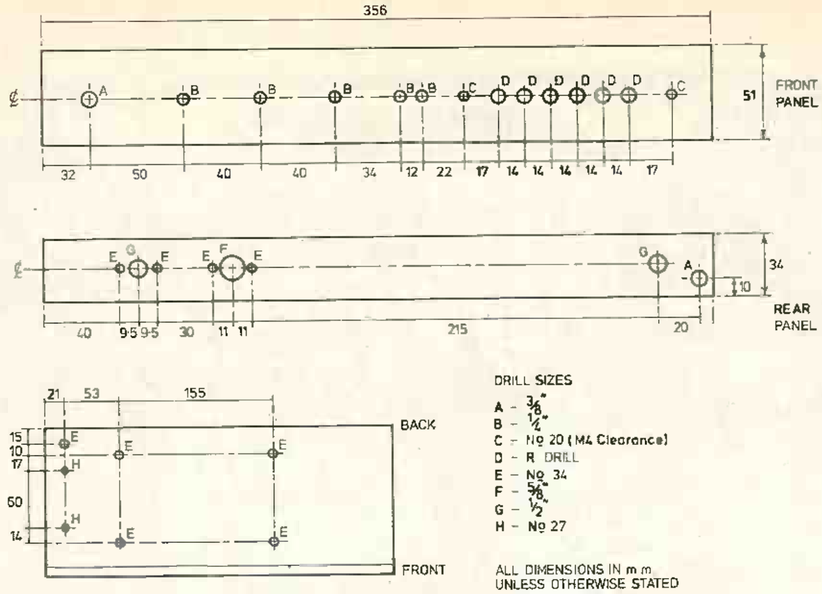


Fig. 2.3. Drilling details for the G.B.1 box

Mounting the other components on the chassis should not present any problems—but note that the aerial socket needs to be an insulated type (such as the Belling Lee L603/s) or an earth loop will be produced.

The printed circuit board should be fitted last and is mounted on ¼in spacers (Fig. 2.4).

All wiring should be kept short and as neat as possible, and in particular wires from the mains transformer should be kept well away from the push-button unit or there will be an objectionable hum.

Before switching on, the wiring should be checked carefully for errors. In particular check that the two integrated circuits, all the transistors and diodes, and the electrolytic capacitors have been inserted the right way round—as these may be permanently damaged if they are wrongly connected.

TESTING

Switch on and check the voltage across C29. This should be between 11·0 and 12·5 volts. If the correct voltage is not obtained switch off immediately and check for errors.

The best way of aligning L1 is to use a sweep generator—and constructors with this equipment will need no further instructions—but it is possible to obtain adequate results with only a voltmeter or even with no instruments at all.

Connect an aerial and connect the output of the tuner to an amplifier. Put the a.f.c. switch to the 'off' position. Now tune across the band to see whether any stations can be received. It should be possible to pick up something, even with L1 badly off tune, but at this stage reception will probably be weak and somewhat distorted.

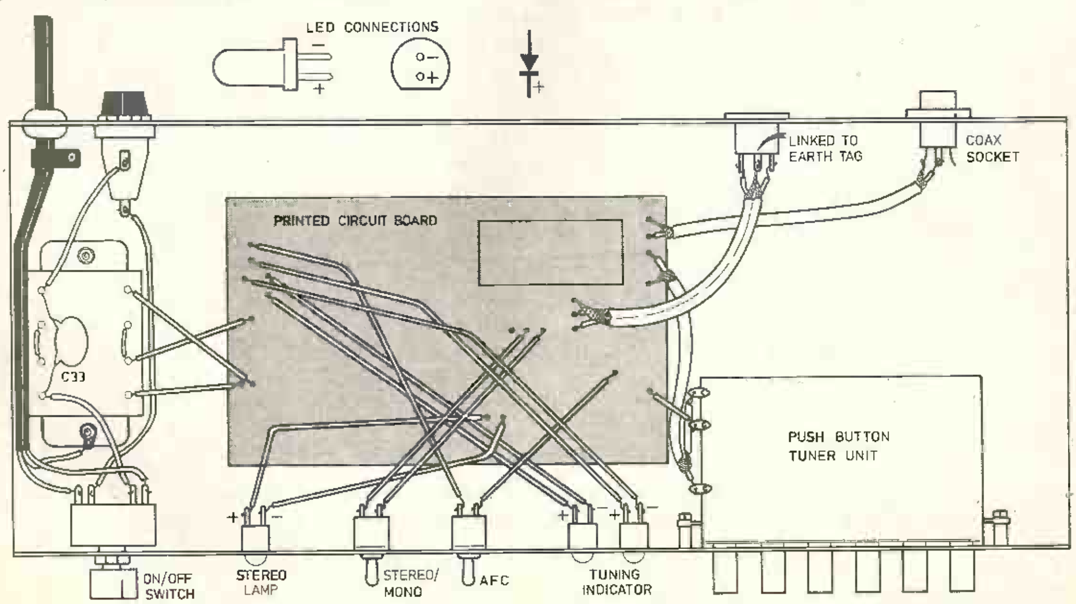
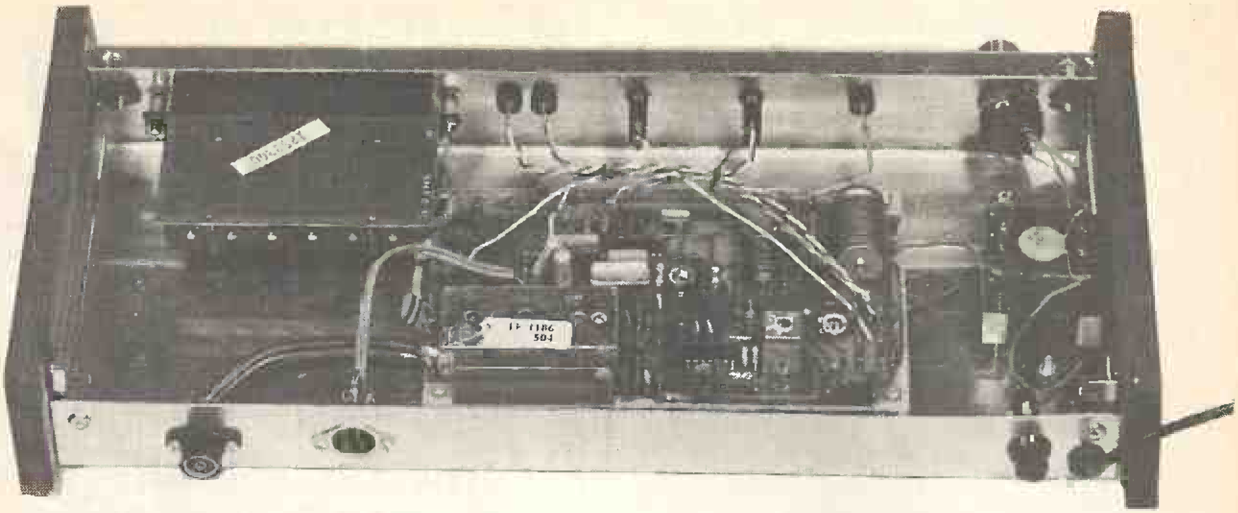


Fig 2.4. External wiring to p.c.b.



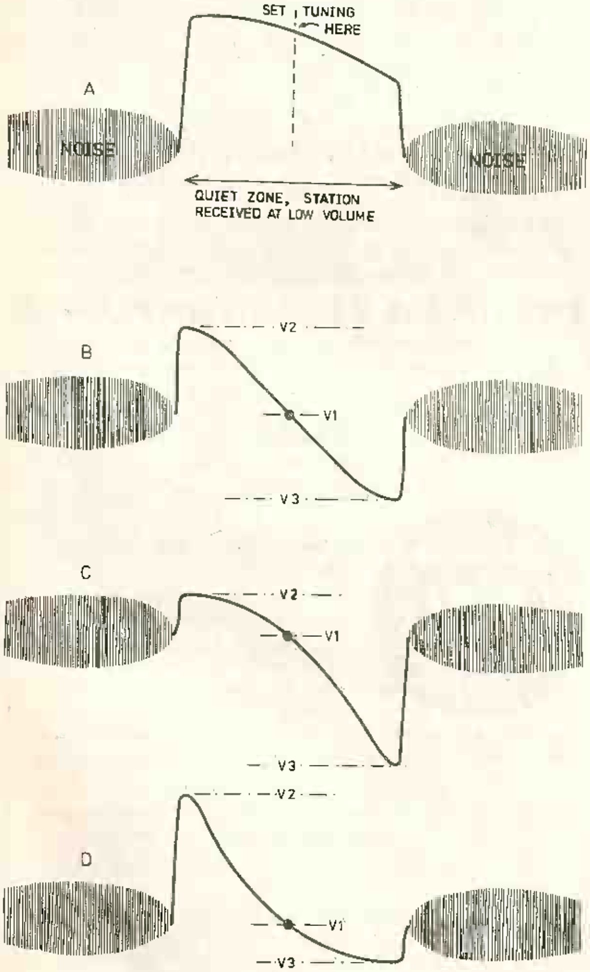


Fig. 2.5. At the start of the alignment procedure the tuner will probably behave as shown in (A) as it is tuned through a station. With L1 adjusted for maximum volume the discriminator curve should be as shown above (B) with V2 and V3 spaced equally about V1. If the adjustment of L1 is not quite correct the response will be as shown in (C) and (D)

Choose the strongest station and determine the two points on either side of the station where noise and obvious distortion appear. Then try to set the tuning accurately mid-way between these two points (see Fig. 2.5). Note that the mid-point may not coincide with maximum volume.

Then adjust the core of L1 for maximum volume. If you do not have a voltmeter you will have to adjust L1 for maximum volume by ear and leave it at the optimum point. It may be easier to do this on a steady tone—such as is transmitted on Radio 3 after the close-down of normal programmes at night.

If a voltmeter is available, check the voltage on the emitter of TR2 and make a note of the reading. Now tune off the station in both directions until noise and distortion are heard and make a note of the voltage readings at both points. These should be equally spaced above and below the first reading. If they are not equally spaced a further slight adjustment to L1 is necessary.

Once L1 has been correctly adjusted, tune to the centre of the station and adjust VR1 so that the two l.e.d. tuning indicators glow with equal brightness. The two l.e.d.s need to be reasonably matched and it is a good idea to select the best pair from the three l.e.d.s required for the tuner, using the remaining one as the stereo indicator lamp.

No adjustments to the LP1186 are necessary as this unit is supplied pre-aligned.

STEREO DECODER

Constructors with access to a digital frequency meter can simply connect it to pin 10 of the MC1310P, tune in to a mono transmission, and adjust VR2 until the frequency meter reads 19kHz. However, most constructors will have to use the following method.

Tune into a stereo transmission and adjust VR2 until the stereo indicator lamp comes on. Now turn VR2 in both directions noting the point at which the stereo indicator lamp goes out. VR2 should then be set mid-way between these two points.

The adjustment of VR2 is not very critical as once the oscillator is within the pull in range of the phase-lock loop its frequency is automatically corrected to the right value when the pilot tone appears.

VOLTAGE TABLE

Location	Voltage
Top of C2	8·3V
Emitter of TR2	6·0V*
Base of TR3	5·2V*
Base of TR4	5·2V
Bottom of R13	6·3V*
Top of R16	1·0V*
Anode of D1	1·5V*
Anode of D2	2·5V*
Emitter of TR5	6·0V*
Pin 2 of IC2	2·0V
Pin 4 of IC2	8·6V
Pin 5 of IC2	8·6V
Pin 6 of IC2	10·5V mono, 0·8V stereo
Collector of TR9	approx 12V
Top of C32	19·6V
Collector of TR7	13·5V
Emitter of TR6	6·0V
Push-button selector rail	13·2V
Top of C3	9·0V
H.T. rail	11·6V
Top of C4	2·2V
Top of C5	1·5V
Collector of TR1	7·5V
Pin 13 of IC1	2·0V
Pin 11 of IC1	11·4V

Voltages marked * vary with tuning.

PROBLEMS

The majority of problems with home built equipment are caused by simple wiring errors, so the first step should always be to carefully check the wiring. Then check that all components are the correct value and are inserted the right way round, and make sure that there are no obvious dry joints or bits of solder shorting out tracks on the p.c.b.

A table of voltages is given and this should be of some assistance in fault finding—but readings should be treated as approximate as component tolerances can cause slight variations from the values given. Readings were taken with an Avo Model 9.

It is difficult to give any specific advice for fault finding as anything could be at fault, and many faults would have the same general effect. However, the following general notes may be of some assistance.

1) If reception is noisy on stereo but all right on mono this indicates that the signal level is too low. The most likely cause is that the aerial is inadequate. A stereo signal needs to be some 26dB higher than a mono signal for the same signal/noise ratio due to the much greater bandwidth of the stereo transmission. If the aerial is all right then there may be a fault in the Tuner Head or i.f. amplifier causing low gain.

2) Severe distortion or a total lack of output probably indicates a fault in the Limiter/Discriminator section. Weak output but with no significant noise indicates that the quadrature detector is badly off tune—possibly due to a faulty capacitor.

3) Mono output from a stereo signal indicates a fault in the stereo decoder section—or that VR2 is badly off tune. ★

GETTING TO GRIPS WITH MICROPROCESSORS

By D.BROWN*

A concise explanation of what a microprocessor is and what it does. A Development Kit incorporating a microprocessor provides a valuable tool for system design. The National SC/MP Development Kit, featured here, is ideally suited for private users and experimenters, as well as for professional users.

MICROPROCESSORS are already in use or under evaluation in a wide range of applications in industry, and are even finding their way into domestic appliances. On the other side of the Atlantic, hobbyists are beginning to experiment with these devices too.

What are the attractions of the microprocessor? Principally, its ability to replace complex electromechanical process timers or boards full of logic i.c.s, but with the added advantage that the control sequence can be modified in part or in whole merely by altering the program stored in the associated memory—no circuit changes are involved.

When using wired random logic, many gates are connected in series and/or parallel, to produce the desired relationship between inputs and outputs. When using a microprocessor, one general purpose gate carries out all the operations, one after another. Clearly some sort of MEMORY is needed, to store the result of one operation while the microprocessor gets on with the next operation, or pauses for breath. The memory also contains a sequence of instructions which tell the microprocessor what to do. This sequence of instructions is called a PROGRAM.

Under control of the program, the microprocessor can perform LOGICAL or ARITHMETIC Functions on data (input or intermediate), or take decisions to JUMP to a different part of the program. For example, when performing division, a subtraction is repeated until

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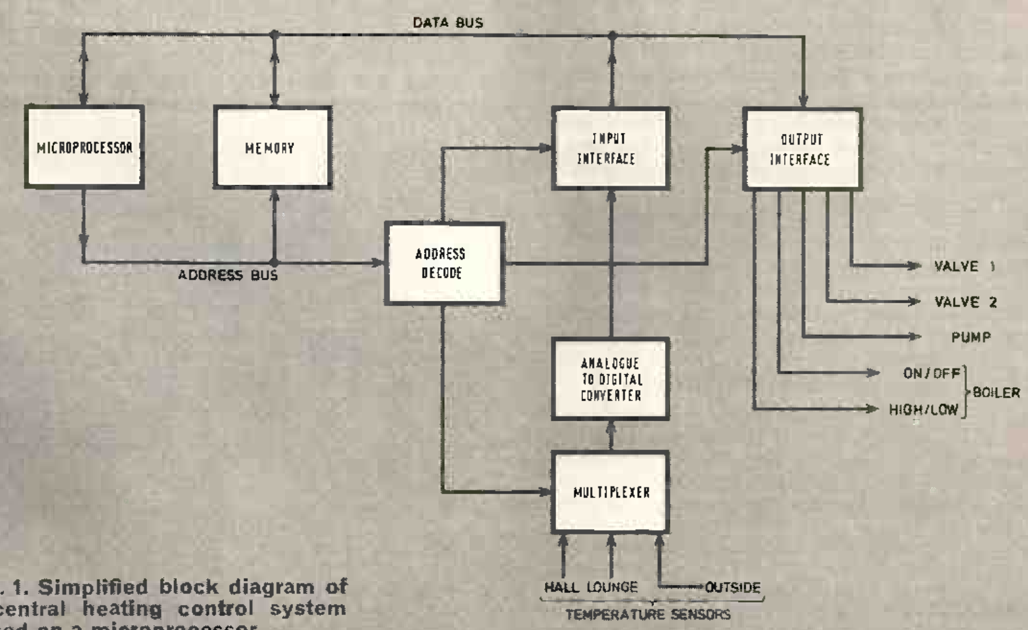


Fig. 1. Simplified block diagram of a central heating control system based on a microprocessor

there is no remainder, by repeating a few steps of the program in a LOOP. When the remainder is zero, or negative, the microprocessor jumps out of the loop, and carries on to the next instruction.

PROCESSOR CONNECTIONS

The microprocessor is connected to the memory by two sets of wires, the DATA BUS and the ADDRESS BUS. The instructions and data flow in on the data bus, and results flow out some time later. At each step the address counter driving the address bus counts up by one. The memory is a matrix of storage elements. The

specification. For the sake of example we will consider a central heating controller, with temperature sensors in the lounge, hall and outside. The boiler system has two heat settings.

System definition:

1. If lounge temperature is less than 21°C, turn on boiler and pump, open valve 1.
2. If hall temperature is less than 18°C, turn on boiler and pump, open valve 2.
3. If outside temperature is less than 0°C, set boiler to high output if on.

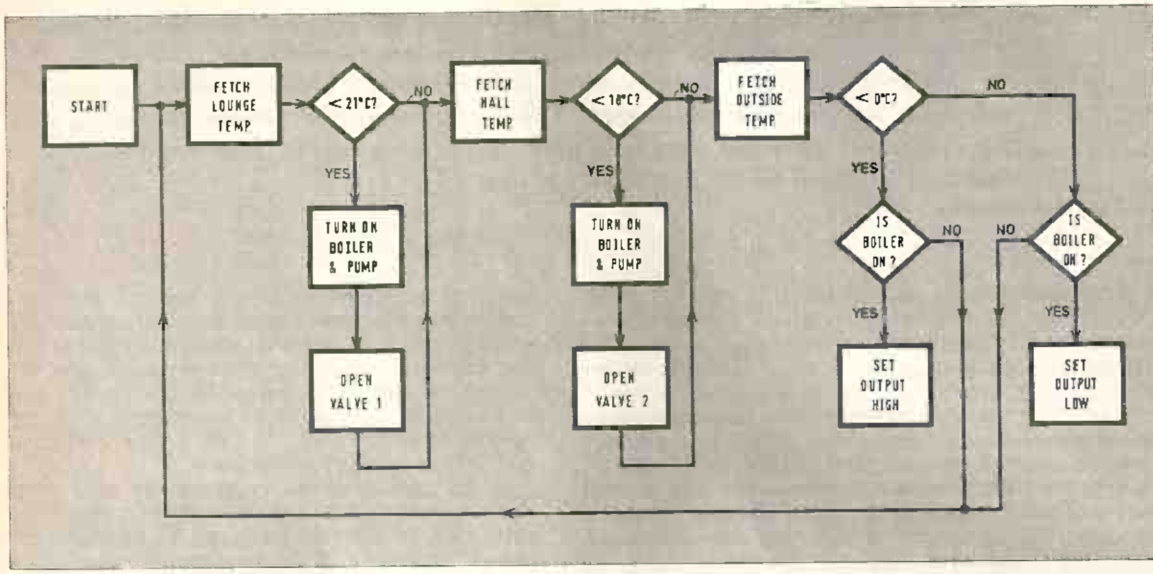


Fig. 2. Flow chart representing the sequence of decisions and commands required to control the central heating system

address bus determines which set of storage elements are connected to the data bus. READ ONLY MEMORY (programmed before use, and retains its data with the power off) and RANDOM ACCESS MEMORY (loses its contents with the power off) are both used. Any part of the program stored in RAM must be loaded every time the system is turned on.

A microprocessor connected to a memory is like a man looking at a "what the butler saw" machine. The eyepiece is the data bus, and instead of turning a handle to see the next picture, the microprocessor address counter advances by one. The analogy is incomplete because the microprocessor also sends data out on the data bus. Perhaps our voyeur could develop flashing eyes!

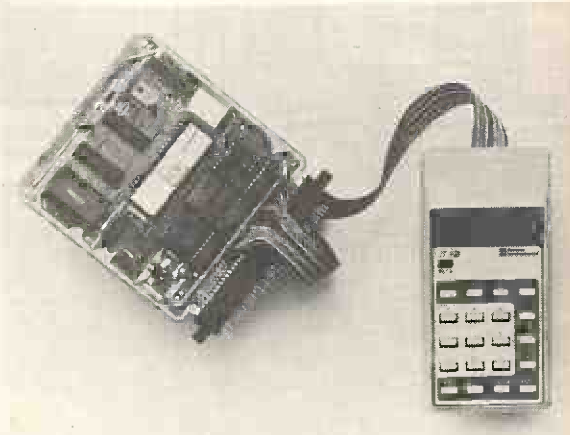
So far we have considered a system with a microprocessor and memory, but no inputs or outputs. A 16-bit address bus can address $2^{16} = 65,536$ locations. Practical systems usually use a much smaller memory. Several unused addresses are decoded with gates, and the results used to enable (i.e. allow) inputs onto the data bus, or load outputs from the data bus into latches. These addresses are called up by the program when the microprocessor needs to input or output data.

SYSTEM DESIGN

When designing a microprocessor based system, the starting point (as in all logic system design) is the system

The hardware required to implement this system is shown in simplified block diagram form in Fig. 1.

Flow chart: The next stage is to construct a flow chart, such as that in Fig. 2, based on the system definition. A flow chart is simply a graphical representation of the series of decisions and commands required to make the system perform in accordance with that definition.



The SC/MP Introkit and its associated Keyboard Kit. The Introkit p.c.b. shown here is one for the U.S. market. The European version contains the same components but is a different shape

Program: The last stage is write a program in machine code (the "language" which the microprocessor understands), but with comments in plain English for future reference! This program is then entered into RAM on a development system such as that described below. The input temperatures are simulated by putting numbers in the appropriate addresses.

When the program operates correctly, build up the hardware and try the two together. Next get your program put into PROM by your friendly PROM supplier, plug it in, and make sure it works.

In practice the microprocessor could easily do very much more. An input from the fuel tank of an oil-fired system would allow it to predict a run-out date, based on fuel consumption. Timing could also be built in.

The central heating controller is offered only as a simple example of how design is done, to show the procedures involved when developing a system.

NATIONAL SC/MP

So much for theory; what about practice? To start with you need a cheap microprocessor development system, like the SC/MP Introkit. This contains everything except power supply. A preprogrammed ROM contains "Kitbug", a program to allow you to enter a program into RAM in machine code from a Teletype, run the program, and print out the result on the Teletype. (No Teletype? Don't despair, read on!) The kit contains full paperwork, and some worked examples.

For those people wanting a cheap Teletype substitute, National Semiconductor have introduced Keyboard Kit. This kit consists of a cheap calculator, with the calculator chip removed. An umbilical cord connects it to the Introkit p.c.b., to which a handful of integrated circuits are added. All integrated circuits and sockets are included, also wire and a wire wrap tool. A new ROM, containing SCMPKB, is included. This new program contains all the routines necessary to interpret the key depressions and drive the 7-segment displays.

The comprehensive handbook gives step by step wiring instructions, and operating instructions for the completed kit. Using the keyboard, programs can be entered in hexadecimal (a shorthand form of machine code easier to use than binary). As well as the 16 hexadecimal keys (0–9 A. B. C. D. E. and F), there are 4 control keys, which allow the contents of any RAM address to be examined or modified.

In the following example, the addresses are in hexadecimal. Hex $200 = (2 \times 16^2) + (0 \times 16) + (0) = 2 \times 256 = 512$ in decimal. Address locations 0 to 1FF (511 in decimal) are occupied by SCMPKB in the ROM, 200 to 5FF are used by the keyboard and display so address location 600 is the first RAM address.

Address location	Enter data	Meaning of data
600	C4	Load immediately the next data word into the accumulator
601	03	The value to be loaded
602	EC	Decimal add immediately to the next data word
603	04	The value to be added
604	C8	Store instruction
605	05	Result of calculation stored 5 places on, i.e. 60A
606	C3	Finish, return to SCMPKB control
FF7	06	Enter start address in RAM location
FF8	00	Under SCMPKB control this value is put in the address counter before the programme is run

The result of the addition of 03 and 04 (07) is found in location 60A after the programme has been run by pressing the appropriate button.

To this simple system may be added some address decoding, tristate buffers (DM81LS95) and latches (DM74LS175), allowing real TTL inputs and outputs to connect to the system.

The Introkit at £62·37 + 8% VAT, the Keyboard kit at £59·85 + 8% VAT, and a pack of all relevant data (£1·50 or free with kits) are available ex stock from A. Marshall (London) Ltd., 42 Cricklewood Broadway, London NW2 3ET, distributors of National Semiconductor consumer products. ★

SERT Symposium "Microprocessors at Work"

The interest in and importance of microprocessors in the future development of electronics is indicated by the attendance of over 200 delegates at the three-day residential symposium organised by the Society of Electronic and Radio Technicians at the University of Sussex in September. The symposium highlighted the tremendous potential of the microprocessor as part of a microcomputing system for control, display and calculation. The delegates were drawn mainly from technical management of research and development, but also included representatives from marketing, training and education, maintenance, test and production engineering.

A total of 23 papers were presented by authors drawn from microprocessor manufacturers, electronic equipment manufacturers and universities. The opening papers served as an introduction to microprocessors and their features. A survey of all the currently available processors followed, with some hints on selecting the right device for a particular application. The hardware papers concluded with descriptions of prototyping aids and various testing procedures.

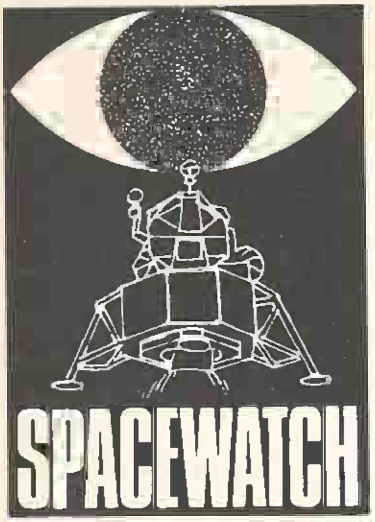
Next it was the turn of programming and software, then on to what was for many delegates the real "meat" of the proceedings, the applications papers. These dealt with such varied subjects as railways, remote graphics displays, instrumentation, lift controls, domestic cookers and industrial weighing systems.

The recurring message from authors throughout the symposium was that prospective users should "get their feet wet". Get hold of one of the development kits now available and gain some practical experience. Better by far than spending hours poring over literature from the various manufacturers, trying to make up your mind which is the best microprocessor for you.

The previously announced competition to find the best application of a microprocessor by a home constructor had unfortunately to be cancelled. Although about half a dozen constructors had expressed an interest, none of them was able to complete his project within the time available.

Symposium Papers

A volume containing reprints of all the papers presented at the symposium is available. This normally costs £7·50, but is available to PRACTICAL ELECTRONICS readers at the specially reduced price of £6·50 including postage and packing. Orders, with remittance, should be sent to the Secretary, MPU Symposium (Dept. PE), S.E.R.T., 8–10 Charing Cross Road, London WC2H 0HP.



BY FRANK W. HYDE

SPACE SHUTTLE

Aptly named *The Enterprise* a black, white and grey spaceship made its first appearance to the public gaze in September this year. It is America's first Space Shuttle Orbiter. Its name is partly a recognition of the popular TV programme "Startrek".

This vehicle is a sort of aeroplane cum spaceship and is the next generation pioneer of the space age. It is designed for manned activities and near space missions in the 1980s. This is the simplifying generation which will bring space flight nearer to that of normal commercial travel.

In physical size the orbiter is about the size of a DC9 aircraft with swept wings. It is 122ft long and when launched it has two solid fuel detachable rocket boosters plus its own three engines. The boosters are jettisoned and later recovered for re-use. This procedure can be repeated many times before the boosters are scrapped.

Though launch will be vertical in the normal mode, the orbiter will cruise to a normal aircraft approach landing, or rather, like a glider landing for it will not be under power.

The orbiter has two main sections, a double decker flight deck and a rear cargo bay. This will provide room for satellites or space experiments. It also has room for other space experiments in the working quarters where the crew of seven can work.

All this is in addition to the 72 cubic metres of the two deck cabin. This area is for the equipment which controls and maintains the spacecraft. The lower deck is for the scientists and engineers as passengers who will work and sleep in the quarters provided.

The *Enterprise* will have multiple tasks to perform and its large cargo area will be able to carry satellites which can be placed in orbit and later recovered for servicing or even repaired on site. A *Spacelab* will be carried and the first one, built by the European Space Agency, is scheduled for operation in 1980. The *Spacelab* can be instrumented for astronomy, high energy physics and astrophysics, solar research, together with biological, technological and Earth related studies.

Spacelab 1 will have a pressurised module for the experiments, but *Spacelab 2* will have instruments mounted on pallets and controlled from inside the flight deck. The pallets will be exposed directly in space. Canada is building a long arm manipulator for use with the pallet system as well as satellites.

TESTING

Tests of the orbiter will begin in January 1977 at the Dryden Spaceflight Centre. The orbiter will be placed on the back of a Boeing 747 and the first tests will be with unmanned conditions. The *Enterprise* will take off from the back of the 747 fly around and then land.

Fifteen such test flights will take between January and June. The shuttle pilots will then board the pick-a-back in late June and in July the first free flight will take place. For this test the orbiter will separate from the 747 at 28,000ft and the *Enterprise* will make a U-turn and land on the runway.

In March 1979 the second *Enterprise* will fly directly, manned, and after six test flights will be ready to go into scheduled operation in 1980.

The first pilots will be chosen from the *Apollo* astronauts. Although 28 men are attached to the Johnson Spaceflight Centre NASA is recruiting 15 pilots and 15 mission specialists. Applications by men or women will be open till June 30, 1977.

MARS

The vital experiments with regard to biological processes are not yet settled and a good deal of work is still to be done. Indeed, it may well be that until some of the Martian soil can be handled directly in Earth laboratories no final conclusion may be announced.

However, there are now indications that the surface of the planet is similar all over. The rocks appear to be the same and the manner of the debris that has been photographed confirms this. The fact that the two sites have similar signs in the soil, from the chemical point of view, all point to the view that the conditions are the same as the other planets, Earth, Venus and Mercury. Temperatures vary, atmospheres vary but the same basic materials are involved.

A new suggestion from the space centres now implies that the crust of Mars may be relatively thin. It is conceivable that there is water trapped as ice or in the form of permafrost not far below the surface. It is thought that this could be as much as a mile deep. Boreholes might well reveal this and there would seem to be a case for a "mole" tunnelling device remotely controlled or at least a boring device when the first manned landing is made.

All things considered so far it would seem that the first colonies should be sited on Mars for even with present technology this is possible.

SOYUZ 22

A flash back to a unique spaceflight was called to mind when the name of Colonel Valery Bykovsky was announced recently as the commander of *Soyuz 22*. Indeed space history was made when Colonel Bykovsky and the only woman astronaut, so far, Valentina Tereshkova were partners in the flight of *Vostok 5*. This was in 1963 two years after Yuri Gagarin made his flight.

The sequel to the man and woman flight was that they were married. Much has happened since that time thirteen years ago, they now have two sons, Valery and Sergei, and Valentina is now chairman of the Soviet Women's Committee. Bykovsky has actively assisted in the training of Soviet space crews and the *Soyuz* flight missions.

The programme he now commands is a co-operative one by socialist countries. The main object is the improvement of scientific methods and the study from outer space of geological and geographical features of the Earth's surface.

The spacecraft carries multi-zonal photographic equipment developed by Germany and the USSR and manufactured by Zeiss. Medical and biological research is now a regular part of the *Soyuz* missions. The data from the spacecraft will be processed by the Soviet Flight Centre with the help of land based tracking stations and research ships in various parts of the world.

OZONE LAYER

Much confusion still exists regarding the ozone layer. A recent government report comes down in favour of a dangerous future if Freon is not banned from sale. At the same time another school of thought says that the activity of flights in the stratosphere by commercial aircraft may well inhibit the effects of contamination where the chlorofluoromethanes are concerned.

There seems to be some tendency to cry wolf in this area again and the fact should be recognised that wide ranging condemnations in these matters are based mainly on laboratory experiments. Just as the exact make up and "weather" changes in the upper atmosphere as a whole are still not extensively understood there has been too much conjecture as to the operation of the ozone layer. The fact that widely divergent percentages have been quoted (it could be as much as $7\frac{1}{2}$ per cent or as little as 1 per cent) is too random to start a scare, often to little purpose or benefit to mankind.

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Intel Memory Design Handbook, c. 280 pages	£4·75
Intel 8080 Microcomputer Systems Users Manual, c. 220 pages	£4·85
Motorola McMOS Databook (Vol. 5 Series A) c. 500 pages	£2·77
Motorola M6800 Microprocessor Applications Manual, c. 650 pages	£12·45
Motorola M6800 Programming Manual, c. 200 pages	£6·85
Motorola Booklet introducing Microprocessors	£1·58
National SC/MP Introkit Users Manual	£0·75
National SC/MP Programming and Assembly Manual	£6·30
National SC/MP Technical Description	£1·95
2650 Microprocessor Manual 220 pp	£24·50

DATASHEETS on Microprocessors: (usually Xerox Copies)

Intersil IM6100, 12 bit, CMOS	£0·75	RCA CDP1802 8 bit, CMOS	£0·35
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CD4006	1·22	CD4031	2·24	CD4056	1·37	CD4094	1·84
CD4007	0·17	CD4032	1·11	CD4057	27·95	CD4095	1·08
CD4008	0·85	CD4033	1·45	CD4059	4·98	CD4096	1·08
CD4009	0·56	CD4034	1·98	CD4060	1·18	CD4097	3·67
CD4010	0·58	CD4035	1·22	CD4062	9·07	CD4099	1·80
CD4011	0·17	CD4036	3·18	CD4063	1·14	CD4502	1·28
CD4012	0·17	CD4037	0·99	CD4066	0·64	CD4510	1·41
CD4013	0·56	CD4038	1·22	CD4067	3·87	CD4511	1·82
CD4014	1·05	CD4039	3·09	CD4068	0·22	CD4514	2·85
CD4015	1·05	CD4040	1·11	CD4069	0·22	CD4515	3·25
CD4016	0·55	CD4041	0·87	CD4070	0·60	CD4516	1·41
CD4017	0·99	CD4042	0·87	CD4071	0·22	CD4518	1·30
CD4018	0·88	CD4043	1·05	CD4072	0·22	CD4520	1·30
CD4019	0·58	CD4044	0·97	CD4073	0·22	CD4527	1·64
CD4020	1·16	CD4045	1·45	CD4075	0·22	CD4532	1·50
CD4021	1·05	CD4046	1·38	CD4076	1·61	CD4555	0·84
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CD4023	0·17	CD4048	0·58	CD4078	0·22	MC14528	1·18
CD4024	0·81	CD4049	0·55	CD4081	0·22	MC14553	8·24
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BFS97	15p	ZTX302	15p	ZTX501	14p	ZS170	13p		
BFS98	16p	ZTX303	18p	ZTX502	16p	ZS171	16p	ZENERS	
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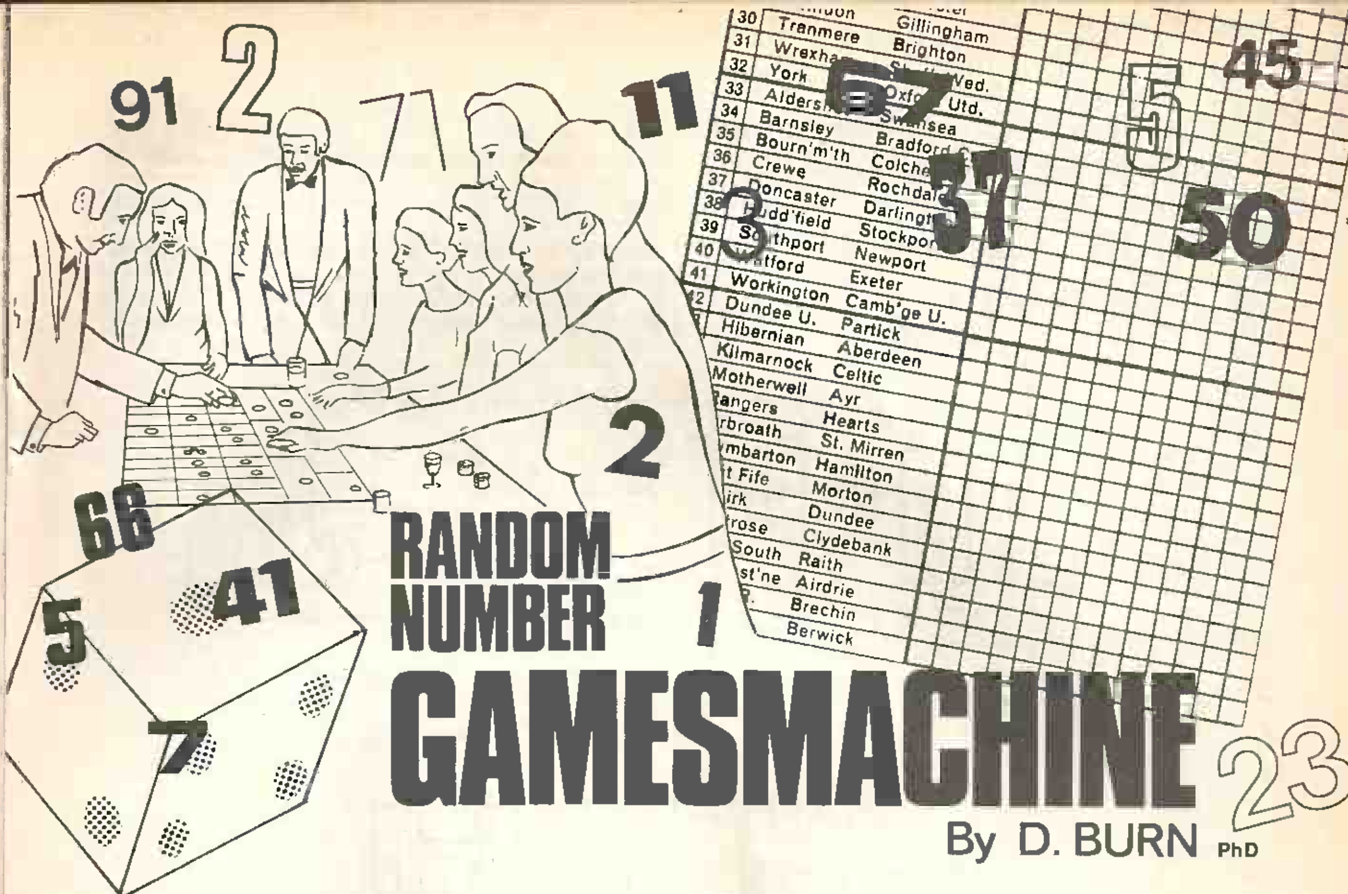


RANDOM NUMBER GAMESMACHINE

By D. BURN PhD

A CHANCE remark, in humorous vein, by a neighbour sparked off the train of thought that led finally to a versatile random number generator. "Can't you," he asked, "make a gadget that will win the 'pools' for me?" I explained that I didn't think that I could do an H. G. Wells and produce a time machine, and that perhaps some sort of random number device was the most likely alternative. At least, the chances should be about the same as with "Ernie" and a Premium Bond.

As the idea took shape, it became clear that any such device need not be limited to the football pools, and so the final design incorporates switching for four modes of operation; a random number generator up to a maximum of 99, a pools game selector limited to 59, a roulette wheel counting up to 36, and a dice simulator in which each digit has a maximum value of 6.

PRINCIPLE

In order that the circuit shall be as free as possible from external influences, two essentially random events are employed in selecting a number. First, a white noise generator produces a sequence of pulses which are quite random with respect to time and second, these pulses are counted for a relatively long and indeterminate length of time. A block diagram which demonstrates this principle is shown in Fig. 1.

Operation of the "play" switch sets the bistable which enables the gate so that the stream of very high speed pulses from the noise generator is passed into the counting circuit. When this happens, the free-running clock circuit will be at some unknown point in its operating cycle, so that a short and indeterminate time later its next output will reset the bistable, stopping the count and displaying the result on the two seven-segment displays. During this period, the counters will have cycled through their count sequences a very large number of times, and it has been so arranged that the displays are blanked during counting so that there can be no possible indication of the final result until the number has been selected and displayed.

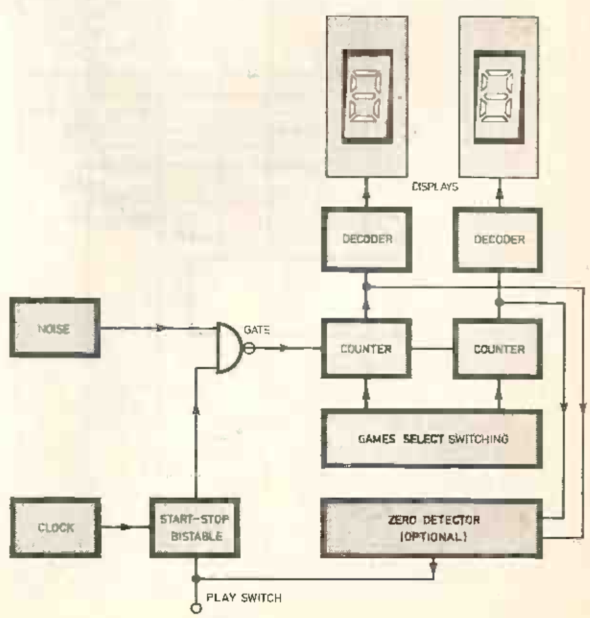
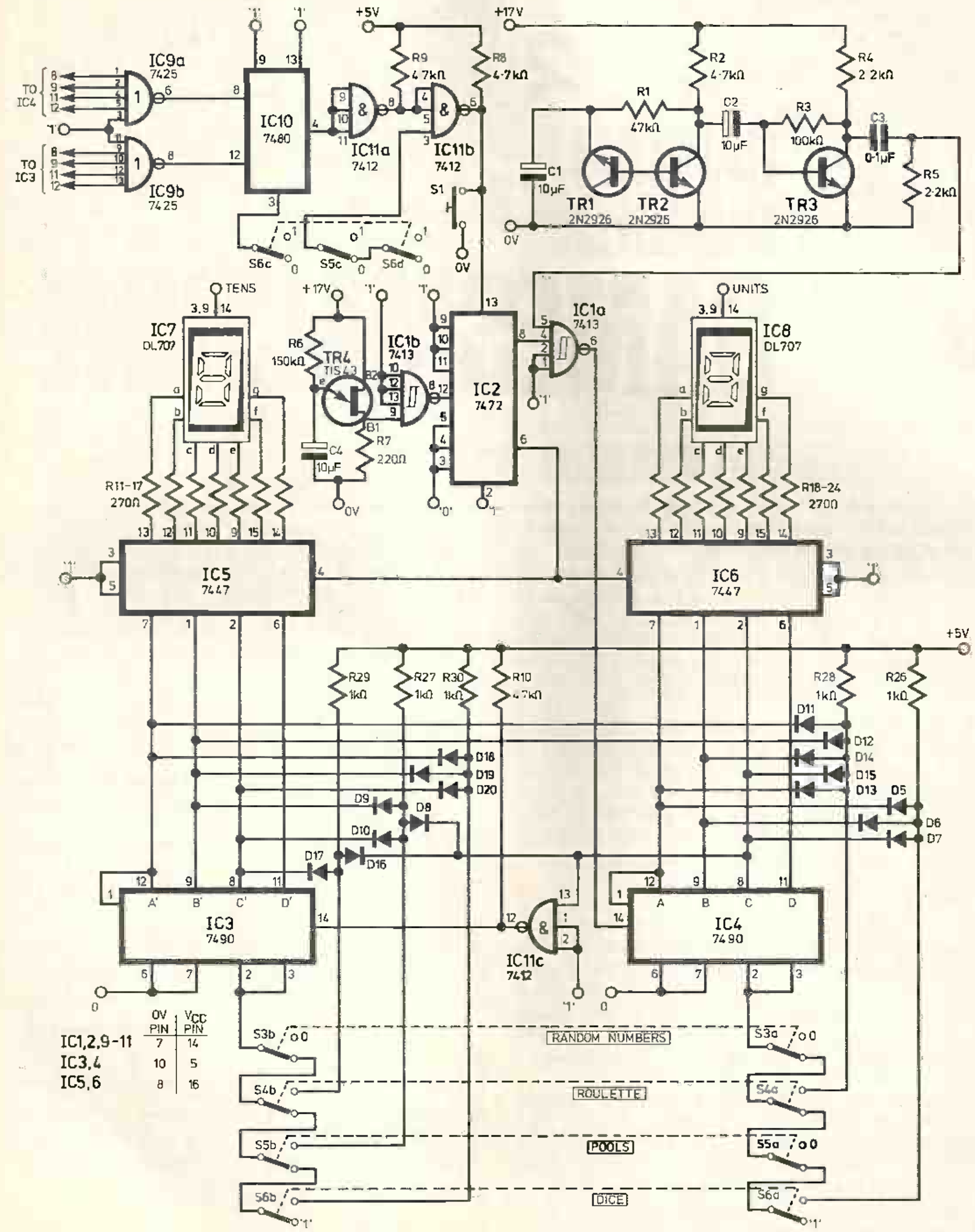


Fig. 1. Block diagram of unit

CIRCUIT

The major part of the circuit is shown in Fig. 2. The noise signal is derived from the base-emitter diode of transistor TR1 and is further amplified by TR2 and TR3; the resulting signal is squared and limited by IC1a, which is one half of a dual TTL Schmitt trigger, type 7413, which also doubles as the signal gate. The clock pulse is produced by the very simple unijunction oscillator TR4, which has a period of about 3–4 seconds; its output is also squared, in the second half of the Schmitt IC1b. The bistable IC2 is a TTL type 7472 J-K flip-flop, whose J inputs are permanently at a logic "0" level and K inputs are permanently "1". Thus the clock pulses will keep it in the "reset" state in which the Q output is "0" (pin 8) which inhibits the signal gate IC1a.

Pressing S1 places a "0" on the "set" input of the bistable which overrides all other inputs and causes a "1" to appear at the $\bar{Q}$ output, so enabling the signal gate. At the same time, the "0" at the Q output (pin 6)



	0V PIN	V_{CC} PIN
IC1,2,9-11	7	14
IC3,4	10	5
IC5,6	8	16

Fig. 2. Pulse circuitry for the Games Machine

is applied to the blanking inputs of the decoders IC5 and IC6, so blanking the displays while the count is in progress. The next clock pulse to arrive at the bistable after the "play" button is released resets it, stopping the count and enabling the displays. The counting chain consists of the two 7490 decade counters IC3 and IC4, the decoders IC5 and IC6, and the DL707 displays IC7 and IC8.

In a chain of counters, it is normal practice to drive each decade from the D output of the preceding decade, but in the present application this method will not work. Consider, for example, the dice option. The "units" counter cycles up to 6 and then resets, so that the D output never changes state, and cannot possibly provide the carry pulse for the "tens" counter. However, inspection of the truth table of the 7490 counter shows that the C output also changes state once per decade, and can therefore provide the necessary carry pulse. Unfortunately, the required "1" to "0" transition occurs on the count of 8, and this gives rise to some further problems in the roulette option. Inverting the C output produces the required transition on the count of 4, and it turns out that this is perfectly suitable for all the options that are to be provided. Of course, it does give rise to a most peculiar count sequence, since the "tens" counter will now increment each time the "units" counter reaches 4. While this may appear very odd, no numbers are missed, and the actual sequence is quite irrelevant in this application.

MAINS POWER UNIT

Power for the circuit is applied by a simple mains power unit (Fig. 3) based on an integrated voltage regulator IC12 which provides a stabilised 5 volt output; the noise and clock generators require a higher voltage and so their supply is taken from the bridge output of about 17 volts. In the prototype, the seven-segment displays are also powered from the output of the i.c. regulator and the current limiting resistors R11–R24 were chosen accordingly to be 270Ω. However, the current drain is such that the regulator is running close to its maximum dissipation and it does get rather hot. While a small heat sink is shown in the constructional details, a better solution would perhaps be to run the displays from the unstabilised 17 volt line, and increase the limiting resistors to about 820–1,000Ω; although this has not been tried out, it is standard practice and should not give any trouble.

GAMES SWITCHING

Without further modification, the circuit so far described will count from 00 to 99 and continuously recycle. This is fine for the random number option, but for the other options it is necessary to limit the count cycles. To do this, use is made of the reset-to-zero facility of the 7490 counter: in order to count, this input must be held at the logic "0" level. A "1" at this input will immediately reset the counter to zero and inhibit further counting until the "0" level is restored. In principle therefore, it is simply necessary to detect the required maximum count and to cause a "1" to momentarily appear at the reset-to-zero input. In practice, it is rather more complicated because several different counting cycles are required.

The switches which carry out this selection are S3/S6, linked so that depressing one switch releases the others. They are all shown in the released position, so that there is a connection through all four switches from the reset-to-zero input to a logic "1" level. Thus any attempt to operate the device without one of the games being correctly selected will cause the displays to permanently show zeros.

The required maximum count is detected by decoding its binary equivalent in the diode-resistor gates; at this time, all the inputs to the selected gate will be at a "1" level, so that its output will also go to "1". This "1" level is then routed to the reset-to-zero input of the appropriate counter by one of the switches.

Switch S3 selects the random number option. Hence operation of S3 applies a logic "0" to counter IC4 via S3a, and to counter IC3 via S3b; both counters are therefore permanently enabled and cycle through the full 00–99 count as required.

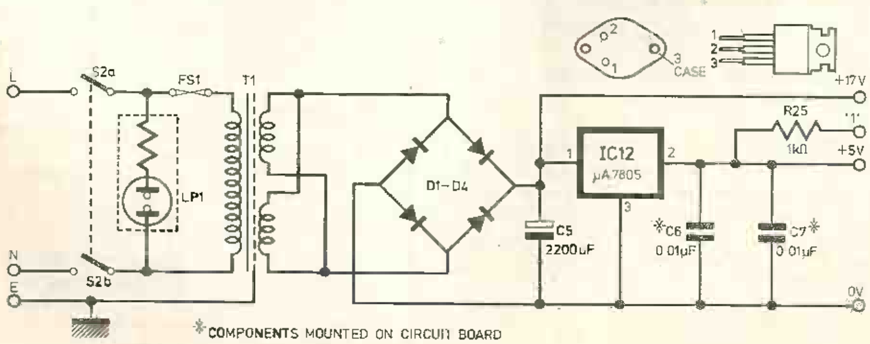


Fig. 3. Mains power unit

Switch S4 selects the roulette option, in which the maximum count will be 36; the counters must therefore be reset as soon as the count of 37 is reached. Examination of the count sequence around this number reveals that two resetting operations will be necessary. First, 37 is detected by the gate D11, D12, D13, D14, D15 and R28 and the reset signal is applied, via S4a, to the units counter only. This ensures that the counts of 30–33, which would have been lost if both counters had been reset to zero, do in fact appear. Next, the count of 44 is detected by gate D16, D17 and R29 and the reset signal is applied, via S4b, to the tens counter; if the full sequence is written out, it will be seen that no numbers are lost. The maximum number of matches on a football coupon never exceeds 60, and so for the pools option the count is limited to this number. Looking once again at the counting sequence around 60, we find that the first number that appears in the sixties is in fact 64:

. . . 57 58 59 50 51 52 53 64 65 66 . . .

so this is detected by the gate D8, D9, D10 and R27 and applied to the reset-to zero of the "tens" counter only; the modified count is then: 52 53 64 4 5. Switch S5b is used for this reset signal; S5a applies a "0" to the reset of the units counter so that the full 0–9 range is covered.

Finally, the much simpler dice option. Each counter is required to cycle up to 6, so that 7 has to be detected individually for each counter and used to reset it. D5, D6, D7, R26 and S6a carry out this operation for the "units" counter, while D18, D19, D20, R30 and S6b do the same for the "tens" counter.

ZERO DETECTOR

The circuit that has so far been described may be built without further elaboration and will operate exactly as planned but, there is a small snag. We have so far been very concerned with the various maxima that are required for the different games, but the corresponding minima have been ignored. This is fine as far as random numbers and roulette are concerned, for a selection of 00 is perfectly acceptable. However, there is no match number 0 on a pools coupon, neither do dice have zero on any face.

An optional extra to the circuit is therefore some additional logic which will prevent these forbidden scores being selected. What then are the requirements for such a circuit? It must of course know which game has been selected so that it will know when and how to operate; clearly, some additional switching will be necessary. It must be able to detect the zeros, and determine whether a single zero is permissible (for example, 04 or 20) as for the pools, or whether neither digit is allowed (dice); should either of the forbidden states be selected, the circuit should initiate a new count, and continue to do so until an allowed selection is made.

The counter outputs are wired to two 4-input NOR gates IC9a and IC9b (7425), each of whose outputs will be a "1" when, and only when, all its inputs are "0". Next, these "1"s must be combined in a circuit that will distinguish between the "either" and "both" requirements, that is, it will perform the logical AND and OR functions at will.

Whilst there are several ways in which this may be implemented, a particularly simple way in practice is to use an i.c. full adder; the truth table for the 7480 one-bit adder shows that when the "carry" input is at a logic "0", the "carry" output performs the NAND

COMPONENTS . . .

Resistors

R1	47kΩ
R2	4·7kΩ
R3	100kΩ
R4	2·2kΩ
R5	2·2kΩ
R6	150kΩ
R7	220Ω
R8	4·7kΩ
R9	4·7kΩ
R10	4·7kΩ
R11–R24	270Ω
R25–R30	1kΩ

All ½W carbon

Capacitors

C1	10μF, 16V, tantalum
C2	10μF, 16V, tantalum
C3	0·1μF
C4	10μF, 16V, tantalum
C5	2,200μF 25V electrolytic
C6	0·01μF
C7	0·01μF

Semiconductors

TR1	2N2926
TR2	2N2926
TR3	2N2926
TR4	TIS43 or 2N2646
IC1	7413
IC2	7472
IC3	7490
IC4	7490
IC5	7447
IC6	7447
IC7	DL707
IC8	DL707
IC9	7425
IC10	7480
IC11	7412
IC12	μA7805 or similar 5 volt regulator
D1–D4	1N4001 or 50 volt, 1 amp bridge
D5–D20	1N914 or similar general purpose silicon diode.

Switches

Push-button switches with 8-switch mounting frame including latching bar and return spring (Doram), and 6 buttons (square opaque)

S1	2-pole changeover
S2	2-pole mains
S3	2-pole changeover
S4	2-pole changeover
S5	2-pole or 4-pole changeover according to version built
S6	2-pole or 4-pole changeover according to version built

Miscellaneous

Two-tone polystyrene case, size 188×110×60mm (Doram type 509–585)
Transformer miniature 6VA, 0–12V, 0–12V secondaries (Doram)
Miniature group panel
"Soldercon" pins
Veroboard, 0·1in matrix, 86×180mm
6BA threaded rod, sundry nuts and bolts
Small pieces of celluloid and 18swg aluminium
Lightweight, colour coded, single core and stranded hook-up wire

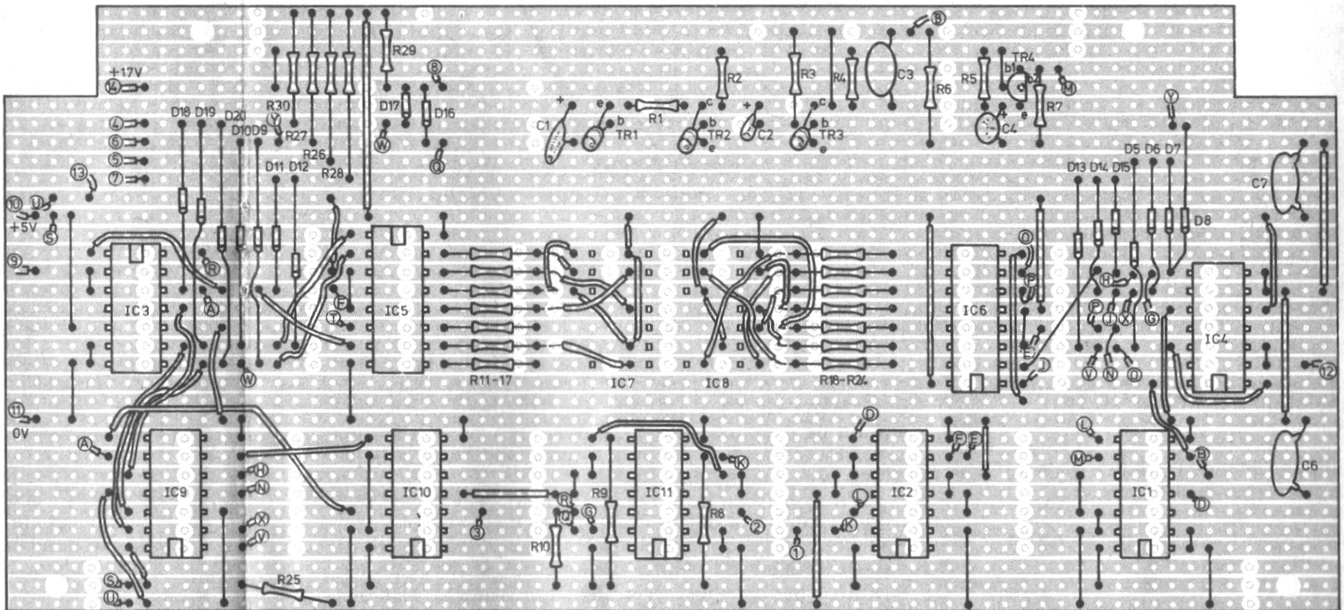


Fig. 4. Main board wiring and assembly

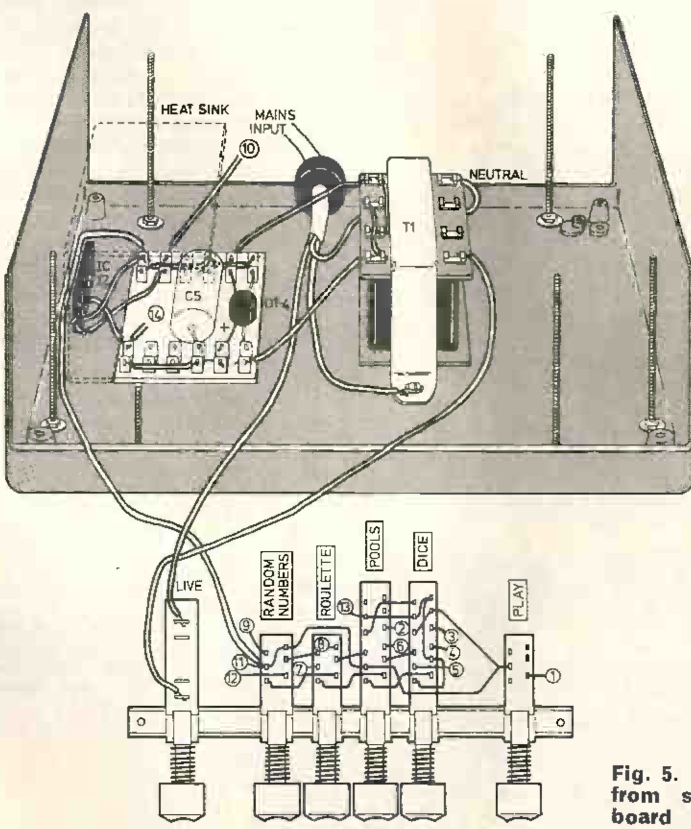
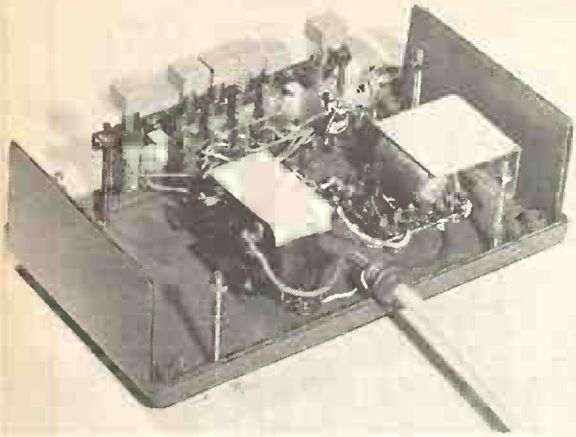


Fig. 5. P.s.u. assembly and wiring from switch assembly to main board



The unit with the main board removed showing the p.s.u. Note the angled heat sink for IC12

operation on the inputs A and B, while a logic "1" on the "carry" input produces the NOR function:

A	B	Carry in	Carry out	
0	0	0	1	NAND
0	1	0	1	
1	0	0	1	
1	1	0	0	
0	0	1	1	NOR
0	1	1	0	
1	0	1	0	
1	1	1	0	

Thus, by inverting the "carry" output of the adder, the desired AND and OR functions are obtained. The "carry" input is used as a control and is supplied by a further pole on the dice switch, S6c (Fig. 2), so that when dice is selected, a "1" is applied and the OR operation is carried out; for all other options, the AND function results.

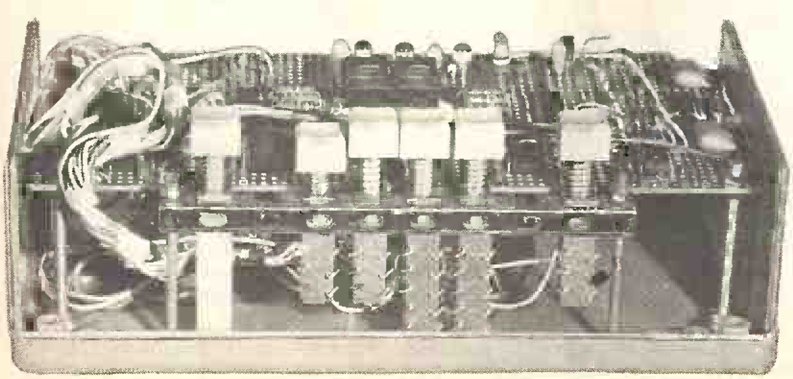
However, this circuit is only required to operate on the dice and pools options, so a second gate IC11b is enabled by application of a "1" to one of its inputs by S5c or S6d when these games are selected; selection of the other alternatives disables this gate so that its output is permanently "1". So now we have the result that whenever a forbidden selection is made, as determined by the extra switching, the output of the gate IC11b goes to a logic "0" level, and this is precisely what is required to set bistable IC2 and restart the count: it will be recalled that the "set" input of the J–K flip-flop overrides all others so that correct operation is assured. Because the restart signal has to be combined with the "play" signal from S1, it is necessary to use an open-collector gate for IC11b so that the "wired-or" connection can be utilised: IC11a, b and c are therefore the three open-collector gates of the 7412 package, and each requires a pull-up resistor R8, R9, and R10.

CONSTRUCTION

Most of the components, and all of the i.c.s, are mounted on a single piece of 0·1in matrix Veroboard approximately 86 × 180mm; the length in particular should be trimmed so that the board is a snug fit in the case. Note the two cut-outs to clear the fixing pillars which are moulded into the case.

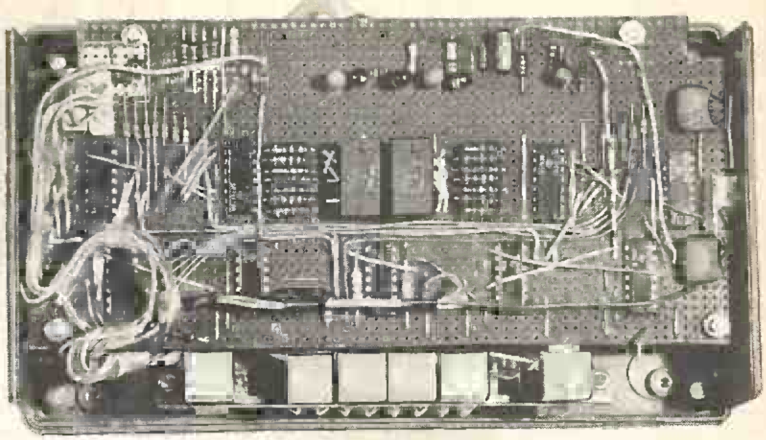
As may be seen from Fig. 4, the l.e.d. displays are set roughly centrally on the board, which is held in place just below the top of the case by four pillars cut from 6BA threaded rod. Along the long side of the board is mounted the assembly of pushbutton switches, also on 6BA pillars, and underneath it is the mains transformer and the power unit.

The circuit board itself is fairly complex, and it is recommended that the following system is adopted in its assembly. First the i.c.s are mounted in position and then used as reference points to identify the breaks in the copper strips; it is vital that none of these are missed. Note that all the i.c.s with the exception of the displays are mounted directly on to the board. These latter are set in holders of Soldercon pins which, together with their extra long leads, ensures that they are higher off the board than any other component; it also conveniently allows some of the wiring to pass between the package and the board. Next, the connection of each individual i.c. to the supply strips, together with any connections to logic "1" and "0" levels, is tackled, using a lightweight, single-core insulated wire. Finally, the interconnections between the i.c.s are completed.



Showing how the Doram pushbutton switches are mounted on the eight switch mounting frame. For wiring details see Fig. 5

The majority of the flying leads to the main board are made up as a loom and numbered as shown in Fig. 4. Lead interconnections on the board, however, are shown lettered



The switch assembly is constructed from Doram pushbutton switches: although only six switches are used, they are mounted on an eight-switch mounting frame, with spaces between the first and last switch (on/off and "play") and the central group of four game selector switches. Assembly details should follow the instructions in the Doram catalogue, the following points being noted:

The on/off switch is of the push-on/push-off type and is used as supplied.

The "play" switch is push-on/release-off so that the action link should be removed.

The four selector switches are used in a latched mode. They are linked so that pushing one releases all the others. The action links are removed from all four and the latching bar, which must be cut down from the eight-switch length supplied to a four-switch length, should be fitted as per instructions; the latching return spring is fitted to the right hand switch.

The complete assembly is again mounted on long pillars cut from 6BA threaded rod so that the four-pole switches just touch the bottom of the case; the buttons will then be found to project through the top of the case by just the correct amount. There are several choices for the style and colour of these buttons; possibly the square, grey type best match the case and the dimensions given later are for this type.

The wiring of the switches is shown separately in Fig. 5.

TESTING

By its very nature, it is impossible to tell whether the completed unit is operating correctly. A test procedure must therefore be adopted, and this requires a few temporary modifications to the circuit. First, the noise and clock generators are disconnected from the remainder of the logic. The rather slow pulses from the unijunction oscillator may easily be seen by monitoring the voltage across R7 with a multimeter; the noise generator can only really be checked with an oscilloscope—which incidentally will confirm the random nature of its output as it will be found impossible to synchronise the time-base to noise waveform. A push-on/release-off switch should be connected between IC1, pin 9 and the 0 volt line, and the blanking inputs of the decoders IC3 and IC4, pin 4, should be wired to the logic "1" line so that the displays remain on. Finally, a slow pulse wave at, say, 1–2Hz should be fed into the signal gate IC1, pin 5: in the absence of a pulse generator, a simple unijunction oscillator such as that shown in Fig. 2, but with C4 reduced to 2μF, will suffice.

It is now possible to start and stop the logic circuit at will, and to observe the count sequences whilst it is running. The following checks are carried out:

1. With no game selected, that is, with all the switches out—which can occur if the switches are not fully depressed, the display will show 00 and will not count when the "Start" switch is pressed.

2. Random numbers selected: on pressing the "Start" button, the display will cycle from 00 to 99 in the rather curious sequence already described; it can be stopped—with the temporary "stop" switch—at any count, including 00.

3. Roulette: the count will reach 33, via 36 30 31 32, reset to 04, and continue 05 06 07 . . . ; the count can again be stopped at 00.

4. Pools: the count will follow the sequence . . . 58 59 50 51 52 53 04 05 . . . It can be stopped if a single zero is displayed, e.g. 03, 40, but if two zeros are shown, the stop signal will be ignored and counting will continue.

5. Dice: neither display will show a number greater than 6, and the count cannot be stopped if either or both displays show a zero.

Providing that all these responses are correct, the temporary connection between the decoder blanking inputs and "1" should be removed and these inputs should be reconnected to the $\overline{Q}$ output of the bistable (IC2, pin 6). Now when the "Start" button is pressed, the display will blank out and will remain blanked until the "Stop" button is pressed, when the selected number will be displayed. If this also checks out, all the remaining temporary connections should be removed and the circuit completed. ★

SEMICONDUCTOR UPDATE... By R.W. COLES

RC4194
DF215
ZN423T

PERSONAL AWARD

As regular readers of this column will be aware, I am eternally grateful for the way that integrated circuit technology continues to solve all those little housekeeping problems which crop up in all the circuits I put together. You know the sort of thing, when you are building a circuit with a sprinkling of 741 op-amps and a few CMOS gates which will perform (you hope!) the most amazing electronic miracles, you really don't want to have to spend nail biting hours inventing a power supply regulator to provide the necessary milliamps. No, what you want is a ready-made, off-the-shelf solution so that you can concentrate on the creation of those electronic miracles, and these days, thanks to the variety of regulator chips available, to a large extent your needs (and mine) have been satisfied.

Any addition to this existing pool of labour-saving goodies is always welcome, and a new device from Raytheon, the **RC4194** dual tracking voltage regulator, has just been awarded my own personal "Good-Housekeeping Award" for services to overworked designers.

The two outputs of the regulator track to within 2 per cent and their magnitude can be set with a single resistor to any voltage between the limits ±50mV and ±42V. Output current from each rail is a creditable 200mA, although, of course, due attention must be paid to the power dissipation rating of the device in individual applications.

To give flexibility in power dissipation the RC4194 is available in two package styles, the suffix D 14-pin d.i.l. which will handle 900mW, and the suffix TK 9-pin TO66 which can handle 3W.

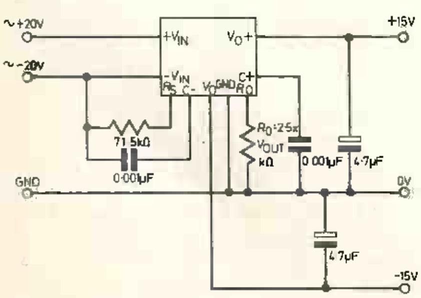


Fig. 1. The RC4194 used for an op amp supply

POINT-TO-POINT

My next offering is something of a challenge, because what I want to describe is an all-singing, all-dancing new device, which I could ramble on about for at least a couple of pages, if space permitted!

The **DF215** is described by its manufacturer, Siliconix, as a Dual Set Point Timer/Counter, for automatic control interval timing, but its true usefulness and originality can only be appreciated after an extended perusal of the bulging data-sheet. The DF215 is an MOS l.s.i. circuit in a 28-pin plastic package which will run happily on supplies between 8 and 20V, and which offers a multitude of different timing, counting, and control functions.

The logic of the chip breaks up into three basic building blocks. A versatile counter which can count events or act as an accurate timebase when driven by 50Hz mains frequency. A double comparator which can continuously compare the four most significant digits of the counter with the inputs from *two* banks of four digit thumbwheel switches, and a display driver which provides synchronised outputs to display the current contents of the counter in seven-segment decimal form.

Flexibility of the chip is ensured by four control inputs which configure the internal circuit blocks in a variety of different ways, making this much more than just another clock chip. With appropriate control functions switched (or wired) in, counting can be from 50 or 60Hz mains frequency or from an asynchronous pulse (event) input. Counter range can be 0 to 999·9 seconds, 0 to 99 minutes 59 seconds, 0 to 999·9 minutes or 0 to 99 hours 59 minutes. Using the event input as a count source, 0 to 9999 events can be totalised.

The chip serialises the BCD data from the two four digit thumbwheel switch banks (set points A and B), and compares their setting with the counter. When either comparison is valid, a control output is produced providing accurately controlled intervals of 0 to set point A, and set point A to set point B, when a 50Hz clock is used.

Inputs are provided to start the cycle or to reset it part way through if necessary, and by connecting the set point B output back to the start input, a continuous operating cycle can be maintained—Phew!

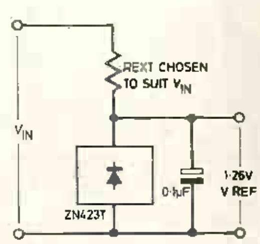


Fig. 2. The ZN423T as an accurate voltage reference

REFERENCE ONLY

I recently described the National LM399 voltage reference integrated circuit which had a temperature controlled heater as part of the chip in order to realise an extremely low apparent temperature coefficient. This novel idea yielded a high precision reference source, but there are other ways of realising a low temperature coefficient which are potentially cheaper to produce and which devour less current, if a small relaxation of specification is possible.

By clever design it is possible to produce a self-compensating reference such that a positive temperature coefficient in one part of a circuit is cancelled by a negative coefficient in another.

Past masters at ingenious chip design are Ferranti, and their new **ZN423T** device uses the self-compensation principle to yield an accurate, low voltage (1·26V) reference with a temperature coefficient of just 0·01 per cent per degree C. The reference elements of the ZN 423T do not employ the Zener or Avalanche breakdown principles but in fact depend on the energy band gap of transistor base-emitter junctions.

The low voltage reference which results can be a positive advantage in low voltage circuits where previously it was necessary to step down the 6 volts or so from a standard low T.C. Zener type reference. The use of the band-gap principle also removes the noise source inherently present with the alternative breakdown mechanisms, making this new device attractive on several counts.

Breakdown TESTER

By M.H. GEORGE

THE unit to be described allows the testing of the voltage breakdown characteristics of electronic devices. This is particularly appropriate for checking the voltage ratings of transistors, rectifiers, Zener diodes, neon lamps, etc.

DEVICE CHARACTERISTICS

A voltage breakdown region is that area of the device characteristic where a large increase in current through the device results in only a small increase in voltage across it. A typical characteristic is shown in Fig. 1. This might represent current against voltage in a Zener diode, or the collector/emitter characteristic of a transistor with the base connection open-circuited.

Obviously if the current is allowed to increase too far, the power dissipated will eventually cause destruction of the device. If, however, the current is limited to a safe value, the breakdown may be observed non-destructively.

CONSTANT CURRENT GENERATOR

The ideal constant current generator is a power source which allows the voltage across any circuitry connected to it to rise until a set value of current flows in the network. This current is the same value, whatever the network connected. A generator of this type connected to a device having a voltage/current characteristic like that in Fig. 1 will cause the breakdown voltage to appear across the device, provided that the current generated exceeds the leakage current.

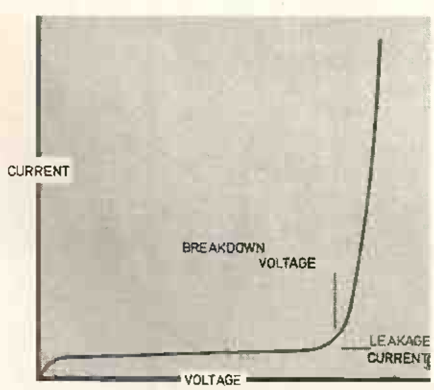


Fig. 1. Typical breakdown characteristic of a semiconductor junction

COMPONENTS . . .

Resistors

R1	220kΩ 1W carbon film
R2	25kΩ 10W wirewound
R3	330Ω 2·5W wirewound
*R4	1·5kΩ 5W wirewound
R5	220Ω 1W carbon film
R6	100Ω
R7	56kΩ
R8	33kΩ
R9	910kΩ
R10–R13	1MΩ (4 off)
R14	10kΩ

(R6–R14 all 2% metal oxide)

Potentiometers

VR1 10kΩ wirewound. At least 1W rating

Capacitors

C1 32μF 450V working electrolytic

Semiconductors

*TR1	2N5657 or MJE340
D1–D4	1N4007 (4 off)
D5	BZX61 C10 10V 1W Zener
D6	OA91 or any small germanium diode
D7	BZY88 C5V6 5·6V 400mW Zener

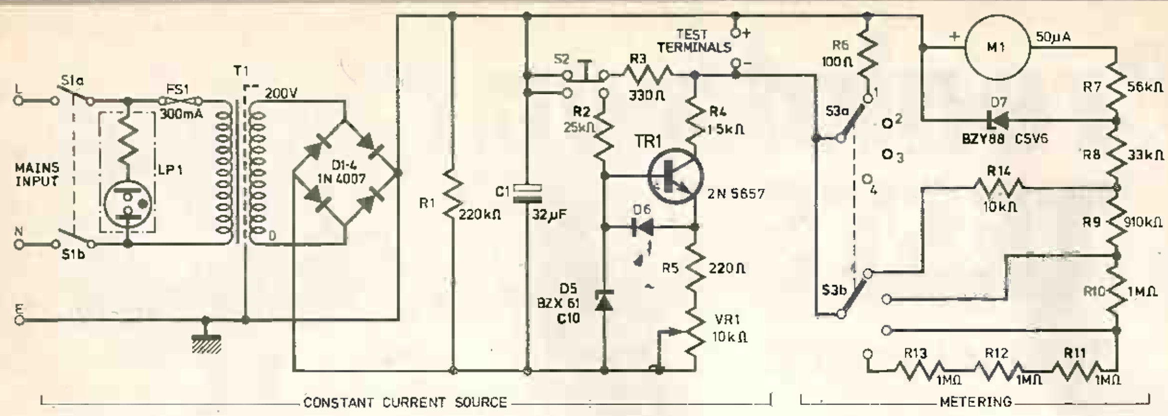
Miscellaneous

M1	50μA f.s.d. Coil resistance 1kΩ
T1	Pri: 240V. Sec: 200V 50mA approx. (e.g. Belclere MS3173)
S1	DPST mains toggle switch
S2	Press to changeover, momentary action microswitch
S3	2P 4W rotary switch
FS1	300mA A/S fuse and holder
LP1	Mains neon indicator

Heatsink and insulating kit for TR1
Instrument case. Red and Black 4mm terminals.

* See text

Note—If an external multimeter is to be used, R6–R14, D7, M1 and S3 are not required.



L
N
E
S1a
S1b
MAINS INPUT
FS1
300mA
LP1
T1
200V
D1-4
1N 4007
R1
220kΩ
C1
32μF
S2
R3
330Ω
TEST TERMINALS
R2
25kΩ
R4
1·5kΩ
TR1
2N 5657
D6
D5
BZX 61
C10
R5
220Ω
VR1
10kΩ
R6
100Ω
S3a
S3b
M1
50μA
R7
56kΩ
D7
BZY88 C5V6
R8
33kΩ
R14
10kΩ
R9
910kΩ
R10
1MΩ
R13
R12
R11
1MΩ
CONSTANT CURRENT SOURCE
METERING

Fig. 2

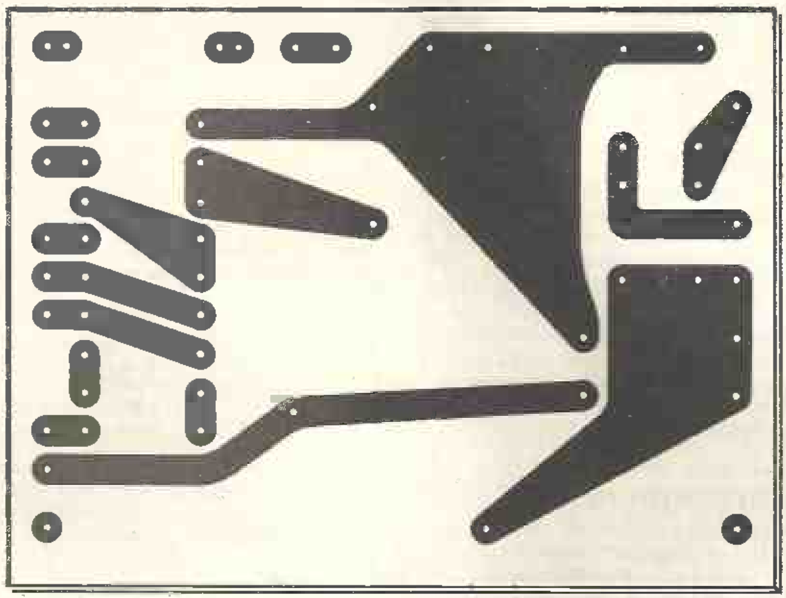
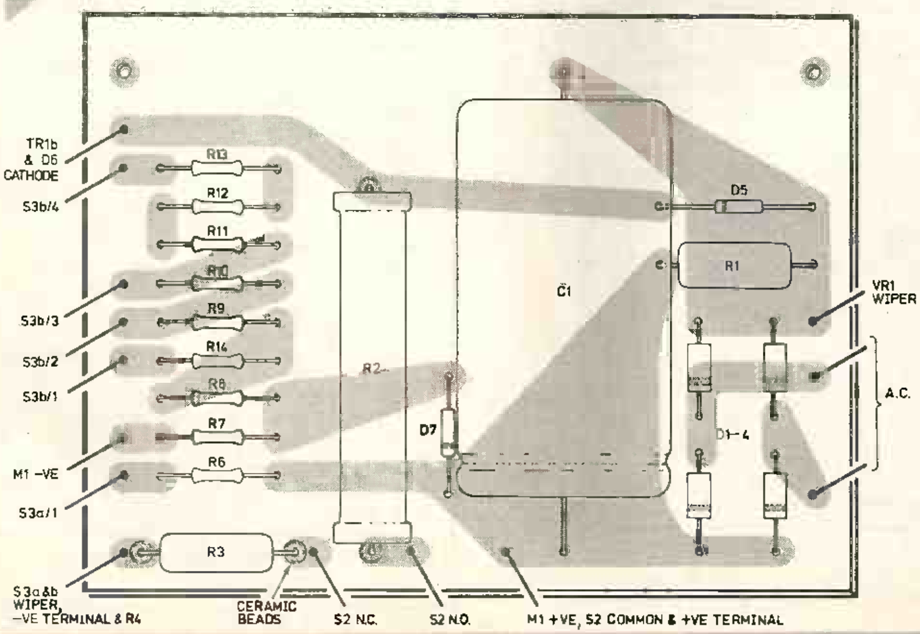


Fig. 3



TR1b & D6 CATHODE
S3b/4
S3b/3
S3b/2
S3b/1
M1 −VE
S3a/1
S3a&b WIPER, −VE TERMINAL & R4
CERAMIC BEADS
S2 N.C.
S2 N.O.
M1 +VE, S2 COMMON & +VE TERMINAL
R13
R12
R11
R10
R9
R14
R8
R7
R6
R3
R2
D7
C1
D5
R1
D1-4
VR1 WIPER
A.C.

PRACTICAL CIRCUIT

The circuit diagram of the complete unit is given in Fig. 2. Transformer T1 provides isolation from the mains, and the associated rectifying and smoothing components develop about 250 volts d.c. across C1. When S2 is depressed, about 8mA passes through R2 and D5, providing a 10 volt reference at the top of D5. This voltage, minus the V_{BE} drop in TR1, appears across R5 and VR1, so that a constant current of about

$$\frac{9\cdot 3}{R5 + VR1} \text{ amps}$$

flows in the emitter circuit of TR1. By transistor action, a fraction α (equal to the common base current gain—about 0·96 in the MJE340) of this current flows in the collector circuit, through R4 and the device connected to the test terminals. Thus VR1 varies the collector current, which is independent of the collector load until the transistor saturates. This occurs when the voltage drop across R4, R5, VR1 and the device under test approaches the voltage available across C1.

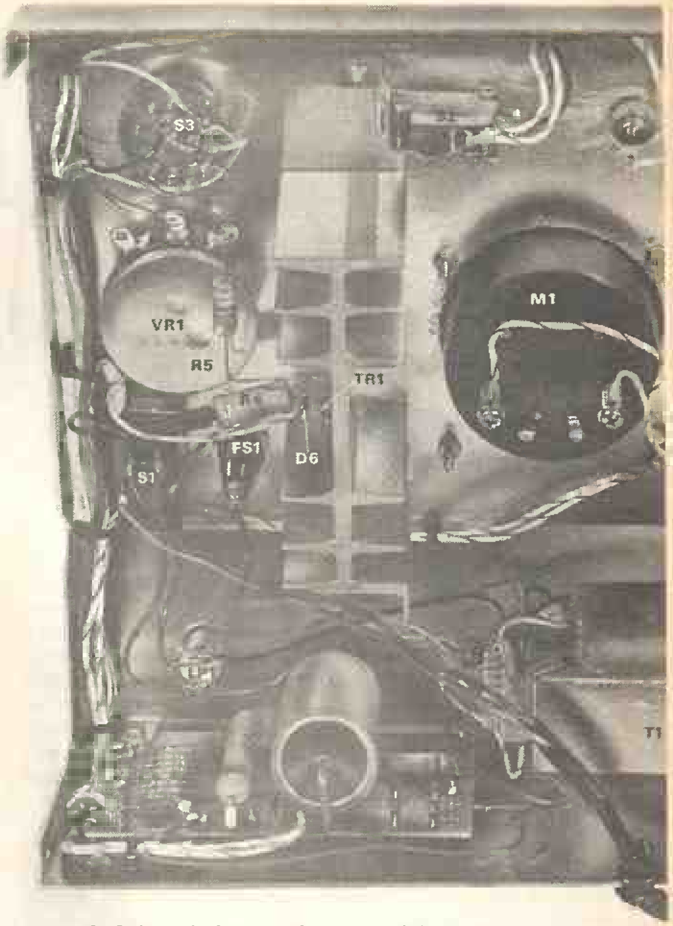
The meter circuit measures the voltage appearing across the test terminals, and thus across the device. Three ranges are provided, of 50V, 100V and 250V f.s.d. With S3 in position 1, the meter is connected as a milliammeter of 50mA f.s.d., and is used to set the test current.

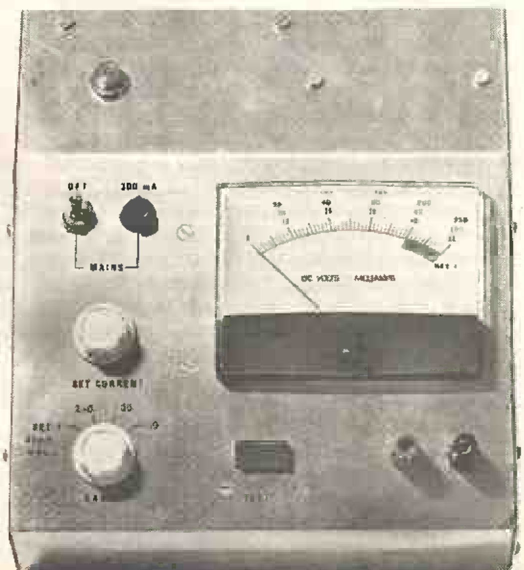
The meter circuit is entirely optional, and a multimeter connected across the test terminals would be an acceptable alternative, especially where only occasional use is to be made of the unit. The "Set current" measurements may then be made straight through the multimeter on a suitable current range.

CONSTRUCTION

Most of the components are mounted on a printed circuit board (Fig. 3), which should be of glass fibre for preference because of the high voltages on some of the tracks. The wirewound resistors should be spaced about 6mm (0·25in) off the board.

Requirements for TR1 and R4 depend to some extent on the transformer secondary voltage. If this is rated at 200 volts r.m.s. or more, use a 2N5657 for TR1 and 1·5kΩ for R4. For 180 volts r.m.s. or less, a MJE340 is suitable, and R4 (which merely protects TR1 and D5 in the event of collector/base breakdown) may be reduced to 820Ω or 1kΩ.





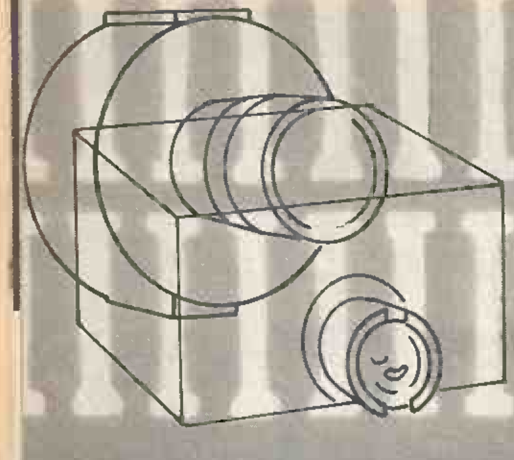
For TR1, a heatsink such as that employed in the prototype is hardly necessary unless prolonged operation into near-short-circuit loads is anticipated. In most cases it will be sufficient to bolt the transistor to the metal case, making sure that the two are electrically isolated.

OPERATION

Before connecting the device to be tested, set the meter range switch to SET CURRENT, depress the TEST switch and adjust VR1 for the desired test current. Release the TEST switch.

Connect the device to be tested to the test terminals (red positive). Set the range switch to 250 volts. Depress the TEST switch and read the breakdown voltage on the meter, adjusting the range switch for optimum meter deflection.

The principal use for this unit will probably be for testing the collector/emitter breakdown voltages of transistors. It should be borne in mind that the collector/emitter leakage of some power transistors, particularly germanium, may be of the order of a few milliamps. A quick check on a multimeter set to the ohms range will reveal this. Also bear in mind that at maximum current, the device connected may dissipate up to 10 watts (250V × 40mA)—easily enough to destroy a small high voltage transistor carelessly connected: also that 250 volts can give quite a nasty shock. ★



SOLID STATE TV CAMERAS

By D.V. EDDOLLS

CONVENTIONAL television cameras convert light to an electric charge pattern on a target in a vacuum tube. An electron beam scans the target producing a voltage waveform or video signal which is transmitted to the television receiver. However, these camera tubes are bulky, fragile and need a high voltage power supply.

Many military, industrial and commercial applications require compact, lightweight imaging systems. This need, combined with rapid advances in silicon technology, has resulted in all-solid state television cameras becoming commercially available. This article traces their development from relatively insensitive systems tested in the early sixties to present day cameras able to work at very low light levels.

INTEGRATED ARRAYS

In solid state imaging an array of light sensitive elements, such as photodiodes, replaces the continuous target of the conventional camera. The scanning electron beam is replaced by an electronic circuit which connects the output of each element in turn to the video amplifier.

Solid state colour TV camera (courtesy Bell Laboratories)

Integrated arrays of diodes are made by coating the semiconductor slice with a photosensitive resist, a solution of resins in organic solvents. This is exposed to ultra-violet light through a glass plate carrying an opaque pattern identical to the diode array.

The photoresist areas protected by the opaque pattern are dissolved away leaving a chemically resistant masking layer. The slice with its protective layer is then exposed to an *n* or *p*-type impurity under carefully controlled conditions. The impurity diffuses into the unprotected parts of the semiconductor to form diodes. Finally, the photoresist masking layer is removed.

Phototransistor arrays and integrated scanning circuits are made by the same technique. However, several stages of masking and diffusion are necessary.

PHOTODIODES AND PHOTOTRANSISTORS

When a semiconductor diode is used as a photodetector it is usually operated in reverse bias. Under this condition negligible current flows in the diode unless light falls on it.

Light shining on the diode raises electrons to higher energy levels allowing them to cross the potential barrier at the *p-n* junction. This produces a current in the external circuit if its resistance is low compared with the junction resistancce. If the circuit resistance is high a voltage is generated.

One of the earliest solid state imaging systems was developed by the IBM Corporation in America. The imaging array consisted of a line of 75 diodes, each 0·075mm by 0·25mm, in a silicon slice 1·27mm wide and 9·5mm long. In operation the diodes were normally biased in the forward direction. By scanning the array with a ramp voltage each diode in turn was switched into reverse bias producing an output current pulse proportional to the incident light.

The array was used in a facsimile system by mounting the document on a rotating drum and focusing its image onto the array. A line of type was scanned vertically by electronically scanning the array and horizontally by rotating the drum.

This technique, called linescan, in which movement of the object or the imager provides one direction of scan, is widely used to provide a two dimensional image with a linear array. Examples include airborne surveillance and the monitoring of continuous industrial processes.

The disadvantage of the IBM approach was that each diode only detected while it was generating a video signal. In an array of a hundred by a hundred diodes only one ten thousandth of the light incident on each device would contribute to the output.

This problem was solved independently by the Plessey Company in England and the Fairchild Corporation in America. They used the incident light to discharge the capacitance which is always associated with a *p-n* junction. For a given semiconductor material this capacitance depends on the junction area, electron concentration and bias.

The capacitance is charged by connecting the diode to a voltage supply once in each frame period. With no incident light this voltage decreases slowly due to the very low leakage current which is always present. Light shining on the diode increases this current and the voltage decays more rapidly.

A video signal is generated once in each frame period by monitoring the discharge of the diode capacitance. This is done by measuring either the voltage remaining on the capacitance or the current needed to recharge it to its original value.

Whichever technique is used, light falling on the detector during the entire frame period contributes to the video signal. Imaging arrays using this approach, which is called light integration, have a frame storage sensitivity similar to that of a vidicon and are sensitive to much lower light levels than the IBM system.

The resolution of a vidicon is determined by the diameter of the scanning beam. The maximum value for an integrated array depends on the number of imaging elements. However, this resolution is degraded because part of each element is employed as a contact or to provide isolation from adjacent elements and does not detect light from the scene. Obviously this dead space must be kept to a minimum.

In addition to diodes, transistors can also be used as photodetectors. They operate with the base open circuit and light incident on the base-collector junction. A phototransistor operates in a similar way to a photodiode but also provides current gain.

Phototransistors were used in an imaging system developed for NASA by the Westinghouse Electric Corporation. By 1967 they had produced a complete television camera 254mm long and 216mm square. The image was detected by a matrix of 100 × 128 phototransistors, each one 0·1mm by 0·125mm, on a 12·7mm square silicon substrate.

In each of the 100 rows the collectors were common and in each of the 128 columns the emitters were connected by aluminium strips. Readout of a phototransistor *MN* was achieved by simultaneously applying voltage pulses to collector row *M* and to the transistor switch connecting column *N* to the video amplifier.

The camera, which used a 6 volt supply, was capable of producing seven grey tones and working at up to 60 frames per second. Since it used silicon photodetectors it was sensitive over the visible spectrum and into the near infra-red.

A disadvantage was that the imaging array and scanning circuits were on separate substrates mounted on integrated circuit logic cards. Thus it was necessary to make separate interconnections to each of the 100 rows and 128 columns. Another problem was the variation in gain between transistors. This meant that even with uniform illumination the response varied across the array.

Because of this variation in gain, diodes were generally preferred to transistors in later development work. By the early seventies completely integrated arrays with imaging and scanning circuits on a single silicon slice were available.

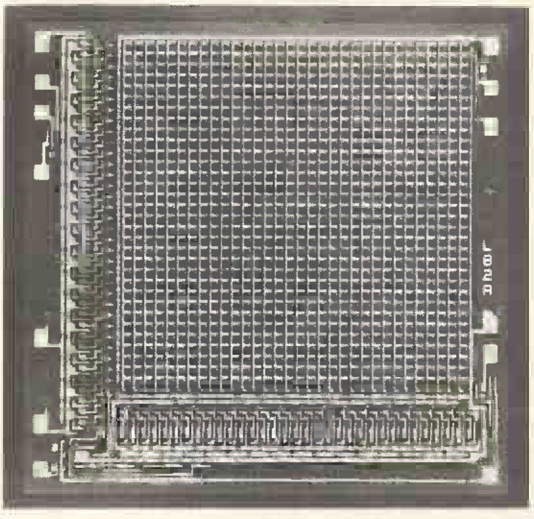
The Plessey array shown in the photograph is an example of this technology. The elements are on a 0·06mm pitch and each consists of a photodiode and transistor switch. In America, integrated arrays of up to 2,500 diodes are marketed by the Reticon Corporation. The largest of these is on a 6·35mm square slice mounted on a 16-pin dual in line package.

PHOTOCONDUCTORS

The imaging systems described so far used integrated arrays of silicon devices. All the diodes or transistors were made in a single silicon slice by carefully controlled diffusion of *n* or *p*-type impurities.

However, the difficulties encountered in producing very large numbers of close spaced devices by this technology led workers at RCA Laboratories to try a different approach. They evaporated a continuous photoconductive film and used conventional photoresist processing techniques to define an array of isolated photoconductors.

A photoconductor is made from a semiconducting material, in this case a mixture of cadmium sulphide and cadmium selenide, and has no *p-n* junction. Incident light releases electrons normally bound to atoms and decreases the material's resistance. The RCA photoconductor arrays were able to store this photo-excited charge for a frame period, making them suitable for imaging.



Self-scanned imaging array. Each element consists of a photodiode and an MOS transistor switch (courtesy Plessey)

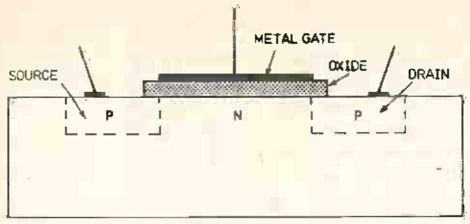


Fig. 1a. Construction of a MOS transistor

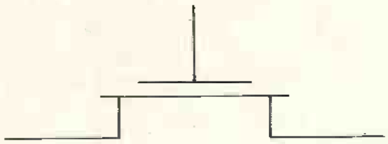


Fig. 1b. Circuit symbol for a MOS transistor

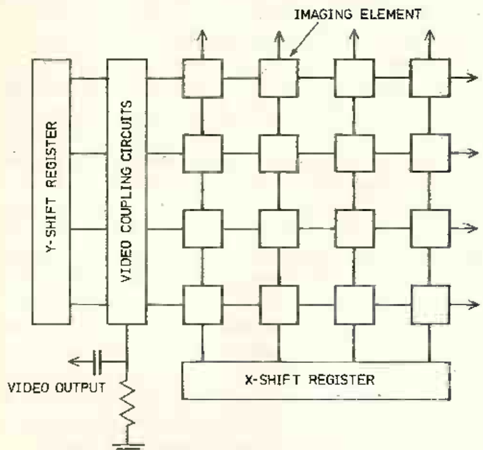


Fig. 2. Block diagram of self-scanned imaging array

Each photoconductor had one ohmic indium contact. The second contact, tellurium, was rectifying and normally high resistance preventing current flow through the photoconductor. Once in each frame period the tellurium contact was biased positively, making it low resistance, and the stored charge read out.

The imaging array, X and Y scanning circuits and the video coupling transistors were on separate 25mm square glass substrates. These were cemented together and mounted on a printed circuit card. Interconnections between the circuits were made by conducting strips evaporated through a mask.

In 1967 RCA delivered a solid state camera to the American Air Force in which the imaging array consisted of 180 × 180 (32,400) photoconductors on 0·05mm centres. This camera was about the same size as a 35mm camera and was powered by a self-contained 14 volt battery. It was connected to the receiver by a u.h.f. link. By 1969 RCA had built a camera with 65,000 imaging elements. However, processing techniques were still at the research stage and the devices were unstable.

SCANNING THE ARRAY

Whether the imaging elements are photoconductors or silicon junction devices a switch is needed to connect them to the video amplifier once in each frame period. The junction capacitance of a diode or transistor is simultaneously recharged.

One approach is to make each element in the array two back to back diodes. One diode is the photodetector and the other is the switch. When voltage pulses are applied to the element the diode switch is forward biased and of low resistance, allowing the junction capacitance of the reverse biased diode to recharge.

Two back to back diodes are equivalent to a transistor with its base open circuit, and transistors have been used in the dual role of detector and switch. The collector-base junction acts as the light detector and the emitter-base junction as the switch.

An alternative switch is the metal-oxide-semiconductor (MOS) transistor (Fig. 1). This is a high resistivity silicon substrate into which two *p*-type diffusions have been made. These are called the source and drain and are separated by a channel which is covered with an insulator, silicon dioxide, and a metal electrode called the gate.

With no voltage applied to the gate, negligible current flows between the source and drain. When a negative voltage is applied, positive current carriers or holes are drawn into the channel increasing its conductance and allowing current to flow.

Whether the switch is a diode or MOS transistor a shift register provides the scanning voltage pulse. For a two dimensional array, pulses from X and Y registers coincide at each element in turn to connect it to the video amplifier (Fig. 2).

Each stage of the shift register consists of two dynamic inverters. A voltage pulse injected at the first stage will progress through the register as clocking pulses are applied alternately to each inverter. The outputs are taken from alternate inverter stages in the register. The clock pulses are obtained from a master pulse generator which is either on the same chip as the scanning circuit or external to it.

When one voltage pulse is moving through the shift register it is essential that it should reach the last stage before another is injected. This is achieved by feeding back the output from each stage except the last through a logic circuit called a NOR gate. This only allows a new pulse to be injected when no feedback pulse is obtained.

DISADVANTAGES

Imaging arrays for commercial broadcasting would need 250,000 close-spaced elements to give acceptable picture quality. By the early seventies integrated arrays of up to 10,000 silicon photodiodes with vertical and horizontal scanning circuits could be made. The main limitations were the size of the slice that could be produced with acceptable yield, and the processing technology.

There is also a fundamental noise problem with these systems. When each element is connected to the video amplifier, noise spikes are produced by the voltage pulses from the scanning circuits.

CHARGE-COUPLED DEVICES

A significant advance was made in 1970 with the invention of the silicon charge-coupled device (CCD) at Bell Telephone Laboratories. These devices use conventional silicon technology but are simpler to make than diode or transistor arrays. This allows smaller elements with closer spacing to be made. In addition coupling between the scanning circuit and the video amplifier can be completely eliminated.

A two dimensional array of CCDs is shown in Fig. 3. It consists of a slice of *p*-type silicon with a silicon dioxide insulating layer covering the whole surface. On top of the oxide a two dimensional pattern of metal electrodes is deposited.

Each element in the array consists of three adjacent electrodes in each vertical column. A positive voltage of about 10 volts is normally applied to the centre electrode (P2) of each element, and 1 volt to the electrode above and below. The array is divided into an imaging area and a storage area.

When light is incident on the imaging area, photo-excited electrons will accumulate under the P2 electrode of each element because of its higher positive voltage. Once in each frame period this accumulated charge is transferred to the storage area (Fig. 4).

This is done by raising the P3 electrode in each group to 10 volts and gradually reducing the P2 electrode to 1 volt. All the stored electrons move down one row to the more positive P3 electrodes.

Next the P1 electrodes are raised to 10 volts and the P3 electrodes gradually reduced to 1 volt. The stored electrons again move down one row. This process is repeated until all the charge reaches the storage area. From here it is moved line by line into the serial readout section and transferred to the video output. Coupling between the scanning circuits and the video output is prevented by a positively biased gate after the last stage of the serial readout.

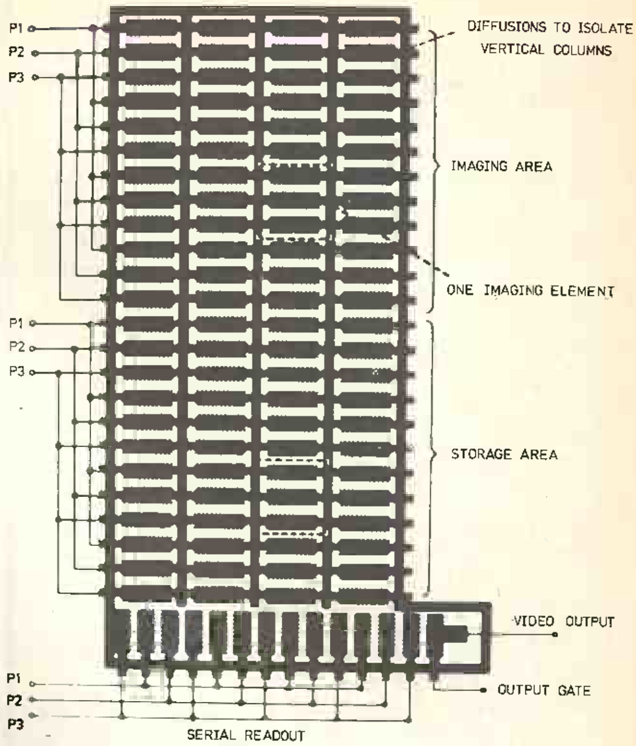


Fig. 3. Layout of charge-coupled imaging array

INTERLACING

Conventional television cameras use a picture scanning technique called interlacing to reduce flicker. The focused image of the scene is scanned in a series of horizontal sweeps every twenty-fifth of a second.

If the horizontal sweeps are numbered from top to bottom the odd numbered sweeps are made in the first fiftieth of a second and the even numbered sweeps in the second fiftieth of a second.

Interlacing is achieved with CCD arrays in the following way. In the first fiftieth of a second, charge is accumulated under the P2 electrode and then transferred to the storage area and the video output as described above. In the second fiftieth of a second, charge is accumulated simultaneously under the P3 and P1 electrodes and transferred to the storage area and output.

Accumulating charge under the P3 and P1 electrodes is equivalent to scanning along a line mid-way between them. Since this line is also mid-way between the P2 electrodes the desired interlacing effect is achieved.

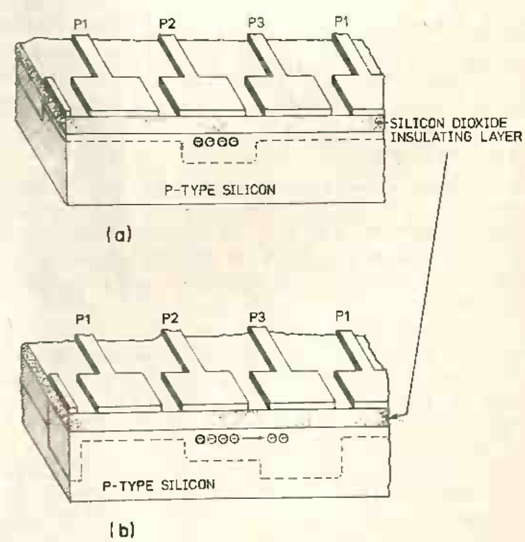


Fig. 4. (a) When light is incident on a CCD imaging array photo-excited electrons are accumulated under the centre electrode in each element because of its higher positive voltage. (b) Once in each frame period the accumulated charge is transferred to the storage area by sequentially adjusting the positive voltage on each electrode

CCD CAMERAS

Bell Telephone Laboratories have demonstrated both monochrome and colour transmission with CCD cameras. However, only monochrome cameras are commercially available.

In 1974 Fairchild became the first company to market CCD cameras. The model shown in the photograph is 76mm diameter, 48mm long and weighs 11 ounces. The light sensitive area is a 100 × 100 array with each element 0·03mm by 0·02mm on 0·03mm vertical and 0·04mm horizontal centres.

The Fairchild TV camera using a charge-coupled imaging array (courtesy Fairchild Corporation)

The array is mounted on a 24-pin dual in line package with an optical glass window.

The camera uses interlaced scanning, produces nine grey tones and, since the imaging array is silicon, is sensitive into the near infra-red. The power consumption is 1·5 watts with all operating potentials less than 20 volts.

RCA are now marketing a CCD camera with a resolution comparable with a ⅔in vidicon and capable of producing a usable picture with one third the scene illumination required by the vidicon. The imaging array contains 320 vertical columns each with 256 sensing elements 0·03mm square. The effective number of vertical resolution elements is increased to 512 by interlacing.

As with the Fairchild camera the silicon imaging array is mounted on a hermetically sealed 24-pin dual in line package with an optical glass window. The camera weighs 2·5lbs and the power requirement is 4 watts at 12 volts.

APPLICATIONS

Since these cameras can work with low levels of illumination they are suitable for security surveillance in commerce and industry. In industry they can be used to monitor processes in hostile environments, for example where high pressures or poisonous gases are involved.

Solid state imaging systems are already being used to transfer data into computers. In some American cities they are used to sort mail since they are faster and more accurate than manual sorting. The performance of available systems is also adequate for page and document reading.

Transmitting images of documents and drawings is one of the aims of the Picturephone system being developed at Bell Telephone Laboratories. By using a miniature camera and television display the Picturephone allows subscribers to both see and hear one another.

In the immediate future solid state imaging systems will only reach a specialist market. However, as advances in technology and increased demand reduce prices, hand-held TV cameras may become as widely used in the 1980s as photographic cameras are today. ★

NEWS BRIEFS

TV Import Restrictions

FOLLOWING strong representations from British set makers, the government has decided to restrict imports of portable monochrome TV sets from Taiwan to a level of 70,000 sets during a 15 month period, commencing from October 1, 1976. This restriction applies to sets with cathode-ray tubes having a bulb diagonal measurement of 39cm or less.

Transistorised television receivers originating in or consigned to the United Kingdom from the Eastern Area (which comprises Albania, Bulgaria, Czechoslovakia, The German Democratic Republic and Berlin (East), Hungary, North Korea, North Vietnam, The People's Republic of China, The People's Republic of Mongolia, Poland, Romania and The Union of Soviet Socialist Republics) are already subject to quota licensing arrangements which are unaffected by the new restrictions.

Code of Practice

GOOD news for the consumer is the setting up and publication of a "Code of Practice" by the Radio, Electrical and Television Retailers' Association (RETRA). Contained in a 12-page booklet, the Code was drawn up in consultation with the Office of Fair Trading and other professional bodies. The Code will be operated by over 4,000 member outlets, from the one man business to the larger independent High Street retailer and multiple companies.

Some of the subjects covered in the Code are pricing, refunds, deposits, retailer's guarantee, repairs and servicing, and guarantee of repairs.

On the touchy subject of repairs, the Code stipulates specific time limits within which retailers must complete repairs. It is claimed that 80 per cent of repairs undertaken in the workshop will be completed within five working days.

Many dealers will be able to finish repairs undertaken in the home on the same day but if this proves to be impossible, then 15 working days is laid down as the maximum time to effect a repair under normal working conditions. All repairs will be guaranteed for a minimum of three months for parts fitted and workmanship.

If there is any delay, or a repair cannot be made, the retailer will ensure that his customer is kept fully informed of the reason.

Copies of the "Code of Practice" have been distributed to such bodies as the Citizens Advice Bureau, Local Authorities, Chief Trading Standards and County Consumer Protection Officers. Also, copies can be obtained from any RETRA dealer or direct from The Secretary, Radio, Electrical and Television Retailer's Association (RETRA) Ltd., 100 St Martin's Lane, London, WC2N 4BD. (s.a.e.)

Overseas Symposium & Exhibition

THE 2nd Electromagnetic Compatibility Symposium and Exhibition will be held from June 28 to 30, 1977 at Montreux, Switzerland.

The forthcoming conference will again be aimed at the problems of interaction of r.f. energy with electrical and biological systems, spectrum pollution and system immunity or, "protection of the electromagnetic environment".

Papers (in English) covering the above fields of research should be sent to Prof. Dr. F. L. Stumpers, Elzentlaan 11, Eindhoven, Netherlands. The last date for papers is October 30, 1976.

Further details of the exhibition can be obtained from the Secretary General, T. Dvorak, EMC Symposium & Exhibition, Montreux, Switzerland.

MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

MICROPROCESSOR KITS

Elsewhere in this issue we are printing a special article on "Getting to Grips with Microprocessors" and a review of a recent "Microprocessor Symposium". In one of the articles it recommends that readers should "get their feet wet" as practical experience is far more informative than becoming too immersed in the theory.

This comment has been taken up by **A. Marshall (London) Ltd.**, who are stocking the SC/MP microprocessor kit discussed in the article, and **Limrose Electronics**.

The Marshall's SC/MP kit will sell for £122·22, plus 8% VAT. The kit consists of the Introkit (£62·37, plus 8% VAT) and the Keyboard kit which will retail for £59·85, plus 8% VAT. For further details readers should write to **A. Marshall (London) Ltd. (Dept. P.E.), 42 Cricklewood Broadway, NW2 3ET.**

A fast and an inexpensive way to develop a fundamental understanding of microprocessors is claimed for the Microtutor 8080 from Limrose Electronics.

The claim is that the 8080 gives you "hands on" experience necessary to master microprocessors. However, it is not just a learning module, it is a full 8-bit microcomputer with an 8080 CPU, lk × 8-bit Random Access Memory, an input port, an output port, an interrupt instruction port and a status port.

Also, with facilities for manual loading of the memory and for single stepping, the processor can be used as a prototyping computer for development of applications software and can be expanded with additional memory and a Teletype interface, using plug-in cards for more advanced work.

All important signals, data bits and addresses are continuously displayed using over 40 l.e.d. indicators. Inputs are provided on several switch registers and pushbutton switches. The data paths, and how they relate to various registers, are clearly shown on the front panel of the unit.

By following the instruction book provided with the Microtutor, it is claimed, a person with limited technical knowledge can rapidly learn how microprocessors work. Trained electronics engineers can quickly bridge the gap between conventional hardware and microprocessor software by making a step-by-step progression from developing simple alogrithms to complex programmes.

The Microtutor 8080 is available fully tested and assembled for £249, single units. Further information can be obtained from **Limrose Electronics Ltd. (Dept. P.E.), 241–243 Manchester Road, Northwich, Cheshire.**

LEARNING AID

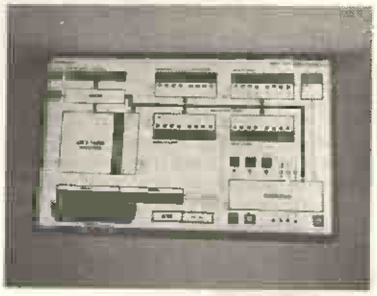
As a Christmas present with a difference we suggest the "Little Professor", a calculator-based learning aid with preprogrammed basic math problems for children (age group 6 to 9) now being marketed by **Texas Instruments.** This 16-key machine has addition, subtraction, multiplication and division sequences in variable degrees of difficulty.

Problems can be selected according to degree of difficulty by the user. Once the type of problem and degree of difficulty is selected, the machine presents the problem (with function and equal sign) in the large v.l.e.d. display. The user keys in an answer, if correct the complete equation appears for one second and then the next problem in sequence is displayed. If incorrect the problem reappears.

If a wrong answer is entered three times, the "Prof" automatically displays the correct answer. The answer remains in the display until the user presses the "go" key. If the next problem is also answered incorrectly three times, the correct answer would again be displayed.

The machine will, after ten problems, display a score out of ten. This "score" display would be followed by the next set of problems in sequence.

Addresses of nearest stockists and price of the Texas "Little Professor" can be obtained from **Texas Instruments Ltd., Calculator Division (Dept. P.E.), Block C, Manton Centre, Manton Lane, Bedford, MK41 7PU.**



The Microtutor 8080 from Limrose

Texas "Little Professor"

AM/FM Stereo Tuner from Eagle

AM/FM STEREO TUNER

The new a.m./f.m. stereo tuner now being marketed by **Eagle International** is a low cost unit which is claimed to match virtually any amplifier. The AA102 is based on Eagle's TST152 and retains a number of features including wide range, switchable a.f.c., stereo indicator beacon, noise filter and variable output to avoid mismatch.

The **AA102** has a frequency response of 25Hz to 14kHz ±2dB. The sensitivity for 30dB quieting is better than 7μV and total harmonic distortion is less than 0·8 per cent. The signal to noise ratio is better than 54dB.

Backed by Eagle's two year guarantee and complete after sales service the AA102 recommended retail price is £52, plus VAT.

CATALOGUE

A new catalogue from **General Instrument Microelectronics** gives comprehensive details of their current range of over 200 MOS/LSI microcircuits. Applications covered are calculators, clocks, radio, television, TV games, electronic organs, appliance timers, telecommunications, data communications, counters and digital meters, microprocessors, RAMs, EAROMs, ROMs, and keyboard encoders and character generators.

Entitled MOS Data 1976 and priced £1·50, the catalogue is available from GIM distributors (including **SDS Components Ltd., Hilsea Industrial Estate, Portsmouth, Hants. PO3 5JW).**

In our October issue we mentioned the excellent catalogue from Marshall's and the fact that an error had crept into the case outline drawings. This has now been corrected and Marshall's are now issuing a "stick-in" amendment page.

Copies of the amendment page can be obtained from A. Marshall (London) Ltd., 42, Cricklewood Broadway, NW2 3ET.

Strictly Instrumental

by K. Lenton-Smith

LAST August's British Musical Instruments Trade Fair—surely International rather than British—offered a number of new models, though the mixture was largely as before. Indeed, the common denominator is now so strong that it is difficult to differentiate between one organ and another once reverberation and the inevitable Leslie have been switched in.

SHARP'S THE WORD

I was highly tempted by the large Kawai organ being demonstrated by Brian Sharp. He was showing his audience how to cope with three manuals with only two hands—by playing the synthesiser with his nose. Fortunately, Brian's nose lives up to his name! The idea of inscribing the waveform on controls seems eminently sensible where electronic music is deviating increasingly from the conventional.

Wurlitzer were showing an unusual electric piano, where the cabinet was arranged as a miniature baby-grand containing the electro-mechanical and speaker systems. The sound was good but the selling point in the U.S. is equally its attraction as a fine piece of furniture.

The Hammond Aurora is a very pleasant instrument to play, with an excellent poly-synthesised percussion piano sound. The Auto-Vari Rhythm Unit, which I referred to in the April issue, is fitted to this model. Despite the multiple-derivative-divider used in this series of Hammonds, voicing closely approaches the older tone-wheel instruments. But I find that the drawbar settings have to be slightly different with m.d.d. models.

The Japanese-made Hammond X-5, though falling short of the U.S. manufactured organs tonally, represents good value and is suited particularly to the combo player on grounds of portability. The highest compliment to Hammond is the use of their drawbar system by other manufacturers. On this stand, the "Old Organ Grinder" Robin Richmond was seen taking an active interest in the Aurora: it is incredible to me how Robin's voice belies his age and experience in the organ field!

SOUND DESIGN

I suspect that a number of readers have still not seen the very useful P.E. publication *Sound Design*. Although convenient to have complete projects in one volume—to save thumbing through the series in back copies—the more important fact is that there has been up-dating, particularly with regard to the Minisonic. Douglas Shaw's original design had the younger constructor in mind, but it was soon to appeal to a wider range of readers. Since then, the Minisonic has been the study of a group of musicians and Synthesiser Musical Services and also republished in *Sound Design* as the Minisonic Mk. II.

MINISONIC

Ignoring the other projects in this book, the major changes to the Minisonic should be mentioned. The v.c.o.s have been greatly improved and phase-locking added: the phase lock helps enormously when using the Ring Modulator, of course, making for accurate tracking with a fixed interval between v.c.o.s. The Hold circuit of the original version was somewhat unstable and has been improved in the Mk. II by using a FETMOPA and a reed relay to reduce loading on the Hold capacitor. Modification of the Envelope Shapers includes visual indication of the envelopes by means of l.e.d.s. The $\pm$6V supplies are now derived from the power pack through separate transistors, minor changes being made to the Ring Modulator, Noise Generator and Keyboard Controller.

From the playing aspect, inconvenient patch cords (which get tangled with fingers and playing keys at the wrong moment) have been replaced by press-button switches. *Sound Design* gives modification data for original owners, the Mk. II version adding up to a reliable and useful small synthesiser. With printed circuit boards readily available for the Mk. II Minisonic, I suggest readers send for their copy of *Sound Design* before it goes out of print: this is available for £1·20, post paid, from Practical Electronics, IPC Magazines Ltd., Receiving Cashiers Dept., Kings Reach Tower, Stamford Street, London SE1 9LS.

THE ALLEN ORGAN

We must now differentiate between Allen organs, for this time the reference is to Model MES 53, designed by Roger Allen of Maplin Electronic Supplies and frequently mentioned on the back page of this magazine. The MES 53 was recently demonstrated to the London meeting of the Electronic Organ Constructors Society with great success: a full scale account of this organ by Alan Douglas will appear in P.E. shortly.

EOCS members were most impressed by this instrument. Minor criticisms were on layout of the controls only, a point totally at the constructor's discretion. This instrument has drawbars and rocker tabs, with attack/decay and seven keyed pitches on each manual. Individual voices were up to professional standards, whilst the total lack of "beehive" effect was considerably better than most commercial instruments. The Society's demonstrators put the MES 53 through its paces, to the delight of members, and summed it up as a very good organ indeed. Roger Allen is to be congratulated on his excellent circuitry, and Maplin on the price of the kit for such a comprehensive instrument. Readers further interested should write to Maplin Electronic Supplies for their leaflet MES 53.

GENERATION GAME

Mr. Francis T. Chambers of Ballycroy, Co. Mayo has written to me to describe his multi-recording technique, using a four-channel recorder, for synthesiser build-up. His machine has four sets of record, play and erase heads and by using the low quality 'playback' signal from an unused record head he can obtain synchronous monitoring. He uses a carefully planned sequence of mixing and recording and believes that ten good quality voices are obtainable.

Four of these are reserved for the more important voices and are first generation (i.e., direct) recordings, the remaining six being second generation (re-recordings). Space does not allow publication of his sequence chart, but a recording plan that minimises re-recording is always well worth while if a multi-channel machine is available.

A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

CAR LAMP FILAMENT MONITOR

THIS simple design (Fig. 1) gives a constant indication of the condition of a car lamp filament, regardless of whether it is switched on or off. Now that the law requires the obligatory car lamps to be in good order, day or night, this is a useful safeguard.

Transistor TR1 is used as an electronic switch. Taking first the case where the lamp is switched off; if the filament is intact, the base of TR1 is grounded and the transistor cut off. This means that point A is approximately at the potential of the positive supply rail, and the red l.e.d. D1 is "off". The green l.e.d. D2 conducts, however, and is lit to show that the lamp is healthy.

If the lamp filament goes open circuit, TR1 conducts and D1 is lit to show that the bulb has failed. The potential at point A is approximately 0·7 volts ($V_{ce} - V_d$), and D2 is therefore extinguished.

Two components have been included to allow the circuit to continue to function when the lamp is switched on. These are RLA, comprising a normally-open reed switch and a specially wound operating coil, and the germanium diode D3. The latter prevents the lamp supply being applied to the base of TR1. The lamp operating current flows through the coil of RLA, the contacts of which ground the base of TR1 provided the lamp is intact.

The reed switch requires approximately 40–50 ampere turns to operate, therefore the operating coil should be wound with 20 turns of 18 s.w.g. for headlamps, and with 40–80 turns of 22 s.w.g. for other lamps, depending on their power. The total current consumption of the unit is less than 12mA.

T. H. Gibson,
Barnsley.

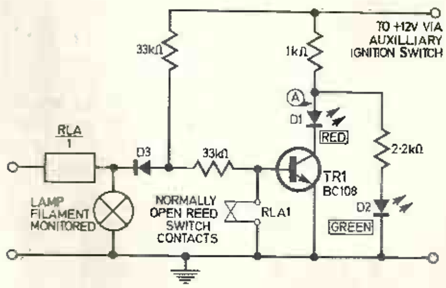


Fig. 1

SIMPLE TIMER

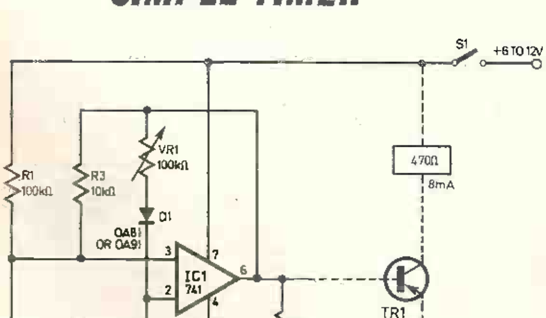
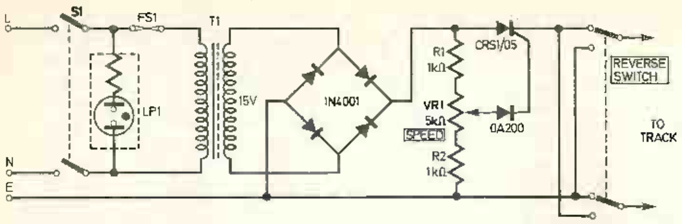


Fig. 1

THIS timer will drive a light emitting diode direct from the output of IC1 via a 1kΩ limiting resistor, or it will operate a relay with the addition of a suitable transistor.

The 741 i.c. acts as a multivibrator, the timing interval being determined by the variable resistor VR1, C1 and D1. The diode is necessary to prevent the multivibrator running continuously. With the component values shown, the timing interval is variable over the range from about one second to 75 seconds. Maximum current consumption is 15mA.

M. P. Wilson,
Oswestry,
Salop.



MODEL TRAIN SPEED CONTROLLER

Fig. 1

THE circuit of Fig. 1 is extremely simple and has proved to be very reliable also. Variation of the SPEED control alters the conducting period of the thyristor, so producing varying pulse lengths. The torque of the motor remains constant, however.

The components are not at all critical. The thyristor rating should be sufficient to pass 1 ampere per engine controlled. The resistors R1 and R2 control the "dead zones" of the potentiometer VR1: the values shown are suitable for a CRS1/05 and may have to be altered for other thyristors.

P. D. Johnson,
Chelmsford,
Essex.

L.E.D. VU METER

THE basis of this circuit (Fig. 1) is a Hex Schmitt trigger i.c. the SN7414. The unit is connected to the loudspeaker terminals of an amplifier and requires a minimum of 16V peak signal. If the unit is required to monitor lower signal levels a simple voltage amplifier using an op. amp could be used to boost the signal up to this level.

The main advantages of the l.e.d. VU meter are its ease of reading, fast response without overshoot and in this case, cheapness.

The loudspeaker voltage is first rectified and then divided down by the preset. The resistor divider networks are so calculated that for 3dB increase in power the threshold of another Schmitt is reached.

Calibration is done by driving the amplifier to clipping and adjusting the preset until all the l.e.d.s just come on. The +3dB light then corresponds to full power, the 0dB to half power, the −3dB to quarter power etc. The unit can be extended to −18dB by using an extra i.c. and the components shown in the box. For a little extra cost different coloured l.e.d.s can be used (green, orange etc.). The value of R is given by (the +ve rail voltage × 10) Ω. The value of C is chosen to suit the attack and decay time desired and can be between 0 and 100μF.

J. S. Broadhurst,
Northwich.

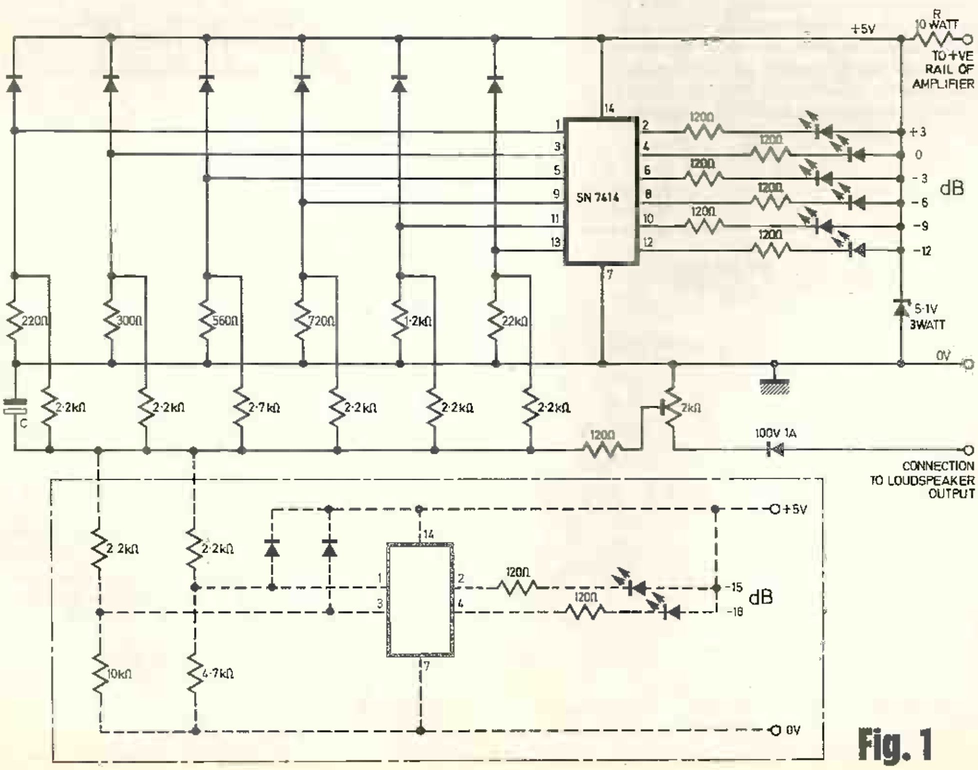


Fig. 1

QUIZ MONITOR

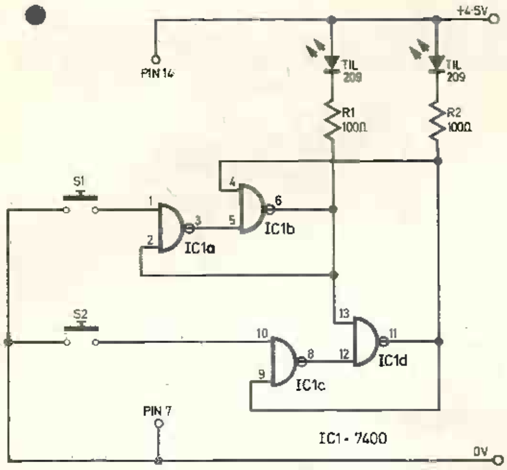


Fig. 1

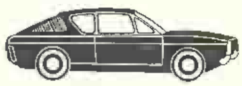
The circuit in Fig. 1 is of a two station latching quiz monitor, with l.e.d. indication.

The circuit is built around a 7400 quad two input NAND gate. Two gates are used to make each latch. When one of the buttons S1 or S2 is pressed its corresponding latch will latch. The output drives an l.e.d. via a current limiting resistor (R1 or R2) and is also fed to the reset input of the other latch. This arrangement ensures that the first person to press their button is indicated, and the second is eliminated.

The circuit can be increased to as many stations as required. For more stations use a gate with the required amount of inputs for the l.e.d. driver gates, and a two input gate for the other gate in each latch.

C. F. Shorto,
Weymouth.

CAR SIREN



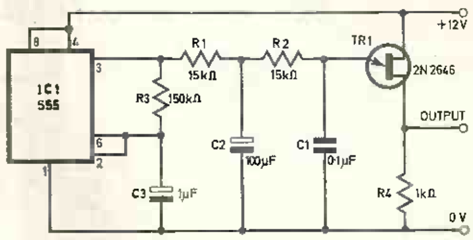


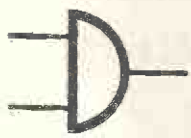
Fig. 1

The circuit shown in Fig. 1 is for an electronic siren; it was designed for use in a car burglar alarm. As a car horn is a commonplace sound, I thought that a siren was a good way of making a distinctive noise.

The unijunction transistor 2N2646 is employed as a relaxation oscillator R2 and C1 determining the tone. The IC is a 555 timer, and here it is employed in an astable mode, the output pulses being fed to the oscillator from pin three via R1. Using the values given for R3 and C3, a pulse is given out about every half second, giving the siren its wailing sound. If the output is fed into a 5 watt amplifier driving a re-entrant horn speaker it can be heard several streets away, and is sure to give the would-be burglar second thoughts.

P. Jones,
Gower.

"PRESET-TO-ONE" COUNTER



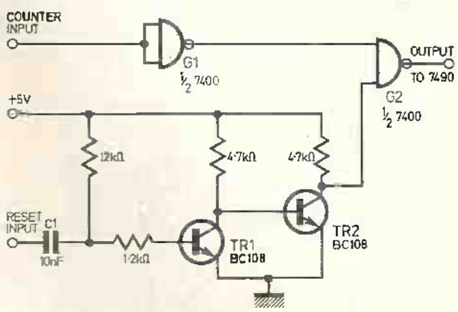


Fig. 1

In certain counting operations it is necessary to have a counter which, on reset, starts counting from one rather than the more normal zero. A common example occurs in calendars, where both the day and month counts must be reset to one at the end of the month or year. The hour counter in twelve hour digital clocks must also reset to one. As simple decade counters such as the 7490 reset to zero, the more expensive presettable counters such as the 74163 are normally used. Fig. 1 shows a circuit which uses a 7490 in a "preset-to-one" mode, and is suitable for low-speed counting uses.

The reset input is connected to an output of the counter which before reset is at logic 1, and after reset is at logic 0. This output must only go high once during the count cycle. An example is the tens of months output of a calendar, which is high only for months 10, 11 and 12 in each year. When the reset input goes low, G2 receives a short negative-going pulse from the collector of TR2. The counter input is low after reset, so the output of G1 and the input of G2 are high. The negative pulse at G2 therefore causes a positive pulse at the output. This advances the count on the decade counter from zero to one.

John Cowking,
Ambleside,
Cumbria.

VARIABLE CHANCE RATIO DEVICE

THE circuit (Fig. 1) consists of an astable producing a square wave, which, when the spin button is depressed, is fed into a bistable. The l.e.d.s will indicate heads or tails depending on the state of the bistable when the button is released.

The circuit was originally developed for use as an electronic coin tosser, however, by varying the value of one of the timing resistors the mark/space ratio of the square wave can be altered thereby changing the chance ratio. In the original device the 10kΩ resistor was a preset so an accurate ratio could be set and left unaltered, however, it could take the form of a panel mounted control. Ratios of between 1:1 and 1:4 can be obtained. When setting or calibrating the resistor the spin button should be depressed as resistances in the bistable will also affect the mark/space ratio and should be compensated for.

N. H. Quick,
Bristol.

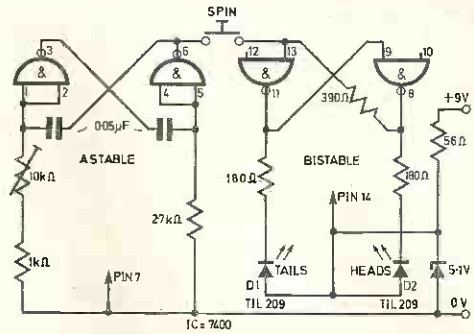


Fig. 1

VOLTMETER IMPEDANCE MULTIPLIER

IT is often necessary to take voltage readings around transistor circuits, for example when fault finding, where an ordinary voltmeter is not suitable due to its low resistance. A "front end" which effectively increases the input impedance of the meter is desirable, and the arrangement of Fig. 1 was evolved for this purpose.

The circuit is simply a voltage follower using a 741 operational amplifier, producing an input impedance of the order of 2 megohms. With the input lead floating, the output took up a potential of about −6·5V.

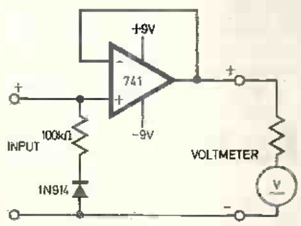


Fig. 1

This problem was overcome by providing a high resistance return path to ground for the input, and this is the function of the 1N914 diode which should have very low leakage.

With ±9 volt supplies, the linear range should extend to about 7·5 volts. With ±15 volt supplies this should go up to about 12 volts. Input overload protection can be incorporated by connecting two Zener diodes back to back in series across the input terminals.

T. K. Wong,
Plymouth.

TELL-TALE ALARM

THIS circuit (Fig. 1) is intended to operate a warning light or bell if someone such as a burglar enters a darkened room using a torch. When light from the torch falls on the light dependent resistor, R1, its resistance decreases, reducing the forward bias on the base of TR1. The rise in voltage at TR1 collector then turns on TR2, lighting the warning lamp LP1.

Once the circuit has been actuated, it will remain in the "alarm" state until the RESET button, S1, is pressed. The level of light at which the circuit operates can be set by means of VR1.

T. Robinson,
Malton,
Yorks.

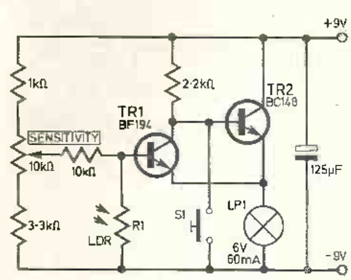


Fig. 1

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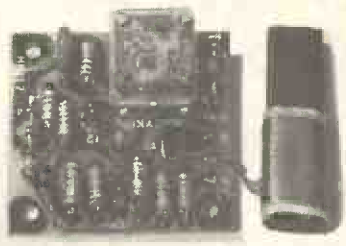

HF 61 is an extended diode receiver for mediumwave-reception. By means of a very simple technique a reasonable reception even from foreign medium stations is attained.
HF 61 is built on a small circuit board of the same size as the general purpose amplifier AF 380. The two assemblies should be connected to produce power for a loudspeaker.
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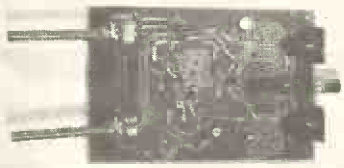

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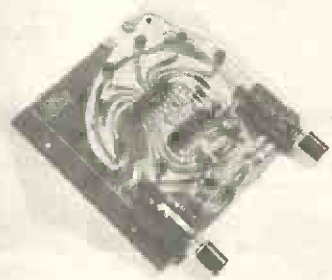

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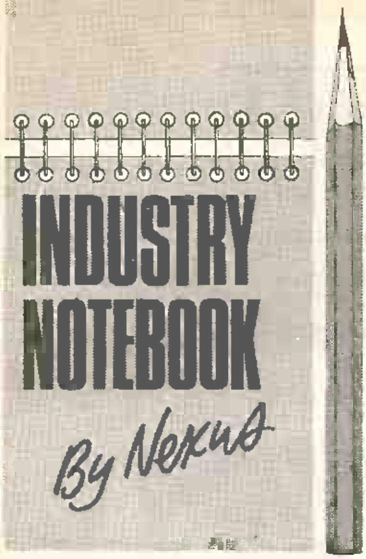


COST OF TRAVEL

Getting my bags packed in readiness to attend yet another international conference I came across some interesting statistics on the conference business—said to be the fastest growing sector of international travel.

As a patriot I was pleased to discover that the United Kingdom is Number One conference country in Europe, with Europe itself being the leading continent with (in 1974) 70% of all the world's conferences. North America is second with only 15%.

Another interesting fact was that the average delegate, excluding travel and registration fees spends, and I quote the figure for London, £26 per day. Although it has always been a puzzle to me on how my cash disappears at these functions I'm glad to report that I must be a model of economy or just plain mean, because even my most reckless days are generally below the average.

The growth rate in conferences is such that for London alone the forecast for 1980 is that they will attract a million people who will spend some £140 million. On a world scale the projection is that 15,500 international conventions and conferences will be held in 1980 and attended by 10·5 million people.

But sending delegates to business, scientific or engineering conferences is only a small part of a company's travel budget. Most are big spenders and the biggest of all are multinationals with executives thinking nothing of several transatlantic trips a year. On high density routes like London–Brussels or the internal London–Edinburgh flights it's hard to travel without meeting someone you know in the electronics business. All of it seemingly essential, even at over £40 return to Edinburgh, over £70 return to Brussels plus hotels, meals and getting to and from the airport.

Are their journeys really necessary? Perhaps not all, but how do you measure the pay-off? Racal Electronics Group with a world wide business in over 130 countries makes no secret of spending over £1 million a year on travel and expenses of sales engineers.

SELLING TIME

The high cost of travel is one of the factors that is changing business methods. If you're in the big league then you may well be able to absorb all the costs of sending your own people into the world. For smaller businesses it can be a crippling expense. Hence the increasing use of agents overseas who do the selling for you and of wholesalers or distributors at home, some of whom have become highly specialised.

One such specialist is Electroplan, distributing electronic instruments and accessories. It is part of the Electrocomponents Group which, before it went public, was universally known as Radiospares with that part of the business still flourishing today under the name RS Components Ltd. Electroplan, formed four years ago, acquired Dave Hall as managing director a year ago, and he has just completed a re-organisation of the product line.

The whole of the Electroplan business is based on the cost of selling and today this is as much the cost of travel as the cost of the salesman himself. To put a good person on the road with a car and expenses now costs between £10,000 and £15,000 a year and taking out non-productive travel and administration time there are about 1,000 hours of actual selling time available in a year at a cost price of £10–15 an hour.

The sales people have to support not only themselves but a whole series of operations behind them such as warehousing, accounts department, test laboratory, after-sales service, and to make a profit Hall says each of the sales force needs to generate business at the rate of £200 per selling hour minimum.

Looked at in this light, what chance has the small man?

ENG (or EJ)

ENG, sometimes called EJ is now the rage among t.v. professionals. The initials stand for Electronic News Gathering and Electronic Journalism through the use of lightweight t.v. cameras Spaceflight t.v. led the way to small is beautiful, and now every major company is in on the act on pedestrian-portable systems, electronics now supplanting the long-established cine camera with all its delay in film processing before the picture could be transmitted.

Probably the smallest and lightest portable colour camera is the Thomson-CSF Microcam with a camera package weighing only eight pounds plus an electronics package which can be slung at waist level weighing another three pounds. With a power consumption of only 20W, the system can be operated in an emergency from flash light cells. The camera can be used for newscasting in real time or even if the event is taped, no re-processing is necessary at the studio.

Exploiting every promotional aspect, Thomson-CSF suggests that the Microcam may well broaden opportunities for women in t.v. journalism, clearly regarding the girls, even in the lib age, as being by far the frailer sex.

But even with heavier models you don't need to be a professional weight lifter to shoot pictures. RCA's TK-76 candid camera weighs 19lb, all in one package without a back-pack. But the Ampex AVR-3 one-man t.v. news system weighs nearly 50lb.

Britain's native contribution to ENG is the Marconi Mk VIII P which is the lightweight portable version of the outstandingly successful Mk VIII "hands-off" automatic studio camera. It weighs 17lb and is thus very manageable on a shoulder mount. After only a year since its introduction to the market it is already in use in the Soviet Union, Yugoslavia, the United States, Australia and Qatar.

Cashing in on the new craze for mobility, Marconi has just designed a "mini" OB vehicle which can shoot on the move, be used as a stationary base for pedestrian news gathering, or as a platform for roof-mounted cameras on tripods. Video and audio mixers, sync generators, colour monitors, waveform monitors are all in the small vehicle and powered from an on-board generator.

While the domestic market for t.v. receivers remains flat, the professional broadcasting side of the business seems to be experiencing a boom. There are still plenty of countries with no t.v. service at all.

Even in recession-ridden Britain, 200 new t.v. relay stations have been introduced by the IBA in the past four years, bringing the total of IBA radio and t.v. stations to 300. Low power relay stations are still opening at the rate of one every week. Nice work for the manufacturers but no extra employment for IBA engineers, whose numbers are no greater today than in 1969 when there were under 50 stations. Nearly all the new stations are unattended, including many high-powered ones.

PATENTS REVIEW...

SOUND/SYNC

BP 1 418 776

The name of Alan Sidi, of Leeds, is well known in home movie circles, and in BP 1 418 776 he describes one of his sound-sync inventions. A sound recording to be synchronised is made on one track of the tape with a conventional pulse track applied during filming on an adjacent track.

The pulses (usually one per film frame) and the sound signals are read by adjacent playback heads of the tape machine (Fig. 1) and the sound signals conventionally reproduced. The pulses are fed to a transistor triggering circuit, which feeds a corresponding train of voltage pulses to a rotating light emitting diode or neon, via slip rings. The neon or l.e.d. 1 is carried by a rotary disc, either mounted on the projector shutter shaft or driven via a Bowden cable link.

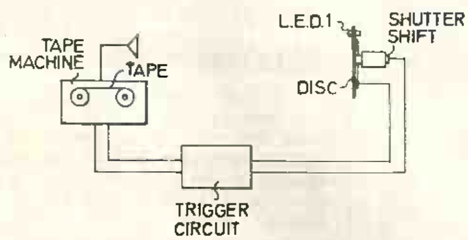
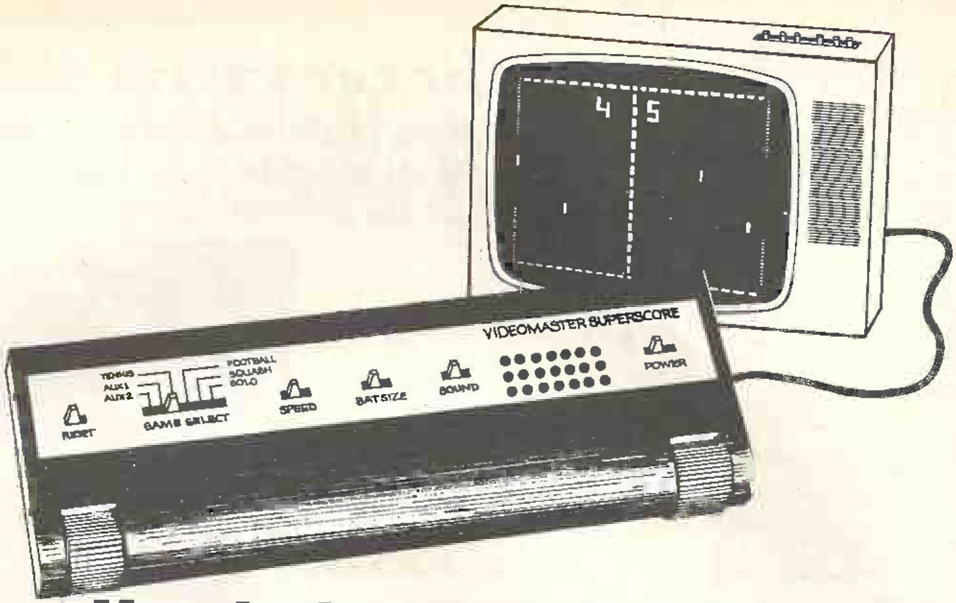


Fig. 1

When the frequency of the pulses from the tape exactly equals the frequency of rotation of the disc (which is directly proportional to the speed at which the film is passing through the projector) the spot of light will appear stationary relative to a stationary pointer outside the circumference of the disc.

If either the projector or the tape recorder is rotating too fast or too slowly the spot of light will appear to "creep" forwards or backwards with respect to the pointer in the manner of a stroboscopic display. Such movement is halted by adjustment of the tape recorder or (preferably) the projector speed, until the light again appears stationary.

Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent Price 75p each



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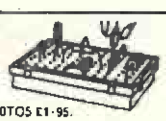

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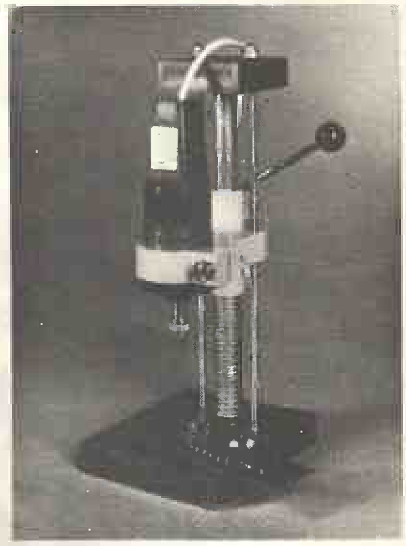

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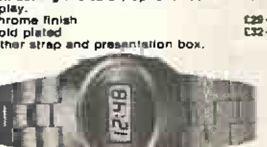

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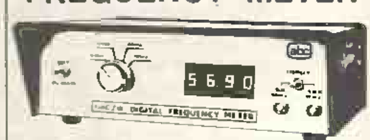

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PRACTICAL

ELECTRONICS

INDEX

JANUARY 1976 TO DECEMBER 1976

VOLUME 12

IPC Magazines Ltd., Fleetway House, Farringdon St., London EC4A 4AD Reg. No. 53626 VOLUME 12

CONSTRUCTIONAL PROJECTS

CONSTRUCTIONAL PROJECTS—*Continued*

GENERAL FEATURES

GENERAL FEATURES—*Continued*

NEWS AND COMMENT

SPECIAL SUPPLEMENTS

SAXON ENTERTAINMENTS LTD

A FULL RANGE OF PRINTED CIRCUIT MODULES FOR ALL P.A. & DISCO & GROUP APPLICATIONS

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Printed circuit module assembled & tested with all components ready mounted.

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* Front panel to suit £3·50

- Mixes two decks, tape and mic.
- Wide-range bass & treble controls on mic. & music channels.
- Variable autofade (mic. override)
- Ample headphone power.
- Needs only front panel* knobs and selector switch.
- Push-pull monitor circuit
- 20HZ–20KHZ—Noise —77dB
- Comprehensive wiring details provided
- Perfect for incorporation in *your* system

ALL PURPOSE CUSTOM—MIXER MODULES (Mono or Stereo)

- Using these modules, mixers may be built to your specification up to 20 Channels, mono or stereo, or a combination of both. System 7000 custom-mixer modules have monitoring facilities too!

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- Accept low/high 2 mics, ceramic & magnetic cartridges, all musical instruments & line signals
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- Echo sound/return etc easily fitted

Mono—IM7001M
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- Only one required per mixer track whether mono or stereo
- Feeds up to ten power modules
- Complete with ½W monitor amplifier
- Accepts up to 20 input modules
- Will match any other make of amplifier

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Stereo—IM7002S **£9·00**

Power supply for up to 20 modules—PPM18 £8·50

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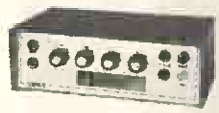
- Individual level controls + master
- RCA 8A Triacs
- 1W–240W input
- Individual channel fuses
- Needs only front panel*

SYSTEM 7000 MINOTAUR 100—All Purpose Wide Range Amplifier



- 100W rms — 1dB
- Standard 8 ohm output
- Twin mixed inputs accept a wide range of signals
- 30HZ–30KHZ ±2dB
- 23dB bass/treble

An extremely compact and versatile amplifier with full protection and a clean, attractive appearance. Ideal for all groups, disco's & clubs

£49·50

A four input, high power amplifier which will deliver up to 150 watts output. An absolute must where multiple mixing & power are required.

- Four individually mixed inputs
- Wide range bass/treble + master

- Vynide covered case
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SAXON 150 HEAVY DUTY AMPLIFIER £59·00

SYSTEM 7000 COMPLETE DISCO MIXERS (with Auto Fade)

*Ready to plug in & use
* Mono or Stereo

The choice of the professional D.J.

Controls: Mic. volume, bass, treble, A/fade depth, tape, L/deck r/deck vols., treble, bass, master, headphones vol., selector, left/right fader.

MONO 18V £37·50 MONO MAINS £43·50

- Automatic mic. override
- Mixes two decks, tape & mic
- Facilities as for modular version opposite
- Mute positions on headphone selector for ease of monitoring
- Two tone stainless steel panel
- Sockets on front & rear panels
- Left/right deck fader
- May be operated from any power supply or from mains

Stereo 18V £53·50
Stereo Mains £59·50

SYSTEM 7000 COMPLETE CUSTOM MIXERS (Mono or Stereo)

- Similar to the modules opposite these mixing modules are complete with front panels, sockets, knobs, monitor switch etc. Up to 20 channels (mono or stereo) may be incorporated in one system with any number of output tracks.

Ideal for the economical & quick assembly of a purpose built mixer with individual channel monitoring, and optional extra facilities—consult our technical dept. to discuss *your* needs.

- Stainless steel panels
- Built-in monitoring
- Will feed all amplifiers
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- Infinitely adaptable

Mono input module	£8·50
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Stereo mixing module	£12·00
Power supply	£8·50

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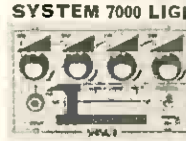

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- Two + Two sequence facility

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- Stainless steel panel
- Heavy duty terminations
- Bondene case
- Matches System 7000 mixers

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SPEAKER KITS

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Complete kits in stock for Radford Studio 90, Radford Monitor 180, Radford Studio 270, Radford Studio 360, Hi-Fi Answers Monitor (Rogers), Hi-Fi News No Compromise (Frisby), Hi-Fi News State of the Art, Wireless World Transmission Line (Bailey), Practical Hi-Fi and Audio Monitor (Giles), Practical Hi-Fi and Audio Triangle (Giles), Popular Hi-Fi (Colloms), etc.

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15-240 WATTS!

HY5
Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.) are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropiate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: complete pre-amplifier in single pack, multi-function equalisation; low noise; low distortion; high overload; two simply combined for stereo.
APPLICATIONS: hi-fi; mixers; disco; guitar and organ; public address.
SPECIFICATION: Inputs-magnetic pick-up 3mV; ceramic pick-up 30mV; tuner 100mV; microphone 10mV; auxiliary 3–100mV; input impedance 47kΩ at 1kHz. Outputs—tape 100mV; main output 500mV R.M.S. Active Tone Controls—treble ±12dB at 10kHz, bass ±12dB at 100Hz. Distortion—0·1% at 1kHz; signal/noise ratio 68dB. Overload—38dB on magnetic pick-up. Supply Voltage—±16–50V.

Price £4·75 + 59p VAT. P. & P. free
HY5 mounting board B.1. 48p + 6p VAT. P. & P. free

HY30
15W into 8Ω

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of: I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up to date technology available.

FEATURES: complete kit; low distortion; short, open and thermal protection; easy to build.
APPLICATIONS: updating audio equipment; guitar practice amplifier, test amplifier; audio oscillator.
SPECIFICATION: Output Power—15W R.M.S. into 8Ω. Distortion—0·1% at 15W. Input Sensitivity—500mV. Frequency Response—10Hz–16kHz −3dB.

Price £4·75 + 59p VAT. P. & P. free

AVAILABLE EX STOCK

HY50
25W into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: low distortion; integral heatsink; only five connections; 7 amp output transistors; no external components.
APPLICATIONS: medium power hi-fi systems, low power disco, guitar amplifier.
SPECIFICATION: Input Sensitivity—500mV. Output Power—25W R.M.S. into 8Ω. Load Impedance—4–16Ω. Distortion—0·04% at 25W at 1kHz. Signal/Noise Ratio—75dB. Frequency Response—10Hz–45kHz −3dB. Supply Voltage—±25V. Size—105 × 50 × 25mm.

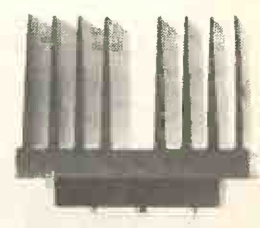
Price £6·20 + 77p VAT. P. & P. free

HY120
60W into 8Ω

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: very low distortion; integral heatsink, load line protection; thermal protection; five connections; no external components.
APPLICATIONS: hi-fi; high quality disco; public address; monitor amplifier; guitar and organ.
SPECIFICATION: Input Sensitivity—500mV. Output Power—60W R.M.S. into 8Ω. Load Impedance—4–16Ω. Distortion—0·04% at 60W at 1kHz. Signal/Noise Ratio—90dB. Frequency Response—10Hz–45kHz −3dB. Supply Voltage—±35V. Size—114 × 50 × 85mm

Price £14·40 + £1·16 VAT. P. & P. free



HY200
120W into 8Ω

The HY200 (now improved to give an output of 120 watts) has been designed to stand the most rugged conditions such as disco or group while still retaining true hi-fi performance.

FEATURES: thermal shutdown; very low distortion; load line protection; integral heatsink; no external components.
APPLICATIONS: hi-fi; disco; monitor; power slave; industrial; public address.
SPECIFICATION: Input Sensitivity—500mV. Output Power—120W R.M.S. into 8Ω. Load Impedance—4–16Ω. Distortion—0·05% at 100W at 1kHz. Signal/Noise Ratio—96dB. Frequency Response—10Hz–45kHz −3dB. Supply Voltage—±45V. Size—114 × 100 × 85mm

Price £21·20 + £1·70 VAT. P. & P. free

HY400
240W into 4Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES thermal shutdown; very low distortion; load line protection; no external components
APPLICATIONS: public address; disco; power slave; industrial.
SPECIFICATION: Output Power—240W R.M.S. into 4Ω. Load Impedance—4–16Ω. Distortion—0·1% at 240W at 1kHz. Signal/Noise Ratio—94dB. Frequency Response—10Hz–45kHz −3dB. Supply Voltage—±45V. Input Sensitivity—500mV. Size—114 × 100 × 85mm.

Price £29·25 + £2·34 VAT. P. & P. free

POWER SUPPLIES: PSU36—suitable for two HY30s £4·75 + 59p VAT. P. & P. free. PSU50—suitable for two HY50s £6·20 + 77p VAT. P. & P. free. PSU70—suitable for two HY120s £12·50 + £1·00 VAT. P. & P. free. PSU90—suitable for one HY200 £11·50 + 92p VAT. P. & P. free PSU180—suitable for two HY200s or one HY400 £21 + £1·68 VAT. P. & P. free.

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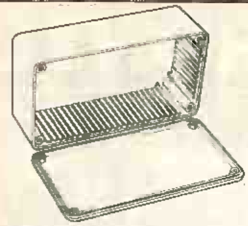

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Easily drilled or punched, grey ABS boxes incorporate slots for 1.5mm pcb's with lid fixing screws running into integral brass bushes

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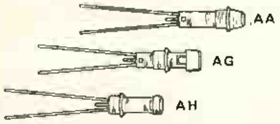

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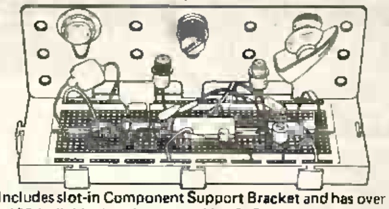

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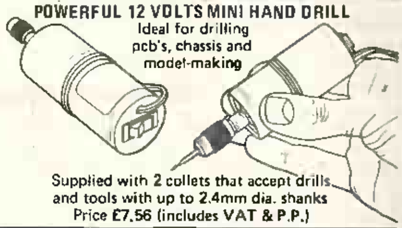

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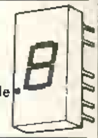

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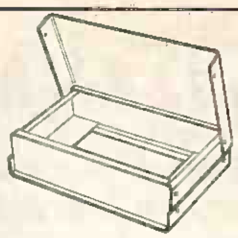

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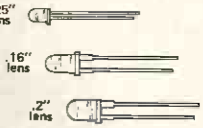

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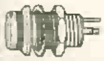

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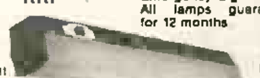

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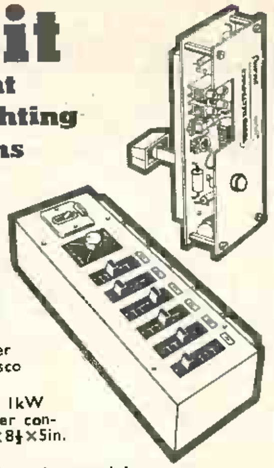

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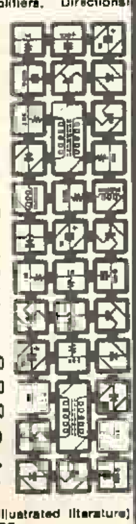

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