PRACTICAL

ELECTRONICS

DECEMBER 1976

40p

RANDOM NUMBER GAMESMACHINE

INDEX FOR VOL. 12

METAL PIPE OR WIRING LOCATOR

PRACTICAL
ELECTRONICS

VOLUME 12 No. 12 DECEMBER 1976

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

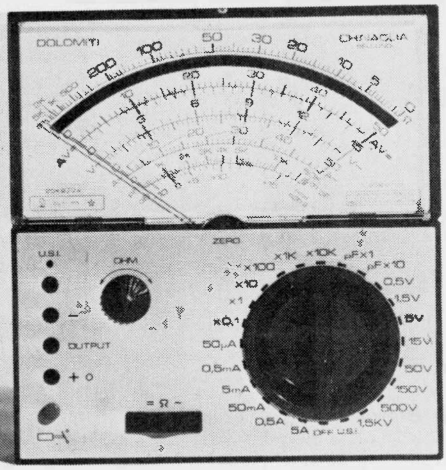
NEWS AND COMMENT

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

FROM THE BIGGEST RANGE OF GOOD QUALITY MULTIMETERS

CHINAGLIA

PRESENT THE



DOLOMITI

20kΩ/V a.c. and d.c.

A NEW HIGH SENSITIVITY MULTIMETER WITH ALL THE FEATURES YOU WILL EVER NEED

Accuracy: d.c. ranges, ±2·0%, a.c. and Ω ranges ±2·5%.
39 ranges: d.c. V, 0–150mV, 500mV, 1·5V, 5V, 15V, 50V, 150V, 500V, 1·5kV. d.c. 1. 0–50μA, 500μA, 5mA, 50mA, 500mA, 5A; a.c. V. 5V, 15V, 50V, 150V, 500V, 1·5kV, a.c. 1. 5mA, 50mA, 500mA, 5A; dB −10 to +65 in 6 ranges; Ω 0–0·5kΩ, 5kΩ, 50kΩ, 500kΩ, 5MΩ, 50MΩ, pF50kpF, 500kpF.

Automatic overload protection and high current range fusing
Scale mirror and fine pointer for accuracy of reading. Single knob main range switching and all panel controls. C.E.I. Class 1 movement with sprung jewel bearings. Extended 92mm scale length for extra clarity. Compact ABS case 125 × 131 × 37mm. Weight 650g with batteries. Supplied complete with carrying case, fused leads, hand-book and full 12-month guarantee. Optional 30kV d.c. probe available.

Meter £40·50 incl. VAT (£1 P. & P.)
30kV Probe £12·85 incl. VAT

For details of this and the many other exciting instruments in the Chinaglia range, including multimeters, component measuring, automotive and electronic instruments, please write or telephone.

ALCON Instruments Ltd.

19 MULBERRY WALK · LONDON SW3 6DZ TEL. 01-352 1897

10,000μF 16VW ELECTROLYTICS. Size $3\frac{1}{8} \times 1\frac{3}{16}$in. at **15p**, 4 for **50p.**
5MHz 10X CRYSTALS. At **50p** each.
POWER TRANSISTORS. MP8512 p.n.p. at **15p**, MP8112 n.p.n. at **15p**, R2008 at **50p**, R2010 at **80p.**
600KHZ 1 OXAJ CRYSTALS. At **50p** each.
DUAL GATE MOS FETS LIKE 40673. At **33p**, 4 for **£1·10.**
TEXAS PNP POWER DARLINGTON TYPE TIL117. At **35p** each.
STC 12V DPDT RELAY. At **50p.**
GLASS WIRE ENDED 28KHz CRYSTALS at **50p.**
1 POLE 21 WAY ROTARY SWITCHES. At **65p.**
1,250 PIV 1A SILICON DIODES. BY294 at 12 for **£1.**
BF177 100V NPN 600MW TRANSISTOR. 10p, 6 for **50p.**
COMPRESSION TRIMMERS. 10PF, 30PF, 50PF, 150PF, 750PF, 1,000PF. All at **6p** each.
B7G GLASS CRYSTALS. 324, 327, 333, 335·5, 338, 339, 341, 342, 345, 346, 348, 349. 350, 352, 354, 355, 359, 358, 370, 382, 386KHz. At **40p** each.
SILICON SOLAR CELLS. 0·5V 5MA at **35p** each.
800V 2A PLASTIC TO3 NPN POWER TRANSISTOR R2600A. At **50p.**
TEXAS PNP DARLINGTON POWER TRANSISTORS TIP117. At **35p.**
2,000 PIV 100MA WIRE ENDED SILICON DIODES. 7 for **£1.**
VHF POWER TRANSISTORS. Unmarked 2N3866 at **40p**, 3 for **£1.**
PLASTIC SCR'S. 50 PIV 6A at **15p**, 400PIV 6A at **40p.**
10A STUD MOUNTING SCR'S. 100PIV at **25p**, 400PIV at **50p**, 800PIV at **60p.**
1,000μF 40VW ELECTROLYTICS. Size $1\frac{1}{2} \times \frac{1}{2}$in. at 3 for **35p.**
SILICON BRIDGES. 100PIV 10A at **83p**, 200PIV 2A at **30p**, 400PIV 1A at **30p.**
TAG ENDED ELECTROLYTICS. Size $2\frac{1}{2} \times 1\frac{5}{8}$in. 3,300μF 64VW at **50p**, 4,700μF 40VW at **45p.**
60 ASSORTED WIRE WOUND RESISTORS. 1 to 10W at **57p.**
200 CARBON FILM $\frac{1}{4}$W RESISTORS. Assorted odd values at **75p.**
100 ASSORTED MIN. $\frac{1}{8}$, $\frac{1}{4}$W RESISTORS. 17 different values at **57p.**
MULLARD 455KHz VERSION OF LP1175 FILTER with Data at **55p.**
TEXAS RF TRANSISTORS TYPE BF224. At 6 for **57p.**
80 METRE 10X CRYSTALS. 3545 at **40p** each.
50 AC128 TRANSISTORS. Branded but untested for **57p.**
10 8μF 300VW ELECTROLYTICS for **57p.**

Please add 20p for post and packing on orders under £2. Overseas orders at cost.

J. BIRKETT
RADIO COMPONENT SUPPLIERS
25 The Strait, Lincoln LN2 1JF
Tel. 20767

"I MADE IT MYSELF"

Imagine the thrill you'll feel! Imagine how impressed people will be when they're hearing a programme on a modern radio you made yourself.

Now! Learn the secrets of radio and electronics by building your own modern transistor radio!

Practical lessons teach you sooner than you would dream possible.

What a wonderful way to learn—and pave the way to a new, better-paid career! No dreary ploughing through page after page of dull facts and figures. With this fascinating Technatron Course, you learn by building!

You build a modern Transistor Radio . . . a Burglar Alarm. You learn Radio and Electronics by doing actual projects you enjoy—making things with your own hands that you'll be proud to own! No wonder it's so fast and easy to learn this way. Because learning becomes a hobby! And what a profitable hobby. Because opportunities in the field of Radio and Electronics are growing faster than they can find people to fill the jobs!

No soldering—yet you learn faster than you ever dreamed possible.

Yes! Faster than you can imagine, you pick up the technical know how you need. Specially prepared step-by-step lessons show you how to: read circuits—assemble components—build things—experiment. You enjoy every minute of it!

You get everything you need. Tools. Components. Even a versatile Multimeter that we teach you how to use. All included in the course. AT NO EXTRA CHARGE! And this is a course anyone can afford. (You can even pay for it by easy instalments.)

So fast, so easy, this personalised course will teach you even if you don't know a thing today!

No matter how little you know now, no matter what your background or education, we'll teach you. Step by step, in simple easy-to-understand language, you pick up the secrets of radio and electronics.

You become a person who makes things, not just another of the millions who don't understand. And you could pave the way to a great new career, to add to the thrill and pride you receive when you look at what you have achieved. Within weeks you could hold in your hand your own transistor radio. And after the course you can go on to acquire highpowered technical qualifications, because our famous courses go right up to City & Guilds levels.

Send now for FREE 44 page book—see how easy it is—read what others say!

Find out more now! This is the gateway to a thrilling new career, or a wonderful hobby you'll enjoy for years. Send the coupon now. There's no obligation.

POST TODAY FOR FREE BOOK

To: ALDERMASTON COLLEGE, DEPT. CPE12 READING RG7 4PF

CPE12

Also at our London Advisory Office, 4 Fore Street Avenue, Moorgate, London EC2Y 5EJ. Tel: 01-628 2721

Yes, I'd like to know more about your course. Please send me free details—plus your big, 44-page book that tells about all your courses.

NAME ....

ADDRESS ....

....

POSTCODE ....

BIET

HOME OF BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY

W:K:F ELECTRONICS

THE P.C.B. SPECIALISTS

PRACTICAL ELECTRONICS "PRINTED CIRCUIT BOARDS" NOW AVAILABLE

TYPE 'A': Made in 1.6mm Epoxy/Glass-fibre, supplied Roll-tinned & drilled.
TYPE 'B': Made in 1.6mm S.R.B.P., supplied Roll-tinned & drilled.

All units available Ex. Stock by return. All prices INCLUDE Post—Pack. and V.A.T.
TERMS: Cash with order. Cheques & P.O.s payable to W.K.F. Electronics.

ISSUE	PROJECT	QTY of P.C.B.s	TYPE 'A' PRICE	TYPE 'B' PRICE
Sept. 1976	Cross-Hatch Generator	1	3.75	—
Sept. 1976	Gas—Smoke Detector	1	2.25	1.65
Sept. 1974	Gas & Smoke Detector	1	—	1.75
JAN. 1975	ORION STEREO 20W AMPLIFIER	1	3.60	2.20
May 1975	I.C. Pulse Generator	1	—	1.40
DEC.-JAN. 1976	50 + 50W GUITAR AMPLIFIER	3	3.25	2.00
JUNE 1976	DIGITAL FREQUENCY METER	4	4.25	3.50
June 1976	Audio Millivolt Meter	2	—	1.60
JUNE-AUG. 1976	RADIO CONTROL SYSTEM	8	5.70	4.30

PRODUCTION SPACE ALWAYS AVAILABLE FOR:

P.C.B. PRODUCTION—ELECTROPLATING—SCREEN PRINTING—TINNING
CONTRACT DRILLING—ANY PHOTOGRAPHIC ART PROCESS

SERVICE FOR:

P.C.B. MASTER PREPARATION + ANY GRAPHIC ARTS PROCESS

FROM:

ROUGH COPIES—EXISTING UNITS—CIRCUIT DIAGRAM
EVEN FELT TIP PEN ON OLD FISH & CHIP PAPER!!

QUOTATIONS FREE OF CHARGE BY RETURN

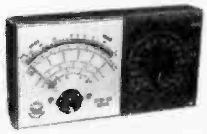
Large discounts given for long runs. Run-on's and repeat orders. Also call-off orders accepted

FOR OUTLINE QUOTATIONS PHONE:
WHITWELL (DERBY'S) 695 (STD 090974)

ALL ORDERS & MAIL TO:
W.K.F. Electronics,
Welbeck Street,
Whitwell, Near Worksop,
Notts.

Test Equipment

Multimeters



The Eagle range of multimeters covers every possible need of the electrical or electronic engineer. They cost from about £6 to £58 (inc V.A.T.). There's at least one which suits your job precisely.

We have a lot of other test equipment too. Send the coupon and we'll send you our complete catalogue.

Please send me details of all your test equipment.

NAME ....

ADDRESS ....

....

....

Eagle International, Precision Centre, Heather Park Drive, Wembley HA0 1SU Tel: (01)-902 8832

Eagle

DISCOUNTS

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

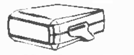
SHIPMENT MADE VIA AIR-POSTAGE PAID
3 DAYS FROM RECEIPT OF ORDER

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

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	74132	·50
7445	75	74141	68		
7446	85	74145	75		
7447	73	74150	59		
7448	80	74151	60		
7450	12	74153	56		

LOW POWER

74L00	£0-16	74L51	£0-16	74L90	£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
74LS20	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	4585A	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	2-21	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	18p	47 mfd	6V	25p
6.8 mfd	6V	18p	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 bread-boarding IC circuitry £1

MISC DEVICES

ULN 2208	FM gain block 34dB 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.	1-50

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

LINEAR CIRCUITS

300	Pos V Reg (super 723) TO-5	£0-49
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
376	Pos V Reg mDIP	38
380	2w Audio Amp DIP	93
380-8	.6w Audio Amp mDIP	1-02
381	Lo Noise Dual preamp DIP	1-13
382	Lo Noise Dual preamp DIP	1-13
531	High Slew rate Op Amp	2-07
540	Power driver TO-5	1-38
550	Prec V Reg DIP	62
555	Timer mDIP	44
556A	Dual 555 Timer DIP	1-02
560	Phase Locked Loop DIP	2-23
562	Phase Locked Loop DIP	2-23
565	Phase Locked Loop DIP TO-5	1-38
566	Function Gen mDIP TO-5	1-38
567	Tone Decoder mDIP	1-38
709	Operational AMP TO-5 or DIP	31
710	Hi Speed Volt Comp DIP	24
711	Dual Difference Compar DIP	51
723	V Reg DIP	44
733	Diff. video AMPL TO-5	63
739	Dual Hi Perf Op Amp DIP	75
741	Comp Op Amp mDIP TO-5	29
747	741 Dual Op Amp DIP or TO-5	54
748	Freq Adj 741 mDIP	31
1304	FM Mulpx Stereo Demod DIP	75
1307	FM Mulpx Stereo Demod DIP	52
1456	Op Amp mDIP	91
1458	Dual Comp Op Amp mDIP	44
1800	Stereo multiplexer DIP	1-73
3900	Quad Amplifier DIP	38
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

BANKAMERICARD / BARCLAYCARD — MASTERCHARGE / ACCESS — CHARGEX / EUROCARD

Satisfaction guaranteed. Shipment will be made postage prepaid within 5 days from receipt of order. Payment may be made with personal check, charge card (include number and exp. date), international money order (include receipt) or bank cheque made payable in U.S.$

Add 50p to cover shipping and handling if order is less than £5.

The above prices do not include any taxes leviable by a purchasers country of residence.

INTERNATIONAL ELECTRONICS UNLIMITED
P.O. BOX 3036 / MONTEREY, CA. 93940 USA
PHONE (408) 659-3171

FABULOUS
NEW KITS
EASY TO CONSTRUCT
DORAM KITS CONTAIN EVERYTHING DOWN TO THE LAST NUT!
TV PATTERN GENERATOR
TV Pattern Generator
£19·77 +S
Completely self contained unit. Output switchable for cross-hatch, dots, black level or grey scale. Mains P.S.U. Has integral pulse generator and UHF modulator. Only requires connection to aerial socket and mains.
FM TUNER
£64·95 +H
★ 'Varicap' tuning. ★ Ultrasonic filter for pilot tone rejection to 65dB. ★ 'Mix' control. ★ Sensitivity 1.2 μV for 26dB quieting. ★ 6 pre-set station selection.
TRANSISTOR TESTER
£9·95 +S
Measures hFE leakage for PNP, NPN, Silicon or germanium transistors. Includes battery check facility.
Available NOW!
NO MORE WET CLOTHES ON WASHDAY.
NO MORE OVERFLOWING BATHS.
£3·50 +S
WATER ALARM
Ideal for mum on washdays this neat device emits an audible warning at the slightest sign of rain. ★ Very sensitive and easy to use.
ELECTRONIC CAR IGNITION
GIVE YOUR CAR NEW LIFE!
£9·95 +S
Will give your car greater performance and help to reduce fuel consumption. 12V Neg. operation. Includes many mechanical features.
★ New 16 page brochure contains complete details of kit range.
★ Big range of kits to interest Radio, Electronic and Hi-Fi enthusiasts.
★ Kits sent by return-of-post.
★ Each kit designed by specialists, only reliable and highest quality components included.
SEND FOR YOUR NEW KIT BROCHURE TODAY
Only 25p inc. post and packaging.
S = 8%VAT. H = 12½%VAT.
Doram
PE 12/76
DORAM ELECTRONICS LTD
P.O.Box TR8,
Leeds LS12 2UF.
I enclose 25p please send me by return my new Doram Kit brochure. Overseas orders except N. Ireland please add 10p for post and packing, surface only. Customers purchasing the edition 3 Doram catalogue plus the Kit brochure can obtain the pair together for 70p, saving 15p, and receive two 25p vouchers free.
PLEASE PRINT IN BLOCK CAPITALS
All products are offered for sale subject to the terms of business set out in our current catalogue.
Name
Address
Post Code
An Electrocomponents Group Company.

The Experimentor.

From Continental Specialities.

US Patent Design No 235554.

The Experimentor is not so much a new breadboard, practically a new way of life!, Says Ronald J. Portugal (President, Continental Specialities Corporation.)

No soldering.
No spoilt devices.
No fuss.
No fiddling.
No wasted time.

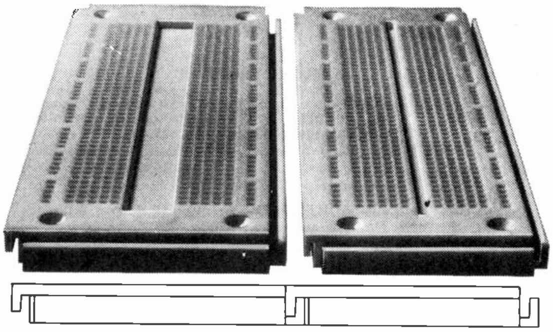
Now you can put circuits together as quickly as you think them up.

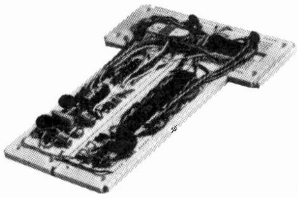
Just plug your devices in, pull them out, plug them in again, as many times as you want.

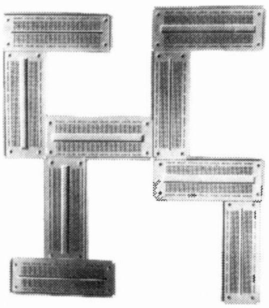
Two Versions.

Experimentor 600.
The world's first breadboard specially designed for 0.6 pitch devices. It gives you all the fan-out you need for complex MSIs, Micro-processors, Memories, Displays etc., (40 pins or more) with plenty of room for other components alongside.

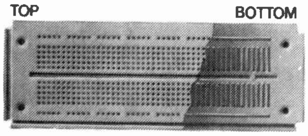
Experimentor 300.
This one is designed to be ideal for 0.3 pitch DILs, any kind, from 6 pins up. Excellent fan-out. (You can also use it for 0.6 devices, though for these the 600 version is recommended.)







TOP BOTTOM



Easy to Buy.

There's no problem buying from USA.

Just send name, address (block letters please), quantity of each required, and a perfectly normal UK bank cheque, made out in Pounds Sterling, to Continental Specialities Corporation.

Or you can use an International Money Order, from any Post Office. We also accept your American Express Card or Access number.

Then we post by return airmail, and you should receive the goods within 2-3 weeks.

Dealer enquiries invited. Note that any UK taxes or duties chargeable are solely the responsibility of the buyer.

Apart from ICs, both versions take TO-5 transistors, diodes, LEDs, capacitors, resistors; any component with lead size between .015 and .032 inch diameter. And for interconnections you use standard solid hook-up wire.

Unique Construction.

Each version of the Experimentor gives you 94 five-contact terminals, arranged in two rows of 47, plus two integral bus-strips for Ground and Power, with 40 contacts on each.

That's 550 contacts in all! (See diagram).

All terminal strips are recessed into the bottom of the plastic body, and covered with a stick-on vinyl backing, so you have no insulation problems.

The contact rows are numbered 1-5-10 etc. and A-B-C---J lengthways, so each position is clearly defined. The bus-strips are labelled X-Y, each end.

The plastic body is rigid, strong and longlasting, with a recessed screw-hole at each corner, and all four edges have a special quick-locking lip so that you can build rigid arrays of two or more boards.

The Domino Theory.

See how the Experimentor boards fix together, side by side, end to end, or at right-angles, to give unlimited scope for circuit building, planning, extending, rearranging.

You can mix 0.3 and 0.6 DILs in any arrangement you like.

And all your displays can face the way you want them.

And look at these prices!

Experimentor 300, £6.85, Experimentor 600, £7.50. All made to top CSC professional quality, and every one is fully checked before dispatch.

Free Catalogue!

Page after page of fascinating CSC products. Just write and ask.

Name..
Address..
....
....

Please send me.............(qty). Experimentor 300 @ £6.85 each,
and...........(qty). Experimentor 600 @ £7.50.
I enclose cheque/imo for £.................(total).
Amex/Access No

CSC

Continental Specialities Corporation, 44 Kendall St., PO Box 1942, New Haven, Conn. 06509 USA. Telephone: 203-624 3103.

B. BAMBER ELECTRONICS

Dept PE, 5 STATION ROAD, LITTLEPORT, CAMBS., CB6 1QE
Telephone: ELY (0353) 860185 (2 lines) Tuesday to Saturday

PLEASE ADD 8% VAT UNLESS OTHERWISE STATED

A Merry Xmas to all our Customers

VARIABLE STABILISED POWER SUPPLY, mains input, 0–24V output, stabilised and current limiting at 500mA + 32V at 50mA. Brand new by British manufacturer. Size approx. 7½ × 2½ × 4in, complete with external 5kΩ 3-turn pot for voltage control. Connection data supplied. £7.

50µA (25–0–25µA) **EDGEWISE METERS,** modern type by Sangamo Western, display area ¼ × 1½in with 2 mounting lugs. (Can be zeroed left or right hand.) £1·50 each, while stocks last.

MAINS ISOLATION TRANSFORMERS. Tapped mains input, 240V at 3A + 12V at 500mA output. New, boxed, made by Gardners, £12.

FLEXIBLE HEATER STRIP, 240V a.c., 150W, approx. 1 metre long (insulated with fibreglass) with mains connector block. Many, many uses, 60p each.

Good Quality Pressure Guages, 2½in dia. flange mounting. 3 models avail. 0–60 lb/sq.in, 0–100 lb sq. in, 0–200 lb/sq. in, state which £1·25 each.

2N3055 type Transistors, O.K., but unmarked, 5 for £1.

110V NEONS, SCREW-IN-TYPE, 4 for 50p.

SLOW MOTION MOTORS (suitable for programmers, displays, etc.) 230–240V a.c. input, rotation, 1 rev. every two to three minutes, £1·25 each.

MINIATURE PLIERS High quality "Crescent", made in USA. £4·35 + VAT (35p).
SIDE CUTTERS, high quality, £3·70 + VAT in pairs 30p.

MIXED COMPONENT PACKS, containing resistors, capacitors, switches, pots, etc. All new (random sample bag revealed approx. 700 items), £2 per pack, while stocks last.

TUNED COILS, 2 section coils, around 1MHz, with a black smart tuning knob, which moves an internal core to vary the inductance, many uses, easily rewound, 3 for 50p.

HIGH QUALITY SPEAKERS, 8½in × 6in elliptical, only 2in deep, inverse magnet, 4 ohms, rated up to 10W, £1·50 each, or 2 for £2·75 (qty. discount available + 12½% VAT.

PROGRAMMERS (magnetic devices). Contain 9 microswitches (suitable for mains operation) with 9 rotating cams, all individually adjustable, ideal for switching disco lights, displays, etc., or industrial machine programming. (Need slow motion motor to drive cams, not supplied) 9 switch version £1·50.

HEAVY DUTY HEATSINK BLOCKS, undrilled, base area 2½in × 2in, with 6 fins, total height 2½in 50p each.

SPERRY 7-SEGMENT P.G.D. DISPLAYS, digit height 0·3in red, with decimal points, 150V to 200V (nominal 180V) operation. These are high-volt industrial type and therefore brighter than normal displays. All brand new, AT THE BARGAIN PRICE OF 50p PER DIGIT. TYPE 332 (two digits in one mount) £1 each, TYPE 333 (three digits on one mount) £1·50. (Sorry, no single digit available.) Data Supplied.

BSX20 (VHF Osc/Mult), 3 for 50p.
BC108 (metal can), 4 for 50p.
PBC 108 (plastic BC108), 5 for 50p.
BFY51 Transistors, 4 for 60p.
BCY72 Transistors, 4 for 50p.
PNP audio type TO5 Transistors, 12 for 25p.
BF152 (UHF amp/mixer), 3 for 50p.
2N3819 Fet., 3 for 60p.
BA121 Varicap Diodes, 4 for 50p.
1N914 diodes, 10 for 25p.

SMALL MAINS SUPPRESSORS (small chokes, ideal for radio, Hi-Fi inputs, etc.) approx. ½in × 1½in, 3 for 50p.

PERSPEX TUNER PANELS (for FM Band 2 tuners) marked 88-108 MHz and Channels 0-70, clear numbers, rest blacked out, smart modern appearance, size approx. 8½in × 1½in, 2 for 35p. Lead suppressors (10kohm) for mobile plug leads, 4 for 50p.

HEAVY DUTY RELAYS, 24V d.c. operated (will work on 18V) 3 heavy duty make contacts (around 10A rating) + 4 change over contacts + 1 break contact. New, complete with mounting bracket (ideal for switching HT on Linears.) Many uses for this high quality unit. £1·50 each.

PLEASE ADD 8% VAT UNLESS OTHERWISE STATED

TO3 transistor insulator sets, 10 for 50p.

ALU-SOL ALUMINIUM SOLDER (made by Multicore). Solders aluminium to itself or copper, brass, steel, nickel or tinplate. 16 s.w.g. with multicore flux, with instructions. Approx. 1 metre coil 30p pack. Large reel £2·75.

1¼in polythene chassis mounting fuseholders, 6 for 30p.

I.C.'s, some coded, 14 DIL type, untested, mixed, 20 for 25p.

Mobile Converters, 24V DC input 13·8V at approx 3·4A DC output, fully stabilised. £3·50 each (ideal for running 12V car radio from 24V lorry battery).

We now stock Spiralux Tools for the electronic enthusiast. Screwdrivers, Nut Spanners, BA and Metric sizes, pop rivet guns, etc. S.A.E. for list.

Miniature earphones with min. jack plug, 2 for 50p + 12½% VAT.

I.F. Cans, ½in square, suitable for rewind, 6 for 30p + 12½% VAT.

TWIN I.F. CANS, approx. 1in × ½in × 1in high, around 3·5–5MHz, 2 separate transformers in 1 can, internally screened, 5 for 50p + 12½% VAT.

Dubilier Electrolytics, 50µF, 450V, 2 for 50p.
Dubilier Electrolytics, 100µF, 275V, 2 for 50p.
Plessey Electrolytics, 470µF, 63V, 3 for 50p.
TCC Electrolytics, 1000µF, 30V, 3 for 60p.
Plessey Electrolytics, 1000µF, 180V, 40p each (3 for £1).
Dubilier Electrolytics, 5000µF, 35V, 50p each.
Dubilier Electrolytics, 5000µF, 50V, 60p each.
ITT Electrolytics, 6800µF, 25V, high grade, screw terminals, with mounting clips, 50p each.
Plessey Electrolytics, 10,000µF at 63V, 75p each.
Plessey Cathodray Capacitors, 0–0·4µF at 12·5kV DC. Screw terminals. £1·50 each.
PLEASE ADD 12½% VAT TO ALL CAPACITORS

A LARGE RANGE OF CAPACITORS AVAILABLE AT BARGAIN PRICES, S.A.E. FOR LIST.

TV PLUGS AND SOCKETS
TV Plugs (metal type), 5 for 50p.
TV Sockets (metal type), 4 for 50p.
TV Line Connectors (back-to-back sockets), 4 for 50p. Please add 12½% VAT.

PLUGS AND SOCKETS
N-Type Plugs 50 ohm, 60p each, 3 for £1·50.
N-Type Sockets (4-hole chassis mounting), 50 ohms (a small coax lead type), 50p each.
PL259 Plugs (PTFE), brand new, packed with reducers, 65p or 5 for £3.
SO239 Sockets (PTFE), brand new (4-hole fixing type), 50p each or 5 for £2·25.
25-way ISEP Plugs and Sockets, 40p set (1 plug + 1skt).
Plugs and sockets sold separately at 25p each.
Bulgin Round Free Skts, 3 pin, for mains input on test equipment, etc., 25p each.

WELLER SOLDERING IRONS
EXPERT. Built-in-spotlight illuminates work Pistol grip with fingertip trigger. High efficiency copper soldering tip.
EXPERT SOLDER GUN. £6·80 + VAT (54p)
EXPERT SOLDER GUN KIT (spare bits case, etc.), £9·80 + VAT (78p)
SPARE BITS, PAIR, 30p + VAT (2p)
MARKSMAN SOLDERING IRONS
SP15D 15W £3 + VAT (24p)
SP25D 25W £3 + VAT (24p)
SP25DK 25W + bits, etc. kit £3·85 + VAT (31p)
SP40D 40W £3·44 + VAT (28p)
BENCH STAND with spring for Marksman Irons, £2·22 + VAT (18p)
SPARE BITS
MT8 for 15W, 48p + VAT (4p).
MT4 for 25W, 38p + VAT (3p)
MT10 for 40W, 42p + VAT (3p)
TCP1 TEMPERATURE CONTROLLED IRON.
Temperature controlled iron & PSU, £20 + VAT (£1·60)
SPARE TIPS
Type CC single flat, Type K double flat fine tip Type P, very fine tip, £1 each + VAT (8p).
MOST SPARES AVAILABLE

MULTICORE SOLDER
Size 5 Savbit 18 s.w.g. in alloy dispenser, 32p + VAT (3p).
Size C1SAV18 Savbit 18s.w.g., 56p + VAT (4p).
Size 12 SAVBIT 18s.w.g. on plastic reel £1·80 + VAT (15p)

Terms of Business: CASH WITH ORDER. MINIMUM ORDER £1. *ALL PRICES INCLUDE POST & PACKING (UK ONLY). SAE with ALL ENQUIRIES Please.* **PLEASE ADD VAT AS SHOWN.** *ALL GOODS IN STOCK DESPATCHED BY RETURN. CALLERS SATURDAYS ONLY 9.30–12.00, 1.30–5.00.*

TRANSFORMERS

ALL EX-STOCK—SAME DAY DESPATCH

NO HIDDEN EXTRAS— Prices include VAT and P. & P. EXCEPT † WHERE CARRIAGE WILL BE ACCORDING TO WEIGHT AND DISTANCE—BRS
Electroseal Audio accessories, semiconductors, panel meters and multi-meters.

CALLERS WELCOME (MON.-FRI.) OR SEND STAMP FOR LISTS.

MAINS ISOLATING
PRI. 120/240V
SEC. 120/240
CENTRE TAP WITH SCREEN

Ref.	VA (Watts)	£
07*	20	4·57
149	60	6·68
150	100	7·65
151	200	11·95
152	250	14·47
153	350	17·14
154	500	19·73
155	750	27·25†
156	1000	37·97†
157	1500	43·33†
158	2000	48·34†
159	3000	76·38†

*115V or 240V Sec. only.

30 VOLT RANGE
Prim. 200–240V
Sec. 0–12–15–20–24–20V

Ref.	Amps	£
112	0·5	3·15
79	1·0	4·00
3	2·0	5·55
20	3·0	6·87
21	4·0	7·93
51	5·0	9·55
117	6·0	10·69
88	8·0	14·15
89	10·0	14·51

60 VOLT RANGE
Prim. 200-240V
Sec. 0-24-30-40-48-60V

Ref.	Amps	£
124	0·5	3·94
126	1·0	5·43
127	2·0	7·65
125	3·0	11·00
123	4·0	13·07
40	5·0	14·20
120	6·0	16·64
121	8·0	19·56†
122	10·0	24·09†
189	12·0	25·18†

12 and or 24 Volt
PRIMARY 240-250 VOLTS

Ref.	Amps 12v	Amps 24v	£
111	0·5	0·25	2·30
213	1·0	0·5	3·01
71	2	1	3·69
68	3	–	5·10
18	4	2	4·56
85	5	–	5·61
70	6	3	6·36
108	8	4	7·34
72	10	5	7·86
116	12	6	8·39
17	16	8	10·48
115	20	10	15·42
187	30	15	19·50
226	60	30	21·94†

HIGH VOLTAGE
Mains Isolating
Prim. 200/220 *or* 400/440
Sec. 100/120 *or* 200/240

VA	Ref.	P & P £
60	243	6·62
350	247	15·23
1000	250	32·68†
2000	252	54·80†

AUTO TRANSFORMERS

Ref	VA (Watts)	Auto Taps	£
113	20	0-115-210-240	2·61
64	75	0-115-210-240	4·65
4	150	0-115-200-220-240	6·24
66	300	0-115-200-220-240	8·62
67	500	0-115-200-220-240	13·10
84	1000	0-115-200-220-240	19·70
93	1500	0-115-200-220-240	23·62†
95	2000	0-115-200-220-240	31·56†
73	3000	0-115-200-220-240	45·76†

CASED AUTO TRANSFORMERS
240V mains lead input & USA 2 pin outlets.

20VA	£4·95	Ref 113W
150VA	£8·94	Ref 4W
500VA	£15·11	Ref 67W
1000VA	£22·84†	Ref 84W
2000VA	£35·66†	Ref 95W

ELECTRONIC CONSTRUCTION KIT
10 projects (including Electronic Organ). Ideal gift at £8·63

50 VOLT RANGE
Prim. 200-240V
Sec. 0-19-25-33-40-50V

Ref. No.	Amps	£
102	0·5	4·07
103	1·0	5·27
104	2·0	7·17
105	3·0	6·77
106	4·0	11·26
107	6·0	17·29
118	8·0	18·62
119	10·0	22·04†

SCREENED MINIATURES

Ref	mA	Volts	£
238	200	3-0-3	2·50
212	1A, 1A	0-6, 0-6	2·97
13	100	9-0-9	2·28
235	330, 330	0-9, 0-9	2·39
207	500, 500	0-8-9, 0-8-9	3·14
208	1A, 1A	0-8-9, 0-8-9	4·51
236	200, 200	0-15, 0-15	2·28
214	300, 300	0-20, 0-20	3·22
221	700 (DC)	20-12-0-12-20	3·66
206	1A, 1A	0-15-20, 0-15-20	5·37
203	500, 500	0-15-27, 0-15-27	4·77
204	1A, 1A	0–15-27, 0-15-27	6·00
S112	500	12, 15, 20, 24, 30	3·15

NEW **TRANS CASES**
Combined wall and floor mounting
Send for details.

BRIDGE RECTIFIERS

200V	2A	0·67
400V	2A	0·72
200V	4A	0·89
500V	10A(PM 7A6)	2·70

TEST METERS

AVO 8 MK5	£67·33
AVO 72	£26·66
AVO TT 169	£27·34
AVO MM5	£23·40
U4315 (USSR) inc steel carry case	£13·93

POWER UNIT
CC12-05 Output Switched 3–4·5–6–7·5–9–12V at 500mA £5·18

C1000 MINI-MULTIMETER
D.C.—1,000V, A.C.—1,000V, 1,000Ω/V.
D.C.1—100mA, Res.—150kΩ.
BARGAIN AT £4·59

ANTEX SOLDERING IRONS
15W £3·57 18W £3·31 25W £2·99
SOLDERING IRON KIT £4·48
STAND FOR ABOVE £1·49

MAGNETIC TO CERAMIC CARTRIDGE CONVERTOR
OPERATING VOLTAGE 20-45V only £3·17.

HIGH QUALITY MODULES

3 Watt RMS AMPLIFIER	£2·78
5 Watt RMS AMPLIFIER	£3·17
10 Watt RMS AMPLIFIER	£3·51
25 Watt RMS AMPLIFIER	£4·67
125W RMS AMPLIFIER	£17·50
PRE-AMP for 3-5-10W	£7·50
PRE-AMP for 25W	£15·79
POWER SUPPLIES 3-5-10W	£1·54
POWER SUPPLIES 25W	£3·56
TRANSFORMER 3W	£2·54
TRANSFORMER 5-10W	£2·99
TRANSFORMER 25W	£3·38

BSR MINI-DECK
4 Speed Auto Changer £7·61
Garrard SP25 (Chassis) £22·36

NEW STEREO 30
Complete Stereo Chassis inc.
7 + 7w RMS. Amp. Pre-amp. Power Supply. Front Panel. Knobs (only needs Mains Trans.). Stereo 30 £17·99 Mains Trans £3·56. Teak veneered cab. £4·54.
Power unit plugs direct into 13A 3 pin socket, 6–7·5–9V 300mA with multi-plug £3·59.

COMPONENT PAKS
200 Mixed value resistors (count by weight)
150 Mixed value capacitors (count by weight)
30 Mixed value precision resistors ½w 2%
15 Assorted pots & pre-sets
10 Reed switches
3 Micro switches
20 Assorted tag strips
1 Pack wire 50 meters, assorted colours
PLEASE STATE PAK REQUIRED 90p PER PACK

AUDIO KIT 25W
2 + 25W Amplifiers, 1 + Pre-Amp 1 + Power supply, 1 + Transformer 1 + Front Panel 1 + Kit of parts to include on/off switch, neon ind. Stereo headphone socket. Plus Instructions book £32·18.

TEAK AUDIO KIT 25W
Teak veneered cabinet 16¾ + 11½ + 3½, aluminium chassis, heat sink and front panel brackets plus back panel and sockets etc. £11·21

CARTRIDGES

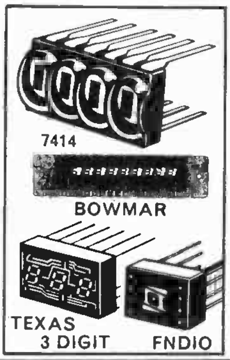
Magnetic Sonotone 100	£5·31
Ceramic E.E.I.CS 2000	£2·72
ALOS GP93-1	£2·11
TCC AT55 (magnetic)	£4·42

STEREO FM TUNER WITH PHASE-LOCK LOOP
4 Pre-selected stations supply 20-35V. 90mA Max. £22·72

Barrie Electronics Ltd.
3, THE MINORIES, LONDON EC3N 1BJ
TELEPHONE: 01-488 3316/7/8
NEAREST TUBE STATIONS: ALDGATE & LIVERPOOL ST.

CALCULATOR DISPLAYS

⅓" digit height, bright red LED 7 segment displays for calculators, digital watches, miniature clocks, DVMs, timers etc.
✳ Fairchild FND-10, single digit common cathode £1.00 (+vat 8p) 6 for £5.00 (+vat 40p)
✳ HP 7414 4 digit, common cathode 12 pin d.i.l. pin out 99p+(vat 8p) 6 for £5.00 (+vat 40p)
✳ Bowmar 8½ digit, common cathode with pc connector, and red bezel £1.85 (+vat 15p) 6 for £10 (+vat 80p)
✳ Texas 3 digit common cathode 12 pin d.i.l. pin out 85p (+vat 7p) 6 for £4.00 (+vat 32p)
✳ Texas 4+5 digit, common cathode 2×14 pin d.i.l. £1.85 pair (+vat 15p)
✳ 30 pin termination board for all types except FND-10 20p (+vat 2p)
Texas calculator keyboards. 19 gold plated 'snap' type key contacts on gold plated pcb. 75p (+vat 6p)
p & p on all the above 25p.



TAPE HEADS

BX12E343 ¼ TRACK ERASE HEAD – £1.25 (+vat 15p)
BX12RP63 WITH BX12E343 – £2.95 (+vat 36p)
STEREO CASSETTE R/RP HEAD (200 ohm) – £2.25 (+vat 28p)
TWIN STAGGERED MARRIOTT HEADS R/RP1 – £1.50 (+vat 18p)
MARRIOTT RECORD/REPLAY & ERASE HEAD – £1.75 (+vat 21p)
MINIFLUX R9N ERASE – £2.25 (+vat 28p)
GX11 E388 ERASE 675 ohms 2 mA – £0.88 (+vat 11p)
GX12 E387 ERASE 675 ohms 2 mA – £0.88 (+vat 11p)
GX20 E362 ERASE 90 ohms 90 mA – £0.88 (+vat 11p)
R/RP1/3 TAPE HEAD ¼ TRACK – £0.65 (+vat 8p)
HR-RP TAPE HEAD SINGLE TRACK £0.55 (+vat 6p)
XRPS17 ¼ TRACK – £3.25 (+vat 40p)
XRPS18 ¼ TRACK RED – £3.25 (+vat 40p)
XRPS36 ¼ TRACK – £6.75 (+vat 79p)
XES11 ¼ TRACK ERASE – £1.25 (+vat 15p)
BX/RP/63 ¼ TRACK – £2.25 (+vat 28p)

MULLARD TUNER MODULES –

LP1171 combined AM/FM IF strip – £4.29 (+vat 53p) ✳ LP1179 FM front end with AM tuning gang, used with LP1171 – £4.29 (+vat 53p) ✳ LP1171 & 79 pair – £8.00 (+vat £1.00) ✳ LP1157 complete AM strip – £2.05 (+vat 26p) ✳ Ferrite Aerial – 95p (+vat 7p)
p & p all modules 25p each

HENELEC RADIO CONTROL SYSTEM

✳ INCLUDING PROPORTIONALLY CONTROLLED SWITCH
✳ FEATURING COSMOS DIGITAL LOGIC to minimise power consumption and extend battery life.

Specially designed to provide aircraft and boat modelmakers with a low-cost, easy-to-use radio control, the Henelec system gives you everything from single channel, up to sophisticated 7-channel Digital Proportional System! Buy the components you want. Ideal for any radio control application.
★ Simple transmitter – £2·95 (+ vat 37p) ★ Single-ch. add-on for receiver – £11·75 (+ vat £1·47p) ★ PC board for above – 75p (+ vat 6p) ★ Case for transmitter – £1·25 (+ vat 16p) ★ Basic receiver – £6·95 (+ vat 87p) Send now for leaflet No. 8 (35p) for full details.
Post etc., 50p each.

HENRY'S GREAT NEW CATALOGUE

For this latest edition, we have made hundreds of changes and additions. Containing virtually everything for amateurs and professionals, Henry's Radio Catalogue is also a "must" for manufacturers.
Again, we have included a complete alphabetical index, as well as a sectional index, so that you'll have no trouble at all in finding what you need.

★ OVER 5,000 ITEMS
★ OVER 200 PAGES
★ DISCOUNT VOUCHERS
★ QUANTITY DISCOUNTS ON MOST ITEMS

ONLY 85p PLUS 14p p&p

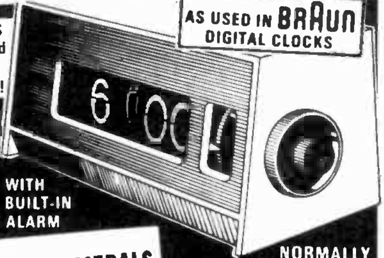
FREE – *to educational establishments and manufacturers when ordered on official headed notepaper.*

BULK PURCHASE – EXCLUSIVE TO HENRY'S ALLOWS US TO SELL AT SUCH FANTASTIC PRICES!

QUALITY ITEMS
Compare performance and specification with units costing 3 times as much!

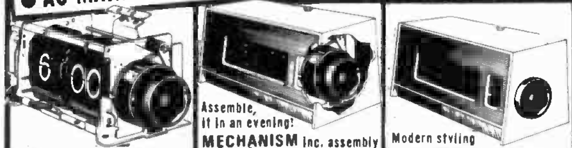
AS USED IN BRAUN DIGITAL CLOCKS

DIGITAL 24 HOUR CLOCK WITH BUILT-IN ALARM



● SILENT RUNNING
● LARGE ILLUMINATED NUMERALS
● AC MAINS ● SIZE 6⅜ x 2⅜ x 2¾

NORMALLY £24 WITH CASE



MECHANISM ONLY	MECHANISM AND CASE	COMPLETE UNIT
	Assemble, it in an evening! Inc. assembly instructions	Modern styling
£6.00 +VAT 48p P&P 25p	£7.99 +VAT 64p P&P 25p	£8.99 +VAT 72p P&P 25p
THREE FOR £16.50 +VAT £1.32 POST FREE	THREE FOR £22.00 +VAT £1.76 POST FREE	THREE FOR £25.00 +VAT £2.00 POST FREE

TEXAN AMPLIFIER

featured by PRACTICAL WIRELESS still the best selling amp in the UK.

DESIGNED BY TEXAS

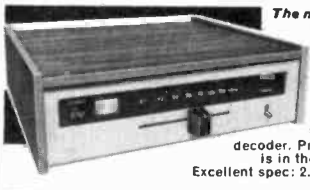
30,000 ALREADY SOLD!

Build it yourself
£29.95 +VAT £3.74 P&P £1 Built £39.95 + VAT £4.93

Build the Texan stereo amplifier, and be doubly proud! You'll own a superb home entertainment unit. And the pleasure of doing it yourself.
Look at the Texan specification
Fully integrated stereo preamp and power amp, 6 IC's, 10 transistors, 6 rectifiers and zener diodes. Plus stabilised, protected circuitry, glass fibre pcb; Gardeners low-field low-line mains transformer; all facilities and controls. Slim design, chassis 14½" x 6" x 2" overall. 20 watts per channel RMS.

★ Can be built stage by stage. *Ask for leaflet 21.*
★ Everything necessary supplied. Full after sales service and guarantees.

The natural follow on!

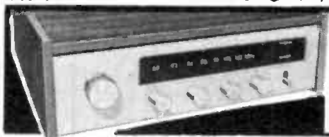


TEXAN FM TUNER KIT £20.95 + VAT £2.62

Built and tested £25.95+VAT £3.24

Build the matching Texan stereo tuner! Features advanced varicap tuning. Phase lock loop decoder. Professionally designed circuit. Everything you need is in the kit. From the glass fibre pcb to the cabinet itself. Excellent spec: 2.5 uV aerial sensitivity. 500 mV output (adjustable). Tuning range 87–102 MHz. Mains powered.

NEW HENELEC Mullard AM/FM TUNER MODULE £21·95 +VAT £2.74 p&p £1.00



MAY BE ASSEMBLED IN AN EVENING. FEATURES ✳ Built-in AM Ferrite aerial ✳ LW coverage 150KHz-250KHz ✳ MW coverage 530KHz-1.6MHz ✳ FM coverage 87-104MHz ✳ 75Ω aerial for FM ✳ 150mV output ✳ Size 8¾(L) x 6¾(W) x 2½(H)

This new AM/FM tuner kit incorporates 2 Mullard modules. Supplied as a pre-aligned and tested printed circuit, the constructor only has to build the PCB into the chassis, connect the power, aerial and output loads. Styled to match the Texan amp, mains operated.

Easily adapted for stereo, using the Henelec IC stereo decoder kit, high performance modular design, phase lock loop principle. Low pass filters for optimum performance.
Price £8.75+VAT £1.02 p&p 50p.

We will be pleased to quote for parts for circuits in this magazine. Send your list for quotation in S.A.E.
Ask for FREE leaflets and lists on our kits projects.

HENRY'S RADIO

All mail to: Henry's Radio 303 Edgware Rd. London W2

LONDON W2: 404/6 Edgware Road. Tel: 01-402 8381
LONDON W1: 231 Tottenham Ct Rd. (lower sales floor) Tel: 01-636 6681

20x20 Watt STEREO AMPLIFIER

Superb Viscount IV unit in teak-finished cabinet. Black fascia with aluminium rotary controls and pushbuttons, red mains indicator and stereo jack socket. Function switch for mic, magnetic and crystal pick-ups, tape, tuner, and auxiliary. Rear panel features two mains outlets, DIN speaker and input sockets, plus fuse. 20+20 watts rms, 40+40 watts peak.

£29.90 + p & p £2.10

HOW YOU CAN SAVE

SYSTEM 1B
For only £80, you get the 20+20 watt Viscount IV amplifier; a pair of our 12-watt-rms Duo Type IIb matched speakers; a BSR MP 60 type deck complete with magnetic cartridge, de luxe plinth and cover.

£80.00 + p & p £6.50

SYSTEM 2
Comprising our 20+20 watt Viscount IV amplifier; a pair of our large Duo Type III matching speakers which handle 20 watts rms each; and a BSR MP 60 type deck with magnetic cartridge, de luxe plinth and cover.

£92.00 + p & p £7.60

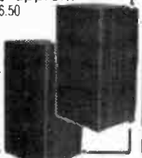
Carriage surcharge to Scotland: System 1b £2.50, System 2 £5

SPEAKERS
Two models – Duo IIb, teak veneer, 12 watts rms, 24 watts peak, 18½"x13½"x7¼" approx.

£34 + p & p £6.50 PER PAIR

Duo III, 20 watts rms, 40 watts peak, 27"x13"x11½" approx.

£48 + p. & p. £7·50 PER PAIR

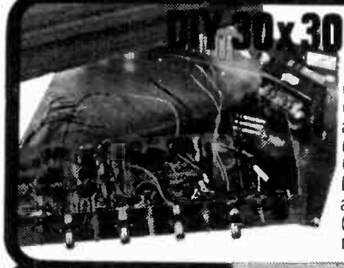


TURNTABLE
Popular BSR MP 60 type, complete with magnetic cartridge, diamond stylus, and de luxe plinth and cover.

£24.00 + p & p £3.50

VALUE

DIY 30x30 AMPLIFIER KIT



Specially designed by RT-VC for the experience constructor, this kit comes complete in every detail. Same facilities as Viscount IV amplifier. Chassis is ready punched, drilled and formed. Cabinet is finished in teak veneer. Black fascia and easy-to-handle aluminium knobs. Output 30+30 watts rms, 60+60 peak.

£29.00 + p & p £2.10

STEREO CASSETTE DECK KIT
Again, this kit is specially designed for the experienced constructor – for mounting into his own cabinet. Features include solenoid-assisted AUTO-STOP, 3-digit counter, record/replay PC board, mains transformer and input and output controls. AC BIAS AND ERASE.

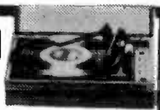
£32.50 + p & p £1.50

DELUXE ACCESSORY KIT
Comprises of a matched pair of dynamic mics. and two replacement slider level controls.

£3.95 + p & p £1

P. & P. FREE WHEN PURCHASED TOGETHER WITH ITEM BELOW.

DIY STEREO SYSTEM



COMPLETE WITH SPEAKERS

Here's real value in DIY! Comprises ready-built amplifier module, 3-speed Garrard auto-return deck, and teak-veneer simulate cabinets with clear plastic top. Easily built by hobbyists.

£26.95 + p & p £4.05

NEW sinclair I.C 20, 20 WATTS STEREO AMPLIFIER KIT WITH PZ 20 POWER UNIT

FANTASTIC SAVING. A build-it-yourself stereo power amplifier with latest integrated circuitry, 10W RMS per channel output, full short-circuit and overheat protection.

LIST £14.50 OUR PRICE **£4.95** p+p £1.

TOURIST IV PUSH BUTTON CAR RADIO KIT

(Motor Top 10 Award)

Complete with speaker, baffle and fixing strips. The Tourist IV – for the experienced constructor only. The Tourist IV has five push buttons, four medium band and one for long wave band. The tuning scale is illuminated and attractive spun aluminium control knobs are used for manual tuning and volume control. The modern style facia has been designed to blend with most car interiors and the finished radio, will slot into a standard car radio aperture. Size: approx. 7" x 2" x 4½". Power Supply: Nominal 12 volts positive or negative earth (altered internally). Power Output: 4 watts into 4 ohms.

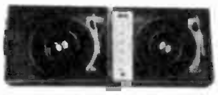
£10.50 + p&p £1.50

35-WATT DISCO AMP

Here's the mono unit you need to start off with. Gives you a good solid 35 watts rms, 70 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.

£27.50 + p & p £1.50

PORTABLE DISCO CONSOLE with built-in pre-amplifiers



Here's the big-value portable disco console from RT-VC! It features a pair of BSR MP 60 type auto-return, single-play professional series record decks. Plus all the controls and features you need to give fabulous disco performances. Simply connects into your existing slave or external amplifier.

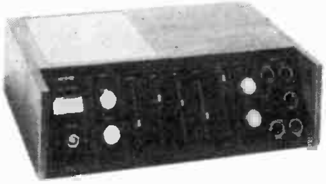
£55.00 + p & p £6.50

70 and 100 WATT DISCO AMPLIFIERS
Brilliantly styled for easy disco performance. Sloping fascia, so that you can use the controls without fuss or bother. Brushed aluminium fascia and rotary controls. Five smooth acting, vertically mounted slide controls – master volume, tape level, mic level, deck level. PLUS INTER DECK FADER for perfect graduated change from record deck No 1 to No 2, or vice versa. Pre-fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level. 70 watts rms, 140 watts peak output.

£49.00 + p & p £3.00

All the big features as on the 70-watt disco amplifier, but with a massive 100 watts rms, 200 watts peak output power.

£65.00 p & p £4.00



DIY SPEAKER KITS

EASY-TO-BUILD, WITH ENCLOSURE
Specially designed by RT-VC for cost-conscious hi-fi enthusiasts, these kits incorporate two teak-simulate enclosures, two EMI 13" × 8" (approx.) woofers, two 3¼" (approx.) tweeters and a pair of matching crossovers. Easily constructed, using a few basic tools. Supplied complete with an easy-to-follow circuit diagram, and crossover components. Input 15 watts rms, 30 watts peak, each unit. Cabinet size 20" × 11" × 9½" (approx).

£25.50 PER PAIR + p & p £5.50

15-WATT KIT IN CHASSIS FORM
YOU CAN'T DO BETTER

When you are looking for a good speaker, why not build your own from this kit. It's the unit which we supply with the above enclosures. Size 13" × 8" (approx.) EMI woofer, 3¼" (approx.) tweeter, and matching crossover. Power handling capacity 15 watts rms, 30 watts peak.

£7.50 PER SET + p & p

'COMPACT' FOR TOP VALUE
How about this for incredible bookshelf value from RT-VC! A pair of high efficiency units for only £7.50 — just what you need for low-power amplifiers. These infinite baffle enclosures come to you ready mitred and professionally finished. Each cabinet measures 12" × 9" × 5" (approx.) deep, and is finished in simulated teak. Complete with two 8" (approx.) speakers for max. power handling of 7 watts.

£7.50 p&p £1.70 per pair

DECCA 20 WATTS STEREO SPEAKER
This matching loudspeaker system is hand-made, as only Decca know how, built to a specification, not down to a price.

The kit comprises of two 8" diameter approx. base drive unit, with heavy die cast chassis laminated cones with rolled P.V.C. surrounds Two 3½" diameter approx. domed tweeters complete with crossover networks.

Our price per stereo pair **£30.00** + £4.00 P & P.

ELECTROLYTIC CAPACITORS AT BARGAIN PRICES
all brand new from reputable international manufacturers.

PACK 1—Containing 30 mixed Electrolytics, valves from 4.7mF to 47mF. Minimum 16 volt working. 55p + 20p p & p.

PACK 2—Containing 17 mixed Electrolytic valves from 100mF to 2200mF. Minimum 16 volt working. Majority 40 volt working. 75p + 20p p & p.

ALL PRICES INC. VAT
AT CURRENT RATES

All items subject to availability. Prices correct at 1st October 1976 and subject to change without notice.

We are unable to show all our products, so please send S.A.E. for our fully descriptive catalogue and any further information.

RTVC

21D HIGH STREET, ACTON, LONDON W3 6NG
323 EDGWARE ROAD, LONDON W2

Personal Shoppers EDGWARE ROAD 9 a.m.—5.30p.m. Half day Thurs.
ACTON: 9.30a.m.—5p.m. Closed all day Wed.

Minimum order on Access and Barclaycards £15

DO NOT SEND CARD

Just write your order giving your credit card number

SEMI-CONDUCTORS

TRANSISTORS

BRAND NEW FULLY GUARANTEED

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC117K	*0·30	AF178	*0·51	BC169	0·10	BC440	*0·31	BF117	*0·46
AC126	*0·18	AF179	*0·51	BC169C	0·10	BC460	*0·37	BF118	*0·71
AC126	*0·14	AF180	*0·51	BC170	0·09	BD115	*0·63	BF119	*0·71
AC127	*0·11	AF181	*0·51	BC171	0·09	BD116	*0·81	BF152	0·56
AC128	*0·11	AF186	*0·51	BC172	0·09	BD121	*0·81	BF153	0·46
AC128K	*0·26	AF239	*0·38	BC173	0·09	BD123	*0·87	BF154	0·46
AC141	*0·19	AL102	*0·75	BC174	0·15	BD124	*0·70	BF155	*0·71
AC141K	*0·80	AL103	*0·75	BC175	*0·22	BD131	*0·36	BF156	*0·40
AC142	*0·19	BC107	*0·08	BC177	*0·16	BD132	*0·40	BF157	*0·56
AC142K	*0·26	BC108	*0·08	BC178	*0·16	BD133	*0·87	BF158	0·56
AC153K	*0·24	BC109	*0·08	BC179	*0·16	BD135	0·41	BF159	0·61
AC176	*0·11	BC113	0·10	BC180	*0·25	BD136	0·41	BF173	*0·15
AC176K	*0·26	BC114	0·16	BC181	0·25	BD137	0·46	BF176	0·36
AC180	*0·29	BC115	0·16	BC182	0·09	BD138	0·51	BF179	*0·31
AC180K	*0·30	BC116	0·15	BC182L	0·09	BD139	0·56	BF180	*0·31
AC181	*0·20	BC117	0·19	BC183	0·09	BD140	0·61	BF181	*0·31
AC181K	*0·30	BC118	0·09	BC183L	0·09	BD155	*0·81	BF194	0·10
AC187	*0·17	BC119	*0·31	BC184	0·09	BD175	*0·81	BF195	0·10
AC187K	*0·23	BC120	*0·81	BC184L	0·09	BD176	*0·81	BF196	0·12
AC188	*0·19	BC137	0·16	BC186	*0·29	BD177	*0·87	BF197	0·12
AC188K	*0·23	BC139	*0·41	BC187	*0·29	BD178	*0·87	BF198	0·12
AD140	*0·49	BC140	*0·31	BC207	0·11	BD179	*0·71	BF199	0·12
AD142	*0·55	BC141	*0·31	BC208	0·11	BD180	*0·71	BF257	*0·26
AD143	*0·48	BC142	*0·31	BC209	0·12	BD185	*0·67	BF258	*0·36
AD149	*0·45	BC143	*0·31	BC212	0·10	BD186	*0·67	BF259	*0·46
AD150	*0·65	BC145	0·46	BC212L	0·10	BD187	*0·71	BF262	0·56
AD161	*0·36	BC147	0·09	BC213	0·10	BD188	*0·71	BF263	0·56
AD162	*0·36	BC148	0·09	BC213L	0·10	BD189	*0·77	BF270	*0·36
AD161 & AD162(MP)	*0·63	BC149	0·09	BC214	0·10	BD190	*0·77	BF271	*0·31
AF114	*0·22	BC150	0·19	BC214L	0·10	BD195	*0·87	BF272	*0·81
AF115	*0·22	BC151	0·20	BC225	0·26	BD196	*0·87	BF273	0·36
AF116	*0·22	BC152	0·18	BC226	0·36	BD197	*0·92	BF274	0·36
AF117	*0·22	BC153	0·29	BC251	0·10	BD198	*0·92	BFX29	*0·25
AF118	*0·32	BC154	0·20	BC301	*0·28	BD199	*0·98	BFX84	*0·19
AF124	*0·28	BC157	0·11	BC302	*0·25	BD200	*0·98	BFX85	*0·25
AF125	*0·28	BC158	0·11	BC303	*0·31	BD205	*0·81	BFX86	*0·22
AF126	*0·26	BC159	0·11	BC304	*0·37	BD206	*0·81	BFX87	*0·22
AF127	*0·26	BC160	*0·46	BC327	0·12	BD207	*0·98	BFX88	*0·22
AF139	*0·31	BC161	*0·51	BC328	0·12	BD208	*0·98	BFY50	*0·13
		BC167	0·10	BC337	0·12	BDY20	*1·02	BFY51	*0·13
		BC168	0·10	BC338	0·12	BF115	*0·15	BFY52	*0·13

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
BFY53	*0·13	OC75	*0·16	2N706	*0·08	2N2646	*0·34	2N3703	0·09
BSY19	*0·16	OC76	*0·16	2N706A	*0·09	2N2904	*0·14	2N3704	0·08
BSX20	*0·16	OC77	*0·26	2N708	*0·11	2N2904A	*0·16	2N3705	0·08
BSY25	*0·16	OC81	*0·16	2N914	*0·15	2N2905	*0·18	2N3706	0·08
BSY26	*0·16	OC81D	*0·16	2M918	*0·18	2N2905A	*0·18	2N3707	0·08
BSY27	*0·16	OC82	*0·16	2N1131	*0·18	2N2906	*0·12	2N3708	0·08
BSY28	*0·16	OC82D	*0·16	2N1132	*0·18	2N2906A	*0·14	2N3709	0·08
BSY29	*0·16	OC83	*0·20	2N1302	*0·15	2N2907	*0·15	2N3710	0·09
BSY38	*0·19	OC139	*0·20	2N1303	*0·15	2N2907A	*0·16	2N3711	0·09
BSY39	*0·19	OC140	*0·23	2N1304	*0·18	2N2923	0·15	2N3819	*0·14
BSY40	*0·29	OC169	*0·26	2N1305	*0·18	2N2924	0·15	2N3820	*0·40
BSY41	*0·29	OC170	*0·26	2N1306	*0·21	2N2925	0·15	2N3823	*0·16
BSY95	*0·13	OC171	*0·26	2N1307	*0·21	2N2926G	0·09	2N3903	0·12
BSY95A	*0·13	OC200	*0·26	2N1308	*0·24	2N2926Y	0·09	2N3904	0·12
BU105	*1·90	OC201	*0·29	2N1309	*0·24	2N2926O	0·08	2M3905	0·14
MJE521	*0·56	OC202	*0·29	2N1613	*0·16	2N2926R	0·07	2N3906	0·14
MJE2955	*0·88	OC203	*0·26	2N1711	*0·16	2N2926B	0·07	2N4287	0·18
MJE3055	*0·57	OC204	*0·26	2N2147	*0·73	2N3053	*0·15	2N4288	0·18
MJE3440	*0·51	OC205	*0·38	2N2148	*0·58	2N3054	*0·40	2N4289	0·18
MPF102	*0·28	OCP71	*0·44	2N2218	*0·18	2N3055	*0·40	2N4290	0·18
MPF104	*0·28	ORP12/NSL4931	*0·48	2N2218A	*0·19	2N3402	*0·21	2N4291	0·18
MPF105	*0·28	ORP60	*0·41	2N2219	*0·18	2N3403	*0·21	2N4292	0·16
OC19	*0·36	ORP61	*0·41	2N2219A	*0·19	2N3404	*0·29	2N4293	0·16
OC20	*0·80	TIP29	*0·40	2N2220	*0·22	2N3405	*0·43	2N5172	0·12
OC22	*0·47	TIP30	*0·45	2N2221	*0·16	2N3614	*0·69	2N5457	*0·28
OC23	*0·49	TIP31A	*0·52	2N2222	*0·18	2N3615	*0·76	2N5458	*0·28
OC24	*0·57	TIP32A	*0·60	2N2368	*0·18	2N3616	*0·76	2N5459	*0·28
OC25	*0·39	TIP41A	*0·65	2N2369	*0·12	2N3646	0·09	40361	*0·30
OC26	*0·38	TIP42A	*0·72	2N2369A	0·12	2N3702	0·09	40362	*0·35
OC28	*0·60	TIS43	*0·25						
OC29	*0·60	UT46	*0·20						
OC35	*0·45	ZTX107	0·07						
OC36	*0·51	ZTX108	0·07						
OC41	*0·20	ZTX109	0·07						
OC42	*0·25	ZTX300	0·07						
OC44	*0·16	ZTX500	0·09						
OC45	*0·13	2N696	*0·10						
OC70	*0·10	2N697	*0·11						
OC71	*0·10	2N698	*0·20						
OC72	*0·15	2N699	*0·36						
OC74	*0·15								

VAT CHAT

Please add 8% to prices marked *. Remainder add 12½%. Do not add VAT to prices marked †.

THE FINEST VALUE IN UNTESTED SEMICONDUCTORS

Pak No.	Description	Price
U50	100 germ. gold bonded OA47 diode	*60p
U51	150 germ. OA70/81 diode	*60p
U52	100 silicon diodes 200mA OA200	*60p
U53	150 diodes 75mA 1N4148	*60p
U54	50 sil. rect. top hat 750mA	*60p
U55	20 sil. rect. stud type 3 amp	*60p
U56	50 400mW zeners DO7 case	*60p
U57	30 NPN trans. BC107/8 plastic	60p
U58	30 PNP trans. BC177/178 plastic	60p
U59	25 NPN TO39 2N697/2N1711 silicon	*60p
U60	25 PNP TO59 2N2905 silicon	*60p
U61	30 NPN TO18 2N706 silicon	*60p
U62	25 NPN BFY50/51	*60p
U63	30 NPN plastic 2N3904 silicon	60p
U64	30 PNP plastic 2N3905 silicon	60p
U65	30 germ. OC71 PNP	*60p
U66	15 plastic power 2N3055 NPN	*£1·20
U67	10 TO3 metal 2N3055 NPN	*£1·20
U68	20 unijunction trans. TIS43	*60p
U69	10 lamp SCR TO39	*£1·20
U70	8 3 amp SCR TO66 case	*£1·20

Code numbers mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

THYRISTORS

PIV	0·6A TO18	0·8A TO92	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
10	*0·13	*0·15	—	—	—	—	—	—	—	—
20	*0·15	0·13	—	—	—	—	—	—	—	—
30	*0·19	*0·22	—	—	—	—	—	—	—	—
50	*0·22	*0·28	*0·20	*0·25	*0·36	*0·36	*0·48	*0·51	*0·54	*1·18
100	*0·25	*0·30	*0·25	*0·25	*0·48	*0·48	*0·51	*0·57	*0·58	*1·43
150	*0·31	*0·38	—	—	—	—	—	—	—	—
200	*0·38	*0·44	*0·25	*0·30	*0·50	*0·50	*0·57	*0·62	*0·62	*1·63
400	—	—	*0·30	*0·39	*0·55	*0·57	*0·62	*0·71	*0·77	*1·79
600	—	—	*0·39	*0·48	*0·69	*0·69	*0·78	*0·89	*0·90	—
800	—	—	*0·58	*0·65	*0·81	*0·81	*0·92	*1·22	*1·39	*4·07

SILICON RECTIFIERS

PIV	300mA (DO 7)	750mA (SO 16)	1 Amp Plastic		1·5 Amp (SO 16)	3 Amp (SO 10)	10 Amp (SO 10)	30 Amp (TO 48)
50	0·05*	0·06*	IN4001	0·05*	0·07*	0·14*	0·19*	0·56*
100	0·05*	0·07*	IN4002	0·06*	0·09*	0·16*	0·21*	0·69*
200	0·06*	0·09*	IN4003	0·07*	0·12*	0·20*	0·23*	0·93*
400	0·07*	0·14*	IN4004	0·08*	0·14*	0·28*	0·35*	1·25*
600	0·08*	0·16*	IN4005	0·09*	0·18*	0·33*	0·42*	1·76*
800	0·11*	0·18*	IN4006	0·10*	0·18*	0·35*	0·51*	1·94*
1000	0·13*	0·28*	IN4007	0·11*	0·23*	0·44*	0·60*	2·31*
1200	—	0·32*			0·28*	0·54*	0·69*	2·88*

SIL. G.P. DIODES

300mW 40 PIV (min) SUB-MIN FULLY TESTED
Ideal for Organ builders
30 for *50p, 100 for *£1·50, 500 for *£5, 1,000 for *£9.

TRIACS

	Case	100V	200V	400V
2 Amp	TO5	*0·31	*0·51	*0·71
6 Amp	TO66	*0·51	*0·61	*0·77
10 Amp	TO48	*0·77	*0·92	*1·12

GP300

115 WATT SILICON TO3 METAL CASE
Vcbo 100V. Vceo 60V. IC 15A. Hfe. 20-100 suitable replacement for 2N3055. BDY11 or BDY20.

1–24	25–99	100+
*50p	*48p	*46p

GP Switching Trans

TO18 SIM. TO 2N706/8 BSY27/28/95A
All usable devices. No open and shorts. ALSO AVAILABLE IN PNP similar to 2N2906. BCY70.
20 for *50p, 50 for *£1, 100 for *£1·80, 500 for *£8, 1,000 for *£14.
When ordering please state NPN or PNP

WORLD SCOOP!!

JUMBO SEMICONDUCTOR PAK
Transistors-Germ. and Silicon.
Rectifiers-Diodes Triacs-Thyristors-I.C.'s and Zeners.
ALL NEW AND CODED
Approx. 100 pieces only *£1·85p

ZENER DIODES

FULL RANGE IN STOCK. 2-33 Volts
400mW *8p 1·5W *17p 10W *30p

HANDBOOKS

TRANSISTOR DATA BOOK
DTE 1 151 Pages packed with information on European Transistors. Full specification including outlines.
Price †£2·95 each

TRANSISTOR EQUIVALENT BOOK
BPE 75 256 Pages of cross references and equivalents for European, American and Japanese Transistors. This is the most comprehensive equivalents book on the market today and has an introduction in 13 languages.
Price †£2·68 each

DIODE EQUIVALENT BOOK
DE 74 144 Pages of cross references and equivalents for European, American and Japanese diodes. Zeners, Thyristors. Triacs. Diacs and L.E.D.'s.
Price †£1·98 each

THE WORLD'S BROADCASTING STATIONS
WBS 75 An up to the minute guide for those interested in DX-ing. Contains all the world's broadcasters on SW. MW and LW. as well as European FM/TV stations.
Price £3·58 each

TTL DATA BOOK
DIC 75 Now complete Data book of 74 series TTL (7400-74132). Covering 13 main manufacturers in the U.S.A. and Europe. this book gives full data as well as equivalents.
Price †£3·74 each

A full range of technical books available on request.

P&P

Postage and Packing add 25p unless otherwise shown. Add extra for airmail. £1 minimum order.

BI-PAK

P.O. BOX 6, WARE · HERTS

SEMI-CONDUCTORS

Linear IC's

Type	1	25	100+
72702	0·46	0·44	0·42
72709	0·23	0·21	0·19
72709P	0·19	0·18	0·17
72710	0·32	0·31	0·28
72741	0·28	0·27	0·26
72741C	0·26	0·25	0·24
72741P	0·28	0·27	0·26
72747	0·79	0·74	0·61
72748P	0·35	0·33	0·31
SL201C	0·46	0·42	0·37
SL701C	0·46	0·42	0·37
SL702C	0·46	0·42	0·37
TAA263	0·74	0·65	0·56
TAA293	0·93	0·88	0·83
TAA350	£1·71	£1·67	£1·57
μA703C	0·26	0·24	0·22
μA709C	0·19	0·18	0·17
μA711C	0·32	0·31	0·28
μA712C	0·32	0·31	0·28
μA723C	0·45	0·43	0·40
76003	£1·39	£1·34	£1·30
76023	£1·39	£1·34	£1·30
76660	0·88	0·86	0·83
LM380	0·93	0·90	0·88
*NE555	0·45	0·43	0·40
*NE556	0·88	0·86	0·83
TBA800	£1·39	£1·34	£1·30

Untested LIN Paks

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

Pak No.	Contents	Price
ULIC709 =	10 × 709	0·60
ULIC710 =	7 × 710	0·60
ULIC741 =	7 × 741	0·60
ULIC747 =	5 × 747	0·60
ULIC748 =	7 × 748	0·60

Untested Audio Paks
Comprising 5, I.C.'s:— 76003/76023 series
ONLY £1 per Pak
Complete with data

FM Stereo Decoder Pak
Comprising 5, I.C's:— like MC1307 and SN 76110
ONLY £1·50 per Pak
Complete with data

★ 74 Series TTL IC's

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

Type	1	25	100+
7400	0·09	0·09	0·08
7401	0·10	0·09	0·08
7402	0·11	0·10	0·09
7403	0·11	0·10	0·09
7404	0·13	0·12	0·11
7405	0·13	0·12	0·11
7406	0·25	0·24	0·23
7407	0·25	0·24	0·23
7408	0·15	0·14	0·13
7409	0·15	0·14	0·13
7410	0·09	0·09	0·08
7411	0·23	0·22	0·21
7412	0·26	0·25	0·24
7413	0·26	0·26	0·25
7416	0·28	0·27	0·26
7417	0·28	0·27	0·26
7420	0·12	0·11	0·10
7422	0·28	0·27	0·26
7423	0·30	0·28	0·26
7425	0·30	0·28	0·26
7426	0·30	0·28	0·26
7427	0·30	0·28	0·26
7428	0·42	0·38	0·36
7430	0·12	0·11	0·10
7432	0·30	0·28	0·26
7433	0·39	0·37	0·35
7437	0·30	0·28	0·26
7438	0·30	0·28	0·26
7440	0·12	0·11	0·10
7441	0·64	0·62	0·60
7442	0·65	0·63	0·61
7443	£1·10	£1·05	£1·00
7444	£1·10	£1·05	£1·00
7445	0·95	0·80	0·85
7446	£1·10	£1·05	£1·00
7447	0·67	0·65	0·63
7448	0·80	0·78	0·76
7450	0·12	0·11	0·10
7451	0·12	0·11	0·10
7453	0·12	0·11	0·10
7454	0·12	0·11	0·10
7460	0·12	0·11	0·10
7470	0·25	0·24	0·23
7472	0·22	0·21	0·20
7473	0·26	0·24	0·22
7474	0·27	0·25	0·23
7475	0·48	0·48	0·44
7476	0·25	0·24	0·23
7480	0·50	0·48	0·48
7481	£1·02	£1·00	0·98
7482	0·83	0·81	0·79
7483	0·98	0·96	0·94
7484	0·90	0·88	0·86
7485	£1·25	£1·20	£1·15
7486	0·32	0·30	0·29
7489	£2·90	£2·80	£2·70
7490	0·37	0·35	0·33
7491	0·60	0·58	0·56
7492	0·43	0·42	0·41
7493	0·43	0·42	0·41
7494	0·43	0·42	0·41
7495	0·70	0·68	0·66
7496	0·88	0·66	0·64
74100	£1·00	0·98	0·96
74104	0·40	0·38	0·36
74105	0·40	0·38	0·36
74107	0·36	0·34	0·32
74110	0·56	0·54	0·52
74111	0·83	0·81	0·79
74118	0·90	0·88	0·86
74119	£1·25	£1·20	£1·15
74121	0·26	0·26	0·25
74122	0·50	0·48	0·46
74123	0·58	0·56	0·54
74141	0·69	0·58	0·56
74145	0·96	0·94	0·92
74150	£1·30	£1·25	£1·20
74151	0·76	0·74	0·72
74153	0·95	0·93	0·91
74154	£1·50	£1·45	£1·40
74155	0·80	0·78	0·78
74156	0·80	0·78	0·76
74157	0·95	0·93	0·91
74160	£1·00	0·98	0·96
74161	£1·00	0·98	0·96
74162	£1·00	0·98	0·96
74163	£1·00	0·98	0·96
74164	£1·25	£1·20	£1·15
74165	£1·25	£1·20	£1·15
74166	£1·48	£1·44	£1·39
74174	£1·00	0·95	0·90
74175	0·95	0·93	0·91
74176	£1·16	£1·11	£1·06
74177	£1·10	£1·11	£1·06
74180	£1·10	£1·11	£1·06
74181	£2·00	£1·90	£1·80
74182	0·90	0·88	0·86
74164	£1·67	£1·62	£1·58
74190	£1·50	£1·45	£1·40
74191	£1·50	£1·45	£1·40
74192	£1·15	£1·10	£1·05
74193	£1·15	£1·10	£1·05
74194	£1·15	£1·10	£1·05
74195	0·80	0·78	0·76
74196	£1·00	0·98	0·96
74197	£1·00	0·98	0·96
74198	£2·10	£2·00	£1·90
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.

Mammoth IC Pak

APPROX. 200 PIECES
Assorted fall-out integrated circuits, including: Logic, 74 series, Linear, Audio and D.T.L. Many coded devices but some unmarked—you to identify.
OUR SPECIAL PRICE £1·20*

P&P
Postage and Packing add 25p unless otherwise shown. Add extra for airmail. Minimum order £1.

★ Indicators

3015F Minitron 7 Segment Indicator £1·11

L.E.D. DISPLAYS

DL707 Common anode 0·3" 85p. DL747 Jumbo common anode 0·6" £1·70. DL727 Double digit display, common anode 0·5" £2·00

L.E.D.'s

Available in 0·125" and 0·2" dia lenses
RED 10p. GREEN 17p. YELLOW 17p.
Mounting clips 2p. each

NIXI TUBE ITT 5870S.
Character height 13.46mm.
SPECIAL OFFER 5 for £2

★ DTL 930 Series

Type	1	25	100+
BP930	0·20	0·19	0·19
BP932	0·21	0·20	0·19
BP933	0·21	0·20	0·19
BP935	0·21	0·20	0·19
BP936	0·21	0·20	0·19
BP944	0·21	0·20	0·19
BP945	0·34	0·32	0·29
BP946	0·20	0·19	0·18
BP948	0·34	0·32	0·29
BP951	0·71	0·66	0·62
BP962	0·20	0·19	0·18
BP9083	0·48	0·46	0·44
BP9094	0·48	0·46	0·44
BP9097	0·48	0·46	0·44
BP9099	0·48	0·46	0·44

★ Untested TTL Paks

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

74G
100 Gates assorted 7400-01-04-10-50-60, etc. ***£1·20**

★ DIL Sockets

	1	25	100+
BPS8 8 pin type (low cost)	0·14	0·12	0·10
BPS14 14 pin type (low cost)	0·15	0·13	0·11
BPS16 16 pin type (low cost)	0·16	0·14	0·12
BPS24 24 pin type (low cost)	0·35	0·33	0·30

★ Voltage Regulators

TO.3 Plastic Encapsulation
μA.7805/L129 5V (equiv. to MVR5V) £1·25
μA.7812/L130 12V (equiv. to MVR12V) £1·25
μA.7815/L131 15V (equiv. to MVR15V) £1·25
μA.7818 18V (equiv. to MVR18V) £1·25

U74 SERIES IC PAKS

74F 50 Flip-Flops assorted, 7470-72-73-74-76-104-109, etc. ***£1·20**

U74 SERIES IC PAKS

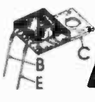
74M 30 MSI, assorted types, 7441-47-90-154, etc. ***£1·20**

VAT

PLEASE ADD 8% TO ITEMS MARKED ★ REMAINDER ADD 12½%

POW! POWER!!

R.C.A. 2N5295 NPN to 3 Plastic Power
VCE 50v.
VCB 60v.
P 36w. Ic 4A
hFE 30-120
ONLY **£1·50*** for 10



BI-PAK

P.O. BOX 6, WARE · HERTS
COMPONENT SHOP:
18 BALDOCK ST., WARE. Tel. 61593

R.C.S. 10 WATT AMPLIFIER KIT

This kit is suitable for record players, tape play back, guitars, electronic instruments or small P.A. systems. Two versions are available. A mono kit or a stereo kit. The mono kit uses 13 semiconductors. The stereo kit uses 22 semiconductors with printed front panel and volume, bass and treble controls. Spec. 10W output into 8 ohms, 7W into 15 ohms. Response 20c/s to 30kc/s, input 100M.V. high imp. Size 9¼in × 3in × 2in.

Mono kit **£11·25** Stereo kit **£18** post 45p

Easy to build. Full instructions supplied.

ELAC 10 inch

Dual cone plasticised roll surround. Large ceramic magnet. 50–16,000 c/s. Bass resonance 55 c/s. 8 ohm impedance. 10W.

9 × 5in. model £3·25. **£4·95**

MAINS TRANSFORMERS

ALL POST 50p each.

250–0–250V 70mA, 6·3, 2A £2·95
250–0–250 80mA, 6·3V 3·5A, 6·3V 1A or 5V 2A £4·60
350–0–350 80mA, 6·3V 3·5A, 6·3V 1A or 5V 2A £5·80
300–0–300 120mA. 6·3V 4A C.T., 6·3V 2A £7·00
220V 45mA, 6·3V 2A £1·75p
HEATER TRANS. 6·3V 3A, £1·45 ½ amp. 95p
GENERAL PURPOSE LOW VOLTAGE.
Tapped outputs at 2A 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V £4·60
1A 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £4·60
2A, 6, 8, 12, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £7·00
3A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £8·70
5A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £11·25
5, 8, 10, 16V ½A £2. 6–0–6V 500mA £1. 9V 1A £1
12V 300mA £1. 12V 500mA £1. 12V 750mA £1.
40V 2A tapped 10V or 30V £2·50. 20V 3A £2.
40V 3A £2·50. 30V 5A + 34V 2A ct. £3·75.
20–0–20V 1A £2. 30V 1½A £1·75. 20V 1A £1·80.
60V, 40V, 20V or 20-0-20V, 1A £3·50.
AUTO TRANSFORMERS. 115V to 230V or 230V to 115V 150W £5; 250W £6; 400W £7; 500W £8.
CHARGER TRANSFORMERS. Input 200/250V for 6 or 12V 1½A £2·75; 4A £4·60.
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12V outputs 1½A 40p; 2A 55p; 4A 85p.

R.C.S. STABILISED POWER PACK KIT

All parts including printed circuit and instructions to build this unit. Voltages available: 6V, 7·5V, 9V, 12V. Up to 100mA output. Please state voltage required. **£2·95** Post 45p.

R.C.S. STEREO FM TUNER

This completely cased mains powered Hi-Fi Tuner with brushed aluminium facia is British made using the latest circuitry. Bargain. **£27·50** Post 45p

Stereo Tuner/Amplifier Chassis. Brand new £38·50.

BARGAIN 3W AMPLIFIER. 4 Transistor Push-Pull Ready built with volume, treble and bass controls. 18 volt battery operated. **£3·95**

WAFER THIN HEATING ELEMENTS

Size 10¾ × 8½ × $\frac{1}{16}$in. Operating voltage 200/250V a.c. 250W approx. Suitable for Heating Pads, Food Warmers, Convector Heaters, etc. Must be clamped between two sheets of metal or asbestos.

ONLY **40p** EACH (FOUR FOR £1·50)

ALL POST PAID—Discounts for quantity.

E.M.I. 13½ × 8in SPEAKER SALE!

With tweeter. And crossover. 10W. State 3 or 8 ohm. As illustrated. **£5·25** Post 45p

15W model £7·95 8 or 15 ohms. Post 50p

20W model £8·95 8 or 15 ohms. Post 50p

BAKER MAJOR 12 £10·35

Post 50p

30–14,500 c/s. 12in double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s. Rated 25W. NOTE: 3 or 8 or 15 ohms must be stated.

Module kit, 30–17,000 c/s with tweeter, crossover, baffle and instructions. As illustrated. **£13**

Please state 3 or 8 or 15 ohms. Post 80p

"BIG SOUND" BAKER SPEAKERS

Robustly constructed to stand up to long periods of electronic power. As used by leading groups and discos. Useful response 30–13,000 c/s. Bass Resonance 55 c/s.

GROUP "25" 12in 30W 3, 8 or 15 ohms. **£8·95** Post 50p

GROUP "35" 12in 40W 3, 8 or 15 ohms. **£10·50** Post 50p

GROUP 50/12in 60W 8 or 15 ohms with aluminium presence dome. **£14·50** Post 90p

GROUP "50" 15in 75W 8 or 15 ohms. **£19·50** Post 90p

Disco, Group + PA Cabinets in stock. Send for Leaflet. Cabinet Fittings, Handles, Corners, Feet, Covering Material all in stock.

BAKER 150 WATT ALL PURPOSE TRANSISTOR MIXER AMPLIFIER

Ideal for Groups, Disco, P.A. and Musical Instruments. 4 inputs speech and music. 4 way mixing. Output 4/8/15 ohm. a.c. Mains Separate treble and bass controls. **£68** Carr. £1·50

50 watt model £49.

NEW 'DISCO 100 WATT' £52

ALL TRANSISTOR AMPLIFIER CHASSIS 2 inputs. 4 outputs separate volume treble and bass controls. Ideal disco or slave amplifier chassis. Carr. £1

BLACK CARRYING CABINET AVAILABLE £9.

PW SOUND TO LIGHT DISPLAY

Complete kit of parts with R.C.S. printed circuit. Three 1,000W channels. As featured in Practical Wireless. **£12·50** CABINET extra £3.

GOODMANS CONE TWEETER

18,000 c/s. 25W 8 ohm. Price **£3·25**

8in Woofer £6·75.

R.C.S. 100 WATT VALVE AMPLIFIER CHASSIS

Professional model. Four inputs. Treble, Bass, Master Volume Controls. Ideal disco, P.A. or groups. **£85**
S.A.E. for details. 5 speaker outputs.
3 or 8 or 15 ohm. 100V line to order. plus £2·50 carr.
Suitable carrying case £16·50.

E.M.I. GRAM MOTOR 120V or 240V a.c. 2,400 r.p.m. 2-pole 70mA. Size 2¾ × 2¼ × 2¼in. **£1·25** Post 30p

E.M.I. TAPE MOTOR 4 pole, 240V a.c. 185 mA 1,400 r.p.m. Spindle $\frac{3}{16}$in dia. 75V version £1. (Illustrated). Size 3½ × 2½ × 2¼in. **£2·00** Post 30p

COLLARO GRAM MOTOR 120V GEAR BOX 25:1 95p. **75p**

PHILIPS GRAM MOTOR 6 VOLT A.C. £2.50

NEW BSR HI-FI AUTOCHANGER

Plays 12in, 10in or 7in records Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. A.c. 200/250V. Size 13¾ × 11¼in. Above motor board 3¼in. Below motor board 2½in. With STEREO/MONO CARTRIDGE. **£11·95**

Single Player version £15·50. All Post 75p

GARRARD AUTOCHANGER Model 6300 £14·95
GARRARD MINICHANGER 12 × 8in £8·95

PORTABLE PLAYER CABINET £4·50

Post 50p.

Modern design. Size 16in × 15in × 7in rexine covered. Large front grille. Hinged lid. Chrome fittings. Motor board cut for Garrard or BSR deck.

R.C.S. DISCO DECK SINGLE RECORD PLAYER

Fitted with auto stop, stereo/compat. cartridge. Baseplate. Size 11in × 8½in. Turntable. Size 7in diameter. A.c. mains. 220/250V.

3 speeds plays all size records. **£6·95** Post 45p

Two for £13. Post 75p.

HEAVY METAL PLINTHS

With P.V.C. Cover. Cut out for most B.S.R. or Garrard decks. Silver grey finish. **£5·95**

Model "A". Size 12½ × 14¾ × 7¼in.
Model "B". Size 16 × 13¾ × 7in. £6·95. Post 75p.
Extra Large Plinth and Cover. Size 20 × 17½ × 9in. Callers only £18·50.

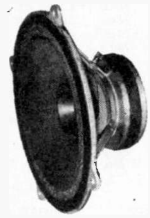
TINTED PLASTIC COVERS ONLY
Sizes: 'A'—14¼in × 12¾in × 4¼in, £2·50. 'B'—20¾in × 12¾in × 4¼in, £3. 'C'—17¾in × 13¾in × 3¼in, £3·25. 'D'—16¼in × 14in × 4in, £3·50.
Ideal for record decks, tape decks, etc. Post 75p.

BAKER HI-FI SPEAKERS

HIGH QUALITY—BRITISH MADE

SUPERB

12in 25 watts



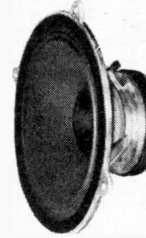
A high quality loudspeaker, its remarkable low cone resonance ensures clear reproduction of the deepest bass. Fitted with a special copper drive and concentric tweeter cone resulting in full range reproduction with remarkable efficiency in the upper register.

Bass Resonance 25 c/s
Flux Density 16,500 gauss
Useful response 20–17,000 c/s
8 or 15 ohms models.

£16·30 Post 80p.

AUDITORIUM

12in 35 watts



A full range reproducer for high power. Electric Guitars, public address, multi-speaker systems, electric organs. Ideal for Hi-Fi and Discotheques.

Bass Resonance 35 c/s
Flux Density 15,000 gauss
Useful response 25–16,000 c/s
8 or 15 ohms models.

£15·50 Post 80p.

15in model 45 watts £19·50. Post 90p.

BLANK ALUMINIUM CHASSIS, 18 s.w.g. 2½in sides, 6in × 4in, 70p; 8in × 6in, 90p; 10in × 7in, £1·15; 14in × 9in, £1·50; 16in × 6in, £1·45; 12in × 3in, 87p; 16in × 10in, £1·70. 12in × 8in, £1·35.

ALUMINIUM PANELS, 18 s.w.g. 6in × 4in, 15p; 8in × 6in, 25p; 10in × 7in, 30p; 12in × 5in, 30p; 12in × 8in, 40p; 16in × 6in, 45p; 14in × 9in, 50p; 12in × 12in, 55p; 16in × 10in, 75p.

ALUMINIUM ANGLE BRACKET, 6in × ½in × ½in, 15p.
ALUMINIUM BOXES MANY SIZES IN STOCK.

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, CROYDON
Open 9—6 Wed. 9—1 Sat. 9—5 (Closed for lunch 1.15—2.30)

Minimum post 30p. Access and Barclaycard Welcome. Radio Books and Components Lists 10p. Rail Selhurst. Tel. 01-684 1665

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.

F.E.B.

Editor
F. E. BENNETT

Editorial
G. C. ARNOLD *Assistant Editor*
D. BARRINGTON *Production Editor*
G. GODBOLD *Technical Editor*

Art Dept.
J. D. POUNTNEY *Art Editor*
D. J. GOODING
R. J. GOODMAN
K. A. WOODRUFF

Advertisement Manager
D. W. B. TILLEARD
Phone: 01-634 4504

P. J. MEW
Phone: 01-634 4181

C. R. BROWN *Classified*
Phone: 01-261 5762

Make-up and Copy Dept.
Phone: 01-634 4372

Editorial & Advertising Offices:
Fleetway House, Farrington St.
London EC4A 4AD
Phone: *Editorial* 01-634 4452
Advertisements 01-634 4504

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.

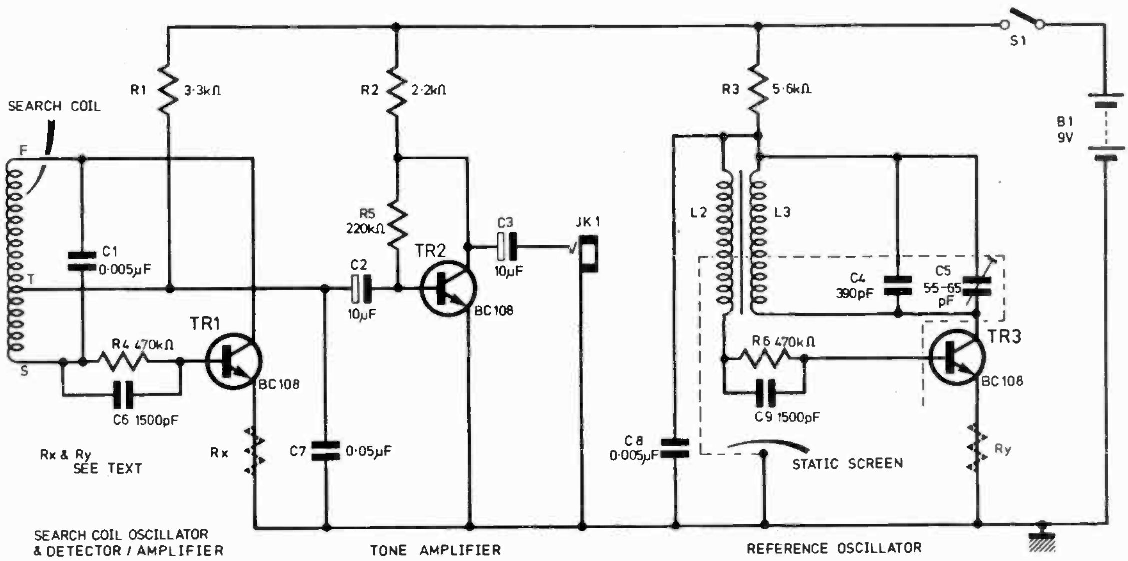


Fig. 1. Circuit diagram of the metal pipe and wiring locator

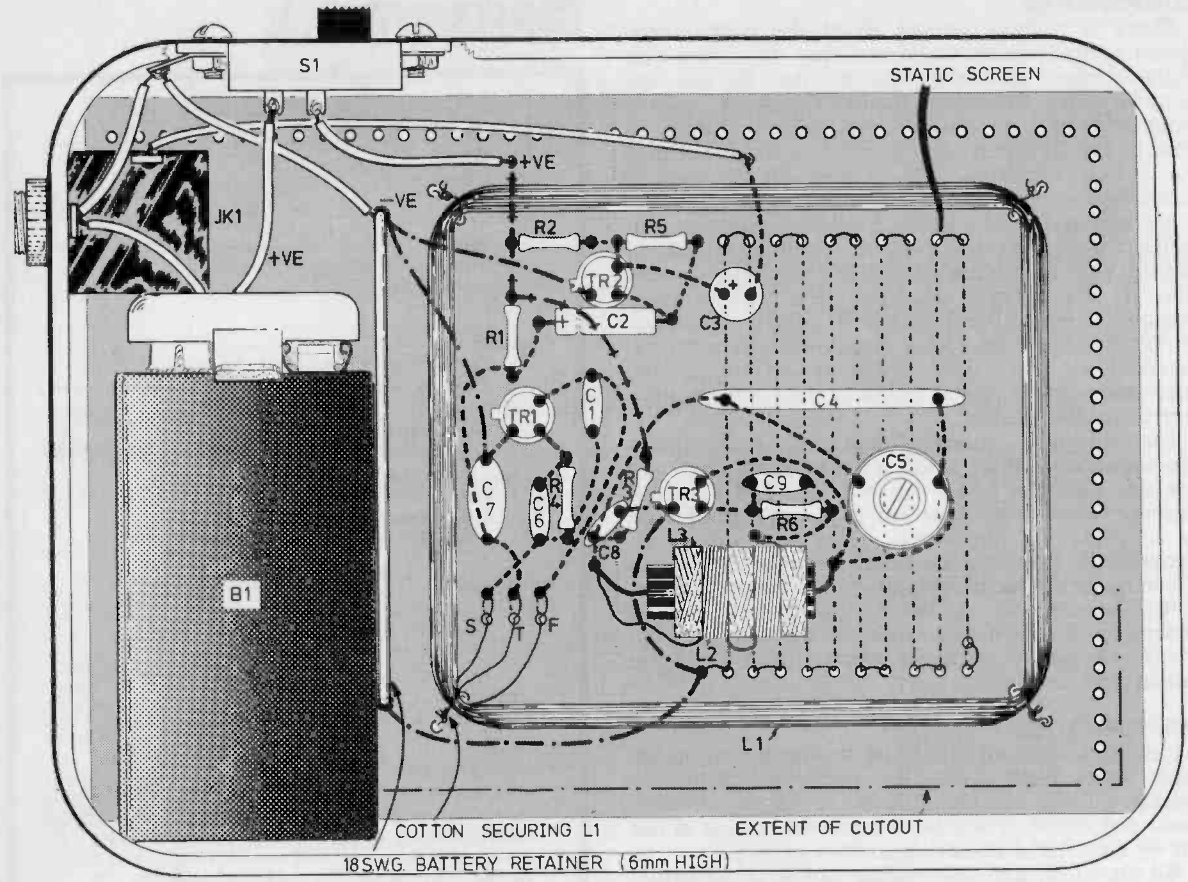


Fig. 2. Component layout and wiring details. All wiring shown in broken line is done on the underside of the board. The static screen is insulated from that wiring by a layer of Sellotape, etc. (see text)

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.

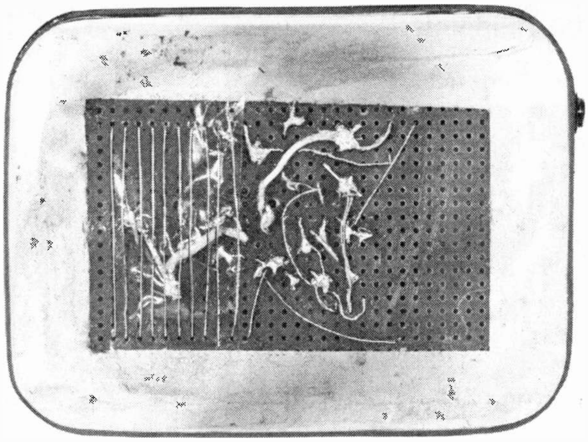


Fig. 3. Underside view of the prototype unit, showing the static screen laid across the board wiring and insulated from it

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. ★

NEXT MONTH...

WIN A MICROPROCESSOR KIT
FREE ENTRY COMPETITION
Full details and entry coupon in NEXT MONTH'S ISSUE

MOTORING

Car Exhaust Monitor

Petrol prices up yet again? Keeping an eye on your driving technique with this unit can cut motoring costs.

RADIO CONTROL

4-Channel Coder/Decoder

A simple, low cost, four-channel tone coded system based on an NE555 coder and TTL decoder circuits.

AUDIO

Microphone Mixer

A versatile two-channel stereo/four-channel mono mixer with high and low impedance inputs available.

PRACTICAL ELECTRONICS
JANUARY ISSUE ON SALE DECEMBER 10

Build this companion to the P.E. Orion Stereo Amplifier PART 2

F.M. STEREO TUNER

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.

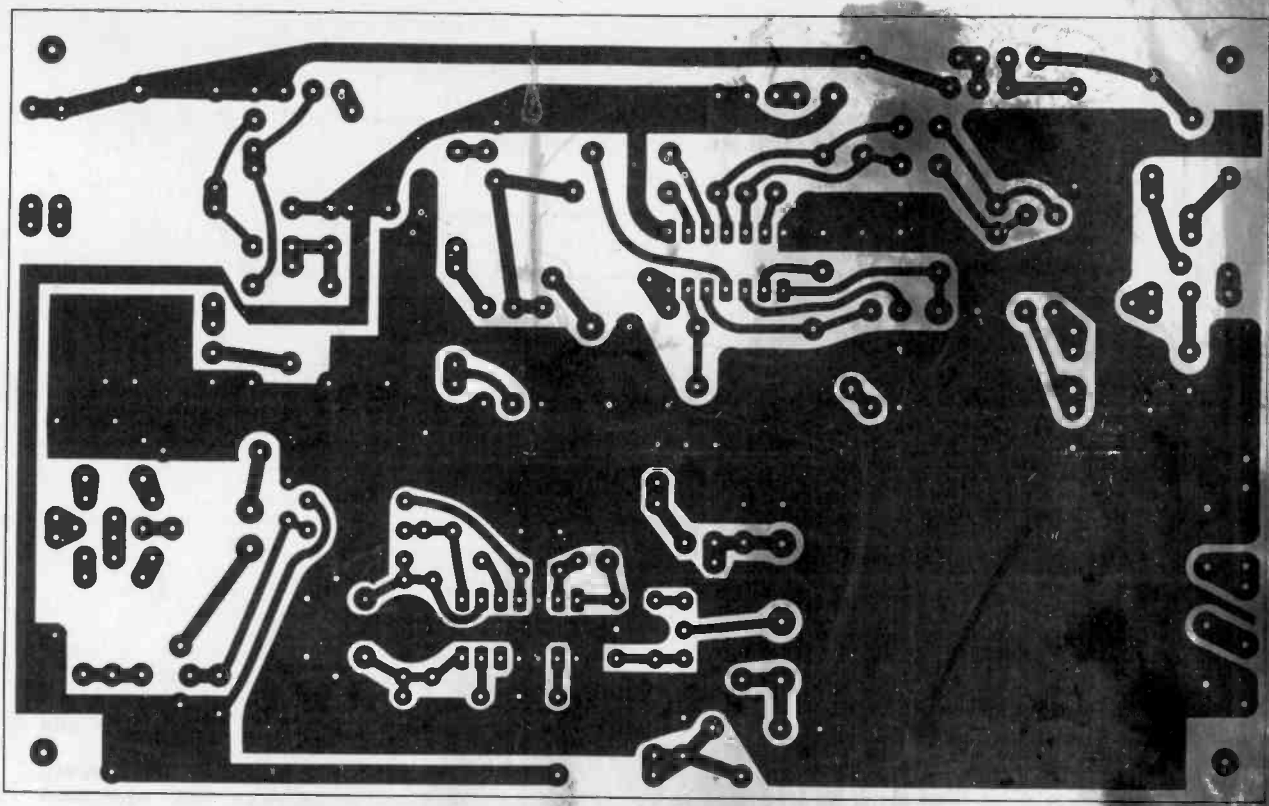


Fig. 2.1. Copper pattern for p.c.b.

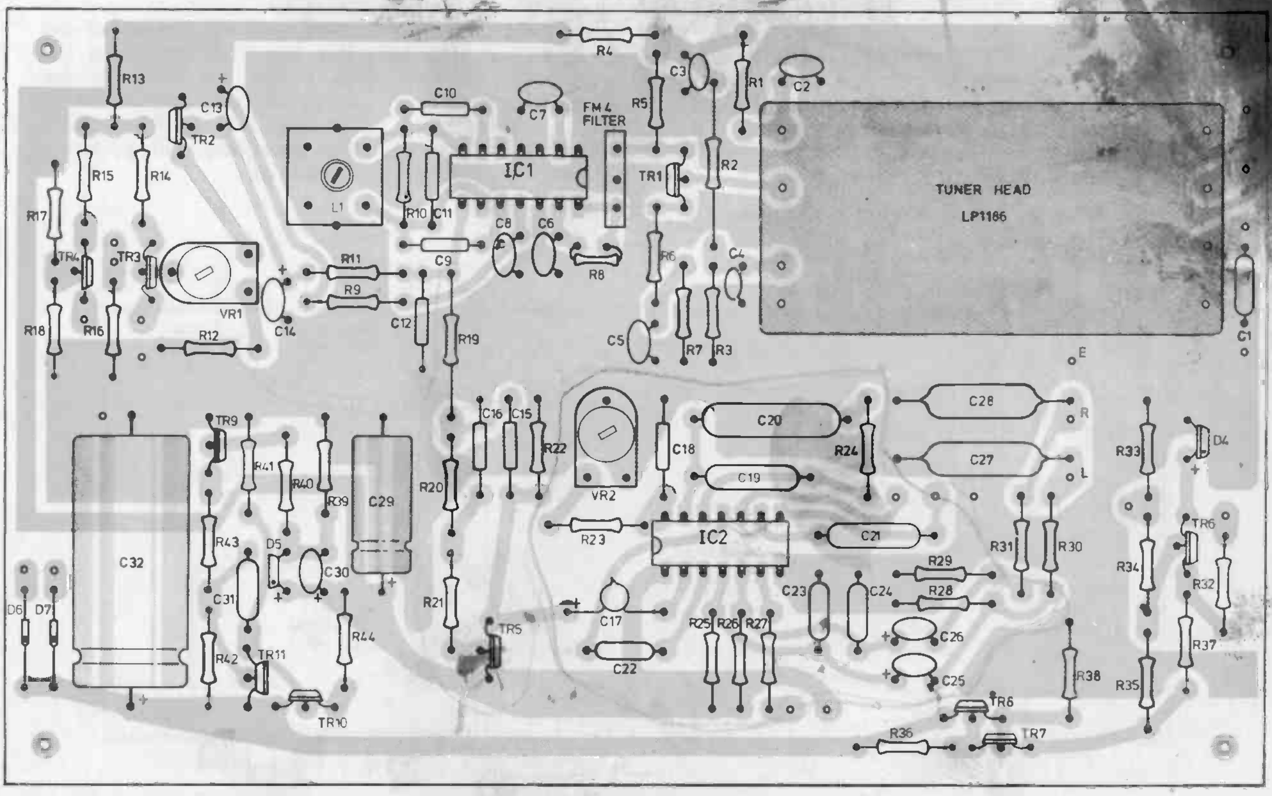


Fig. 2.2. Disposition of components on p.c.b.

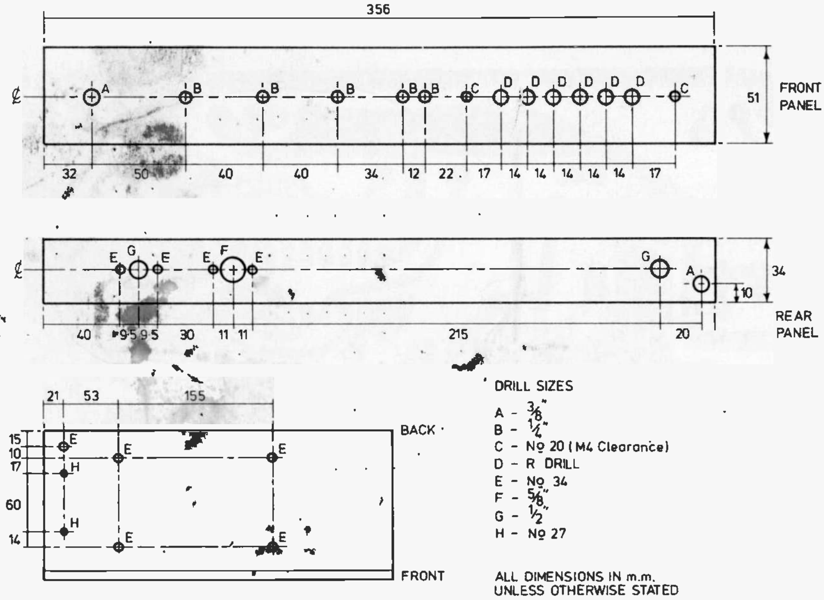


Fig. 2.3. Drilling details for the G.B.1 box

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.

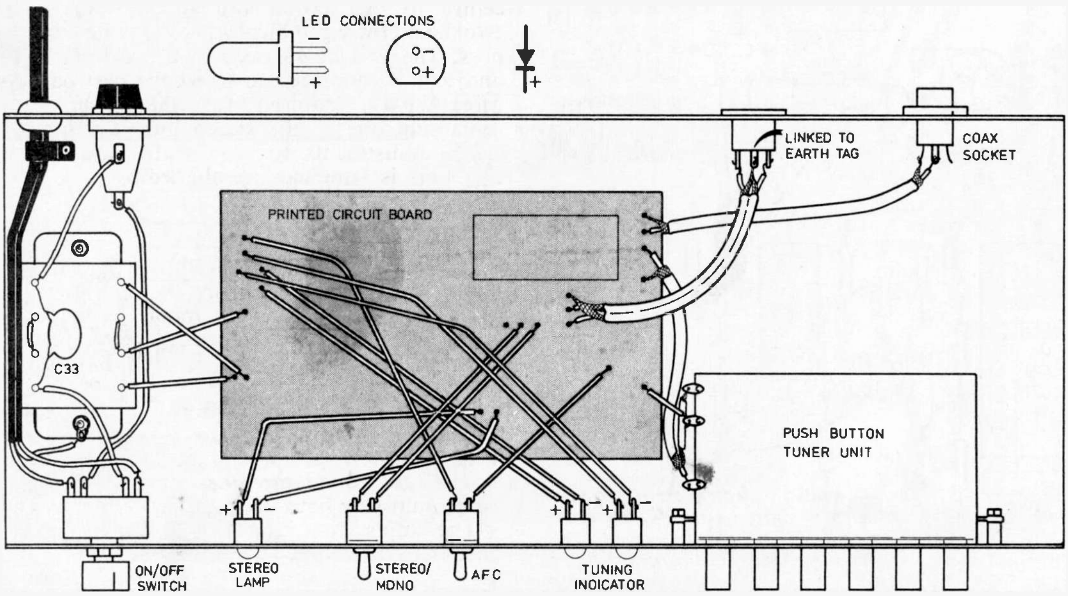
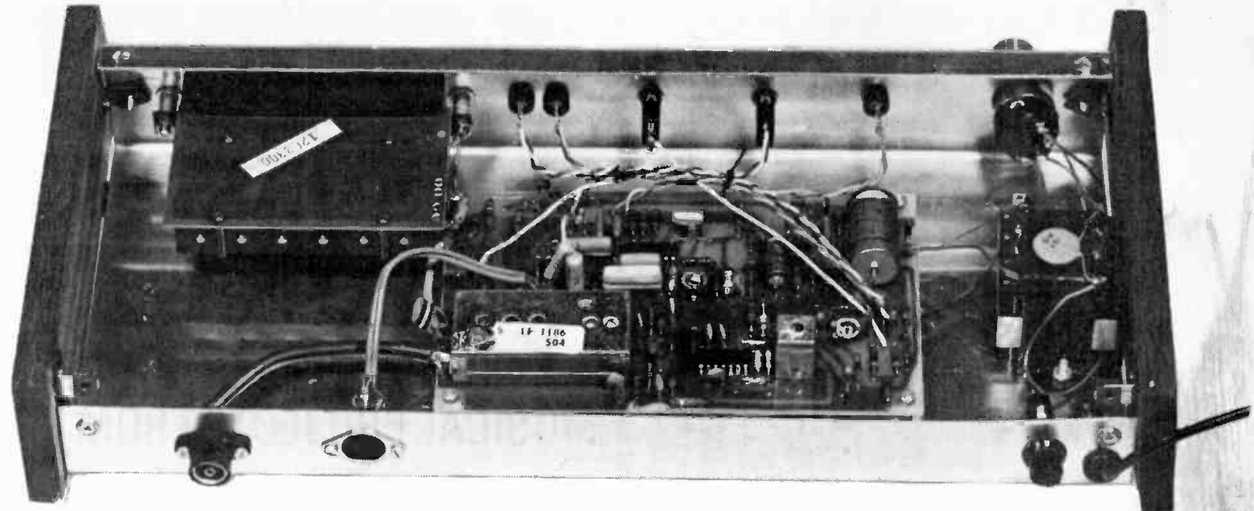


Fig 2.4. External wiring to p.c.b.



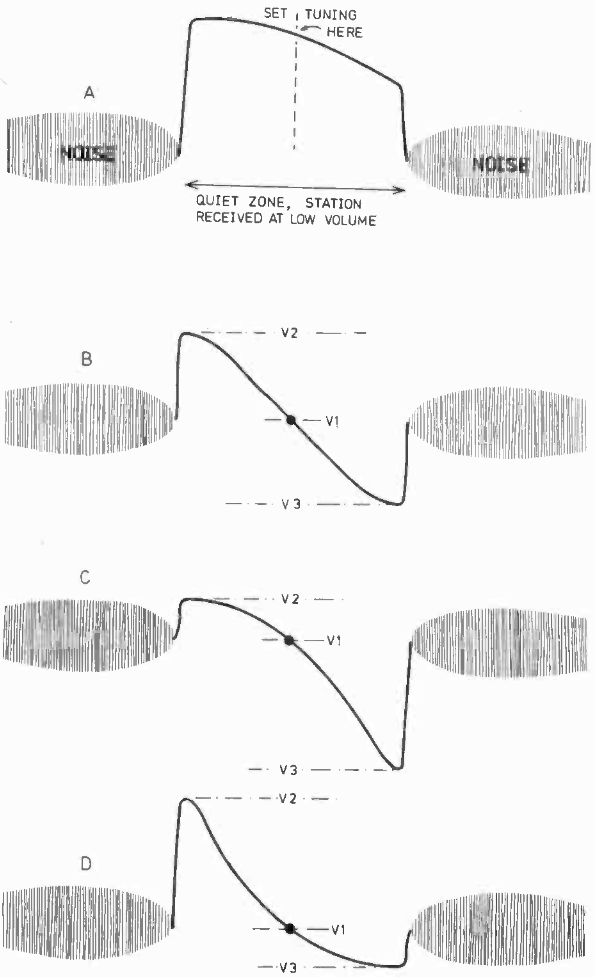


Fig. 2.5. At the start of the alignment procedure the tuner will probably behave as shown in (A) as it is tuned through a station. With L1 adjusted for maximum volume the discriminator curve should be as shown above (B) with V2 and V3 spaced equally about V1. If the adjustment of L1 is not quite correct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

* Applications Engineer, National Semiconductor (U.K.) Ltd.

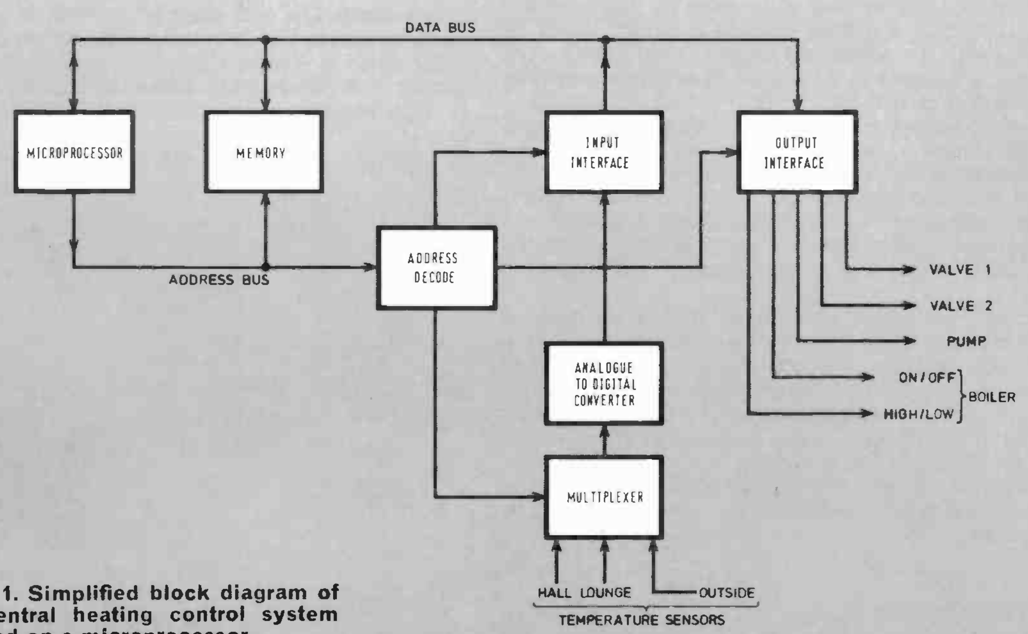


Fig. 1. Simplified block diagram of a central heating control system based on a microprocessor

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 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 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.

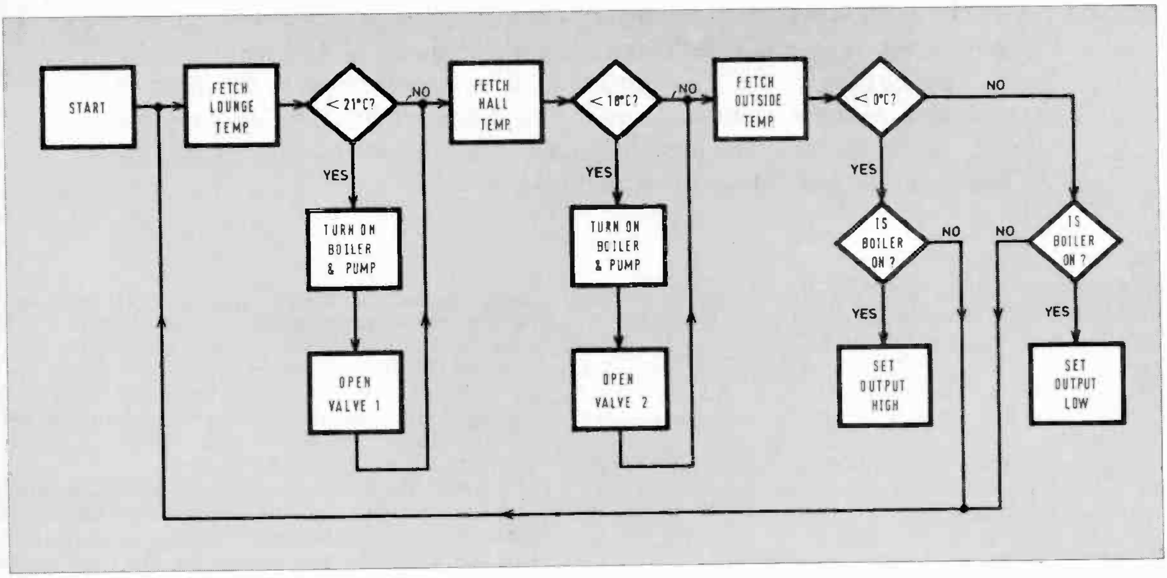
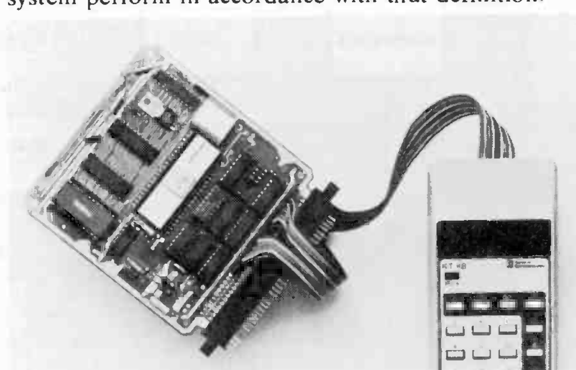


Fig. 2. Flow chart representing the sequence of decisions and commands required to control the central heating system

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.

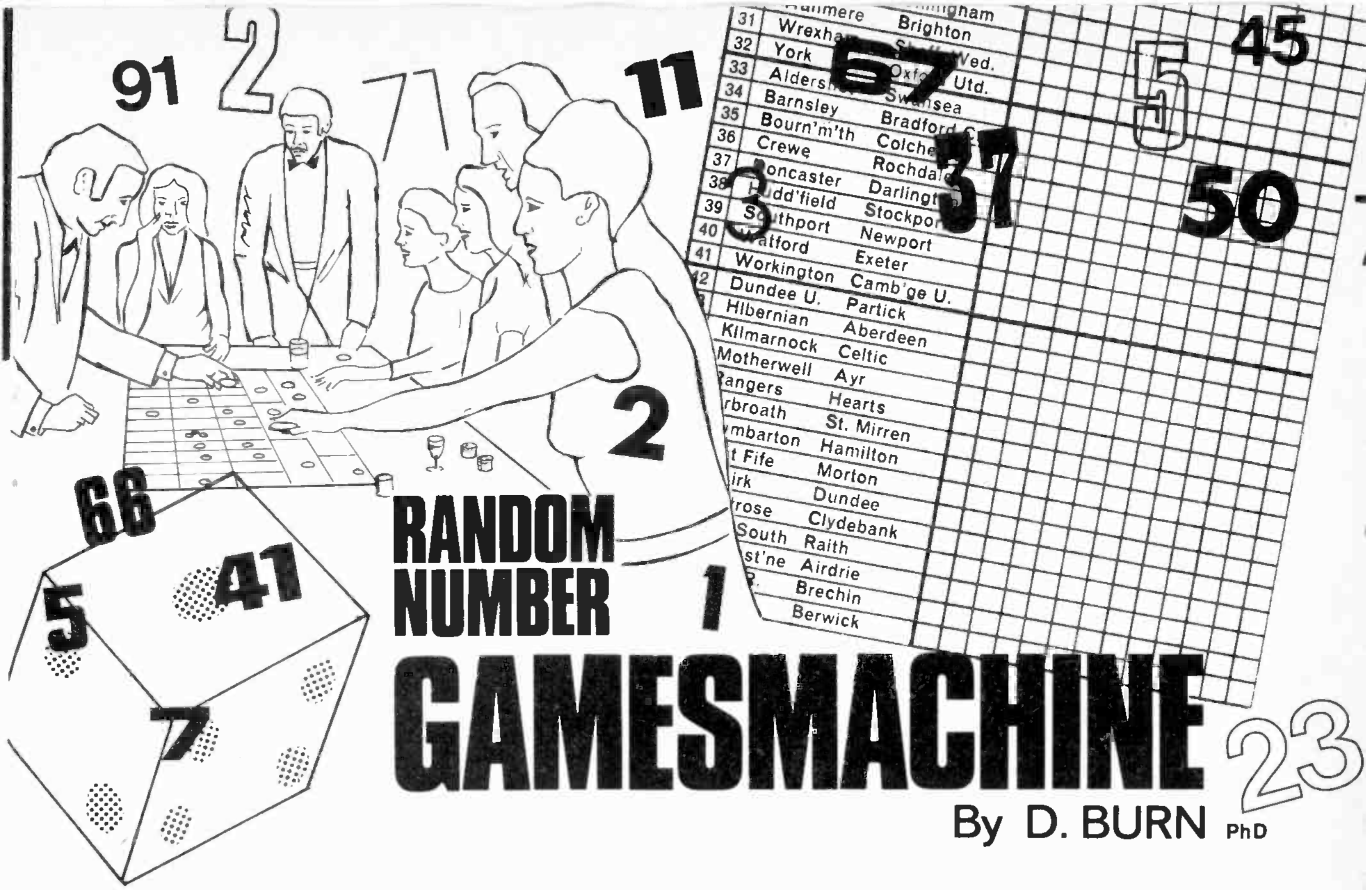
The programme he now commands is a co-operative one by socialist countries. The main object is the improvement of scientific methods and the study from outer space of geological and geographical features of the Earth's surface.

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 7½ per cent or as little as 1 per cent) is too random to start a scare, often to little purpose or benefit to mankind.



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.

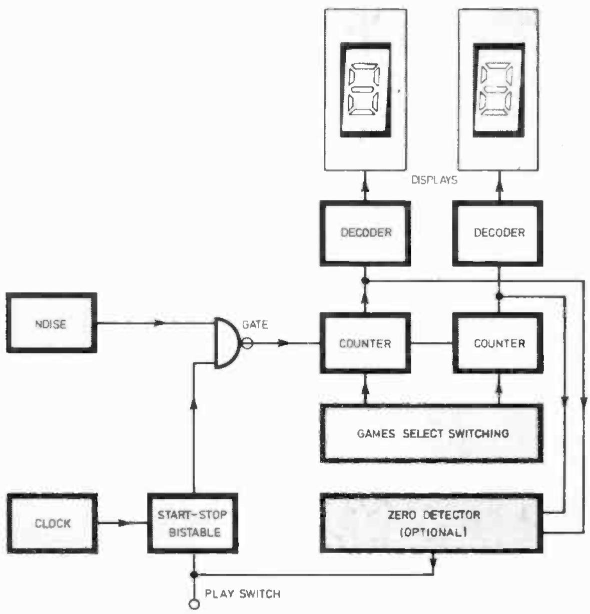


Fig. 1. Block diagram of unit

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)

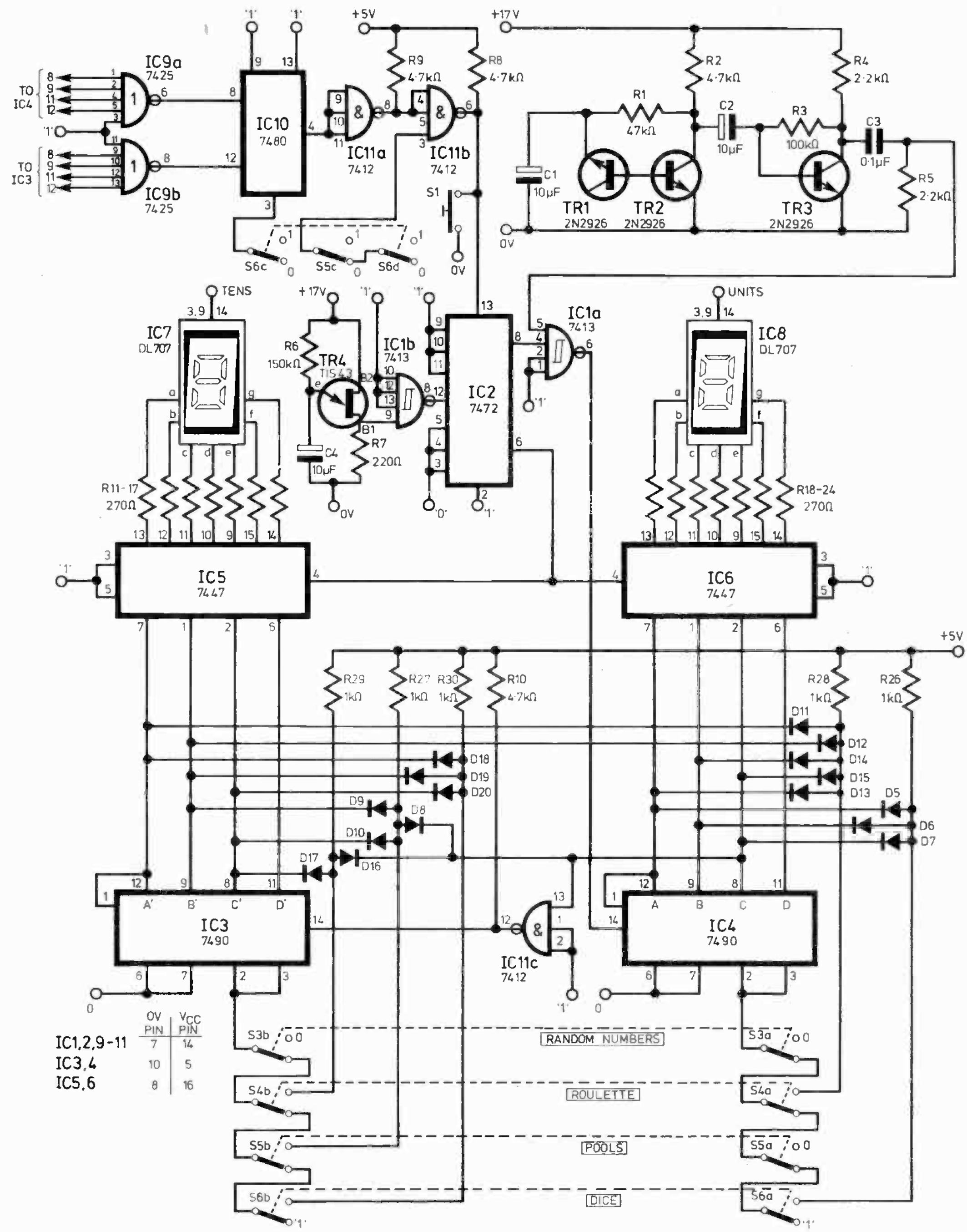


Fig. 2. Pulse circuitry for the Games Machine

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.

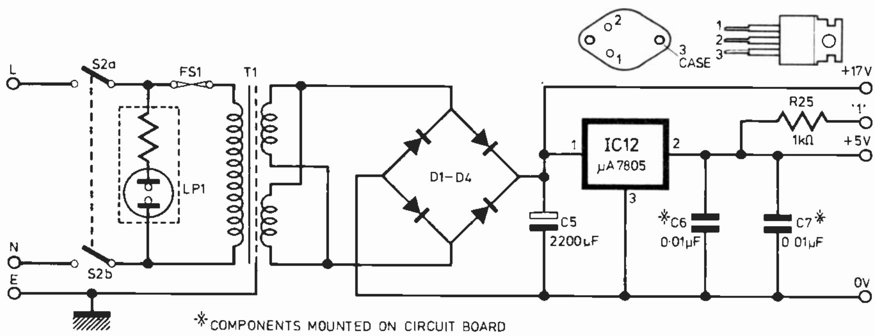


Fig. 3. Mains power unit

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 ¼W 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.

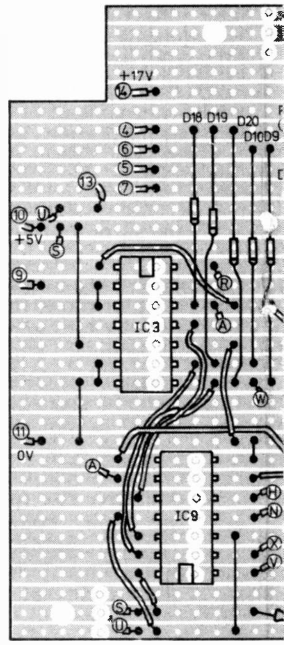
Switches

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



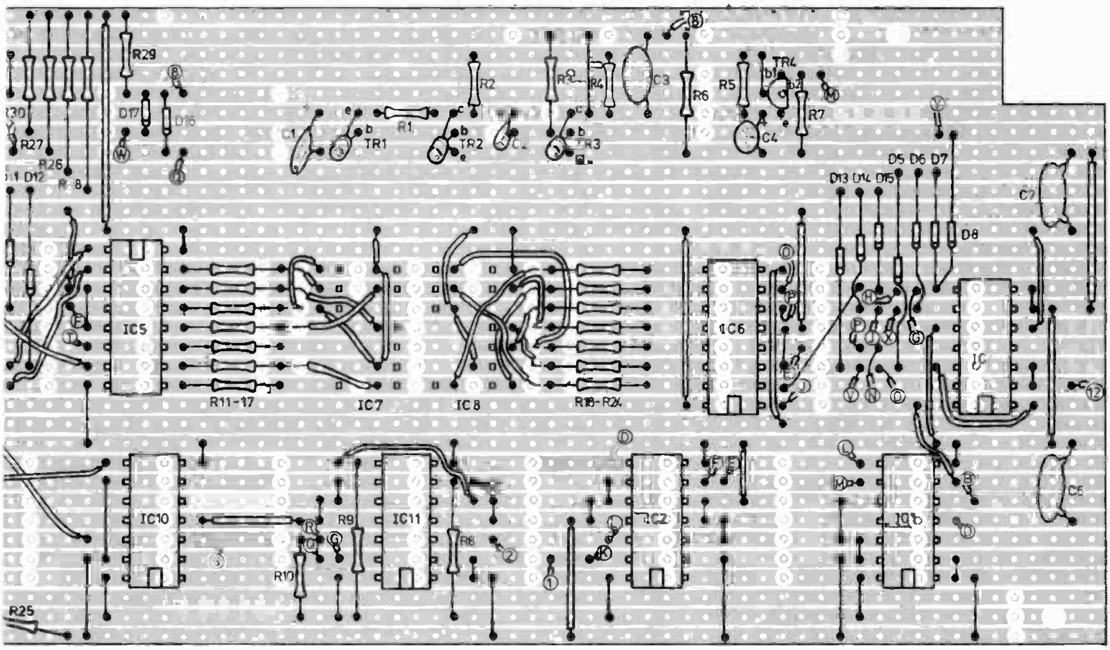


Fig. 4. Main board wiring and assembly

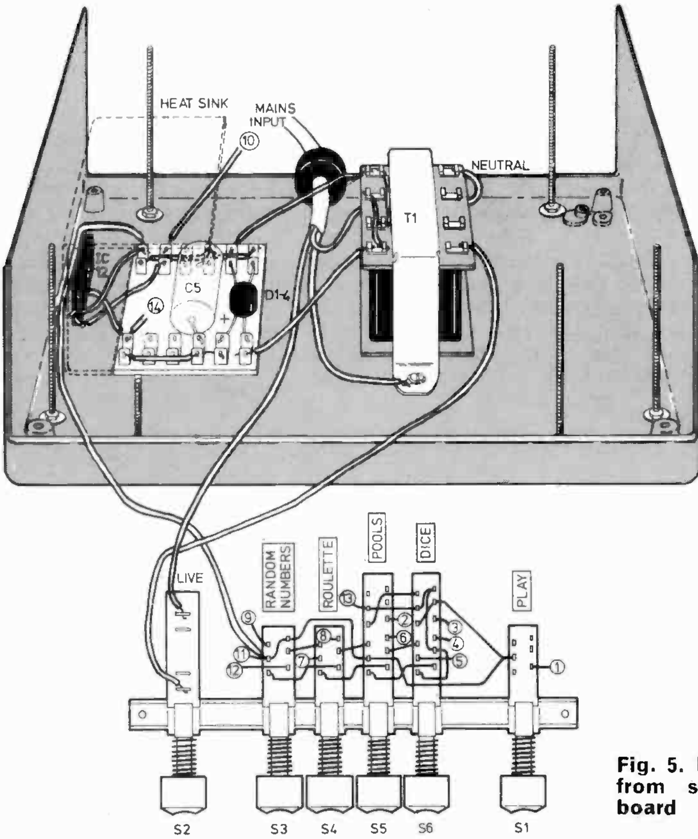
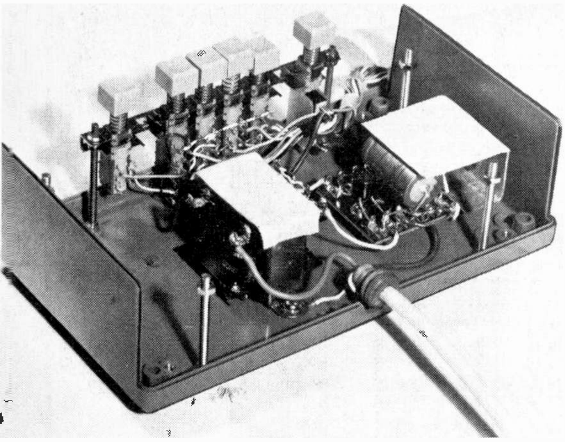


Fig. 5. P.s.u. assembly and wiring from switch assembly to main board



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.

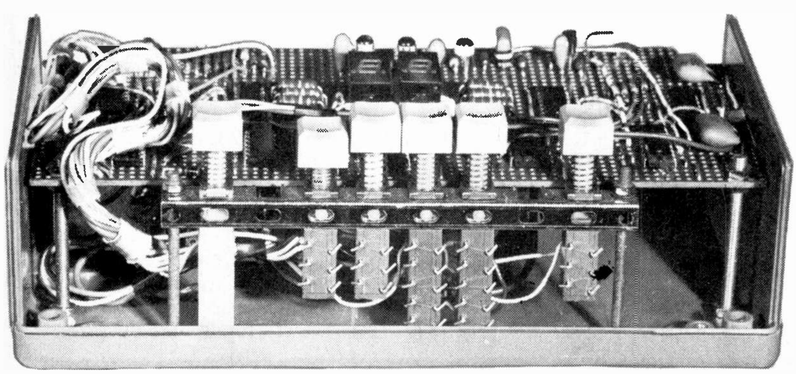
However, this circuit is only required to operate on the dice and pools options, so a second gate IC11b is enabled by application of a "1" to one of its inputs by S5c or S6d when these games are selected: selection of the other alternatives disables this gate so that its output is permanently "1". So 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

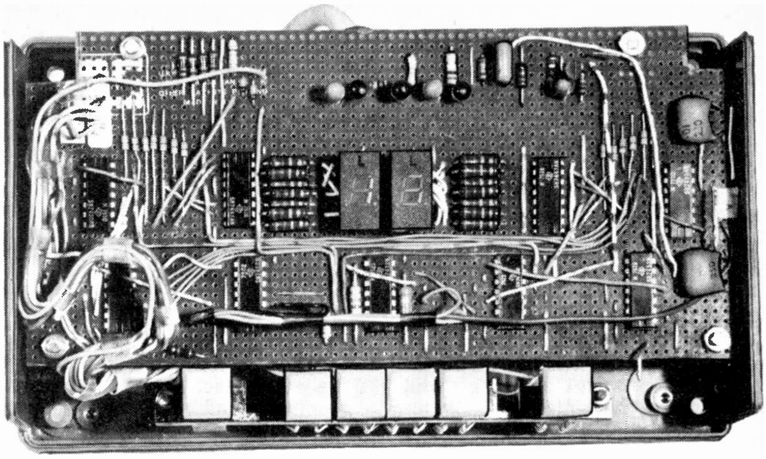
Most of the components, and all of the i.c.s, are mounted on a single piece of 0·1in matrix Veroboard approximately 86 × 180mm; the length in particular should be trimmed so that the board is a snug fit in the case. Note the two cut-outs to clear the fixing pillars which are moulded into the case.

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 push-button 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.

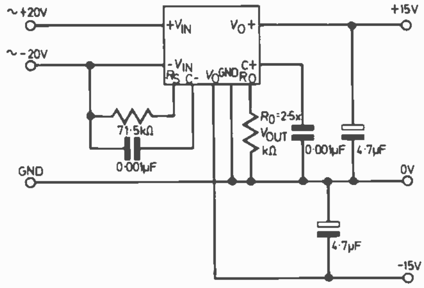


Fig. 1. The RC4194 used for an op amp supply

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!

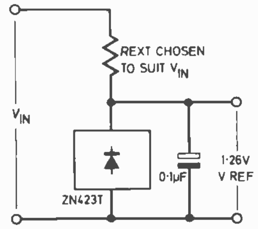


Fig. 2. The ZN423T as an accurate voltage reference

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.

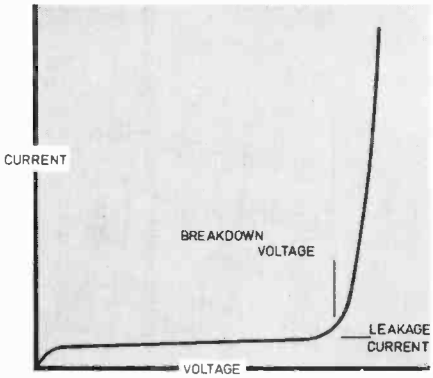


Fig. 1. Typical breakdown characteristic of a semiconductor junction

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

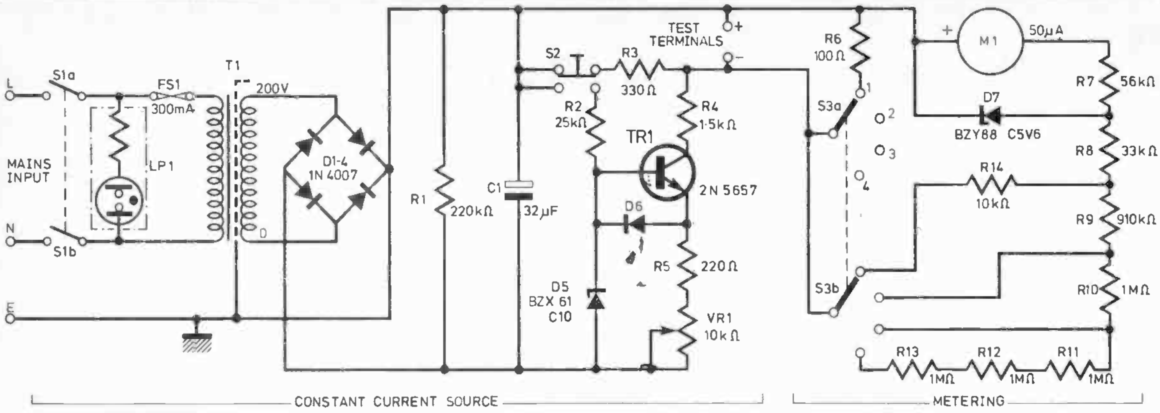
M1	50μA f.s.d. Coil resistance 1kΩ
T1	Pri: 240V. Sec: 200V 50mA approx. (e.g. Belclere MS3173)
S1	DPST mains toggle switch
S2	Press to changeover, momentary action microswitch
S3	2P 4W rotary switch
FS1	300mA A/S fuse and holder
LP1	Mains neon indicator

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
S1a
FS1
300mA
T1
200V
MAINS INPUT
LP1
N
S1b
E
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
1MΩ
R12
1MΩ
R11
1MΩ
CONSTANT CURRENT SOURCE
METERING

Fig. 2

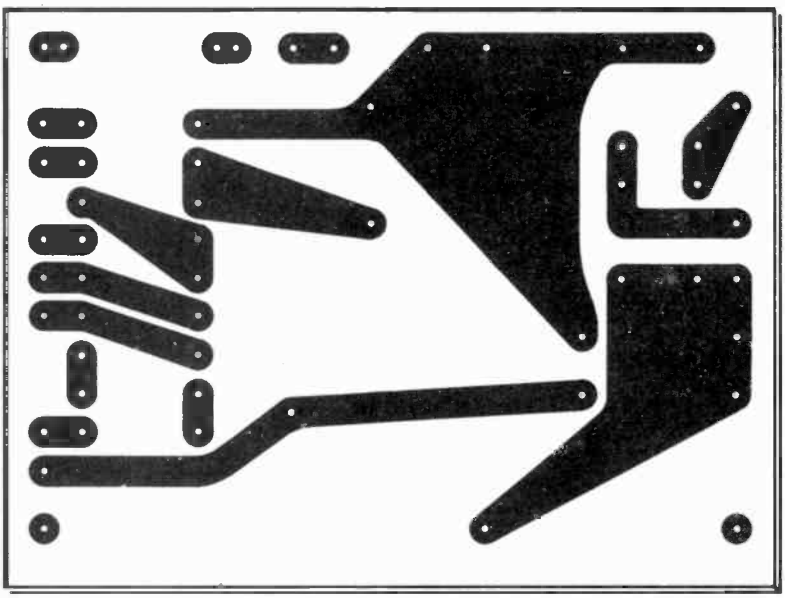
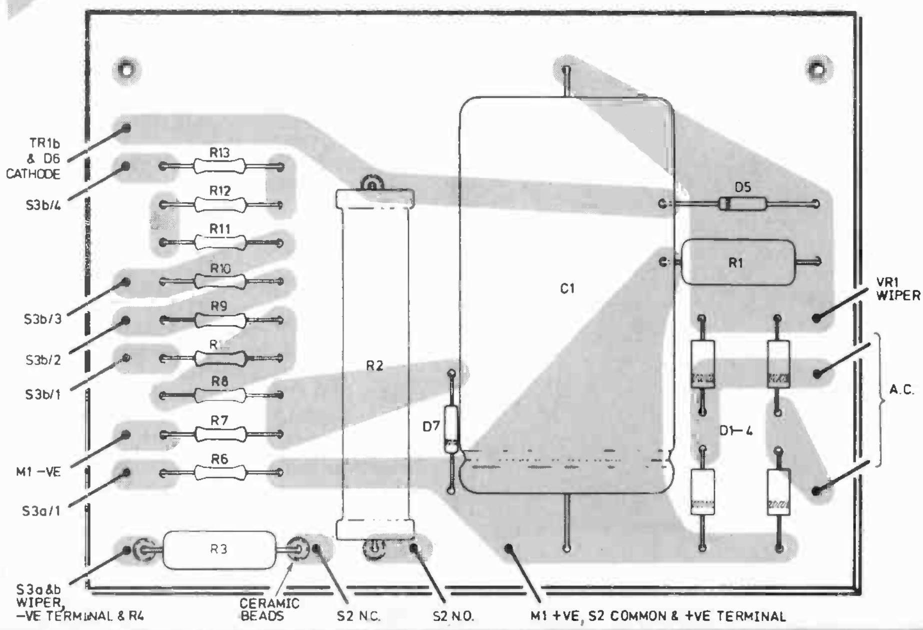


Fig. 3



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
R8
R7
R6
R3
R2
C1
D7
D5
R1
D1–4
VR1 WIPER
A.C.

PRACTICAL CIRCUIT

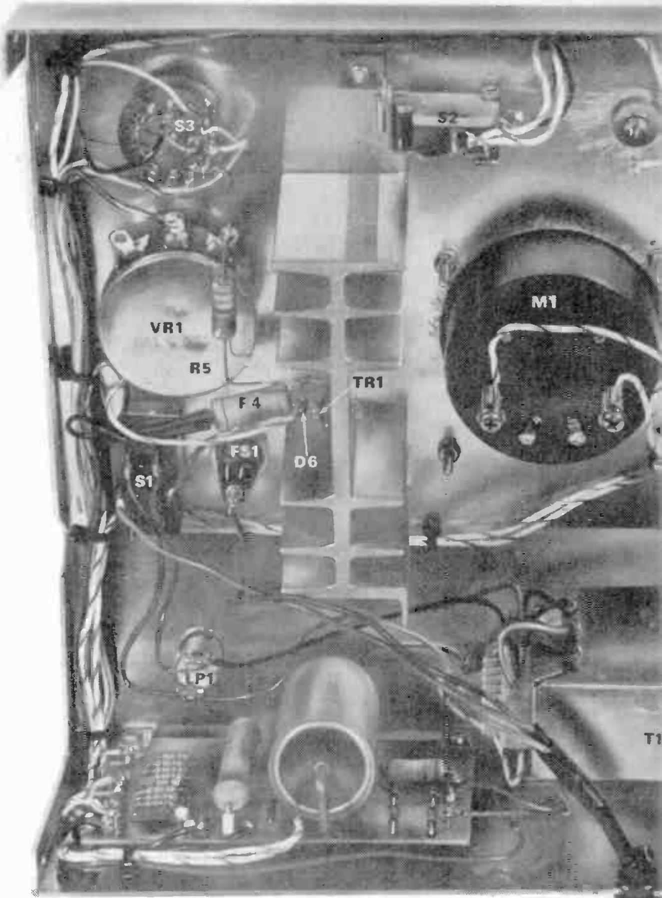
The circuit diagram of the complete unit is given in Fig. 2. Transformer T1 provides isolation from the mains, and the associated rectifying and smoothing components develop about 250 volts d.c. across C1. When S2 is depressed, about 8mA passes through R2 and D5, providing a 10 volt reference at the 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 220Ω 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.

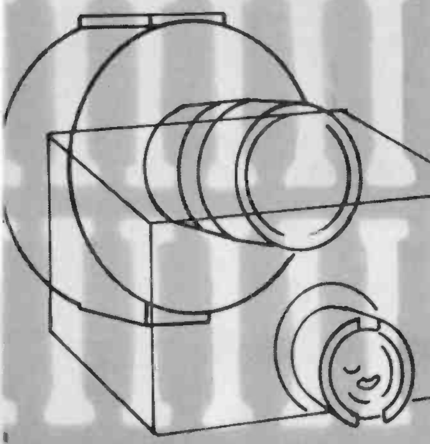
OPERATION

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.

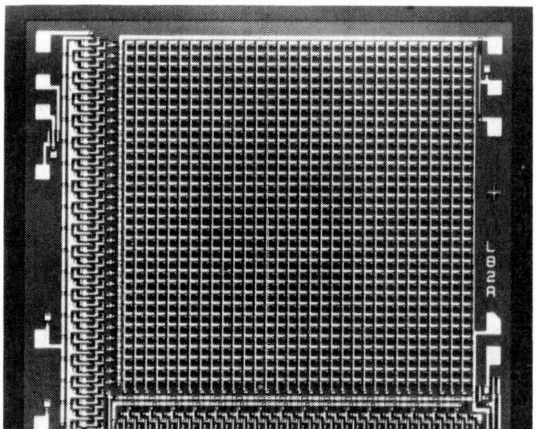
The Plessey array shown in the photograph is an example of this technology. The elements are on a 0·06mm pitch and each consists of a photodiode and transistor switch. In America, integrated arrays of up to 2,500 diodes are marketed by the Reticon Corporation. The largest of these is on a 6·35mm square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

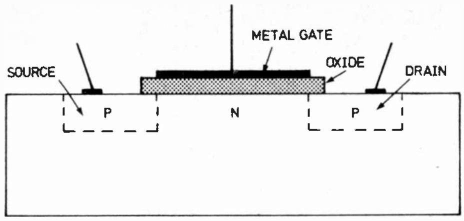


Fig. 1a. Construction of a MOS transistor

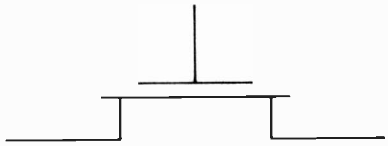


Fig. 1b. Circuit symbol for a MOS transistor

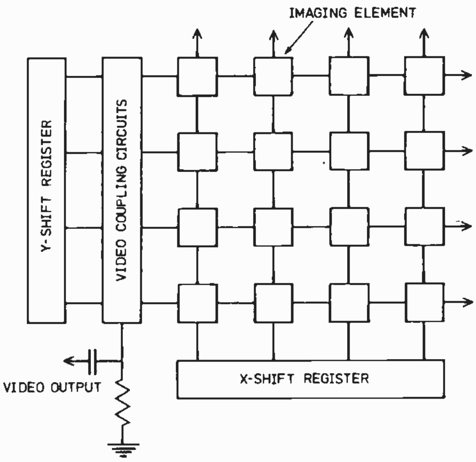


Fig. 2. Block diagram of self-scanned imaging array

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.

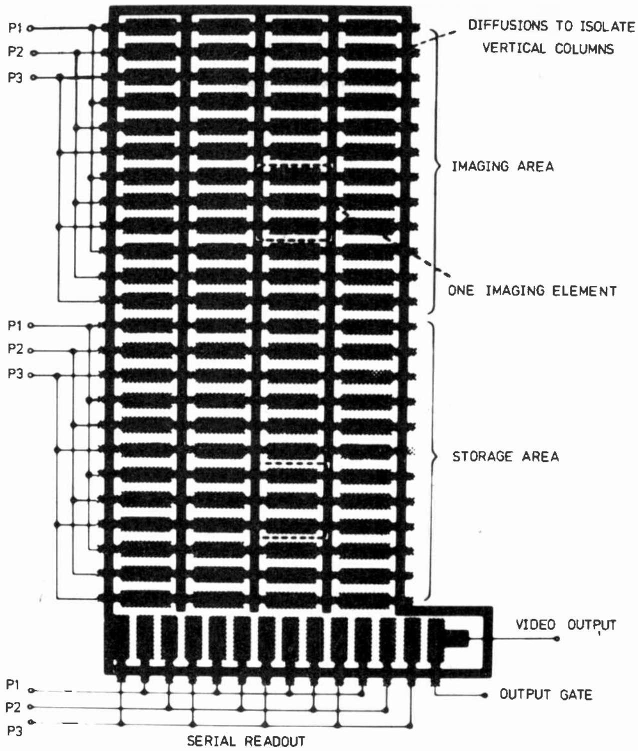


Fig. 3. Layout of charge-coupled imaging array

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.

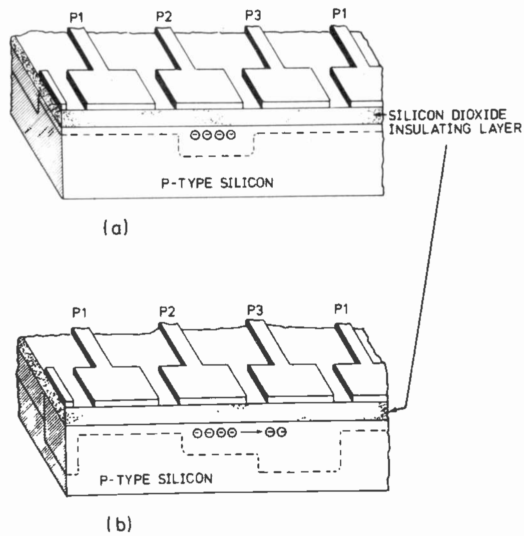


Fig. 4. (a) When light is incident on a CCD imaging array photo-excited electrons are accumulated under the centre electrode in each element because of its higher positive voltage. (b) Once in each frame period the accumulated charge is transferred to the storage area by sequentially adjusting the positive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

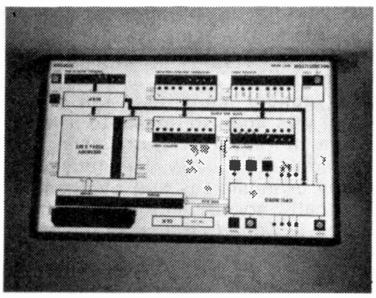
The claim is that the 8080 gives you "hands on" experience necessary to master microprocessors. However, it is not just a learning module, it is a full 8-bit microcomputer with an 8080 CPU, 1k × 8-bit Random Access Memory, an input port, an output port, an interrupt instruction port and a status port.

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.**

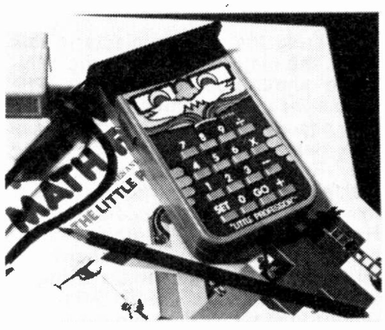


The Microtutor 8080 from Limrose

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.



Texas "Little Professor"

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.

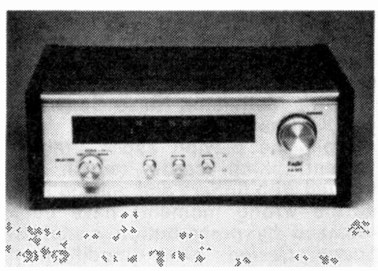
Addresses of nearest stockists and price of the Texas "Little Professor" can be obtained from **Texas Instruments Ltd., Calculator Division (Dept. P.E.), Block C, Manton Centre, Manton Lane, Bedford, MK41 7PU.**

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.



AM/FM Stereo Tuner from Eagle

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.

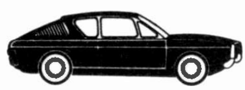
A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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.

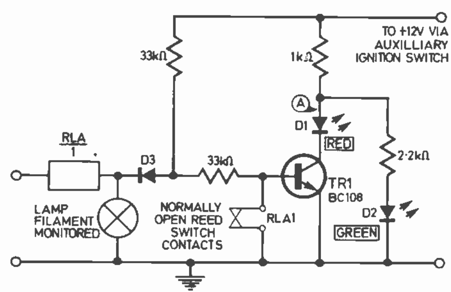
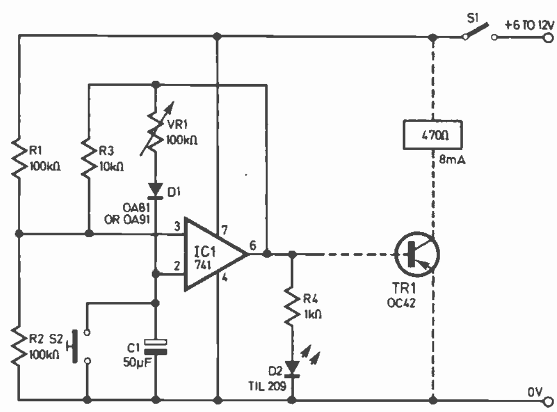


Fig. 1

SIMPLE TIMER

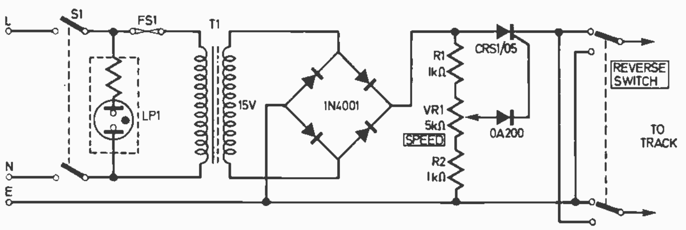


This timer will drive a light emitting diode direct from the output of IC1 via a 1kΩ limiting resistor, or it will operate a relay with the addition of a suitable transistor.

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.

Fig. 1



MODEL TRAIN SPEED CONTROLLER

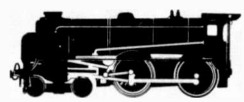


Fig. 1

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.

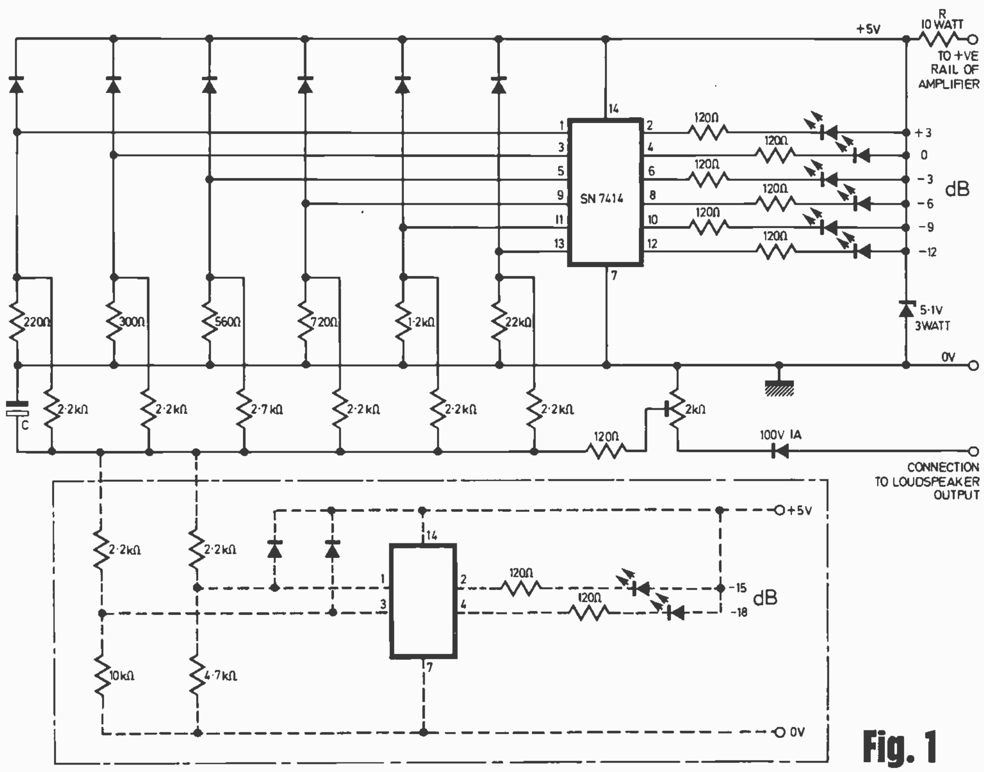


Fig. 1

QUIZ MONITOR

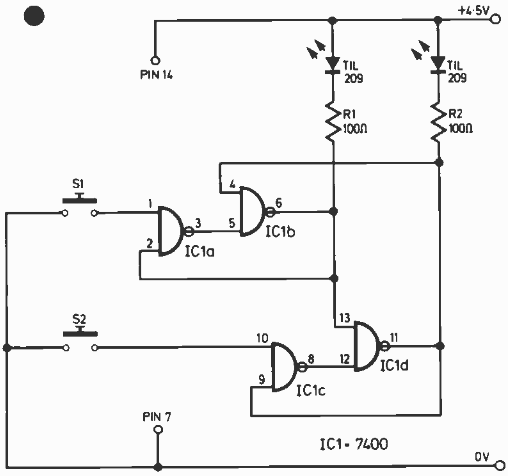


Fig. 1

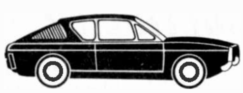
The circuit in Fig. 1 is of a two station latching quiz monitor, with l.e.d. indication.

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



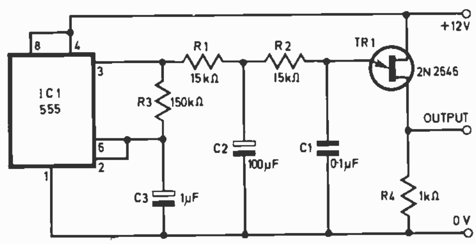


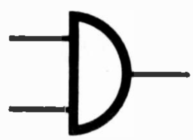
Fig. 1

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



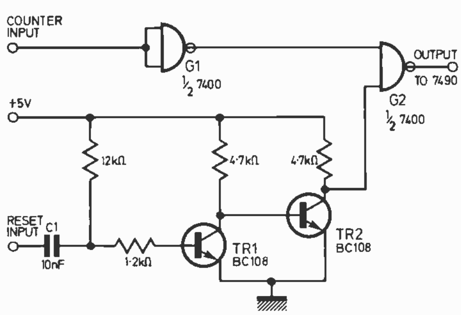


Fig. 1

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.

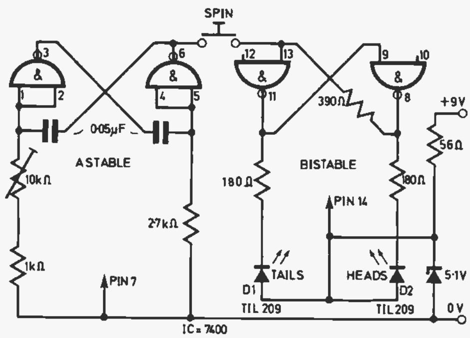


Fig. 1

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.

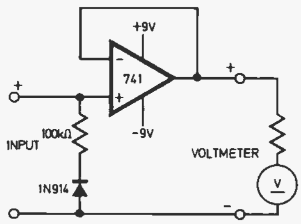


Fig. 1

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.

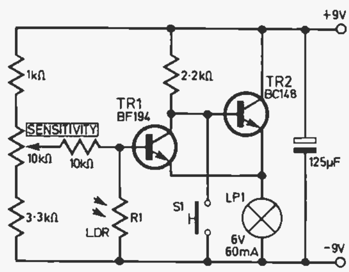
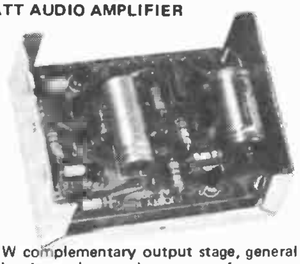


Fig. 1

NEWS FROM JOSTY KIT

JOSTYKIT

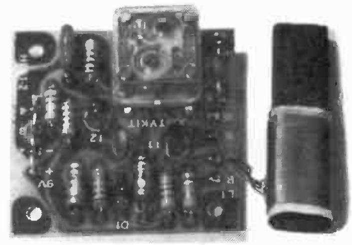
AF 300 3 WATT AUDIO AMPLIFIER



This is a 3 W complementary output stage, general purpose amplifier. Use it to boost the output from your record player, cassette recorder, transistor radio or drive it from one of the HF range of JOSTYKIT receivers. Try it with the HF 310 FM receiver in your car or boat. **£ 6.10**

JOSTYKIT

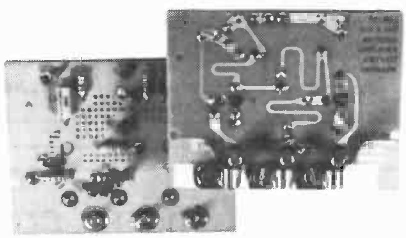
HF 61 DIODE MEDIUMWAVE RECEIVER



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.
HF 61 is especially useful for beginners, who have not tried to assemble electronic kits before. **£ 4.30**

JOSTYKIT

HF 385 VHF/UHF AERIAL AMPLIFIER

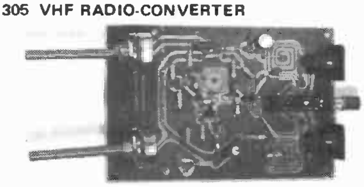


JOSTY KIT

A quality, printed circuit, no trimming, aerial amplifier. Fantastic frequency range due to use of printed coils, 21 dB amplification at 400 MHz. Two separate inputs for UHF and VHF. No loss of signal or intercommunication problems. **£ 5.80**

JOSTYKIT

HF 305 VHF RADIO-CONVERTER



Extend the range of your transistor radio. Listen to Amateurs (2 metre band), Aircraft, Trawlers etc. Two transistor circuit with printed circuit coils, varactor diodes and superior circuit design. Converts radio signals in the 100 - 200 MHz range to output signal at 100 MHz. Pipe this into your VHF receiver and you're in a new dimension. **£ 6.70**

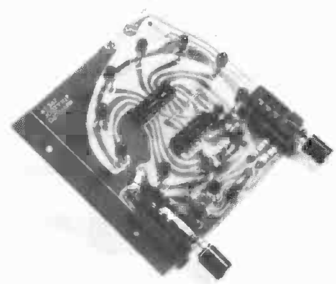
JOSTYKIT

AT 365 3-CHANNEL DISCO LIGHT

A new concept in psychedelic lighting. Uses built-in microphone. Avoids awkward connections to amplifiers. Position light-show to best advantage without long trailing leads - just plug in to nearest power point. Circuit combines latest integrated circuit techniques with solid-state power control. Quad op. amp. makes selection of bass, midrange and treble frequencies easy. Three thyristors (SCRs) control three separate lampbanks. Kit includes fused dc power supply and FET zero light adjustment. WARNING. Only experienced persons should attempt the interconnection of mains equipment. **£ 17.00**

JOSTYKIT

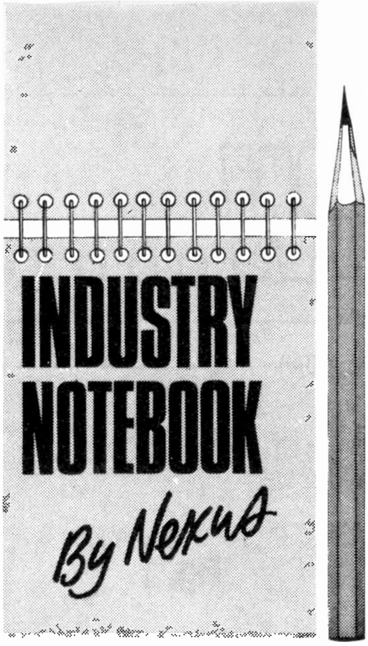
AT 347 ELECTRONIC ROULETTE



A set of exciting games for family and friends. In the home or in the pub they'll envy your electronics wizardry. Two integrated circuits provide a random number system. A 7490 counts the pulses and a 7442 decodes. The decoded outputs turn on a sequentially rotating L.E.D. light display. Your chance to try hand with TTL digital electronics.
Supplied with six colourful game indicators. **£ 8.75**

JOSTY KIT (U.K.) LTD

MAIL ORDER DIVISION
P.O. BOX 68, Middlesbrough, Cleveland, TS1 5DQ, England
Send for our 1966/7 Free Catalogue



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.

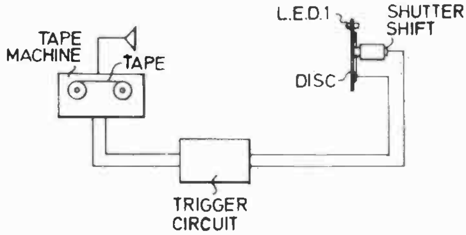


Fig. 1

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

BRANCHES AT CROYDON & WALLINGFORD

CUSTOMERS INCLUDE BBC, LONDON WEEKEND TV, SCOTTISH TELEVISION, NATIONAL TYRES, POST OFFICE, GOVT. DEPTS.

A READY-TO-USE 100W STEREO DISCO WITH BUILT-IN SOUND/LITE SEQUENCER AND LIGHTS FOR ONLY £199

THE CENTAUR

(Carr free in U.K.)

- 100W rms stereo output
- Twin heavy duty loudspeaker
- Four channel fully automatic sound-lite with variable speed sequence
- I.C. pre-amp with tape input & X fade
- Separate mic. & music treble and bass controls
- Attractive Vynide cabinets
- Twin BSR decks with autostop & lift arm
- All connecting leads supplied—ready to plug in
- Loudspeakers have kick-proof grills
- Four colour built-in light display gives ever changing pattern with or without music

Incredible value for money—2/3 cost of separate parts!

A READY-TO-USE 50W MONO DISCO COMPLETE WITH TWIN HEAVY DUTY LOUDSPEAKERS FOR ONLY £89·90

- 50W rms output
- Twin heavy duty loudspeakers
- Separate mic. input
- Wide range bass & treble controls
- Smart Vynide cases—clip together to form one neat package
- Twin BSR decks with lift & autostop
- Tremendous value—price includes leads just plug in & go!

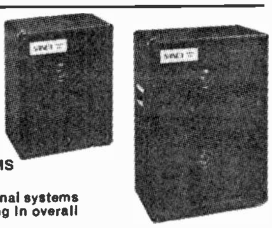
Accessories for complete discos & other systems

- Electret Condenser Mic ECM31 C/W windshield & clip £12·00
- ECM78—as above but duel impedance with removable lead £13·00
- Crown Stereo Headphones £6·75
- Heavy duty boom mic. stand £12·50

CUSTOM BUILT DISCOS

A full range of custom consoles are available using System 7000, from 50W mono to 500W stereo. Ask for our price list.

LOUDSPEAKER CABINETS



- Kick proof grills.
- Jointed construction
- Protective corners
- Heavy duty units.
- Black Vynide finished.
- Smart & professional

Single Twelve: Empty £14
With 60W unit £33·00
Twin Twelve: Empty £24
With units from £59·00
Folded Horn—Full range P.A. Bin 100W RMS £120·00

This cabinet is 3–4 times as loud as conventional systems for a given input power—thus there is a saving in overall size & cost.

- Many other cabinets available—ask for details.

EMPTY DISCO CONSOLES

£19 with plain motorboard. £21 with cutouts.

- Black Vynide finish
- Protective corners
- With your choice of cutouts

STROBES & PROJECTORS (We stock the full Pluto range) Send for details

SUPERSTROBE £19·75

- 2–3 Joules
- 80W Tube for long life
- Compact 4″ × 4″ × 4″

PRO-STROBE £32·50

- 6–8 Joules
- External trigger
- Long Life tube timer circuit

150 WATT LIQUID WHEEL PROJECTOR

- Accepts all accessories
- C/w with wheel & motor plate
- Sturdy steel construction

Remarkable value—Sold elsewhere at £39·50. Our price is only: £31·50

Please add 8% VAT to all orders (12½% for SA308/PM301)
We accept Access & Barclaycard—simply telephone or send your card number—Do not send your card.

You may pay by cheque, crossed postal orders, cash (registered) or bank draft

To order—or for advice phone (01) 684 6385 or (01) 684 0098
Mail orders to: 327-333 Whitehorse Rd., Croydon, Surrey CR0 2HS
Shop open 9am–5pm Mon.–Sat. Mail order desk 10am–3pm Mon.–Fri.

Wallingford Branch: Flint House, High St., Wallingford, Oxon
(Callers only)
9am–5pm Mon.–Sat. Telephone (0491) 35529

ROSE ELECTRICAL TO BONA FIDE TRADE CUSTOMERS

GREENWELD

443 Millbrook Road Southampton
SO1 OHX Tel:(0703) 772501

All mail orders and callers to this address please—callers only to 21 Deptford Broadway, SE8 (Tel. 01-692 2009) and 38 Lower Addiscombe Road, Croydon

44 PAGE CATALOGUE 10P + LARGE S.A.E.

Free with orders over £2

DIGITAL I.C.s

7400	12p	7450	15p	7495	73p
7401	14p	7451	14p	7496	85p
7402	14p	7453	14p	74107	37p
7404	17p	7454	14p	74121	36p
7405	23p	7460	14p	74122	51p
7406	28p	7472	29p	74123	64p
7408	14p	7473	29p	74132	56p
7410	13p	7474	29p	74150	173p
7413	28p	7475	51p	74154	144p
7414	62p	7476	29p	74155	73p
7420	14p	7483	91p	74157	66p
7430	14p	7486	40p	74159	200p
7432	18p	7490	48p	74174	110p
7437	18p	7491	75p	74179	120p
7440	15p	7492	52p	74180	120p
7447	84p	7493	52p	74367	120p

DIL Sockets—8 pin 12p; 14 pin 13p; 16 pin 14p. 100+ less 25%.

LINEAR I.C.s

741 25p; 555 40p; 723 (TO99) 50p
Plastic Voltage Regulators:
TO126 case 5V 600mA 80p, 12V 500mA 80p

TRANSISTORS

AC127	15p	BC183	12p	2N2646	42p
AC128	15p	BC184	12p	2N2926G	12p
AC176	16p	BC212	14p	2N3053	18p
AC187	18p	BC213	14p	2N3054	49p
AC188	18p	BC214	14p	2N3055	38p
AD161	35p	BCY70	15p	2N3440	54p
AD162	35p	BCY71	15p	2N3442	£1·20
BC107	10p	BCY72	15p	2N3702	10p
BC108	10p	BD131	38p	2N3703	10p
BC109	10p	BD132	40p	2N3704	10p
BC109C	15p	BFY50	15p	2N3705	10p
BC147	10p	BFY51	15p	2N3708	10p
BC148	10p	BFY52	15p	2N3819	22p
BC149	10p	TIP41A	60p	2N4059	10p
BC157	10p	TIP42A	75p	2N4418	10p
BC158	10p	TIP2955	96p	2N5294	30p
BC159	10p	TIP3055	42p	40673	50p
BC161	18p	2N2219	28p		
BC182	12p	2N2369	22p		

VEROBOARD

Good size offcuts; all packs contain 100 sq. in. (About 8 pieces). All packs £1·20.
Pack A, all 0·1in pitch;
Pack B, all 0·15in pitch;
Pack C, mixed 0·1 and 0·15;
Pack D, all 0·1in plain.
Also available by weight: 1lb £3·45; 10lbs £30.
17 × 3¾ × 0·1in sheets £1·90;
0·1in or 0·15in pins, single or double sided 35p/100.

DIODES AND LEDs AND SCR's

500V 5A SCR 45p; 400V 2A Triac 80p; Diac BR100 25p; 400V 15A Triac £1·50; ORP12 45p; MRD450 40p; TIL209 Red LED 15p; 0·2in LED Red 22p; green, Yellow or amber 24p
1N4002 5p; 1N4004 6p; 1N4007 9p; 1N4148 4p; BY127 12p; 100V 3A 12p; 400V 3A 15p; OA81 5p; OA91 5p
50V 1A bridge 22p; 800V 1A 40p; 250V 2½A 40p; 200V 5A 70p; 500V 6A £1·80.
50V 30A rect. + or − stud 40p
Zeners—400mW BZY88. All voltages from 3V to 30V 10p
1·3W plastic from 3V to 200V 20p

RESISTORS

Carbon film 5% ¼W miniature. All values in E12 series from 1Ω to 10MΩ (over 1MΩ 10%) 1½p each.
Metal Film 5% 1W. All values in E12 series from 27Ω to 10MΩ 2½p.
Sub-min presets, vert. or horiz. all values from 20Ω to 4MΩ, 7p.
Standard pots, lin or log, 22p.
Wirewound 2½W 0·25, 0·33, 0·47 1Ω 8p.
Wirewound 5W all values from 1Ω to 47K 10p each.

TRANSFORMERS

6–0–6V 100mA 90p; 9–0–9V 100mA 95p; 12–0–12V 50mA 90p; 12–0–12V 100mA £1; 12–0–12V 1A £2·80; 20V 55mA 90p; 22V 100mA £1; 29V 50mA 85p; 6·3V 1½A £1·95; 6–0–6V 1½A £2·30; 12V 150mA 80p; 17V 1A £1·80; 25V 1½A £2·30; 30–0–30V 1A £3·70.

REEDS

1in inserts, 5p; 10/40p; 100/£3·50. DIL relay, 3·7–10V, £2·20.

WIRE

Enamelled copper wire on 2oz reels SWG/price: 16/32p, 18/34p, 20/36p, 22/38p, 24/40p, 26/42p, 28/44p, 30/46p, 32/48p, 34/50p, 36/52p, 38/54p, 40/56p.

RF CHOKES

0·75, 2·95, 6·8, 10, 22, 47μH, all 10p each; 1·5, 2·5, 5·0, 7·5, 10mH, all 30p each.

CAPACITORS

Ceramic plate, 22pF to 1,000pF 2p; polyester 1,000 to 6,800pF 5p; 0·01, 0·015, 0·022, 0·033, 0·047, 0·068, 0·1mF 4p; 0·15, 0·22mF 5p; 0·33 6p; 0·47 8p; 0·68 10p; 1mF 12p; 2·2mF 18p; 3·3mF 24p. 1,000pF feedthrough 5p.
1%: 1,000pF, 10,000pF 15p; 0·1μF, 0·2μF, 0·25μF 30p; 2·2μF 55p.
Polystyrene 10pF to 1,000pF 4p; 1,200pF to 10,000pF 6p. All 2½%.
Electrolytics:
All 25V: 0·47, 1, 2·2, 4·7, 10, 22, 47mF 6p; 100mF 7p; 220mF 9p; 470mF 11p; 1,000mF 18p; 2,200mF 27p; 40V: 47mF 7p; 100mF 8p; 220mF 10p; 470mF 18p; 1,000mF 32p; 2,200mF 48p.
Tantalum bead, mF/V: 0·1/35; 0·22/35; 0·33/35; 0·47/35; 1/35; 2·2/16; 2·2/35; 3·3/35; 4·7/35; 6·8/35; 10/16; 10/25; 15/10; 22/6·3; 22/10; 22/16; 33/10; 47/6·3; 100/3, 12p each.

BREADBOARDS

S-DEC Breadboard £2·10;
T-DEC Breadboard £3·75.
Special price to colleges etc. for quantities—ring for quote.

ALUMINIUM BOXES

Complete with base and PK Screws.

AB7	133 × 70 × 38mm	50p
AB8	102 × 102 × 38mm	50p
AB9	102 × 70 × 38mm	47p
AB10	102 × 133 × 38mm	50p
AB11	102 × 64 × 51mm	47p
AB12	76 × 51 × 25mm	44p
AB13	152 × 102 × 51mm	85p
AB14	178 × 127 × 64mm	85p
AB15	203 × 152 × 76mm	£1·50
AB16	254 × 178 × 76mm	£1·80
AB17	254 × 114 × 76mm	£1·50
AB18	307 × 128 × 76mm	£1·75
AB19	307 × 203 × 76mm	£2·00
AB23	102 × 102 × 64mm	80p
AB24	133 × 102 × 64mm	90p
AB25	152 × 102 × 76mm	£1·00

VEROBOXES AND CASES

Professional 2 part boxes made of dark and light grey high impact polystyrene.

2518	120 × 65 × 40mm	£1·90
2520	150 × 80 × 50mm	£2·15
2522	188 × 110 × 60mm	£2·85

Sloping front version, ideal for mixers

2523	220 × 174 × 100/52mm	£4·95

Cases, white plastic top and bottom, front and back aluminium panels that slot in. Type;

1410	205 × 140 × 40mm	£2·90
1411	205 × 140 × 75mm	£3·25
1412	205 × 140 × 110mm	£4·20
1237	154 × 85 × 40mm	£1·80
1238	154 × 85 × 60mm	£2·25
1239	154 × 85 × 80mm	£2·75

Small general purpose plastic boxes:

1413	71½ × 40 × 24½mm	32p
PB1	115 × 75 × 36mm	42p

DEVELOPMENT PACKS

Save ££££ s by buying a full range of components at one go! All full spec. marked devices, no rejects or old stock.
50V ceramic plate capacitors 5% 10 of each value, 22pF to 1,000pF. Total 210 capacitors £2·70.
CR25 carbon film resistors, ¼ watt 5% 10 of each value 10Ω to 1MΩ, total 610 £6·00.
Extended range, 1 ohm to 10M 850 resistors £8·30.
Electrolytics, wire ended 25V working 10 each of: 1, 2·2, 4·7, 10, 22, 47 and 100mF 70 capacitors for £3·20.
Zeners, 400mW 5% BZY88. 10 each 3V to 30V total 260 £14·00.
½ pack, 5 of each value £8·20.
Tantalum Bead caps, 14 values from 0·1/35 to 100/3, 10 of each total 140 caps £12·00.

See Practical Wireless for details of packs of components, surplus goods, etc. All prices quoted include VAT. Add 20p postage on orders under £2. Most orders despatched on day of receipt. SAE with enquiries. Send 10p for Multimeter catalogue—free on request on orders over £3. Official Orders accepted from Schools, etc. Export/wholesale enquiries welcome. Surplus components always wanted.

WILMSLOW AUDIO

THE Firm for speakers!

SPEAKERS

Baker Group 25, 3, 8 or 15 ohm	£9·00
Baker Group 35, 3, 8 or 15 ohm	£10·75
Baker Group 50/12 8 or 15 ohm	£14·00
Baker Group 50/15 8 or 15 ohm	£18·62
Baker Deluxe 124, 8 or 15 ohm	£13·38
Baker Major 3, 8 or 15 ohm	£10·69
Baker Superb 8 or 15 ohm	£16·31
Baker Regent 12in 8 or 15 ohm	£9·00
Baker Auditorium 12in 8 or 15 ohm	£14·85
Baker Auditorium 15in 8 or 15 ohm	£19·41
Castle 8RS/DD 4 or 8 ohm	£9·28
Celestion G12M 8 or 15 ohm	£13·50
Celestion G12H 8 or 15 ohm	£16·75
Celestion G12/50 8 or 15 ohm	£16·50
Celestion G12/50TC 8 or 15 ohm	£20·00
Celestion G12/50 2236 s/cone	£18·00
Celestion G12/50 2239 s/cone, alum. dome	£18·50
Celestion G15C 8 or 15 ohm	£26·95
Celestion G18C 8 or 15 ohm	£39·95
Celestion HF1300 8 or 15 ohm	£6·98
Celestion HF2000 8 ohm	£8·55
Celestion MH1000 8 or 15 ohm	£13·50
Celestion C03K	£4·46
Coles 4001G	£5·90
Coles 4001K	£5·90
Decca London ribbon horn	£29·95
Decca London CO/1000/8 crossover	£6·95
Decca DK30 ribbon horn	£19·95
Decca CO/1/8 crossover (DK30)	£4·75
EMI 150 13 × 8in d/cone 8 ohm	£2·94
EMI 13 × 8in 20W bass 8 ohm	£9·00
EMI 14 × 9in bass 8 ohms, 14A770	£11·92
EMI 8 × 5in, 10W, d/cone, roll surr.	£3·75
EMI 6½in d/cone, roll surr., 8 ohm	£3·93
EMI 8in roll surr. bass	£5·73
EMI 5in mid range	£3·50
Elac 59RM 109 (15 ohm), 59RM114 (8 ohm)	£3·38
Elac 6½in d/cone, roll surr., 8 ohm	£3·95
Elac 10in 10RM239, 8 ohm	£3·95
Eagle Crossover 3000Hz 3, 8 or 15 ohm	£1·57
Eagle FR4	£5·51
Eagle FR65	£8·95
Eagle FR8	£11·95
Eagle FR10	£14·06
Eagle HT15	£3·96
Eagle HT21	£4·95
Eagle MHT10	£4·00
Eagle FF28 Multicell. horn	£5·95
Fane Pop 15, 8 or 16 ohm	£5·50
Fane Pop 33T, 8 or 16 ohm	£9·75
Fane Pop 50, 8 or 16 ohm	£12·50
Fane Pop 55, 8 or 16 ohm	£16·75
Fane Pop 60, 8 or 16 ohm	£19·95
Fane Pop 70, 8 or 16 ohm	£21·75
Fane Pop 100, 8 or 16 ohm	£33·95
Fane Crescendo 12, 8 or 16 ohm	£42·95
Fane Crescendo 12BL, 8 or 16 ohm	£44·95
Fane Crescendo 15/100A, 8 or 16 ohm	£54·95
Fane Crescendo 15/125, 8 or 16 ohm	£64·95

SPEAKERS

Fane Crescendo 18, 8 or 16 ohm	£75·95
Fane 910 Mk II horn	£15·75
Fane 920 Mk II horn	£45·95
Fane HPX1 crossover 200W	£2·50
Fane 13 × 8in, 15W dual cone	£5·50
Fane 801T 8in d/c, roll surr.	£8·96
Gauss 12in	£95·00
Gauss 15in	£110·00
Gauss 18in	£121·00
Goodmans Axent 100	£8·50
Goodmans Audiom 200 8 ohm	£14·95
Goodmans Axiom 402 8 or 15 ohm	£22·00
Goodmans Twinaxiom 8, 8 or 15 ohm	£10·60
Goodmans Twinaxiom 10, 8 or 15 ohm	£10·95
Goodmans 8P 8 or 15 ohm	£6·20
Goodmans 10P 8 or 15 ohm	£6·95
Goodmans 12P 8 or 15 ohm	£16·50
Goodmans 12PG 8 or 15 ohm	£17·75
Goodmans 12PD 8 or 15 ohm	£18·75
Goodmans 12AX 8 or 15 ohm	£44·00
Goodmans 15AX 8 or 15 ohm	£49·00
Goodmans 15P 8 or 15 ohm	£24·00
Goodmans 18P 8 or 15 ohm	£39·95
Goodmans Hifax 750P	£16·00
Goodmans 5in midrange 8 ohm	£4·05
Jordan Watts Module, 4, 8 or 15 ohm	£15·36
Kef T27	£5·18
Kef T15	£10·75
Kef B110	£6·75
Kef B200	£7·85
Kef B139	£16·50
Kef DN8	£2·08
Kef DN12	£5·39
Kef DN13 SP1015 or SP1017	£4·05
Lowther PM6	£32·00
Lowther PM6 Mk 1	£35·00
Lowther PM7	£48·60
Peerless KO10DT 4 or 8 ohm	£8·25
Peerless DT10HFC 8 ohm	£9·50
Peerless KO40MRF 8 ohm	£9·95
Peerless MT225HCF 8 ohm	£3·40
Richard Allan CA12 12in bass	£19·80
Richard Allan HP8B	£12·50
Richard Allan LP8B	£8·50
Richard Allan DT20	£6·25
Richard Allan CN8280	£16·95
Richard Allan CN820	£3·15
Richard Allan Super Disco 60W 12in	£16·95
Richard Allan CG15 15in bass	£27·45
Richard Allan Super Disco 12in 60 watt	£16·95
Richard Allan Super Disco 10in 50 watt	£13·25
Richard Allan Super Disco 8in 50 watt	£12·95
Radford BD25	£23·20
Radford MD9	£11·50
Radford MD6	£15·75
Radford TD3	£8·25
Radford Cross Over Network	£14·75
Coles 4001 G & K	£5·90
Tannoy 10in Monitor HPD	£78·00
Tannoy 12in Monitor HPD	£86·00
Tannoy 15in Monitor HPD	£99·95
Wharfedale Super 10 RS/DD 8 ohm	£13·50

SPEAKER KITS

Baker Major Module 3, 8 or 15 ohm	*each*	£13·28
Fane Mode One Mk II 15W	*each*	£10·35
Fane D40 Disco Kit	*each*	£19·95
Goodmans DIN 20 4 or 8 ohm	*each*	£15·75
Goodmans Mezzo Twin Kit	*pair*	£51·95
Helme XLK 30	*pair*	£21·95
Helme XLK 35	*pair*	£26·75
Helme XLK 40.	*pair*	£38·50
Kefkit 1	*pair*	£51·00
Kefkit III	*each*	£46·00
Peerless 1060	*pair*	£54·00
Peerless 1070	*each*	£46·00
Peerless 1120	*each*	£54·00
Peerless 2050	*pair*	£39·50
Peerless 2060	*pair*	£53·00
Richard Allan Twin assembly	*each*	£13·95
Richard Allan Triple 8	*each*	£20·75
Richard Allan Triple 12	*each*	£25·95
Richard Allan Super Triple	*each*	£29·50
Richard Allan RA8 Kit	*pair*	£37·80
Richard Allan RA82 Kit	*pair*	£59·40
Richard Allan RA82L Kit	*pair*	£65·70
Wharfedale Linton II kit	*pair*	£21·50
Wharfedale Glendale 3XP kit	*pair*	£47·70
Wharfedale Dovedale III kit	*pair*	£59·40
Wharfedale Denton 2XP kit	*pair*	£23·25
Wharfedale Linton 3XP kit	*pair*	£34·25

HI-FI ON DEMONSTRATION in our showrooms:

Akai, Armstrong, Bowers & Wilkins, Castle, Celestion, Dual, Goodmans, Kef, Leak, Pioneer, Radford, Richard Allan, Rotel, Tandberg, Trio, Videotone, Wharfedale, etc.—ask for our Hi-Fi discount price list.

THIS MONTH'S SPECIALS! (Carr. £2·50)

Rotel RA412	£77·95
Rotel RX202 Mk. II	£97·50
Videotone Minimax II	£43·00
Videotone Saphir II	£49·00
Pioneer SX450	£116·00
Sansui SC2000/2002	£149·70

We stock the complete Radford range of amplifiers, preamplifiers, power amplifiers, tuners, etc., and also Radford Audio Laboratory equipment, low distortion oscillator, distortion measuring set, audio noise meter, etc.

ALL PRICES INCLUDE VAT
(PRICES CORRECT AT 6/10/76)

Send stamp for free 38 page booklet "Choosing a Speaker"

ALL UNITS GUARANTEED NEW AND PERFECT

Carriage and insurance: Speakers up to 12in 60p; 12in £1; 15in £1·75; 18in £2·50. Kits £1 each (£2 per pair). Tweeters and Crossovers 33p each.

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.

On dem. Answers Monitor, State of Art, etc.

Construction leaflets for Radford, Kef, Jordan Watts, Tannoy, Hi-Fi Answers Monitor, free on request.

P.A. amplifiers, microphones, etc., by Shure, Linear, Eagle, Beyer, AKG, etc.

FREE with orders over £10—"Hi-Fi Loudspeaker Enclosures" book.

WILMSLOW AUDIO

Dept PE

Loudspeakers, mail order and export: Swan Works, Bank Square, Wilmslow.

Hi-Fi, Radio and TV: Swift of Wilmslow, 5 Swan Street, Wilmslow, Cheshire.

PA, Hi-Fi and Accessories: Wilmslow Audio, 10 Swan Street, Wilmslow, Cheshire.

Telephone: Loudspeakers, mail order and export—Wilmslow 29599; Hi-Fi, Radio, etc.—Wilmslow 26213.

Access and Barclaycard orders accepted by phone

Build yourself this high quality touch-sensitive piano. The design also features the new transpose control which is an external tuning control—this tunes the entire keyboard higher or lower than the concert pitch by one whole octave. Two models are available: TS50 which is a straight piano and TS53 has piano, honky tonk, harpsichord, and fast and slow tremolo effects. These professional pianos can be built in just 12 hours.

Parts List	*Price*
Constructional details are available with complete kit	£1·50
ESU/5 Divider and Touch-Sensitive Keyer Unit	
1 × AY-1-5051 i.c. divider	£1·20
25 × diodes low noise high resistance (5p each)	£1·25
5 × transistors 2N3703 (12p each)	60p
10 × elect. caps 3·3μF 25V (5p each)	50p
48 × resistors watt 5% (1p each)	48p
12 × terminal pins (½p each)	6p
1 × p.c. board, drilled	£1·00
2 × 0·01 (4p each)	8p
3 × 0·02 (4p each)	12p
Total Price per unit (11 units required)	£5·29
ESU/6 Divider and Touch-Sensitive Keyer Unit	
1 × AY-1-6721/5	£1·30
30 × diodes low noise high resistance (5p each)	£1·50
6 × transistors 2N3703 (12p each)	72p
12 × elect. caps 3·3μF 25V (5p each)	60p
58 × resistors watt 5% (1p each)	58p
14 × terminal pins (½p each)	7p
1 × P.C. board, drilled	£1·00
2 × 0·01 (4p each)	8p
4 × 0·02 (4p each)	16p
Total Price (only 1 unit required)	£6·01
Power Supply	
3 × yards main cable (10p yard)	30p
1 × mains transformer 20-0-20 1A	£2·45
1 × mains plug and socket	76p
2 × fuse holders (20p each)	40p
2 × fuses 1A (6p each)	12p
4 × rectifier diodes (5p each)	20p
2 × elect. caps 2,200μF 40V (95p each)	£1·90
1 × elect. caps 1,000μF 35V	40p
2 × resistors 5W (12p each)	24p
1 × neon lamp	25p
1 × pot with switch	54p
1 × metal knob	55p
2 × capacitor clamps (5p each)	10p
1 × chassis	60p
Total Price (only 1 unit required)	£8·81
1 × voltage regulator	£1·75
1 × 5-octave keyboard C-C or F-F	£22·00
1 × cabinet, front plate and fittings	£26·00
1 × jack socket	15p
1 × switched jack socket	50p
1 × stereo jack socket	25p
1 × stereo jack plug	25p
4 × rocker switches (29p each)	£1·16
1 × headphone amp. built and tested	£2·89
1 × loud and soft pedal	£6·00
1 × tremolo unit for TS53 only	£3·68
1 × toneforming unit for TS53 only	£5·50
1 × variable capacitor, 10 turns	£3·72
1 × GU500 built and tested, M.T.G.	£14·05
3 × yards gold wire (59p yard)	£1·77
2 × yards rhodium bar (£1·50 yard)	£3·00
3 × yards 25 core cable (58p yard)	£1·74
61 × terminal pins (½p each)	30½p
1 × pre amp for TS50 only	£1·95

TS50 Complete Kit £168·81 + £21·10 VAT
TS53 Complete Kit £172·72 + £21·59 VAT

Carriage on Complete Kit £6 (U.K. only).

Wide range of Electronic Organ Kits available, i.e. Mayfair Mk. II Portable Organ—4 octave keyboard, 4 pitches, 10 voices, sustain, vibrato, split keyboard, transpose control. Price £166 inc. VAT, carriage £6 (U.K. only). Overseas customers C.I.F. at cost.
Also available from stock, a huge quantity of specialised I.C.s and components. Send 60p for catalogue. Data Sheets for organics 25p.

Elvins *Electronic Musical Instruments*

***Showroom:* 12 Brett Road, Hackney, London E8 1JP. Tel. 01-986 8455**
***Component Shop:* 40a Dalston Lane, Dalston Junction, London E8 2AZ. Tel. 01-249 5624**

Make light work of wiring with the NEW SELF ADHESIVE WIRE STAPLES

Countless uses in industry and offices

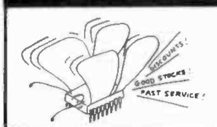
***QUICK AND EASY TO APPLY – EVEN IN AWKWARD PLACES**
***SAVES DAMAGE TO WOOD AND PAINTWORK**
***STICKS ON INSTANTLY : HOLDS WIRE FIRMLY**

You'll save enormous time and trouble with the new Brandauer adhesive staple. Just peel off the backing strip and press staple into place. Then bend clips over to hold wire firmly in position. No messing with pins, tacks, soldering or drilling. No damage to woodwork, e.g. skirting boards. Use the Brandauer Staple for any wall, frame or cabinet wiring jobs — it's wonderfully easy for fitting in those awkward corners.
Send now for details to:

SPECIAL PRODUCTS DISTRIBUTORS LTD.
81 Piccadilly, London W1V OHL. Tel: 01-629 9556.

CMOS WITH DISCOUNTS!

Any mix: Discount 10% for 25+, 25% for 100+, 33⅓% for 1,000+



C US 4 CMOS!

4000	0·20	4037	1·08	4075	0·24	14175	1·04	14528	1·22
4001	0·20	4038	1·20	4076	1·71	14194	1·17	14529	1·72
4002	0·20	4039	3·00	4077	0·65	14410	5·70	14530	0·95
4006	1·31	4040	1·10	4078	0·24	14411	9·54	14531	1·74
4007	0·20	4041	0·93	4081	0·24	14412	17·07	14532	1·39
4008	1·07	4042	0·93	4082	0·24	14415	7·35	14534	0·15
4009	0·60	4043	1·12	4085	0·60	14419	2·07	14536	4·00
4010	0·60	4044	1·04	4086	0·60	14422	4·90	14537	13·17
4011	0·20	4045	1·58	4089	1·74	14435	7·93	14539	1·24
4012	0·20	4046	1·48	4093	0·89	14440	11·50	14541	1·82
4013	0·60	4047	1·01	4094	2·00	14450	2·07	14543	1·82
4014	1·12	4048	0·60	4095	1·10	14451	2·07	14549	4·10
4015	1·12	4049	0·60	4096	1·10	14490	0·51	14552	10·50
4016	0·60	4050	0·60	4097	4·13	14501	0·20	14553	4·86
4017	1·12	4051	1·04	4098	1·22	14502	1·38	14554	1·07
4018	1·12	4052	1·04	4099	2·03	14503	0·75	14555	1·01
4019	0·60	4053	1·04	40101	1·76	14505	4·38	14556	1·01
4020	1·24	4054	1·29	40102	2·10	14506	0·57	14557	4·65
4021	1·12	4055	1·46	40103	2·10	14507	0·60	14558	1·25
4022	1·07	4056	1·46	40104	2·28	14508	3·08	14559	4·10
4023	0·20	4057	28·81	40107	0·60	14510	1·51	14560	2·17
4024	0·87	4059	0·20	40108	0·10	14511	1·74	14561	0·76
4025	0·20	4060	1·24	40109	2·21	14512	1·03	14562	5·50
4026	1·92	4061	25·80	40181	4·30	14514	3·47	14566	1·87
4027	0·80	4062	10·10	40182	1·73	14515	3·47	14568	3·15
4028	1·00	4063	1·22	40194	2·28	14516	1·51	14569	3·72
4029	1·27	4066	0·69	40257	2·28	14517	4·02	14572	0·27
4030	0·60	4067	4·13	4700	1·75	14518	1·30	14580	0·35
4031	2·46	4068	0·24	7083	4·25	14519	0·57	14581	4·30
4032	1·10	4069	0·24	14160	1·10	14520	1·38	14582	1·64
4033	1·55	4070	0·65	14161	1·10	14521	2·77	14583	0·84
4034	2·11	4071	0·24	14162	1·18	14522	2·15	14585	1·10
4035	1·31	4072	0·24	14163	1·10	14526	2·15		
4036	3·00	4073	0·24	14174	1·08	14527	1·76		

'E' LED DISPLAYS	
DL-704E 0·3"	79p
DL-707E 0·3"	79p
DL-728E 2 × 0·5"	£1·80
DL-727E 2 × 0·5"	£1·80
DL-750E 0·6"	£1·50
DL-747E 0·6"	£1·40
RED LEDS	
0·1"	15p
0·2"	15p
CLOCK CHIPS	
AY-5-1224A	£3·50
MK 50253	£5·80
SOLDERCON PINS	
100	60p
1000	£4·00
2500	£8·75
DIL SOCKETS 14/16 PIN	15p
RED ACRYLIC FILTER	
For L.E.D. displays 157 × 92 × 3mm	70p
PUSH SWITCHES	
Type SW9	15p
OP-AMPS	
CA 3130 (COS/MOS)	£1·00
CA 3140 (BIMOS)	95p
741 Minidip	25p

Terms: C.W.O. Add VAT to all prices at 8%. Post, etc. U.K. 25p (+ 2p = 27p) per order. All orders processed same day. Official Govt., 'Varsity, Poly., etc. orders (written or telephoned) welcome.

GREENBANK ELECTRONICS (Dept. E12P)
94 New Chester Road, New Ferry, Wirral, Merseyside, L62 5AG, England. Tel: 051-645 3391

Get a great deal from

Marshall's

Call in and see us 9-5.30 Mon-Fri 9-5.00 Sat

Trade and export enquiries welcome

A Marshall (London) Ltd Dept: PE
40/42 Cricklewood Broadway London NW2 3ET
Tel: 01-452 0161/2 Telex: 21492
& 85 West Regent St Glasgow G2 2QD
Tel: 041-332 4133
& 1 Straits Parade Fishponds Bristol BS16 2LX
Tel: 0272-654201/2
& 27 Rue Danton Issy Les Moulineaux Paris 92

160-page Catalogue full of new products, data, Jap equivalents, etc., 40p (30p to callers)

TOP 500 SEMICONDUCTORS FROM THE LARGEST RANGE IN THE U.K.

All devices manufacturer's branded stock

2N456	1·40
2N456A	1·54
2N457A	1·70
2N490	4·60
2N491	5·00
2N492	5·75
2N493	5·98
2N696	0·25
2N697	0·16
2N698	0·82
2N699	0·55
2N706	0·12
2N706A	0·12
2N708	0·21
2N709	0·50
2N711	0·55
2N718	0·22
2N718A	0·40
2N720	0·69
2N914	0·22
2N916	0·43
2N918	0·34
2N929	0·25
2N930	0·26
2N1302	0·37
2N1303	0·37
2N1304	0·40
2N1305	0·40
2N1306	0·45
2N1307	0·45
2N1308	0·60
2N1309	0·60
2N1671	1·80
2N1671A	1·92
2N1671B	2·12
2N1711	0·27
2N1907	5·50
2N2102	0·60
2N2147	1·40
2N2148	1·65
2N2160	1·10
2N2218A	0·47
2N2219	0·42
2N2219A	0·52
2N2220	0·35
2N2221	0·22
2N2221A	0·26
2N2222	0·25
2N2222A	0·25
2N2368	0·17
2N2369	0·25
2N2369A	0·21
2N2646	0·55
2N2647	1·10
2N2904	0·36
2N2904A	0·37
2N2905	0·37
2N2905A	0·38
2N2906	0·28
2N2906A	0·25
2N2907	0·21
2N2907A	0·22
2N2924	0·15
2N2925	0·17

2N2926	
Green	0·13
Yellow	0·13
Orange	0·13
2N3053	0·25
2N3054	0·50
2N3055	0·65
2N3390	0·37
2N3391	0·34
2N3392	0·14
2N3393	0·15
2N3394	0·15
2N3402	0·30
2N3414	0·15
2N3415	0·17
2N3416	0·23
2N3418	0·27
2N3440	0·57
2N3441	0·78
2N3442	1·20
2N3638	0·18
2N3638A	0·16
2N3639	0·30
2N3641	0·20
2N3702	0·17
2N3703	0·15
2N3704	0·15
2N3705	0·15
2N3706	0·14
2N3707	0·18
2N3708	0·14
2N3709	0·15
2N3710	0·14
2N3711	0·15
2N3712	1·20
2N3713	2·30
2N3714	2·45
2N3715	2·45
2N3716	2·60
2N3771	1·60
2N3772	1·70
2N3773	2·65
2N3789	2·60
2N3790	2·75
2N3791	2·75
2N3792	2·90
2N3794	0·20
2N3819	0·36
2N3820	0·29
2N3823	0·61
2N3904	0·21
2N3906	0·22
2N4036	0·67
2N4037	0·55
2N4058	0·20
2N4059	0·15
2N4060	0·20
2N4061	0·17
2N4062	0·18
2N4126	0·17
2N4289	0·30
2N4919	0·85
2N4920	0·90
2N4921	0·60

2N4922	0·65
2N4923	0·70
2N5190	0·70
2N5191	0·80
2N5192	1·00
2N5195	1·10
2N5245	0·29
2N5294	0·35
2N5295	0·40
2N5296	0·36
2N5298	0·40
2N5457	0·29
2N5458	0·26
2N5459	0·29
2N5492	0·42
2N5494	0·45
2N5496	0·50
2N5777	0·45
2N6027	0·45
3N128	0·80
3N139	1·45
3N140	1·00
3N141	0·85
3N200	2·60
40361	0·45
40362	0·48
40363	1·00
40389	0·60
40394	0·60
40395	1·20
40406	0·48
40407	0·38
40408	0·50
40409	0·55
40410	0·55
40411	2·30
40594	0·75
40595	0·85
40601	0·70
40602	0·50
40603	0·60
40604	0·60
40636	1·15
40673	0·73
AC126	0·37
AC127	0·44
AC128	0·37
AC151V	0·35
AC152V	0·50
AC153	0·40
AC153K	0·42
AC154	0·45
AC176	0·40
AC176K	0·45
AC187K	0·46
AC188K	0·45
AC187	0·45
AC188	0·42
AD142	0·65
AD143	0·75
AD149	0·74
AD150	1·20
AD161	0·75
AD162	0·75

AD161 } AD162 } PR	1·70
AF106	0·45
AF114	0·65
AF115	0·65
AF116	0·65
AF117	0·65
AF118	0·65
AF124	0·65
AF125	0·65
AF126	0·65
AF127	0·65
AF139	0·69
AF186	0·50
AF200	0·70
AF239	0·74
AF240	0·90
AF279	0·80
AF280	0·85
AL102	1·50
AL103	1·50
BC107	0·14
BC108	0·12
BC109	0·15
BC113	0·17
BC115	0·19
BC116	0·19
BC116A	0·20
BC117	0·22
BC118	0·16
BC119	0·30
BC121	0·45
BC125	0·18
BC126	0·25
BC132	0·30
BC134	0·15
BC135	0·15
BC136	0·19
BC137	0·14
BC140	0·60
BC141	0·65
BC142	0·30
BC143	0·30
BC147	0·10
BC148	0·10
BC149	0·13
BC153	0·27
BC154	0·27
BC157	0·12
BC158	0·11
BC160	0·78
BC167	0·12
BC168	0·12
BC168	0·12
BC169	0·12
BC169	0·12
BC170	0·16
BC171	0·14
BC172	0·12
BC177	0·19
BC178	0·18
BC179	0·21
BC182	0·11
BC182L	0·14

BC183	0·11
BC183L	0·14
BC184	0·12
BC184L	0·14
BC207	0·11
BC208	0·10
BC212	0·14
BC212L	0·17
BC214L	0·17
BC237	0·17
BC238	0·12
BC239	0·16
BC251	0·15
BC253	0·22
BC257	0·17
BC258	0·17
BC259	0·18
BC261	0·21
BC262	0·19
BC263	0·30
BC300	0·45
BC301	0·45
BC302	0·40
BC303	0·60
BC307	0·20
BC308	0·18
BC309C	0·25
BC317	0·14
BC318	0·13
BC337	0·19
BC338	0·21
BC547	0·12
BC548	0·10
BC549	0·13
BCY30	1·03
BCY31	1·06
BCY32	1·18
BCY33	0·90
BCY34	0·98
BCY38	2·00
BCY42	0·60
BCY58	0·55
BCY59	0·62
BCY70	0·25
BCY71	0·26
BCY72	0·24
BD115	1·20
BD116	1·20
BD121	2·00
BD123	2·00
BD124	2·00
BD131	0·51
BD132	0·54
BD135	0·42
BD136	0·42
BD137	0·45
BD138	0·48
BD139	0·50
BD140	0·50
BD529	0·35
BD530	0·38
BDY20	1·13
BF115	0·36
BF117	0·70
BF121	0·55
BF123	0·55

BF152	0·25
BF153	0·25
BF154	0·25
BF159	0·35
BF160	0·30
BF161	0·60
BF166	0·40
BF167	0·33
BF173	0·33
BF177	0·38
BF178	0·45
BF179	0·48
BF180	0·45
BF181	0·45
BF182	0·45
BF183	0·45
BF184	0·35
BF185	0·30
BF194	0·12
BF195	0·11
BF196	0·13
BF197	0·14
BF198	0·15
BF200	0·31
BF225J	0·25
BF244	0·35
BF245	0·34
BF246	0·75
BF254	0·20
BF255	0·20
BF257	0·37
BF258	0·49
BF259	0·49
BFR39	0·24
BFR79	0·24
BFS21A	2·60
BFS28	1·04
BFS61	0·30
BFS98	0·27
BFX29	0·36
BFX30	0·38
BFX84	0·38
BFX85	0·41
BFX87	0·35
BFX88	0·32
BFX89	0·95
BFY50	0·30
BFY51	0·38
BFY52	0·36
BFY53	0·34
BFY90	1·27
BRY39	0·50
BSX20	0·31
BSX21	0·32
BU105	3·05
BU205	2·40
C106D	0·65
CA3020A	1·50
CA3028A	0·85
CA3035	1·35
CA3046	0·73
CA3048	2·15
CA3052	1·62
CA3080A	1·10
CA3089E	2·00
CA309AQ	4·25

CA3130	0·88
LM301A	0·47
LM308N	1·32
LM309K	1·80
LM380	0·98
LM381AN	2·07
LM702C	0·75
LM709	
TO99	0·40
8DIL	0·40
14DIL	0·40
LM710	0·45
LM723C	0·60
LM741	
TO99	0·38
8DIL	0·35
14DIL	0·40
LM747CN	0·78
LM748	
8DIL	0·44
14DIL	0·41
LM3900N	0·55
LM7805P	1·39
LM7812P	1·39
LM7815P	1·39
LM7824P	1·39
LOO5TI	1·80
MC1303	1·47
MC1310	1·96
MC1330P	0·75
MC1351P	0·87
MC1352P	0·87
MC1466L	3·95
MC1469R	2·50
MEO402	0·20
MEO404	0·15
MEO412	0·20
ME4102	0·10
ME4104	0·10
MJ480	1·05
MJ481	1·30
MJ490	1·05
MJ491	1·55
MJ2955	1·21
MJE340	0·58
MJE2955	1·25
MJE3055	0·75
MJE370	0·68
MJE371	0·81
MJE520	0·65
MJE521	0·75
MP8111	0·35
MP8112	0·40
MP8113	0·45
MPF102	0·30
MPSA05	0·20
MPSA06	0·20
MPSA12	0·35
MPSA55	0·20
MPSA56	0·20
MPSU05	0·40
MPSU06	0·40
MPSU55	0·45
MPSU56	0·45
NE555V	0·48
NE556	1·30
NE560D	4·48

NE561	4·48
NE565A	1·30
OC28	2·00
OC35	1·50
OC42	0·50
OC45	0·75
OC71	0·45
OC72	0·45
OC81	0·75
OC83	0·50
ORP12	0·70
R53	1·80
SL414A	2·35
SL610C	2·35
SL611C	2·35
SL612C	2·35
SL620C	3·50
SL621C	3·50
SL623C	5·75
SL640C	4·00
SL641C	4·00
SN76003N	2·36
SN76013N	1·50
SN76023N	1·45
SN76033N	2·50
ST2	0·20
TAA263	1·25
TAA300	2·67
TAA350	2·48
TAA550	0·60
TAA611C	2·25
TAA621	2·15
TAA661B	1·32
TBA641B	2·50
TBA651	1·80
TBA800	1·20
TBA810	1·16
TBA820	1·03
TBA920	1·79
TIL209	0·30
TIP29A	0·50
TIP29C	0·75
TIP30A	0·60
TIP30C	0·85
TIP31A	0·62
TIP31C	0·85
TIP32A	0·75
TIP32C	1·00
TIP33A	1·00
TIP33C	1·45
TIP34A	1·20
TIP34C	1·70
TIP35A	2·50
TIP36A	3·35
TIP41A	0·70
TIP41C	1·00
TIP42A	0·90
TIP42C	1·20
TIP2955	1·00
TIP3055	0·50
TIS43	0·30
ZTX300	0·15
ZTX301	0·15
ZTX302	0·20
ZTX500	0·15
ZTX501	0·15
ZTX502	0·18
ZTX530	0·23
ZTX531	0·22

NEW RANGE TOOLS—HIGH QUALITY MINIATURE ELECTRONIC PLIERS AND CUTTERS INSULATED HANDLES

Round nose box joint 4in long £2·50
Diagonal cutters box joint 4in long £2·80
Flat nose box joint 4in long £2·40
Snipe nose box joint 4in long £2·40

DESOLDERING TOOL £5·00

P.C. MARKER PEN DALO 33PC, 87p.
ZENER DIODES 400MW **11p**, 1W **17p**, 2·5W **35p**.
IC SOCKETS 8 DIL **14p**, 14 DIL **15p**, 16 DIL **16p**.
RESISTORS ¼W **2p** (100 per value £1·30) ½W 3p (100 per value £2·00)
SCORPIO CAR IGNITION KIT £12·95.
JUMBO 7 SEGMENT DISPLAYS £2·16.
DL 707 £1·60.
MINITRON £1·50.
LEDs Red, green and yellow, 0·2in or 0·16in dia. **24p.**

SEE MARSHALL'S FOR CMOS

CD4000	0·20	CD4018	1·01	CD4042	0·83
CD4001	0·20	CD4019	1·10	CD4043	1·00
CD4002	0·20	CD4020	1·12	CD4044	0·94
CD4006	1·18	CD4021	1·01	CD4045	1·43
CD4007	0·20	CD4022	0·97	CD4046	1·32
CD4008	0·97	CD4023	0·20	CD4047	1·15
CD4009	0·57	CD4024	0·79	CD4049	0·56
CD4010	0·57	CD4025	0·20	CD4050	0·56
CD4011	0·20	CD4027	0·56	CD4510	1·54
CD4012	0·20	CD4028	0·91	CD4511	1·54
CD4013	0·57	CD4029	1·17	CD4516	1·40
CD4014	1·01	CD4030	0·57	CD4518	1·25
CD4015	1·01	CD4031	2·26	CD4520	1·25
CD4016	0·56	CD4037	0·97	CD4553	4·07
CD4017	1·01	CD4041	0·83		

Please enquire about CMOS not listed

MICROPROCESSORS FROM MARSHALL'S

Read the article, buy the kits!
SCAMP INTRO KIT £62·37
KEYBOARD KIT £59·85
Contact Marshall's for RAM's, ROM's and PROM's.
Full range of Low Power Schottky and Octal Tristate Buffers.

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

SN7400	0·16	SN7412	0·25	SN7438	0·35	SN7454	0·16	SN7483	0·92	SN74100	1·15	SN74153	0·73	SN74175	0·94
SN7401	0·16	SN7413	0·25	SN7440	0·16	SN7460	0·16	SN7484	0·85	SN74107	0·30	SN74154	1·29	SN74176	0·86
SN7402	0·16	SN7416	0·43	SN7441	0·76	SN7470	0·32	SN7485	1·25	SN74118	0·90	SN74155	1·20	SN74180	1·23
SN7403	0·16	SN7417	0·43	SN7442	0·55	SN7472	0·26	SN7486	0·29	SN74119	1·80	SN74157	0·68	SN74181	2·58
SN7404	0·18	SN7420	0·16	SN7445	0·94	SN7473	0·30	SN7490	0·43	SN74121	0·34	SN74160	1·20	SN74190	1·33
SN7405	0·18	SN7423	0·27	SN7446	0·86	SN7474	0·30	SN7491	0·68	SN74122	0·45	SN74161	1·20	SN74191	1·33
SN7406	0·51	SN7425	0·27	SN7447	0·81	SN7475	0·40	SN7492	0·43	SN74123	0·40	SN74162	1·20	SN74192	1·13
SN7407	0·18	SN7427	0·27	SN7448	0·81	SN7476	0·36	SN7493	0·43	SN74141	0·72	SN74163	1·20	SN74193	1·13
SN7408	0·18	SN7430	0·16	SN7450	0·85	SN7480	0·45	SN7494	0·74	SN74145	0·74	SN74164	0·93	SN74196	0·81
SN7409	0·18	SN7432	0·27	SN7451	0·18	SN7481	1·10	SN7495	0·59	SN74150	1·20	SN74165	0·93	SN74197	0·81
SN7410	0·16	SN7437	0·35	SN7453	0·16	SN7482	0·87	SN7496	0·78	SN74151	0·77	SN74167	3·70	SN74198	2·04
												SN74174	1·06	SN74199	2·04

Potentiometers 1kΩ to 2MΩ (E3)

Linear or Log	Single	Double
Rotary Pots (no 1kΩ log)	25p	75p
Rotary Switched	55p	—
Sliders	45p	75p

Full range of VERO products stocked. See catalogue for details

Presets—Horizontal or Vertical
0·1W **9p** 0·3W **11p**

DIN PLUGS— 14p DIN CHASSIS SOCKETS—10p
3-pin, 4-pin, 5-pin 180°, 5-pin 240°, 6-pin, 7-pin and Speaker

LINE SOCKETS—14p each
3 pin, 5 pin 180° and Speaker

PHONO PLUGS (screw top)
Red, white, black, green or pellow **10p**, Chrome **15p**

LINE PLUGS (same colour) **10p**, Chrome **15p**

PHONO CHASSIS, sockets
single **7p**, double **10p**, 3-way **12p**, 6-way **25p**, 8-way **35p**

JACK PLUGS AND SOCKETS
¼in mono plastic plug **15p**
¼in mono chrome plug **22p**
¼in chrome line socket **15p**
¼in plastic switch socket **18p**
¼in stereo plastic plug **20p**
¼in stereo chrome plug **30p**
¼in stereo plastic line socket **20p**
¼in stereo chrome line socket **35p**
¼in stereo plastic switched socket **25p**
3·5mm plug **10p**; 3·5mm socket **10p**; 3·5mm line socket **10p**;
2·5mm plug **10p**; 2·5mm socket **10p**

SUB-MIN CERAMICS 63V 1pF–0·015μFd **5p**

5% POLYSTYRENE CAPACITORS
10pF–1,000pF **6p**
1,500pF–0·01μFd **10p**

Full range of MICA, POLYESTER, POLYCARB, TANTALUM and ELECTROLYTICS always in stock.

PLEASE ADD VAT TO YOUR ORDER. POSTAGE AND PACKING 30p.

ALL PRODUCTS FULLY GUARANTEED TO MANUFACTURER'S SPECIFICATIONS

SEND FOR OUR NEW 160 PAGE CATALOGUE—CRAMMED WITH NEW PRODUCTS, TECHNICAL INFORMATION AND ALL BACKED BY THE USUAL SUPERLATIVE MARSHALL'S SERVICE—FOR ONLY 40p POST-PAID OR 30p TO PERSONAL CALLERS.
NATIONAL CLOCK MODULE WITH ALARM OR SNOOZE £8·50
TRANSFORMER £1·30
SWITCHES £1·55

Illuminated thumbwheel switches, decimal output 50p each. End cheeks 25p per pair. Sub min. I c/o toggle switch, very high Q, 50p each. Sub min. I c/o toggle switch, non locking 50p each. Relay 3 c/o mains coils round 11 pin base £1 each. P.C. or solder tag socket for relay 25p each. 19mm PVC adhesive tape. 33 metre rolls 50p per roll. Vero board 0·2in pitch 4in × 3¾in (approx.) 10p each. 4-core common screened cable 10p per metre. Still some P.C. boards left as advertised in "Practical Electronics", June and August £1·33 each.

All prices *include* VAT and P. & P.

Minimum order £1.

Free set of four plastic clip on P.C. board supports for every full £1 spent.

Many other switches, relays and other components on special offer.

Free list sent with every order.

PAYLOR CONTROLS LTD.
1 WELLINGTON GARDENS
BURY, LANCS. BL8 2PQ

VALVES, RADIO, TV, TRANSMITTING, INDUSTRIAL. 1930 to 1975. 2,200 types in stock, many obsolete. List **20p.** Quotation S.A.E. Postal export service. We wish to purchase new and boxed valves. Dealers, wholesalers, etc., stocks purchased. COX RADIO (SUSSEX) LTD., The Parade, East Wittering, Sussex. Tel. West Wittering 2023.

FOR SALE

DOUBLE BEAM OSCILLOSCOPE. Separate y-amps, accessories, manual, as new, carriage paid **£70.** Mr. MARSHALL, 4 Hall Place, Harbledown, Canterbury, Kent, CT2 9AF.

DISCOLIGHTS: 3-chan soundlights **£17·50!** Strobes **£22!** Full catalogue from—AARVAK ELECTRONICS, 12a (L) Bruce Grove, London N17. (01-808 8923).

PATCHBOARD and 9 unused Dewtron Synthesiser Modules, half price, S.A.E. for details—STEELE, 42 Quarry Road, Ryde, Isle of Wight.

EDUCATIONAL

UNIVERSITY OF ST. ANDREWS

PHYSICS AND ELECTRONICS

A new Joint Honours BSc Degree course in Physics and Electronics (UCCA course No. 3350). Scotland's oldest University offers the opportunity to study this interesting combination of subjects. Details from Physics Department, North Haugh, St. Andrews, Fife, KY16 9SS.

BOOKS AND PUBLICATIONS

START YOUR OWN BUSINESS REWINDING ELECTRIC MOTORS

This unique instruction manual shows step by step how to rewind motors, working part or full time, without previous experience. Everything you need to know easily explained, including where to obtain materials, how to get all the work you need, etc., etc. A goldmine of information and knowledge. Only **£3·90** plus 26p P. & P. From:

MAGNUM PUBLICATIONS, Dept. PES
Brinksway Trading Estate, Brinksway
Stockport SK3 0BZ

Overseas Distributors wanted.

Theory and practice of
MODEL RADIO CONTROL
2nd edition with latest circuitry
Development of proportional digital systems explained. Gives practical examples of a modern digital system transmitter-receiver-decoder and servo's.
£2·25 plus 35p P. & P. C.W.O.
SAE for lists to:
D. J. & D. MODEL GEAR
58 Lowther Grove, Garforth, Leeds LS25 1EN

WANTED

"GLENN MILLER"

Collector requires recordings taken from BBC broadcasts during 1944-5 of the American Band of the A.E.F., under the headings "A.E.F. Band", "Swing Shift", "Uptown Hall", "Johny Desmond Sings", "Strings with Wings", etc. Condition not important; tape copies acceptable; good price paid or will exchange from my unique collection. A. HIBBERD, 59 Waverley Road, Rugby, Warks. Or phone: Day 76473, Evening 71066.

WANTED, NEW VALVES, TRANSISTORS, top prices, popular types—KENSINGTON SUPPLIES (B), 367 Kensington Street, Bradford 8, Yorkshire.

ELECTRICAL

STYLI, CARTRIDGES AND AUDIO LEADS, etc. For the best at keenest prices send S.A.E. for free illustrated list to: FELSTEAD ELECTRONICS (PE), Longley Lane, Gatley, Cheadle, Cheshire, SK8 4EE.

SERVICE SHEETS

SERVICE SHEETS, Radio, TV, etc., **50p** and S.A.E. Catalogue **20p** and S.A.E. HAMILTON RADIO, 47 Bohemia Road, St. Leonards, Sussex.

BELL'S TELEVISION SERVICES for service sheets on radio, TV, etc., **75p** plus S.A.E. Colour TV service manuals on request. S.A.E. with enquiries to B.T.S., 190 Kings Road, Harrogate, N. Yorkshire. Tel. 0423 55885.

SERVICE SHEETS, radio, TV, etc. 10,000 models. Catalogue **24p** plus S.A.E. with orders-enquiries. TELRAY, 154 Brook Street, Preston, PR1 7HP.

PROFESSIONAL SERVICES

PATENTS AND TRADE MARKS. KINGS PATENT AGENCY LIMITED (Est. 1886), B. T. King, Director, M.I.Mech.E., Registered Patent Agent, 146a, Queen Victoria Street, London, EC4V 5AT. Booklet on request. Tel. 01-248 6161. Telex 883805.

LADDERS

LADDERS. Varnished, 20ft. 9in. extd. **£23·03.** Carr. **£1·90.** Leaflet. Alloy ext. and Loft ladders. Immed. despatch. THE LADDER CENTRE (PEE), Halesfield (1), Telford, Salop. Tel.: 586644. Order C.O.D.

MISCELLANEOUS

NO LICENSE EXAMS NEEDED

To operate this miniature, solid-state **TRANSMITTER RECEIVER** kit. Only **£8·25** plus 20p P. & P.

'Brain-freeze' 'em with a **MINI-STROBE** kit, pocket-sized 'lightning flashes', vari-speed, for disco's and parties. A mere **£3·80** plus 20p P. & P.

Experiment with a psychedelic **DREAM LAB**, or pick up faint speech/sounds with the **BIG EAR** sound-catcher: ready-made modules. **£4·75** plus 20p P. & P.

LOTS MORE! Send 20p for lists.
(Prices include VAT).
(Mail Order U.K. only).

BOFFIN PROJECTS
4 Cunliffe Road
Stoneleigh, Ewell, Surrey (P.E.)

CINE/TAPE SYNCHRONISATION (STEREO TOO). Our kit converts Philips mono cassette recorders to variable speed with spare track for sync pulse recording or stereo. Ideal for the PE synchroniser. Only **£9·95** (P. & P. 30p). A.M.P.C., 115 York Street, Cambridge.

BUILD THE TREASURE TRACER MK III Metal Locator

- Varicap tuning
- Britain's best selling metal locator kit
- Fitted with Faraday shield
- Speaker and earphone operation
- 4,000 already sold
- Prebuilt search coil assembly
- Five transistor circuit
- Thoroughly professional finish
- You only need soldering iron, screwdriver, pliers and snips
- As seen on BBC-1 and BBC-2 TV

Send stamped, addressed envelope for leaflet

Complete Kit **£14·75** Post £1 + £1·18 VAT

Built and tested **£19·75** Post £1 + £1·58 VAT

MINIKITS ELECTRONICS, 6g CLEVELAND ROAD LONDON E18 2AN (Mail Order Only)

CLEARING LABORATORY, scopes, recorders, testmeters, bridges, audio, R.F. generators, turntables, tapeheads, stabilised P.S.U.s, sweep generators, test equipment, etc. Lower Beeding 236.

SITUATIONS VACANT

RADIO TECHNICIANS

Government Communications Headquarters has vacancies for Radio Technicians. Applicants should be 19 or over.

Standards required call for a sound knowledge of the principles of electricity and radio, together with 2 years experience of using and maintaining radio and electronic test gear.

Duties cover highly skilled telecommunications/electronic work, including the construction, installation, maintenance and testing of radio and radar telecommunications equipment and advanced computer and analytic machinery.

Qualifications: Candidates must hold either the City and Guilds Telecommunications Part I (Intermediate) Certificate or equivalent HM Forces qualifications.

Salary scale from **£2,230** at 19 to **£2,905** at 25 (highest pay on entry) rising to **£3,385** with opportunity for advancement to higher grades up to **£3,780** with a few posts carrying still higher salaries. Pay supplement of £313·20 per annum.

Annual leave allowance is 4 weeks rising to 6 weeks after 27 years service.

Opportunities for service overseas.

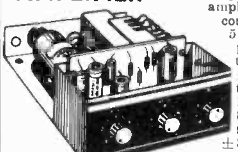
Candidates must be UK residents.

Further particulars and application forms available from:

Recruitment Officer, Government Communications Headquarters
Oakley, Priors Road, Cheltenham, Glos. GL52 5AJ
Tel.: Cheltenham (0242) 21491 (Ext. 2270)

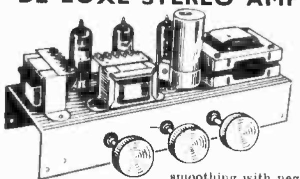
INDEX TO ADVERTISERS

SUPERSOUND 13 HI-FI MONO AMPLIFIER



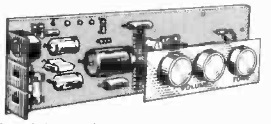
A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power out-put transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz. 30KHz ±3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £13·75. P. & P. £1·00.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line-up:-2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11"w × 4"d. Overall height including valves 5". Ready built and tested to a high standard. £12·40. P. & P. £1·30.

HARVERSONIC STEREO 44



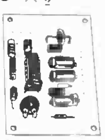
A solid state stereo amplifier chassis, with an output of 3-4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with built in short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets and 5 pin din tape rec./play socket are mounted on the printed circuit panel, size approx. 9½" × 2½" × 1" max. depth. Supplied brand new and tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically), at only £7·50 plus 50p P. & P. Mains transformer with an output of 17V a/c at 500 m/a can be supplied at £1·50 plus 40p P. & P. if required. Full connection details supplied.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240v. Secondary combinations 0-5-10-15-20-25-30-35-40-60v. half wave at 1 amp. or 10-0-10, 20-0-20, 30-0-30v. at 2 amps full wave. Size 3in. long × 3½in. wide × 3in. deep. Price £2·90. P. & P. 90p.

MAINS TRANSFORMER. For power supplies.
Pri. 200/240v. Sec. 9-0-9 at 500 mA. £1·50. P. & P. 60p.
Pri. 200/240v. Sec. 12-0-12 at 1 amp. £1·65. P. & P. 60p.
Pri. 200/240v. Sec. 10-0-10 at 2 amp. £2·35. P. & P. 90p.
Pri. 200/240v. Sec. 23v. at 1.5 amp, 6v at ·6 amp, 8v. at 50 mA. £2·00 + 65p P. & P.

ALL PURPOSE POWER SUPPLY UNIT 200/240v. A.C. input. Four switched fully smoothed D.C. outputs giving 6v. and 7½v. and 9v. and 12v. at 1 amp on load. Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case overall size 6" × 3¼" × 2¼". Ready built and tested. Price £5·75. P. & P. 85p.

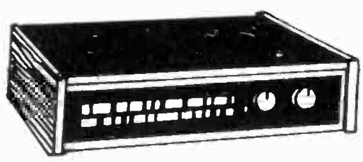
STEREO-DECODER SIZE 2"×3"×½"



Ready built. Pre-aligned and tested. Sens. 20-560mV for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £5·62 plus 20p P. & P. Stereo beacon light if required 40p extra.

QUALITY RECORD PLAYER AMPLIFIER MK. II A top quality record player amplifier employing heavy duty double wound mains transformer. ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in wide × 3in deep × 6in high. Ready built and tested. PRICE £6·20. P. & P. 90p. ALSO AVAILABLE mounted on board with output transformer and speaker. PRICE £7·30. P. & P. £1·00.

HARVERSONIC MAINS OPERATED SOLID STATE STEREO FM TUNER

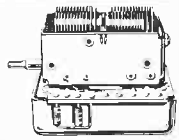


Designed and styled to match our 10 + 10 amplifier but will suit any other standard stereo amplifier. The design incorporates the very latest circuitry techniques with high-grain, low noise IF stages. Automatic frequency control to "lock on" station and prevent drift. IC stereo decoder for maximum stereo separation. L.E.D. for stereo beacon indicator. Nominal output of tuner 100mV. Approximate size 12¼in wide × 8in deep by 2½in high. Supplied ready built, fully tested and fully guaranteed. AC mains 200/240V (not available in kit form).

Special Offer £22·50 + £1·40 P. & P.

SPECIAL OFFERS

Mullard LP1159 RF-IF Double Tuned Amplifier Module for nominal 470kHz. Size approx. 2¾" × 1¼" × ½" 7·6V + earth. Brand new pre-aligned. Full specification and connection details supplied. £2·25 + P. & P. 12p.



Pye VHF/FM Tuner Head covering 88-108M/Hz. 10·7M/Hz IF output 7-8V + earth. Supplied pre-aligned, with full circuit diagram. Connection details supplied. Beautifully made with precision-geared FM Gang and 323 Pf + 323 Pf AM Tuning Gang only £3·15 + P. & P. 35p.

PRECISION MADE
Push Button Switch bank. 8 Buttons giving 16 S/P C/O interlocked switches plus 1 Cancel Button Plus 3 d/p c/o. Overall size 5" × 2¼" × 1". Supplied complete with chrome finished switch buttons 2 for £1·50 + 20p, P. & P.

HI-FI LOUDSPEAKER SYSTEM MkII

Beautifully made simulated teak finish enclosure now with most attractive slatted front. Size 16½" high × 10¼" wide × 9" deep (approx.). Fitted with E.M.I. Ceramic Magnet 13" × 8" bass unit, H.F. tweeter unit and crossover. AVAILABLE IN NOMINAL 4 ohm. 8 ohm or 16 ohm impedance (state which).

OUR PRICE £12·00 each. Carr. £1·90

Cabinet Available Separately £7·25. Carr. £1·40.

Also available in 8 ohms with EMI 13" × 8" bass speaker with parasitic tweeter £10·25. Carr. £1·90

LOUDSPEAKER BARGAINS
5in. 3 ohm £1·45, P. & P. 35p. 7 × 4in. 3 ohm £1·69, P. & P. 48p. 10 × 6in. 3 or 15 ohm £2·50, P. & P. 75p. E.M.I. 8 × 5in. 3 ohm with high flux magnet £2·06, P. & P. 50p. E.M.I. tweeter. Approx. 3½". Available 3 or 8 or 15 ohms, £2·00 + 25p, P. & P.

VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 54 in. wide. Our price £1·50 yd. length. P. & P. 50p per yd. (min. 1 yd.). S.A.E. for samples.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 11¾" × 14¹³⁄₁₆" × 1³⁄₁₆" deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz–20kHz. Can be mounted on ceilings, walls, etc. and used with or without baffle. Send S.A.E. for details. Only £8·40 each. P. & P. 75p for one, 90p for two.

Now also available 8"-8 ohm. 10 watts r.m.s. 20 watt peak 40 Hz-20,000 Hz. Overall depth 1". Ideal for Hi-Fi or for use in cars. £5·10 + P. & P. (one 35p, two 65p).

SPECIAL LINES OFFERED SUBJECT TO STOCK AVAILABILITY

Hi-Fidelity stereo cassette tape deck transport mechanisms as used in Hi-Fi Music Centres. Electronically speed controlled motor, belt-driven flywheel capstan, three digit re-settable counter. Record/Play pre-amps. Bias oscillator. Record/Play and erase heads, etc. Power supply required 12V D.C. Circuit diagrams, etc. supplied. These units are brand new, but un-tested and are only offered to the more advanced constructor enthusiast. PRICE £16·87 + £1·25 P. & P.
WE REGRET THAT WE ARE UNABLE TO ENTER INTO CORRESPONDENCE ON THESE UNITS.

OUR PRICES INCLUDE VAT AT CURRENT RATES

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT

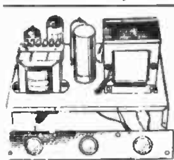
A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specifications: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ±3dB 12-30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ±3dB 12-15,000 Hz. Bass, boost approx. to +12dB. Treble cut approx. to —16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1·0 amp. Overall Size 12"w. × 8"d. × 2½"h.
Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

AMPLIFIER KIT	£13·50	P. & P. 65p
(Magnetic input components 33p extra)		
POWER PACK KIT	£4·85	P. & P. 85p
CABINET	£4·85	P. & P. 85p

Special offer—only £22·50 if all 3 units ordered at one time plus £1·00 P. & P.

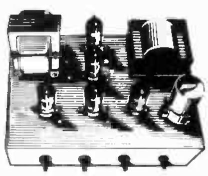
Full after sales service
Also available ready built and tested £29·25. P. & P. £1·00.

3-VALVE AUDIO AMPLIFIER HA34 MK II.



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½"w. × 4"d. × 4½"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £7·80. P. & P. £1·00.
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £7·00. P. & P. £1·00.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate base and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p × SAE (Free with parts). All parts sold separately. ONLY £11·25. P. & P. £1·35. Also available ready built and tested £15·20. P. & P. £1·35.

SPECIAL OFFER

Latest model Garrard 6300 Auto/Manual changer de luxe with cueing lever, bias compensator, counter-balanced low resonance arm and fitted with Acos 104 diamond ceramic stereo cartridge, PRICE ONLY £14·50 + £1·50 P. & P.

Limited number of the latest BSR C141R1 Auto/Manual changer de-luxe. Lightweight tubular arm cueing lever. bias compensator. PRICE £12·60 + £1·40 P. & P.

Also similar but without cueing lever or bias compensator. ONLY £11·00 + £1.40 P. & P.

New but very slightly marked 'GLENBURN' BSR automatic record changer decks fitted with cueing lever, lightweight arm and ceramic Hi-Fi stereo/compatible cartridge. Can be used for automatic or manual play. PRICE £9·56 + £1·20 P. & P.

Open 9.30-5.30 Monday to Friday. 9.30-5 Saturday
Closed Wednesday.
Prices and specifications correct at time of press. Subject to alteration without notice

HARVERSON SURPLUS CO. LTD.

(Dept. P.E.) 170 HIGH ST., MERTON, LONDON, S.W.19 Tel.: 01-540 3985
A few minutes from South Wimbledon Tube Station
SEND STAMPED ADDRESSED ENVELOPE WITH ALL ENQUIRIES

(Please write clearly)

PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.

Published approximately on the 15th of each month by IPC Magazines Ltd., Fleetway House, Farringdon Street, London EC4. Printed in England by Chapel River Press, Andover, Hants. Sole Agents for Australia and New Zealand—Gordon & Gotch (A/sia) Ltd. South Africa—Central News Agency Ltd.
Subscriptions not available at home or overseas.
International Giro facilities Account No. 5122007. Please state reason for payment, "message to payee".

The new Maplin Catalogue is no ordinary catalogue...

Hundreds of fascinating new lines.

Several major new projects to build.

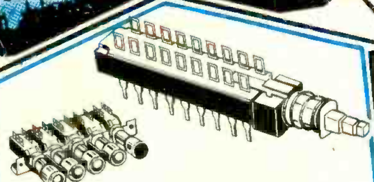
Test Gear Section includes superior quality single-beam and dual beam OSCILLOSCOPES at remarkably low prices. These superb SCOPEX scopes are, undoubtedly the best value for money around.

MULTI-CHANNEL MIXER

Projects section includes complete construction details of a professional quality MULTI-CHANNEL MIXER with modular sections for complete flexibility. Extremely low noise and distortion AND low cost.

Super Discount Voucher Scheme – saves you pounds!

Hundreds of photo-graphs and illustrations



Just one of the hundreds of new lines in the component section. A new range of FULLY INTERLOCKING PUSH BUTTON SWITCHES – high quality – low price – large range.

Catalogue includes a very wide range of components: hundreds of different capacitors; resistors; transistors; I.C.'s; diodes; wires and cables; discotheque equipment; organ components; musical effects units; microphones; turntables; cartridges; styli; test equipment; boxes and instrument cases; knobs, plugs and sockets; audio leads; switches; loudspeakers; books; tools – AND MANY MANY MORE.

SEND THIS COUPON FOR **YOUR** COPY OF OUR CATALOGUE ON APPROVAL! Price 50p – SEND NO MONEY NOW.
Please rush me a copy of your brand new 1977/78 catalogue the instant it is published. Only if I am completely satisfied that it is worth every penny, will I send 50p within 14 days of receipt. If I am not satisfied, I may return the catalogue to you within 14 days without obligation. I understand that I need not purchase anything from your catalogue should I choose to keep it.

NAME ____________________

ADDRESS ____________________

____________________ PE 12

Maplin Electronic Supplies P.O. Box 3, Rayleigh, Essex, SS6 8LR

*** Our bi-monthly newsletter keeps you up to date with latest guaranteed prices – our latest special offers (they save you pounds) – details of new projects and new lines. Send 30p for the next six issues (5p discount voucher with each copy).**

Owing to delay in completion of larger warehouse, catalogue will be delayed by up to four weeks – so there's still time to order before publication and get your pack of ten super special offer coupons, giving big discounts on ten different popular items. YOU COULD SAVE POUNDS! – SO DON'T DELAY – FILL IN AND POST COUPON NOW!

MAPLIN
ELECTRONIC SUPPLIES
P.O. BOX 3, RAYLEIGH, ESSEX SS6 8LR
Shop: 284, London Road, Westcliff-on-Sea, Essex
(Closed on Monday) Telephone: Southend (0702) 44101