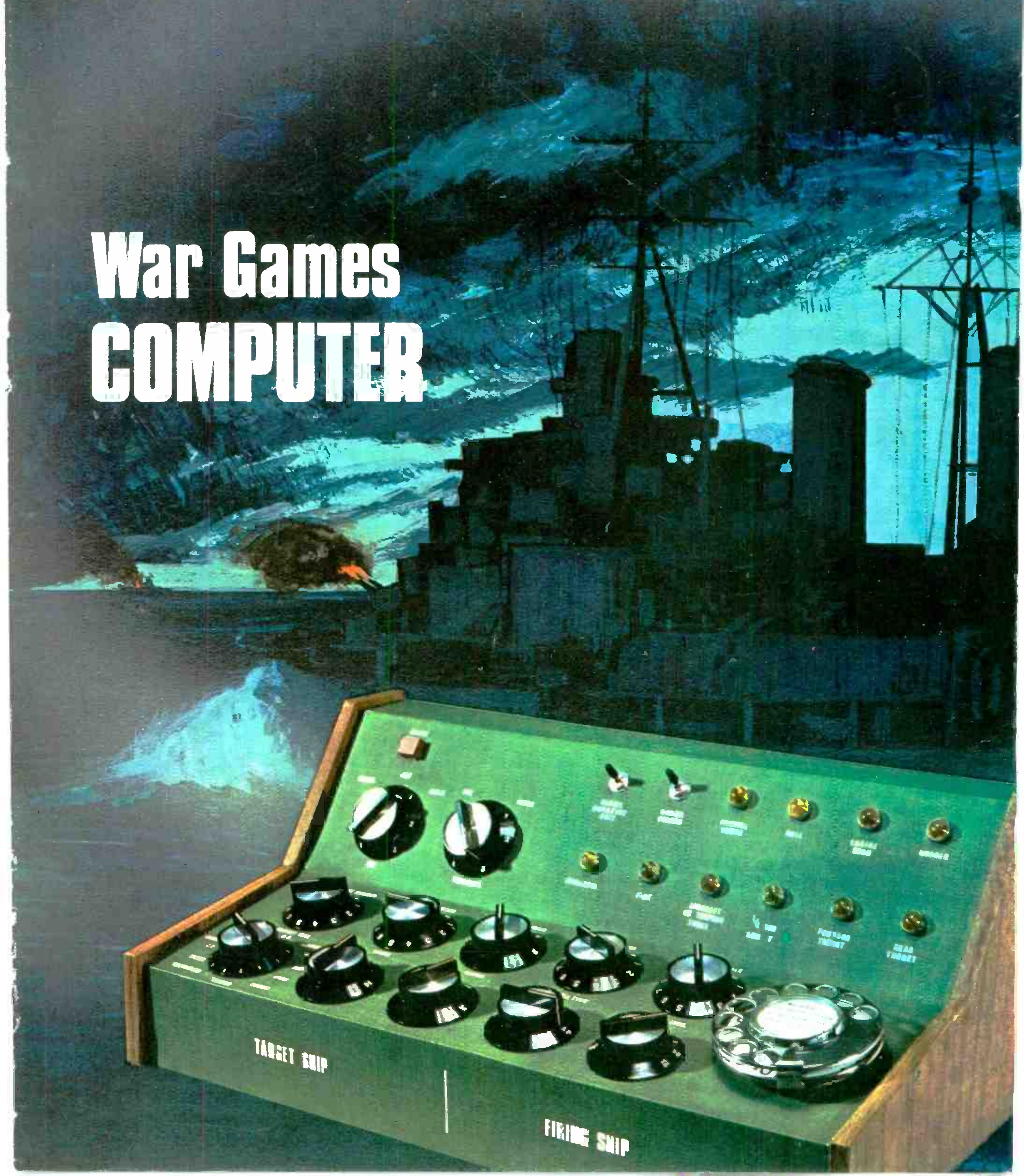
PRACTICAL

ELECTRONICS

AUGUST 1971

20p

War Games COMPUTER



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400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, **2½p.** 0·0068μF, 0·01μF, 0·015μF, 0·022μF, 0·033μF, **3p.** 0·047μF, 0·068μF, 0·1μF, **4p.** 0·15μF, **6p.** 0·22μF, **7½p.** 0·33μF, **11p.** 0·47μF, **13p.**
160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, **3p.** 0·1μF, 0·15μF, 0·22μF, **4p.** 0·33μF, **6p.** 0·47μF, **7½p.** 0·68μF, **11p.** 1·0μF, **12½p.**

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250V P.C. mounting: 0·01μF, 0·015μF, 0·022μF, **3p.** 0·033μF, 0·047μF, 0·068μF, **3½p.** 0·1μF, **4p.** 0·15μF, 0·22μF, **5p.** 0·33μF, **6½p.** 0·47μF, **8½p.** 0·68μF, **11p.** 1·0μF, **13p.**

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Miniature P.C. mounting (μF/V): 10/12, 50/12, 100/12, 200/12, 5/25, 10/25, 25/25, 100/25.

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Carbon track 5kΩ to 1MΩ, log or linear (log ¼W, lin ½W).
Single, **12p.** Dual gang (stereo), **40p.**

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Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1 watt, **4p** each. Miniature 0·25 watt, **5p** each.

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AC126	**15p**	BFY52	**22½p**	OC81	**15p**	2N3055	**72p**
AC127	**15p**	BSY56	**30p**	OC82	**15p**	2N3702	**15p**
AC128	**15p**	BSX21	**25p**	ORP12	**47½p**	2N3703	**14p**
AD140	**40p**	BY124	**7½p**	1N4001	**7½p**	2N3704	**17½p**
AF115	**17½p**	BYZ10	**30p**	1N4002	**10p**	2N3705	**15p**
AF117	**17½p**	BYZ13	**20p**	1N4003	**11p**	2N3706	**12p**
BC107	**14p**	OA85	**7½p**	1N4004	**12½p**	2N3707	**18½p**
BC108	**10p**	OA91	**7½p**	1N4005	**14p**	2N3708	**10p**
BC109	**10p**	OA202	**7½p**	1N4006	**15p**	2N3709	**11p**
BFY50	**22p**	OC71	**15p**	1N4007	**16p**	2N3710	**12p**
BFY51	**19p**	OC72	**15p**	2N2926	**11p**	2N3711	**14p**

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400mW 5% 3·3V to 30V, **17p.**

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	0·1	0·15		0·15	0·1
2½ × 3¾	**22p**	**16p**	17 × 3¾ (plain)	**52½p**	—
2½ × 5	**24p**	**24p**	17 × 2½ (plain)	**37½p**	—
3¾ × 3¾	**24p**	**24p**	2½ × 5 (plain)	**17½p**	—
3¾ × 5	**27p**	**27p**	2½ × 3¾ (plain)	**15p**	—
17 × 2½	**75p**	**57½p**	Pin insertion tool	**47½p**	**47½p**
17 × 3¾	**100p**	**75p**	Spot face cutter	**37½p**	**37½p**
17 × 5 (plain)	—	**75p**	Pkt. 50 pins	**20p**	**20p**

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Standard ¼in screened	**17½p**	2·5mm insulated	**7½p**
Standard ¼in insulated	**14p**	3·5mm insulated	**7½p**
Stereo ¼in screened	**35p**	3·5mm screened	**12½p**
Standard ¼in socket	**15p**	2·5mm socket	**7½p**
Stereo ¼in socket	**17½p**	3·5mm socket	**7½p**

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12" × 6" = **25p**; 12" × 2½" = **10p**; 9" × 2" = **7p.**

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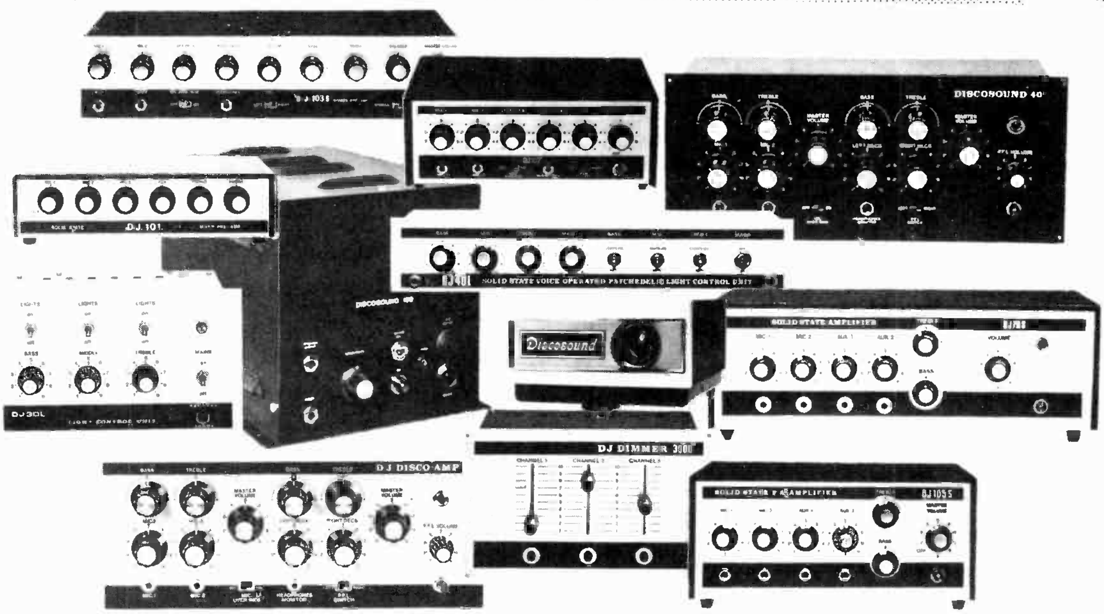

D.J.101 Mixer Pre-Amplifier
Six inputs allow full mixing facilities for all types of equipment. 9V battery operation. Size: 10¾in × 2¾in × 4¾in.
Suggested Retail Price £14

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Four inputs each with its own volume control plus master volume control, PFL monitoring and mic. override switches. Size: 10½in × 4in × 4in.
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D.J.105S P.A. Amplifier
4-channel mixing facilities each with separate inputs and volume controls. 30W r.m.s. power output: a.c. mains 200/250V a.c. Size: 11¾in × 5in × 6in.
Suggested Retail Price £41

D.J.70S Integrated Mixer Amplifier
Power output 70W r.m.s. 4-channel mixer with separate inputs and volume controls, plus master volume and separate bass and treble controls. Size: 15¼in × 5in × 6in.
Suggested Retail Price £63

D.J. Disco-Amp.
Designed specifically for use with discotheques. Power output 100W r.m.s. Two mic. inputs and two gram inputs, with independent volume controls plus bass and treble controls. Incorporates many exclusive features. Front panel size: 16½in × 7in.
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Discosound 40 Discotheque Pre-Amplifier
Features independent inputs and volume controls for two microphones and two turntables plus separate bass, treble and master volume controls. Self-powered and ideal for use with Discosound 100 Power Amplifier (is capable of running 10 of these power amplifiers—total 1,000W). Front panel size: 15¼in × 7in.
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100W r.m.s. power amplifier (at 8 ohms) utilising all silicon transistors and features full automatic overload against short or open circuits. Frequency response 20–20,000Hz ±3dB. Distortion less than 1% at 70W r.m.s. ±1dB. Size: 10½in × 8in × 7in.
Suggested Retail Price £49·50

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D.J.30L Psychedelic Light Control Unit
3-channel light unit enabling bass, middle and treble frequencies from the amplifier to be operated individually. Handles 1,000W per channel. Front panel size: 10in × 6in.
Suggested Retail Price £37·50

D.J.40L Sound Operated 3-channel light unit
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3-channel light dimmer unit offered in two versions: Dimmer 3000—a straight 3-channel dimmer unit with mains input and three light outputs. Dimmer 3000S—for use in conjunction with D.J.30L Light Control unit only and has three mains inputs and three light outputs. Front Panel size: 10in × 6in.
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50	0·23	0·25	0·47	0·50	0·53	1·15
100	0·25	0·33	0·53	0·58	0·63	1·40
200	0·35	0·37	0·57	0·61	0·75	1·60
400	0·43	0·47	0·67	0·75	0·93	1·75
600	0·53	0·57	0·77	0·97	1·25	—
800	0·63	0·70	0·90	1·20	1·50	4·00

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PIV	300mA	750mA	1A	1·5A	3A	10A	30A
	£p	£p	£p	£p	£p	£p	£p
50	0·04	0·05	0·05	0·07	0·14	0·21	0·47
100	0·04	0·06	0·05	0·13	0·16	0·23	0·75
200	0·05	0·09	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·23	0·34	0·45	1·85
800	0·10	0·17	0·13	0·25	0·37	0·55	2·00
1000	0·11	0·25	0·15	0·30	0·46	0·63	2·50
1200	—	0·33	—	0·33	0·57	0·75	

TRIACS

VBOM	2A TO-1	6A TO-66	10A TO-88
	£p	£p	£p
100	0·50	0·63	1·00
200	0·70	0·90	1·25
400	0·90	1·00	1·60

SILICON HIGH VOLTAGE RECTIFIERS
10-Amp 3-K.V. (3000 P.I.V.) Stud Type with Flying Leads, **80p** each.

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BC107/8/9, **10p** each; 50–99, **9p**; 100 up, **8p** each; 1,000 off, **7p** each. Fully tested and coded TO-18 case.

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

AF239 PNP GERM, SIEMENS VHF TRANSISTORS. RF MIXER & OSC. UP TO 900 MHZ. USE AS REPLACEMENT FOR AF139-AF186 & 100's OF OTHER USES IN VHF. OUR SPECIAL LOW PRICE:—1–24 **37p** each, 25–99 **34p** each 100 + **30p** each.

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ORP12 **43p**
ORP60, ORP61 **40p** each

PHOTO TRANS.

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40PIV (Min.)	100 ..	1·50
Sub-Min.	500 ..	5·00
Full Tested	1,000 ..	9·00

Ideal for Organ Builders.

D13D1 Silicon Unilateral switch 50p each.
A Silicon Planar, monolithic integrated circuit having thyristor electrical characteristics, but with an anode gate and a built-in "Zener" diode between gate and cathode. Full data and application circuits available on request.

AD161 *NPN*
AD162 *PNP*

MATCHED COMPLEMENTARY PAIRS OF GERM. POWER TRANSISTORS.
For mains driven output stage of Amplifiers and Radio receivers.
OUR LOWEST PRICE OF **63p** *PER PAIR*

2N3055 115 WATT SIL. POWER NPN
OUR PRICE **63p** EACH

FULL RANGE OF ZENER DIODES VOLTAGE RANGE 2-33V. 400mV (DO-7 Case) **13p** ea. 1½W (Top-Hat) **18p** ea. 10W (SO-10 Stud) **25p** ea. All fully tested 5% tol. and marked. State voltage required.

BRAND NEW TEXAS GERM. TRANSISTORS
Coded and Guaranteed

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T3	8	2G3744A	OC81D
T4	8	2G381A	OC81
T5	8	2G382T	OC82
T6	8	2G344A	OC44
T7	8	2G345A	OC45
T8	8	2G378	OC78
T9	8	2G399A	2N1302
T10	8	2G417	AF117

All **50p** each pak

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS. **Our price 25p each.**

120 VCB NIXIE DRIVER TRANSISTOR. Sim. BSX21 & C407, 2N1893 FULLY TESTED AND CODED ND120. 1–24 **17p** each. TO-5 N.P.N. 25 up **15p** each.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 **5p** each. Any Qty.

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AF117 transistors. Large can 4 leads type. Leads cut short but still usable, real value at 15 for **50p.**

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U18	8 6-Amp silicon rectifiers BYZ13 type up to 600 PIV	0·50
U19	25 Silicon NPN transistors like BC108	0·50
U20	12 1·5-Amp silicon rectifiers Top-Hat up to 1,000 PIV	0·50
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U23	30 Madt's like MAT series PNP transistors	0·50
U24	20 Germanium 1-Amp rectifiers GJM up to 300 PIV	0·50
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Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked.

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Q6	4 OC72 transistors	0·50
Q7	4 AC128 trans. PNP high gain	0·50
Q8	4 AC126 trans. PNP	0·50
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Q10	7 OC71 type trans.	0·50
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Q22	20 NKT trans. A.F. R.F. coded	0·50
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Q25	6 IN914 sil. diodes 75PIV 75mA	0·50
Q26	8 OA95 germ. diodes sub-min. IN69	0·50
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Q28	2 Sil. power rects. BYZ13	0·50
Q29	4 Sil. trans. 2 × 2N696, 1 × 2N697, 1 × 2N698	0·50
Q30	7 Sil. switch trans. 2N706 NPN	0·50
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Q37	3 2N3053 NPN sil. trans.	0·50
Q38	7 PNP trans. 4 × 2N3703, 3 × 2N3702	0·50
Q39	7 NPN trans. 4 × 2N3704, 3 × 2N3705	0·50
Q40	7 NPN amp. 4 × 2N3707, 3 × 3N3708	0·50
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Q42	6 NPN trans. 2N5172	0·50
Q43	7 BC107 NPN trans.	0·50
Q44	7 NPN trans. 4 × BC108, 3 × BC109	0·50
Q45	3 BC113 NPN TO-18 trans.	0·50
Q46	3 BC115 NPN TO-5 trans.	0·50
Q47	6 NPN high gain 3 × BC167, 3 × BC168	0·50
Q48	4 BCY70 NPN trans. TO-18	0·50
Q49	4 NPN trans. 2 × BFY51, 2 × BFY52	0·50
Q50	7 BSY28 NPN switch TO-18	0·50
Q51	7 BSY95A NPN trans. 300MHz	0·50
Q52	8 BY100 type sil. rect.	1·00
Q53	25 Sil. & germ. trans. mixed all marked new	1·50

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Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACEMENTS FOR:—OC25–28–29–30–35–36. NKT401–403–404–405–406–450–451–452–453. TI3027–3028, 2N250A, 2N456A–457A–458A, 2N511 A & B, 2G220–222, ETC.

SPECIFICATION
VCBO 80V VCEO 50V IC 10A PT. 30 WATTS HFE 30–170.

PRICE	1–24	25–99	100 up
	43p each	**40p** each	**36p** each

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Coded GP300. BRAND NEW TO-3 CASE. POSSIBLE REPLACEMENT FOR:—2N3055, BDY20, BDY11.

SPECIFICATION
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PRICE	1–24	25–99	100 +
	55p each	**50p** each	**47p** each

GENERAL PURPOSE NPN SILICON SWITCHING TRANS. TO-18 SIM. TO 2N706/8, BSY27/28/95A. All usable devices no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

		£p			
			100	For	1·75
20	For	0·50	500	For	7·50
50	For	1·00	1000	For	13·00

TRANSISTOR EQUIVALENTS BOOK. A complete cross reference and equivalents book for European, American and Japanese Transistors. Exclusive to BI-PAK **75p** each.

GERM. POWER TRANS.

Type	Price each	Type	Price each
OC20	50p	OC29	40p
OC22	30p	OC35	33p
OC23	33p	OC36	40p
OC25	25p	AD140	40p
OC26	25p	AD142	40p
OC28	40p	AD149	43p

OUR STOCKS of individual devices are now too numerous to mention in this Advertisement. Send S.A.E. for our listing of over **1,000 Semiconductors.** All available **Ex-Stock** at very competitive prices.

HIGH POWER SILICON PLANAR TRANSISTORS TO-3.
FERRANTI ZT1487 NPN
VCB60 Ic 6A fT. 1M/cs
VCE40 Ptot. 75W
VEB8 hFE15–45
PRICE 30p EACH

RTL MICROLOGIC CIRCUITS

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

Price each. Data and Circuits Booklet for I.C's Price 7p.

Dual-in-Line Low Profile Sockets
14 and 16 Lead Sockets for use with Dual-in-Line Integrated Circuits

Order No.	1–24	25–99	100 up
TSO 14 pin type	30p	27p	25p
TSO 16 pin type	35p	32p	30p

Price each

-the lowest prices!

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

NOW LOWER THAN EVER PRICES —GREATER RANGE

BI-PAK Semiconductors offer you the largest and most popular range of I.C's available at these **EXCLUSIVE LOW PRICES.** TTL Digital 74N Series fully coded, brand new. Dual in-line plastic 14 and 16 pin packages.

BI-PAK Order No.	Similar Types to:—Description	Price and qty. prices 1–24 £p	25–99 £p	100 up £p
BP00 = 7400	Quadruple 2-input NAND gate ..	0·23	0·20	0·15
BP01 = 7401	Quadruple 2-input positive NAND gate (with open collector output)..	0·23	0·20	0·15
BP02 = 7402	Quadruple 2-input positive NOR gates ..	0·23	0·20	0·15
BP03 = 7403	Quadruple 2-input positive NAND gates (with open-collector output)	0·23	0·20	0·15
BP04 = 7404	Hex Inverters ..	0·23	0·20	0·15
BP10 = 7410	Triple 3-input positive NAND gates..	0·23	0·20	0·15
BP13 = 7413	Dual 4-input Schmitt trigger..	0·35	0·32	0·29
BP20 = 7420	Dual 4-input positive NAND gates ..	0·23	0·20	0·15
BP30 = 7430	8-input positive NAND gates ..	0·23	0·20	0·15
BP40 = 7440	Dual 4-input positive NAND buffers	0·23	0·20	0·15
BP41 = 7441	BCD to decimal nixie driver ..	0·87	0·77	0·67
BP42 = 7442	BCD to decimal decoder (4–10 lines, 1 of 10) ..	0·87	0·77	0·67
BP47 = 7447	BCD-seven-segment decoder/drivers (15V outputs) ..	1·40	1·30	1·20
BP50 = 7450	Expandable dual 2-input and-or-invert ..	0·23	0·20	0·15
BP51 = 7451	Dual 2-wide 2-input and-or-invert gates ..	0·23	0·20	0·15
BP53 = 7453	Quad 2-input expandable and-or-invert ..	0·23	0·20	0·15
BP54 = 7454	4-wide 2-input and-or-invert gates ..	0·23	0·20	0·15
BP60 = 7460	Dual 4-input expander ..	0·23	0·20	0·15
BP70 = 7470	Single-phase J-K flip-flop ..	0·35	0·32	0·29
BP72 = 7472	Master-slave J-K flip-flop ..	0·35	0·32	0·29
BP73 = 7473	Dual master slave J-K flip-flop ..	0·43	0·40	0·37
BP74 = 7474	Dual D type flip-flop ..	0·43	0·40	0·37
BP75 = 7475	Quad latch ..	0·47	0·45	0·43
BP76 = 7476	Dual J-K with pre-set and clear ..	0·47	0·45	0·43
BP80 = 7480	Gated full adders ..	0·87	0·77	0·67
BP81 = 7481	16-bit read/write memory ..	1·35	1·25	1·15
BP82 = 7482	2-bit binary full adders ..	1·30	1·20	1·00
BP83 = 7483	Quad full adder ..	0·87	0·77	0·67
BP86 = 7486	Quad 2-input exclusive or gates ..	0·80	0·70	0·60
BP90 = 7490	BCD decade counter ..	0·87	0·77	0·67
BP91 = 7491	8-bit shift registers ..	1·21	1·00	0·87
BP92 = 7492	Divide-by-twelve counters ..	0·87	0·77	0·67
BP93 = 7493	4-bit binary counters ..	0·87	0·77	0·67
BP94 = 7494	Dual entry 4-bit shift register ..	0·87	0·77	0·67
BP95 = 7495	4-bit up-down shift register ..	0·87	0·77	0·67
BP96 = 7496	5-bit parallel in parallel out shift-register ..	1·10	1·00	0·90
BP100 = 74100	8-bit bistable latches ..	1·75	1·65	1·55
BP118 = 74118	Hex set-reset latches ..	1·30	1·20	1·00
BP121 = 74121	Monostable multivibrators ..	0·87	0·77	0·67
BP141 = 74141	BCD-to-decimal decoder/driver ..	0·87	0·77	0·67
BP145 = 74145	BCD-to-decimal decoder/drivers	1·80	1·70	1·60
BP151 = 74151	8-bit data selectors (with strobe) ..	1·40	1·30	1·20
BP153 = 74153	Dual 4-line-to-1-line data selectors/multiplexers ..	1·40	1·30	1·20
BP191 = 74191	Binary counter reversible ..	3·50	3·25	3·00

PRICE-MIX. Devices may be mixed to qualify for quantity prices.
PRICES for quantities in excess of 500 pieces mixed, on application.
Data is available for the above Series of Integrated Circuits in booklet form, price 13p.

TTL INTEGRATED CIRCUITS

Manufacturers' "Fall outs"—out of spec. devices including functional units and part function but classed as out of spec. from the manufacturers' very rigid specifications. Ideal for learning about I.C's and experimental work.

PAK No.		PAK No.		PAK No.	
UIC00 = 12 × 7400N	50p	UIC42 = 5 × 7450N	50p	UIC80 = 5 × 7480N	50p
UIC01 = 12 × 7401N	50p	UIC50 = 12 × 7450N	50p	UIC82 = 5 × 7482N	50p
UIC02 = 12 × 7402N	50p	UIC51 = 12 × 7451N	50p	UIC83 = 5 × 7483N	50p
UIC03 = 12 × 7403N	50p	UIC60 = 12 × 7460N	50p	UIC86 = 5 × 7486N	50p
UIC04 = 12 × 7404N	50p	UIC70 = 8 × 7470N	50p	UIC90 = 5 × 7490N	50p
UIC05 = 12 × 7495N	50p	UIC72 = 8 × 7472N	50p	UIC92 = 5 × 7492N	50p
UIC10 = 12 × 7410N	50p	UIC73 = 8 × 7473N	50p	UIC93 = 5 × 7493N	50p
UIC20 = 12 × 7420N	50p	UIC74 = 8 × 7474N	50p	UIC94 = 5 × 7494N	50p
UIC40 = 12 × 7440N	50p	UIC75 = 8 × 7475N	50p	UIC95 = 5 × 7495N	50p
UIC41 = 5 × 7441AN	50p	UIC76 = 8 × 7476N	50p	UIC96 = 5 × 7496N	50p

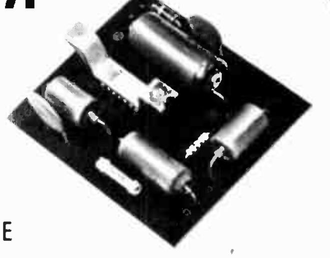
UICX1 = 25 × Asst'd 74's £1·50

Paks cannot be split but 20 assorted pieces (our mix) is available as PAK UICX1
Every PAK carries out BI-PAK Satisfaction or money back GUARANTEE.

BRAND NEW LINEAR I.C's—FULL SPEC.

Type No.	Case	Leads	Description	Price 1–24	25–99	100 up
BP 201C—SL201C	TO-5	8	G.P. Amp	63p	53p	45p
BP 701C—SL701C	TO-5	8	OP Amp	63p	50p	45p
BP 702C—SL702C	TO-5	8	OP Amp Direct OP	63p	50p	45p
BP 702—72702	D.I.L.	14	G.P. OP Amp (Wide Band)	53p	45p	40p
BP 709 —72709	D.I.L.	14	High OP Amp	53p	45p	40p
BP 709P—μA709C	TO-5	8	High Gain OP Amp	53p	45p	40p
BP 711—μA711	TO-5	10	Dual comparator	58p	50p	45p
BP 741 —72741	D.I.L.	14	High Gain OP Amp (Protected)	75p	60p	50p
μA 703C—μA703C	TO-5	6	R.F.–I.F. Amp	43p	35p	27p
TAA 263—	TO-72	4	A.F. Amp	70p	60p	55p
TAA 293—	TO-74	10	G.P. Amp	90p	75p	70p

ANOTHER BI-PAK FIRST!



THE NEW **S.G.S.** EA 1000 AUDIO AMPLIFIER MODULE

***GUARANTEED NOT LESS THAN 3 WATTS RMS**

Especially designed by S.G.S. incorporating their proven Linear I.C. Audio Amp. TA/621 providing unlimited applications for the enthusiast in the construction of radios, record players. Audio and Stereo units. Also ideal for intercom systems, monitoring applications and phone answering machines. OTHER USES: *portable applications where supply rails as low as 9V are of prime importance.*

- **Sensitivity 40 mV for 1 watt VOLTAGE GAIN 40dB but can be varied up to 73dB for some applications.**
- **Signal to Noise Ratio 86dB.**
- **Frequency response better than 50 Hz to 25 KHz for −3dB.**
- **Normal supply Voltage 9-24V.**
- **Suitable for 8-16 OHM Loads.**
- **Overall Size 2″ × 3″ × 1″.**
- **Typical Total Harmonic distortion at 1 watt less than 1%.**

Supply voltage (Vs) = 24V 15ohm load.

Module Tested and Guaranteed

Quantity	1-9	10-25
Price each	£2·63	£2·28

Larger quantities quoted on request

Full hook-up diagrams and complete technical data supplied free with each module or available separately at 10p each.

NOTE THESE PRICES!

IC's DTL 930 SERIES LOGIC

Type No.	Function	Price 1–24	25–99	100 up
BP930	Expandable dual 4-input NAND ..	23p	20p	15p
BP932	Expandable dual 4-input NAND buffer ..	25p	23p	20p
BP933	Dual 4-input expander ..	25p	23p	20p
BP935	Expandable Hex Inverter ..	25p	23p	20p
BP936	Hex Inverter ..	25p	23p	20p
BP944	Dual 4-input NAND expandable buffer without pull-up ..	25p	23p	20p
BP945	Master-slave JK or RS ..	35p	32p	29p
BP946	Quad, 2-input NAND ..	23p	20p	15p
BP948	Master-slave JK or RS ..	35p	32p	29p
BP954	Monostable ..	90p	85p	80p
BP962	Triple 3-input NAND ..	23p	20p	15p
BP9093	Dual Master-slave JK with separate clock	80p	75p	70p
BP9094	Dual Master-slave JK with separate clock	80p	75p	70p
BP9097	Dual Master-slave JK with Common Clock	80p	75p	70p
BP9099	Dual Master-slave JK Common Clock ..	80p	75p	70p

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

DTL (Diode Transistor Logic) INTEGRATED CIRCUITS manufacturers' "Fall outs"—out of spec. devices including functional units and part functional but classed as out of spec. from the manufacturers' very rigid specifications. Ideal for learning about I.C's and experimental work.

Pak No.		Pak No.	
UIC930 = 12 × μA 930 ..	50p	UIC948 = 8 × μA 948 ..	50p
UIC932 = 12 × μA 932 ..	50p	UIC951 = 5 × μA 951 ..	50p
UIC933 = 12 × μA 933 ..	50p	UIC961 = 12 × μA 961 ..	50p
UIC935 = 12 × μA 935 ..	50p	UIC9093 = 5 × μA 9093 ..	50p
UIC936 = 12 × μA 936 ..	50p	UIC9094 = 5 × μA 9094 ..	50p
UIC944 = 12 × μA 944 ..	50p	UIC9097 = 5 × μA 9907 ..	50p
UIC945 = 8 × μA 945 ..	50p	UIC9099 = 5 × μA 9099 ..	50p
UIC946 = 12 × μA 946 ..	50p	UIC×925 Assorted 930 Series	£1·50

Paks cannot be split but 25 Assorted Pieces (our mix) is available as Pak UICX9. Every Pak carries our BI-PAK Satisfaction or money back guarantee. Data Booklet available for the BP930 Series. PRICE 13p.

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

BI-PAK

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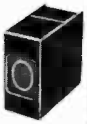
Postage and packing add 7p. Overseas add extra for airmail. Minimum order 50p. Cash with order please.

Guaranteed Satisfaction or Money Back

LOW COST ELECTRONIC AND SCIENTIFIC EQUIPMENT AND COMPONENTS

DIGITAL INDICATORS KGM TYPE M3



A neat compact indicator providing selective display 0–9. Fig. Ht. 18mm. Panel mounting. 6mm tubular midget flange lamps. Supplied with 28V bulbs. Finished matt black anodized. W. 1in, H. 2in, Wt. 4oz. **£3·25.** Post free.

NUMICATOR PRICE LIST

END READING (16mm Fig. Height) B13 base

GR10M/U Clear 0–9 Display
GR10M Amber filter 0–9 Display

Quantity	Price each (less base)
1–3	**£1·40**
4–10	**£1·35**
11–25	**£1·30**
26–100	**£1·20**

Bases **20p** each

SIDE READING (14mm Fig. Height) 0–9 Display

XN3F/A 38mm leads Amber Filter
XN3F 38mm leads Red Filter
XN3A/F 6mm leads Red Filter
XN3A 6mm leads Clear Filter
XN11/F 38mm leads Red Filter
XN23/FA 38mm leads Amber Filter

SPECIAL DISPLAYS

XN9 38mm leads Clear Filter
NX10/C 6mm leads Clear Filter
NX22 38mm leads Clear Filter

Displays Fig. "2"
Displays "+, — and ~"
Displays Vx, A, Ω, Vmv

Quantity	Price each
1–3	**£1·15**
4–10	**£1·10**
11–25	**£1·05**
26–100	**95p**

All Post free.

TELESCOPIC CABINET LID STAYS

Lift lid once stays open. Lift twice catch releases and allows lid to close. Closed length 7¼in, open length 10¾in. Finished dull plating brand new. **4 for £1.** Post free.

SLIDING CABINET LID STAYS

Similar principle to above closed length 1¾in, open length 5¾in. Finished dull plating brand new. **5 for £1.** Post free.

NEW MICROSWITCHES—HONEYWELL

1 PL 900 6 contacts. 15 Amp. 125/250 volts. Single pole. ON/OFF. Plunger operated. L.1 7/8", W. 5/8", H. 3/4". Price 5 for **£1·25.** Post free.

NEW FRACTIONAL H.P. CAPACITOR MAINS MOTORS

230V, 50Hz, 0·65A, 1/20 h.p., 2,850 r.p.m. Cont. rated. Shaft $\frac{3}{16}$in, dia. × ⅞in long. Circular clamp mounting. **£3·50.** Post free.

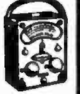
DELAY LINE LEXOR MDN 2484D

Miniature resin encapsulated module. Total delay 50msec to 10msec. Tapped at 10% intervals. Impedance 75 ohms to 10 kΩ. 30V wkg. Attenuation 0·5 dB/msec. Also available MDN 2484C 3 micro-sec 600 ohm impedance. 2¼in × ¼in × ⅜in. **£1·50.** Post free.

MIDGET POWER RELAY OMRON Mk I

230V, 50Hz. 1PDT new. Faulty plating on frame. **5 for £1·50.** Post free.

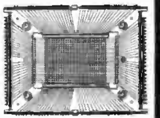
OVERHAULED AVOMETERS



Models 40, 47A, 48A. (Models 47A and 48A are Admiralty pattern.)
D.C. volts: 0·12, 1·2, 12, 120, 480, 1,200.
Amps: 0·012, 0·12, 1·2, 12.
A.C. volts: 12, 120, 480, 1,200.
Amps: 0·012, 0·12, 1·2, 12.
Ohms: 1,000, 10,000, 1,000,000 (external voltage source).
Sensitivity: 166·6 Ohms/Volt, 333·3 Ohms/Volt when divided by two button is pressed on both a.c. and d.c. ranges. **£16.** P. & P. 75p.
Complete with voltage multiplier for 480V and 3,600V. Current shunts for 120A and 480A. A.C. current transformer for 20A and 60A. In special wooden box. **£18·50.** P. & P. £1.

Due to demand it may not always be possible to supply a particular model, and a different type to that ordered may be dispatched. These models are electrically identical.

MEMORY CORE STORES



42 × 52. 2kΩ bit ferrite core store. C/W quantity OA10 load diodes. Ideal for building computer store, holding information, teaching experiments, demonstrations, etc. Price **£2·25.** P. & P. 38p.

BRAND NEW CAPACITOR REVERSIBLE SINGLE PHASE PARVALUX MOTORS

230/250V, 50Hz, 2,800 r.p.m.; 1/30 h.p. cont. rated; $\frac{5}{16}$in dia. shaft; 3¼in long foot mounting: wt. 6lb. C/W capacitor. **£3·50.** Post free.

THERMOMETER

Industrial instrument employing Bourdon tube principle. Scaled 0–105 degrees C. and 32–221 degrees F. 3in dia. scale. 36in capillary tube. Sensing element ⅜in dia. × 2¼in long. **Price 75p.** P. & P. free.

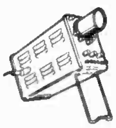
NEW ENICRON SHADED POLE MOTORS

240/250V, 50Hz, 2,500 r.p.m. (no load). Shaft $\frac{3}{16}$in dia. × 1¼in long. Suitable record player, blower motor, etc. **65p.** Post free.

TELEPHONE DIALS

Clear Perspex, very good condition. No markings. **75p** each. P. & P. 25p.

OSCILLOSCOPE TYPE CT 52



A very handy miniature portable instrument for general purpose applications. 2¾in diam. tube. Wave form investigation from 10Hz–20MHz. Pulse monitoring duration 50 microseconds to 0·1 microsecond. Time base free running 10Hz–40kHz. Also single sweep facility from 50 microseconds to 3 microseconds. "Y" Amplifier. Delay Line Calibration Voltage. Power supply 110–250V, 40/60Hz, 50W. Supplied with metal carrying case. L. 13in, H. 8in, W. 5¾in. Weight 14½lb (less Graticule, assembly and Viewing Hood). Price **£22.** P. & P. £1·50.

GOOD QUALITY INSTRUMENTS TAKEN IN PART EXCHANGE OR PURCHASED FOR CASH

Electronic Brokers Ltd. (Dept. P.E.) 49-53 Pancras Road London NW1 Tel. 01-837 7781 Telex 267307

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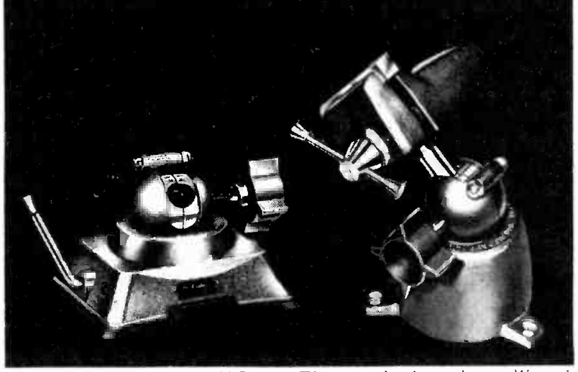
COLBERT
WORK POSITIONERS-300 SERIES



Colbert Pana-Vise WORK POSITIONERS are specially designed to quickly and easily achieve the most CONVENIENT, COMFORTABLE and TIME-SAVING work position.

Available with vacuum clamp or screw-on base. They can be ROTATED, TIPPED, TILTED, ANGLED, ELEVATED, LOWERED.

The required work position is firmly secured with a patented ONE KNOB CONTROL, a unique feature of COLBERT POSITIONERS.

A series of special holders is available for various types of work.

Full details available on request.

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Joan E. Allen & Company
offers a comprehensive range of
COIN & METAL DETECTORS

THE HUNTER
High sensitivity combined with marked stability to give a simple-to-use detector which is a must for the professional man such as tree surgeon, electrical contractor or serious treasure hunter **£24·00**

THE EXPLORER
Inexpensive but sensitive. Will give hours of treasure hunting fun for the whole family on the beach, whilst walking or at home in the garden. A useful robust general purpose detector **£19·50**

THE DISCOVERER
1. The Do-It-Yourself kit entails a minimum capital outlay and can be easily assembled in a few hours. The kit is complete except for a standard portable transistor radio as most families have one of these available. As sensitive and stable as the more expensive detectors but a fraction of the cost **£5·40**
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3. Portable transistor radio ideal for use with the "Discoverer" Metal Detector **£1·95**

TREASURE HUNTER'S HANDBOOK
"A Fortune Under Your Feet". This new publication answers all your questions on treasure hunting. Find out the How, Where, When and Why of this fascinating new hobby **45p** plus 6p post and packing

PLEASE ADD 30p TO DETECTOR ORDERS TOWARDS COST OF POST, PACKING AND INSURANCE.

ALL DETECTORS ARE GUARANTEED FOR ONE YEAR.

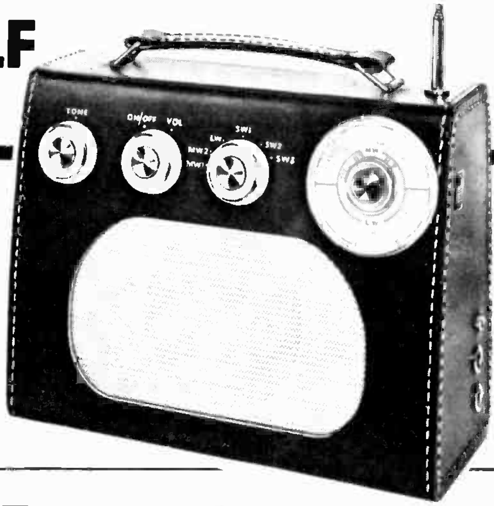
SHOWROOM DEMONSTRATIONS: MONDAY–FRIDAY 10–5 p.m.
SATURDAY 9–1 p.m.

FURTHER DETAILS OF ALL DETECTORS AVAILABLE ON REQUEST (A 3p stamp would be appreciated).

184 Main Road, Biggin Hill, Kent. Telephone: Biggin Hill 4234

TRANSISTOR RADIOS TO BUILD YOURSELF

Backed by after sales service



NEW! roamer eight mk 1

WITH VARIABLE TONE CONTROL

7 Tunable Wavebands: Medium Wave 1, Medium Wave 2, Long Wave, S.W.1, S.W.2, S.W.3, and Trawler Band. Built-in ferrite rod aerial for Medium and Long Waves. 4 section 24in. retractable chrome plated telescopic aerial for Short Waves for maximum performance. Push-pull output using 600Mw type transistors. Socket for car aerial. Tape record socket. Selectivity switch. Switched earpiece socket complete with earpiece for private listening. 8 transistors plus 3 diodes. Famous make 7 × 4in speaker. Air spaced ganged tuning condenser. On/off switch volume control. Wave change switch and tuning control. Attractive case in rich chestnut shade with gold blocking. Size 9 × 7 × 4in approx. Easy to follow instructions and diagrams make the Roamer Eight a pleasure to build. Parts price list and easy build plans 25p (FREE with parts).

Total building costs £6·98

Post, packing and insurance 41p

Overseas P. & P. 90p

roamer seven mk IV

7 FULLY TUNABLE WAVEBANDS—M.W.1, M.W.2 L.W., S.W.1, S.W.2, S.W.3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for Medium and Long Waves. Retractable 4 section 24in chrome plated telescopic aerial for peak Short Wave listening. Socket for Car Aerial. Powerful push-pull output. 7 transistors and two diodes including Micro-Alloy R.F. Transistors. Famous make 7 × 4in P.M. speaker. Air spaced ganged tuning condenser. Volume/on/off control, wave change switches and tuning control. Attractive case with carrying handle. Size 9 × 7 × 4in approx. Easy to follow instructions and diagrams make the Roamer 7 a pleasure to build. Parts price list and easy build plans 15p (FREE with parts).

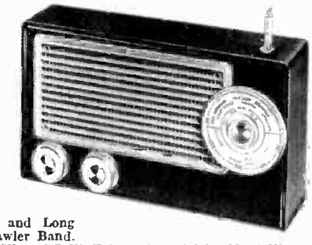
Total building costs £5·98

Personal Earpiece with plug and switched socket for private listening, 30p extra.

Post, packing and insurance 41p

Overseas P. & P. 90p

NEW! transeight



SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case in black with red grille and black knobs and dial with spun brass inserts. Size 9 × 5½ × 2¾in. approx. Tunable on Medium and Long Waves, 3 Short Waves and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 8 improved type transistors plus 3 diodes. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans 25p (FREE with parts).

Total building costs £4·48

Earpiece with plug and switched socket for private listening, 30p extra.

Post, packing and insurance 31p

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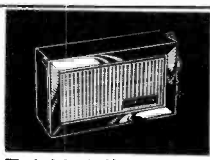

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER

Attractive black and gold case. Size 5½ × 1¼ × 3½in. Tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Easy build plans and parts price list 8p (FREE with parts).
Earpiece with plug and switched socket for private listening, 30p extra.

Total building costs £2·23

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transona five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER

Attractive case with red speaker grille. Size 6¼ × 4½in × 1½in. 7 stages—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker. Easy build plans and parts price list 8p (FREE with parts).
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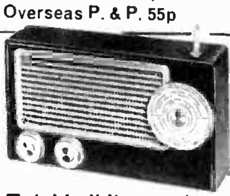

SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive black case with red grille and black knobs and dial with spun brass inserts. Size 9 × 5½ × 2¾in. approx. Tunable on Medium and Long Waves, two Short Waves, Trawler Band plus an extra M.W. band for easier tuning of Luxembourg, etc. Sensitive ferrite rod aerial and latest telescopic aerial for Short Waves. Improved circuit. 8 stages—6 transistors and 2 diodes including Micro-Alloy. R.F. Transistors, etc. Easy build plans and parts price list 10p (FREE with parts).
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Total	£59.00

Available complete for only £52.00 + £2.50 p&p.

SPECIFICATION

14 watts per channel into 3 to 4 ohms. Total distortion @ 10W @ 1kHz 0.1%. *P.U.1* 150mV into 3 Meg. *P.U.2* 4mV @ 1kHz into 47K. equalised within ±1dB R.1.A.A. *Radio* 150mV Into 220K. (Sensitivities given at full power.) Tape out facilities; headphone socket, power out 250 mW per channel. *Tone controls and filter characteristics*. Bass: + 12 dB to − 17 dB @ 60HZ. Bass filter: 6dB per octave cut. Treble control; treble + 12 dB to − 12 dB @ 15 kHz. Treble filter: 12 dB per octave. *Signal to noise ratio:* (all controls at max) RT101 — P.U.1. & radio — 65dB. P.U.2 — 58 dB. RT100 same as RT101 but P.U.2. 450 mV into 3 Meg. *Cross talk* better than −35dB on all inputs. *Overload characteristics* 26dB on all Inputs.

Size 13¾" × 9" × 3¾".

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As System 1, but with 2 x Duo Type III speakers at pair £32.00 + £3 p&p

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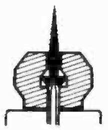

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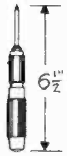

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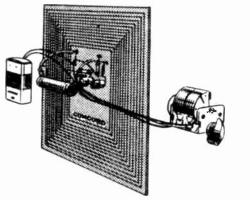

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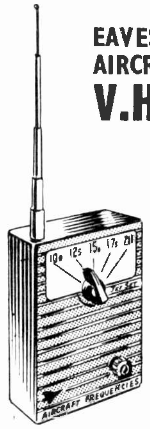

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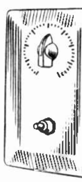

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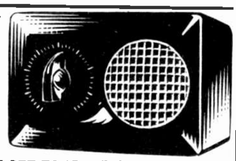

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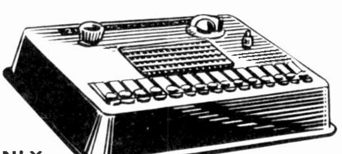

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PRACTICAL ELECTRONICS

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CHANGE OF COMMAND

War games played with miniature models and conducted on severely objective lines have for long been an essential part of military training. More recently war gaming has been taken by non-professionals and has grown into a popular hobby which its adherents claim is most exciting and mentally stimulating.

Today our professional militarists play a very scientific game. Advanced technical aids are employed to help create realism and to determine accurately the results achieved by every manoeuvre in the simulated battle. The electronic computer has replaced the human adjudicator of former times.

The non-professional devotees playing for fun and recreation are (so we gather) always looking for ways to raise the status of their pastime and to dispel any juvenile "playing with toy soldiers" image it may conjure up in the minds of the uninitiated. Now, thanks to electronics, it is possible to instal more realism into their game by use of a home-made computer.

However, recourse to electronics does not have to end there, we venture to suggest. Come to think of it, why should our amateur, spare-time strategists be satisfied with inanimate models (soldiers, tanks, warships, or what have you) that must be deployed by hand? Each piece in the game could well be a miniature automaton capable of inflicting punishment on the enemy while, being sensitive to missiles directed towards it, able to manoeuvre out of the line of fire.

But steady on, some dire consequences will arise from the unfettered use of electronics. Will our amateur battle commanders be prepared to sit quietly and impotently, merely watching while the automatons fight it out on the carpet or table top, unaided by human minds or hands?

Quite a problem. But not, in actual fact, confined to the world of make-believe and harmless pastimes. It is one the professional militarists will have to face shortly, *for real*. It is reported that in the United States a special Combat Development Command committed to the automation of modern warfare is already at work. The whole paraphernalia of science and technology is being pressed into service, towards this end. Every move of the enemy will be detected by light or heat radiation sensors, robots will replace front line troops, and the wealth of data derived from such sources will be processed by computers which will then advise the most effective tactics to employ.

The next logical step is to let the computers control and fire all weapons, and so dispense with any human intervention at all. A chilling prospect for the top brass, who will presumably be relegated to the role of computer data processers.

THIS MONTH

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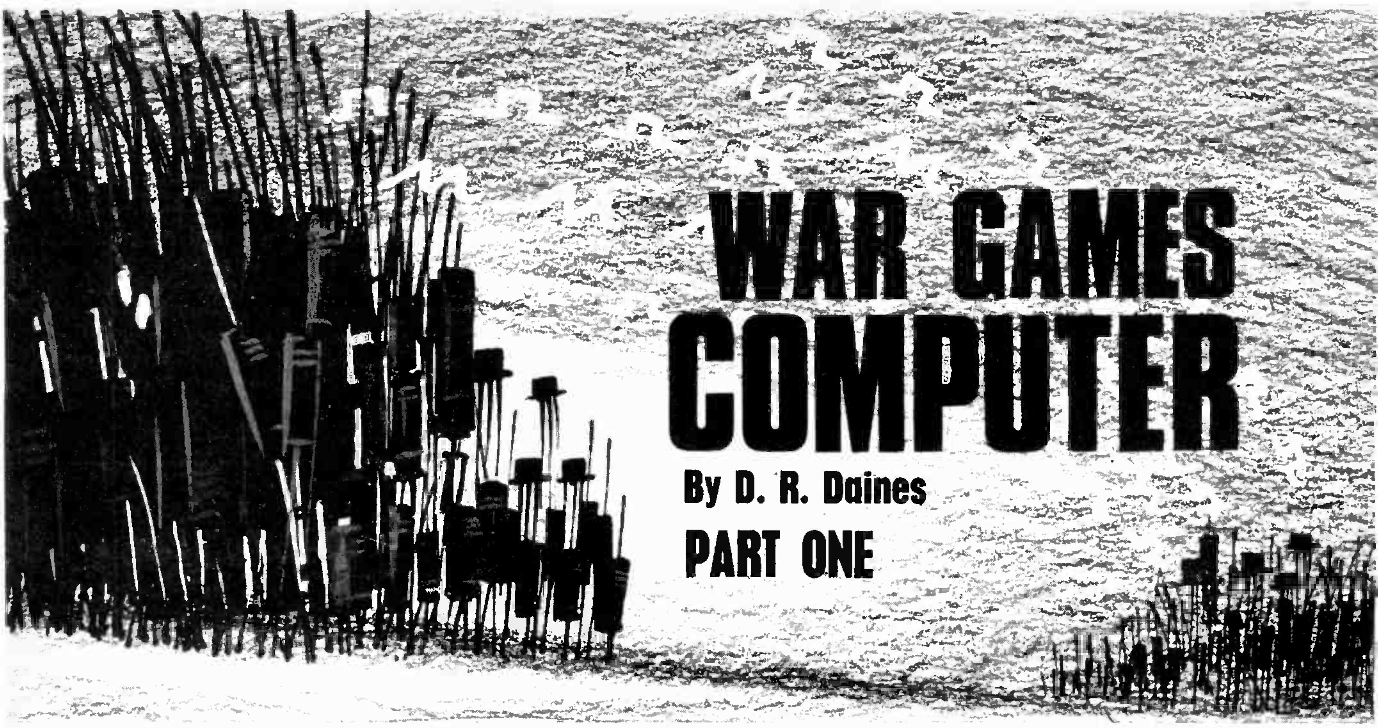


WAR GAMES COMPUTER

By D. R. Daines

PART ONE

It is said that deep in the heart of every Englishman is a sea-dog trying to get out. Whether this is true or not, many people will find the games to be described of great interest, affording as they do real insight into the problems of Naval strategy as well as some fun and excitement.

WAR-GAMING as a hobby suffers under a severe handicap: either chance assumes too large an aspect (six—you're dead!) or else in the search for realism, rules become so complicated and tedious that all pleasure is lost. In either case, interest soon wanes. Again, most war-gamers are tied to the use of dice for their chance effects. War-gaming has been called "chess with a thousand pieces", but whereas there is no chance on the chessboard, there is on the battlefield.

Chance therefore must play some part at least, and it may be that as long as war-gamers continue to use dice they will be considered to be merely "playing soldiers". It follows that electronics—and particularly computerisation—has much to offer war-gaming in accuracy, speed and a carefully controlled modicum of chance.

Constructors of *Operation Seasearch* will perhaps have noticed that the use of dice for chance effects in variations 5 and 6 can lead to some absurd situations—an unarmed supply ship sinking a cruiser, for example. When highly realistic effects are required, we must turn to computerisation since so many variables are involved.

NAVAL GUNNERY

The computer to be described has been designed as a naval gunnery computer, but it will be shown that by the use of card overlays it may be used most effectively for any other form of gunnery and for any period; whether for Roman galleys, Napoleonic artillery, American Civil War, modern missiles or what-have-you.

The computer has been designed in stages so that it is usable at each stage, but of course each additional stage adds to the versatility and convenience. There is a built-in ability to handle ten targets, with provision for the external addition of others without number.

Since this external addition is very inexpensive and easily adaptable, whole fleets or armies may be involved. This opens up exciting possibilities, with any number of people taking part. Each could captain his own ship, for example, with admirals able to communicate only by "signal"—slips of paper handed to captains the move after they were written.

The setting-up of the computer requires only a few seconds and the result of a salvo is available immediately, in the complete version. The total cost is in the region of £30, but since it can be built in stages this can be spread over many months, play beginning almost immediately, or left at some suitable stage with limited operations.

EFFECT OF CHANCE

In a combat between any two contestants, whether war, chess, or other game, it is necessary to draw a distinction between striking strength and resistive strength (Fig. 1). A low resistive strength increases damage sustained, which in turn lowers resistive strength still further as well as affecting striking power. It is well known that soccer teams must keep a fine balance between attack and defence; too much emphasis on one or the other results in lost games. Similarly in war, H.M.S. *Hood* was sunk by *Bismarck* mainly because her power to resist in no way matched her power to strike.

Chance enters at every point. A few yards difference in the landing point of a shell may make all the difference between superficial damage and sinking; in much the same way a gunner's indigestion or personal problems can affect the outcome of a battle.

We might perhaps add that one of the horrors of modern war is that the element of chance is reduced to a mathematical certainty, but the reader is invited to speculate on Fig. 1, considering the effects of chance if two men are shooting at each other with smooth-bore pistols, bow and arrows, or machine guns.

DAMAGE SUSTAINED

Fig. 2 follows the course and effects of a naval salvo. The number of shells fired in a certain span of time depends on their calibre, the number of guns firing, and the skill of the crew. Not all of the shells fired will be hits. A list of factors determining the proportion of hits has been drawn up in the diagram. It is not definitive, but includes the major factors; readers may like to add their own.

Out of the much smaller number of hits, the amount and severity of damage sustained will vary enormously according to (again) the calibre of the shells, the range, the type of shell, the thickness of armour and chance. A lot of hits will cause fire to break out, which of course assumes a malignancy of its own (particularly in wooden ships) and must be brought under control if the fight is to be carried on.

voltage applied and this is adjusted in analogue form by the CALIBRE and MORALE controls. Strictly speaking, morale and efficiency are two different things and many war-gamers carefully differentiate between them, but for the purpose of this computer they are considered synonymous.

The PROBABILITY multivibrator runs much slower and therefore in conjunction with a gate would reduce the number of pulses passing to a strict proportion of their original.

However, to make the outcome unpredictable there is a third and even more slow-running multivibrator termed CHANCE, in which not only is the repetition rate governed by the SEA control, but the mark/space ratio is altered by the VISIBILITY control.

Now the gate will pass pulses forward only when pulses are present from all three multivibrators. It will be apparent that adjustment of any of the seven controls will affect the pattern of outgoing pulses. Details will be given of a burst fire button circuit which can be used in place of the dial contacts.

The pulses are normally grounded through the pulse contacts at the back of a telephone dial, hence nothing appears beyond this point. Dialling a "1" will allow a few pulses to pass forward; dialling a "2" will pass twice this number, and so on.

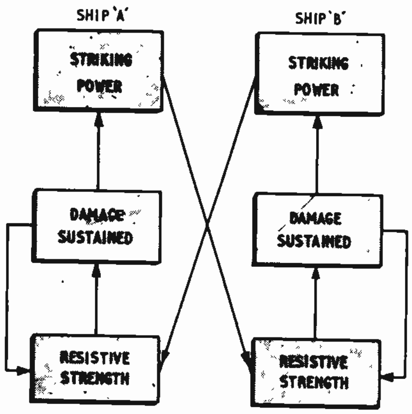


Fig. 1. War game strategy

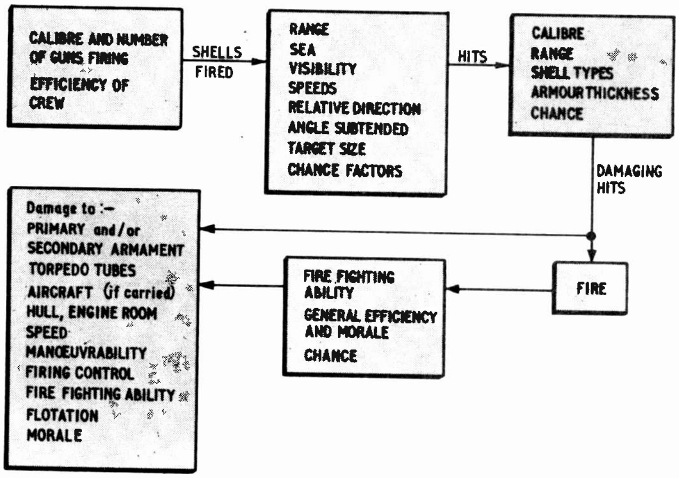


Fig. 2. Parameters affecting the war game strategy

Many war-gamers use multiple tables and charts, with much dice-throwing, to get realistic results along the lines of the above. The writer has played such games and very good they are too, but when it takes nearly half an hour to work out the result, interest soon wanes.

ANALOGUE COMPUTER

The outline of Fig. 2 is roughly followed in the design of the computer. This is an analogue computer of a specialised type designed specifically for use in mock naval battle. One could if preferred relabel the controls to suit other kinds of battle.

Fig. 3 shows the full block diagram of the system parameters, although it is sub-divided so that a smaller system can be built.

Individual shells are represented by pulses generated in the "rate of fire" multivibrator. The rate at which they are generated is governed by the

Hence the dial is used to feed the computer with the number of guns firing and also functions as a start switch since nothing can go forward until the dial is operated.

There is a further chance element here since at the heavier calibre settings the rate of fire multivibrator runs at a slower frequency than the dial. In other words, the dial contacts may open at an instant when no pulse is present to pass. This happens to other settings too, but in the case of heavy calibres the pulse may arrive between openings of the dial contacts.

Of course, as in any other chance element, the more samplings that are taken the nearer does the overall result approach to a mathematical proportion.

HIT ATTENUATION

All pulses passing the dial are considered potential hits, but as yet all are of equal amplitude; light

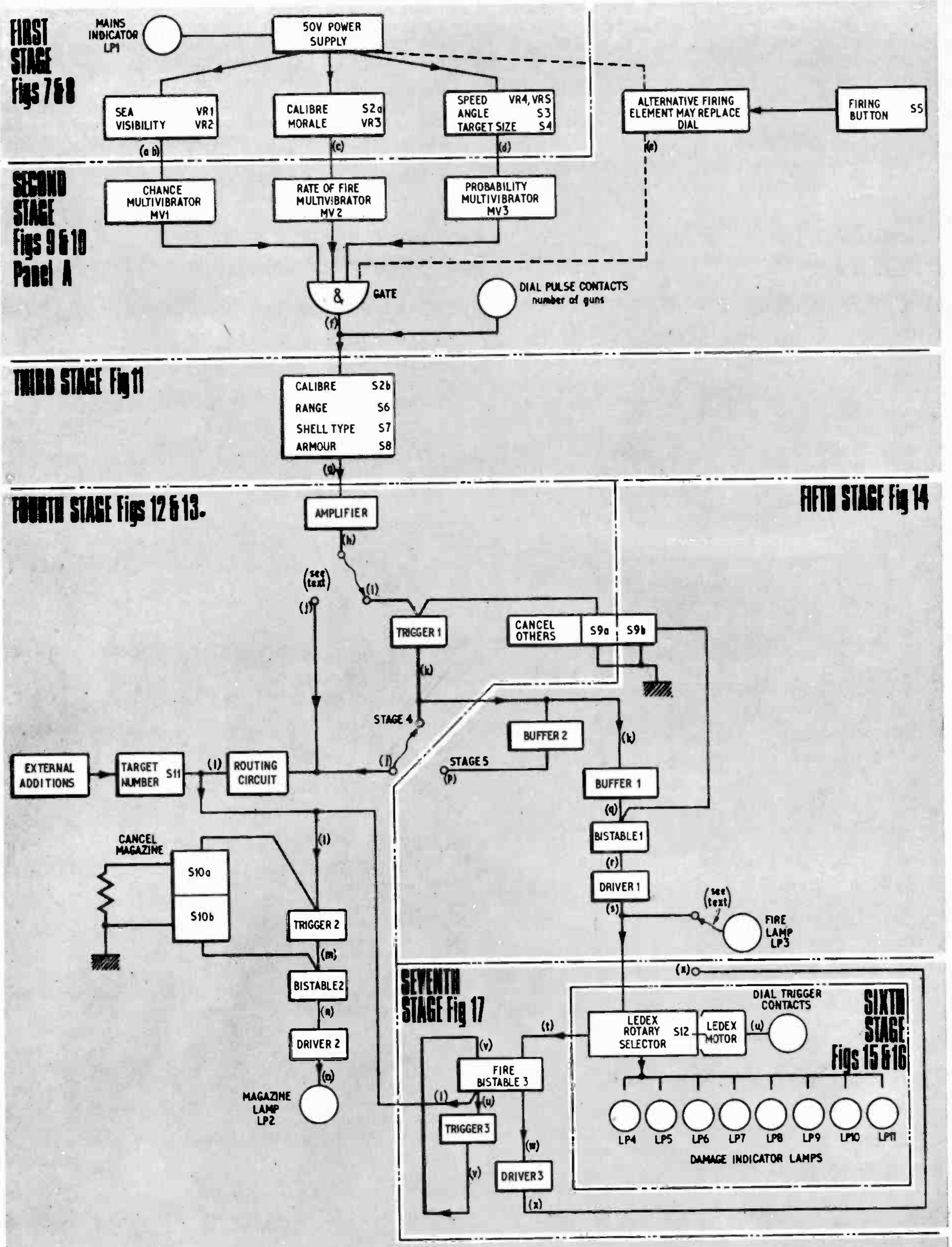
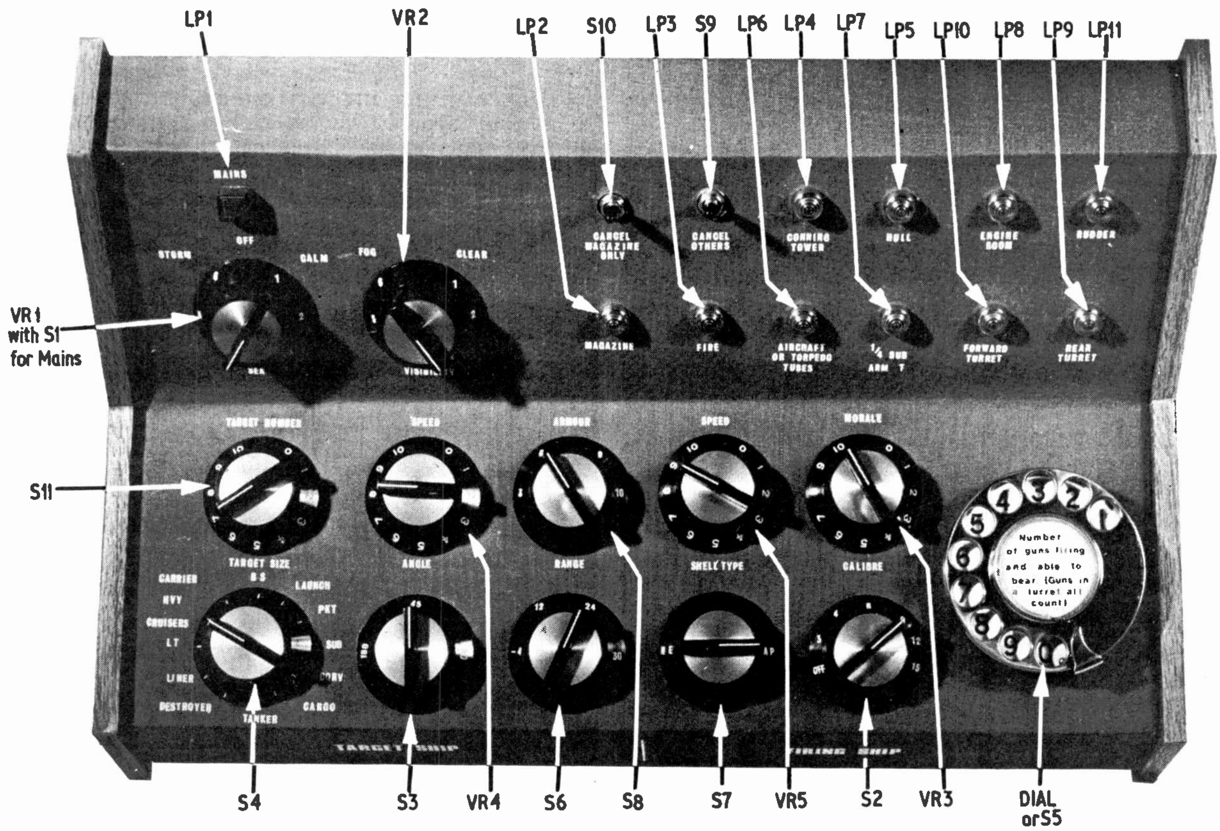


Fig. 3. Block diagram of the complete war game computer with alternative operational modes for smaller systems. The equipment is built up in stages, each stage being a workable progression from the previous



The controls are temporarily fitted for marking stop positions, then removed for lettering

calibre as well as heavy. Now they are attenuated according to their ability to inflict quantitive damage. To this end they pass through voltage dividers on the CALIBRE, RANGE, SHELL TYPE and ARMOUR controls and then passed through an amplifier which also functions as a buffer.

The output is applied to a storage capacitor. When the energy of the incoming pulses has raised the charge on the capacitor to a certain preset level, Schmitt Trigger 1 fires, passing on one pulse of fixed duration and amplitude, which we might term a unit of damage.

In this way, many low amplitude pulses are required to charge the capacitor and produce a damage pulse, but only one high amplitude pulse produces the same damage. Damage pulses may occur only once per salvo, immediately upon completion of dialling.

MAGAZINE SECTION

The damage pulses are applied equally to two buffers. Buffer 2 presents pulses to another storage capacitor, which fires Trigger 2. There is a separate capacitor for each target ship, of different size to suit the size of the target; a rotary switch S11 switches the appropriate target capacitor into the circuit. The capacitor will of course retain its charge from the time a certain target is under fire to the next and therefore functions as a cumulative damage counter.

When the charge on the capacitor reaches a certain preset level, Schmitt Trigger 2 fires, the outgoing pulse this time switching over Bistable 2. In its second stable state the bistable primes Lamp Driver 2, illuminating a lamp indicating that the magazine has blown up. That particular target ship is of course out of the battle.

OTHER DAMAGE

A more interesting game results when ships receive damage bit by bit, affecting their fighting capacity. The output from Buffer 1 switches over Bistable 1, which in turn primes Lamp Driver 1.

A single lamp could be taken from this, indicating a unit of damage, but where is the damage? One means of indicating the damage is shown in Fig. 3. Every time the dial is used, a motor-driven rotary switch is made to move round one position of twelve. The switch outputs are used singly and in pairs to indicate eight types of damage—conning tower, hull, rudder, engine room, aircraft or torpedo tubes, sub-armament, forward turret and rear turret.

FIRE

Another attempt to simulate some realism and to introduce some very real tension into the game is to incorporate a fire. One third of the damage pulses are routed by the Ledex motorised rotary switch to trigger a "fire" bistable, Bistable 3. This lights the "fire" lamp, applies a trickle charge to the storage capacitor in the magazine section and also a third storage capacitor in front of Trigger 3.

When Schmitt Trigger 3 fires, the output switches the bistable off again. Thus in play, when the "fire" lamp lights, the player can do nothing but watch and wait.

If he is lucky, the lamp will go out in ten seconds, but if he is unlucky the magazine lamp will light. Even though the fire lamp will subsequently go out, the magazine lamp will stay on and he is out of the game. This method of using a storage capacitor in conjunction with a bistable and Schmitt trigger is much better than a monostable for long time delays.

That concludes the basic description of the computer functions; more detailed circuits and construction notes follow in seven stages, followed by the final hints of its use in operation.

CASE CONSTRUCTION

The layout of the computer is in no way critical, so the constructor may lay out his controls as he pleases. He should really decide early on how much of the equipment he is likely to build based on the information given in Fig. 3.

Construction of the case was started with $\frac{3}{8}$in thick sheet plywood cut to the dimensions given in Fig. 4. Four rubber feet were screwed to the underside and then the mains transformer T1 bolted on

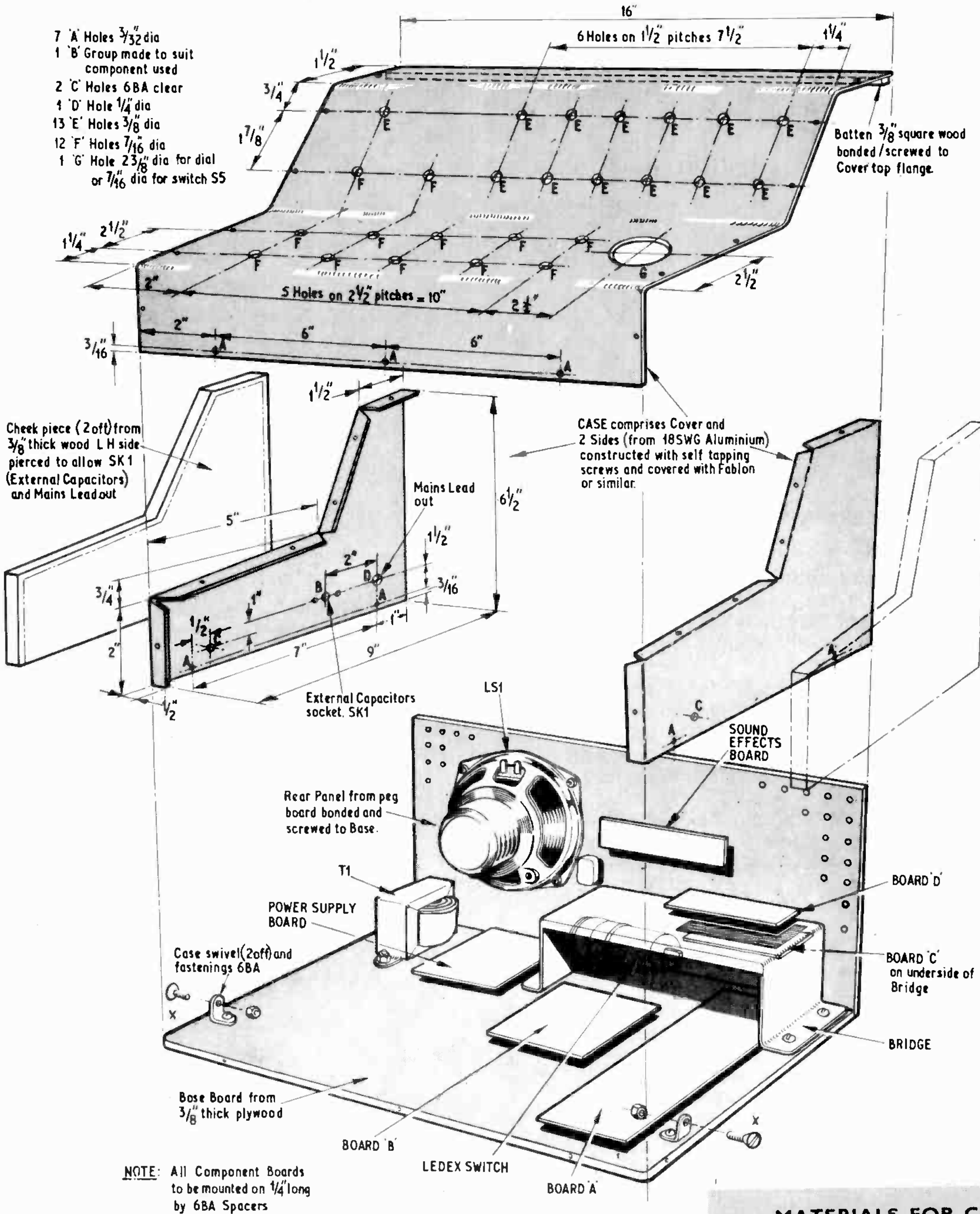


Fig. 4. Construction details of the case and baseboard layout

MATERIALS FOR CASE
Tinned iron sheet (tinplate) or aluminium
Veneered chipboard side cheeks
Hardboard, plywood (to choice)

top. A length of component board was bolted along side to carry the rectifying diodes and smoothing capacitors (Figs. 4 and 7).

The centre tap of T1 secondary was ignored, giving a 50V output. The rectifying diodes can be any type capable of handling 100V at 3 amp, although those shown will handle much more.

The shaped top of the case (Fig. 4) was cut out of heavy-gauge tinplate (which is cheaper than aluminium) and all cutting and drilling completed while the sheet was still flat. Bending was done in a vice, a small-radius curve being left on all corners.

Notice that the bend across the centre is forward, the others all being back. The ½in tabs on each side are for soldering or screwing the side pieces on. A gas-torch was used for soldering tinplate since such large sheets of metal conduct away nearly all the heat from a soldering gun.

Many constructors will want to paint the face or use adhesive plastics sheet, but it is wise to make sure all drilling and bending is carried out first. The surface must be absolutely clean and free from grease or finger marks. Excess material at the edges was wrapped round and glued underneath.

The shaped and covered top was then checked against the baseboard for a snug fit and was secured in place by wood screws along the front and at each side. If one screw at each side is left in position (marked "x" on Fig. 4) the top may be pivoted on them, allowing easy access to the panels and underside without disturbing the wiring.

The back of the computer is a piece of perforated hardboard fitting inside the metal top. It is screwed to the edge of the base and to a strip of wood glued and screwed ½in inside the top edge.

LETTERING

With the cover removed from the base, all lamps and controls are temporarily fitted and the positions of all stops marked. Controls are then removed and lettering and spots applied with rub-on Letraset (see photograph).

Note that 12 pointer-type knobs are required with escutcheon plates to match. On the prototype, some escutcheons have numbers 0 to 10 on them, plus one blank space, so they are admirably suited for 12-way switches. The lettering is given a spray of clear lacquer, and the escutcheons replaced.

Lampholders are also fixed at this stage, if required, although they are not wired up until much later. Many "surplus supply" shops will supply an

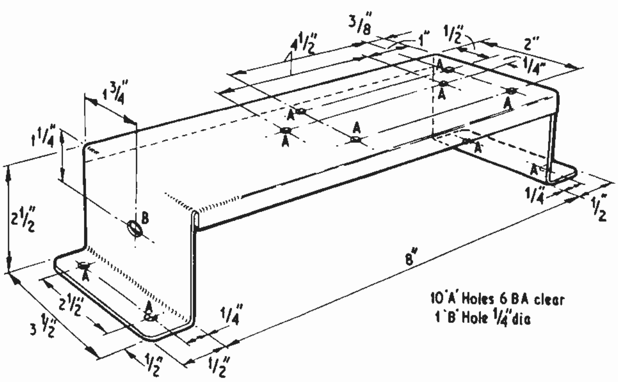


Fig. 5. Panel bridge for mounting the various stage panels

POWER SUPPLY

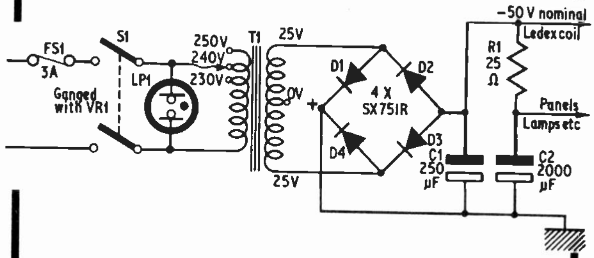


Fig. 6. Circuit diagram of the power supply (stage one)

COMPONENTS . . .

STAGE ONE (Power Supply Fig. 7)

Resistor

R1 25Ω 5W wirewound

Capacitors

C1 250µF elect. 50V
C2 2,000µF elect. 50V

Transformer

T1 Tapped mains primary 0–250; secondary 25–0–25V 2A or 50V 2A

Diodes

D1 to D4 Rectifier diodes SX751R (4 off) or 100V 3A type

Switch

S1 Double pole on/off toggle or may be coupled with VR1

Miscellaneous

FS1 Cartridge fuse 2 amp in mains plug
LP1 Mains neon indicator with ballast resistor
Rubber grommets, component tag board

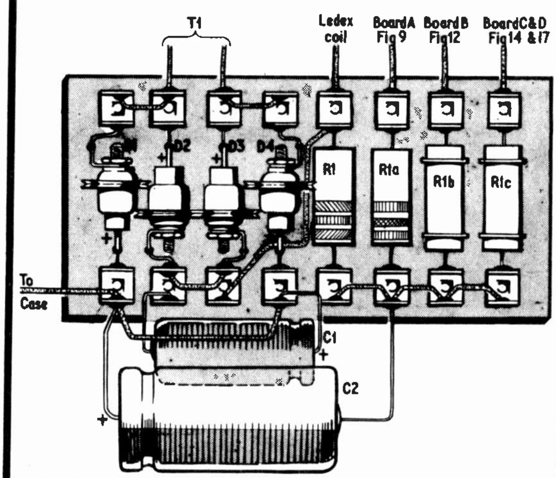


Fig. 7. Wiring of the diodes and capacitors. R1a, R1b, R1c are decoupling resistors 330Ω 3W to supply Boards A, B, C, and D.

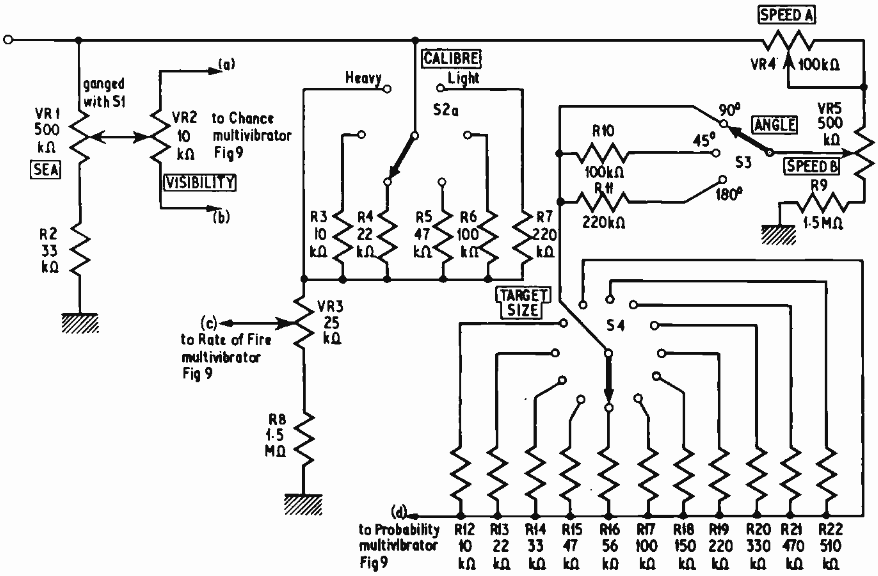


Fig. 8. Analogue parameter controls (stage one)

old telephone dial for about 75 pence or less; after careful cleaning, light oiling and adjusting, it is secured in place with Araldite.

FIRST-STAGE WIRING

First-stage wiring presents no problems. VR1 has an integral mains double pole on/off switch S1, while the associated mains neon LP1 is mounted close by. The incoming three-core mains lead is brought through a rubber grommet and both supply leads soldered to the switch.

Keep the leads from S1 to T1 long enough for the top to open easily. Watch the polarity of the rectifying diodes D1 to D4 very carefully (Fig. 7). Good smoothing by C1 and C2 is required otherwise the Schmitt Triggers may fire when not wanted. Soldering tags screwed to the base board and metal panel provide convenient take-off points for earth connections.

Wire the controls from Fig. 8, taking off four flying leads of flexible wire, (a), (b), (c) and (d). Resistors to earth such as R2 may be soldered to the tinplate or chassis tags at any convenient spot—there are no problems with earth loops such as occur with audio circuits. One length of flexible wire connects the panel to the positive side of the power pack.

COMPONENTS . . .

STAGE ONE (Analogue Controls Fig. 8)

Resistors

R2 33kΩ	R9 1·5MΩ	R16 56kΩ
R3 10kΩ	R10 100kΩ	R17 100kΩ
R4 22kΩ	R11 220kΩ	R18 150kΩ
R5 47kΩ	R12 10kΩ	R19 220kΩ
R6 100kΩ	R13 22kΩ	R20 330kΩ
R7 220kΩ	R14 33kΩ	R21 470kΩ
R8 1·5MΩ	R15 47kΩ	R22 510kΩ

All ±10%, $\frac{1}{4}$W carbon

Potentiometers

VR1 500kΩ (may have double-pole on/off switch S1)
VR2 10kΩ
VR3 25kΩ All linear carbon types
VR4 100kΩ
VR5 500kΩ

Switches

S2 Double-pole, 6-way wafer switch
S3 Single-pole, 12-way (only 3 ways used)
S4 Single-pole, 12-way wafer switch

USING THE FIRST STAGE

For a very small outlay the constructor has an analogue computer giving 10^7 variations 10,000,000. If we proceeded no further, this would be worth having. Directions for the full game will be given later, but for the time being we can use what we have built so far in the following way.

Ignore output (b); take output (a) through a 1 megohm resistor and connect it to outputs (c) and (d). The resulting voltage (indicated on a suitable meter) will vary according to the setting of the controls, all resistors acting in a series-parallel divider configuration in a complex manner. The voltage will also depend to a certain extent upon the impedance of the meter used, varying from 48 volts to about 15 volts. This voltage reading is used as the starting point for "damage" points.

For the chance element, one can use a dice, multiply by ten and add to the voltage reading. A points value is accorded to each ship at the commencement of the game and a running total of damage points kept. When damage reaches the awarded value, the ship is sunk.

Many interesting games can be played by varying the chance element (multiplying the dice throw by 5, or squaring) or varying the points value. As a starting point, try 250 for a destroyer and 2,000 for a battleship.

Next month: Second and third stages

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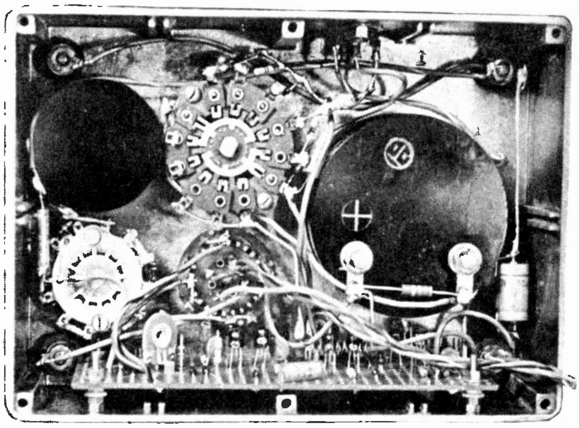
PART TWO

VOLTAGE STABILISER

By A. J. Ewins



THIS month we finish the circuit description and give construction and application details of the Voltage Stabiliser.

RESISTOR MATCHING

Several ways of matching the padded 11 kilohm resistors with the 10 kilohm variable control will no doubt suggest themselves to the constructor. Here are two possible ways. A simple Wheatstone bridge with two, equal in value, 1 per cent resistors for the ratio arms may be rigged up. The 10 kilohm wire-wound control is used as the "known" resistor and the 11 kilohm fixed resistors are connected, in turn, as the "unknown" resistor. The 11 kilohm resistors are then shunted as required until a balance (zero current) is obtained on the meter. See Fig. 3.

Alternatively, when the control unit has been constructed and is working, the 10 kilohm wire-wound control only can be inserted with its full resistance in circuit. The output of the unit is then set to read 2·5 volts by adjustment of the preset control, VR1. (An Avometer or other reliable voltmeter should be used for measuring the output voltage from the unit.)

The 11 kilohm resistors can then be inserted in the circuit, in turn and in place of the 10 kilohm wire-wound control, and shunted until the same 2·5 volts output is obtained. Using the small $\frac{1}{8}$ watt resistors allows a neat arrangement of the 10 kilohm resistors around the 12 way switch (just visible in the bottom left-hand corner of the photograph of the internal view of the unit). To those constructors who are hesitant about this method of obtaining accurate 10 kilohm resistors, a word of reassurance; the author did not have to use more than two padding resistors per 11 kilohm resistor and in the majority of cases used only one.

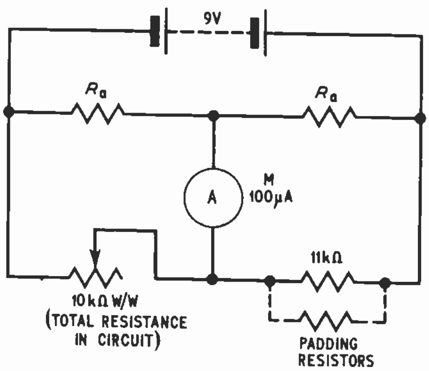


Fig. 3. Wheatstone bridge for resistor matching

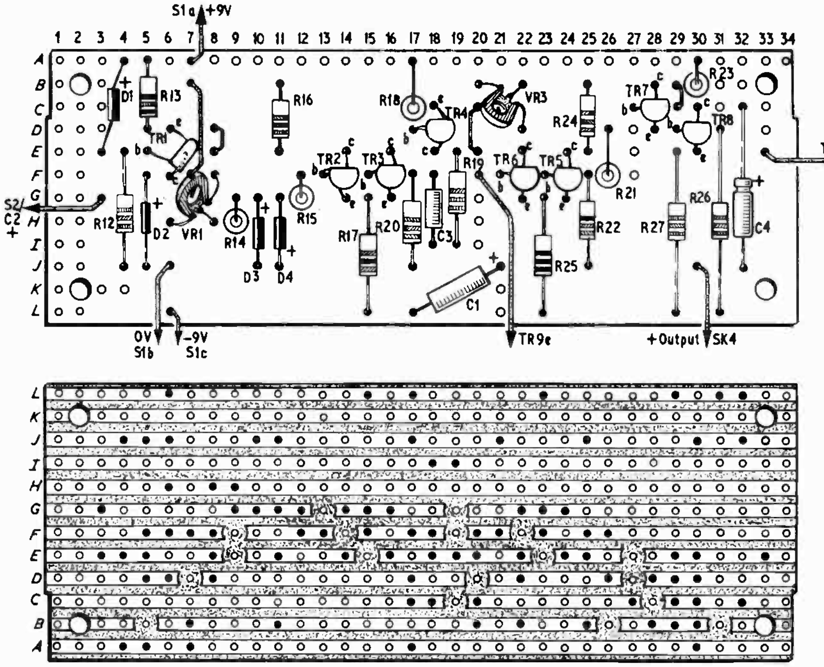
CURRENT RANGES

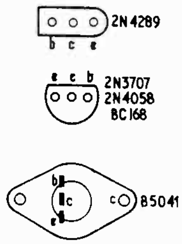
For full current limiting the voltage developed across the selected value of TR9's emitter resistor is nominally one volt giving a value for R_e of $1/I_1$, depending on the value of I_1 required. For current limiting ranges of 10, 25, 50, 100 and 250mA the required values of resistance are 100, 40, 20, 10 and 4 ohms respectively. If the precise value of the limiting current is not important the 40 and 4 ohm resistors can be replaced by the standard values of 39 and 3·9 ohms. One section of a 4 pole, 5 way rotary switch (S3c; only three poles are needed) was used to switch in the five values of resistance. The other two sections were used to switch in a shunt resistor (R33) across the milliammeter to give an additional range of 0 to 250mA for the three upper current limiting ranges.

The section S3b may appear to be redundant, but omitting it means that heavy currents will flow through the contacts of section S3a. As the contacts of S3a are in series with the shunt resistor, erroneous and erratic readings can be expected on the meter due to the relatively large value of resistance of the contacts compared with the shunt. (This, indeed, was the author's experience). Including the section S3b puts the contacts of S3a effectively in series with the meter, which has a resistance of 9 times the shunt and draws one ninth of the current flowing through the shunt, thus greatly reducing the effect of the contact resistance.

For the 4 pole, 5 way switch, the author was lucky enough to possess a Yaxley type wafer with two 1 pole, 5 way sections on either side. The constructor's best bet, if somewhat of an expensive solution,

Fig. 4. Veroboard layout and wiring





Note: It is regretted that the wrong transistor base connections were published last month; this is corrected above.

Also under **Specification**, the last line of **Stabilised Voltage Output** should read "2 and 35V in excess . . ."

In the second paragraph of the introduction 85 volts should read "65 volts"

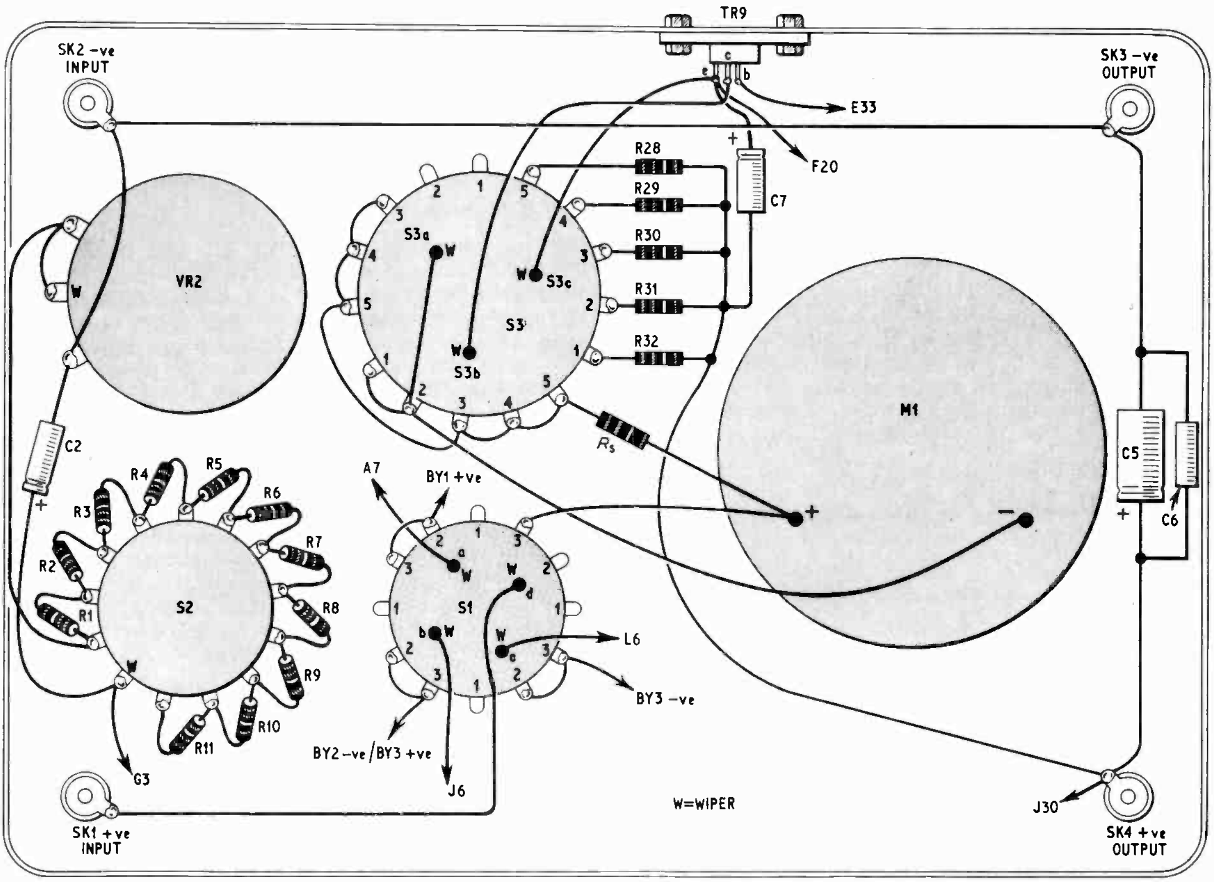
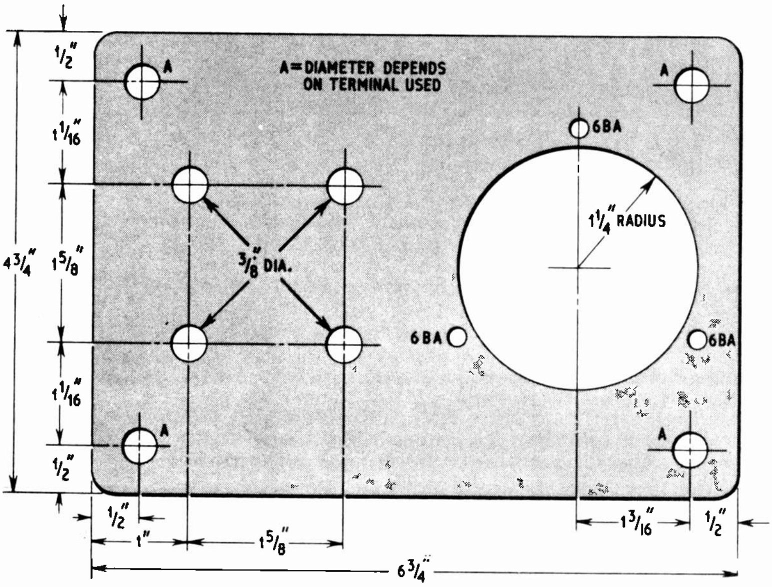


Fig. 5. Internal wiring of the stabiliser

Fig. 6. Front panel drilling details



is to construct a "Makaswitch" assembly using two 2 pole, 5 way wafers mounted close together, without using spacers, in order to conserve space.

As stated, the value of R_S (the meter shunt resistor) will be one ninth of the meter resistance. Where the meter resistance is known the value of R_S may be easily made up using a coil of 22 s.w.g. Eureka resistance wire. If the meter resistance is not known the best way to determine it is to measure the voltage dropped across the meter, when it is indicating full scale deflection, by means of a suitable voltmeter. (The sensitivity of the voltmeter, in terms of ohms/volt is unimportant). For most meters, other than the popular Japanese types, the voltage dropped will be about 100mV giving a meter resistance of about 4 ohms. A shunt is then required of about 0·44 ohms. This can be made from about 14·5 inches of 22 s.w.g. Eureka resistance wire (2·75ft/ohm for 22 s.w.g. Eureka resistance wire).

MAIN CONSTRUCTION

Using the type of controls and meter described, the author was able to fit all the components of the unit, including batteries, into a die-cast box of size, 6¾in × 4¾in × 2⅛in. The two diagrams, Figs. 4 and 5, show Veroboard layout and internal wiring of the completed unit.

It is possible to mount all the electronics of the unit, except of course the controls, on a piece of Veroboard measuring 5¼in by 2in.

Details of the positioning and size of the holes drilled in the front panel are shown in Fig. 6. The mounting position of the Veroboard layout can be clearly seen in the photograph of the internal view. The series regulator transistor, TR9, can be mounted in any convenient position. In the photograph it can be seen at the top of the unit near M1. The particular transistor specified for TR9 is the B5041, which is on a X53a base.

The mounting of the batteries on the back panel of the box is left to the ingenuity of the constructor. In the prototype a special bracket was manufactured from 16 s.w.g. aluminium.

USING THE STABILISER

The stabiliser is shown in Fig. 7 being used to provide a stable output voltage. When operating in this manner the difference between the input and output voltages of the unit must not be allowed to exceed 55 volts, which is the maximum V_{ce} rating of the series regulator transistor. The current meter

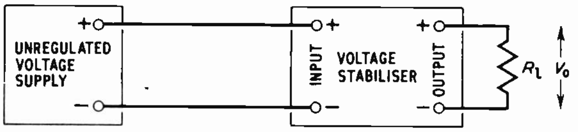


Fig. 7. The voltage stabiliser being used to provide a stable output voltage

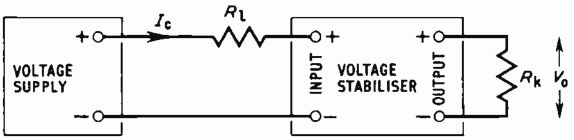


Fig. 8. The stabiliser being used to provide a constant current

is connected in the collector line of the series regulator transistor and hence gives an indication of the current being drawn from the external supply. The current flowing through the load applied to the output terminals will be equal to the meter reading less the sensing current, I_s, which is 250μA.

The unit being used to provide a constant current is shown in Fig. 8. As the output voltage of the unit is completely insensitive to changes in voltage from the external supply (providing that the external supply volts do not drop below about 2 volts in excess of the output voltage setting), the current drawn from the supply is independent of its voltage.

The precise value of the current drawn from the external supply is equal to the output voltage setting of the unit divided by the value of the load resistor, plus the sensing current which equals 250μA. A range of constant currents from 250μA to 250mA is thus possible. The current drawn from the external supply will fall below its constant value when the voltage dropped across the external resistor is equal to or greater than the difference between the external supply volts and the voltage output setting of the unit, less about 2 volts. As for the stabilised voltage mode of operation, the difference between the input and output voltages of the unit must never exceed 55 volts.

★

NEWS BRIEFS

Tape Competition

YOUNG tape recordists are invited to enter the Animal Sounds recording competition for under-18's organised by the 3M Company, manufacturer of Scotch magnetic tape. Entry is free, and there are two classes: British birds in song; and Animals (including domestic pets).

For the three best recordings in the birds section a 472-page guide to the identification of all the birds commonly seen in Britain is the prize.

For the three best recordings in the animal section a 428-page Living World of Animals will be awarded.

The recording judged best overall will merit a £30 portable cassette recorder, complete with microphone, carrying case and supply of Scotch low-noise cassettes, and there are certificates for the winning entrants' schools.

Entry forms are being distributed to some 20,000 schools, or can be obtained direct from Magnetic Products Marketing, 3M Comany Ltd., 3M House, Wigmore Street, London, W1A 1ET.

Last date for receipt of entries is October 31, 1971.

PO Copying Service

MEMBERS of the public needing a quick copy of important documents can now use coin-operated (5p) photocopying machines in 20 head and branch post offices. The Post Office has installed the machines for an extended trial following an initial trial at five offices during the past 18 months.

The machines chosen are simple to operate and make copies in A4 size (8¼in × 11¾in).

The 20 offices involved are the head offices at Harrow, Belfast, Coleraine, Chester, Plymouth, Swindon, Dundee, Portsmouth, Hastings, Bury St Edmunds, Worcester, Blackpool, Sunderland (probable), Leeds, Coventry, Bolton and Cambridge, and branch offices at Great Portland Street, London, Swansea (Kingsway) and Edinburgh (Frederick Street).

If the extended trial is successful, the Post Office plans to install photocopiers on a much wider scale.

Heated Diagnosis

DOCTORS at Cape Town's Groote Schuur hospital are to use infra-red techniques in diagnosing breast cancer, thrombosis and other ailments following the purchase of a "Thermoscan" thermal imaging system from EMI.

With this electronic equipment, the first British system of its type, the famous South African hospital will be able to assess or investigate quickly disorders which disturb the body's normal heat distribution, by obtaining a heat "picture" of a suspected area of infection.

The thermal imaging equipment comprises a mobile infra-red scanner unit (similar in appearance to a small television studio camera) and a monitor, incorporating a cathode ray tube. The system operates by scanning the distribution of heat over the area of the body being studied and is sensitive enough to detect differences in temperatures as small as 0·2 degrees Centigrade.

The scanner can be operated remotely, with the monitor located up to 30 metres away from it. This facility enables a patient to be separated completely from the clinician, allowing free discussion of the observed symptoms.

The Thermoscan systems are currently being evaluated by Britain's Department of Health and Social Security at selected hospitals where they are aiding diagnosis of a wide variety of conditions which are difficult or impracticable to study by other means.

Socket Guide

IN RECENT years a good deal of confusion has arisen over the use of connectors for public address equipment. The German DIN connectors are suitable for permanent installations, but where equipment is portable or is available for hire, a more robust connector is needed.

To resolve these problems, the Association of Public Address Engineers has published a technical information sheet which recommends that XLR connectors are used for all professional public address applications. The Information Sheet gives details of the correct use of XLR connectors for microphones, loudspeakers and auxiliary circuits.

The Information Sheet, reference T.I.S.2 is available free to members of the A.P.A.E. or price 5p to non-members on application to the Secretary, 394 Northolt Road, South Harrow, Middlesex HA2 8EY.

Luxury Viewing

WITHOUT even raising their heads from the pillows, guests at the new Capital Hotel in Knightsbridge can select from nine channels of sound and vision from Top Rank designed remote control panels fitted in the bed headboard.

The h.f. distributor system which makes this remote control possible carries television signals in monochrome and colour. The television sets are bracketed so they can be viewed either from the bed or from the easy chairs.

Green Diodes

THE Electronic & Display Equipment Division of Ferranti Ltd. has successfully developed the world's first gallium phosphide monolithic green light emitting array. Perfected at the Gem Mill, Chadderton laboratories of the Division, the array is based on a unique masking and diffusion process for use on gallium phosphide to produce high output, low consumption light emitting diodes.

The gallium phosphide is enveloped by a dielectric layer, so protecting it and ensuring that it attains an exceptionally long life to an extent previously obtained only from hermetically-sealed devices.

Vacation School on Circuit Theory

THE Moscow Institute of Medical Instrument-making has designed an ultrasonic apparatus for the diagnosis of cerebral diseases. It is claimed that scientists regard it as quite promising for neurosurgery and neuropathology.

The instrument makes it possible to examine the patient quickly and painlessly. By touching alternatively various parts of the cranium with a sensor, the physician completely "sounds" the cranium.

Clinical tests have shown its high accuracy in diagnostics. Experts note that the new way is also most reliable in control of the results of intra-cranial operative intervention. Examinations are harmless and can be repeated many times.

The apparatus is now in batch production.

BY FRANK W. HYDE

MARINER INQUEST

The cost of the loss of *Mariner 8* cannot easily be calculated in totality. The spacecraft and its launch vehicle was a £50 million project but the loss of data cannot be measured in terms of money.

Sadly, the cause of the disaster was a part costing a few cents and microscopic in size. It was part of the autopilot system of the vehicle, and the part of the integrated circuit which failed was a diode about the diameter of a human hair.

The investigating team simulated the telemetry which was returned by the *Centaur* vehicle to mission control up to the time of failure. It was possible from this data to determine that the engine, which should have had a swivel range of 3 degrees to enable it to be accurately steered, could only cover a range of 1·3 degrees.

The amplifier which was a part of the system had an output which was between 20 and 30 per cent of what it should have been. This was due to a voltage overload that the diode should have controlled.

Many other tests were carried out to simulate possible faults but only this one produced the conditions radioed back at the time of the failure.

Though there is no way to tell now why the diode malfunctioned, the investigating team have devised tests to make sure that the same thing will not happen with *Mariner 9*. Certain other modifications were made which will help to minimise the loss of the *Mariner 8* experiments. Some of these were added to *Mariner 9* before it was launched.

The launch could have been delayed until the middle of June, but any later launch date would have compromised the mission, as a favourable period would not arise again for 25 months. This means that the next launch would have to be delayed until 1973 when the Earth and Mars are in correct alignment. However, the amount of power required then would be greater than the capacity of the present *Centaur* vehicle.

The arrival time of *Mariner 9* at its destination will not now be November 14 but more likely November 24.

SOVIET THOUGHTS ON PULSARS

A Russian Academician, Vitaly Ginzburg, has advanced a new hypothesis on the subject of Pulsars. It is generally accepted that the Pulsars are in fact Neutron Stars and are known to be stars which are in a certain stage of cooling.

Ginzburg is suggesting that his mathematical model fits the known facts about these bodies. He believes they are in a state of compression so great that they are reduced to a thousandth of their original size.

Their speed of rotation, he says, can be measured to a small fraction of a second and that the density of the material is of the order of a thousand million tons for a cubic centimetre, if measured on the earth. The radiation pulses from these bodies, which have been observed by radio astronomers, are the result of the fact that their magnetic and rotational axis do not coincide.

It is also suggested that the temperature of these pulsars is of the order of hundreds of millions of degrees, and that under a plasmic liquid or gaseous outer layer there is a hard crust about one kilometre thick. Inside there would be a superfluid and superconductive mixtures of liquids consisting of elementary particles. The matter is being investigated at the Pulkovo Observatory near Leningrad.

LUNOKHOD I

The *Lunokhod I* moon vehicle continues to pursue its programme of exploration of the Moon's surface. It is in its ninth lunar day of operation since it was landed on November 17, 1970. A film of its work compiled from the television pictures sent back to earth has been showing in Russian cinemas to enthusiastic audiences.

The vehicle has successfully overcome many difficulties. For example, it encountered a crater which was full of fair sized boulders and was able to negotiate the rugged terrain. It did have one serious difficulty where the side of a crater proved to have a very loose surface and the telemetry showed a slip of up to 90 per cent of the wheels. Such was the skill of the earth based controllers that the vehicle was got safely out of the crater.

Studies of the chemical composition of the surface have been made and continuous mapping is being carried out.

MORE SPIN-OFF BENEFITS

There are a number of medical benefits available from space activities, sometimes relating directly to space medicine, and sometimes to other techniques, which have been turned to medical use on earth.

A special version of the space helmet has been used to measure the oxygen consumption of children while they were undergoing special hard exercise in hospitals. The multilayered principles of the space suit has been adapted and used as a pulsating device to assist in respiration for severely paralysed patients. It may well be possible that this system can be used to replace the iron lung. The advantages of giving possible mobility to such unfortunate sufferers may well open a new avenue of hope for them.

BODY MONITOR

A personal health monitoring device has been adapted from the space techniques. This is in the form of a battery operated device about the size of a cigarette box which can be strapped to the patient and will then transmit the temperature, blood pressure, respiration, pulse and other vital physiological information.

Seated at a console a nurse will be able to monitor up to 60 or so patients in an intensive care unit with consequent increase in moment to moment observation and a great increase of efficiency in dealing with emergencies.

Another system which was used to improve the detail of pictures returned to Earth from Mars has been applied to X-ray pictures and has resulted in great improvement in these by enhancing detail.

An early study of lunar mobility involved the development of a six-legged walking device for astronauts. This has now been applied to handicapped patients enabling them to negotiate stairs, curbs and avoid obstacles where the ordinary wheelchair could not cope.

LUNAR EXCHANGE

Samples of lunar rock brought back to earth by *Luna-16* and *Apollo-11* and *12* were exchanged by Soviet and American scientists on June 10.

The exchange took place under an agreement between the U.S.S.R. Academy of Sciences and the United States National Aeronautics and Space Administration. The scientists expressed the hope that the exchange of lunar material would enable them to make, in the laboratories of their respective countries, a comparative analysis of rock samples brought from different areas of the lunar surface.

PART 5 PROGRAMMING

By M. J. HUGHES M.A.

CONCLUDING ARTICLE

The "P.E. Aurora" system has the great advantage that light control is effected by low voltage levels from fairly high impedance sources. This fact enables a wide range of sources for control. This part explores some possibilities which have been tried successfully by the author, and which might provide some hints for further experimentation.

No doubt apart from domestic use the next most likely application for "P.E. Aurora" is in the field of discotheques and clubs. As already shown, sound control of lights can be achieved successfully, but sometimes fast strobing effects may be required. Xenon flash tubes are normally used for this, but they cannot be left running for long periods of time. They do not have a very great power for long range illumination.

STROBE EFFECT

While a "freeze" strobe cannot be produced from "P.E. Aurora", a very good simulated strobe can be obtained with the advantage that up to eight channels can be independently operated simultaneously with different colours and at different speeds. The basis for this effect is a simple free running multivibrator. The circuit of one is shown in Fig. 1. It is suggested that instead of having eight circuits (for a full system) only four are needed; complementary outputs of the unit being applied to adjacent channels.

Some spectacular effects can thus be obtained if complementary colours are alternately strobed against each other, for example, red with green, or blue with yellow. It is best for the mark/space ratio of the strobe to be approximately 1 to 1, therefore if variable speed is required a ganged potentiometer (VR1 and VR2) should be used so that both sides of the multivibrator are identically controlled.

Note that in this circuit *pnp* transistors are used. The common emitter rail (positive) should be commoned to the +15V rail of the "P.E. Aurora" controller—the 0V rail should *not* be commoned with the 0V rail of the controller if an external power supply is used. If the internal supply of this controller is to be used, apply decoupling in the 0V line as explained in part 3.

SEQUENTIAL STROBE

Some of the lighting arrangements described last month can be shown to best advantage if the lights appear to move. This can be done by switching lights on and off in a given sequence. For example a set of four lamps A, B, C, and D can be made to look as if they are moving by first of all lighting lamp A, it is then extinguished and B lit; B is extinguished and C lit and so on. As D is extinguished, A lights for the second time.

A sense of movement can be obtained with three lamps but the effect is better with four, especially if the effect is to be repeated down a long string of lamps paralleled together in four groups.

This effect can be produced very simply by using four of the control channels (if more power is required the remaining four channel controls can be paralleled in by strapping the input signals across pairs of channels). Fig. 2 shows one way to produce a sequential step from one lamp channel to the next. It utilises some simple logic controlled by a clock which is used to set the speed of switching.

Integrated circuits are used and the prototype system was designed around DTL. There is no reason why other logic systems should not be used, but TTL could be difficult to use because of the need for short inter-connections.

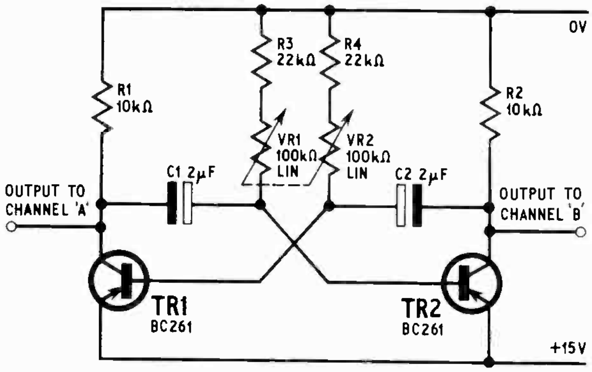
POSITIVE LOGIC

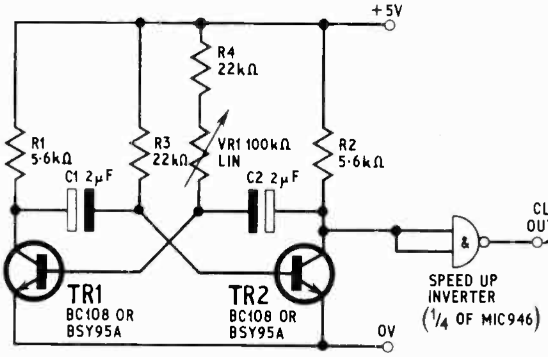
Assuming positive logic throughout; the most positive voltage (+15V level of the controller) is "1", therefore a logic "0" (provided the difference in level between it and a "1" is greater than 1V) applied to a control input will turn that lamp on.

Provided we do not excessively load the outputs of gates or flip flops, when they have an output of level "1", the actual output voltage is very close to $+V_{cc}$. Thus if the logic system has its $+V_{cc}$ rail commoned to the +15V rail of the controller, a logic "1" will turn a lamp off and a 0 will do the converse.

Referring back to Fig. 2, the free running multivibrator can be adjusted by VR1 to oscillate from

Fig. 1. A simple multivibrator as this can produce some interesting strobe effects especially if the two collector outputs are fed to adjacent channels, thus, for example, strobing red and green in complementary mode. Note that pnp transistors are used; this ensures that an active "pull up" to +15V will ensure that lamps can be totaly extinguished





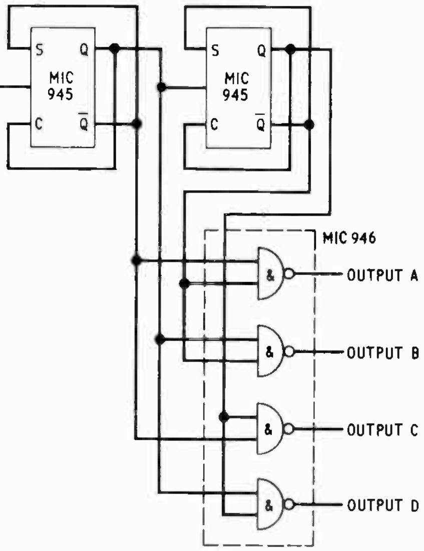


Fig. 2. A simple scale of four counter with output gating which produces sequential "O" level pulses on four separate output lines. These can be fed to four separate channels thus producing a sequential strobe. The elements shown are a discrete component clock followed by DTL elements. Note that the +5V above is the positive rail supplying the integrated circuits and is used as the common line when connecting the output gates to the controller. It should be connected to the +15V rail of "P.E. Aurora" system

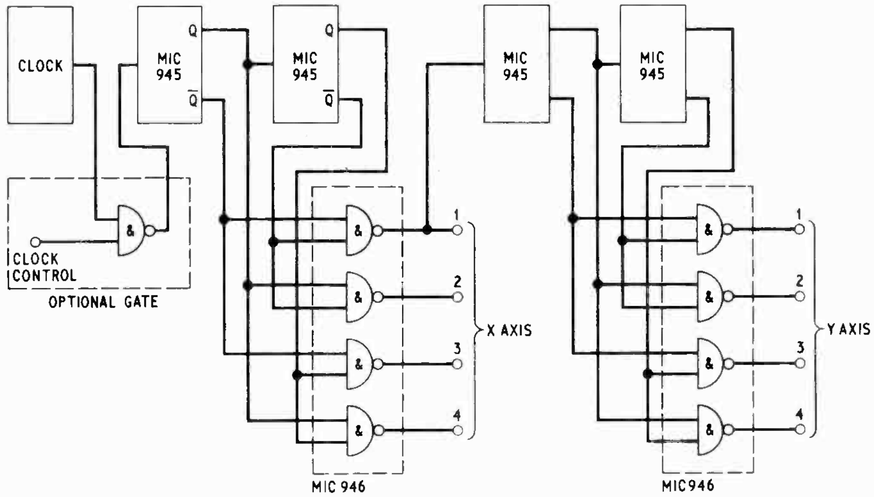


Fig. 3. Using the output from one of the gates of Fig. 2 to drive an identical system, we can sequentially switch on every lamp in turn in a 4 × 4 lamp matrix

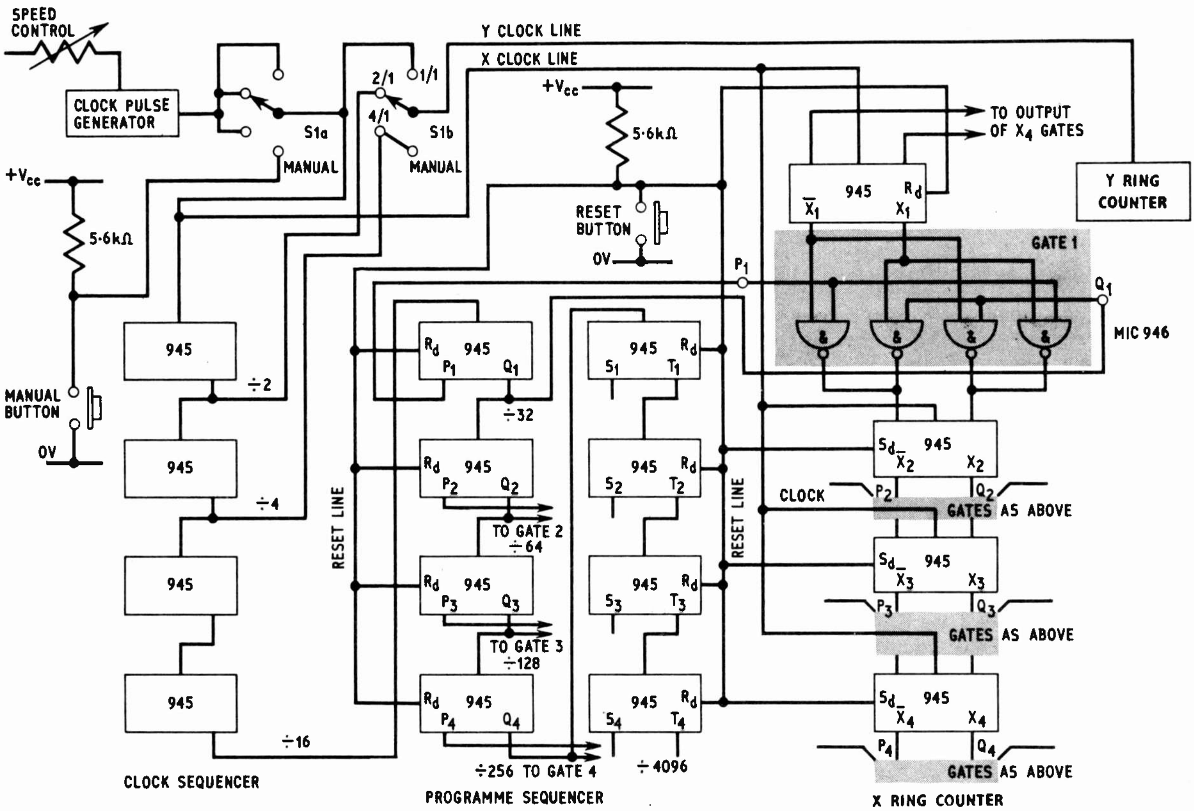


Fig. 4. This shows a much more ambitious system of sequentially switching the lamps. Designed to make full advantage of the matrix display, this unit comprises two multiple twist ring counters whose twists are controlled by a programme sequencer. Discrete DTL units were used in the prototype. It is possible to use MSI circuits to simplify some of the system and smaller systems based on this could be devised. The block labelled Y ring counter is identical to the X ring counter and uses type 945 flip-flops and 946 gates. They are fed in the same way from the S and T series of flip-flops in the programme sequencer

between several pulses per second to approximately one pulse per two seconds. The output waveform of this is speeded up by using a single NAND gate as an inverter. This is then fed to a pair of cascaded binaries which are straightforward clocked RS flip-flops with the outputs cross-coupled back to the inputs. If a JK flip-flop is used no cross coupling is required.

The four discrete output conditions of the two binaries are decoded by the four gates. The decoding sequence is such that there is an output of "0" from only one gate at any instant and this "0" steps from one gate to the next in the sequence A, B, C, D, back to A and so on. These outputs should be connected to respective inputs of the controller. Again note that the 0V rail of the logic system should *not* be commoned to the 0V line of the controller.

SEQUENTIAL MATRIX SWITCHING

Use can be made of logic to select and switch any given lamp node or nodes within the Aurora matrix (see Part 1). One could envisage, for example, a lamp being lit at the top left-hand corner of a matrix and moving along a horizontal row of four, then back to the beginning of the next line down, across it and down to the next and so on (rather like a television beam scan producing a raster).

Some of the lighting arrangements shown last month are designed around 16 controlled nodes in a matrix. If the 16 nodes were spacially set in a circle one could use logic to select any one of the 16 lamps in turn and turn it on. With a little more thought one could make this step from one to the next all the way round the circle (this in itself could make an interesting attraction at fetes).

Fig. 3 shows a fairly simple way in which this fixed programme can be obtained. It uses two circuits identical to that shown in Fig. 2. Each time one circuit completes a cycle it steps the other circuit on one position, hence 16 separate lamps can be individually switched on in sequence at any speed selected by the clock. A gate could be inserted between the clock and the first binary so that the clock can be started and stopped after a random period of time by some other circuitry.

RING COUNTER

The system just described produces an interesting sequence, but cannot accommodate any variation from the simple step-by-step sequence. A much more ambitious system which includes a variable programme is shown in Fig. 4. The circuit as shown uses electronic programme change, but if the constructor so desired he could simplify the system, and cut down on the number of integrated circuits used by using toggle switches to select any particular programme manually.

In this case the X and Y axes are controlled by the outputs of stages in two separate ring counters.

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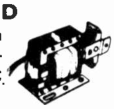

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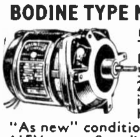

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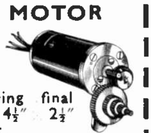

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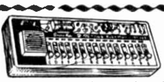

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230	9–18	2 c/o HD	63p*	1,250	24–36	4 c/o	63p*
230	9–12	4 c/o	78p*	2,500	36–45	6M	63p*
280	9–12	2 c/o	73p*	2,400	30–48	4 c/o	50p
600	18–32	4 c/o	78p*	5,800	40–70	4 c/o	63p*
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Table 1: TRUTH TABLE FOR 34 OF THE DIGITAL SEQUENCES

Sequence	X1	X2	X3	X4	Y1	Y2	Y3	Y4
Reset	0	1	1	1	0	1	1	1
1	1	0	1	1	0	1	1	1
2	1	1	0	1	0	1	1	1
3	1	1	1	0	0	1	1	1
4	0	1	1	1	1	0	1	1
5	1	0	1	1	1	0	1	1
6	1	1	0	1	1	0	1	1
7	1	1	1	0	1	0	1	1
8	0	1	1	1	1	1	0	1
9	1	0	1	1	1	1	0	1
10	1	1	0	1	1	1	0	1
11	1	1	1	0	1	1	0	1
12	0	1	1	1	1	1	1	0
13	1	0	1	1	1	1	1	0
14	1	1	0	1	1	1	1	0
15	1	1	1	0	1	1	1	0
16 X prog. ch.	0	1	1	1	0	1	1	1
17	1	1	1	1	0	1	1	1
18	1	0	1	1	0	1	1	1
19	1	0	0	1	0	1	1	1
20	1	0	0	0	1	0	1	1
21	0	0	0	0	1	0	1	1
22	0	1	0	0	1	0	1	1
23	0	1	1	0	1	0	1	1
24	0	1	1	1	1	1	0	1
25	1	1	1	1	1	1	0	1
26	1	0	1	1	1	1	0	1
27	1	0	0	1	1	1	0	1
28	1	0	0	0	1	1	1	0
29	0	0	0	0	1	1	1	0
30	0	1	0	0	1	1	1	0
31	0	1	1	0	1	1	1	0
32 X prog. ch.	0	1	0	1	0	1	1	1
33	1	0	0	0	0	1	1	1
34	0	1	1	0	0	1	1	1

etc.

The stages in each ring counter are connected to the next through a set of crossover gates which can be controlled to "twist" the data between stages. A set of these gates is provided between each pair of stages, thus in one counter there are up to 16 possible ways of coupling (some of the 16 are equivalents).

The state of the cross coupling gates is set for both the X and Y axis by the programme sequencer which is simply an eight-stage binary divider, the first four stages controlling the X counter, and the final four the Y counter. Thus the X counter goes through 16 permutations of programme before the Y counter takes up its next condition.

The clock sequencer allows 16 pulses to be applied to the X counter before the programme sequencer changes the programme. S1b allows pulses to be applied to the Y counter on a one for one basis with the X counter or alternatively one for two or one for four. A fourth position on switch S1a allows manual stepping of the lights and programme by means of a push button.

PROGRAMME SEQUENCE

To start the whole operation it is useful to know that a precise condition is set and that the programme is at the start, therefore a reset button has been incorporated. Note that this resets everything in the system except the second, third, and fourth stage of each ring counter which is set.

Table 1 shows the movement of "0"s (i.e. lamp illuminating signals) through the X and Y counters for the first 34 clock pulses.

This is a very short extract of the early part of the self-programming switching sequence. It can be seen that at the count of 16 a twist is introduced between stages one and two of the X counter and a further twist is introduced between stages two and three while the first twist is removed at the count of 32. This procedure continues indefinitely and will eventually recycle after going through all combinations of twists and counts.

The Y programme will make its first change after 16 X programme changes.

A "0" in Table 1 indicates that that channel is switched on.

This digital sequencer was successfully built by the author and demonstrated with "P.E. Aurora" at the Audio Fair last year. When left to run through the complete programme some fascinating sequences are obtained, some of an extremely regular nature and some random. Sometimes the unit seems to stop and dwell on certain combinations of lights: this is merely the effect of a freak code cycling through the ring counters.

A word of warning for anyone who wishes to construct this unit—due to the constantly changing combinations of the cross coupling gates it is extremely difficult to keep track of the switching sequence and trouble shooting can become extremely hair raising! Nevertheless certain parts could be abstracted from this complete system for special types of application.

Full constructional details are not provided here since it is expected that anyone interested would be able to translate the logic diagrams into practical wiring. It can prove to be an expensive project, however, and some research into costing is thoroughly recommended before starting.

PHOTO ELECTRIC CONTROL

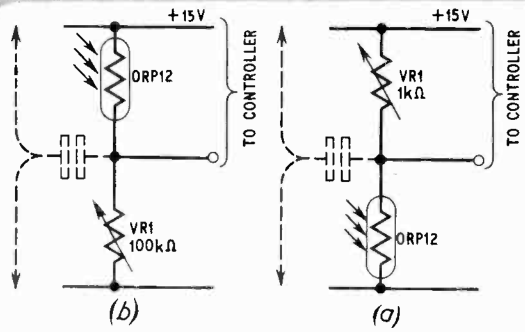
Let us move to one of the simplest—and to some extent most amusing—forms of control; namely using light to control light. This is simply done in the case of "P.E. Aurora" by using a photo-sensitive cell and a resistor. Depending on which way round they are connected, a positive or negative logic can be arranged, i.e. light falling on a photo cell to increase the controlled light output of another lamp, or vice versa. Fig. 5 shows both systems.

If the light being controlled is used to illuminate the controlling photocell, some interesting types of positive and negative feedback can be obtained. Even more interesting is to form a ring of control using the light output of one channel to control the next and so on until the loop is closed.

If this is done a delay can be introduced by inserting a capacitor (1 to 10μF) as shown. If one cell is momentarily obscured a ripple can be made to move round the loop—with care and the correct amount of positive feedback coupling one might achieve regenerative oscillation.

TAPE CONTROL

Quite early on it was envisaged that the "P.E. Aurora" system could be used in conjunction with a loop tape recorder to provide control of shop window or boutique lights. The author has built a system which worked well with three channels. There



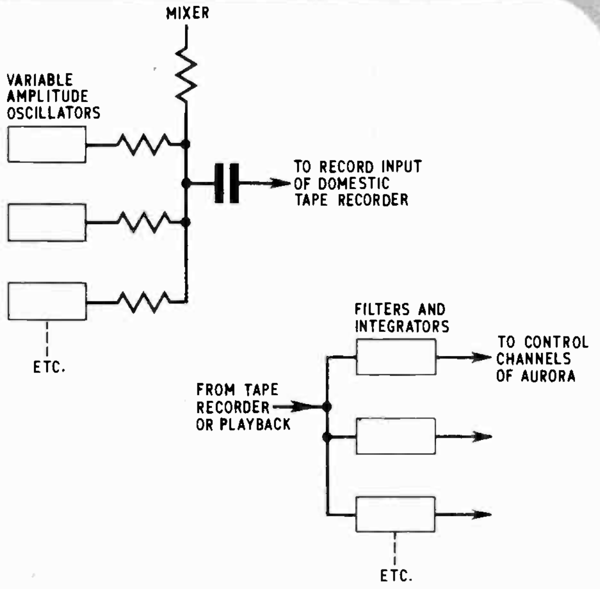


Fig. 5 (above). Two simple control circuits using photo resistive cells. In circuit (a), light falling on the cell will make the controller increase the brightness of a lamp—thus positive feedback could be used to make a self latching system. Circuit (b) does the opposite—light falling on the cell reducing the intensity via the controller. VR1 is made variable to adjust sensitivity. Some interesting ring systems could be made by using the light from one channel to influence the next. Deliberate delays could be introduced with capacitors (as shown dotted)

Fig. 6 (top right). Simple schematic for a tape control lighting. The prototype used only three channels to avoid the possibility of interaction. It is quite possible that by careful selection of frequencies harmonic interaction could be avoided if a larger number of channels was desired

Fig. 7 (right). A simple phase shift oscillator. Three mixed together can provide a signal that when recorded could be used with suitable filters (see Fig. 8) to provide tape control of lights. VR2 is used to control the relative levels of signal during recording

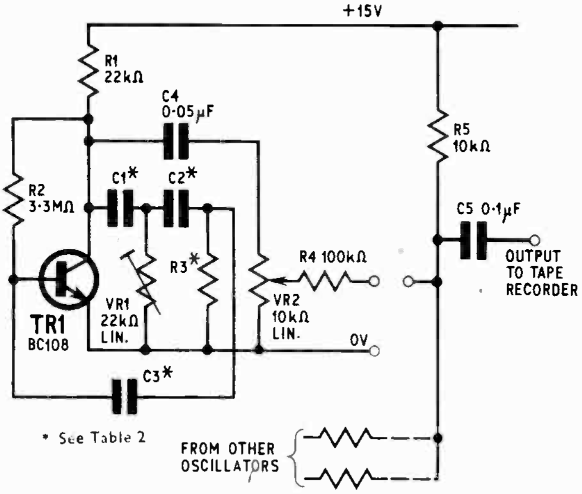
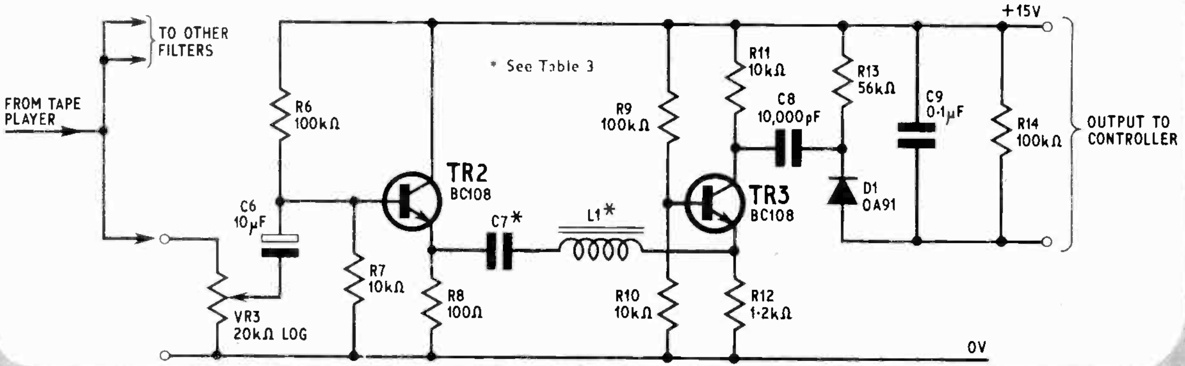


Fig. 8. A more gentle active filter using a series LC tuned circuit for use with a tape recorder if tape control of lights is required. D1 and C9 detect and integrate the filtered audio signal, the amplitude of the resulting d.c. level controls the respective light channel of Aurora, VR3 is used to balance the channels

TABLE 2		
NOMINAL FREQUENCY	(C1 C2 C3)	R3
1kHz	5000pF	10kΩ
3kHz	1000pF	22kΩ
5kHz	860pF	10kΩ

TABLE 3		
NOMINAL FREQUENCY	L1 (WOUND ON LA1 FERRITE POT CORE)	C7
1kHz	800 TURNS	0·1μF
3kHz	600 TURNS	0·02μF
5kHz	400 TURNS	0·01μF



is no reason (apart from interaction between channels) why this should not be extended by using the eight-channel system, but it was thought to be unnecessary expense.

The tape recorder used should be of conventional domestic quality, having a good frequency response up to about 10kHz. Perhaps the most stringent specification is on wow and flutter. If this is undetectable to the ear when a 3kHz pure sine wave is recorded then the recorder is satisfactory. The recorder should also have a manual record level control and should not use a.g.c.

The technique is quite straightforward as shown schematically in Fig. 6. A number of fixed frequency oscillators having frequencies suitably separated (the prototype had three at 1kHz, 3kHz and 5kHz) have their amplitudes adjusted by manual controls. The outputs are mixed together and applied direct to the tape recorder input.

The individual or mixed tones are recorded at various levels, the amplitude being selected to be in proportion to the intensity of illumination ultimately required.

On playback the composite audio signal is applied to a set of tuned audio filters and thence to integrators—rather like the filter unit already described in Part 3.

PHASE SHIFT OSCILLATORS AND FILTERS

The prototype phase shift oscillator circuit is shown in Fig. 7 and the tuned filter in Fig. 8. It might be argued that the active RC filter already described would be satisfactory, but it was felt that the characteristic was a little too viscious for precise linear control of amplitude, hence the LC circuit was chosen. Tables 2 and 3 show component values for each of the three frequencies.

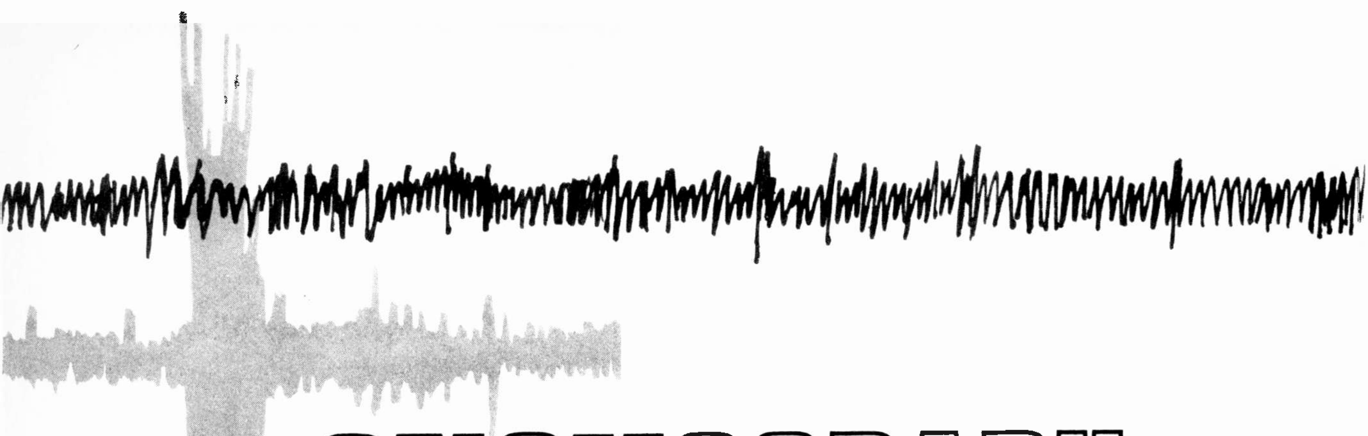
Obviously due to component tolerances it will be difficult to obtain precise frequencies and so the oscillators must be tuned to match the respective filter. This is best effected by directly connecting the output of the oscillator in question to the input of the filter; with both VR2 and VR3 set at about mid-range, connect a voltmeter across C9 (range 4V) and adjust VR1 until a maximum is read on the meter. If the bandwidth appears excessive, reduce the output level of the oscillator and retune.

When recording it is best to start with a test signal. Set all the oscillator outputs to maximum and set the recording level so that the tape recorder shows maximum level; all other settings of controls will thus be relative to this setting. Record about 30 seconds with all controls at maximum, then record the programme required.

On playback use the maximum level output signal at the leader end to adjust the settings of VR3 for each channel; these should be set so that the light output from "P.E. Aurora" is only just maximum. This equalises the system to counter any devious frequency response of the tape recorder.

It is hoped that the above suggested applications will form the basis for other ideas constructors might have. In an article such as this it is extremely difficult to cover every possibility, but suffice to say any form of input signal in the range of 0 to 1 volt can be used to provide control. ★

Note: The notation of connections of TR7 into the board (Fig. 19, p. 501, June 1971) may not agree with the configuration of the wires as they appear from the transistor. Check lead notation of the f.e.t. used before soldering into position.



SEISMOGRAPH

BY D. BOLLEN

An instrument for the detection and graphing of earth tremors

ELECTRONIC techniques are now extensively employed for detecting and processing signals arising from earth tremors. The circuits and information given in this article are intended to serve as a basis for the construction of a seismograph which has the capability of recording displacements of less than 10 nanometres, roughly the diameter of a medium sized molecule.

Described are a seismometer, a seismometer amplifier, and a pen amplifier which drives an inexpensive chart recorder based on a G.P.O. relay and a clock motor. A block diagram of the complete instrument is shown in Fig. 1.

SEISMOMETER

A seismometer is the "front end" of a seismograph and consists typically of an inertial mass suspended from a stout frame on a weak spring. When the ground moves, together with everything resting on it, including the seismometer frame, the mass tends to remain more or less static.

A common form of sensing arrangement, for converting the relative motion of the mass and the seismometer frame into an electrical signal, is a coil of wire free to move between the poles of a powerful magnet, known as a velocity transducer.

The chief advantage of a velocity transducer is that it is insensitive to slow drift caused by thermal and atmospheric displacements of the seismometer mass, but its output is proportional to the energy of the ground movement and not the amplitude.

There are two conflicting requirements in seismometry, on the one hand a faithful response to ground movements covering a wide band of frequencies at low sensitivity, or else a high sensitivity and selectivity with resulting distortion of the signal. A weight suspended from a spring is a

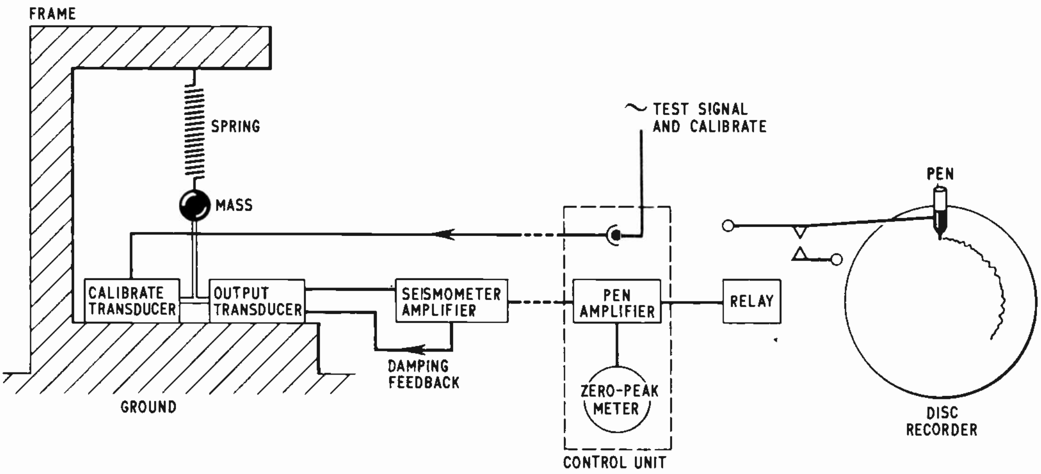


Fig. 1. Block diagram of seismograph

mechanical analogue of a tuned electrical circuit which, when undamped, possesses a high magnification at one particular frequency.

Like the tuned circuit with a high Q, a seismometer will offer maximum sensitivity when it is sharply resonant, but then exhibits a marked tendency to continue oscillating or "ringing" for some time after the initial disturbance.

The modern trend is to use a damping factor of less than unity and have the seismometer tuned to a relatively narrow range of frequencies, but obviously, much depends on individual requirements.

SEISMOMETER AMPLIFIER REQUIREMENT

Seismometer amplifiers must be capable of resolving microvolt level signals at frequencies generally lower than 5Hz, and this poses special problems. The noise generated by amplifying devices rises steeply at sub-audio frequencies. For example, a transistor with a noise figure of 5dB at 1kHz could show as much as 25dB at 1Hz.

In order to achieve low noise working at high gains, the frequency range of seismometer amplifiers is usually restricted to a narrow bandwidth. It will be evident from the above remarks, and also bearing in mind the stringent drift performance demanded by continuous operation day after day, that even the best general purpose laboratory type amplifiers would be unsuitable for seismic work.

With a peak noise level of less than 0·2 microvolt over the frequency range of 0·1Hz–10Hz, the seismometer amplifier described here enables the microseismic background noise to be recorded even in quiet areas. In terms of ground movement with the transducer used, 0·2 microvolt corresponds approximately to 4 nanometres at maximum gain. In addition, seismometer damping can be adjusted between almost zero and unity by electrical feedback to an extra winding on the transducer coil.

Seismograph response can be varied from a sharply resonant peak at around 1Hz to a substantially flat characteristic extending beyond 0·2Hz–8Hz.

Velocity response curves for the seismometer amplifier combined with a 1Hz vertical seismometer are given in Fig. 2, and this shows how damping affects sensitivity.

SEISMIC ACTIVITY

One of the mysteries of inner space still waiting to be explained is the origin of some of those tiny earth tremors or microseisms which cause the ground to move continuously. A sensitive seismograph will record microseisms as a noise trace upon which occasional dramatic events, such as earthquakes and large explosions, are superimposed.

It is known that meteorological conditions play some part in influencing the level of microseismic activity. An increase in seismic noise amplitude is often noticed several hours before the approach of a low pressure system and can be used to predict a deterioration in weather conditions.

It is also true that seismic recording stations near the sea have a higher background noise than stations situated in the middle of a continent, and this is attributed to large waves below the ocean surface striking against the continental shelf. However, even when weather conditions are very calm and all known factors have been taken into account, there still remains a significant level of seismic background noise which cannot easily be explained.

EARTHQUAKE WAVES

An earthquake will cause wave motions to be set up in surrounding rock. Waves of differing character and orientation will move away from the epicentre at various speeds; some will be refracted and reflected by discontinuities in the earth's structure.

First to arrive at a distant location will be the P or primary wave, causing a movement of earth particles in the direction of travel. P waves are, in fact, sound waves transmitted by the inner regions of the globe, and their speed is approximately 5 miles per second.

The slower S or secondary wave arrives next, at a speed of 3 miles per second, producing a motion transverse to the line of travel. The time lapse between the onset of the P wave and the arrival of the S wave can be used to compute the distance of the earthquake. S waves cannot pass through the liquid core of the earth, and therefore only have a range of about 7,000 miles.

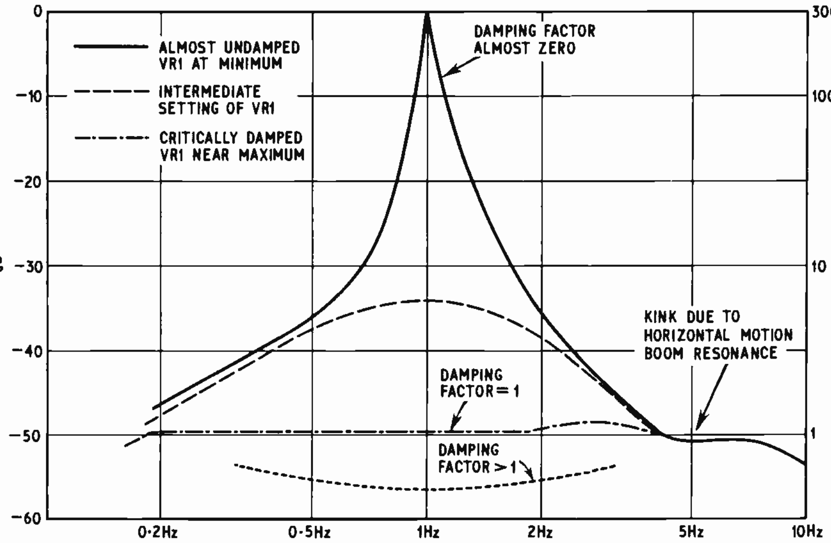


Fig. 2. Seismometer response to constant energy input

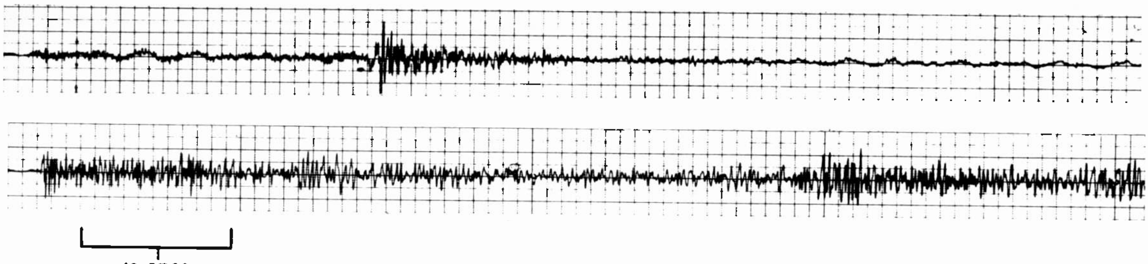


Fig. 3. Professionally recorded traces of earthquakes occurring in the British Isles. Upper trace: earthquake at Glen Spean in Scotland; lower trace: earthquake under South Downs in England (Photo by courtesy U.K.A.E.A. Blacknest)

There are other types of waves which move more slowly and travel on the surface, such as Rayleigh and Love waves, but these are not detected by short-period seismometers of the type described here.

It is important to realise that a *P* or *S* wave may be considerably bent or twisted during its passage through the earth and the actual motion of the ground in response to either could be horizontal, vertical, or a mixture of both, depending on the angle of approach. Therefore, a seismometer which is sensitive to, say, vertical motion only is capable of detecting *P* and *S* waves simultaneously.

Considering an earthquake as a source of broad-band noise, over long distances the high frequency components are gradually filtered out, to leave a mixture of waves with periods extending from about 1 second to 1 hour.

Taking rough averages from past records, there are something like 10,000 earthquakes per year of magnitude equivalent to an explosion of 10 tons of T.N.T., 50 per year of about 200 kiloton magnitude, and just two per year of 10 megatons magnitude.

Earthquakes do not receive much publicity unless they are exceptionally large or occur near centres of population. As far as the amateur seismologist is concerned, an event will be recorded perhaps once a week and will either be a large distant earthquake or a local tremor. Much depends on the siting of the seismometer and the manner in which it is coupled to the ground.

To underline the fact that earthquakes occur almost everywhere, two professionally recorded detailed traces of small events in the British Isles are shown in Fig. 3. The upper trace is of an earthquake which had its epicentre at Glen Spean in Scotland, quite near to the recording station, and the lower trace is of an earthquake under the South Downs in England. It is doubtful if local inhabitants were even aware of these events because they were of small magnitude.

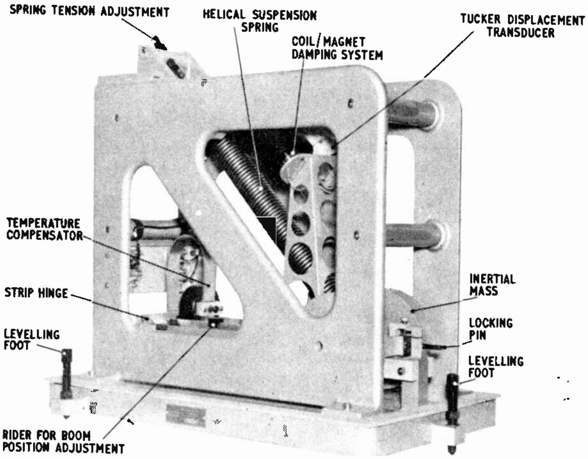


Fig. 4. A professional seismometer

SEISMOMETER STRUCTURES

It can be seen from Fig. 4, that a modern, professional seismometer is far removed from those early instruments which had masses and booms weighing several tons. The reduction in size is mainly attributable to the use of electrical transducers which need only a small force to drive.

As far as the construction of a seismometer is concerned, this is perhaps less important than the environment in which the instrument is placed. Nearby trees, draughts, loud noises, and local movement caused by animals or humans should be avoided if the best performance is desired.

Successful seismometers have been built by amateurs from pieces of wood and bent wire, but wherever possible the most rigid and durable constructional methods are to be preferred.

Seismometer structures suitable for use with the circuits given here are depicted in Fig. 5. Transducer magnet poles are labelled relatively and can be reversed.

It is important to orientate the transducer coil windings and magnets according to the figures, for maximum electrical output.

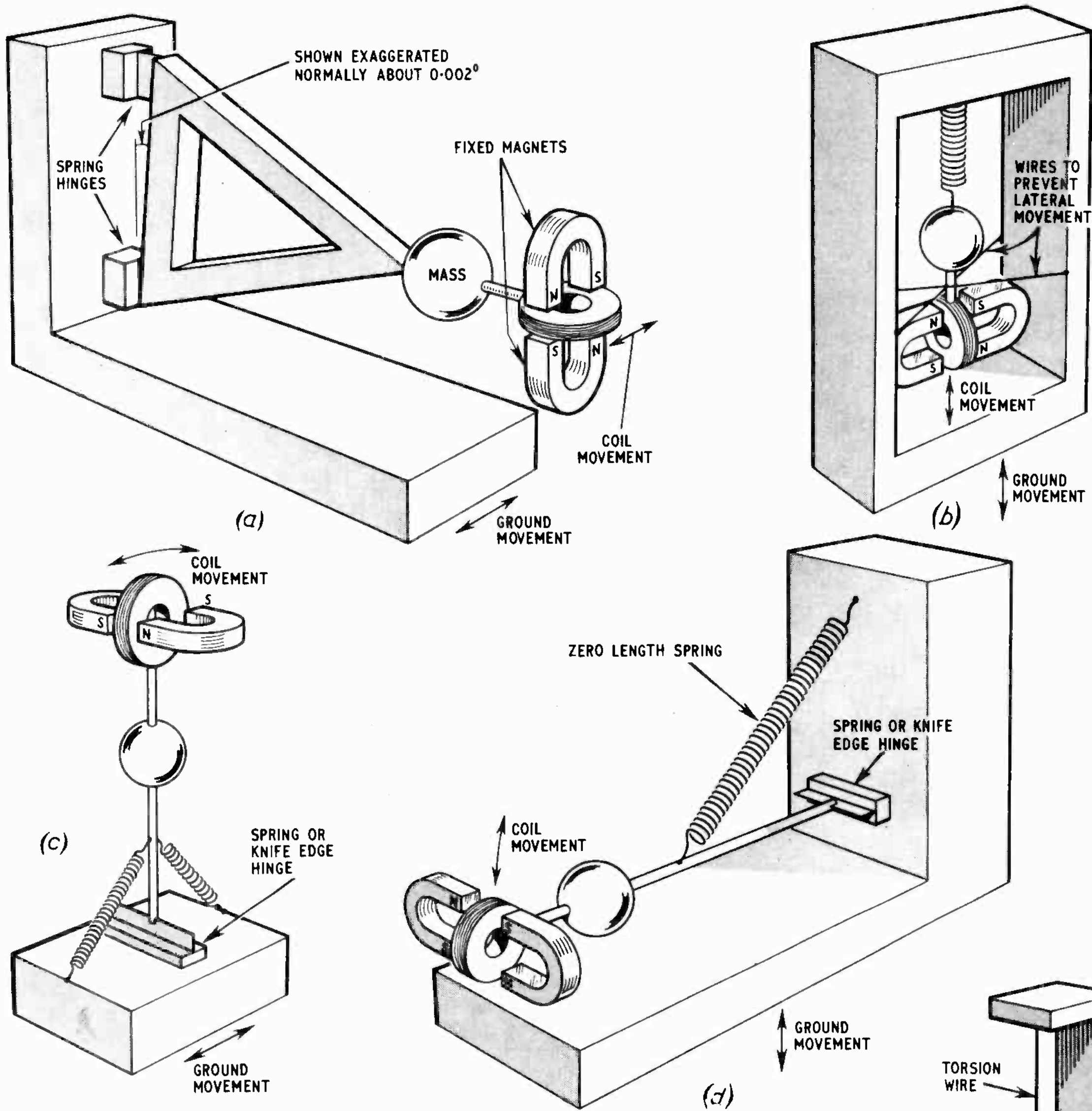
A CHOICE OF FIVE

Looking first at the horizontal pendulum seismometer of Fig. 5a; this uses a triangular shaped boom supported on two spring strip hinges, similar to a garden gate. If the hinge axis was vertical the boom would be unstable, but a slight inclination of the boom downwards, towards the mass, supplies a gravitational restoring force. Strips of 0·002in phosphor bronze or steel shim will serve for hinges.

Although simple to build, with a frame and boom of wood or metal, this seismometer is notoriously difficult to set up and operate, and readily becomes unstable.

In Fig. 5b, the mass-spring seismometer can form a compact and rugged instrument. A mass of several pounds is suspended from a coil spring, and is prevented from moving horizontally by thin cross wires. Resonant frequency is determined by the length of the spring and the weight of the mass.

The vertical pendulum of Fig. 5c consists of a mass secured to an upright boom, which is in turn supported on a strip hinge or knife edge, with restoring force supplied by two coil springs. Resonance can be adjusted by sliding the mass up or down the boom.



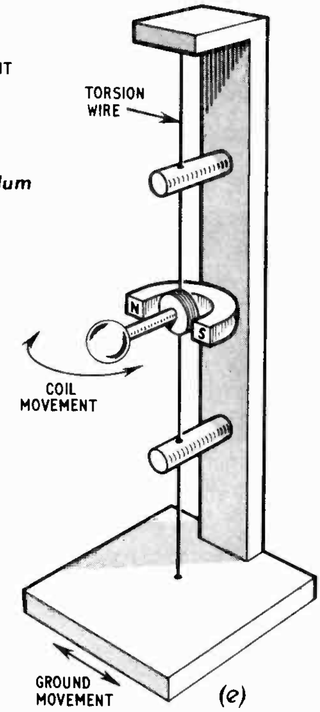


Fig. 5. The five seismometer structures that can be used: (a) horizontal pendulum, (b) mass-spring pendulum, (c) vertical pendulum, (d) spring pendulum, (e) torsion pendulum

Fig. 5d shows a spring pendulum seismometer on the same principle as the Sprengnether of Fig. 4. Resonance is adjusted by sliding the mass along the boom, and moving the spring anchoring points. A special spring must be employed for best results, and the boom pivots on a strip hinge or knife edge.

The choice of seismometer described in this article is based on this principle of operation.

A restoring force is supplied by a tensioned wire in the torsion pendulum instrument of Fig. 5e, and the transducer coil rotates between the poles of a horseshoe magnet. The wire should be about 0·001in in diameter, with the same coefficient of expansion as the upright part of the frame.

To prevent unwanted longitudinal vibrations, the wire is arranged to pass through, but not touch the sides of, holes in two rods. A drop of oil placed in each hole serves to damp the wire. Resonance will depend on the weight of the mass, its distance from the wire, and wire tension.

SEISMOMETER AMPLIFIER

Resistors
- R1 390kΩ
- R2* 1·5MΩ (see text)
- R3 47kΩ
- R4 330kΩ
- R5 68kΩ
- R6 22kΩ
- R7 4·7kΩ
- R8 1kΩ
- R9 100Ω
- All 10%, ½ watt carbon

Potentiometer
- VR1 22kΩ sub-min horizontal skeleton

Capacitors
- C1 160µF elect. 12V
- C2 160µF elect. 12V
- C3 160µF elect. 12V
- C4 0·01µF 250V polyester
- C5 8,000µF elect. 6V
- C6 100µF elect. 12V

Transistors
- TR1 BC109
- TR2 BC109
- TR3 BC107

Sockets
- SK1 Two way DIN with plug
- SK2 Non-reversible two way with plug

Battery
- BY1, BY2 Two Ever-ready 996 6V batteries in series

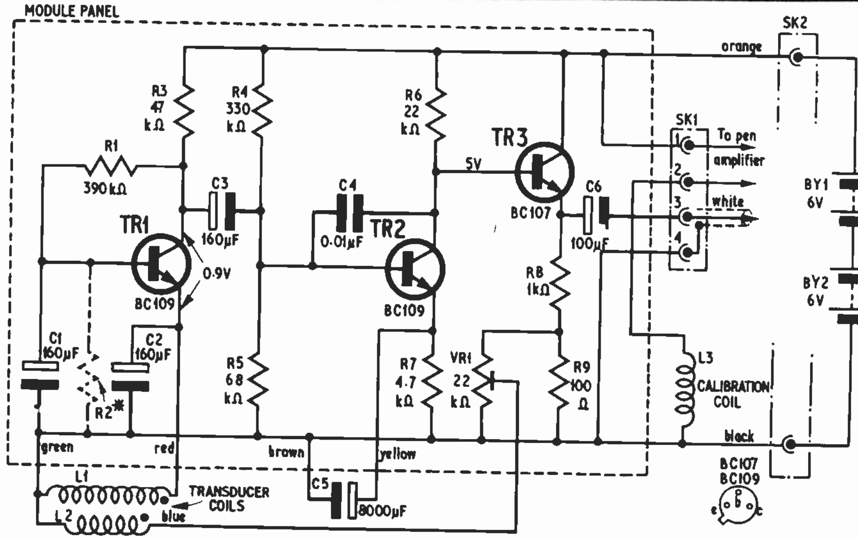


Fig. 6. Circuit diagram of low noise seismometer amplifier

Miscellaneous

Veroboard 4·3in × 1·9in × 0·1in matrix, 40 s.w.g. enamelled copper wire for transducer coils, four loudspeaker magnets or similar, and one small bar magnet. Aluminium chassis 8in × 3in × ½in, s.r.b.p. 8in × 1½in, screened microphone cable, capacitor fixing clip to suit C5.

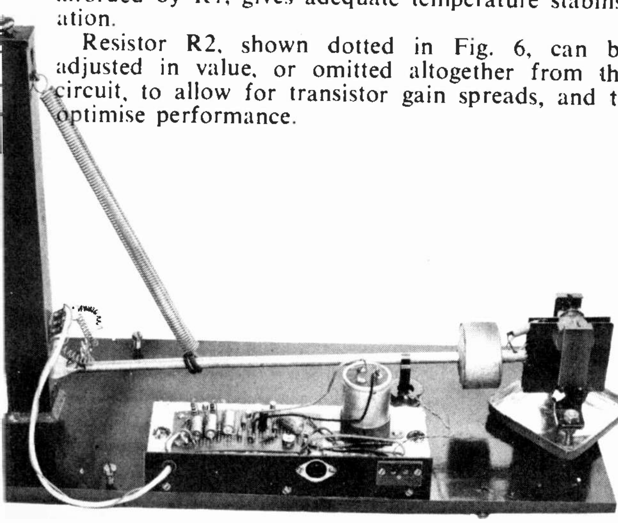
SEISMOMETER AMPLIFIER CIRCUIT

High gain, low noise transistors are employed for the first two stages of the a.c. coupled amplifier circuit in Fig. 6. Maximum gain of the circuit is in the region of 88dB.

Grounded base silicon transistor TR1 has a collector to emitter voltage of not more than one volt, thus satisfying one of the conditions for minimum noise. Collector current is also low.

The d.c. resistance of the transducer coil in series with the emitter junction of TR1 is about 450 ohms, and this, together with the negative feedback afforded by R1, gives adequate temperature stabilisation.

Resistor R2, shown dotted in Fig. 6, can be adjusted in value, or omitted altogether from the circuit, to allow for transistor gain spreads, and to optimise performance.



Capacitor C1 decouples the base of TR1 to signal frequencies, while C2 across a TR1 emitter input impedance of only a few ohms merely serves to block unwanted high frequencies and mains ripple.

The reactance of the transducer coil is negligible compared with its d.c. resistance at signal frequencies.

TR2 and associated components form a conventional grounded emitter low noise amplifier stage, except for the unusually high value of emitter capacitor C5.

Feedback capacitor C4 largely determines the amplifier high frequency roll off, while C5 controls the low frequency end of the pass band.

Emitter follower TR3 is directly coupled to the collector of TR2, and acts as an impedance converter and buffer stage. A damping feedback current for the seismometer, derived from potential divider R8 and R9, is tapped off by VR1 before being fed to the winding L2 on the transducer coil.

VR1 is pre-set prior to measuring and recording seismic signals, because any human activity in the vicinity of the seismometer is likely to cause overloading.

DIN socket SK1 connects the remote seismometer amplifier output, via a run of screened cable, to the pen amplifier. Two extra wires are included (unscreened) to allow for battery checks and to energise the calibrating coil L3 without the need for going near the seismometer when it is functioning.

A battery power supply was chosen for the seismometer amplifier to avoid a long run of mains cable, and to eliminate troublesome mains borne noise spikes. Two 996, 6V dry batteries in series will power the seismometer amplifier for about three months continuously.

CONTROL UNIT

Resistors
R10 22kΩ
R11 1·5kΩ.
R12 10Ω
R13 1kΩ
R14 15kΩ
R15 50kΩ
R16 5·6kΩ
R17 180kΩ
R18 3·3kΩ
R19 1kΩ
All 10%, ½ watt carbon

Potentiometers
VR2 5kΩ carbon
VR3 50kΩ carbon pre-set
VR4 500kΩ sub-min skeleton pre-set

Capacitors
C7 100μF elect. 12V
C8 0·01μF polyester 250V
C9 100μF elect. 12V
C10* 160μF elect. 12V
C11 100μF elect. 12V
C12 100μF elect. 12V
C13 2,000–8,000μF elect. 12V
C14 0·5μF–1,000μF elect. 12V (see text)

Transistors
TR4 BC107
TR5 ACY20
TR6 BC107

Diodes
D1 OA6
D2 OA6
D3 ZB12 250mW 12V Zener
D4, D5 RS210AF 130 p.i.v. 1A (2 off)

Meter
M1 50μA Type MR38P

Lamp
LP1 6V 60mA m.e.s.

Transformer
T1 20–0–20V sub-min mains (Radiospares or Home Radio)

Sockets
SK3 DIN 3 way with plug
SK4/SK5 Two miniature single sockets with plugs
JK1/PL1 3·5mm jack socket with plug

Switches
S1 Push-button or biased toggle single pole changeover
S2 Miniature toggle single pole changeover

Miscellaneous
Veroboard 5·7in × 1·9in × 0·1in matrix
Aluminium chassis 6in × 4in × 2¼in
Panel mounting lamp holder

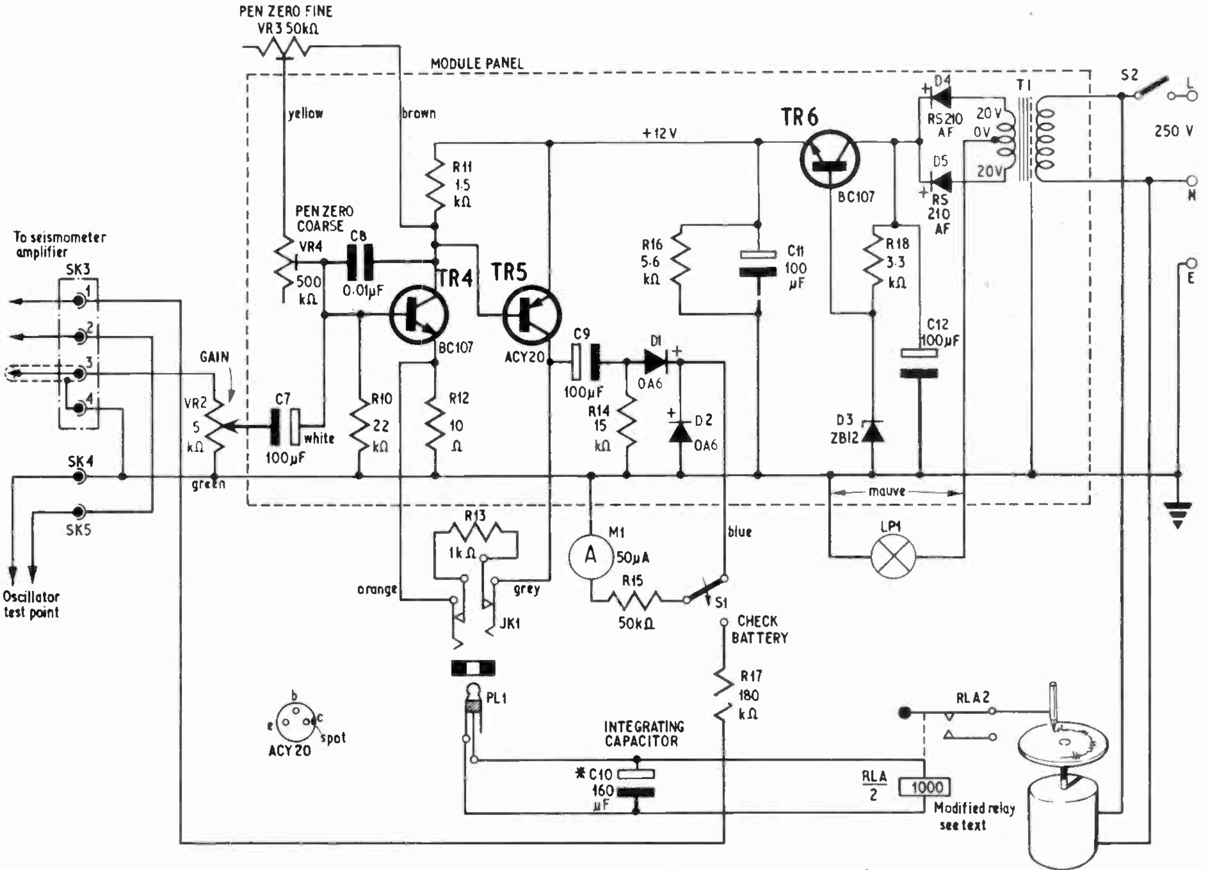


Fig. 7. Circuit diagram of pen amplifier and power supply

PEN AMPLIFIER CIRCUIT

The pen amplifier of Fig. 7 has a DIN socket SK3 to correspond with the output socket on the seismometer amplifier. VR2 across the pen amplifier input allows adjustment of gain to compensate for day to day changes in microseismic level and anticipated tremor amplitudes.

VR3 and VR4 provide fine and coarse adjustment of the d.c. working point of direct coupled pair TR4 and TR5; this alters the standing current flowing through the pen relay RLA for the purpose of zeroing.

Two negative feedback paths for d.c. and signal frequencies exist in the circuit of Fig. 7. First, feedback given by VR3 and VR4 across the collector and base of TR4, and second the feedback between the collector of TR5 and the emitter of TR4 via the load formed by RLA or substitute resistor R13.

Sufficient feedback is provided to ensure a low impedance output, good linearity, and negligible pen zero drift at normal room temperatures.

A signal from the collector of TR5 is taken via C9 to a special zero-peak meter circuit formed by R14, D1, D2, R15, and 50μA meter. Instead of giving a steady meter reading related to amplitude, the pointer oscillates between zero and peak value at the same frequency as the signal; this technique offers certain advantages. The smooth, regular movement of the meter pointer when responding to a seismic signal is not confused with the random motion caused by noise or instability, and malfunctions are immediately revealed.

Large amplitude high frequency seismic noise from local sources, such as quarry blasts, is made apparent by the meter pointer not returning to zero between successive cycles, and the frequency of the longer period signals can be determined by counting the oscillations of the meter pointer. Meter reading accuracy is within 3dB over the range 0·2Hz—10Hz.

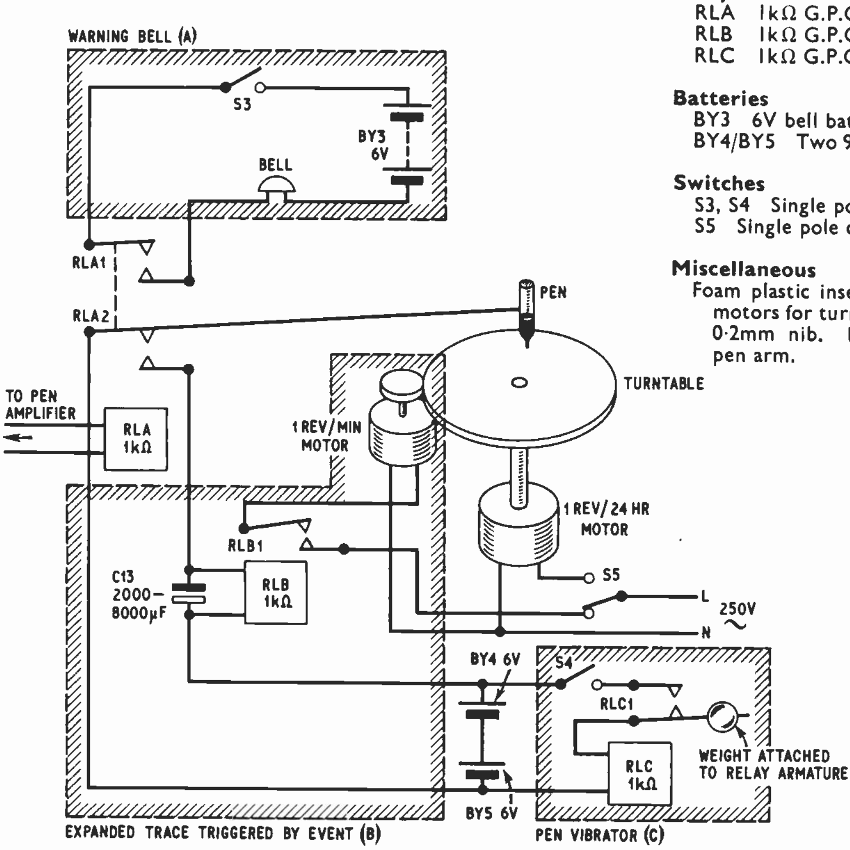
The pen amplifier is powered by a built-in partly stabilised 12V supply, employing a miniature mains transformer T1, and series regulating transistor TR6.

Lamp LP1 serves the double purpose of protecting TR6 in the event of a short circuit, and gives a flashing indication when the pen amplifier is overloaded by a large input signal.

CHART RECORDERS

Seismograph recorders are usually of the helical trace type, giving a detailed record in convenient form of events separated by many hours. A rectangular piece of paper is wrapped around a drum which revolves, say, once every 24 hours. A pen driving mechanism slowly traverses the drum parallel to its axis on a screw driven carriage, drawing a

DISC RECORDER



Relays
RLA 1kΩ G.P.O. type 3000 double pole make
RLB 1kΩ G.P.O. type 3000 single pole make
RLC 1kΩ G.P.O. type 3000 single pole break

Batteries
BY3 6V bell battery
BY4/BY5 Two 996 6V Ever-Ready batteries in series

Switches
S3, S4 Single pole on/off toggle
S5 Single pole changeover

Miscellaneous
Foam plastic inserts for RLA. Synchronous mains motors for turntable drive. Varioscript pen with 0·2mm nib. 18 s.w.g. tinned copper wire for pen arm.

Fig. 8. Disc recorder with extra facilities

helical trace. Needless to say, a helical recorder is expensive to buy.

Another more familiar alternative, often used by amateur seismologists, is the strip chart recorder, where a roll of paper a few inches wide is fed under the recording pen, but these can use as much as 48 feet of paper per day when employed for seismic work.

If a fully detailed record of seismic events is required then a helical or strip recorder must be purchased or constructed. On the other hand, where the main concern is only with the onset time, duration, and relative amplitude of large scale events, then a trace drawn on a small disc of paper will probably suffice.

A paper disc recorder is simple to construct because there is no elaborate paper feed mechanism. One revolution in 24 hours of the disc will give the approximate time of earthquakes, within a minute or two, and will also show variations in microseismic amplitudes for the purpose of weather forecasting.

Yet another possibility is to have the paper disc revolving, say, once per hour. A signal from the earthquake onset triggers the chart motor on, and an expanded trace of the event will be obtained.

DRIVING THE PEN

Given a moving piece of paper, the next step is to arrange some way of making the pen traverse the paper in response to a signal. Meter movements are often used to drive pens, but the mechanism is delicate and susceptible to friction.

An ordinary relay can supply a large mechanical force, but the movement of the armature is not linearly related to the current flowing in the relay coil. However, if the armature of a G.P.O. type relay is packed with small pieces of foam plastic, and the coil is supplied with a bias current to offset the pressure of the relay contact springs, it is possible to achieve a linear pen movement over a small arc.

The pen can be attached to the relay armature on a long wire arm, to magnify the movement.

Fig. 8 shows how extra facilities can be added to the basic disc recorder. The warning bell (A) rings at the onset of a tremor, when the seismic amplitude exceeds a pre-set level.

Unit (B) will give an expanded trace for the duration of a large scale event, but does not record between events. RLA2 contacts close, the capacitor C13 is charged to the full battery voltage, which holds RLB on for a period of about 10 seconds, depending on the value of C13.

If the event lasts longer than 10 seconds—and they usually do—repeated closing of RLA2 contacts will keep C13 fully charged, and the turntable will continue to revolve.

To obviate inking difficulties when a fine pen is used, the pen can be made to vibrate up and down slightly by means of a further relay RLC, contained in unit (C), which is wired as a buzzer.

A weight of a few ounces attached to the armature is sufficient to cause a vibration of several thousandths of an inch when relay RLC is mounted under the disc recorder baseboard, and this will keep the ink flowing.

Next month, constructional details will be given for a 1Hz vertical seismometer, seismometer transducer and amplifier, a pen amplifier and disc recorder, together with information on installing and operating the seismograph.

NEWS BRIEFS

I.E.E. Centenary Exhibition

To mark the centenary of the Institution of Electrical Engineers, a small special exhibition has been arranged in the main hall entrance of the Science Museum.

Founded one hundred years ago, the I.E.E. then had the title of Society of Telegraph Engineers. This was at a time when the main application of electricity was the telegraph. With expansion this was changed to the Institute of Electrical Engineers in 1888.

The exhibition illustrates the growth of electrical and electronic engineering in the period of the Institution's lifetime, by contrasting state of the art exhibits of the past and present in the fields of medicine, communications and computers.

While telegraphy dominated the electrical scene a century ago, electric lighting was being developed. Two complementary light producers of this period are shown. An arc lamp and its current producing magneto-electric generator for lighthouse use.

One of the show cases of contrasts compared a popular nineteenth century multiplication machine with an Elliott microminiature computer.

Two medical exhibits from the same family tree are the "shocking" machine, an ornate piece of Victoriana which produced high voltage from a hand generator and a modern heart pacemaker. Both the construction and arrangement in the body of the pacemaker are shown.

The show case illustrating the development of electrical communication has a telegraph instrument of a type used in 1871. Also included are an early telephone, a crystal set and one of the first domestic valve radios, these being contrasted with a modern telephone instrument and a small portable radio.

A separate case is devoted to the Institution's activities with examples of its most recent publications.

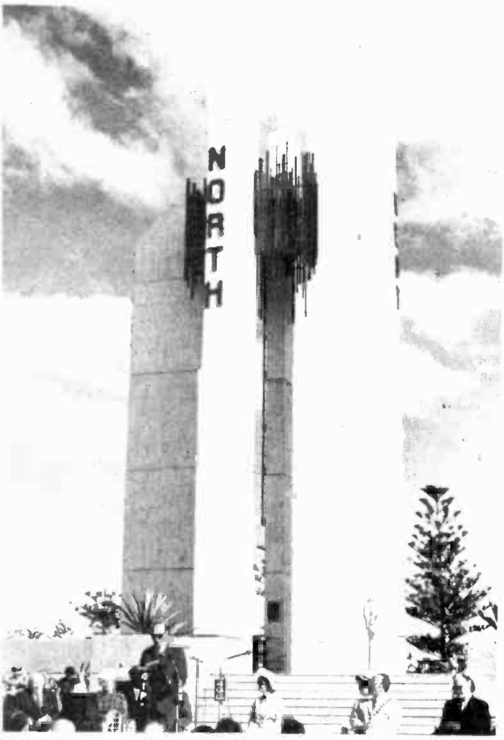
The exhibition, which opened on May 17, is expected to run for approximately three months.

British Amateur Electronics Club

The Secretary of the British Amateur Electronics Club, Mr J. G. Margetts has moved to a new address and anyone who wishes to contact him should write to 17 St Francis Close, Abergavenny, Monmouthshire.

If any readers are interested in the Club, Mr Margetts will be pleased to send details.

ELECTRONORAMA



Laser Lighthouse

THIS gigantic monument was recently completed and opened at Point Danger on the east coast of Australia. It is claimed to be the first laser beam lighthouse in the world combined with a memorial to commemorate the 200th anniversary of Captain Cook's discovery of this east coast point on the border between Queensland and New South Wales.

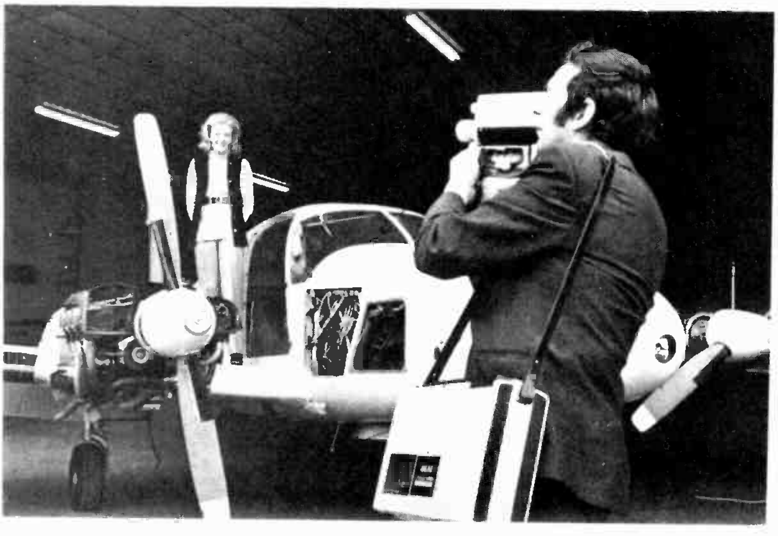
It is expected that the laser light will penetrate rain and fog for distances up to 22 miles out to sea (six miles beyond the horizon) using only 200 watts of electricity. It shows a red flash every 7½ seconds which is visible out to sea only.

Video Tape Recorder To Fly Over North Pole

A SPECIAL, compact video tape recorder will film Miss Sheila Scott's attempt to be the first person to fly solo over the North Pole in a light aircraft—a Piper Aztec. It is the lightweight Akai VT 100 self-contained battery-operated video recording system supplied by The Rank Organisation. It provides instant television recording and playback facilities.

Complicated instruments from NASA, the American space Agency, will record and relay her mental and physical state in flight as well as measuring world air pollution. Her North Pole attempt is just part of a 34,000 mile, five week solo flight that will take her one and a half times around the world.

The original recorder was stolen from Miss Scott's home just before this magazine went to press, and it was expected that Rank Audio Visual would loan her another.



PORTABLE ELECTRONIC MUSIC SYNTHESISER

TAKE a number of electronic signal generators, add a few effects circuits, mix well and there's no limit—but no limit at all—to the variety and range of the sounds you can produce. Theatrical sound effects, or electronic musical compositions—sounds you create yourself—for the moment or for longer life by transferring to magnetic tape. Add a keyboard, and indeed you become a one-man band. (The pop boys will love it!)

Credit must go to Electronic Music Studios (London) Ltd., who have designed and built this latest wonder in the exciting new field of music synthesisers, "Synthi A".

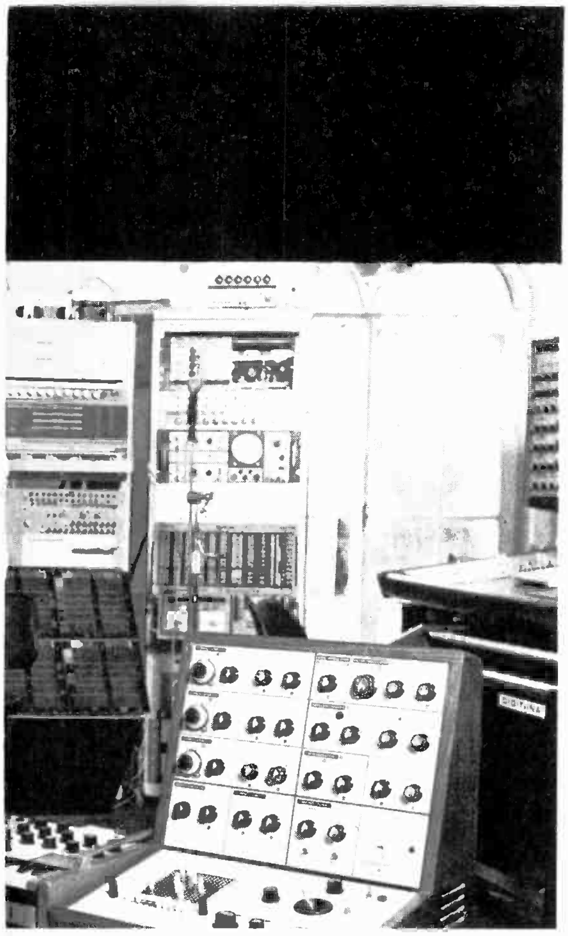
At £198 it is claimed to be the world's cheapest instrument of its kind. Electronically it is essentially the same as EMS's successful model VCS 3, but scaled down to attaché case size—and is of course, completely portable.

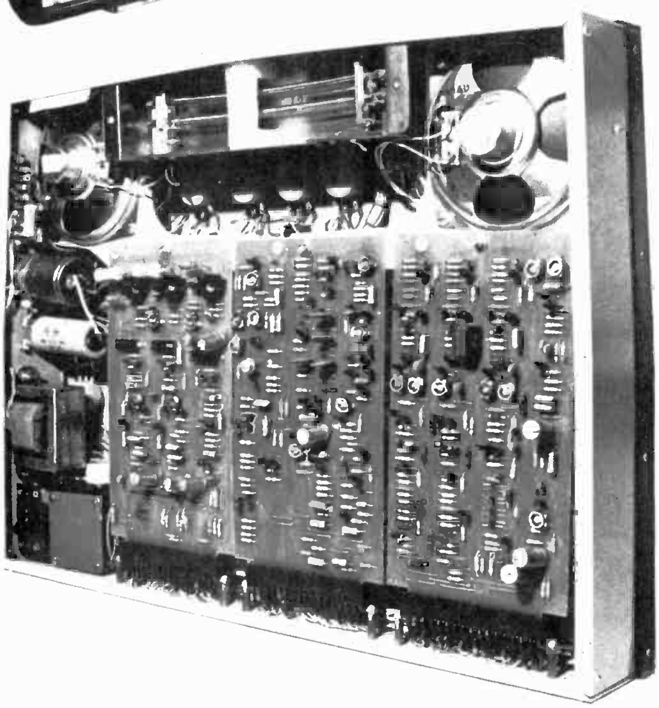
The basic electronic blocks found inside any synthesiser are conventional enough, but devising a system around such circuits and providing maximum flexibility for user control and operation is obviously an art in itself. One of the secrets is that all circuits are voltage controlled.

The important ingredients that make up "Synthi A" are set out below.

Signal generation sources

Three tunable oscillators: one gives sine and ramp waveforms, another square and ramp, and both operate over a frequency





range 1Hz to 10kHz. A third oscillator provides square and ramp waveforms but over the exceptionally low frequency range of 0·025Hz (1 cycle every 40 seconds) to 500Hz.

Noise generator with amplitude and colouration controls, so that various bandwidths of noise can be obtained at any level.

Envelope generator, providing a low frequency control waveform.

Treatment facilities

The foregoing signals can be treated in various ways, for example with reverberation from a spring unit, by filtering via a bandpass filter, which can also be employed as an additional oscillator; and by a ring modulator. Attack/delay can be controlled by the envelope generator.

High and low inputs for microphone and line are provided on the two inputs' amplifiers, both of which have level controls. The two output amplifiers have level controls and, additionally, tone controls, and trols, and can be voltage controlled, allowing amplitude modulation and automatic fades and cross fades.

Monitoring and Patching

Any required signal or control parameter can be monitored on the built-in meter.

Signal patching is by a 16 × 16 way pin-panel matrix—no cords are used. Each of the 256 locations on the matrix board can be identified by a simple map grid reference.

Manual Control

In addition to the attack/delay the "Synthi A" is equipped with a joystick which enables any two control arameters to be varied simultaneously with one hand, leaving the other hand free for keyboard operation.

Keyboard Unit

The versatility of "Synthi A" can be further increased by use of a keyboard unit. This additional, optional unit incorporates its own oscillators and it is simply plugged into the front panel of the synthesiser, which can then be played as a musical instrument.

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.

CCTV CAMERA KIT

Of particular interest to the amateur and professional engineer is the new and updated version of the **Beulah Electronics** closed circuit television camera kit.

Suitable for education and training establishments, and the keen amateur, this high quality, yet fairly inexpensive 625 line video camera has a claimed resolution in excess of 350 television lines.

A fully comprehensive instruction manual is included with the kit and the original manufacturers' guarantees apply to all parts. Beulah Electronics will also carry out inspection, testing and setting up after assembly, if required, for a charge of £5 excluding the cost of postage and packing.

If the "New Beukit" camera is required to operate in conjunction with an off-air television receiver, an r.f. kit is available as an extra.

The price of the "New Beukit" complete with manual and all parts, excluding vidicon tube, is £45·50. Vidicon tubes are available at various qualities and prices from £5–£15 and first grade tubes at £25. The cost of the r.f. kit is £3·75. Various other extras including lenses and tripods are available if required.

Further information and supplies of the "New Beukit" can be obtained from Beulah Electronics (1970) Ltd., Upper Halliford Road, Shepperton, Middx.

AUDIO SUITE

A new range of inexpensive audio equipment marketed under the name Viscount has been introduced by **Radio and TV Components (Acton) Ltd.** Complete stereo systems are offered.

The heart of each system is the Viscount amplifier, of which there are two versions: The RT100 for ceramic cartridges and the RT101 which has an additional input stage designed to accept magnetic cartridges. Both versions have an output of 14 watts per channel r.m.s. with a frequency response of 40Hz to 40kHz ±3dB.

The input stages of these amplifiers incorporate f.e.t.s which give excellent signal to noise ratio. Both units have features unusual in the price range such as a headphone socket, and a separate output for a tape recorder is incorporated.

System 1 (available at £52 complete), comprises the Viscount RT101 amplifier, SP25 with magnetic cartridge, and a pair of Duo Type II speakers.

System 2 (£69), is as System 1, but with Duo Type III speakers capable of handling outputs up to 20 watts.

System 3 (£49), comprises the Viscount RT100 amplifier, Garrard SP25 turntable with ceramic cartridge, and a pair of Duo Type II speakers giving a maximum output of 10 watts.

Postage and package is not included in the above prices.

Examination of the amplifier plus listening tests of the complete systems suggest that this is good all round value for money—the use of imported semiconductors no doubt being a vital factor in keeping the amplifier price to such a modest level. The makers are also modest (and sensible) in that they make no pretensions that this is "hi fi". More to the point, or rather to the ear, and the pocket, the quality is likely to meet the requirements of many who wish to sit down and enjoy music without incurring a tremendous financial outlay.

Audio suite from Radio and TV Components

STEREO AMPLIFIER

A new stereo amplifier incorporating an f.e.t. integrated circuit is the latest product from **Tripletone Manufacturing Co. Ltd.**, 138 Kingston Road, Wimbledon, S.W.19.

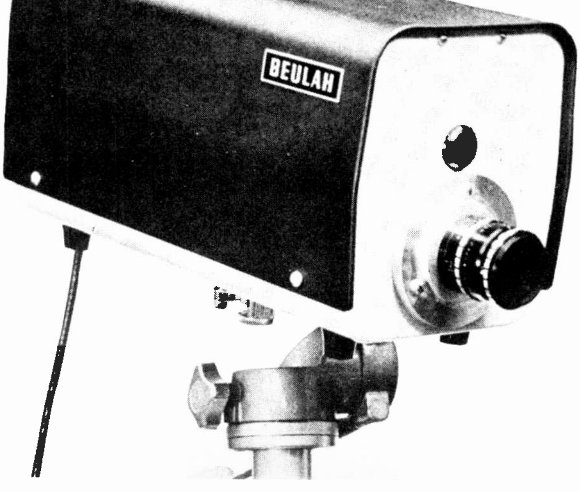
Known as the Tripletone 800 Mk II, it has a claimed continuous power output of 18W r.m.s. per channel into 4 ohms and 15W r.m.s. per channel into 8 ohms. Power bandwidth is quoted as −3dB 30 to 25,000Hz and the distortion level is claimed to be less than 0·2 per cent.

Inputs are provided for tape, radio, magnetic and ceramic cartridge. The load for the ceramic cartridge is kept at 2 megohms at all frequencies by the use of the f.e.t. integrated circuit. The magnetic input will take an overload of 120mV before clipping.

A feature of the amplifier is the inclusion of a dual concentric control for the middle frequencies as well as for the volume, bass and treble. A top cut filter is provided by an illuminated push-button and a jack socket is fitted for headphone listening.

The 800 Mk II is housed in a teak case with a black and silver aluminium facia and is priced at £38·50.

New Beukit camera marketed by Beulah Electronics



Tripletone 800 Mk II stereo amplifier

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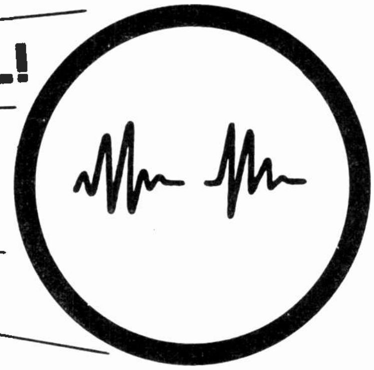

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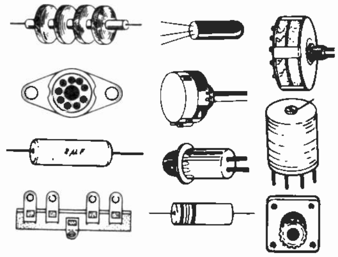

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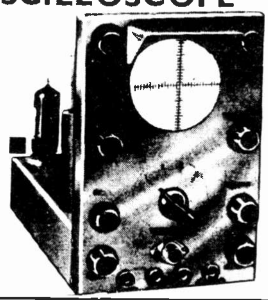

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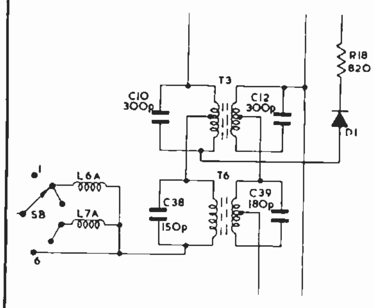

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- BASIC RADIO RECEIVER
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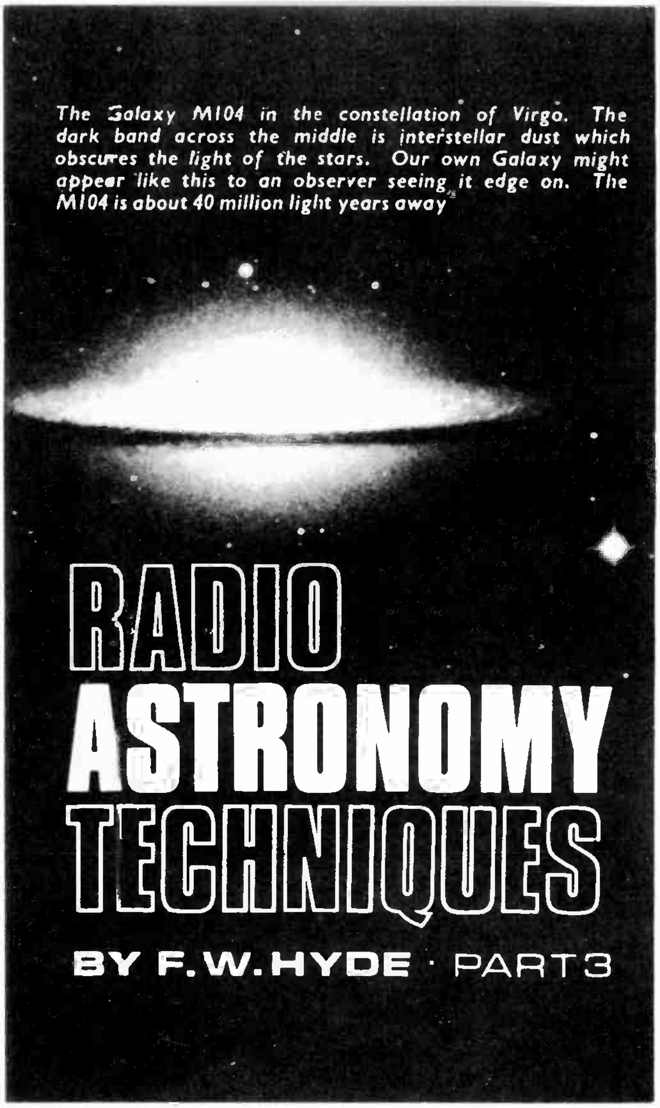

The Galaxy M104 in the constellation of Virgo. The dark band across the middle is interstellar dust which obscures the light of the stars. Our own Galaxy might appear like this to an observer seeing it edge on. The M104 is about 40 million light years away

RADIO ASTRONOMY TECHNIQUES

BY F.W. HYDE · PART 3

IN the previous article the simple two-aerial interferometer was described, the limitations noted, and mention made of a modification which can overcome some of these limitations.

PHASE-SWITCHED INTERFEROMETER

The first important modification came from Ryle in 1952. In this improved system the receiver does not measure the difference in power between two aerials, but is used to measure the correlation between two voltages when the phase of one aerial is changed in relation to the other.

Theoretically, this could be done by moving one aerial one half-wavelength in relation to the other. However, this is not practical, so it has to be done electrically. It is in fact, quite simple to do this, for by introducing a length of line one half-wavelength long, the same result is achieved. This change is made by a changeover switch, see block diagram in Fig. 3.1. For one half-cycle S1 connects aerial (B) directly to the receiver, and for the next half-cycle brings into circuit a length of cable one half-wavelength at the frequency at which the telescope is operating.

In this system, the background radiation from the galaxy, being an extended source, would give equal power in the receiver whether the aerials were in phase or anti-phase. On the other hand, a small source passing through the aerial beam would not have the same effect in both positions, so that the output from the receiver would vary at the frequency at which the aerials were switched. If the recorder is connected to this arrangement then the pattern will appear as in Fig. 3.2.

It is possible to use much greater sensitivity in the recording network by this method, and in the first trials, sources only 1/000 of the background level could be detected. The resolution of the system enabled small sources to be readily distinguished from each other.

ROTATING LOBE INTERFEROMETER

A variation of the phase-switched system is the rotating lobe interferometer, due to Jennison and Latham. This enables the fringes of the system to be rotated quite independently of the movement of the aerial systems across the sky. The block diagram is shown in Fig. 3.3.

One very important advantage of this system is that it may be used in north/south arrangements and it produces a fringe pattern which cannot be achieved with the phase-switched interferometer.

The limitation mentioned earlier in regard to the area of sky covered by the aerial beam from north to south is overcome by the rotating lobe method.

GRATING INTERFEROMETER

The combination of aerials as interferometers is often used to obtain special effects. One of such combinations is the grating interferometer. This system uses a number of aerials in line and connected to a receiver by feeders equal in length, see (a) in Fig. 3.4. The reception pattern that results is similar to a diffraction grating, and is shown in (b) in Fig. 3.4.

An example of the pattern resulting when the sun is scanned is given in Fig. 3.5. This shows the very high degree of resolution of the source which is

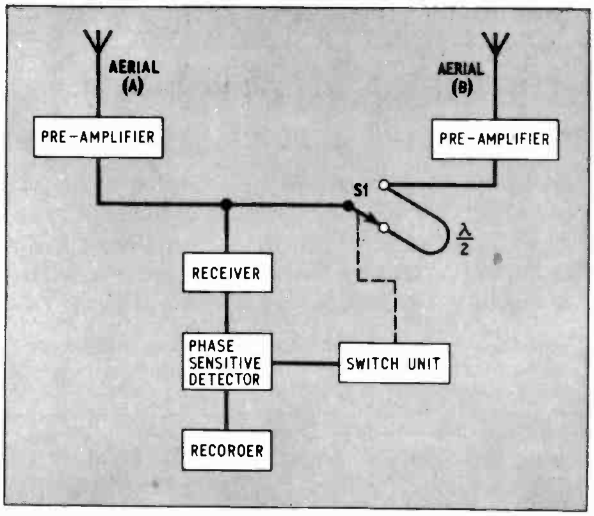

Fig. 3.1. Block diagram of a phase-switched interferometer

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2N697	18p	2N2925	22p	AC126	20p	BC154	20p	BFY51	20p
2N706	12p	2N2926	11p	AC127	20p	BC157	12p	BFY52	23p
2N930	29p	2N3053	27p	AC128	20p	BC158	11p	BSX20	16p
2N1131	29p	2N3055	60p	AC153K	22p	BC159	12p	C407	17p
2N1132	29p	2N3702	13p	AC176	16p	BC167	11p	MC140	25p
2N1302	19p	2N3703	13p	ACY20	20p	BC168	10p	MPS6531	35p
2N1303	19p	2N3704	13p	ACY22	16p	BC169	11p	MPS6534	30p
2N1304	26p	2N3705	13p	AD140	63p	BC177	14p	NKT211	25p
2N1305	26p	2N3706	13p	AD142	50p	BC178	13p	NKT212	25p
2N1306	33p	2N3707	13p	AD149	58p	BC179	14p	NKT214	23p
2N1307	33p	2N3708	10p	AD161	33p	BC182L	11p	NKT274	18p
2N1308	36p	2N3709	11p	AD162	36p	BC183L	10p	NKT403	65p
2N1309	36p	2N3710	13p	AF114	24p	BC184L	11p	NKT405	79p
2N1613	23p	2N3711	13p	AF115	24p	BC212L	16p	OC71	38p
2N1711	26p	2N3819	23p	AF117	22p	BC213L	16p	OC81	25p
2N1893	54p	2N3904	35p	AF124	24p	BC214L	16p	OC81D	25p
2N2147	95p	2N3906	35p	AF127	22p	BCY70	18p	ZTX300	14p
2N2218	34p	2N4058	13p	AF139	33p	BCY71	33p	ZTX301	16p
2N2218A	44p	2N4059	10p	AF239	36p	BCY72	15p	ZTX302	22p
2N2219	38p	2N4060	11p	ASY26	27p	BF115	23p	ZTX303	22p
2N2219A	53p	2N4061	11p	ASY28	27p	BF167	18p	ZTX304	27p
2N2270	62p	2N4062	12p	BC107	12p	BF173	19p	ZTX500	18p
2N2369A	19p	2N4124	18p	BC108	11p	BF194	14p	ZTX501	21p
2N2483	35p	2N4126	27p	BC109	12p	BF195	15p	ZTX502	25p
2N2484	42p	2N4284	15p	BC125	15p	BFX29	31p	ZTX503	22p
2N2646	47p	2N4286	15p	BC126	22p	BFX84	25p	ZTX504	52p
2N2904A	42p	2N4289	15p	BC147	10p	BFX85	52p		

RESISTORS

Code	Power	Tolerance	Range	Values available	1 to 9 (see note below)	10 to 99	100 up
C	1/20W	5%	82Ω–220KΩ	E12	9	8	7
C	1/8W	5%	4·7Ω–470KΩ	E24	1	0·8	0·7
C	1/4W	10%	4·7Ω–10MΩ	E12	1	0·8	0·7
C	1/2W	5%	4·7Ω–10MΩ	E24	1·2	1	0·9
C	1W	10%	4·7Ω–10MΩ	E12	2·5	2	1·9
MO	1/2W	2%	10Ω–1MΩ	E24	4	3·5	3
WW	1W	10% ±1/20Ω	0·22Ω–3·9Ω	E12	7	7	6
WW	3W	5%	12Ω–10KΩ	E12	7	7	6
WW	7W	5%	12Ω–10KΩ	E12	9	9	8

Codes: C = carbon film, high stability, low noise.
MO = metal oxide, Electrosil TR5, ultra low noise.
WW = wire wound, Plessey.

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

Values:
E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24 denotes series: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

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This latest Peak Sound high fidelity amplifier incorporates many strikingly original features including facility for adding in stereo FM tuner. Superb performance characteristics and luxurious styling. Electrovalue choice of simulated soft leather covering in black, blue, red or dark green. As advertised at £45. Our price, net . . **£38·75**

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70W. power amplifier, **£12·60** nett.

30 WATT BAILEY AMPLIFIER PARTS

Transistors and PCB for one channel **£6·46**
Capacitors, resistors (metal oxide), and transistors, one channel. **£8·41.**
Complete unregulated power supply pack, **£4·75**
Suitable heatsink 10DN space 400C, **55p**
Suitable heatsink 10DN 400C, **55p**

INTEGRATED CIRCUITS
SIEMENS TTL

We stock full range of all types in stock for very wide range of applications. For full details, see our latest components list. Please send S.A.E.
PLESSEY SL403D 7·5 ohms. **£2·10** nett. Applications data 10p.

S-DeCs put an end to birds nesting
Components just plug in—saves time—allows re-use of components. S-Dec (70 points), **£1·00**
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NEON chrome bezel, round red NR/R, **24p**; chrome bezel, round amber NR/A, **24p**; chrome bezel, round clear NR/C, **24p.** Neon, square red type L55C/R, **18p**; amber type L55C/A, **18p**; clear type L55C/C, **18p.** All above are for 240V mains operation. **Filament types:** 6V, 0·04A square red type L55C/R-6V, **30p**; 6V, 0·04A amber type L55C/A-6V, **30p**; 6V 0·04A clear type L55C/C-6V, **30p**; 6V 0·04A green type L55C/G-6V, **30p**; 12V 0·04A L55C/R-12V, **34p**; 34V 0·04A L55C/R-28V, **45p.**

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0·27 . . . . . . 7p   0·33 . . . . . . 8p

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			plug	socket
Loudspeaker	. .	2-pole	12p	10p
Audio	. .	3-pole	13p	10p
Audio	. .	4-pole	14p	12p
Audio	. .	5-pole 180deg.	15p	12p
Audio	. .	5-pole 240deg.	15p	12p
Audio	. .	6-pole	15p	13p

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obtained with the extremely narrow beam of one degree obtained by this aerial system, using a phase-switched receiver.

An outstanding example of the grating technique is the crossed dish arrangement set up by Christiansen in Australia. This crossed grating consisted of two rows of 19ft dishes, one line north/south and the other east/west. There were 16 aerials in each arm. This system, which became known as the Chris Cross, presents an array of beams pointing skywards. Though it would show confused records of discrete sources, it is specially suitable for the purpose for which it was designed, that is, the detailed study of the sun.

Another type of grating array is that at Nancay in France. It consists of 32 dishes in line and has a resolution of 4 minutes of arc at a frequency of 169MHz. It is the longest in the world, being 1/55km long.

The Mills Cross designed by B. Y. Mills of Australia has two arms which again are arranged north/south, east/west, and consists of rows of dipoles. The result is a pencil beam of small width at the centre; the pattern produced is seen in Fig. 3.6. The system has a very high resolving power, but is not so sensitive as other methods. It is, however, very valuable as a tool to study fine detail of the sky radiation.

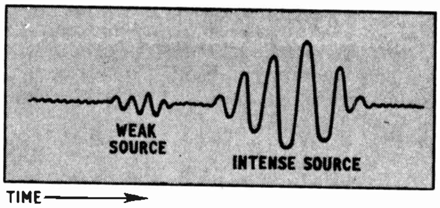


Fig. 3.2. Pattern recorded on phase-switching interferometer

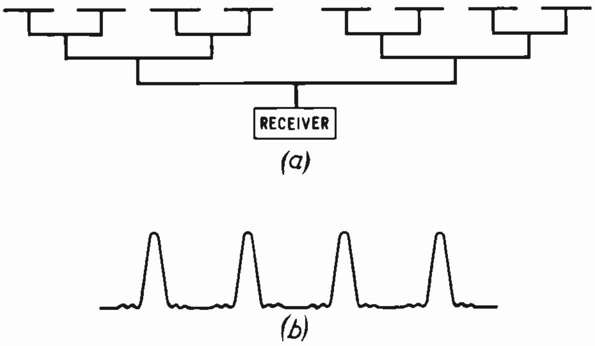


Fig. 3.4. A grating interferometer: (a) arrangement of aerials; (b) reception pattern

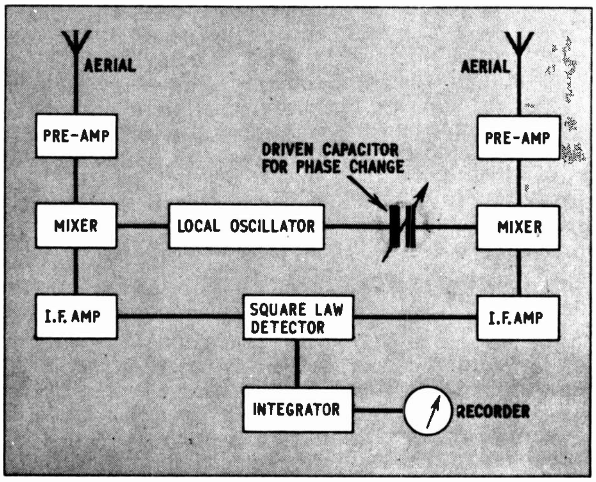


Fig. 3.3. Rotating lobe interferometer

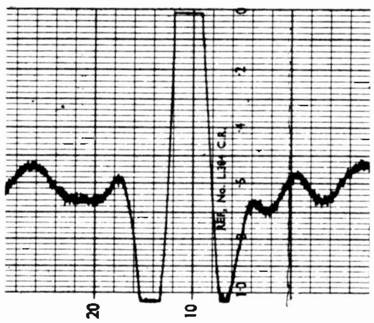


Fig. 3.5. Recording of the sun obtained from the aerial system shown in Fig. 3.4 used in conjunction with a phase-switched receiver

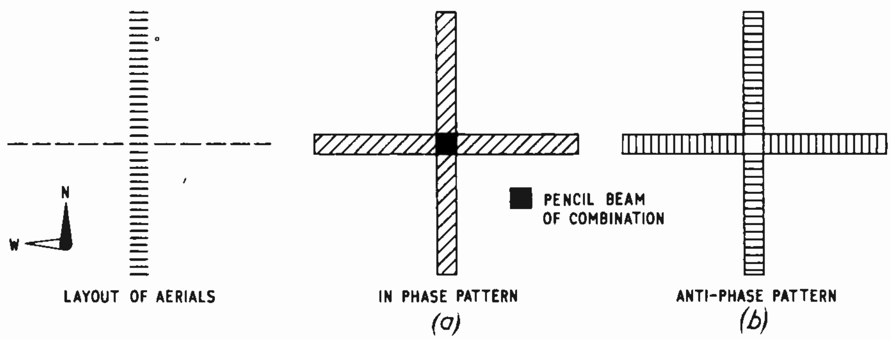
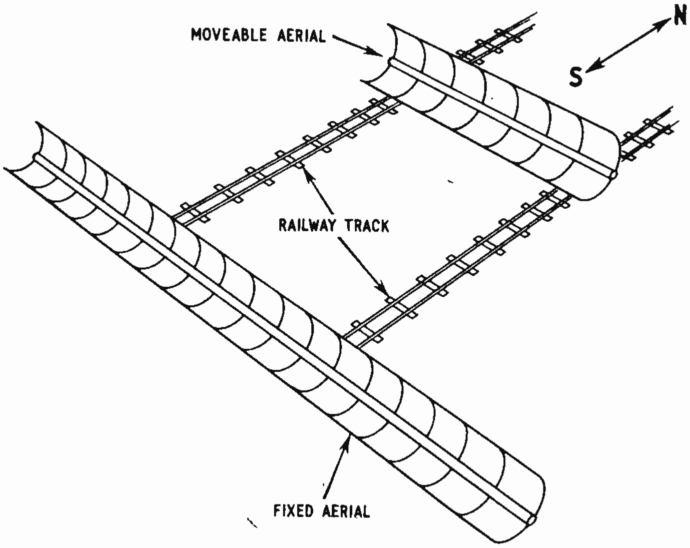


Fig. 3.6. Mills cross grating array



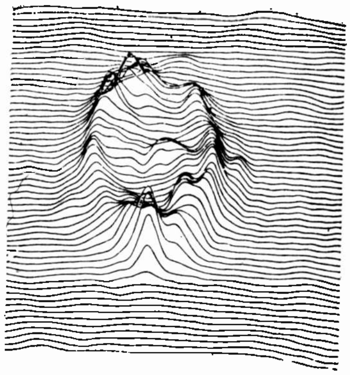


Fig. 3.8. The radio source Cassiopeia A. Brightness distribution at 140MHz (part of a survey by Ryle, Elsmore and Neville)

APERTURE SYNTHESIS

Still another system for increasing resolving power is that of aperture synthesis. If an aerial is moved successively to a number of positions in a given area a detailed plot of that area can be made and detail observed that cannot be equalled by any other method. A number of ways are available to do this.

One system first used at Cambridge by Ryle consisted of a fixed base line of aerials and a smaller movable aerial that could take up any position in a rectangle. By observing at each position, a statistical evaluation could be made of the intensity of variations over the whole area. This was later improved by a system which had one fixed line of aerials and another which ran on a railway track at right angles to it. This is shown in Fig. 3.7.

The one-mile telescope with its three dishes is a further extension of the aperture synthesis technique pioneered by Ryle and his team. Strictly speaking, this should be called "supersynthesis", since its combination of aerials has so many variations of positions. The synthesised results are processed on a computer and fed into a special plotter which shows the intensity variation of the sources like a relief map. An example of this is shown in Fig. 3.8.

FOUR MAIN TYPES OF RADIATION

The radiation that originates in the galaxy and the universe covers a wide range. However, so far as radio astronomy is concerned, the radiation that can be detected is somewhat restricted and depends very largely upon the site of the observatory, that is whether the radio telescope is on the earth or outside the earth.

The limitation so far as earth based observatories are concerned is the radio window. Within this part of the spectrum there are four main groups of radiation. Not all the stars or star systems that can be observed with optical telescopes have detectable radiation in the radio part of the spectrum, indeed many of them are seen and not heard. Conversely, many sources of radiation that are detected cannot be identified optically.

Much of the limitation is governed by the techniques that are at present available for radio-astronomy. Within these limits the four main groups of radiation detected are: Synchroton Radiation, Ionised Hydrogen Gas, Neutral Hydrogen Gas, and Discrete Sources.

SYNCHROTON RADIATION

The physics of synchroton radiation is well understood and is at present applied in particle accelerators used in nuclear investigations. Synchroton radiation is produced when an electron enters a magnetic field. The field compels the electron to spiral round the lines of force and the high speed that is imparted to it causes it to radiate in the metre-wave band. It is this kind of radiation that is detected in the Milky Way and in the halo of the galaxy. It also appears in the radiation from the planet Jupiter.

IONISED HYDROGEN GAS

The emission from ionised hydrogen is also known as thermal emission. Near hot stars the hydrogen becomes ionised, that is the electron is ejected from the atom of hydrogen leaving the proton. Under these conditions there exist free electrons and protons. When an electron passes near a proton it is accelerated but may not be captured. The high acceleration of the electron causes the emission of radiation in the centimetre wavelength band. This type of radiation is abundant in the plane of the Milky Way.

NEUTRAL HYDROGEN GAS

Neutral hydrogen appears in clouds of gas and it was predicted by Van de Hulst in 1944 that this gas would emit radiation at a wavelength of 21 centimetres. It is often referred to as the 21 centimetre line or H.I. line.

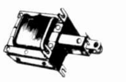
Van de Hulst made his prediction as a result of reading a paper by the American Amateur, Grote Reber, who had studied what he called cosmic noise. In 1951 Ewan in America proved the existence of the line. It can be detected by emission and absorption.

In emission the radiation is caused by the change of direction of the spin of the electron as it orbits

HEARING AID AMPLIFIERS

(Ex behind ear deaf aids) 3 transistors on tiny P.C. board with volume control—whole thing only about half as big as Oxo cube. **£1·75** or with sub-miniature microphone and L.S. attached, **£3·50.**

MAINS OPERATED SOLENOIDS



Model 772—small but powerful ⅜in. pull—approx. size 1½ × 1¼ × 1⅛in, **60p.**
Model 400/1 ½in. pull. Size 2¾ × 2 × 1⅞in, **75p.**
Model TT10 1⅛in. pull. Size 3 × 2½ × 2⅛in. **£1·80** plus 20p post. and insurance.

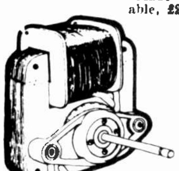
BEST QUALITY BRITISH MADE ELECTRICAL PLUGS AT APPROX. HALF PRICE

15 amp 3 pin, **10p** each or ten for **90p**; 5 amp 3 pin, **8p** each or ten for **70p**; 5 amp 2 pin, **5p** each or ten for **45p.**

DRILL CONTROLLER
NEW IKW MODEL

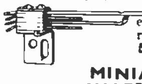
Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£1·50** plus 13p post and insurance. Made up model also available, **£2·25** plus 13p post & p.

MAINS MOTOR



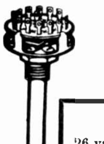
Precision made — as used in record decks and tape recorders—ideal also for extractor fan, blower, heaters, etc. New and perfect. Snip at **50p.** Postage 15p for first one then 5p for each one ordered.

NEED A SPECIAL SWITCH?



Double Leaf Contact. Very slight pressure closes both contacts. **6p** each, **60p** doz. Plastic push-rod suitable for operating, **5p** each, **45p** doz.

MINIATURE WAFER SWITCHES



2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at **18p** each. **£1·80** dozen, your assortment.

WATERPROOF HEATING ELEMENT
26 yards length 70W. Self-regulating temperature control. **50p post free.**

MICRO SWITCH

5 amp, changeover contacts, **9p** each, **£1** doz. 15 amp. On/off **10p** each, 15 amp. changeover **15p** each, 10 for **£1·35.**

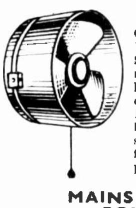
MAINS OPERATED CONTACTOR

220/240V, 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10A. Extremely well made by a German Electrical Company. Overall size 2½ × 2 × 2in. **£1** each.

PAPST MOTORS

Est. 1/40th h.p. Made for 110–120V working, but two of these work ideally together off our standard 240V mains. A really beautiful motor, extremely quiet running and reversible, **£1·50** each. Postage one 23p, two 33p.

EXTRACTOR FAN

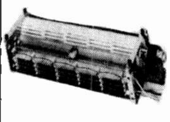


Cleans the air at the rate of 10,000 cubic ft. per hour. Suitable for kitchens, bathrooms, etc., it's so quiet it can hardly be heard. Compact, 5½" casing with 5½" fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets, **£2** plus 36p post and ins.

MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6V, 9V, 12V for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only **83p**, plus 18p postage.

OUT OF SEASON BARGAIN TANGENTIAL HEATERS



Once again we are able to make a special bargain offer of these very popular heating units. Tangential heaters although brought out a few years ago are still the latest and best type as nothing has yet been made which could be called an improvement on them. The Tangential unit is still the only one used in good quality heaters made by Hoover, G.E.C. and all the famous names. The unit comprises quiet running a.c. induction motor with special bearings, the tangential impeller and a 2 section heater element which allows switching half and full heat in the case of the 2kW and one-third, two-thirds and full heat in the case of the 3kW. These heaters are also fitted with a safety cutout to cut the heaters should the impeller stop or the air flow be impeded. They are free-standing and need only the simplest of cases, even a wooden cabinet is suitable or the plinth of the kitchen cabinet. Lots of customers missed our special Summer Offer of these heaters last year so order early. 200/240 2kW model **£2·50.** 200/240 3kW model **£3·50.** Control switch heaters only **25p** or two-heat, cold-blow and off **35p.** Postage and insurance 33p on heaters.

STANDARD WAFER SWITCHES

Standard size 1¼ wafer—silver-plated 5 amp contact, standard ¼in spindle 2in long—with locking washer and nut.

No.ofPoles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole	40p	40p	40p	40p	40p	40p	40p	40p	40p
2 poles	40p	40p	40p	40p	40p	40p	40p	70p	70p
3 poles	40p	40p	40p	40p	70p	70p	70p	95p	95p
4 poles	40p	40p	40p	70p	70p	70p	70p	£1·20	£1·20
5 poles	40p	40p	70p	70p	95p	95p	95p	£1·45	£1·45
6 poles	40p	70p	70p	70p	95p	95p	95p	£1·70	£1·70
7 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£1·95	£1·95
8 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£2·20	£2·20
9 poles	70p	70p	95p	95p	£1·45	£1·45	£1·45	£2·45	£2·45
10 poles	70p	70p	95p	£1·20	£1·45	£1·45	£1·45	£2·70	£2·70
11 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£2·95	£2·95
12 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£3·20	£3·20

AMPLIFIER MAINS TRANSFORMER

50V 1½ amp. Upright mounting with fixing brackets and metal shrouds to contain magnetic field, 50 c/s primary, tapped 110V, 117V, 210V, 230V and 250V. Two secondaries, one 50V 1½ amp, other 6V 1 amp for pilot light, etc., **£1·95**, postage 30p.

THIS MONTH'S SNIP
BATTERY CONDITION TESTER

Made by Mallory but suitable for all batteries made by Ever Ready and others, most of which are zinc carbon types but also mercury manganese-nicad-silver oxide and alkaline batteries may be tested. The tester puts a dummy load on the battery and the meter scale indicates the condition depending upon which section the pointer rests. The section reads "replace", "weak" or "good". The tester is complete in its case, size 3¾ × 6¼ × 2in with leads and prods. Price **£1·75** plus 20p postage.

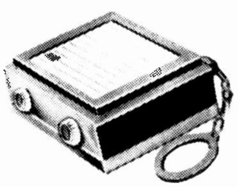
COMPUTER TAPE

2,400ft of the best magnetic tape money can buy. Almost unbreakable and on a metal computer spool. Users have claimed successful results with video as well as sound recordings. 1" wide **£1**, ½" **88p**, ¼" **75p.** P. & P. 33p extra. Spare spools **50p** each. Cassette to hold spool **50p** each. No extra postage if ordered with tape, otherwise 30p extra.

CAPACITOR DISCHARGE IGNITION SYSTEM

Well proved that it helps starting and increases petrol economy. Also increases acceleration but saves contact wear. For details see Practical Wireless June. Gives optional capacitor or standard ignition at the flick of a switch. Price **£4·95.**

MICROSONIC KEYCHAIN RADIO



7 transistor Keychain Radio in very pretty case, size 2¾ × 2⅛ × 1⅛in.—complete with soft leather zipped bag. 7 transistor, ferrite rod. Loudspeaker.
In transit from the East these sets suffered corrosion as the batteries were left in them but when this corrosion is cleared away they should work—offered without guarantee except that they are new. Price only **£1·25** less batteries, plus **13p** post, 6 for **£7** post free. Pair of rechargeable batteries and charger **85p.**

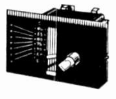
MAINS RELAY BARGAIN

Special this month are some single, double and treble pole changeover relays. Contacts rated at 15 amps. Operating coil wound for 240V a.c. Good British Make. Unused. Size approx. 1½ × 1in. Open construction.
Single pole, **25p** each, 10 for **£2·25.**
Double pole, **32p** each, 10 for **£2·90.**
Treble pole, **40p** each, 10 for **£3·60.**

4 AMP VARIAC CONTROLLERS

With this you can vary the voltage applied to your circuit from zero to full mains without generating undue heat. One obvious application therefore is to dim lighting. Ex equipment but little used—as good as new offered at approx. half price. **£5** plus 75p post and ins.

OVEN THERMOMETER WITH ALARM



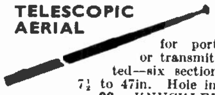
Basically this is a thermometer which is calibrated between 500°C and 900°C using a sensor on a flexible lead. The second feature, however, is an alarm which can be set anywhere within the temperature range. When the temperature is reached a buzzer sounds. Presumably the buzzer could be replaced by a relay or contactor to work another device. Limited quantity only of these units, price **£3·50**, includes thermometer—scale—sensor and buzzer.

ELECTRIC CLOCK WITH 25 AMP SWITCH

Made by Smith's, these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—new and unused only **£2**, less than the value of the clock alone—post and insurance 14p.

P.W
TREASURE TRACER
As described in August issue of *Practical Wireless*
Send today for price list of parts

TELESCOPIC AERIAL



for portable, car radio or transmitter. Chrome plated—six sections, extends from 7½ to 47in. Hole in bottom for 6BA screw. **38p** KNUCKLED MODEL FOR F.M. **50p.**

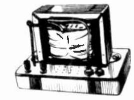
QUICK CUPPA

Mini Immersion Heater, 350W, 200/240V. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. **£1·25**, post and insurance 14p. Jug heater **£1·50** plus 14p P. & P.

THYRISTOR LIGHT DIMMERS

Will dim incandescent lighting up to 600W from full brilliance to out. Assembled and wired ready to install, **£3.**

12 VOLT 1½ AMP POWER PACK



This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 mf/d/ smoothing. Price **£1·50** plus 20p P. & P.

REED SWITCHES

Glass encased, switches operated by external magnet—gold welded contacts. We can now offer 3 types:
Miniature. 1in long × approximately ⅛in. diameter. Will make and break up to ½A up to 300 volts. Price **13p** each. **£1·20** dozen.
Standard. 2in. long × 3/16in. diameter. This will break currents of up to 1A, voltages up to 250 volts. Price **10p** each. **90p** per dozen.
Flat. Flat type, 2in. long, just over 1/16in. thick approximately ⅛in. wide. The Standard Type flattened out, so that it can be fitted into a smaller space or a larger quantity may be packed into a square solenoid. Rating 1 amp 200 volts. Price **30p** each. **£3** per dozen.
Small ceramic magnets to operate these reed switches **9p** each. **90p** per dozen.

PUSH BUTTON CHANGEOVER SWITCHES

This is a Honeywell micro switch mounted on a metal frame with spring loaded plunger to operate. Panel fixing by single ⅝in hole. Single Changeover switch **25p** each or ten for **£2·25**, 2 changeover switches operated by single plunger, **35p** each or ten for **£3·15**, 3 changeover switches **45p** each or ten for **£4·05.**

Meter Box. Designed to take 3¼in flush mounting meter. This has a 2¼in diameter hole with 3 meter fixing holes. Overall size of box 4 × 4 × 2⅛in deep, hinged to a metal base 2½in by 4½in by ⅞in deep. Price **50p.**

Pilot Bulbs. 6–8 Volts 15 amp tubular MES British made good quality. 1 dozen in a box. **25p** per box.

5 Amp Connector Strips. This is the normal type of connector strip. Twelve connectors with grub screws mounted in a line and moulded in polythene. **15p** each, **£1·50** per dozen.

24V Buzzer. Made by G.E.C. in brown heavy bakelite case, these work off a.c. mains through step down transformer. Price **40p** each.

9 Pin Plug and Socket. Suitable for connecting multicore flexer to equipment. Socket size approx. ⅞in diameter. Plug size 9/10in diameter with flex entry. **25p** pair.

A New Service to Readers. A bulletin bringing news of new lines, special snips and "too few to advertise" lines will be posted to subscribers during first week of each month. The bulletin will be called "Advance Advert News" and the Subscription is **60p.** per year. Subscribers will also receive our completed 1971 catalogue when this is published.

Where postage is not stated then orders over £5 are post free. Below £5 add 20p. Semiconductors add 5p post. Over £1 post free. S.A.E. with inquiries please.

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Dept P.E., 7 Park Street, Croydon CRO IYD
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round the proton. The action of the reversal of the spin causes the radiation. Because it emits at the single frequency it differs from the other types of radiation which can cover a broad band. Because it is singular in this effect it is possible to detect the radiation in other sources.

If a cloud of neutral hydrogen lies between the observer and a source of radiation, and is sufficiently thick optically, then the hydrogen line will be absorbed. The structure of the galaxy has been plotted using this method of detection of spectral lines. The comparison type of receiver is used for this purpose and is shown in Fig. 3.9. The kind of recording which is made is also shown.

DISCRETE SOURCES

The discrete sources of radiation emit over a wide range of frequencies. Many of these sources have been identified and much is known about them. The Crab Nebula was one of the first to be identified.

A great deal of continuous observation has been given to this object which was the star which exploded some nine hundred years ago as observed by the Chinese astronomers. It is in our own galaxy and is about 4,100 light years away from us. This means that the actual explosion took place over 5,000 years ago. It has been a source of great power, much of which was not explainable by ordinary theories.

Now, since certain polarisation measurements have been made, and pulsar investigations carried out, a number of puzzling features have been resolved. Other sources of a similar nature have been mentioned earlier in these articles. Many sources have been found in the galaxy, but many more exist beyond it since they appear to be scattered all over the sky. Some of these sources may be exploding star (or Nova) remnants; some are quasars, and some will be pulsars.

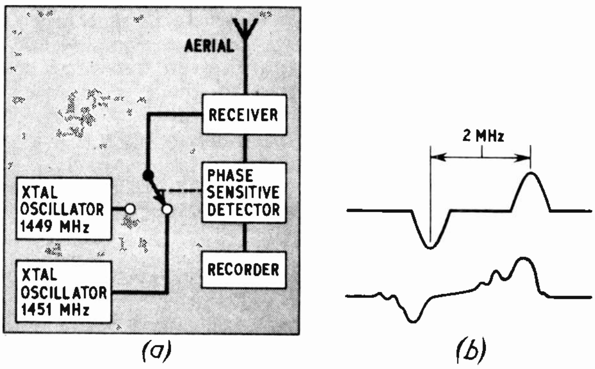

Fig. 3.9. The detection of spectral lines: (a) the switched comparison receiver; (b) typical outputs from receiver

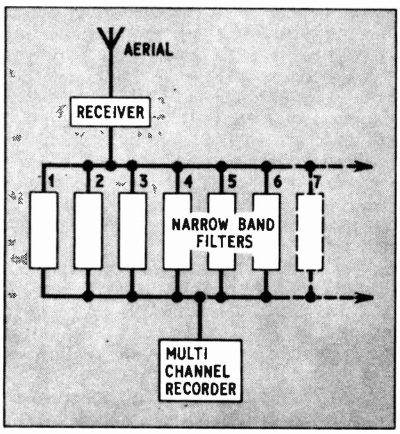

Fig. 3.10. A multi-channel spectrometer

RADIO SPECTROMETERS

A number of special lines have been discovered at various frequencies, such as the OH line (a hydroxyl radical) and, the latest to be recognised, those of ammonia and formaldehyde.

The instruments used for these measurements are called radio spectrometers. Such instruments fall into two types: one has a number of channels each separated by narrow band filters, and the other a system where the frequency is changed rapidly over a band of frequencies—this is known as the swept frequency spectrometer.

As these spectral lines are very narrow, the spectrum covering as little as 2MHz, the hydrogen line can be used to measure the speed at which the parts of the galaxy are moving. It is therefore an important tool with which to explore the universe.

The first type of radio spectrometer is shown in block diagram Fig. 3.10. Spectrometers are used for other purposes, for example, the study of the sun over a wide frequency range. The swept frequency spectrometer has been used for the study of decametre radiation from Jupiter. In this case the range of operation was from 10MHz to 42MHz.

OCCULATION

So far, apparatus has been described for the techniques employed in radio astronomy, and perhaps these various systems might be called the tools. There are however, a number of "tricks" by which the radiations can be studied. For example, in June each year the Crab Nebula passes (apparently) behind the sun. This fact, and also because the level of radiation from the Crab is very high, is used to study the corona of the sun.

The "radio" sun is very much more extended than the "face" that can be seen and which is called the photosphere. The sun has a corona and this extends way beyond that which can normally only be seen at the time of an eclipse. Radio astronomers however can study this atmosphere of the sun at any time.

When the radio waves from the Crab are behind the corona a reduction of the intensity of the Crab radiation is noted. This reduction continues until the Crab is blotted out completely, but it re-appears as it passes out the other side. By this method the density of the corona at various frequencies can be readily determined. This, incidentally, is another project that amateurs can attempt with modest apparatus.

Another type of occultation measurement is to use the moon and planets. As the moon or planet passes in front of a radio source, the power of that source is reduced or sometimes blotted out altogether, depending on its size. Predictions of sources to be affected is circulated to those concerned by the Royal Observatory, and regular observations are carried out at various frequencies.

POLARIMETERS

Generally, the radio waves are received in one plane of propogation, but may well be randomly polarised. To examine this feature, polarimeters are used. Polarimeters consist of aerials which are crossed or arranged in the form of a square with the sections arranged in phase combinations such that the direction of rotation can be detected.

The helical aerial is very useful in this connection, for it can be arranged to give right or left handed polarisation. A system containing helices of both right and left hand polar diagrams can collect a large amount of data. The evaluation is quite a difficult task, for the radiation is rarely consistently polarised in one sense or the other and is more generally elliptical than circular.

RADAR ASTRONOMY

Radar astronomy is a special branch and has its own techniques. The equipment involved is necessarily complex and costly. It is certainly beyond the resources of private individuals. As with any form of radio transmission, a licence is required to operate radar equipment. Participation in radar astronomy is thus, automatically, the prerogative of certain scientific or research establishments.

Contributions made by radar techniques are of great importance, as the following few examples will indicate. Signals bounced off the moon gave a clue to surface conditions before unmanned and manned landings. Venus has been studied and at last an agreed period of rotation has now been arrived at. Radar has been used to study the sun, though of course, enormous powers are necessary for this work. Active studies of meteors have been carried out by radar methods and represent an enormous amount of pioneering work which began in the early days of Jodrell Bank and still continues. At Sheffield the study of meteors with the aid of radar has made great progress under Dr Kaiser. The temperature of the planets and the moon has been closely studied by radar methods.

The next two articles will deal with the equipment needed to set up a small radio astronomy observatory. A project related to solar observations will be detailed and the methods of recording the results explained.

BOOK REVIEWS

TELEVISION SERVICING HANDBOOK (3rd edition)

By Gordon J. King
Published by Newnes-Butterworth
357 pages, 10in × 6¼in. Price £3·80

THE most significant difference in this the third edition, compared with earlier editions, is the inclusion of colour television techniques and problems. Dual standard and 625-line only sets are also included.

Since all these types have shown how transistors and integrated circuits can be usefully employed, the last chapter is a very good treatise on methods adopted commercially, and shows the significant differences from valve circuits. The part on integrated circuits is naturally very short because, at the time of writing the book, the applications to television were in the experimental stages.

My only other comment on an otherwise excellently written book is that perhaps the chapter headings are a bit misleading, because long circuit descriptions and functions are given before fault finding methods. The amount of space so devoted is sometimes unrelated to the headings and cross reference to other chapters often becomes necessary.

The quality of paper and printing is excellent, as is necessary in the accurate reproduction of the pictorial matter taken directly from the screen.

M.A.C.

INTRODUCTION TO A.C. MACHINES
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Introduction to D.C. Machines covers generator principles, commutator action, the magnetic circuit, windings and motor principles.

Capacitance and Capacitors deals with atomic charge concepts and electrostatics. A final section of practical capacitors is instructive.

Resistance and Ohm's Law is concerned with the measurement of electricity in series and parallel circuits.

Introduction to A.C. Machines, proceeds from simple a.c. generation through three phase circuits, examines rotors and stator windings and is completed with sections on synchronous and induction motors.

G.G.

components show

WHILE much discussion on component availability prevails on the domestic scene, let us not overlook some of the problems encountered in industry. Any visitor who regularly attends the Components Show at Olympia, organised by the R.E.C.M.F., will have gazed at the ground floor area from the gallery and admired the massive displays put on by large American and British companies. The view this year was not the same. Many of them were not there.

COMMERCIAL COMBAT

We walked downstairs to the ground floor to find out from close quarters what the electronic components industry is doing, and straight away were confronted by smaller displays, smaller stands (perhaps to suit the smaller components) but many of them. The Goliaths were missing—at least, most of them! There were several Davids finding out that exhibitions are big business (to them at any rate!).

It seems that the bigger the Company, the greater the economies, but are they always in the right direction? Millions of pounds are spent in commercial combat with sling and stone poised; consequently, the customer who is, let's face it, the reason for company existence is often almost cast off as a bore. The customers want the goods and the suppliers shout that they have the goods, but what happens in between is anybody's guess.

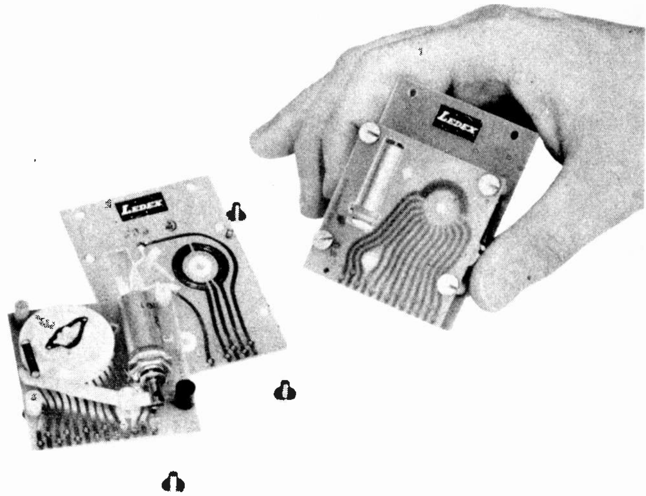
When you look more closely, the source of trouble becomes evident—the economic manipulation of hard cash. Are the priorities in the right quarters? Should the supplier spend money to sell any item in any quantity or spend to produce bigger and better cut-out polystyrene lettering with complementary timber and hardboard structures and glossier brochures?

THE MISSING GIANTS

Well, this year's exhibition, extended over all three halls at Olympia, is a lesson to be learned for anyone in the business and here is the reason why.

It all began with the Vietnam War—no less. The U.S.A. has sunk billions of dollars in mortal combat and in space exploration too. The spin-off of technology from space work has made in-roads into electronics applications all over the world. Since the growth of electronics and associated technology requires capital investment, it is not surprising to learn that the electronics recession in America has spread to other influential countries, while expenditure on space research is reduced.

Consequently, some of the large component manufacturers, companies such as Motorola, Texas Instruments, Honeywell, Marconi-Elliott Microelectronics, Mitsubishi, Muirhead, SGS, were conspicuous by their absence. These are not all Amercian but it does indicate that the U.K. and Japan are influenced by American economics. On the other hand, a large American Government representation incorporating several small companies were apparently quiet.



New approach to the Ledex motorised switch by NSF. Printed circuit board is tracked by a ratchet operated rotating contact wheel (above)

CLOSED SHOP

On the home front we see the continued closing down of departments within the larger organisations so as to attempt to save on small outgoings. Of these, the most shattering is the closure of Electroniques within the American ITT Company, which absorbed S.T.C. a few years ago. The large white-washed display stand of ITT was mainly devoted to a raised platform, on which were paraded at occasional intervals four luxuriously clad young ladies covered in ITT components—a lavish display—with glib commentary selling the advantages of their components.

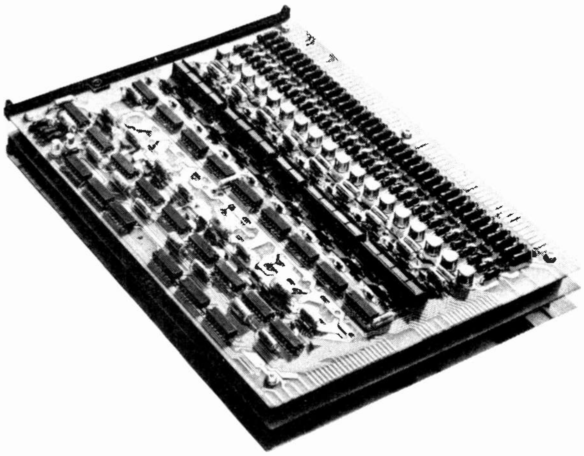
"We have it all!" was not our idea of apologising for the closure of Electroniques—a fine service in the past.

NEW LINEAR ICs

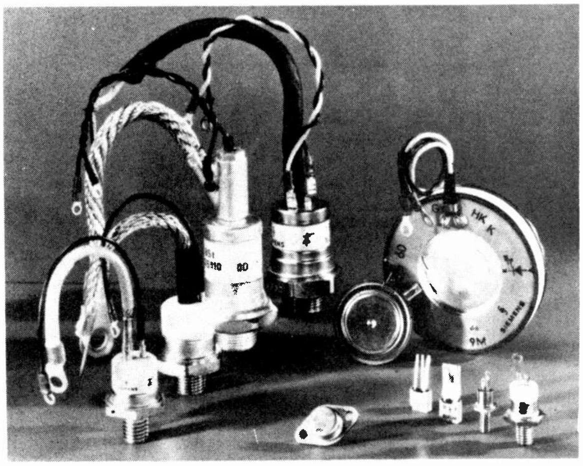
The foregoing may appear to be a rather grey picture of the exhibition, but should not be taken to imply that the electronics industry is in dire straits. Far from it! It was refreshing to find a buoyant mood among many participants, not the least being the ubiquitous Mullard, who had many new developments on display aimed for both consumer and industrial equipment, via trade outlets, of course.

A new range of eight integrated circuits designed for use in the signal processing stages of colour and monochrome receivers continues the trend for miniaturisation. Portable radio set makers can rejoice in the new integrated circuits, types TBA 690 and TBA 700, for these contain all the active stages of an a.m./f.m. receiver with the exception of the mixer. The TBA 690 will deliver an output of 0·5W, and the TBA 700, 1W.

Integrated circuit type TBA 750 includes the mixer and all stages with the exception of the output stage. It can be used in high performance a.m. or a.m./f.m. receivers. Low power i.c. audio amplifiers have a



Basic memory module of the Plessey Planar 850 core memory built on three printed circuit boards



Range of thyristors and triacs rated from 0·8A to 640A from Siemens (U.K.) Ltd. The Thyblock system is a disc shaped thyristor sandwiched between two aluminium extrusions for cooling

ready market for use in television receivers, record players, tape recorders and radiograms.

Unfortunately, it is quite easy to irrepairably damage these devices by accidently short circuiting the output. Plessey Microelectronics have successfully overcome this particular problem with the SL403D package (younger brother of SL403C) which is protected against permanent a.c. and d.c. shorts to ground of its input and output terminals.

LOCK-IN AMPLIFIER

Ever heard of a signal to noise ratio of −100dB? If you encounter such proportions (and that minus is correct here) and wish to eliminate much of the noise that drowns that signal, then Brookdeal Electronics of Bracknell, Berks, may be able to help. Their new "Lock-in" Amplifier type 401 is claimed to be capable of recovering the signal from noise which is 100,000 times greater than that signal. It's frequency range is 1Hz to 50kHz and the amplifier is battery operated.

Amid the problems of supply and demand, it is good to see that one company at least is interested in supplying "one-offs". Tape Recorder Spares Ltd. of London, S.E.17 market pre-pack components for audio equipment, including plugs, sockets, drive belts, fuses, and connecting leads.

Newly introduced by ITT Components Group Europe is the Super-Permacolour television picture tube type A 67-150 X. A 26in shadow mask tube with 110 degreee deflection angle and narrow (29mm diameter) neck, the new tube is claimed to give a sharper picture than 90 degree large screen tubes. The overall length of the tube has been reduced by approximately 4·3in (11cm) to approximately 17in (43·1cm). This enables the depth of the receiver cabinet to be reduced accordingly. Specially designed for use with the tube are a new toroidal reflection yoke ITT Type FAS 110-3 and a convergence unit Type FRK 110-3.

CORE MEMORY

Plessey displayed a large range of components and equipment extending from optoelectronics to sheet metal work. A completely new product from the Memories Division, is the Planar 850 core memory (see photograph) which meets, in part, the increasing demand from industry of inexpensive core systems. This has a capacity of 4,096 18-bit words and, with other modules, this can be extended to 32,786 words.

Gresham Lion have brought out a higher density recording head. The dual gap read-after-write digital recording head is designed to record 36 separate tracks on 1in tape.

A new integrated circuit incorporates the equivalent of 20 TTL packages in one with 30 connec-

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BSY26	0·13	OC23	0·30
BSY27	0·13	OC25	0·25
BSY28	0·13	OC26	0·25
BSY29	0·13	OC28	0·30
BSY95A	0·15	OC35	0·25
OC41	0·13	OC36	0·37
OC44	0·13	AD149	0·30
OC45	0·13	AUY10	1·25
OC71	0·13	2S034	0·25
OC72	0·13	2N3055	0·63
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OC81	0·13	AAY42	0·10
OC81D	0·13	OA95	0·10
OC83	0·20	OA79	0·09
OC139	0·13	OA81	0·09
OC140	0·17	IN9114	0·07

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OC44, OC55 Transistors fully marked and tested, 500+ at **8p** each; 1,000+ at **6p** each.

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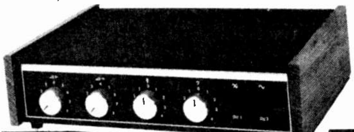

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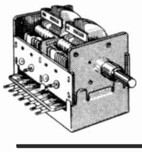

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MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V. Sec. 9-0-9 at 500mA. **70p.** P. & P. 13p. Pri. 200/240V. Sec. 12-0-12 at 1 amp. **88p.** P. & P. 13p. Pri. 200/240V. Sec. 10-0-10 at 2 amp. **£1·38.** P. & P. 30p. Tapped Primary 200-220-240V. Sec. 21·5V at 500mA. **63p.** P. & P. 13p.

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HI-FI LOUDSPEAKER SYSTEM

Beautifully made teak finish enclosure with most attractive Tygan-Vynair front. Size 16½in high × 10½in wide × 5¼" deep. Fitted with E.M.I. Ceramic Magnet 13in × 8in bass unit, two H.F. tweeter units and crossover. Power handling 10W. Available 3, 8 or 15 ohm impedance.

Our Price £8·40 Carr. 65p.

CABINET AVAILABLE SEPARATELY **£4·50.** Carr. 60p.

Also available in 8 ohm with EMI 13in × 8in. bass speaker with parasitic tweeter. **£6·50.** Carr. 65p.

LOUDSPEAKER BARGAINS

3in 4 ohm **50p.** P. & P. 13p. 5in 3 ohm **80p.** P. & P. 15p. 7 × 4in 3 ohm **£1·05,** P. & P. 20p. 10 × 6in 3 or 15 ohm **£1·90,** P. & P. 30p. E.M.I. 8 × 5in 3 ohm with high flux magnet **£1·62,** P. & P. 20p. E.M.I. 13½ × 8in 3 ohm with high flux ceramic magnet **£2·10** (15 ohm **£2·25**). P. & P. 30p. E.M.I. 13 × 8in, 3 or 8 or 15 ohm with two inbuilt tweeters and crossover network **£4·20.** P. & P. 30p. E.M.I. 13" × 8" twin cone (parastatic tweeter) 8 ohm **£2·25.** P. & P. 30p.

BRAND NEW. 12in 15w H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£5·50.** Guitar models: 25w **£6·50.** 35w **£8·50.** P. & P. 38p each.

E.M.I. 3½in HEAVY DUTY TWEETERS. Powerful ceramic magnet. Available in 3, 8 or 15 ohm **98p** each. P. & P. 13p.

12in "RA" TWIN CONE LOUDSPEAKER
10 watts peak handling. 3 or 15 ohm, **£2·20.** P. & P. 30p.
35 ohm SPEAKERS 3". ONLY **63p.** P. & P. 13p.

VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 54in. wide. Usually £1·75 yd., our price **75p** yd. length. P. & P. 15p (min. 1 yd.). S.A.E. for samples.

HI-FI STEREO HEADPHONES

Adjustable headband with comfortable flexifoam ear-muffs. Wired and fitted with standard stereo ¼in jack plug. Frequency response 30–15,000Hz. Matching impedance 8–16 ohms. PRICE **£2·95.** P. & P. 15p.

SINGLE HEADPHONE. With aluminium headband. Approx. 200 ohm. **25p.** P. & P. 8p.

CRYSTAL MIKES. High imp. for desk or hand use. High sensitivity. **93p.** P. & P. 8p.

HIGH IMPEDANCE CRYSTAL STICK MIKES. OUR PRICE **£1·05.** P. & P. 8p.

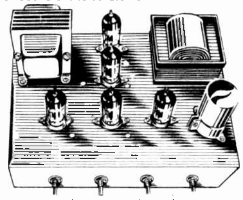
GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER. For P.U. Tape, Mike, Guitar, etc., and suitable for use with valve or transistor equipment. 9–18V. Battery or from H.T. line 200/300V. Frequency response 15Hz–25KHz. Gain 26dB. Solid encapsulation size 1⅝ × 1¼ × ½in. Brand new—complete with instructions. Price **88p.** P. & P. 13p.

BRAND NEW E.M.I. LIGHTWEIGHT PICK-UP ARM WITH ARM REST. Fitted mono t/o stylus and cartridge for LP/78, ONLY **£1.** P. & P. 8p.

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. w. × 3 d. × 6 h. Ready built and tested. PRICE **£3·75.** P. & P. 40p. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit cabinet below. PRICE **£4·88.** P. & P. 50p.

DE LUXE QUALITY PORTABLE R/P CABINET MK II
Uncut motor board size 14½ × 12in., clearance 2in. below, 5½in. above. Will take above amplifier and any B.S.R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18 × 15 × 8in. PRICE **£3·98.** P. & P. 50p.

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 bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **13p** (Free with parts). **All parts sold separately.** ONLY **£7·97.** P. & P. 55p. Also available ready built and tested complete with std. input sockets, **£9·97.** P. & P. 55p.

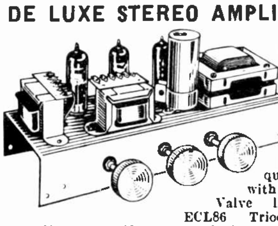
BRAND NEW TRANSISTOR BARGAINS. GET 15 (Matched pair) **75p;** V15/10p, **50p;** OC71 **25p;** OC76 **30p;** AF117 **18p;** 2G339 (NPN) **15p.**
Set of Mullard 6 transistors OC44, 2—OC45, AC128D, matched pair AC128 **£1·25;** ORP12 Cadmium Sulphide Cell **53p.** All post free.

SPECIAL PURCHASE !
SPEAKER CABINET FROM FAMOUS MAKER !

Beautifully made all-wooden construction cabinet with medium walnut finish front, gold anodised expanded aluminium grille and dark sides. Approx. size overall 11½" high × 5" deep × 13½" wide at base. Easily removable baffle cut out for 8" speaker. Fibre board back. Could accommodate amplifier or radio together with speaker. An expensively made cabinet at a give-away price.

LIMITED NUMBER ONLY £1·38 Post Free.

DE LUXE STEREO AMPLIFIER



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

4-SPEED RECORD PLAYER BARGAINS
Mains models. All brand new in maker's packing.

LATEST B.S.R. C109/A21 4-SPEED AUTOCHANGER. With latest mono compatible cartridge **£6·97.** Carr. 50p. With stereo cartridge **£7·97.** Carr. 50p.

SUITABLE PLINTH UNIT FOR ABOVE with rigid plastic cover. **£5·75** complete. P. & P. 50p.

LATEST GARRARD MODELS. All types available 1025, 2025, SP25, 3000, AT60, etc. S.A.E. for Latest Prices!

PLINTH UNITS cut out for Garrard Models 1025, 2025, 2000, 3000, 3500, etc. With rigid transparent plastic cover. Special design enables above models to be used with cover in position. Also suitable for housing AT60 and SP25. OUR PRICE **£5·75** complete. P. & P. 50p.

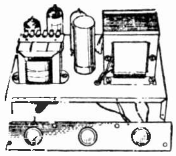
LATEST ACOS GP91/1SC Mono Compatible Cartridge with t/o stylus for LP/EP/78. Universal mounting bracket. **£1·50.** P. & P. 8p.

SONOTONE 9TAHC COMPATIBLE STEREO CARTRIDGE T/O stylus. Diamond Stereo LP and Sapphire 78. ONLY **£2·50.** P. & P. 10p. Also available fitted with twin Diamond T/O stylus for Stereo LP. **£3.** P. & P. 10p.

LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. **£1·63.** P. & P. 10p.

LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. **£1·50.** P. & P. 10p.

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 7½in w. × 4in. d. × 4½in. 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 **£4·75.** P. & P. 35p.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **£3·98.** P. & P. 40p.

HARVERSON'S SUPER MONO AMPLIFIER

A super quality gram amplifier using a double wound fully isolated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3·5 watts. Volume and tone controls. Chassis size only 7in. wide × 3in. deep × 6in. high overall. AC mains 200/240V. Supplied absolutely Brand New, completely wired and tested with good quality output transformer. FEW ONLY.

OUR ROCK BOTTOM BARGAIN PRICE - **£2·75** P. & P. 35p

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A must for servicemen and home constructors. 1971 edition including many 1000's of British, U.S.A., European and Japanese transistors. ONLY **40p.** Post 5p.

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Early closing Wed. 1 p.m.
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components show ....

tions in a d.i.l. encapsulation. It reduces the number of soldered connections considerably from up to about 280 so adding to time saving and reliability. This MOS-LSI device was developed by Integrated Photomatrix Ltd., of Dorchester for a digital panel meter for Evershed and Vignoles.

The behaviour of TTL and DTL in response to random noise spikes is known to cause quite a few headaches to troubleshooters. A new instrument will help by detecting spikes that an oscilloscope may miss. It is a pencil-size probe produced by Birch-Stolec of Hastings to indicate any operation (1 or 0) by means of a lamp.

FOR THE MOTORIST

Of particular interest to motorists is the flexible printed circuit aerial that can be fitted around the periphery of the rear window for a car radio. Screening problems are thus avoided and accessibility from outside vandalism is nil (provided doors and windows are locked). MB Metals of Portslade, Sussex, developed the aerial while engaged on producing complete printed circuit type harnesses for cars and aircraft.

While on the subject of cars, piezo-electric ignition is on the way. Although not yet available, advanced work by a Japanese company, Murata Manufacturing, expects to provide this off-shoot from its low cost ceramic ignition systems for lighters and gas cooker ignitors.

Crompton Parkinson have produced a "zinc-air" primary cell capable of up to eight times the output of conventional cells, and is smaller and lighter in weight. This is believed to be the first commercial one of its kind and should be a breakthrough for electric cars.

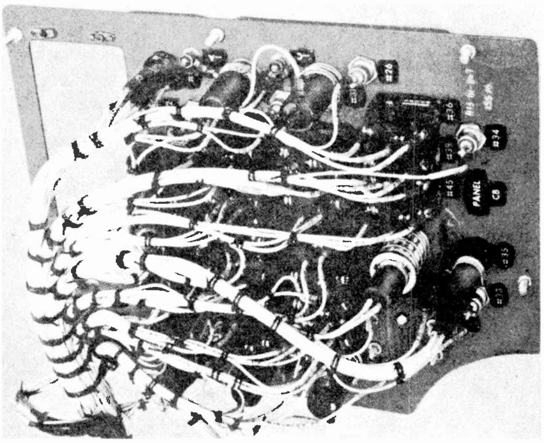
THYRISTOR SUPPRESSORS

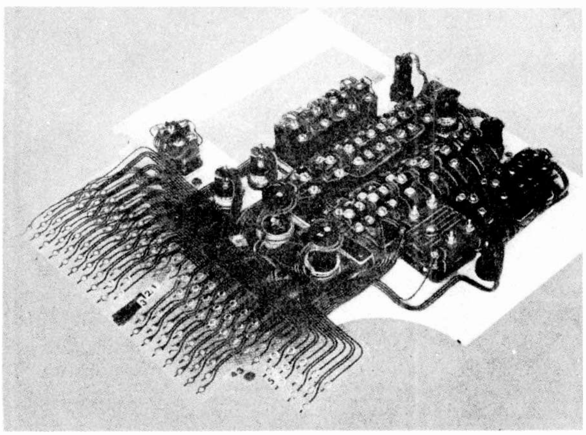
Demonstration of this new range of interference suppressors puts Birch-Stolec among the progressive British companies.

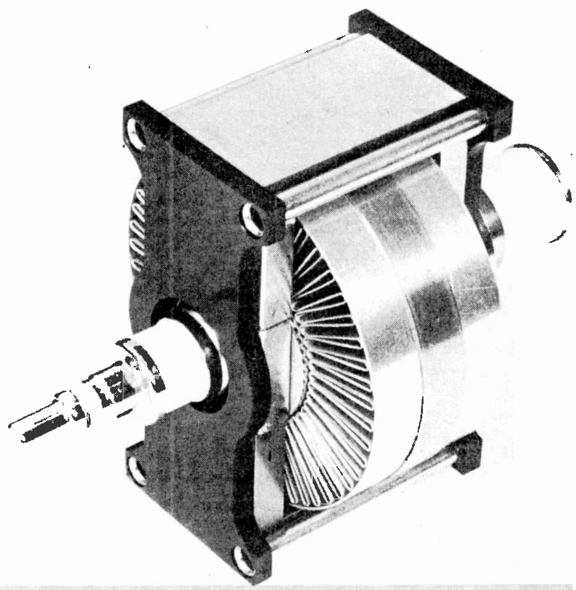
The suppressors have been designed to meet requirements of the latest technological developments covering thyristor and triac suppression and equipment used in computers, data logging instruments and communications. They combine three facilities—the elimination of discrete inductors and capacitors, the absorption of unwanted interference power and the use of suppressor rather than filter techniques.

Birch-Stolec have also set up a new printed circuit division for custom design of flat flexible cables and cards.

One might be forgiven for thinking that a physiological stimulator was intended as a "wakey-wakey" alarm, but it is intended to be a serious scientific instrument for medical research teams. It emits pulses in sequences, set up by the controls, either in continuous mode or in gated trains. The stimulator is expected to assist neurologists in particular, but can also be used in biological research of broader base. Farnell Instruments of Wetherby, Yorks, are responsible for this equipment.







Magnetron type YJ1371 developed by Mullard for use in microwave cookers (above)

MB Metals Ltd. are developing flexible printed wiring harnesses for cars and aircraft. This one (left) is for a helicopter and shows the wiring it replaces (top left)

A commercial development from experimental work at R.A.E. Farnborough is the high speed television camera and video tape recorder which provides an exposure time of 10^{-4} second while running at a picture rate of 100 per second. The result is that immediate playback either in slow motion or with stop action is obtained. The equipment is being manufactured by Aston Electronic Developments Ltd., Pirbright, Surrey.

DISCRETE COMPONENTS

For engineers and designers with appetites for small and simple switching solutions, N.S.F. of Keighley, Yorkshire, introduce the Ledex "sandwich stepper". This is a new 1-pole, 12-position stepping switch so-called because of its unusual rectangular design built on a layer of printed circuit board.

It comprises a 12-position circuit wafer together with a restoration or zero reset wafer control system. These, with a complete solenoid drive assembly are sandwiched between two printed circuit boards. The entire unit is only ½in thick.

Contact breaking current rating is 120mA at 120V a.c. and 500mA at 28V d.c. (resistive). Current carrying capacity is 2 amperes. The stepping speed (intermittent) is 60 per second.

Vitramon Europe displayed their established range of porcelain and ceramic dielectric capacitors. Among the new exhibits were miniature axial leaded ceramic capacitors 10pF to 100,000pF designed for computer application and an extended range of ceramic chip capacitors for hybrid microcircuit use.

An economical and robust magnetron for use in microwave cooking is the Mullard YJ1371 (see photograph). It requires a heater voltage only when starting and subsequently operates at the low anode voltage of 3·6kV, ensuring a long life and low operational cost.

Wire strippers are common place for p.v.c. covering, but these are hardly suitable for fine enamel coverings. Gardners Transformers Ltd., of Christchurch, Hampshire, have introduced an IGWES (Inert Gas Wire Enamel Stripper) for enamelled copper wires. The wire is heated in a nitrogen atmosphere to decompose the insulation. As the wire is withdrawn it is cooled by a nitrogen flow which prevents oxidisation.

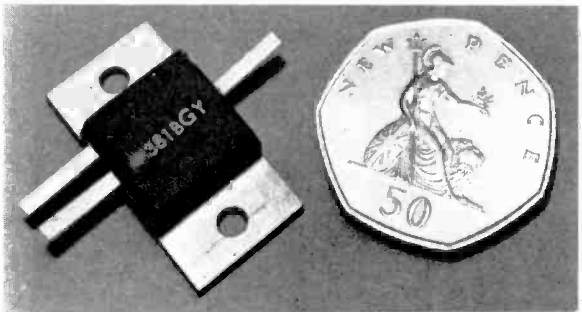
A novel innovation from A. F. Bulgin & Co. of Barking, is their fused crocodile clip CR50 which is designed to protect test meters against false operating conditions, faults, and shorts during fault finding procedures. It is available in clip or probe form.

STANDARD COMPONENT SPECIFICATIONS

The work of the British Standards Institution culminates in an enormous amount of paper work. So much so that one wonders how anyone can find anything. All due credit therefore to BSI for setting up the BS 9000 Scheme for Electronic Parts of Assessed Quality. It is not possible here to go into any detail on the scheme, but briefly the aim is to standardise on manufacturing and usage specifications for electronic components.

Specifications appropriate in the past to the Ministry of Defence, Post Office, and C.E.G.B. are being incorporated in the scheme, which will provide for a universal test procedure for quality control. Over 100 British manufacturers, test centres, and stockists have already applied for approval under the scheme.

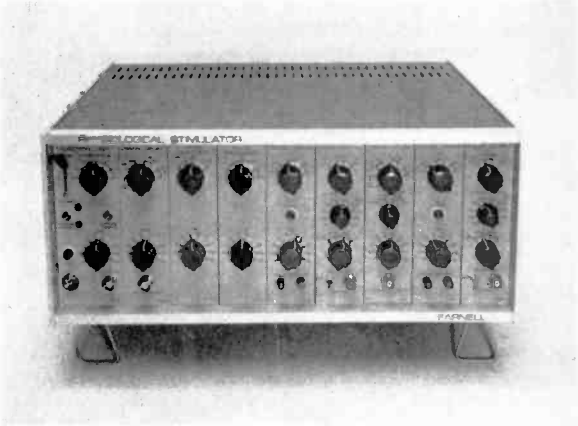
★

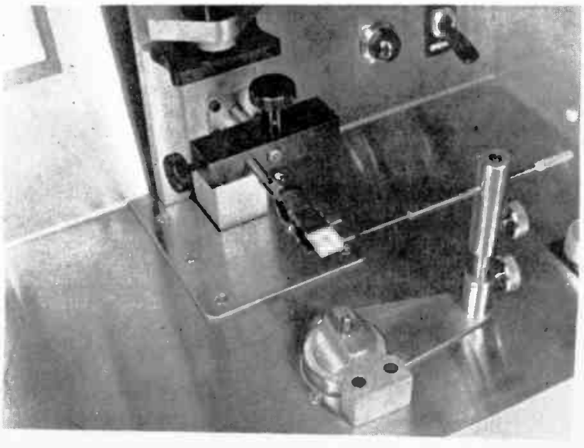


One of the new u.h.f. amplifier modules by Mullard compared with a 50 pence piece (above)

Physiological stimulator by Farnell Instruments (top right)

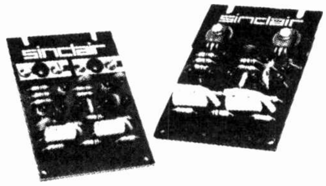
Supplementary Parts Kit (Ref. No. 1) for the Multicore Solderability test machine. This kit is used to determine solderability with short leads down to 1·2mm from the component body (right)





Sinclair Project 60

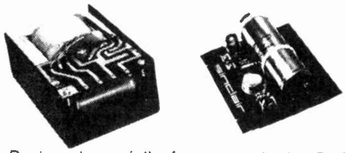
Z.30 & Z.50 power amplifiers



The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to achieve unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at full output and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and may be used with other units in the Project 60 range equally well.

SPECIFICATIONS ***(Z50 units are interchangeable with Z.30s in all applications).***
Power Outputs
Z.30 15 watts R.M.S. into 8 ohms using 35 volts: 20 watts R.M S. into 3 ohms using 30 volts.
Z.50 40 watts R.M S into 3 ohms using 40 volts; 30 watts R.M.S. into 8 ohms, using 50 volts.
Frequency response: 30 to 300 000 Hz ±1dB.
Distortion: 0.02% into 8 ohms.
Signal to noise ratio: better than 70dB unweighted.
Input sensitivity: 250mV into 100 Kohms.
For speakers from 3 to 15 ohms impedance.
Size $3\frac{1}{2}$ x $2\frac{1}{4}$ x $\frac{1}{2}$ in.
Z.30
Built tested and guaranteed with circuits and instructions manual **£4.48**
Z.50
Built, tested and guaranteed with circuits and instructions manual. **£5.48**

Power Supply Units

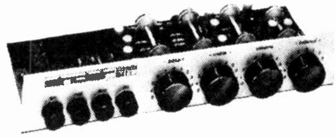


Designed specially for use with the Project 60 system of your choice.
Illustration shows PZ.5 to left and PZ.8 (for use with Z.50s) to the right. Use PZ.5 for normal Z.30 assemblies and PZ.6 where a stablised supply is essential.
PZ-5 *30 volts unstabilised* **£4.98**
PZ-6 *35 volts stabilised* **£7.98**
PZ-8 *45 volts stabilised (less mains transformer)* **£7.98**
PZ-8 *mains transformer* **£5.98**

Guarantee

If within 3 months of purchasing Project 60 modules directly from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work pe fectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter No charge for postage by surface mail. Air-mail charged at cost.

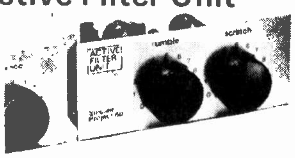
Stereo 60 pre-amp/control unit



Designed for the Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout, achieving a really high signal-to-noise ratio and excellent tracking between channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs.

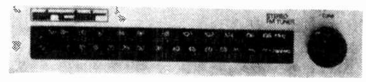
SPECIFICATIONS
Input sensitivities: Radio–up to 3mV. Mag. p.u. 3mV: correct to R.I.A.A. curve ± 1dB: 20 to 25,000 Hz. Ceramic p.u.–up to 3mV: Aux–up to 3mV.
Output: 250mV
Signal-to-noise ratio: better than 70dB.
Channel matching: within 1dB.
Tone controls: TREBLE + 15 to —15dB at 10KHz: BASS + 15 to—15dB at 100Hz.
Front panel: brushed aluminium with black knobs and controls.
Size: $8\frac{1}{4}$ x $1\frac{1}{2}$ x 4 ins.
Built, tested and guaranteed. **£9.98**

Active Filter Unit



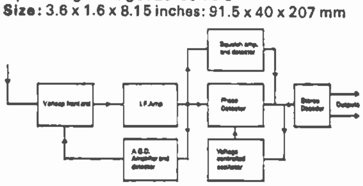
For use between Stereo 60 unit and two Z.30s or Z.50s, and is easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. Two stages of filtering are incorporated – rumble (high pass) and scratch (low pass). Supply voltage – 15 to 35V. Current – 3mA. H.F. cut-off (–3dB) variable from 28kHz to 5kHz. L.F cut-off (–3dB) variable from 25Hz to 100Hz. Distortion at 1kHz (35V. supply) 0.02% at rated output.
Built, tested and guaranteed **£5.98**

Stereo FM Tuner



first in the world to use the phase lock loop principle
Before production of this tuner, the phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio over other systems. Now, for the first time, the principle has been applied to an FM tuner with fantastically good results. Other original features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stereo decoder and squelch circuit for silent tuning between stations. Sensitivity is such that good reception becomes possible in difficult areas. Foreign stations can be tuned in suitable conditions and often a few inches of wire are enough for an aerial. In terms of a high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically as the tuning control is rotated, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with any other high fidelity system.

SPECIFICATIONS:
Number of transistors: 16 plus 20 in I.C.
Tuning range: 87.5 to 108 MHz
Capture ratio: 1.5dB
Sensitivity: 2μV for 30dB quieting: 7μV for full limiting.
Squelch level: 20μV.
A.F.C. range: ±200 KHz
Signal to noise ratio: >65dB
Audio frequency response: 10Hz—15KHz (±1dB)
Total harmonic distortion: 0.15% for 30% modulation
Stereo decoder operating level: 2μV
Pilot tone suppression: 30dB
Cross talk: 40dB
I.F. frequency: 10.7 MHz
Output voltage: 2 x 150mV R.M.S.
Aerial Impedance: 75 Ohms
Indicators: Mains on: Stereo on; tuning indicator
Operating voltage: 25-30 VDC
Size: 3.6 x 1.6 x 8.15 inches: 91.5 x 40 x 207 mm



Price: £25 built and tested. Post free

To: SINCLAIR RADIONICS LTD LONDON ROAD ST. IVES HUNTINGDONSHIRE PE17 4HJ

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SP25 Mk III SPECIAL!

Garrard SP25 Mk. III Single Record Player. Fitted Goldring G850 or AT66 Magnetic Stereo Cartridge as available Complete in Teak Plinth with Rigid Perspex Cover.

Total list Price over £29.

PREMIER PRICE £19·90

P. & P. 50p

TAPE CASSETTES

C60 (60 min.) 37p 3 for £1·05
C90 (90 min.) 62p 3 for £1·80
C120 (120 min.) 87p 3 for £2·55

P. & P. 5p

All cassettes can be supplied with library cases at 3p extra each.

PREMIER QUALITY MICROPHONES

Precision made, beautifully designed and offering reliability at a reasonable price.

FANON MK047 MINIATURE DYNAMIC
Frequency response 60·13,000Hz Impedance 50kΩ (−59dB). Can be used with stand, hand held or around neck. Die cast body satin chrome finish. Features removable windscreen. Complete with 8ft cable, stand adaptor and Lavalier cord.
PREMIER PRICE £5·97. P. & P. 20p.

FANON MK045 3-WAY DYNAMIC
Frequency response 60·12,000Hz. High impedance. Complete with 8ft cable, table stand and Lavalier cord.
PREMIER PRICE £2·87. P. & P. 20p.

FANON MKC54 DYNAMIC
Frequency response 60·12,000Hz. Impedance 50kΩ (−60dB) and 150 ohms (−71dB). On/off switch, Complete with 20ft cable and stand adaptor. **PREMIER PRICE £8·97.** P. & P. 20p.

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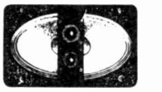

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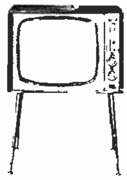

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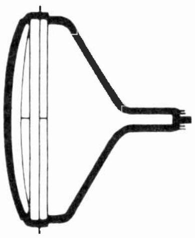

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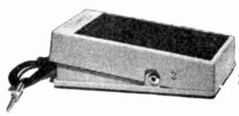

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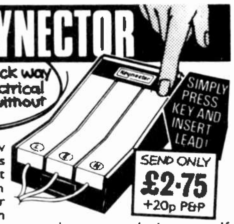

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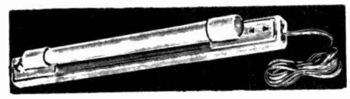

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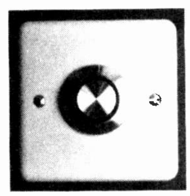

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DABAR
audio mixer modules

A range of audio Pre-amplifier Modules is now available enabling the construction of custom-built audio mixers for studio, P.A. and discotheque installations; at reasonable cost and with many facilities usually available only on expensive systems. The Modules, constructed on glass fibre printed-circuit boards, are complete with anodised aluminium black facia plates and four control knobs indentified: L.F., H.F., Echo Send and P.F.L. The modules are designed for use with external faders or volume controls and fulfil most requirements in the audio field. Up to ten input modules may be mixed into the combined Mixer/Line Amplifier Type MX/LNTA which is available on a matching facia plate with V.U. meter. The line amp will deliver +20dBM. All mixing may be effected with 10k log faders.

The modules are fixed with four screws and dimensions are 7¼in × 2¾in.

Input modules available:

- UM1 200–600 ohm MIC
- UM2 50k ohm MIC
- UM3 Mag P/U 1·5mV R.I.A.A.
- UM4 Mag P/U 5mV R.I.A.A.
- UM5 Crystal P/U 500mV
- UM6 High Level Tape/Tuner 500mV

Mixer/Line amp MX/LNTA: 10 inputs plus expander input; 600 ohm line out with preset for V.U. adjustment.

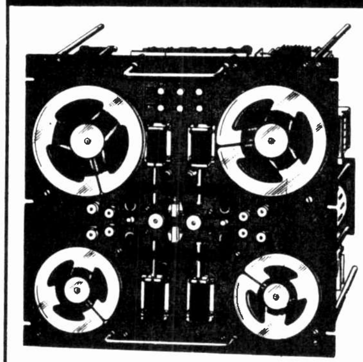
Power Unit for above Modules: Type PU11/30, 30V, 500mA. 100W slave amplifier—100W into 4 ohm load 13¾in × 10¼in × 7¼in.

Prices: UM1–6, **£9** each. MX/LNTA, **£12.** PU11/30, **£8.** 100W Slave Amp **£60.**

Manual showing mixing arrangements, connection data, etc., **25p.** S.A.E. all inquiries. Trade inquiries welcome.

DABAR ELECTRONIC PRODUCTS
98a LICHFIELD STREET
WALSALL, STAFFS WS1 1UZ
WALSALL 34365

UNIQUE TWIN TAPE DECK UNITS



OFFERED AT A FRACTION OF THEIR ORIGINAL COST

£35 EACH TESTED WORKING

(Few available requiring attention at £25 each)

Carriage £3·50 each, including wooden packing case, insurance, etc.

These superb twin tape deck units were originally designed for installations requiring the continuous replay of music or speech when connected to suitable amplifiers and cost approx. **£450** each to manufacture. Consisting of two completely self-contained tape decks operating at either 3¾in (3 button ½ track model) or 7½in (6 button ¼ track model). Each tape drive unit is fitted with a unique automatic solenoid operated tape drive reversal mechanism actuated by metallic stop foil at end of tape or inserted where reversal is desired. Constructed to the highest specification with the finest components available to ensure the utmost reliability. Nothing has been spared in the construction and the superb heavy duty capstan motors (2 off) and rewind motors (4 off), top grade relays, solenoids, etc., all bear witness to the high standards set.

Available in two basic versions with either 3 or 6 button operation. The three pushbutton model 3¾ i.p.s. has interlocked controls operating both tape drive units simultaneously and is fitted with 2 Ferrograph ½ track stereo heads. The 6 button 7½ i.p.s. model has independent control over each tape drive unit and is fitted with 2 Marriott ¼ track stereo heads. A.c. 230/250V. 50c/s. Vertical or horizontal operation. Size 19in × 19in × 8in deep. Weight 54lb.

TECHNICAL SPECIFICATION

Power requirements 230/250V a.c. 50c/s. Vertical or horizontal operation. Overall dimensions: 19in × 19in × 8in deep. Weight 54lb. 3 button model operates at 3¾ i.p.s. 6 button model operates at 7½ i.p.s. **TAPE REEL SIZES:** Upper deck 5¾in. Lower deck 5in. Capstan drive motors: 2 AEI a.c. motors continuous rating Type BC1504-B. 230/250V a.c. 50c/s 1/75th h.p. 1,500 r.p.m. **REWIND AND TAPE UP MOTORS:** 4 Garrard a.c. motors continuous rating Type DHP5C 100–130/200–250V. 50/60c/s 0·3A–0·15A 24W. **RELAY SUPPLY TRANSFORMER:** Primary 210–230–240V a.c. 50c/s. Secondary 24–26–32V. **RECTIFIER.** Sentercel selenium rectifier type 460 SC 21B1 5. **CONDENSERS:** 1 Plessey 2,000uf 50V d.c. 2 AEI 2uf 400V. **SOLENOIDS:** 8 Magnetic Devices Ltd Type. 42766 120 ohms. **RELAYS:** 2 Double coil relays type 593E11/TS 5668 590 ohms. 2 Type 569E14/590/AEF2/24. 2 Type 596/E9/890/G2/24. 2 Type 596E8/590/E2/24 (3 button unit unly 1). **RECORD/REPLAY HEADS.** 3 button unit fitted 2 Ferrograph 350 ohms impedance half track stereo heads. 6 button model fitted 2 Marriott 4 track heads 500 ohms impedance.

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