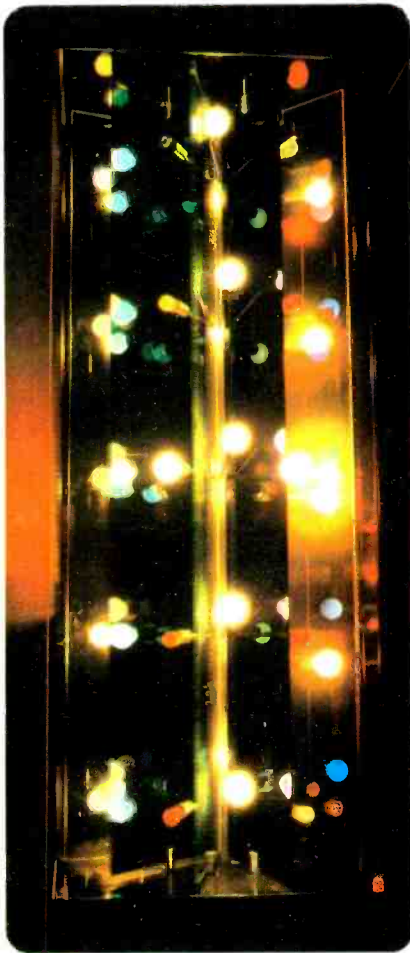


PRACTICAL

# ELECTRONICS

JULY 1971

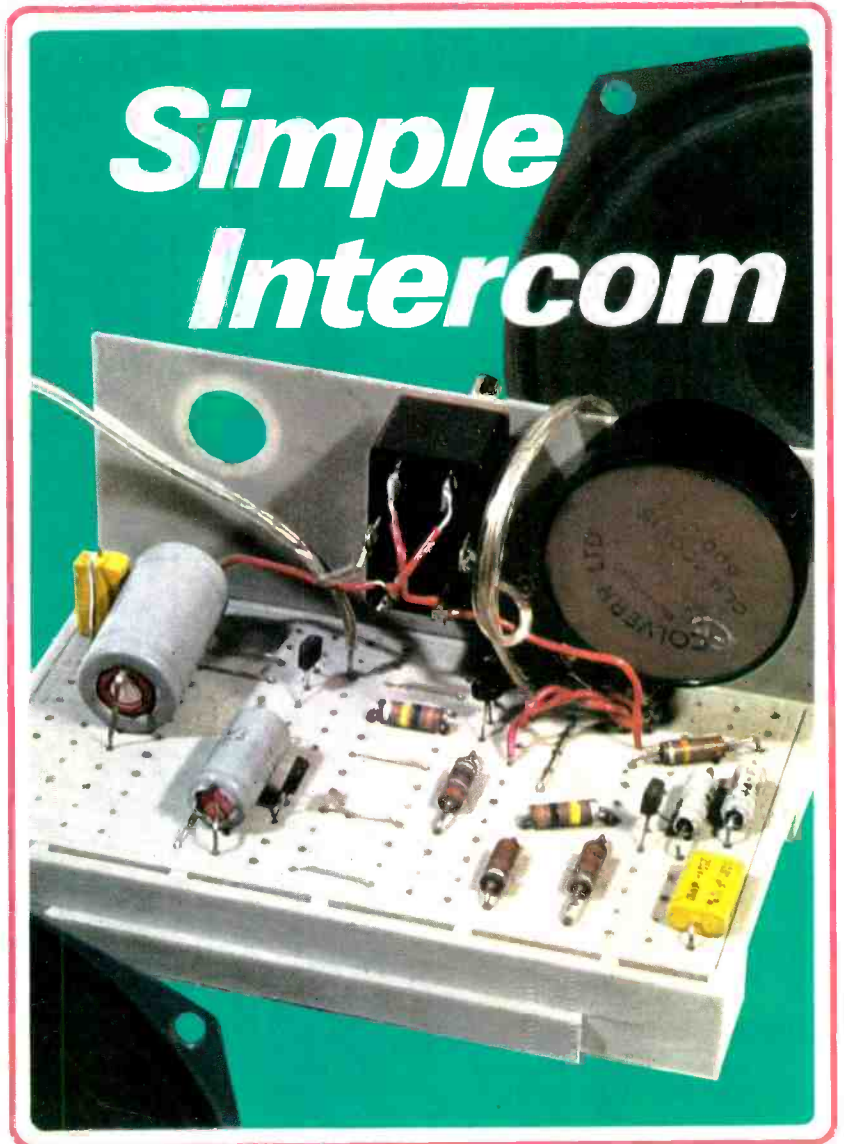
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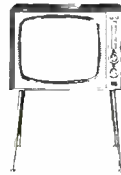
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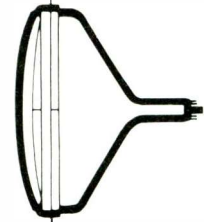
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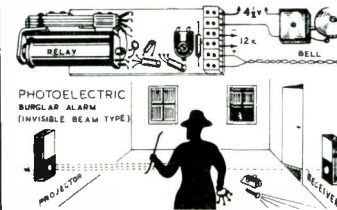
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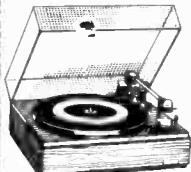
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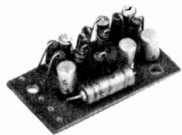
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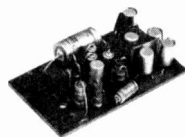


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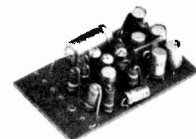


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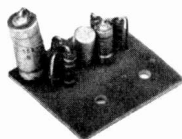


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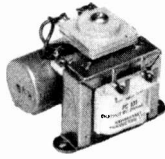
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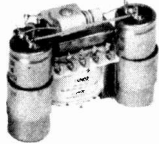
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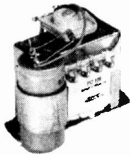
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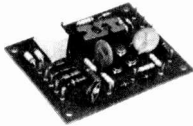
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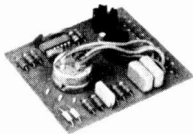
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1/4	10%	3.3MΩ-10MΩ	E12	1.0p	0.8p
1/4	10%	1Ω-3.9Ω	E12	1.0p	0.8p
1/4	5%	4.7Ω-1MΩ	E12	1.0p	0.8p
4	10%	1Ω-10Ω	E12	7 1/2p	7 1/2p

Quantity price applies for any selection. Ignore fractions on total order.

**DEVELOPMENT PACK**

0.5 watt 5% Iskra resistors 5 off each value 4.7Ω to 1MΩ.  
E12 pack 325 resistors £2.50.  
E24 pack 650 resistors £4.80.

**MULLARD POLYESTER CAPACITORS C296 SERIES**

400V: 0.001μF, 0.0015μF, 0.0022μF, 0.0033μF, 0.0047μF, 2 1/2p, 0.0068μF, 0.01μF, 0.015μF, 0.022μF, 0.033μF, 3p, 0.047μF, 0.068μF, 0.1μF, 4p, 0.15μF, 6p, 0.22μF, 7 1/2p, 0.33μF, 11p, 0.47μF, 13p, 0.68μF, 15p, 0.1μF, 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, 7 1/2p, 0.68μF, 11p, 1.0μF, 12 1/2p.

**MULLARD POLYESTER CAPACITORS C280 SERIES**

250V P.C. mounting: 0.01μF, 0.015μF, 0.022μF, 3p, 0.033μF, 0.047μF, 0.068μF, 3 1/2p, 0.1μF, 4p, 0.15μF, 0.22μF, 5p, 0.33μF, 6 1/2p, 0.47μF, 8p, 0.68μF, 11p, 1.0μF, 13p.

**MYLAR FILM CAPACITORS**

100V: 0.001μF, 0.002μF, 0.005μF, 0.01μF, 0.02μF, 2 1/2p, 0.04μF, 0.05μF, 0.068μF, 0.1μF, 3 1/2p.

**CERAMIC DISC CAPACITORS**

100pF to 10,000pF, 2p each.

**CAPACITOR DEVELOPMENT PACK**

Selection of 100 ceramic and polyester capacitors, 100pF to 1.0μF, £2.90.

**ELECTROLYTIC CAPACITORS—One Price—5p Each**

Mullard C426 series (μF/V): 25/6.4, 50/6.4, 100/6.4, 200/6.4, 320/6.4, 16/10, 32/10, 64/10, 125/10, 200/10, 10/16, 20/16, 40/16, 80/16, 125/16, 6.4/25, 12.5/25, 25/25, 50/25, 80/25, 4/40, 8/40, 16/40, 32/40, 50/40, 2.5/64, 5/64, 10/64, 32/64.  
Miniature P.C. mounting (μF/V): 10/12, 50/12, 100/12, 200/12, 5/25, 10/25, 25/25, 100/25.

**POTENTIOMETERS**

Carbon track 5kΩ to 1MΩ, log or linear (log 1/4W, lin 1/2W). Single, 12p. Dual gang (stereo), 40p.

**SKELETON PRESET POTENTIOMETERS**

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.

**SEMICONDUCTORS**

AC126 15p	BFY52 22p	OC81 15p	2N3055 72p
AC127 15p	BSY56 30p	OC82 15p	2N3702 15p
AC128 15p	BSX21 25p	ORP12 47 1/2p	2N3703 14p
AD140 40p	BY124 7 1/2p	IN4001 7 1/2p	2N3704 17 1/2p
AF115 17 1/2p	BYZ10 30p	IN4002 10p	2N3705 15p
AF117 17 1/2p	BYZ13 20p	IN4003 11p	2N3706 12p
BC107 14p	OA95 7 1/2p	IN4004 12 1/2p	2N3707 18 1/2p
BC108 10p	OA91 7 1/2p	IN4005 14p	2N3708 10p
BC109 10p	OA202 7 1/2p	IN4006 15p	2N3709 11p
BFY50 22p	OC71 15p	IN4007 16p	2N3710 12p
BFY51 19p	OC72 15p	2N2926 11p	2N3711 14p

**ZENER DIODES**

400mW 5% 3-3V to 30V, 17p.

**VEROBOARD**

2 1/2 x 3 1/2	0.1	0.15	17 x 3 1/2 (plain)	0.15	0.1
2 1/2 x 5	22p	16p	17 x 2 1/2 (plain)	52 1/2p	—
3 1/2 x 3 1/2	24p	24p	2 1/2 x 5 (plain)	37 1/2p	—
3 1/2 x 5	24p	24p	2 1/2 x 3 1/2 (plain)	17 1/2p	—
3 1/2 x 5	27p	27p	Pin insertion tool	47 1/2p	47 1/2p
17 x 2 1/2	75p	57 1/2p	Spot face cutter	37 1/2p	37 1/2p
17 x 3 1/2	100p	75p	Pkt. 50 pins	20p	20p
17 x 5 (plain)	—	75p			

**ROTARY SWITCHES**

2P2W, 1P12W, 2P6W, 3P4W, 4P3W, 22 1/2p.

**PLUGS AND SOCKETS**

Standard 1/4in screened	17 1/2p	2.5mm insulated	7 1/2p
Standard 1/4in insulated	14p	3.5mm insulated	7 1/2p
Stereo 1/4in screened	35p	3.5mm screened	12 1/2p
Standard 1/4in socket	15p	2.5mm socket	7 1/2p
Stereo 1/4in socket	17 1/2p	3.5mm socket	7 1/2p

**BRUSHED ALUMINIUM PANELS**

12" x 6" = 25p; 12" x 2 1/2" = 10p; 9" x 2" = 7p.

C.W.O. please. Post and packing, please add 10p to orders under £2. Data sheets are available for most of the components listed, and will be sent free on request.

BE39 ELSTOW STORAGE DEPOT, KEMPSTON HARDWICK, BEDFORD

## TRANSISTORISED TWO-WAY TELEPHONE INTERCOM

Operative over amazingly long distances. Separate call and press to talk buttons. 2-wire connection. 1000's of applications. Beautifully finished in ebony. Stated complete with batteries and wall brackets. **£6 97½. P. & P. 17½p.**



### TE15

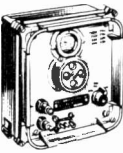
## TRANSISTORISED GRID DIP METERS

Six ranges. 440 Kc/s.-280 Mc/s. Operates on 9V battery. Full instructions **£12-50. P. & P. 17½p.**



## CRYSTAL CALIBRATORS No. 10

Small portable crystal controlled wavemeter. Size 7" x 7" x 4". Frequency range 500 Kc/s. to 10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300 V.D.C. 15mA and 12 V.D.C. 0.3A. Excellent condition. **£3-47½. Carr. 37½p.**



## B.C. 221 FREQUENCY METERS

latest release 125kHz to 20MHz. Excellent condition. Fully tested and checked and complete with calibrator charts. **£27-50 each. Carr. 50p.**

## AM/FM SIGNAL GENERATORS

Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airmeq. Frequency coverage 20-80Mc/s. AM C.W./FM. Incorporates precision dial, level meter, precision attenuator 1µV-100mV. Operation from 12V d.c. or 0/110/200/230V a.c. Size 12" x 8" x 9". Supplied in bracket, new condition complete with all connectors fully tested. **£45. Carr. £1.**

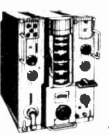


## AVO CT.38 ELECTRONIC MULTIMETERS

High quality 97 range instrument which measures a.c. and d.c. Voltage, Current, Resistance and Power output. Ranges d.c. volts 250mV-10,000V (10 megΩ-110 megΩ input). D.c. current 10µA-25A. Ohms 0-1,000 megΩ a.c. volt 100mV-250V (with R.F. measuring head up to 250MHz) a.c. current 10µA-25A. Power output 50 micro-watts-5 watts. Operation 0/110/200/250V a.c. Supplied in perfect condition complete with circuit lead and R.F. probe. **£25. Carr. 75p.**

## ADMIRALTY 62B RECEIVERS

High quality 10 valve receiver manufactured by Muller. Coverage in 5 bands 150-300 Kc/s; 560 Kc/s-1.5 Mc/s; 3.9-30.5 Kc/s. I.F. 500/KHz. Incorporates R.F. and 3 I.F. stages, bandpass filter, noise limiter, crystal controlled B.F.O. calibrator. I.F. output, etc. Built-in speaker, output for phones. Operation 150/230V a.c. Size 19" x 13" x 16in. Weight 114lb. Offered in good working condition. **£22-50. Carr. £1-50.** With circuit diagrams. Also available B41 L.F. version of above. 15KHz-700Hz. **£17-50. Carr. £1-50.**



## TO-2 PORTABLE OSCILLOSCOPE

A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CPM-1 MHz. Input imp. 2 megΩ 25 P.F. Illuminated scale. 2in. tube. 115 180 250mm. Weight 8lb. 220/240 V a.c. Synchronization. Internally brand new with handbook. **£22-50. Carr. 50p.**



## TO-3 PORTABLE OSCILLOSCOPE

3in tube. Y amp. Sensitivity 0.1V p-p/CM. Bandwidth 1.5 cps-1.5MHz. Input imp. 2 megΩ 35P F X amp. sensitivity 0.9V p-p/CM. Bandwidth 1-5cps -800KHz. Input imp. 2 megΩ 20pF. Time base. 5 ranges 10 cps-300KHz. Synchronization. Internally brand new with handbook. **£27-50. Carr. 50p.**



# SEW PANEL METERS

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES, ETC. ● LOW COST ● QUICK DELIVERY ● OVER 200 RANGES IN STOCK ● OTHER RANGES TO ORDER

## NEW "SEW" DESIGNS! CLEAR PLASTIC METERS. BAKELITE PANEL METERS

TYPE SW. 100 100 x 80 mm		TYPE S-80 80 mm square fronts	
50µA	£3-47	50µA	£3-12
50-0-50µA	£3-37	100-0-100µA	£2-87
100µA	£3-37	500µA	£2-87
100-0-100µA	£2-25	1mA	£2-47
		5mA d.c.	£2-47
		10mA	£2-47
		50V d.c.	£2-47
		300V d.c.	£2-47
		VU Meter	£2-75

## "SEW" CLEAR PLASTIC METERS

Type MR.85P. 4in 4in fronts.		Type MR.85F. 1 21/32in square fronts.	
50µA	£3-60	50µA	£2-00
50-0-50µA	£2-60	100µA	£1-87
100µA	£3-10	100-0-100µA	£1-75
100-0-100µA	£2-75	500µA	£1-37
200µA	£2-75	1mA	£1-37
500µA	£2-60	5mA d.c.	£1-37
1mA	£2-60	10mA	£1-37
1-0-1mA	£2-60	20mA	£1-37
5mA	£2-60	50mA	£1-37
10mA	£2-60	100mA	£1-37

Type MR.52P. 2in square fronts.		Type MR.45P. 2in square fronts.	
50µA	£3-10	50µA	£2-25
50-0-50µA	£2-60	100µA	£2-10
100µA	£2-60	100-0-100µA	£1-87
100-0-100µA	£2-37	500µA	£1-60
500µA	£2-25	1mA	£1-50
1mA	£2-00	5mA	£1-50
5mA	£2-00	10mA	£1-50
10mA	£2-00	20mA	£1-50
50µA	£2-37	50µA	£2-10
50-0-50µA	£2-37	100µA	£2-10
100µA	£2-37	100-0-100µA	£1-87
100-0-100µA	£2-37	500µA	£1-60
500µA	£2-25	1mA	£1-50
1mA	£2-00	5mA	£1-50
5mA	£2-00	10mA	£1-50
10V d.c.	£2-00	20A a.c.*	£2-00

## "SEW" BAKELITE PANEL METERS

Type MR.85 3in square fronts.	
50µA	£2-75
100µA	£2-75
500µA	£2-75
1mA	£2-75
5mA	£2-75
10mA	£2-75
50V d.c.	£2-75
10V d.c.	£2-10

## \* MOVING IRON — ALL OTHERS MOVING COIL Please add postage

## "SEW" EDUCATIONAL METERS

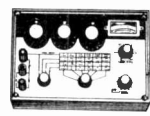
A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The easily accessible to demonstrate internal working. Available in the following ranges:

50µA	£4-50	20V d.c.	£3-97
100µA	£4-25	50V d.c.	£3-97
1mA	£3-97	300V d.c.	£3-97
5A d.c.	£4-25		
1-0-1mA	£3-97	Dual range	
1A d.c.	£3-97	500mA/5A d.c.	£4-25
5A d.c.	£3-97	5V/50V d.c.	£4-25
10V d.c.	£3-97		

## MARCONI TF148E DISTORTION FACTOR METERS. Excellent condition. Fully tested. £20. Carr. 75p.

## TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE

A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω-11.1 megΩ. C. Ranges ±1% ±1.1µH - ±1.1 HENRY'S. G. Ranges -2% C. 10pF ±1110mF d. 6. Turns Ratio 1:1/1000-1:1100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100µA. Meter indication. Attractive 2 tone metal case. Size 7½ x 5 x 2in. **£20. P. & P. 25p.**



## COSSOR 1049 DOUBLE BEAM OSCILLOSCOPE. D.c. coupled. Band width 1kc/s. Perfect order. £25. Carr. £1.50.

TE-16A Transistorised Signal Generator. 5 ranges 400 kHz-50 MHz. An inexpensive instrument for the handyman. Operates on 9V battery. Wide, easy to read scale. 800 kHz modulation. 51 x 51 x 31½. Complete with instructions and leads. **£7-97½. P. & P. 20p.**



## LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

Frequency 0.20 Kc/s on 2 ranges. Output 500D of 5kD. Operation 200/250V. A.C. Supplied in perfect order. **£12-50. Carr. 50p.**

## MARCONI TF885 VIDEO OSCILLATORS. 0-5MHz. Sine Square Wave. £45. Carr. £1.

## LAFAYETTE TE48 RESISTANCE CAPACITY ANALYSER

2pF-2,000 mfd 2 ohms-250 megohms. Also checks impedance, turns ratio, insulation, 200/250V a.c. Brand New **£17-50. Carr. 37½p.**



## CLASS D WAVEMETERS

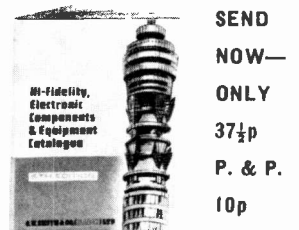
A crystal controlled heterodyne frequency meter covering 1.7-8 Mc/s. Operation on 6V d.c. Ideal for amateur use. Available in good used condition. **£5-97½. Carr. 37½p.** or brand new. **£7-97½. Carr. 37½p.**



## MARCONI TF195M BEAT FREQUENCY OSCILLATORS. 0-40KHz. £20. Carr. £1.50.

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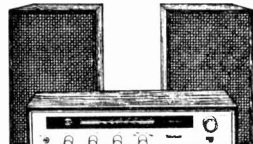
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Carriage 50p extra each item.  
TEAK PLINTHS AND PERSPEX COVERS  
1. For SP25, SL65, SL95, 3000, 2025T/C, 2035, 1000, £3-97  
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Carriage 37 1/2 extra each type.

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CR10T AM/FM STEREO TUNER AMPLIFIER WITH MATCHING PAIR SA1003 SPEAKER SYSTEMS  
Output 4 watts per channel. Excellent reception AFC, built-in MPX. Cer/XTAL input. Total List £50-25. OUR PRICE £29-95. Carr. 62 1/2p.  
Also available with Garrard 2025T/C Record Changer, Plinth cover and stereo cartridge. Ready wired. £48. Carr. £1.

## SPECIAL OFFERS!

Garrard SP25/III fitted Goldring G800 cartridge and wooden plinth and plastic cover. Ready wired. Total list price £35. OUR PRICE £29-95. Carr. 50p.  
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Carr. 37 1/2p extra each item  
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## TAPE CASSETTES

Top quality in plastic library boxes.  
C60 60 min £4 1/3 for £1-22  
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Cassette Head Cleaner 65p. All Post extra.

## ECHO HS-606 STEREO HEADPHONES



Wonderfully comfortable. Light-weight adjustable vinyl headband. 6ft. cable and stereo jack plug. 25-17,000 cps. 8 ohm imp. £3-87 1/2. P. & P. 12 1/2p.

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Project 60. Package offers. 2 x Z30 amplifier, stereo 60 pre-amp, P25 power supply, £18-75. Carr. 37 1/2p. Or with P26 power supply, £18-85. Carr. 37 1/2p. 2 x Z60 amplifier, stereo 60 pre-amp, P28 power supply, £20-25. Carr. 37 1/2p. Transformer for P28, £22-97 1/2 extra. Add to any of the above £4-87 1/2 for active filter unit and £16 for a pair of Q16 speakers. Project 60 FM Tuner £20-97 1/2. Carr. 37 1/2p.  
All other Sinclair products in stock. 2,000 Transformer for P28, £1-25. Carr. 37 1/2p. Neotec amplifier £45-97 1/2. Carr. 37 1/2p.

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Each headphone contains a 2 1/2in woofer and a 1in tweeter. Built in individual level controls. 8 1/2 imp. 25-18,000/cps. with cable and stereo plug. £5-97 1/2. P. & P. 12 1/2p.

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First grade quality American tapes. Brand new. Discounted on quantities.  
3in. 25ft. L.P. acetate ..... 17 1/2p  
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5in. 1,200ft. D.P. mylar ..... 75p  
5in. 1,200ft. L.P. acetate ..... 62 1/2p  
5in. 1,200ft. L.P. mylar ..... 62 1/2p  
5in. 1,800ft. D.P. mylar ..... £1-21 1/2  
5in. 2,400ft. L.P. mylar ..... £1-97 1/2  
7in. 1,200ft. std. acetate ..... 62 1/2p  
7in. 1,800ft. L.P. acetate ..... £2-31 1/2  
7in. 1,800ft. D.P. mylar ..... £1-25  
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IN4002	8p	AC189	80p	BY126	15p	0Z4	30p	25Z6	65p	EM81	50p
IN4003	10p	ACY18	25p	BY127	20p	1L4	20p	30C15	20p	EM84	35p
IN4004	10p	ACY19	25p	BYZ10	40p	1R5	35p	30C17	35p	EM85	41
IN4005	18p	ACY20	35p	BYZ11	35p	1B5	25p	30C18	75p	EM87	42p
IN4006	16p	ACY21	35p	BYZ12	30p	1T4	25p	30F5	85p	EY51	40p
IN4007	20p	ACY22	17p	BYZ13	25p	1U4	27p	30FL1	70p	EY86	40p
IN4146	7p	ACY28	17p	ML480	97p	1U6	40p	30FL12	92p	EY87	45p
IN6054	35p	ACY40	16p	MJ481	£1-25	20Z1	35p	30FL14	75p	EZ40	45p
2G301	20p	AD140	50p	MFF102	42p	3Q4	35p	30L15	55p	EZ41	45p
2G302	25p	AD149	50p	MFF103	35p	3B4	35p	30L17	80p	EZ80	25p
2G303	25p	AD161	37p	MFF104	37p	3V4	45p	30P12	80p	EZ81	25p
2G306	20p	AD162	37p	MFF105	40p	5R4	60p	30P19	90p	EZ82	25p
2G308	30p	AF114	35p	NKT213	25p	1U4	25p	30A11	70p	EZ84	60p
2G309	30p	AF121	25p	NKT214	15p	5V4	42p	30PL13	92p	KT96	£1-70
2G371	25p	AF116	25p	NKT216	37p	5Y3	32p	30PL14	90p	KT88	£1-75
2G374	27p	AF117	25p	NKT217	40p	5Z4G	40p	35L6	90p	MU14	60p
2G381	25p	AF118	62p	NKT224	22p	6J30L2	75p	35W4	30p	PABC80	60p
2N696	17p	AF119	20p	NKT241	27p	6AC7	35p	35Z4	30p	PC86	60p
2N697	17p	AF124	20p	NKT261	20p	6AG7	40p	50Z5	40p	PC88	60p
2N698	45p	AF126	17p	NKT272	25p	6AK5	30p	50C25	45p	PC97	45p
2N706	10p	AF130	20p	NKT274	20p	6AL5	20p	50C35	45p	PC90	45p
2N706A	15p	AF139	47p	NKT275	25p	6AM6	35p	85A2	40p	PC84	40p
2N708	15p	AF178	47p	NKT276	25p	6AQ5	35p	807	50p	PC85	40p
2N914	22p	AF180	52p	NKT278	25p	6A85	35p	807	50p	PC88	55p
2N916	22p	AF181	42p	NKT281	27p	6A86	37p	1825	50p	PC89	55p
2N918	37p	AF186	40p	NKT403	77p	6AT6	30p	5763	70p	PC189	60p
2N949	22p	AF239	42p	NKT404	75p	6AV6	30p	5767	70p	PC82	60p
2N950	22p	AF240	42p	NKT407	75p	6AV6	30p	5767	70p	PC82	60p
2N1131	30p	ASY27	32p	NKT773	25p	6BA6	25p	CY31	35p	PCF84	50p
2N1132	30p	ASY28	28p	NKT10439	37p	6BE6	25p	DAF91	25p	PCF86	60p
2N1302	20p	AZ821	20p	6BH6	45p	DAF96	45p	DAF96	45p	PCF80	80p
2N1303	22p	AYU10	97p	0A10	25p	6B76	45p	DAF96	45p	PCF80	80p
2N1304	22p	BAY31	7p	0C7A	10p	6C7A	10p	DAF96	45p	PCF80	80p
2N1305	22p	BAY37	10p	0A70	10p	6BR7	85p	DK91	35p	PCF80	75p
2N1306	22p	BC108	10p	0A79	10p	6BR8	85p	DK92	50p	PCF80	75p
2N1307	22p	BC109	10p	0A81	10p	6BW6	85p	DK96	42p	PCF80	75p
2N1308	22p	BC113	10p	0A85	10p	6BW7	70p	DL92	35p	PC87	60p
2N1309	22p	BC116	10p	0A90	10p	6BZ6	85p	DL94	42p	PC83	60p
2N1813	22p	BC126	55p	0A91	7p	6C4	35p	DL96	42p	PC84	45p
2N1711	22p	BC126	55p	0A95	7p	6CD6	£1-15	DL70	35p	PC85	40p
2N1889	22p	BC147	17p	0A200	7p	6CL6	50p	YV88	35p	PC86	45p
2N1893	50p	BC148	12p	0A202	10p	6CW4	63p	Y87	35p	PFL200	70p
2N2147	60p	BC149	20p	0A210	17p	6F1	62p	E88CC	65p	PL36	55p
2N2160	60p	BC167	15p	0C19	37p	6FG6	30p	E180F	35p	PL81	50p
2N2193	47p	BC172	17p	0C29	37p	6F13	38p	EABC80	35p	PL82	45p
2N2217	47p	BC177	25p	0C29	37p	6F13	38p	EAF42	35p	PL83	45p
2N2218	30p	BC182L	10p	0C23	60p	6F15	65p	E891	20p	PL84	40p
2N2219	32p	BC184L	12p	0C24	60p	6F18	46p	EBC41	55p	PL500	75p
2N2368	17p	BC186	25p	0C25	37p	6F23	80p	EBC81	30p	PL504	80p
2N2369	20p	BC212L	12p	0C26	25p	6H6	20p	E8F80	40p	PY32	65p
2N2369A	20p	BCY30	22p	0C28	62p	6J4	50p	E8F83	40p	PY33	65p
2N2484	36p	BCY31	30p	0C29	65p	6J5	20p	E8F89	32p	PY40	50p
2N2613	36p	BCY32	30p	0C35	65p	6J5GT	20p	E8F91	30p	PY81	30p
2N2646	36p	BCY33	30p	0C36	62p	6J6	20p	E8C86	60p	PY82	30p
2N2904	30p	BCY34	30p	0C41	25p	6J7	45p	E8C88	60p	PY83	35p
2N2923	17p	BCY38	40p	0C42	30p	6K8G	30p	E8C40	60p	PY88	35p
2N2924	17p	BCY42	15p	0C44	17p	6L6GT	45p	E8C84	30p	PY80	50p
2N2925	17p	BCY43	20p	0C45	15p	6L9D20	40p	E8C86	60p	PY801	50p
2N2926	15p	BCY71	10p	0C29	37p	6C4	35p	E8C86	40p	U26	75p
2N2927	15p	BCY72	10p	0C70	12p	68A7	15p	E8C88	35p	U26	75p
2N2928	15p	BCZ11	40p	0C71	15p	68G7	35p	E8C82	35p	U60	32p
2N3053	65p	BD121	65p	0C72	25p	68J7	40p	E8C86	65p	U92	35p
2N3054	60p	BD123	60p	0C73	30p	68K7	30p	E8C81	57p	U191	75p
2N3055	75p	BD124	60p	0C74	30p	68L7	35p	E8C35	60p	U201	40p
2N3391A	30p	BF115	25p	0C75	25p	68N7	35p	E8C42	70p	U282	40p
2N3416	37p	BF117	40p	0C76	25p	68Q7	40p	E8C81	50p	U801	40p
2N3570	£1-10	BF118	30p	0C77	40p	68Q7	40p	E8C83	40p	U801	£1
2N3702	15p	BF173	30p	0C78	20p	6V6G	20p	E8C80	40p	UABC80	35p
2N3703	15p	BF180	37p	0C81	25p	6V6GT	35p	E8C82	35p	UAF42	55p
2N3704	17p	BF181	37p	0C81D	30p	6X4	30p	E8C83			



## RUSSIAN C1-16 DOUBLE BEAM OSCILLOSCOPES

5MHz Pass Band, Separate Y1, Y2 amplifiers. Calibrated triggered sweep from 0.2µsec to 100msec/cm. Supplied complete with all accessories and instructions. \$87. Carr. paid.



**MARCONI CT44/TF956 AF ABSORPTION WATTMETER**

1 µwatt to 6 watts.  
\$20. Carr. £1.

**TELLI DECADE RESISTANCE ATTENUATOR**

Variable range 0-11dB. Connections. Up balanced T and Bridge T. Impedance 600Ω range (0+1dB × 10) + (1dB × 10) + 10 + 20 + 30 + 40dB. Frequency: 0 d.c. to 200KHz (-3dB). Accuracy: 0.001dB. ±indication 4dB × 0.01. Maximum input less than 4W (50V). Built in 600Ω load resistance with internal/external switch. Brand new \$27.50. P. & P. 25p.



**BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR**



Attractive two-tone case 7 1/2" × 6 1/2" × 2 1/2". Price \$17.50. Carr. 17p.

**BELCO DA-20 SOLID STATE DECADE AUDIO OSCILLATOR**

New high quality portable instrument. Sine 1Hz to 100KHz. Square 20Hz to 20KHz. Output max. +10dB (10KHz). Operation internal batteries. Size 215mm × 160mm × 120mm. Price \$27.50. Carr. 25p.

**T.E.40 HIGH SENSITIVITY A.C. VOLT METER**

10 meg. input 10 ranges: 0.1 / 0.03 / 1 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s. 1.25c/s. Decibels -40 to +40dB. Supplied brand new complete with leads and instructions. Operation 230V a.c. £17.50. Carr. 25p.



**TE-65 VALVE VOLT METER**

High quality instrument with 28 ranges. D.c. volts 1.5-1,000V. A.c. volts 1.5-1,000V. Resistance up to 1,000 megohms, 220/240V a.c. operation. Complete with probe and instructions. \$17.50. P. & P. 30p. Additional probes available: R.F. £2.12 1/2. H.V. £2.50.

**230 VOLT A.C. 50 CYCLES RELAYS**

Brand New. 3 sets of changeover contacts at 5 amp rating, 50p each. P. & P. 10p (100 lots £40). Quantities available.

**POWER RHEOSTATS**

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range ex-stock Single hole fixing, 1/2 in. dia. shafts. Bulk quantities available.

**25 WATT.** 10/25/50/100/250/500/1,000/1,500/2,500 or 5,000 ohms, 72 1/2p. P. & P. 7 1/2p.  
**50 WATT.** 10/25/50/100/250/500/1,000/2,500 or 5,000 ohms, £1.05. P. & P. 7 1/2p.  
**100 WATT.** 1/6/10/25/50/100/250/500/1,000 or 2,500 ohms, £1.37 1/2. P. & P. 7 1/2p.

**ADVANCE TEST EQUIPMENT**

Brand new and boxed in original sealed cartons. **VM79. UHF MILLIVOLT METER.** 100 Kc/s to 1,000 Mc/s. a.c. 10 mV to 3V. D.c. 10 mV to 3V. Current, 0.1 µA to 0.3 mA. Resistance 1 ohm to 10 megohm. \$185.

**TT15. TRANSISTOR TESTER.** Full range of facilities for testing PNP or NPN transistors in or out of circuit. \$37.50. Carriage 50p per item.

# MULTIMETERS for EVERY purpose!

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**MODEL 500.** 30,000 O.P.V. with overload protection, mirror scale 0/5/2.5/10/25/100/250/500/1,000V d.c. 0/2.5/10/25/100/250/500/1,000V a.c. 0/50µA/500mA. 12 amp. d.c. 0/60K/6 Meg/60 Meg. £3.97 1/2. Post paid.

**MODEL TE-70.** 30,000 O.P.V. 0/3/15/60/300/600/1,200V d.c. 0/6/30/120/600/1,200V a.c. 0/30µA/3/30/300mA. 0/16K/160K/1.6M/16 meg. £5.50. P. & P. 15p.

**TMK MODEL TW-50K.** 46 ranges, mirror scale. 50K Volt/d.c. 5K/Volt a.c. D.c. volts: 0-125, 0-25, 1-25, 2-5, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.c. volts: 1-5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.c. current: 25, 50µA, 2-5, 5, 25, 50, 500mA, 5, 10A. Resistance: 10K, 100K, 1 meg, 10 meg. Decibels: -20 to +81.5dB. £3.87 1/2. P. & P. 17 1/2p.

**TE-800 20,000Ω/VOLT GIANT MULTIMETER.** Mirror scale and overload protection. 6in full view meter. 2 colour scale. 0/2.5/10/250/1,000/5,000V a.c. 0/25/12.5/10/50/250/1,000/5,000V d.c. 0/50µA/110/100/500mA/10A. 0.02K/200K/20 meg. ohm. £15. P. & P. 25p.

**MODEL 5025.** 57 ranges, giant 5 1/2in meter, polarity reverse switch. Sensitivity: 50K/Volt d.c. 5K/Volt a.c. D.c. Volts: 0-125, 0-25, 1-25, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.c. Volts: 1-5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.c. current: 25, 50µA, 2-5, 5, 25, 50, 250, 500mA, 5, 10A. Resistance: 2K, 10K, 100K, 1 meg, 10 meg. Decibels: -20 to +85dB. £12.50. P. & P. 17 1/2p.

**MODEL TE12.** 30,000 O.P.V. 0/0.6/30/120/600/1,200/3,000/6,000V d.c. 1/8/30/120/600/1,200V a.c. 0/60µA/6/60/600mA. 0/6K/60K/6 meg/60 Megohm 50PF. MPD £3.97 1/2. P. & P. 17 1/2p.

**FTC-401 TRANSISTOR TESTER**

Full capabilities for measuring A, B and IC0, npn or pnp. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads. £6.97 1/2. P. & P. 15p.

**HONOR TE.10A.** 20kΩ/Volt 5/25/50/250/500/2,500V d.c. 10/50/100/500/1,000V a.c. 0/50µA/2.5mA 250mA d.c. 0/6K/6 meg. ohm. -20 to +25dB. 10-0, 100 mid. 0-100-0-1 mid. £3.47 1/2. P. & P. 15p.

**MODEL TE-300.** 30,000 O.P.V. Mirror scale, overload protection 0/0.6/3/15/60/300/1,200V d.c. 0/6/30/120/600/1,200V a.c. 0/30µA/6mA/60mA/300mA/600mA. 0/8K/80K/800K/8 meg. -20 to +63dB. £3.97 1/2. P. & P. 15p.

**MODEL PL436.** 20KΩ/Volt d.c. 8KΩ/Volt a.c. Mirror scale. 0-6/3/12/30/120/600V d.c. 0/30/120/600V a.c. 0/30µA/150/600mA. 10/100K/1 Meg/10 meg. Ohm. -20 to +46dB. £3.97 1/2. P. & P. 12 1/2p.

**MODEL TE-90.** 50,000 O.P.V. Mirror scale, overload protection. 0/0.3/3/60/300/600/1,200V d.c. 0/6/30/120/300/1,200V a.c. 0/0.3/6/60/600mA. d.c. 0/6K/160K/1.6/16 meg. -20 to +63dB. £7.50. P. & P. 15p.

**TMK MODEL TW-20CB.** Features Resettable Overload Button. Sensitivity: 20KΩ/Volt d.c. 5KΩ/Volt a.c. D.c. volts: 0-0.5, 2-5, 10, 50, 250, 1,000V. A.c. volts: 0-2.5, 10, 50, 250, 1,000V. D.c. current: 0-0.05, 0.5, 5, 50, 600mA. Resistance: 0-5K, 50K, 0-500K, 5 meg. Decibels: -20 to +52dB. £11.50. P. & P. 17 1/2p.

**MODEL AS-100D.** 100KΩ/Volt. 5in. mirror scale. Built-in meter protection 0/3/12/60/120/300/600/1,200V d.c. 0/6/30/120/300/600V a.c. 0/10µA/150/600/300mA/12A. 0/2K/200K/2M/200M. +17dB. £12.50. P. & P. 17 1/2p.

**TMK LAB TESTER.** 100,000 O.P.V. 5 1/2in scale buzzer short circuit check. Sensitivity: 100,000 OPV d.c. 5/Volt a.c. D.c. volts: 0-5, 2-5, 10, 50, 250, 1,000V. A.c. volts: 3, 10, 50, 250, 500, 1,000V. D.c. current: 10, 100µA, 10, 100, 500mA, 2-5, 10A. Resistance: 1K, 10K, 100K, 10 meg, 100 meg. Decibels: -10 to +49dB. Plastic case with carrying handle, size 7 1/2" × 6 1/2" × 3 1/2". £18.90. P. & P. 25p.

**SKYWOOD SW-500**

50 KΩ/Volt. Mirror scale DC Volts 0.6/3/12/30/300/600. AC Volts 3/30/300/600. DC Current 20µA/6/60/600mA. Resistance 10K/100K/1Meg/10 Meg. Decibels -20 to +57dB £7.50. P. & P. 15p.

**270° WIDE ANGLE**

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MW1-6 60mm square £3.97. MW1-8 80mm square £4.97. P. & P. extra.



**UNR-30 RECEIVER**

4 Bands covering 550KHz-30MHz. B.F.O. Built in Speaker 220/240V a.c. Brand new with instructions. £15.75. Carr. 37 1/2p.

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Large quantity available for EXPORT! Excellent condition. Inquiries invited.



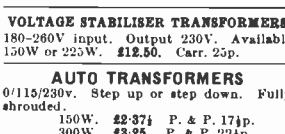
**UR-1A SOLID STATE COMMUNICATION RECEIVER**

4 Bands covering 55KHz-30MHz. FET, 8 Meter, Variable BFO for 8SB. Built in Speaker, Bandspread, Sensitivity Control. 220/240V a.c. or 12V d.c. 12 1/2" × 4 1/2" × 7 1/2". Brand new with instructions. £25. Carr. 37 1/2p.



**LAFAYETTE HA-600 RECEIVER**

General coverage 150-400KHz, 550KHz-30MHz. FET front end, 2 mech. Filters, product detector, variable BFO, noise limiter, 8 Meter, Bandspread, RF Gain. 15in × 9 1/2in × 8 1/2in. 220/240V a.c. or 12V d.c. Brand new with instructions £45. Carr. 50p.



**LAFAYETTE HA-800 SOLID STATE AMATEUR COMMUNICATION RECEIVER**

3-5-4, 7-7-3, 14-14-35, 21-21-45, 28-29-7, 50-54MHz. Dual conversion, 2 mech. filters, product detector, variable BFO, 8 Meter, 100KHz calibrator. 220/240V a.c. or 12V d.c. 16in × 9 1/2in × 8 1/2in. Brand new with instructions. £87.50. Carr. paid (100KHz Crystal £1.97 1/2 extra).

**FULL RANGE OF TRIO EQUIPMENT**

**EDDYSTONE VHF RECEIVERS MODEL 770R.** 19-185 Mc/s, Excellent condition. £150.

**VOLTAGE STABILISER TRANSFORMERS** 180-280V input. Output 230V. Available 150W or 225W. £12.50. Carr. 25p.

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Three Channel: Bass—Middle—Treble. Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier, and connect three 250V up to 500V lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed) **£18.50** plus 38p P. & P.



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

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Two teak finish shelves on a black frame (overall size: 28in x 25in x 12in). Ideal for hi fi equipment: amplifiers, speaker cabinets, etc. The perfect answer for housing unit audio and equipment. This unit is wall mounting. **£2.50** plus 38p P. & P.



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Top quality cassettes at unbeatable prices (complete with standard storage case): C60 38p, C90 63p, C120 88p plus 8p P. & P.



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1,000 Ohm per phone ... **80p**  
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**MIDGET FLEX CONNECTOR**

Approx. 2 amp rating. Two-pin non-reversible midget flex connector. Approx. size: 2in x 1in. Ideal for loudspeaker connections, etc. **8p** plus 2p P. & P.

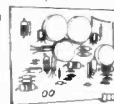
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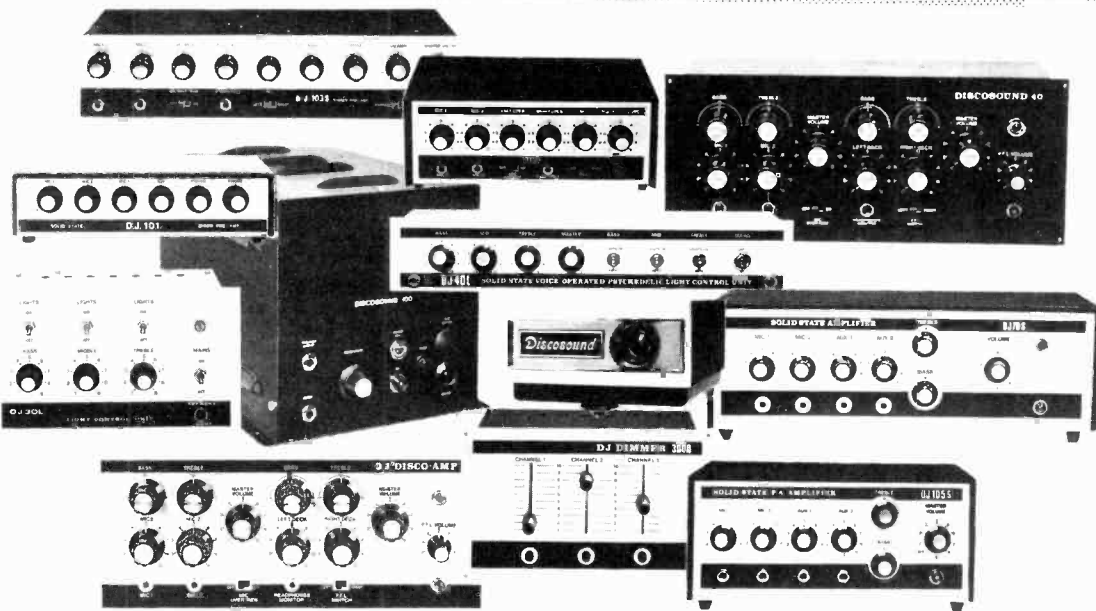
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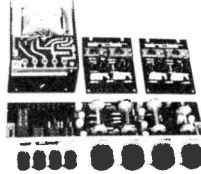
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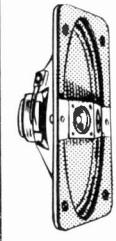


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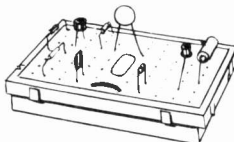
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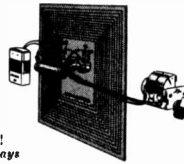
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2N1091	22p	2N3854A	27p	AC127	20p	BD121	65p	B8Y38	25p	NKT613F	32p
2N1131	25p	2N3855	27p	AC128	20p	BD123	83p	B8Y40	40p	NKT677F	30p
2N1132	25p	2N3855A	27p	AC134	22p	BD124	83p	B8Y51	32p	NKT781	50p
2N1302	17p	2N3856	30p	AC176	25p	BD131	75p	B8Y52	32p	NKT781	50p
2N1303	17p	2N3856A	30p	AC187	62p	BD132	80p	B8Y53	32p	NKT10419	30p
2N1304	22p	2N3858	25p	AC188	62p	BDY10	11-27	B8Y54	40p	NKT10439	32p
2N1305	22p	2N3858A	30p	AC177	27p	BDY11	11-28	B8Y78	47p	NKT20329	47p
2N1306	25p	2N3859	27p	AC178	27p	BDY17	11-30	B8Y79	45p	NKT20339	47p
2N1307	25p	2N3859A	32p	AC179	27p	BDY18	11-31	B8Y82	62p	NKT80111	77p
2N1308	25p	2N3860	32p	AC180	27p	BDY19	11-32	B8Y82	62p	NKT80112	77p
2N1309	30p	2N3866	40p	AC181	27p	BDY20	11-33	B8Y82	62p	NKT80113	77p
2N1507	17p	2N3877	40p	AC182	20p	BDY61	11-35	C111	47p	NKT80211	92p
2N1613	25p	2N3877A	40p	AC183	20p	BDY62	11-36	C124	75p	NKT80212	92p
2N1631	35p	2N3900	37p	AC184	20p	BF115	25p	C425	55p	NKT80212	92p
2N1632	30p	2N3900A	40p	AC185	20p	BF117	25p	C426	55p	NKT80212	92p
2N1637	30p	2N3901	37p	AC186	20p	BF117	25p	C428	37p	NKT80215	92p
2N1638	30p	2N3901	37p	AC187	20p	BF167	25p	C744	30p	NKT80216	92p
2N1671B	30p	2N3904	37p	AD140	52p	BF167	25p	D1371	68p	OC20	75p
2N1711	25p	2N3905	37p	AD149	57p	BF183	37p	D16P1	37p	OC22	75p
2N1889	32p	2N3906	37p	AD150	62p	BF173	32p	D16P2	37p	OC23	50p
2N1893	32p	2N4038	17p	AD161	37p	BF177	30p	D16P3	37p	OC24	50p
2N2147	32p	2N4039	10p	AD162	37p	BF178	30p	D16P4	40p	OC25	50p
2N2148	32p	2N4040	12p	AD163	37p	BF179	30p	GET100	40p	OC26	27p
2N2160	67p	2N4041	12p	AF106	42p	BF180	30p	GET110	20p	OC28	62p
2N2193	40p	2N4062	15p	AF114	25p	BF181	32p	GET111	20p	OC29	62p
2N2193A	42p	2N4244	47p	AF115	25p	BF182	32p	GET112	20p	OC30	62p
2N2194A	30p	2N4285	47p	AF117	25p	BF185	42p	GET113	20p	OC31	62p
2N2217	27p	2N4286	17p	AF118	62p	BF194	17p	GET114	20p	OC32	62p
2N2218	27p	2N4287	17p	AF119	80p	BF195	20p	GET118	20p	OC33	62p
2N2219	32p	2N4288	17p	AF124	22p	BF196	42p	GET119	20p	OC36	62p
2N2220	32p	2N4289	17p	AF125	20p	BF197	42p	GET120	52p	OC41	20p
2N2221	25p	2N4290	17p	AF126	20p	BF198	42p	GET173	12p	OC42	20p
2N2222	30p	2N4291	17p	AF127	20p	BF198	42p	GET880	30p	OC43	18p
2N2287	11-07	2N4292	12p	AF127	17p	BF224	50p	GET887	28p	OC48	18p
2N2297	30p	2N4303	47p	AF137	37p	BF225	50p	GET888	28p	OC49	18p
2N2368	17p	2N5027	62p	AF178	72p	BF237	32p	GET889	28p	OC70	18p
2N2369	17p	2N5028	62p	AF179	72p	BF238	32p	GET896	22p	OC71	12p
2N2369A	47p	2N5029	47p	AF180	52p	BF238	32p	GET897	22p	OC72	12p
2N2410	42p	2N5030	42p	AF181	42p	BF244	32p	GET897	22p	OC74	32p
2N2483	27p	2N5172	12p	AF239	42p	BFW58	27p	GET898	22p	OC75	32p
2N2484	27p	2N5174	12p	AF279	47p	BFW60	27p	MJ400	11-07	OC75	22p
2N2539	25p	2N5175	52p	AF280	62p	BFW61	47p	MJ420	11-12	OC76	22p
2N2540	25p	2N5176	52p	AF281	62p	BFX12	22p	MJ421	11-12	OC77	30p
2N2613	30p	2N5232A	45p	AF282	20p	BFX13	20p	MJ430	11-02	OC81	20p
2N2614	30p	2N5245	45p	AF282	20p	BFX20	20p	MJ440	11-02	OC81	20p
2N2646	52p	2N5246	42p	AF283	20p	BFX30	20p	MJ480	97p	OC81D	22p
2N2696	32p	2N5249	67p	AF289	27p	BFX43	37p	MJ480	11-25	OC84	25p
2N2711	30p	2N5265	22-25	AF297	27p	BFX44	37p	MJ490	11-25	OC139	32p
2N2712	30p	2N5266	22-25	AF298	27p	BFX45	37p	MJ491	11-27	OC140	32p
2N2713	27p	2N5307	42-26	AF299	27p	BFX50	67p	MJ1800	22-17	OC171	62p
2N2714	27p	2N5307	42-26	AF300	27p	BFX51	67p	MJ2340	62p	OC200	40p
2N2865	62p	2N5306	40p	AF301	27p	BFX52	67p	MJ5520	62p	OC201	60p
2N2904	30p	2N5307	40p	AF302	27p	BFX53	67p	MJ5520	62p	OC202	60p
2N2904A	37p	2N5308	37p	AF303	27p	BFX54	67p	MJ5520	62p	OC203	60p
2N2905	30p	2N5310	48p	AF304	27p	BFX55	67p	MJ5520	62p	OC204	60p
2N2905A	37p	2N5309	68p	AF305	27p	BFX56	67p	MJ5520	62p	OC205	60p
2N2906	30p	2N5354	47p	AF306	27p	BFX57	67p	MJ5520	62p	OC207	60p
2N2906A	27p	2N5355	27p	BC108	12p	BFY10	12p	MJ5520	62p	OC207	60p
2N2907	30p	2N5356	32p	BC109	12p	BFY11	12p	MJ5520	62p	OC207	60p
2N2923	15p	2N5365	47p	BC113	20p	BFY18	32p	MJ5520	62p	OC207	60p
2N2924	15p	2N5366	32p	BC115	27p	BFY19	32p	MJ5520	62p	OC207	60p
2N2925	15p	2N5367	32p	BC118	27p	BFY20	32p	MJ5520	62p	OC207	60p
2N2926	15p	2N5437	32p	BC118A	27p	BFY21	32p	MJ5520	62p	OC207	60p
.. Green	14p	2N8005	75p	BC121	20p	BFY21	32p	NKT10013	47p	P346A	22p
.. Yellow	12p	2N8020	75p	BC122	20p	BFY22	20p	NKT124	42p	P346A	22p
.. Orange	30p	2N8102	60p	BC125	20p	BFY25	25p	NKT125	27p	P346A	22p
2N3011	30p	2N8103	25p	BC126	35p	BFY26	20p	NKT126	27p	P346A	22p
2N3014	30p	2N8104	25p	BC127	35p	BFY29	20p	NKT127	27p	P346A	22p
2N3033	32p	2N8104	25p	BC140	37p	BFY30	50p	NKT128	27p	P346A	22p
2N3054	30p	2N8502	35p	BC147	17p	BFY41	50p	NKT135	27p	P346A	22p
2N3055	75p	2N8503	37p	BC148	12p	BFY42	50p	NKT137	27p	P346A	22p
2N3123	30p	2N8128	70p	BC149	12p	BFY43	50p	NKT211	30p	T184	40p
2N3134	30p	2N8139	11-27	BC152	17p	BFY50	62p	NKT212	30p	T184	40p
2N3185	25p	2N8140	77p	BC157	20p	BFY51	62p	NKT213	30p	T184	40p
2N3186	25p	2N8141	77p	BC158	20p	BFY52	22p	NKT214	25p	T184	40p
2N3390	25p	2N8142	72p	BC159	20p	BFY56A	80p	NKT215	25p	T184	40p
2N3391	25p	2N8143	72p	BC160	62p	BFY76	42p	NKT216	25p	T184	40p
2N3391A	30p	2N8152	87p	BC167	15p	BFY77	42p	NKT219	30p	T184	40p
2N3392	17p	R.C.A. ---	---	BC168B	14p	BFY90	67p	NKT223	27p	T184	40p
2N3393	15p	40050	55p	BC168C	15p	BPX25	11-25	NKT224	25p	T184	40p
2N3394	15p	40044	55p	BC169B	14p	BPX26	11-25	NKT225	25p	T184	40p
2N3402	25p	40231	32p	BC169C	15p	BPY10	11-25	NKT226	25p	T184</	

## READY BUILT AND TESTED Treasure Locator Module

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(99/-)

**BRAND NEW FULLY TRANSISTORIZED PRINTED CIRCUIT METAL DETECTOR MODULE.** Ready built and tested—just plug in a PP3 battery and 'phones and it's working. Put it in a case, screw a handle on and **YOU HAVE A PORTABLE TREASURE LOCATOR EASILY WORTH ABOUT £20!** Extremely sensitive—penetrates through earth, sand, rock, wood, dirt, water, etc.—**EASILY LOCATES COINS, SILVER, WATCHES, JEWELLERY, SUGGESTS METALLIC ORE, HISTORICAL RELICS, BURIED PIPES, KEYS, NAIL-IN-TREES, ETC. ETC.** Signals exact location by "beep" pitch increasing as you near buried metallic objects. **PRINTED CIRCUIT SEARCH COIL so stable and sensitive it will detect certain objects buried SEVERAL FEET BELOW GROUND! GIVES CLEAR SIGNAL ON ONE COIN!** You could even pay for your holidays with two or three days electronic beachcombing—it's almost like having a licence to print money! Unclaimed treasure now exceeds the combined wealth of all nations. **ORDER NOW**



## FIND BURIED TREASURE!

TREASURE LOCATOR—

NOW IT'S HERE AT LAST,

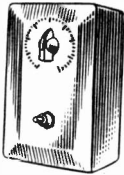


after experimenting for four and a half months with a multitude of different circuits and carrying out actual field tests with prototypes, our design team have come up with this real winner. This fully portable transistorised metal locator detects and tracks down buried metal objects—it signals exact location (no phones used—uses only transistor radio which fits inside—no connections needed). **FINDS GOLD, SILVER, LOST COINS, JEWELLERY, KEYS, WAR SOUVENIRS, ARCHAEOLOGICAL PIECES, METALLIC ORE, NUGGETS, ETC.** Extremely sensitive, will signal presence

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## SOOTHE YOUR NERVES RELAX WITH THIS AMAZING RELAXATRON

**CUTS OUT NOISE POLLUTION—SOOTHS YOUR NERVES!** Don't underestimate the use of this fantastic new design—the **RELAXATRON** is basically a pink noise generator based on avalanche operated transistors. Besides being able to mask out extraneous unwanted sounds, it has other very interesting properties. For instance, many people find a rainstorm mysteriously relaxing, a large part of this feeling of well-being can be directly traced to the sound of falling raindrops!—a well-known type of pink noise. A group of Dentists have experimented on patients with this pink noise—**NO ANAESTHETICS WERE USED!** The noise obviously created a most definite reaction on these patients nervous systems with the results that their pain systems were blocked. **IF YOU WORK IN NOISY OR DISTRACTING SURROUNDINGS, IF YOU HAVE TROUBLE CONCENTRATING, IF YOU FEEL TENSED, UNABLE TO RELAX**—then build this fantastic Relaxatron. Once used you will never want to be without it—use this amazing pink noise generator whenever you feel uneasy, can't relax or wish to concentrate. **TAKE IT ANYWHERE**, pocket sized. Uses standard PP3 batteries (current used so small that battery life is almost shelf-life!). **CAN BE EASILY BUILT BY ANYONE OVER 12 YEARS OF AGE** using our unique, step-by-step, fully illustrated plans. All parts including case, a pair of crystal phones, components, nuts, screws, wire, etc. etc. Send only **£2-25** plus 25p P. & P. (45/- plus 3/-) (parts available separately). No soldering necessary. Examine at home for 7 days. Your money back if not delighted.



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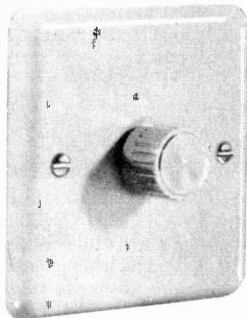


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Listen in to AIRLINES, PRIVATE PLANES, JET PLANES. Eavesdrop on exciting cross-talk between pilots, ground approach, ground control, airport tower. Hear for yourself the disciplined voices hiding tensions on talk-downs. Be with them when they have to take nerve-ripping decisions in emergencies—tune in to the international distress frequency. Covers aircraft frequency band including **HEATHROW, GATWICK, LUTON, RINGWAY, PRESTWICK, ETC.** This fantastic fully transistorised instrument can be built by anyone able to tinety in under two hours. (Our design team built four—everyone worked first time). No soldering necessary. Fully illustrated simply worded instructions take you step-by-step. Uses standard PP3 battery. Size only 4 1/2 in x 3 1/2 in x 1 1/2 in. All you do is extend rod aerial, pocket close to any ordinary medium-wave radio (even tiny pocket radios). **NO CONNECTIONS WHATSOEVER NEEDED.** Use indoors or outdoors. **SEND NOW, ONLY £2-37 + 25p (47/6) P. & P.** for all parts, including case, nuts, screws, wire, etc. etc. (parts available separately).

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## Vary the strength of your lighting with a DIMMASWITCH



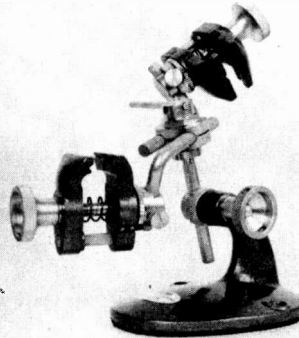
The DIMMASWITCH is an attractive and efficient dimmer unit which fits in place of the normal light switch and is connected up in exactly the same way. The ivory mounting plate of the DIMMASWITCH matches modern electric fittings. The bright chrome control knob activates an on-off switch and controls 40-600 watts of all lights except fluorescents at mains voltages from 200-250 V, 50 Hz. The DIMMASWITCH has built-in radio interference suppression. Price: **£3-20** plus 10p post and packing. Kit Form: **£2-70** plus 10p post and packing. Please send C.W.O. to:

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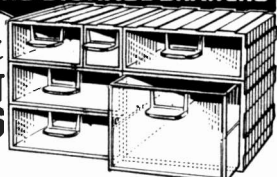
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## NEW! roamer eight mk 1 WITH VARIABLE TONE CONTROL

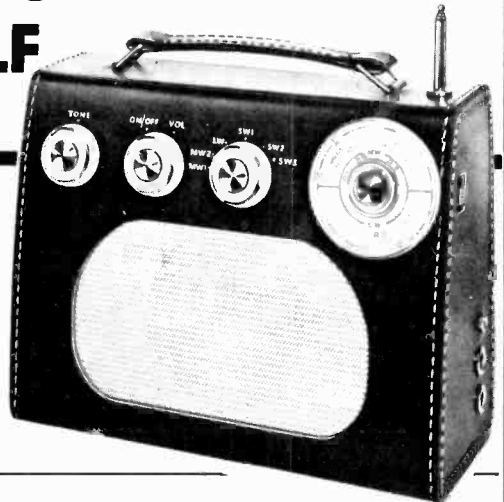
7 Tunable Wavebands: Medium Wave 1, Medium Wave 2, Long Wave, S.W.1, S.W.2, S.W.3, and Trawler Band. Built-in ferrite rod aerial for Medium and Long Waves. 4 section 24in. retractable chrome plated telescopic aerial for Short Waves for maximum performance. Push-pull output using 600Mw type transistors. 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" x 7" x 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" x 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" x 7" x 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

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



## NEW! transeight

### SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

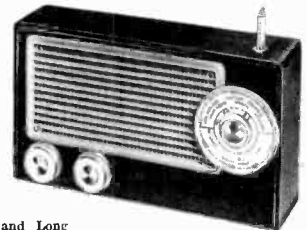
Attractive case in black with red grille and black knobs and dial with spun brass inserts. Size 9" x 5 1/2" x 2 1/2in. approx. Tunable on Medium and Long Waves, 3 Short Waves and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 8 improved type transistors 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**

Post, packing and insurance 31p  
Overseas P. & P. 70p

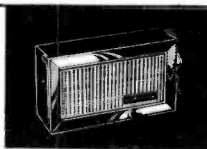
Earpiece with plug and switched socket for private listening, 30p extra.



## pocket five

### MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER

Attractive black and gold case. Size 5 1/2" x 1 1/2" x 3 1/2in. 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, super-sensitive 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**

Post, packing and insurance 21p  
Overseas P. & P. 55p

## transona five

### MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER

Attractive case with red speaker grille. Size 6 1/2" x 4 1/2in x 1 1/2in. 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). Earpiece with plug and switched socket for private listening, 30p extra.



Total building costs

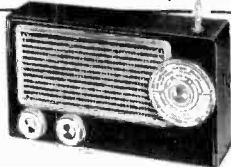
**£2.38**

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## IMPROVED MODEL !

### roamer six SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive black case with red grille and black knobs and dial with spun brass inserts. Size 9" x 5 1/2" x 2 1/2in. 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). Earpiece with plug and switched socket for private listening, 30p extra.



Total building costs

**£3.98**

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| TRANSONA FIVE | <input type="checkbox"/> | ROAMER SIX   | <input type="checkbox"/> |

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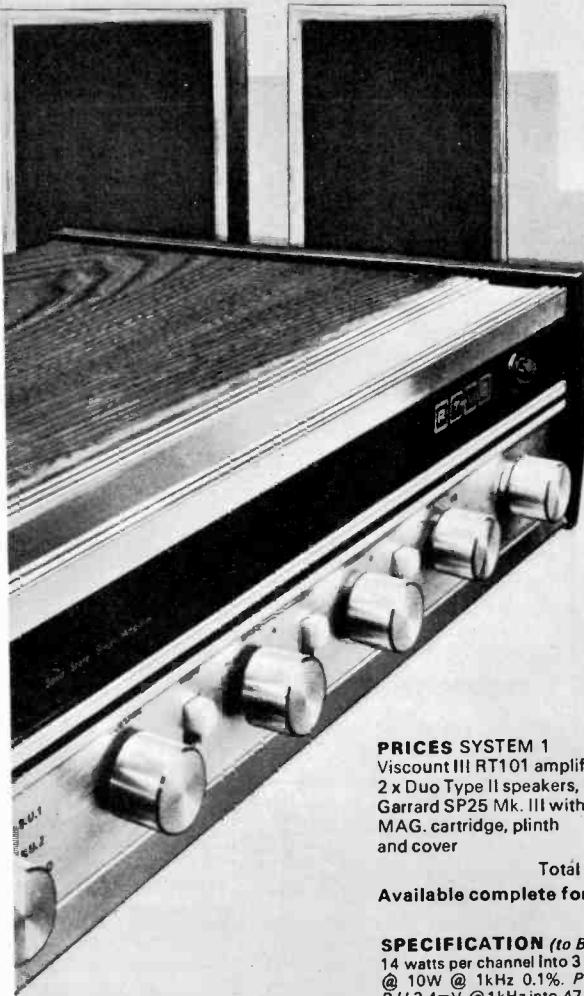
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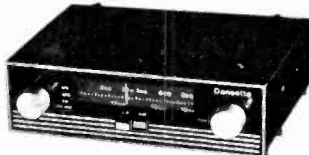
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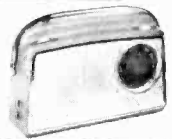
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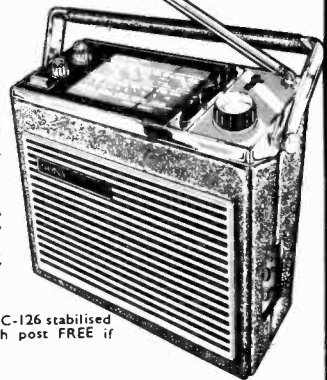
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## THAT SPECIAL PROBLEM

It is now becoming widely appreciated that many private constructors are highly competent, expect up-to-the-minute designs, and that they generate a demand for many new and unusual types of components, such as industry had previously deemed its exclusive own. This is the heartening news to emerge from correspondence arising from our comments in the May issue on the subject of component availability. On the less bright side, problems of supply there are, and will remain; but all concerned—makers of components, industrial distributors, and retailers—seem keen to mollify them.

Several large component manufacturers have made clear that no embargo is imposed by themselves that would prevent their products ultimately reaching the hands of private individuals. The operative word here of course is "ultimately". In the majority of cases the components must pass through the established distribution system. The terminal point so far as the private purchaser is concerned is the retailer or, exceptionally, an industrial distributor.

A significant development, in fact, is the interest certain industrial distributors are showing in the growing amateur market. Some are already entering the retail mail order business. Is this a challenge to the established component retailer? Some retailers admit to us that the supply of "specials" is an uneconomical business, but they are prepared to do it as a service to their customers.

A few retailers, resenting what they felt to be an attack upon their business acumen in our May comment, have laid the blame for much of the present difficulty upon PRACTICAL ELECTRONICS. Two main points have been raised. They are of interest to all involved in amateur electronics, and we will give our answers to both points herewith.

A common (and perfectly understandable) request, is for advance notification of components that will be specified in forthcoming articles. Admirable as this sounds, it overlooks the exigent demands that arise in producing a monthly magazine containing extensive technical detail. Could such problems be overcome, there would remain the severe burden of circulating all advertisers each month: it would be an invidious act to select just a few.

A second criticism levelled at this magazine is that we should make certain that all items specified are actually available to private purchasers. Suppliers and constructors alike can be assured that great pains are taken to verify this. Often alternatives are substituted prior to publication when perusal of retailers' current catalogues

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*Our August issue will be published on  
Friday, July 16*

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THE simplest form of intercommunication system is made up of one master unit and one slave unit. The slave unit consists of a loudspeaker serving in the dual role of microphone and loudspeaker.

For the other unit the choice of title "master" derives from the fact that all two way conversation is controlled from it as seen in Fig. 1. Here, master loudspeaker LS1 is connected by a short twin lead to the amplifier via a two way switch. In the "Talk" position the switch connects LS1 to the amplifier input and the remote slave loudspeaker to the amplifier output.

It is common practice to have the function switch biased to "Talk" as all conversation is initiated by the master. However, as the intercom might find use as a baby alarm or doorphone this convention was dropped.

As a microphone, LS1 acts as a voltage generator with the voice coil responding to sound waves striking the cone. The amplifier steps these voice signals up and relays them to the slave load LS2. A person

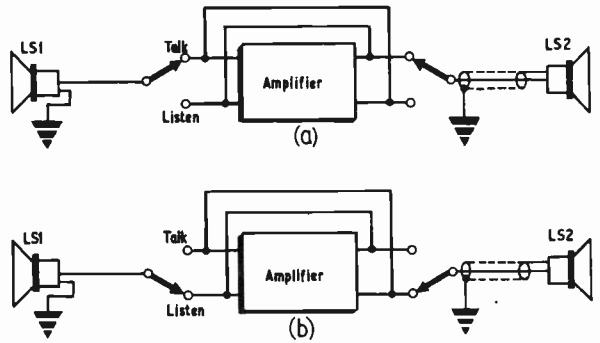


Fig. 1 (a). In the "Talk" position master loudspeaker LS1 acts as a microphone. LS2 functions normally as a loudspeaker (b). In the "Listen" position, slave loudspeaker now functions as the microphone and initiates the call. Ideally screened lead should be used for LS2 to eliminate noise influences

# SIMPLE INTERCOM

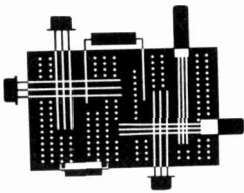
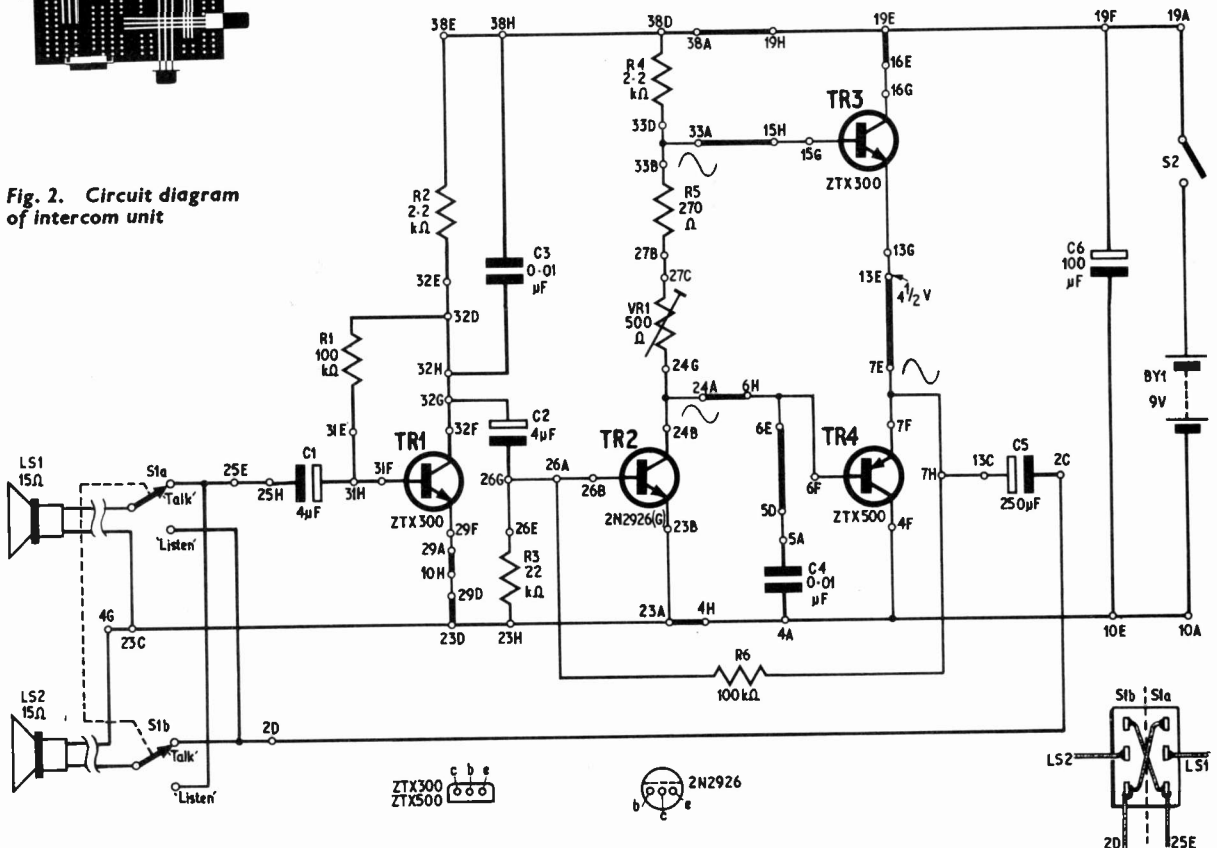


Fig. 2. Circuit diagram of intercom unit



in proximity to this loudspeaker responds by simply speaking up when the master unit switch is set to the "Listen" position.

## COUNTING THE COST

Probably the most important criteria for an intercom system is low running and building costs. Whilst a rectified mains supply will effectively reduce running costs by avoiding batteries, it does introduce the hazard of possible accident, the likelihood of hum on the line and the necessary siting of the master unit near a mains outlet.

Anticipating the manifold applications of the system in garden workshops or garages, battery power was considered a prime requirement. In fact quiescent current drain is about 8mA with peaks, according to speech level, of about 35mA.

The cost of the unit to build should be around £1.50. This excludes the price of the loudspeakers.

Most intercom systems provide peak power outputs from about 100 to 500 milliwatts. To the hi-fi man in pursuit of an ever spiralling power figure this must represent an almost inaudible sound level when coming through a loudspeaker. In fact, a power output of 100 milliwatts is adequate for room listening.

Equally, whilst a sound purist might reach for his hat when you beg to demonstrate your intercom amplifier with a harmonic distortion content approaching 10 per cent, impress on him that an intercom is for intercommunication and the intelligence loses little by this type of distortion.

## CIRCUIT ACTION

In Fig. 2 is given the intercom circuit diagram with T-Dec hole positions for plugging in component parts. If translation of this unit into the form of a more permanent assembly is intended, such as on Veroboard, then the prototype component geometry should be maintained to lessen the likelihood of instability.

The circuit diagram shows S1 in the "Talk" position so that the call facility is with the master unit. C1 provides d.c. isolation so that no biasing of the loudspeaker cone is possible.

Since the loudspeaker in use is a voltage generator of low output impedance it must work into a higher load to effectively transfer small signals. TR1 is a silicon transistor which means that the simplest form of base biasing can be used as the expected small changes in surrounding temperatures are hardly likely to affect its working point.

## Components . . .

### Resistors

R1	100k $\Omega$
R2	2.2k $\Omega$
R3	22k $\Omega$
R4	2.2k $\Omega$
R5	270 $\Omega$
R6	100k $\Omega$
All 10% $\frac{1}{2}$ watt carbon	

### Capacitors

C1	4 $\mu$ F	elect. 15V
C2	4 $\mu$ F	elect. 15V
C3	0.01 $\mu$ F	polyester
C4	0.01 $\mu$ F	polyester
C5	250 $\mu$ F	elect. 15V
C6	100 $\mu$ F	elect. 15V

### Transistors

TR1	ZTX 300
TR2	2N2926 green spot
TR3	ZTX 300
TR4	ZTX 500

### Switches

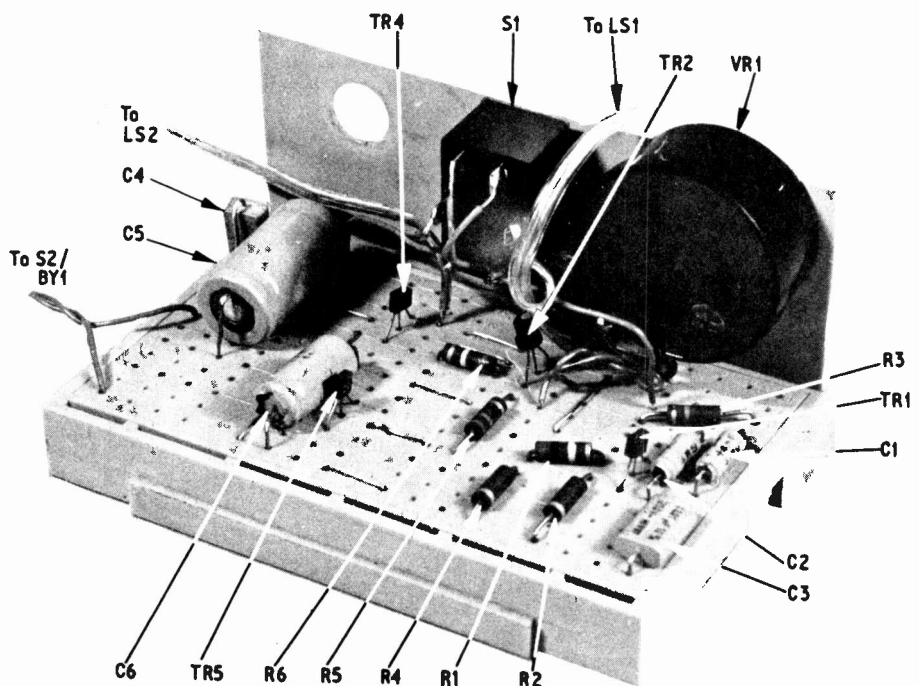
S1	D.P.D.T. toggle
S2	On/off toggle

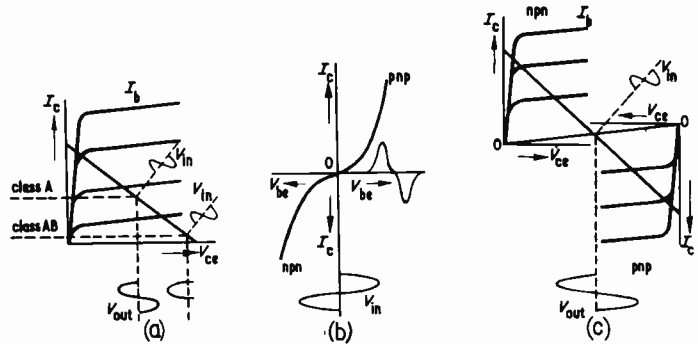
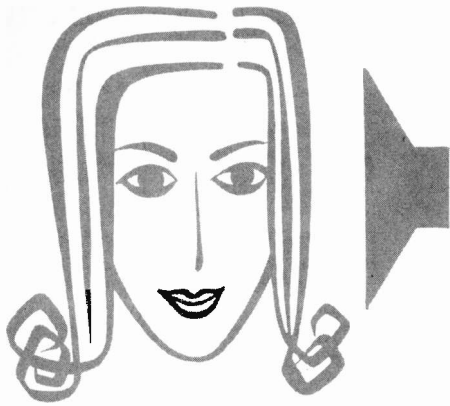
### Loudspeakers

LS1, LS2	5in, 15 $\Omega$	(2 off)
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### Miscellaneous

BY1	—9V
T-Dec, connecting wire	





**Fig. 3 (a).** Transistor output characteristic showing two common bias conditions (b) How input characteristic non-linearity produces crossover distortion with zero biased input signal (c) slight forward bias for the complementary transistors gives a clean output voltage ( $V_{out}$ )

Both this and the succeeding transistor TR2 work in a condition known as Class A. In Fig. 3(a) is shown an output characteristic for a transistor with a resistance load. If a signal current is passed to the base this will be reproduced at the collector ( $V_{out}$ ) only if it is well contained within the load line. For small signals, Class A, or mid point bias, does in fact provide this as can be seen.

Since we are not concerned with power in the first two transistor stages the inefficiency represented by Class A biasing can be ignored. However, where transistors are used as power amplifiers, with large collector current swings, mid-point biasing would mean a large continuous drain from the power source and the batteries would soon be flat.

### CLASS AB

Biasing further down the load line to near cut-off will give a very low quiescent current drain but intolerable distortion as the collector voltage is only reproducing half the signal voltage. Biasing at this point is known as Class AB.

If an npn/pnp combination are arranged as TR3/TR4 in the circuit and the gain characteristics of these transistors matched then we have the advantage of excellent efficiency and low distortion in a power output pair. As previously stated, since second harmonic distortion in speech is not a cause for concern the cost or problems of matching, can be ignored.

### CROSSOVER DISTORTION

There is a form of distortion found with this type of output configuration which is intolerable. Known as crossover distortion, it occurs when the transistors are zero biased as seen in Fig. 3(b).

Here a sinusoidal signal applied to the transistor bases will be distorted at the output due to curvature on the input characteristics. At low signal levels this distortion is particularly bad.

To overcome this a small amount of bias is applied to both transistors so that any signal transfer is made on the linear part of the input characteristics. Fig. 3(c) shows how effective this is when related to the output characteristics.

In the circuit diagram VR1 is used to make this bias adjustment.

### NOISE

In any high gain amplifier there is always the possibility of noise being introduced, this applies particularly where long runs of wire are introduced directly to the preamplifier input. With an input impedance of less than 1 kilohm the noise problem, in general, should only be a small one even for substantial twin runs to the slave loudspeaker.

It must be realised, however, that noise will raise the quiescent current level. Since this is normally about 8mA single screened lead connected as in Fig. 1 will prove effective against such influences.

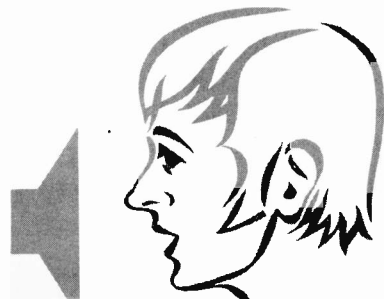
Spontaneous high frequency oscillation can also be a nuisance so decoupling capacitors C3 and C5 are included.

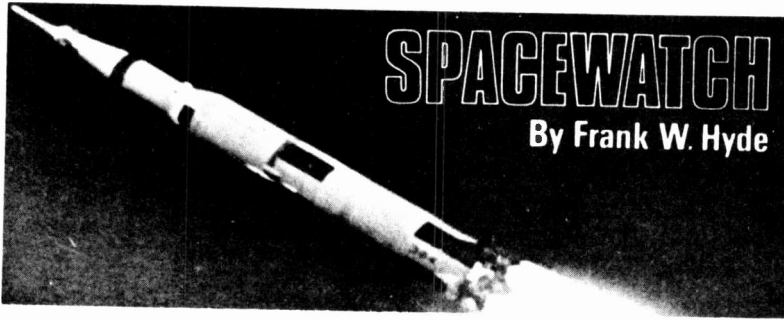
### SETTING UP

Since there is only one control requiring preliminary adjustment, namely VR1, setting the amplifier up is simple and only requires a multimeter. First set VR1 wiper to mid travel. With S1 in the "Talk" position connect the multimeter in series with the battery with range switches set to 100mA d.c.

With the unit switched on the current reading should be about 20-30mA. Now adjust VR1 to the lowest current reading which should be about 8mA. If now a transistor radio is placed before LS1, preferably tuned to some speech programme, VR1 should be adjusted for minimum distortion at the slave output LS2. If the radio volume is set too high you will probably overload the amplifier as it has an input sensitivity of about 1mV r.m.s. to provide an output of 120mW.

Turn the radio off and check the quiescent current, this should not have moved much from the 8mA figure. With these procedures satisfactorily carried out, the intercom should be ready for use.





## CANADIAN SATELLITE

Another Canadian satellite of the *ISIS* series launched by America triggers off another international scientific project. Code named *ISIS 2* it weighs 260 kilograms and will, for the first time in the series, send continuous "ionograms" for display on television consoles.

The name "ionogram" is given to the picture which records the depth and density of the ionosphere. Sudden changes in density or depth as viewed from above can give direct indication of the propagation conditions for radio communication.

The first *ISIS* satellite launched in 1969 is still in operation but only transmits ionograms at specific periods, most of its data is in the form which requires processing at ground stations in order to arrive at a picture.

Previously the ground station made an ionospheric sounding as the satellite passed overhead and two sets of data were correlated and a picture built up. This results in a delay in warning when ionosphere disturbances arise.

## TRACKING CENTRE

The *ISIS 2* satellite is of a more advanced design containing a new telemetry system where the ionograms are relayed directly to each participating centre, together with other data, with the result that immediate knowledge is available of the ionospheric condition.

The stations involved are the tracking stations in America, Canada, United Kingdom, Norway, Japan, India, Australia and New Zealand. The information is also deposited at the World Data Centre at Boulder, Colorado.

The advanced *ISIS 2* is the forerunner of a series of ionospheric operational satellites and these together with a world wide network of ground stations will be of the utmost value to communications operations, enabling a minute by minute decision to be made as to the choice of the best frequency for propagation.

Other data provided by these satellites will include information of

the effect of the sun on the earth's atmosphere and may lead to the solution of how atmospheric pollutants are disposed, and how and what mechanism might be available naturally for dispersal.

## LUNAR NAVIGATION

The two astronauts Shepard and Mitchell in their report on the *Apollo 14* mission have made the point that personal navigation on the Moon needs instrumentation.

Part of their work task was to reach the Cone Crater in the Fra Mauro Region, but they turned back before reaching it as they thought there was not sufficient time to carry out this operation. In actual fact they were within 50 feet of the crater but the difficulty of deciding on distance made it impossible for them to know this. The horizon is so close, there are no colour differences to compare distances against, and the lack of contrast on the surface indicates that some kind of range finder is required.

## LUNAR LOPE

The astronauts said that the most difficult thing they found in their walks was this inability to judge distance accurately. They thought that they were covering more distance than in fact they were because of this, and also that in doing the "Lunar Lope" of one step and a hop they did not move more than three or four feet a second; which is only slightly faster than walking normally on Earth. This bothered them because they felt in the one sixth gravity condition on the Moon that they were moving much faster than this.

The long distances that will be covered by the crews of *Apollo 15* and *16* using the "lunar rovers" will be accurately indicated on the vehicle instruments.

The report also noted that the magnetometer which they set up on the *Apollo 14* mission has indicated that the magnetic field in the Fra Mauro area is much higher than that found at the other landing sites visited by *Apollo 11* and *12* missions.

The command module pilot, astronaut Roosa, took thousands of photographs of the moon's surface and one of these, on the far side of the moon, showed a new crater which is probably the youngest on the moon.

On the near side, another new feature was detected near the Crater Lansburg which looks like a winding ditch. It is not a rille or fault line and the astronaut has called this feature "The Thing".

## ROCK COLLECTION

It seems that some of the rocks collected from the moon are at least 4,500 million years old and must belong to the original crust. This was the preliminary statement made by Paul Gast and Robin Brett of the Manned Spaceflight Centre at Houston.

The samples brought back differ considerably from those of the *Apollo 11* and *12* missions, and also from the *Luna 16* mission of the Soviet Union. For one thing they are more complex, containing more minerals and so far 23 different minerals have been detected, though ten of these have not yet been positively identified. It is also apparent that these rocks reveal several different phases of the moon's history.

Another difference between the *Apollo 14* and previous missions for rock collection is that the latest samples contain very few fragments of igneous rock but they do contain some of the elements that formed the Earth's crust.

It is possible to learn more about the earth from the moon samples since they are probably in exactly the same condition as when they were formed, whereas on earth much of the geological record has been obliterated.

## MOON BIRTH

A theory has been advanced that the moon was formed some 4,500 million to 5,000 million years ago by planetoids composed of the lighter gases that were thrown off from the coalescing earth and formed a ring round it. It is also suggested that another of the planetoids moved in an erratic path and when the earth and moon became distinct and separate it crashed on to the moon to form the oldest maria the Mare Imbrium or Sea of Rains.

Whether this is a tenable theory or not may emerge from the different centres to whom parts of the moon rocks have been distributed. There will be more than 700 investigators in some 187 groups all over the world working on these samples.

This is one aspect of the value of the manned missions to the moon and later other planets.

## MATRIX DISPLAYS

In the preliminary design work on the "P.E. Aurora" unit a simple control system with a matrix of lamps was used as the basis for the switching control. The first arrangement made is shown in Fig. 1, where 16 bulbs are set out on a  $4 \times 4$  grid. The control system described previously in Part 1 was such that, in order to light up the bulbs, it was necessary to power them through both co-ordinate axes (x and y).

Experiments showed that there is a great potential in programming lights by the use of a matrix. Besides the obvious variations in thyristor controlled a.c. the disposition of the matrix itself is an important visual aspect of the whole system.

If the point sources in Fig. 1 are changed to small tungsten strip lights, the pattern configurations are radically altered.

The grid may be disposed in many ways Fig. 2 shows, for example, an arrangement where one co-ordinate is radial and one concentric.

Fig. 3 combines three co-ordinates, two being curved radials, and the third eccentric. Visual effects achieved could be rotation and counter-rotation or expansion and contraction from the centre.

A light display may be three dimensional in form, and the matrix applied as in Fig. 4.

PREVIOUS articles in this series on the "P.E. Aurora" light display system described how to control the lighting by using a sound source split up into several restricted frequency bands. Before going on to some other methods for triggering the lamp controller, let us first look at some ideas in forming an artistic display with the bulbs.

First, various forms of geometric arrangement will be described, leading to the large cabinet that was shown at the "Audio Fair" and the "Electric Theatre" exhibitions. Later some suggestions for less ambitious and less expensive arrangements that, although different, are just as pleasing in an appropriate setting.

The constructor has the choice of matrix operation with 16 lamps (see Part 1), some degree of interaction being inevitable. Alternatively "straight" operation with eight lamps can be used.

Both systems are employed in the following suggested ideas, and it is left to the reader to experiment to some extent to find which method suits him best.

The creative use of light can be classified into two categories. The first is that in which bulbs or projection sources are hidden, and throw their lights onto walls or screens. An obvious example of this is theatre lighting, and will be described later in this article.

Light sources may be visible, arranged into patterns and controlled by switching systems... a technique frequently used in advertising signs.

Light sources may combine both these approaches, so that light is thrown onto plain or reflective surfaces, illuminates translucent material, and also features the lighting element as a point, line or even shaped source.

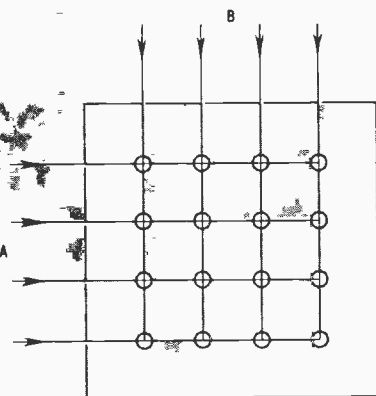


Fig. 1. Basic matrix of 16 lamps triggered from an eight-channel controller

# P.E. AURORA

MUSIC INSPIRED LIGHT AND COLOUR  
PART 4 - LIGHT DISPLAYS BY M. LEONARD A.R.I.B.A.



## BULB SELECTION

Examination of manufacturers' catalogues will show bulbs of various shape and size. It is suggested that the reader obtains a number of bulbs in differing forms for experiment. It is advisable to obtain prices before committing oneself to a particular arrangement, as some bulbs can be very expensive when buying eight or even 16 of them.

The characteristics of a particular bulb will often be the starting point in the design of a display. Many bulbs are too bright to be left exposed, but those of lower wattage or of opal finish may be glare free.

Bulbs like quartz-iodine have small point source and throw sharp shadows, whereas strip-lights obviously give a more diffused light. Silver spot bulbs are internally mirrored at the base end in order to throw light forward as a beam; whereas "crown silvered" are mirrored on the top, and thus send light back to the socket end of the bulb at which there is normally a reflector. This can be adjusted to vary the focus of the beam.

In the course of selecting suitable bulbs, take heed of the restrictions imposed by the power ratings of the thyristor controller (see Part 1). Examination of some of the better designed light fittings is worthwhile, for these show how a great variety of control can be achieved over a source as mundane as the domestic light bulb. Certain fittings may give a soft diffused light, others may throw a texture of light and shade on to surrounding surfaces.

Glass elements may be incorporated to simulate the glistening chandelier, or a bright light screened by metal in which there are a number of fine perforations—this giving a brilliant sparkle of light.

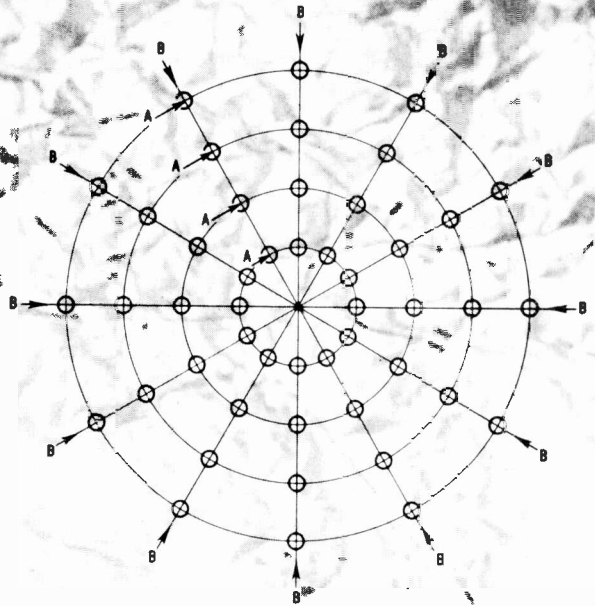


Fig. 2. Two-dimensional display taking in four concentric channels and 12 radial channels (total 48 lamps, 16 control channels)

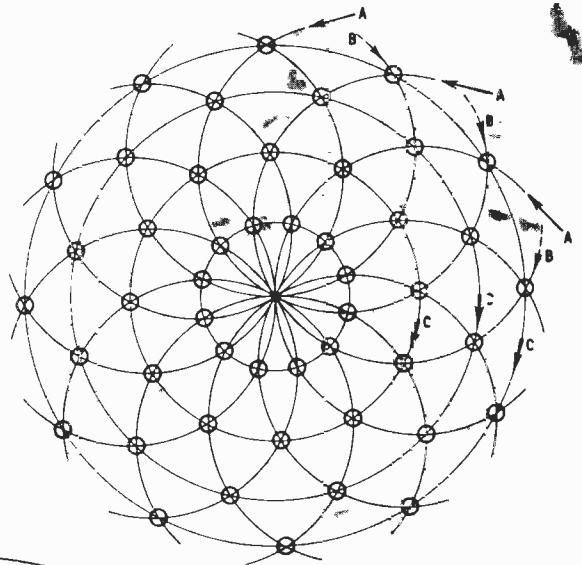


Fig. 3 (right). Three-dimensional display taking in four concentric channels, 12 A radial channels, and 12 B radial channels (total 48 lamps, 2 x 16 control channels)

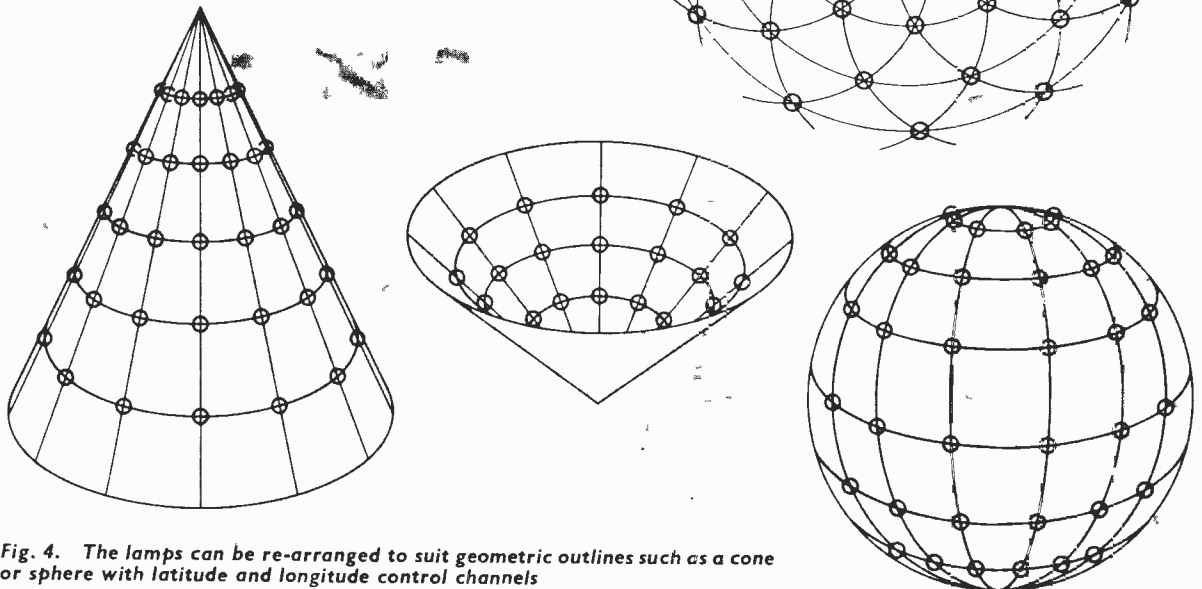


Fig. 4. The lamps can be re-arranged to suit geometric outlines such as a cone or sphere with latitude and longitude control channels

## COLOUR MIXING

A very important principle in the control of colour is the use of additive or subtractive colour mixing. In mixing paint the primary colours are red, blue and yellow. The colour seen from a painted surface is that component of white light left after the pigment has absorbed the remaining part of the spectrum. Combinations of pigment may be made which progressively absorb more and more of a white light source, until black is reached; at this point all light is absorbed and none reflected.

The effect achieved by overlaying transparent colour filters is also a subtractive one. Thus the mixture of blue and yellow paint, or the overlay of blue and yellow filters will produce green. It is important to remember this principle to distinguish colour light from colour pigment.

## DISPLAY CABINET

In the final display cabinet, as illustrated on the front cover and in Fig. 6, the bulbs used were 40 watt 240 volt "continental" fittings, of 1½ in diameter. These were "pearl" in finish and were left exposed, creating perfect spheres of white light.

Fig. 5 shows the plan arrangement of a single bulb, set within a fan of coloured transparent plastics sheet. The surfaces, being highly reflective, act as mirrors; the image of the bulb appears at points A, B, C, D. Each reflected image appears to be a different colour, and the colours will be different from different viewpoints.

At the rear of the display was a glass mirror so that the form which was a half cylinder appeared reflected as a complete cylinder. Lights arranged in spiral form (Fig. 6) gain the best effect from the multiple reflections, only half the spiral being constructed.

Wiring was taken from each lamp holder, via a stalk to the main vertical support column and then to the backboard of the structure. The stalks consisted of metal tubes fitted at one with the lamp holders, and the other end fixed to a common large diameter central trunk, through which all the supply lines are fed. The ballast lamps shown in the matrix in Part 1 can be incorporated as permanent lamps shown in the display.

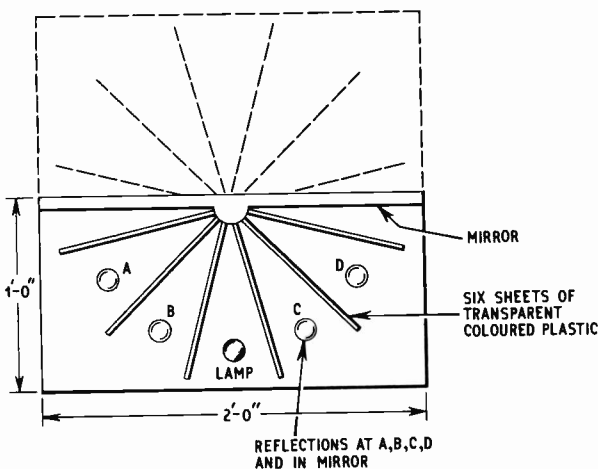


Fig. 5. One bulb can supply a large number of images by reflections in Perspex panels in the shape of a fan

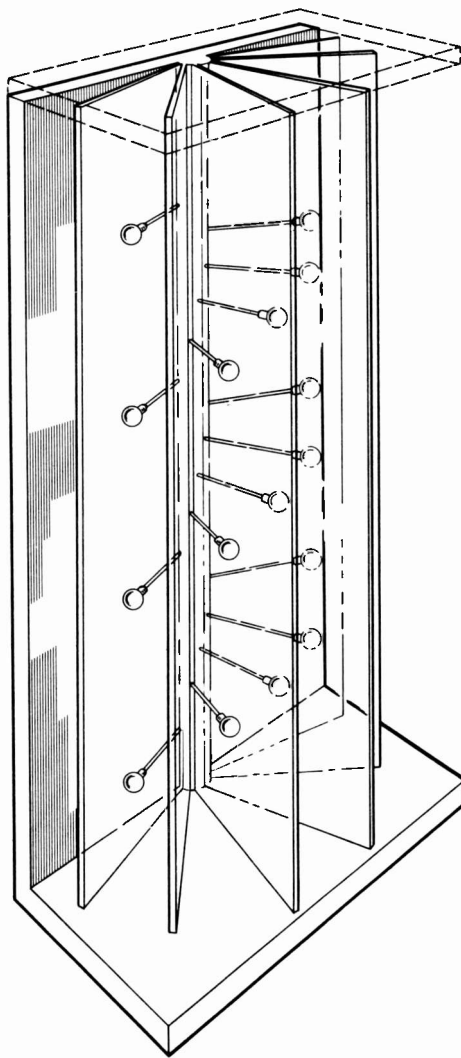


Fig. 6. The finished display cabinet was built around a central trunk with radiating fins of coloured Perspex and a mirror at the back. Matrix wiring is used as in Part 1, the diodes being mounted on the back panel

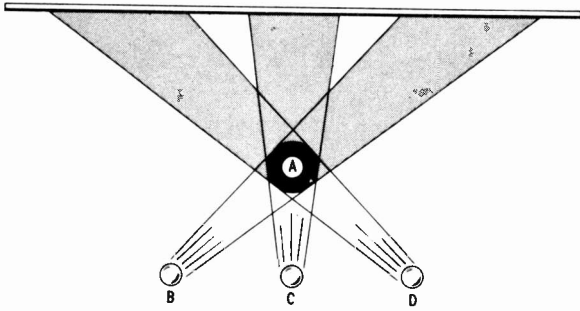


Fig. 7. Tri-colour shadow casting technique

## COLOUR LIGHT MIXING

However, when coloured beams of light are overlaid the effect is completely different, for the principle is that of additive mixing. The *light* primaries are red, blue and green. Those readers who try this technique for the first time may be surprised to find that, for example, the addition of red, and green light produces yellow light.

If three light sources which are the light primaries are arranged to illuminate an opal screen and completely overlap one another (this could be a flat surface, a sphere or cylinder) and each bulb controlled in light intensity, variations in intensity will produce a complete spectrum of colour. In the first instance controls could be operated manually, and later, sequences of colour change programmed electronically.

Fig. 7 shows another way in which the three light primaries can be used. An object A is lit by a red, blue and green light. The red light will illuminate the wall behind the object, casting a black shadow.

The addition of the green light will overlight the shadow turning it green, and where red and green light mix, the product will be yellow. The addition of blue will increase the complexity of colours and shadows. Movement of the lights will cause further complications if the shadows are allowed to overlap.

This experiment is a very rewarding one and can be translated in a number of ways. If the object is a dancing figure, and the light primaries provided by theatre spot lights, dramatic effects of colours and shadows can be back projected onto a translucent screen. Alternatively, the whole idea can be miniaturised in the form of a small light box.

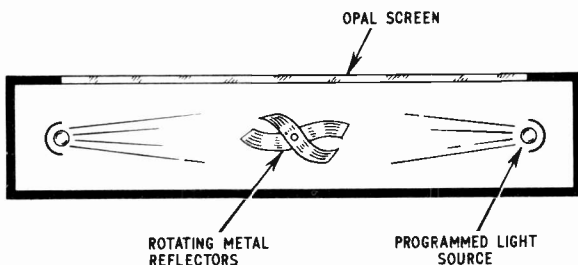


Fig. 8. Colour reflecting from the idea shown in Fig. 7. The coloured light is projected onto a translucent screen of opal finish

## LIGHT MURALS

A number of methods have been used to make light murals; the main problem is how to keep the depth behind a screen surface to a minimum. One system shown in Fig. 8 is to replace the object illuminated with a series of rotating shaped reflectors.

Light sources are beamed in from the edge of the screen, and coloured reflections are thrown forward; mixing taking place on the screen can be reduced to a few inches. One example of a system similar in principle to this is the "Dreamscreen" (see *Electronorama* last month).

Fig. 9 outlines a completely different approach. The elements are arranged in layers. The rear layer is that of the light sources, which can be white, coloured, or combinations of both. In front of this are a series of cut out shapes which can be opaque, or translucent colour filters, or again combinations of both. The next layer can be hardboard, which is obtainable with a variety of perforations; reeded or cross reeded glass gives further interesting effects.

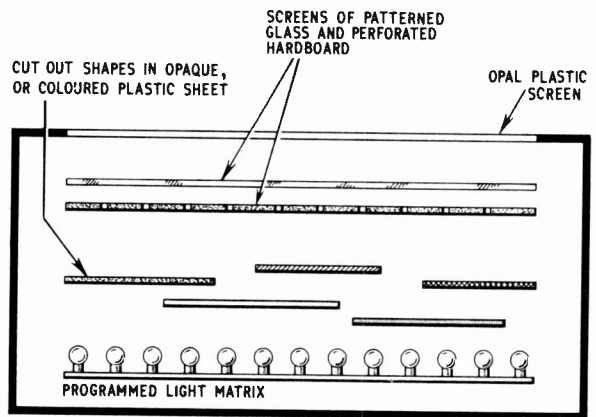


Fig. 9. Back projection onto an opal finish screen through layers of translucent material or perforated sheet

The final layer is an opal screen. A simple framework will be needed to allow the planes to be suspended, and the distance between the elements easily varied.

Switching lights in sequence will give a movement of shadows and colours on the front screen. The perforated layer can give a pinhole camera effect focusing images, the definition of which will depend on size and shape of the holes. In some instances this layer may work best close to the bulbs. The reeded glass can act like a series of lenses, and often the opal screen can be omitted, and the effects of the programmed lighting seen directly in the glass layer.

The light beam of a slide projector will give a whole new range of effects if used to replace the light sources shown in Fig. 9. Optical effects can be introduced in front of and behind the lens.

## PLAN A SYSTEM

The foregoing ideas are based mainly on geometric arrangements, and will in some way produce a formal display restricted only by the boundary of the

the appearance of an extended display showing reflections of light in the floor.

If possible, the wall of foil should be made slightly concave to help spread the light projected onto it. When set up, the foil is wrinkled and dented by gently tapping all over with the flat palm of the hand. The larger the indentations are, the better will be the final effect.

### EIGHT CHANNEL OPERATION

The lights are now set up for straight eight-channel operation (not matrix), i.e. one bulb per channel.

Although expensive to purchase initially, it is well worth obtaining colour flood lamps (e.g. Philips "Comptalux" E27) rated at 240V 100W a.c. These can be obtained in red, blue, green and yellow and clear, with reflective rear inside surfaces and diffuser lenses, and will provide the basis for some interesting colour mixing as described earlier. These lamps use Edison screw bases, which are mounted on either side of the foil screen, either on wooden battens or in cases.

The spacing of the lamps will best be found by experiment. They can be mounted close together about six feet away from the foil, but the light will be restricted to a small area on the foil (Fig. 11). However, by doing this, some colour mixing can be achieved.

If there is an apparent gap in the centre of the screen, use two lamps to project from the centre near the floor. The small pictures on the front cover will give some idea of what can be done.

### ADDING VARIANTS

There are some simple variations that the reader will want to try, such as suspending twists of foil strips, each about 2in wide from cotton just in front of the screen. Any ambient heat in the room will encourage the twist strips to rotate while the light shines on them.

The screen could be made entirely of freely suspended narrow strips that can move, but no movement should be violent or the effects will be spoilt.

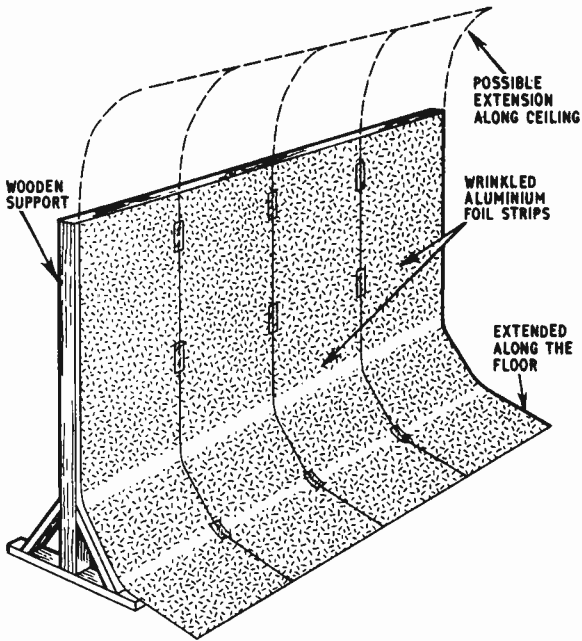


Fig. 10. Simple wall of wrinkled aluminium foil for direct front projection of coloured light

arrangement. An example of their applications would be as an exhibition centre piece. Several other arrangements can be devised and it is well worth the constructor's time to sit down with pencil and paper and plan a system suitable to the setting.

If a less formal display is required, maximum use can be made of walls, ceilings or other fixtures to convey the light patterns.

### ALUMINIUM WALL OR SCREEN

One experimental system that was tried successfully at *Sound '71* exhibition was a wall of wrinkled aluminium foil (Fig. 10). A simple timber framework was used to hang domestic cooking foil; heavy duty foil is recommended and in fact a caterer's pack size would be particularly suitable.

The foil is hung from the top cross bars of the frame, fixing with transparent adhesive tape. Try not to fold over or crease the foil during the setting up, otherwise undesirable crease lines will remain.

When hung, just tack together the adjacent vertical edges of the strips to hold the whole screen fairly stable. The strips of foil could be made to extend about four to six feet along the floor in front of the foot of the wall. This will then give

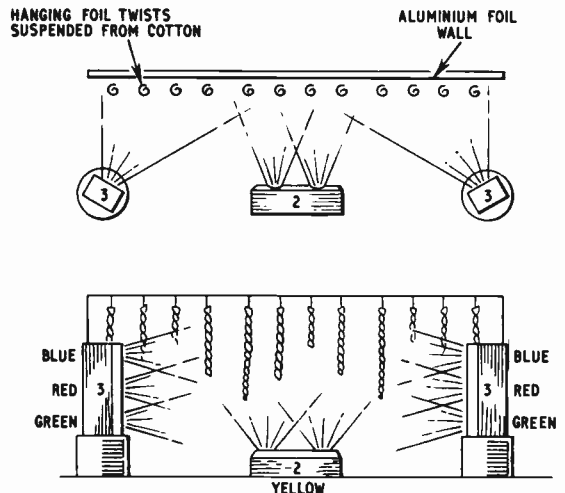


Fig. 11. Suggested positions of the eight coloured lamps in relation to the aluminium wall

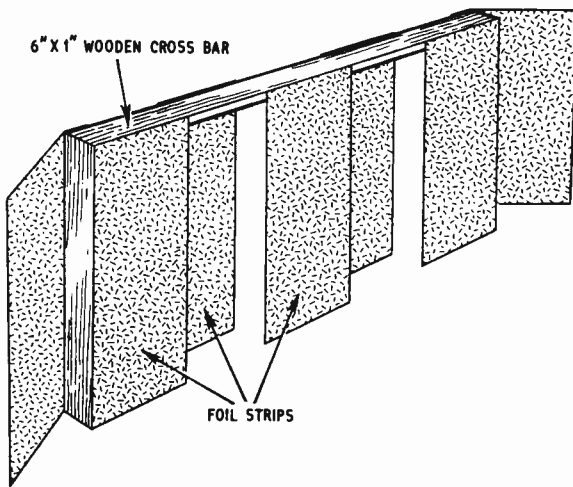


Fig. 12. Staggered foil strips on a 6in wide supporting batten

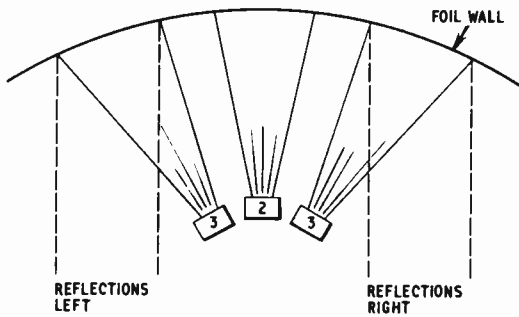


Fig. 13. "Cinemascope" concave mirror of foil

Try staggering the positions of the large foil strips on either side of a 6in board (Fig. 12).

One of the simplest and cheapest ways of displaying the light is by projecting across a ceiling, especially one that has the modern stipple finish texture. The lamps are fitted below ceiling level, perhaps on the top of a pelmet. The result is a changing ambient coloured light that is not too violent to the eyes, but spread over large areas of the ceiling.

### SUBTLE CHANGES

When setting up any colour light display, always bear in mind that the "P.E. Aurora" system was designed for subtle changes in light intensity without flashing. The degree of change and the speed of switching will depend on the music driving the system, but overall one should not expect to get harsh flashing unless the preset controls in the electronics are incorrectly set up.

Follow the setting up instructions given in the earlier articles, and experiment fully with light positioning. Earlier notes on using patterned glass or coloured Perspex apply equally well, whatever the type of display you choose.

In any house there are many objects, from cheese-graters, to glass ash trays which can be used as a starting point in the experiments of displaying light. From these simple beginnings the reader can progress to the manufacture of optical elements more tailored to his own needs and finally to systems of switching and dimming of the light sources.

Next month's article will discuss some alternative methods of driving the lamp controller and included will be a random digital sequencer which triggers the lamp channels in all possible sequence codes.

The best display for this method, which incidentally does not require the use of filter circuits, is to matrix the channels to get maximum number of bulbs operating. This is typically a "Christmas Tree" effect suited to displays of random flashing lights, and is ideal for the 'geometric displays described earlier in this article.

Note: In Fig. 21 last month (page 505), C19 should be C24.

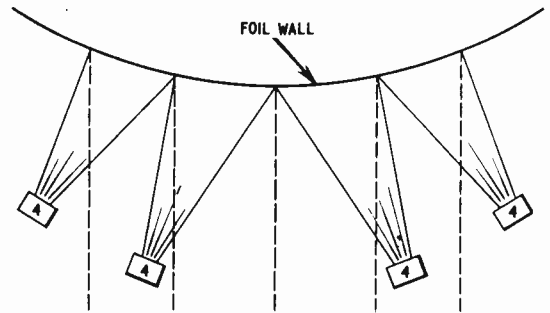


Fig. 14. Convex side projection

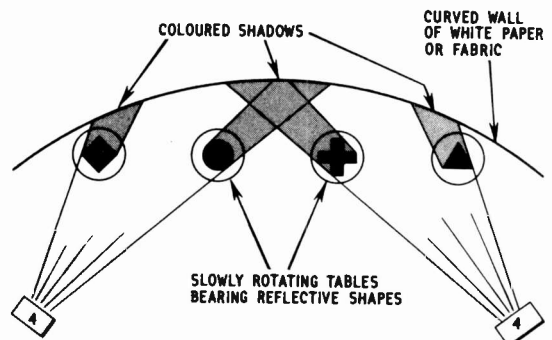


Fig. 15. Rotating reflective shapes in front of a curved white screen

# Gerry Brown . . . ON THE FRINGE

## BITTER SWEET

When next you are mucking about in your workshop, or study, with an audio frequency tone generator do be careful to make certain that you don't happen to be eating, or swallowing a mouthful of beer, at the same moment. Why? Well you just might be on the wrong frequency!

Sounds idiotic, I know, but the Danish psychologist, Dr Kristian Holt-Hansen, has recently indicated that there definitely seems to be a strong connection between the perception of sounds and taste.

In his experiments, subjects have reported that quite widely varying foods and drink seem to relate with specific frequencies at which they taste best. Apparently, when the pitch of the sound was taken either above or below this specific tone the taste became less pleasing; furthermore, a unique "harmony-tone" could be shown to exist for each taste.

The really interesting point, I think, is that the subjects were almost unanimous in agreeing that each food had a tone-pattern which was the same for every person being tested.

With the diminishing prices of i.c.'s, one can conjecture that it will not be long before some enterprising individual puts a vinegar on the market that has all the bouquet of a good wine provided that the battery, driving an oscillator built into the bottom of the bottle, doesn't go flat!

## CHICKEN

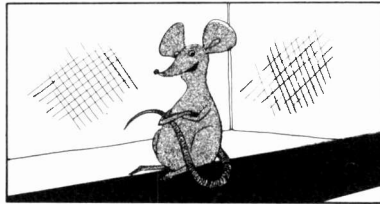
Don't ask me why, but a farmer friend of mine was telling me, over a glass of beer the other day, that he wanted to be able to determine the movements of a particular cockerel he owned.

However, this had caused him some head-scratching at the time, because a photo-cell technique would have been useless in the application due to its inability to discriminate between one bird and another. He had also thought of using a radio-active tracer, but decided against that on the grounds of contamination.

His final solution to the problem was to attach a tiny magnet a little way up the chicken's leg and use this to cause a movement on the needle of a compass buried a couple of inches in the ground. The needle movement was sensed by a simple pick-up coil and the output fed to a low-frequency amplifier connected to a delay circuit and relay, Fig. 2.

Whenever the cockered walked over the compass the needle would spin and thereby induce a current in the sensing coil. After amplification and a short time delay it operates the relay which activates a counter.

I understand that this fowl plan was eminently successful!



## PSI EFFECT

One can never fail to admire the fortitude of the psychic researcher. An example which perhaps typifies what I mean has been set recently by Professor Rhine of Duke University, North Carolina.

Because the rules of human studies in the ESP (extra sensory perception) field have proved so indeterminate, he has chosen to use mice in his studies.

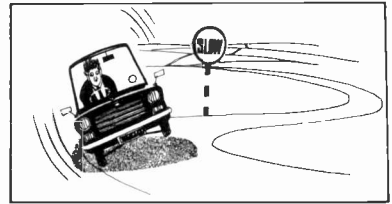
In the tests, the mice are placed in a cage which has a low lengthwise division which forms a barrier the mice can jump over easily when escaping from a harmless electric shock applied randomly through the floor on one or other sides of the partition. Although the shocks are applied randomly, relative to sides, they occur at regular times and so the mice have the chance to develop "hunches" about which side of the barrier the shock will occur and either jump or not, as the case may be.

Statistically they ought to be correct 50 per cent of the time, but (mice being what they are) this worked out to be 54 per cent! Precognition? Rhine seems to think so; in fact he goes so far as to say that he believes the whole of the animal world may have this power.

Who can say; certainly it's beginning to look as though there might just be something in what he says.

Believe it or not, I was reading a paper only today, by J. L. Randell, entitled "Experiments to Detect a Psi Effect with Small Animals". And the animals? Would you believe woodlice?

Suffice to say that these experiments appear to have proved positive and are backed by good solid mathematical logic.



## ROUND THE BEND

Motorcyclists have a term for a particular form of enjoyment known to their fraternity as "bend-swinging". Simply, this amounts to laying one's machine over at an angle approaching the horizontal when navigating the various bends in the road.

Whilst this kind of amusement can be dangerous, even for motorcyclists, the similar practice of "taking 'em as fast as you can" could be positively prohibitive in a car when one has little or no idea of the banking-angle/speed required to turn the vehicle completely over!

Since it is difficult to determine just how close a car is to instability at such times the little device given in Fig. 1 should help provide the warning required. The device comprises a pair of mercury switches, suitably mounted on the bulkhead of the car, interconnected with some form of "attention-getter" like a buzzer or an oscillator.

In use, if one enters a bend too fast without much conscious thought, the centrifugal force acting on the car will cause the mercury to climb the walls of the relevant switch and so close the circuit to give warning to reduce speed.

A similar device I built for my "wagon" has proved to me just how easy it is to be lulled into a false sense of security and exceed the limitations of the vehicle.

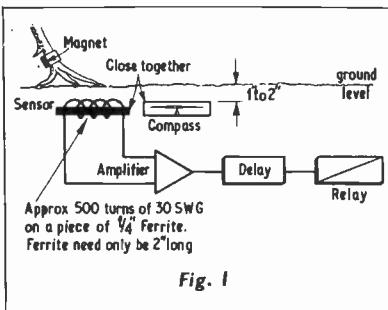


Fig. 1

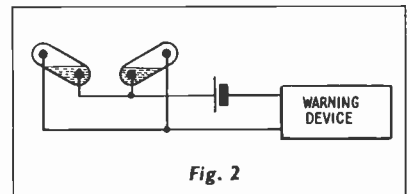


Fig. 2

CN 15 Watts. Ideal for miniature and micro miniature soldering. 18 interchangeable spare bits available from .040" (1mm) up to 3/16" For 240, 220, 110, 50 or 24 volts.

from £1.70

*Sign here!!*

for your miniature soldering iron.

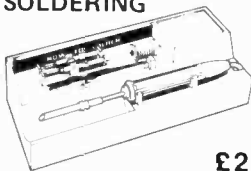
### SK2 Soldering kit

In polystyrene pack, containing 15 watt miniature soldering iron, 240 volts fitted with  $\frac{3}{16}$ " bit, 2 spare bits  $\frac{5}{32}$ " and  $\frac{3}{32}$ ". Coil of resin-cored solder, heat sink, 1A fuse and booklet "How to Solder".



£2.40

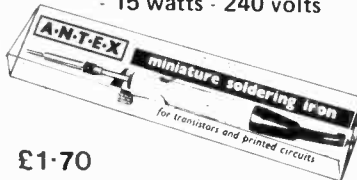
### SK1 SOLDERING KIT



In rigid plastic "tool box" containing Model CN - 15 watts - 240 volts miniature iron fitted  $\frac{3}{16}$ " bit. Spare bits  $\frac{5}{32}$ " and  $\frac{3}{32}$ ". Reel of resin-cored solder, heat sink, cleaning pad, stand and booklet "How to Solder".

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## THAT SPECIAL PROBLEM

*continued from page 545*

and advertisements suggest that this is wise. Bearing in mind the volatile state of the electronic component market (and the inevitable lapse between going to press and publication) it would be hardly surprising if we slipped up on occasion. With regard to the more exclusive type of components, we always verify that they are listed either in the manufacturer's or a distributor's catalogue. It remains for the retailer to make his own arrangements to procure such items.

A further suggestion that we should restrict our contributor-designers to "popular" components is quite untenable: it is defeatist and unrealistic. Any magazine that has pretensions to be known as serious and forward-looking must at times venture beyond the wares displayed by the average retailer. And indeed how do components become "popular"? Often because of the attention originally drawn to them through some interesting and appealing project published by a magazine. Public demand then encourages traders to locate a source of supply and to incorporate such items in their catalogues and lists.

Component availability is a big and important subject. It involves a number of different trading organisations operating at different levels. The market they endeavour to serve is composed of a vast number of individuals, whose requirements are bound to be diverse in the extreme. Some contentious issues emerge when this matter is discussed openly, but we must all try to appreciate the difficulties and problems of others involved in this business.

Finally, although it is but little consolation, it is perhaps worthwhile remembering that industrial users have similar difficulties and often have to endure long delays for some components.

F.E.B.

*A representative selection of letters from the large correspondence received on this topic appears in Readout this month, page 581*

## BACK NUMBERS

We very much regret that Back Numbers of PRACTICAL ELECTRONICS can no longer be supplied. Consequently, it is now more important than ever to place an advanced order with your newsagent to make sure of getting your copy.

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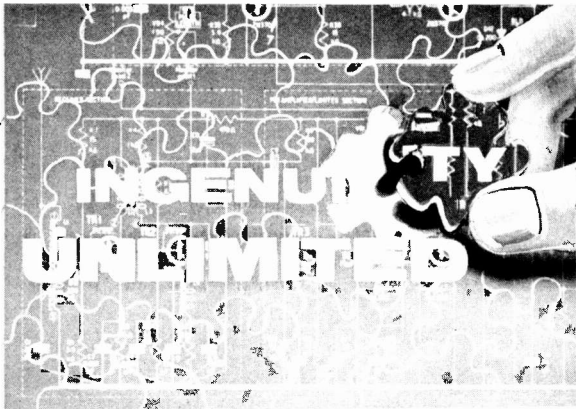
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**PRACTICAL  
ELECTRONICS**

ON SALE JULY 16



A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. This is YOUR page and any idea published will be awarded payment according to its merit.

## TEMPERATURE CONTROLLER

THE temperature controller circuit shown (see Fig. 1) was initially designed for keeping cactus seeds at a constant 40 degrees Fahrenheit in a greenhouse. However, when the circuit was constructed it was found that by adjusting the potentiometer VR2 it would keep a room or greenhouse at a constant temperature from 30 degrees to 90 degrees Fahrenheit,  $\pm 3$  degrees.

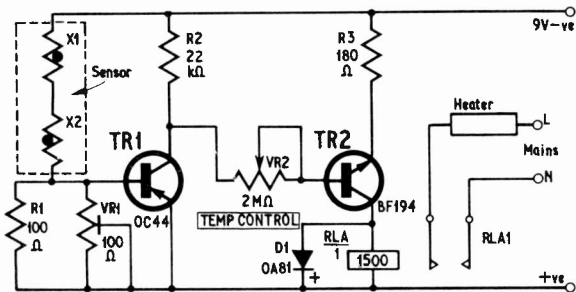


Fig. 1. Circuit diagram of the temperature controller. The thermistors X1 and X2 are types VA1070 as used in television heater chains and are rated at 0.3A

The combined resistance of R1 and VR1 gives fine control over the forward bias of TR1. It was found in practice that TR1 continued to function perfectly with no thermal runaway component in the circuit; even in the hottest condition.

The relay was the only one available at the time, its working voltage was 20V, although it pulled in at 7.5V and the coil resistance was 1.5 kilohm. A relay of a lower working voltage would obviously improve the performance of the circuit.

When setting up the controller, the end of VR2 connected to the collector of TR1 should be disconnected and a voltmeter connected between the collector and the positive line. VR1 should be adjusted to give a meter reading of 7.5V. When VR1 has been adjusted to give the correct setting the meter should be removed and VR2 reconnected—the controller is now ready for use.

It should not be difficult to replace the relay with a thyristor. This should be done by omitting RL1 and D1, replacing this with a 1.5 kilohm resistor. The collector of TR2 could then operate the gate of a thyristor to switch on the heater. This has not been tried in practice.

A. D. Huff,  
Dagenham,  
Essex.

## POWER SUPPLY CUT-OUT

IN transistor power supplies there often arises a need for a simple overload cut-out circuit. The one shown in the circuit diagram Fig. 2 uses a minimum number of components, is quite fast-acting and is extremely versatile in application.

The resistor R1 sets the limiting current, which can be anything from a few milliamps to the maximum current rating of the relay contacts. When the limiting current is reached, the transistor is turned on by the voltage across R1 and the relay contacts open, thus isolating the power supply from its load and at the same time providing a self-latching effect which drives the transistor even harder into conduction. The circuit can be reset by a push-button switch across the relay contacts. An overload indicator lamp LP1 may be used if a relay with change-over contacts is incorporated in the device.

No component values are given for R1, TR1 and the relay as these will depend on the individual power supply. The transistor should be silicon; adequately rated to withstand the current requirements of the relay and the voltage of the power supply. For supplies using a negative earth a *pn*p transistor is used, and D1 is reversed.

The relay should have a switching voltage about 5 volts less than the supply voltage.

The value of R1 can be found approximately from the following formula

$$R1 = \frac{0.6}{\text{Limiting current}} \text{ Ohms}$$

The value is, however, best found by experiment after using the above formula to find the approximate value.

G. H. Birkinshaw,  
Brimington,  
Chesterfield.

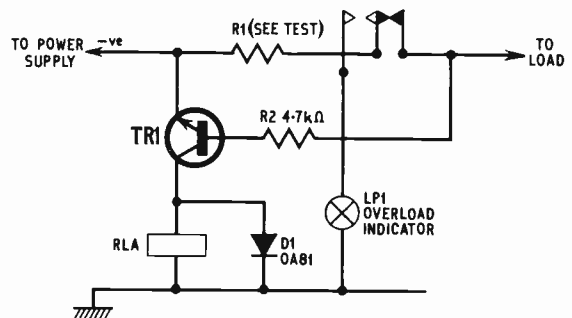
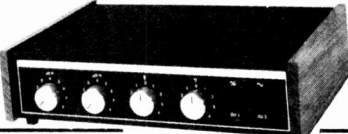


Fig. 2. Circuit diagram of the power supply cut-out

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BSY28	0-13	OC28	0-30
BSY29	0-13	OC35	0-25
BSY95A	0-15	OC36	0-37
OC41	0-13	AD149	0-30
OC44	0-13	AUY10	1-25
OC45	0-13	2S034	0-25
OC71	0-13	2N3055	0-63
OC72	0-13		
OC73	0-17	<b>Diodes</b>	
OC81	0-13	AA42	0-10
OC81D	0-13	OA95	0-10
OC83	0-20	OA79	0-09
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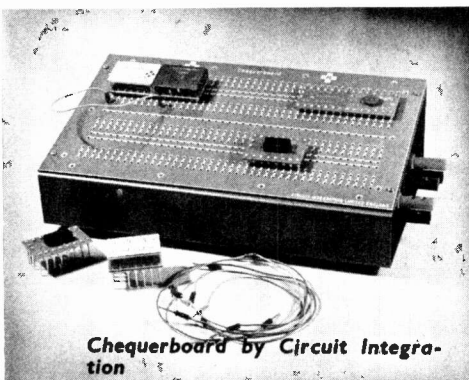
# MARKET PLACE

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

## EXPERIMENTER'S BOARD

The Chequerboard system by Circuit Integration Ltd comprises a series of patchboards and component carriers designed to facilitate the design, construction and proving of logic systems.

The patchboards, which can accommodate from 12 up to 48 14-pin carriers according to size, consist of a series of sockets on pin centres into which the carriers are plugged. The arrangement of these sockets is such that each pin of the carrier has two further sockets connected to it, so that interconnections can be made with the patchcords provided.



**Chequerboard by Circuit Integration**

Power is conveyed to each carrier through two special pins which engage in further rows of bussed sockets, placed so that the carriers cannot be inserted the wrong way round. The power busses are wired to sockets on the side of the patchboard so that connection may be made to a suitable power supply.

Although the emphasis is clearly on digital circuits, one of the patchboards has an extra row of bussed sockets which allows for the provision of the +, 0, - supplies required by many linear circuits.

A wide variety of 14 and 16-pin carriers is available. The 14 and 16-pin DIL, 8 and 10-pin TO5, and flat-pack i.c.'s can all be accommodated, either by soldering to a blank carrier or, more usefully, by plugging into carriers which have the appropriate sockets on them. A

plain carrier enables units to be constructed from discrete components. A very good point is that provision is made on each carrier for decoupling the supply lines.

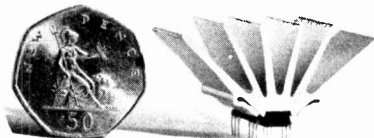
The system also includes a number of pre-wired modules which include a switch unit, a pulse generator, an indicator unit with three filament lamps, and several TTL gates and flip-flops. It would perhaps be less confusing if the indicator unit followed the normal positive logic convention, i.e. lamp ON for a positive, rather than a zero, input level.

The complete system has been well designed and certainly makes the wiring-up of a prototype logic circuit a very simple and rapid operation. The totally enclosed and very rugged construction will commend it to industrial and educational applications, although the price will probably put it out of the reach of all but the most dedicated amateur.

Full details and price list for the Chequerboard system is available from Circuit Integration Ltd., Canal Street, Runcorn, Cheshire.

## SUPER I.C.

After two highly successful years, the Sinclair IC-10 integrated circuit



**IC-12 marketed by Sinclair Radio-nics**

amplifier has had to give way to a successor.

Designated the Super IC-12 it has all the virtues of the original IC-10 but with the following improvements: greater output; lower quiescent consumption; works on any voltage from 6 to 28V, without adjustment; full output into 3, 4, 5 or 8 ohms and a specially designed built-in heatsink.

The output claimed is 6W r.m.s. continuous (12 watts peak). Frequency response is quoted as 5Hz to 100kHz  $\pm 1$ dB. The total harmonic distortion is claimed to be less than 1 per cent (typically 0.1 per cent) at all output powers and all frequencies in the audio band. The quiescent current stated is 8mA at 28V. Input impedance is 250 kilohms nominal and the load impedance is 3 to 15ohms.

With the addition of very few external resistors and capacitors the Super IC-12 makes a complete high fidelity audio amplifier suitable for use with pick-up or f.m. tuner. For more elaborate systems it can be used in conjunction with modules from the Project 60 Range.

Each Super IC-12 is supplied with a comprehensive Manual giving full circuit and wiring diagrams for numerous applications including high fidelity amplifiers, car radios, and oscillators.

The price of the Super IC-12 is £2.98 including a printed circuit board for mounting.

## STYLUS BALANCE

Calibrated in  $\frac{1}{4}$  gram divisions, the Bib Model 32 stylus balance is claimed to be the first balance designed for determining the pressures of modern cartridges.

It has a non-magnetic base mounted on foam plastic and the crossbar of the beam has recesses which are mounted on a pair of pivot points. The end of the pivot boom has a red rubber insert on to which the pick-up stylus has to be lowered.

The price of the Bib model 32 stylus balance is £1.80 and as the balance will only be used occasionally, it is packed in a robust plastics case.



**Bib Model 32 stylus balance from Multicore Solders**

## LITERATURE

A comprehensive publication on Stroboscopes is available from Dawe Instruments. Written by W. V. Richings, the Company's Technical Director, it describes the basic principles of stroboscopy and the various stroboscopic devices, with particular emphasis on the modern electronic stroboscope using a high-power discharge lamp.

The design criteria and technical features of stroboscopes are discussed and details are given of accessories and typical applications.

It provides a guide to the subject for technicians, production personnel and students. It is available free on request from: Dawe Instruments Ltd., Concord Road, Western Avenue London, W3 0SD.



Fully variable, self contained, low voltage, d.c. stabiliser.

# VOLTAGE

By  
A. J. Ewins

# STABILISER

MANY home constructors must have required a fully variable, d.c. low voltage supply when experimenting with electronic circuits. One solution is, of course, to construct a fully variable, mains powered, stabilised power supply. However, there are the odd number of occasions when a mains supply is not available and a battery is the only source of power. With this in mind, the author has designed a self-powered, electronic, voltage stabilising control unit, the design and construction details of which are given in this article.

The stabiliser can accept input voltages of up to 85 volts d.c. (depending on the output voltage setting) and provide a fully variable stabilised output voltage from 0 to 30 volts d.c. at up to 250mA

load current. To obtain a stabilised output voltage the input voltage must exceed the required level by 2 volts. The stabiliser draws virtually no current from the external supply and is completely self-contained. Automatic current limiting is built into the unit and can be set to any one of five values, namely, 10, 25, 50, 100 or 250mA.

By connecting a resistor across the output terminals, a constant current is available between the external voltage supply and the input terminals of the stabiliser. The value of the constant current is determined by the value of the load resistor and the output voltage setting of the unit. It can be set to any value from 250µA to 250mA.

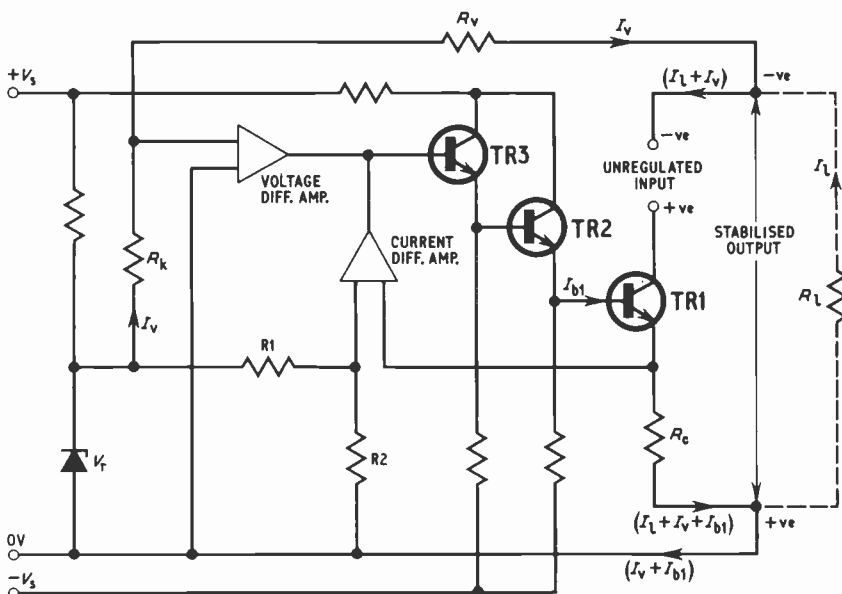
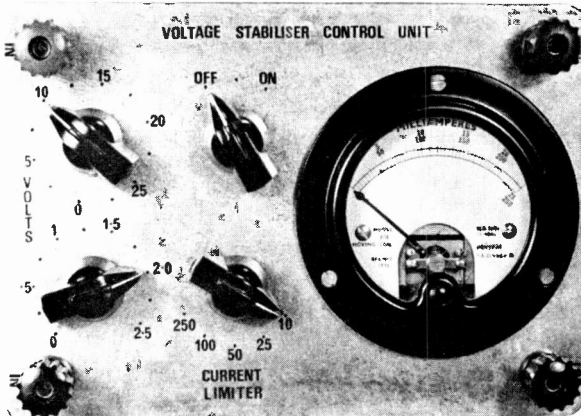


Fig. 1. Block diagram showing fundamental stabiliser

## PRINCIPLE OF OPERATION

The complete circuit diagram of the unit is shown in Fig. 2. In order to understand the operation of the circuit it is shown in simplified, block diagrammatic form in Fig. 1. The output voltage of the unit is determined by the values of  $V_r$ ,  $R_k$ , and  $R_v$ , and is equal to,  $V_o = V_r \cdot R_v / R_k$ , since both inputs to the voltage differential amplifier will be zero volts when the output is stabilised and thus,  $I_v = V_o / R_v = V_r / R_k$ . The output voltage,  $V_o$ , is directly proportional to  $R_v$  if both  $V_r$  and  $R_k$  are kept constant. Keeping  $V_r$  and  $R_k$  constant has the advantage of maintaining the sensing current,  $I_v$ , constant for all values of the output voltage.



## SPECIFICATION . . .

**Stabilised Voltage Output:** 0 to 30 volts in switched steps of 2.5 volts, plus 0 to 2.5 volts, fully variable. Input voltage must be between 2 and 55V in excess of output level required.

**Constant Current Capability:** 250 $\mu$ A to 250mA, continuously variable.

**Current Limiting:** Five ranges: 10, 25, 50, 100 and 250mA.

**Accuracy of Output Setting:** 1 per cent on all switched voltage ranges.

### Stabilised Voltage Stability:

- $\pm 0.1$  per cent for variations in the input voltage of from 2 to 35 volts in excess of the output voltage.
- $\pm 0.1$  per cent for variations in the external load from 0 to 250 mA.
- $\pm 1$  per cent for normal room temperature variations
- $\pm 0.1$  per cent for variations of  $\pm 10$  per cent of the unit's internal battery supply voltages.

**Output Impedance:** Less than 0.03 ohms over audio frequency range (No current limiting).

**Ripple Voltage:** Less than 2mV peak-to-peak on full load (when used with a full-wave rectified unregulated supply of 35 volts output).

Providing the output current is below its limiting value, the output voltage is stabilised and the current flowing into the base of TR3 is controlled by the voltage differential amplifier. (Both the voltage and current differential amplifiers are in fact voltage differential amplifiers; the words "voltage" and "current" are used to describe the function that the corresponding differential amplifiers control, i.e. the "voltage" differential amplifier controls the output voltage and the "current" differential amplifier controls the limiting current).

When the output current nears its limiting value, the voltage developed across  $R_v$  nears the reference voltage level fed to the current differential amplifier, which is equal to  $V_r \cdot R_2 / (R_1 + R_2)$ . The result of this is that current is drawn away from the base of TR3 by the current differential amplifier thus reducing the output voltage in order to maintain a constant current through  $R_v$ .

When completely current limiting the current differential amplifier has full control over the current flowing into the base of TR3, the voltage across  $R_v$  is stabilised at a value equal to  $V_r \cdot R_2 / (R_1 + R_2)$  and the current flowing through  $R_v$  is maintained at a constant value equal to  $V_r \cdot R_2 / (R_1 + R_2) / R_v$ . Because the currents  $I_{b1}$  and  $I_v$  are flowing through  $R_v$  in addition to the load current,  $I_L$ , the output current in the limiting condition is given by the expression:

$$I_L = V_r \cdot R_2 / R_v \cdot (R_1 + R_2) - I_{b1} - I_v$$

Now, the current flowing through  $R_v$  is also equal to the emitter current of TR1,  $I_{e1}$ , which is equal to  $(\beta_1 + 1)I_{b1}$ , where  $\beta_1$  is the current gain of TR1. Thus  $I_{b1} = I_{e1} / (\beta_1 + 1)$  and  $I_L$  becomes:

$$I_L = \beta_1 \cdot V_r \cdot R_2 / R_v \cdot (R_1 + R_2) / (\beta_1 + 1) - I_v$$

Thus, providing  $\beta_1$  is very much greater than one,  $I_L$  is approximately equal to:

$$V_r \cdot R_2 / R_v \cdot (R_1 + R_2) - I_v$$

Current  $I_v$  has a maximum value of  $V_r / R_k$  when the output voltage is stabilised (designed to be 250 $\mu$ A) and will have a value of approximately  $V_1 / R_v$  when the output voltage is reduced to a value  $V_1$  due to current limiting.

## GENERAL CIRCUIT DESCRIPTION

Returning now to Fig. 2 it will be seen that transistors TR2 and TR3 form the voltage differential amplifier in a conventional long-tailed pair circuit. Transistors TR5 and TR6 form the current differential amplifier, again in a conventional long-tailed pair circuit. Matched pairs of 2N3707's are used for the two differential amplifiers but virtually any pairs of npn silicon transistors with a current gain of greater than 100 at a collector current of 100 $\mu$ A will do.

The common collector load of transistors TR3 and TR6 is made to appear very high by employing a constant current source provided by TR4. The emitter resistor of TR4 and the Zener diode, D1, determine the value of this constant current which is designed to be 100 $\mu$ A.

When the output voltage is stabilised (i.e. no current limiting) transistor TR6 is cut-off since its base voltage is below the value of the base voltage of TR5 with the result that all of the 100 $\mu$ A constant

current, except that which flows into the base of TR7, flows through the collector of TR3. Any change in output voltage is inversely reflected at the base of TR2. A drop in the output voltage raises the voltage at the base of TR2 above zero and hence raises its emitter voltage. As the base of TR3 is connected to the zero volt line, by way of R20, a rise in its emitter voltage starts to cut the transistor off directing more of its collector current into the base of TR7. This in turn increases the current into the bases of TR8 and the series regulator, TR9, reducing TR9's effective resistance and therefore the voltage dropped across it. The output voltage is thus restored to its original stable value.

When the current through the emitter resistor of TR9 reaches the limiting value the voltage at the base of TR6 equals or nears that at the base of TR5 with the result that TR6 starts to conduct, drawing some of the current away from the base of TR7. When this starts to happen the output voltage drops, TR3 starts to cut-off and the 100 $\mu$ A constant current supplied by TR4 comes under the control of TR6. Any variation in the current flowing through the emitter resistor now controls the amount of current flowing into the base of TR7 and hence the current through TR9 emitter resistor. The output voltage is therefore automatically adjusted to maintain a constant current through TR9 emitter resistor.

## REFERENCE VOLTAGE

The reference voltage circuit consists of D1, TR1, R12, R13, and D2. The transistor, TR1, is fed with a stable voltage at its base by D1. The emitter resistor (R13) determines the values of the emitter and collector currents of TR1. Zener diode D2 is in the collector line of TR1 and, since all the currents flowing away from the junction of TR1 and D2 are constant, the current through D2 will also be constant. Thus a stable reference voltage is maintained. Transistor TR1 is a silicon *pn*p transistor operating at a collector current of nearly 5mA. The 2N4289 type specified is entirely suitable in this position, but any *pn*p silicon type with a current gain of the order of 100 at 5mA collector current will be equally suitable.

The silicon diodes, D3 and D4, protect the base of TR2 from any large voltage swings. D2 also prevents the base of TR2 from going more than 0.6 volts positive when current limiting takes place. Any low current type of silicon diode is suitable in these positions.

## REMAINING COMPONENT FUNCTIONS

The 0.47 $\mu$ F capacitor, C2, in parallel with the resistors around S2 and VR2, effectively increases the loop gain of the stabiliser to alternating voltages at the output, with the result that the ripple content is reduced as is the output impedance of the unit.

The 0.001 $\mu$ F capacitor, C3, and the 22 kilohm resistor, R19, connected in series between the collector and base of TR3 reduce the loop gain of the amplifier at high frequencies and prevent instability that would otherwise occur.

The reference voltage for the current differential amplifier is derived from D2 by a potentiometer network consisting of R21, R22 and VR3. The current limiting ranges are set to their correct values by adjustment of VR3.

The resistor  $R_k$  referred to in Fig. 1 becomes R14 and VR1 in Fig. 2. The output voltage ranges are set accurately by adjustment of VR1.

The total consumption of the 9V positive rail is approximately 11mA. Two 4.5V pocket lamp batteries (No. 1289) were chosen for this supply rail because of their large capacity and convenient size.

The total consumption of the 9V negative rail is less than 1mA. A 9V (PP3) battery was chosen for this supply rail because of its small size and adequate capacity.

A 4-pole, 3-way rotary switch (S1) switches the unit on and off. One pole (S1d) is used to control the external supply and the remaining three poles

## COMPONENTS . . .

### Resistors

R1-R11	10k $\Omega$ —see text (11 off)		
R12	1.1k $\Omega$	R23	2k $\Omega$
R13	510 $\Omega$	R24	16k $\Omega$
R14	16k $\Omega$	R25	47k $\Omega$
R15	680 $\Omega$	R26	100k $\Omega$
R16	20k $\Omega$	R27	100k $\Omega$
R17	43k $\Omega$	R28	4 $\Omega$ (see text)
R18	24k $\Omega$	R29	10 $\Omega$
R19	22k $\Omega$	R30	20 $\Omega$
R20	680 $\Omega$	R31	40 $\Omega$ (see text)
R21	16k $\Omega$	R32	100 $\Omega$
R22	5.1k $\Omega$	R <sub>s</sub>	see text
All $\pm$ 5% $\frac{1}{4}$ W, carbon high stabs.			

### Capacitors

C1	10 $\mu$ F elect. 12V
C2	0.47 $\mu$ F polyester
C3	0.001 $\mu$ F polyester
C4	10 $\mu$ F elect. 12V
C5	50 $\mu$ F elect. 100V
C6	0.1 $\mu$ F polyester 250V
C7	10 $\mu$ F elect. 12V

### Potentiometers

VR1	5k $\Omega$ skeleton preset
VR2	10k $\Omega$ wire wound
VR3	5k $\Omega$ skeleton preset

### Semiconductors

TR1	2N4289
TR2, 3	2N3707 (matched pair)
TR4	2N4058
TR5, 6	2N3707 (matched pair)
TR7	2N3707
TR8	BC168
TR9	B5041
D1	3V, 400mW Zener diode
D2	4.7V, 400mW Zener diode
D3, 4	any good low current silicon diode (2 off)

### Miscellaneous

M1	25mA moving coil meter (2 $\frac{1}{2}$ in diameter case)
S1	4 pole 3 way rotary switch
S2	Single pole 12 way rotary switch
S3	4 pole 5 way rotary switch (only 3 poles used)
SK1, SK4	Red screw terminals (2 off)
SK2, SK3	Black screw terminals (2 off)
BY1, BY2	No. 1289 4 $\frac{1}{2}$ V battery (2 off)
BY2	PP3, 9V battery
Veroboard	5 $\frac{1}{2}$ in $\times$ 2in $\times$ 0.15in matrix
Die-cast box	6 $\frac{1}{2}$ in $\times$ 4 $\frac{1}{2}$ in $\times$ 2 $\frac{1}{2}$ in
4B.A. fixings,	connecting wire, knobs for VR2, S1 to S3, material for battery fixing.



connect the unit to the two internal batteries. In the first position of the switch all supplies are disconnected. In the second position the unit is switched on and in the third position the external supply is connected in addition to the internal batteries. This arrangement ensures that the unit is operating before the external supply is connected.

### RANGE SWITCHING

The sensing current,  $I_v$  (see Fig. 1) is designed to be  $250\mu\text{A}$ , which gives a value for  $R_v$  of 4 kilohms per volt. The maximum output from the unit is 30 volts giving a total resistance for  $R_v$  of 120 kilohms. A 10 kilohm wire-wound control (VR2) provides 0 to 2.5 volts fully variable and a twelve position rotary switch (S2), switching in successively

eleven 10 kilohm fixed resistors ( $R_1$  to  $R_{11}$ ), provides 0 to 27.5 volts in 2.5 volt steps. The rotary switch used for this operation is a single-pole 12-way wafer type. Eleven 10 kilohm fixed resistors are required for the construction of the switched ranges; 1 per cent, high-stability types could be used, but they are invariably large and expensive. The author found it more convenient, and cheaper, to use  $\frac{1}{4}$  watt, 5 per cent, high-stabs. of 11 kilohms in value and shunt them, as required, with 5 per cent resistors of values 100 kilohms, 200 kilohms, 390 kilohms and 820 kilohms. This method enables them to be matched to the value of the wire-wound control which is unlikely to be within 1 per cent of its nominal value.

**Next month: construction details**

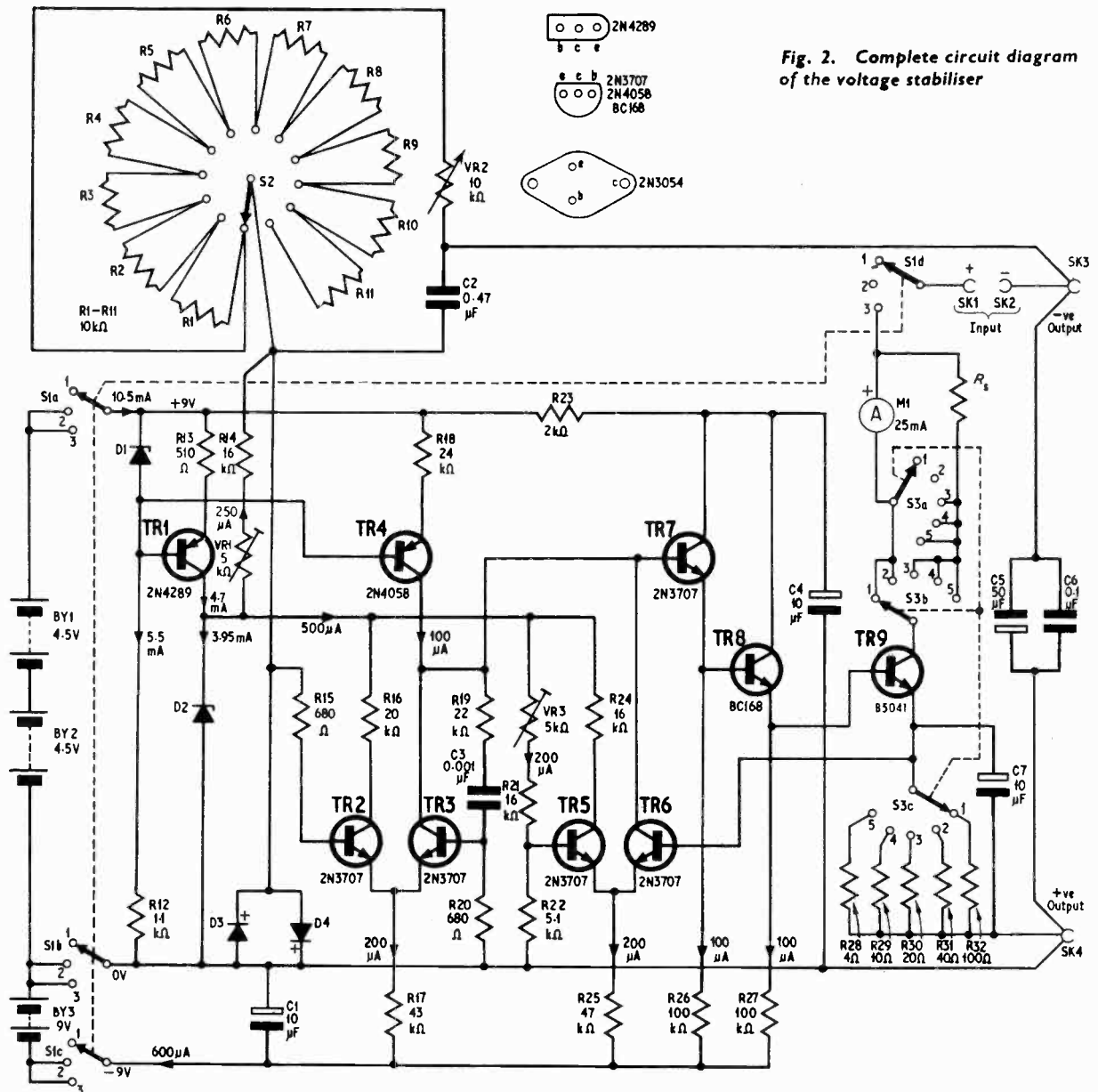


Fig. 2. Complete circuit diagram of the voltage stabiliser

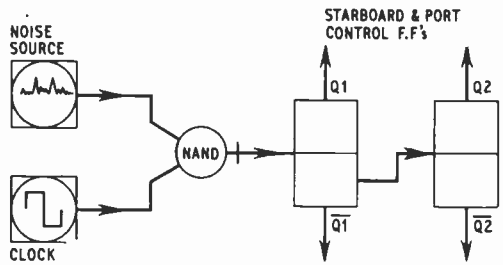


Fig. 6. Basic principle of the noise processing

IN Part I we considered the theoretical aspects of XEE's operational characteristics. This month, in the second and final part, we look at the system logic, construct the animal and perform the various tests.

### RANDOM CONTROL SYSTEM

Since our noise source produces spikes having a high occurrence rate, it is necessary to perform some processing before they can be usefully employed. The concept behind the scheme used here is quite a simple one (see Fig. 6) which shows the basic principle). Noise pulses are fed continuously to the NAND gate, and the clock periodically "lets a few through" to operate the counter.

In the durations between clock pulses, the counter remains in the state previously set by the pulses occurring during the last clock period. It is at such times the counter can be "read" and so provide the required control information for the rest of the animal. It will be seen now that the occurrence rate of the noise pulses in no way affects the rate at which the random control data appears.

The principle is thus one of "throw the dice—look at the result—use the information", and so on. Indeed, a set-up of this type might usefully be employed in a dice throwing machine or, perhaps, a reaction-analyser.

### NOISE PROCESSING

The general idea is shown in Fig. 6, but in practice the system is a little different. In Fig. 5 we see that because JK flip-flops are used we are able to take advantage of the JK function for gating purposes. Hence the effect of the noise pulses at the clock input to the starboard control flip-flop will only be valid at times when the clock applies a logical 1 at both the J and K inputs.

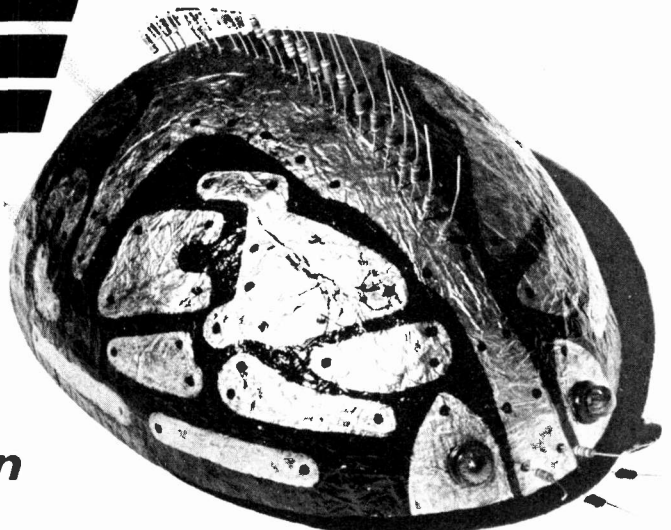
A clearer picture of what happens can be seen from the waveforms given in Fig. 7. From these waveforms it can be seen that during every clock pulse, or "window", the counter represented by the starboard and port flip-flops can be cycled many times before it finally comes to a stop. However, the important point to note is that this operation occurs quite randomly and hence the counter, following a clock period, can be set to any one of its several possible states.

# XEE

## PART 2

*An animal approximation utilising integrated circuits to process optical and tactile sensing together with a random control to give reasonably lifelike responses*

**By G. Brown**



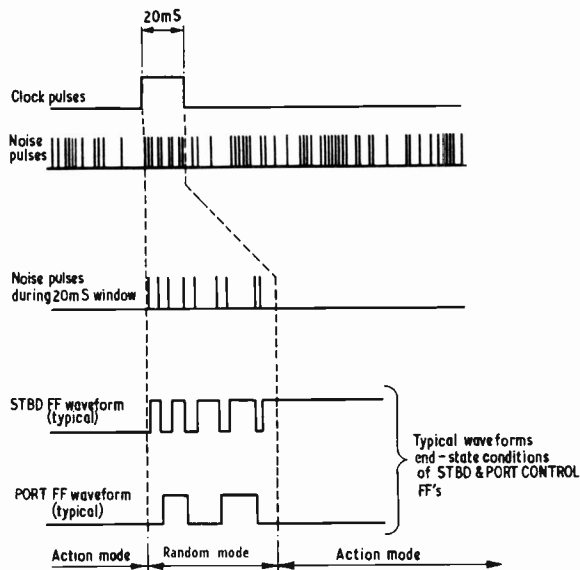


Fig. 7. Waveforms associated with random control system

The random control system has control, either directly or indirectly, over all gating functions within XEE. Since this information is derived from the Q and Q terminals of the flip-flops, the control is complimentary.

### REVERSE GATING

The direction of rotation of the motors is dependent on the outputs at the starboard and port reverse gates. For forward rotation, the inputs to the particular gate must all be at logical 1 (output goes to 0). If both gates are in this condition, the animal will drive forward; if only one gate is producing a 0, the animal will turn either right or left.

If any input to the gates is taken to logical 0, the output will change to a 1, with the result that the corresponding motor will reverse. Both gates in this condition result in reverse drive of the animal.

### INHIBIT REVERSE GATING

Inhibit reverse gating is provided by gates G2 and G3 (IC4); it is part of the stop function and serves to inhibit any reverse command given by the control flip-flops at such times. It is also included to ensure that correct homing on to light sources is provided when the optical sensors are stimulated (this only applies under conditions which will be mentioned later).

### STOP GATING

The stop function, overriding all other functions, is available through the agency of gate G3 (IC1). If both its inputs are at logical 1 then the output is at 0, with the result that all motor supplies are disconnected and the animal stops. If, on the other hand, either or both inputs are at 0, then the output will be 1, permitting resumption of motor operation. The stop gate also controls the inputs to the inhibit gates to ensure that under stop conditions all muscle control relays are de-energised and consequently current in this area is reduced to a minimum.

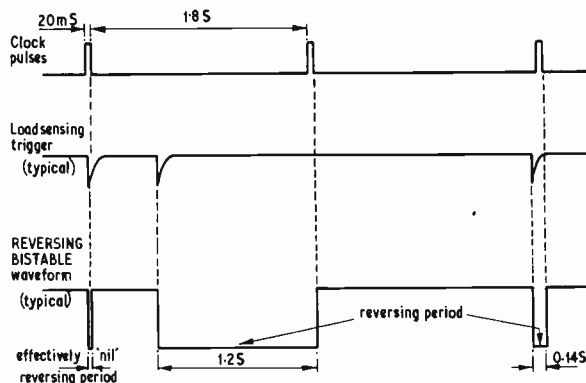


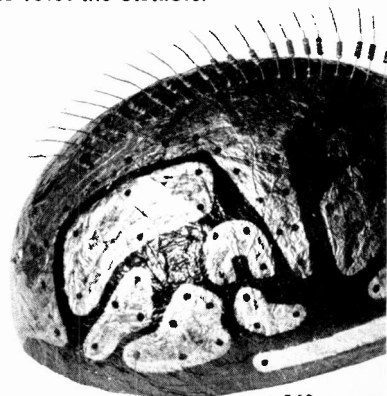
Fig. 8. Waveforms associated with load sensing and reversing bistable

### AVOIDANCE FUNCTION

Application of any load exceeding a given period of time or amplitude will result in the avoidance routine being elicited. This amounts to the animal reversing for a short while then reverting to whatever the random system has currently set. The routine might thus be: reverse and turn left, or right, or stop. Whenever the Schmitt trigger is fired, a negative-going pulse sets the reversing bistable which simultaneously applies a 0 to one input of the reverse gates. Both gates thus return a 1 to the muscle control circuits, and XEE moves backwards.

The duration of the reversing mode is determined by the time interval from when it began, to when the clock pulse arrives to reset the reversing bistable. This will always be random, and can never exceed a complete clock period; take a look at Fig 8, which indicates the type of relationships that can occur between clock and load sensing pulses.

For operation of the reversing bistable it is convenient to think of it being first reset by the clock. Since, at the clock pulse, a 0 is fed to G2 (IC5) its output will go to logical 1. As a result, G1 (IC5) will have one input at the same level, and because its other input is connected to a capacitor (C11), this too is effectively at 1; the output from this gate is thus 0. Due to the cross-coupling between the gates, G2 (IC5) will have one input held at 0 by the output from G1 (IC5). The bistable will remain in this state unless a pulse arrives from the Schmitt; if this occurs, a 0 will be effectively applied to one input of G1 (IC5) whose output will go to 1. As a consequence, both the inputs of G2 (IC5) will then be at logical 1 and its output will go to 0. Again, due to the cross-coupling, this state will exist until the clock pulse arrives to reset the bistable.



## OPTICAL SENSE AND RANDOM FUNCTION

For simplicity, the optical sensors do not boast any lens system, although, of course, there is absolutely no reason why this kind of sophistication should not be included if the constructor wishes.

The way in which the optical sense operates will depend on whether direct sensing is used, or whether the constructor chooses to permit some degree of random control. Since operation of this section of XEE is more easily understood by reference to the direct sensing arrangement, we will consider this first.

### DIRECT SENSING

For this form of sensing, the connections to the input gating marked with an asterisk in Fig. 5, are disconnected. The gates, however, must be left connected in all other aspects otherwise the logic will be affected.

Under dark conditions, when neither of the sensors are illuminated, the animal will be under the control of the random system; it will be either turning in one direction or another, or driving forward. If, say, the starboard sensor is illuminated, a logical 0 will appear at the output of the starboard input gating which will be applied to the inputs of the starboard reverse gate and the inhibit port reverse gate. The former gate will thus show an output of 1 and so cause motor MO1 to go into reverse drive. At the same time, the inhibit port reverse gate's output will be 1, and, provided the remaining inputs to the port reverse gate are also at 1, the additional input will ensure that a 0, and hence forward drive, is established for MO2.

This complementary control over both channels is necessary because, ostensibly, there could be a counter command from the random control system to the opposite channel, when, in fact, no optical input was present on that side.

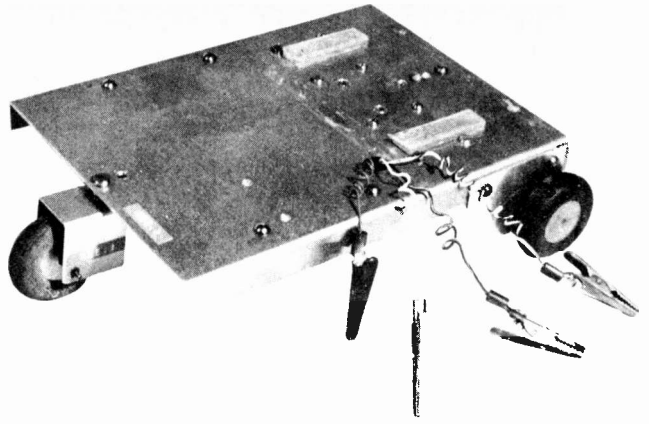
A similar regime will be operative if only the other sensor is stimulated. If both channels are active, though, the effects of the inhibit gates will be nullified, since the reverse gates will each have a 0 on at least one of their inputs, causing them to both return outputs of 1 resulting in XEE driving backwards.

Simultaneous illumination of both sensors is fairly rare, but can be an obvious embarrassment because when it happens XEE will continue its backing routine (up walls, if need be!) until the source of light is removed. A way of overcoming this difficulty is discussed later.

An important aspect of the optical sense is that a form of homing function is permitted. Take the case where light has fallen on the starboard sensor; this will cause a turn to the right. In doing so, the machine will move this sensor away from the source of illumination, but this will also result in the port sensor being brought in to line with the source. If this occurs, the animal will turn left, and so on. Under these conditions XEE thus performs a kind of "serpentine" movement until it is fairly close to the light, when it will suddenly veer off to the left or right.

### RANDOM CONTROL

If the inputs to G2 (IC1) and G3 (IC7) are left connected to the starboard and port control flip-flops,



the optical sense displays quite different characteristics. One interesting point is that XEE no longer shows quite the same zest for mounting walls when in the reverse mode!

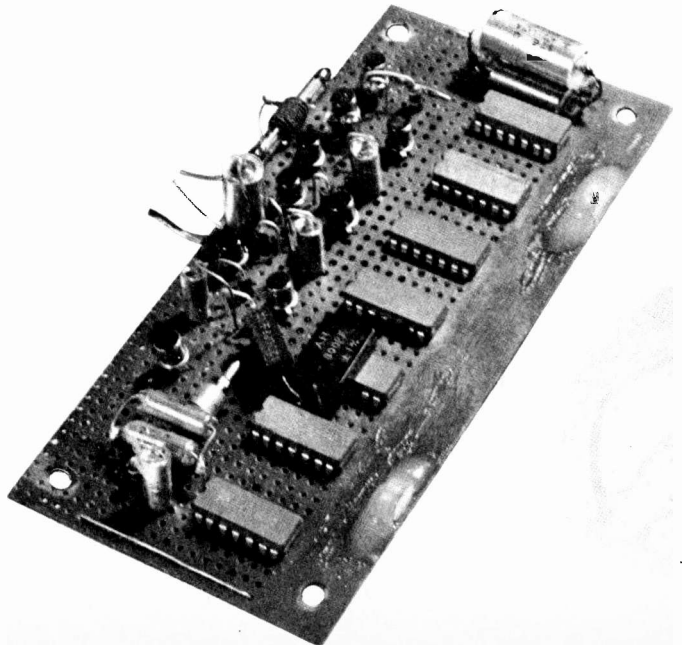
Optical sensing under random control permits XEE to extricate itself from powerful light sources. This is achieved by means of the control over the input gates. As a consequence, even though an input may be present at either of the sensors, unless the relevant gate is in receipt of a 1 from its associated flip-flop, the input will be ineffective.

XEE can therefore (apparently) make up its own mind about what it does, and does not, wish to look at! This does of course mean that in this mode of operation XEE is now free of the fetters that most moths seem unable to shake off.

### CONSTRUCTION

An illustration of the general wiring scheme for the main circuit board is given in Fig. 9. This shows the wiring and layout on Veroboard. Additional, simpler boards which are involved with the muscle control circuits are shown in Fig. 10.

The main board must be drilled in accordance with the chassis holes shown in Fig. 11. The two smaller boards must be cut to the sizes given in the



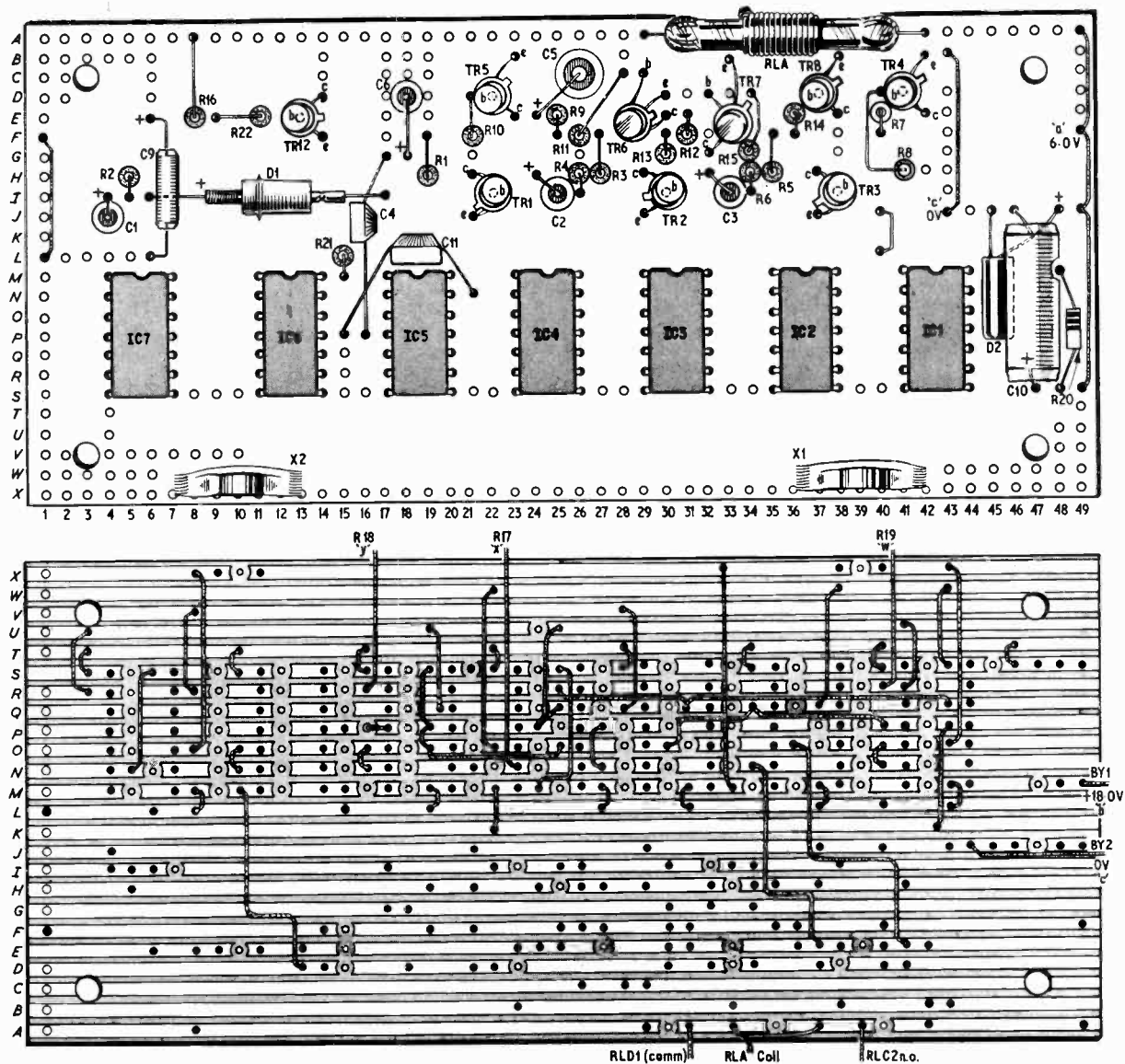


Fig. 9. Layout and wiring of the circuit board

components list. All components are mounted by means of their leads; breaks in the copper strips must be made before the associated components are fitted. It is most important to make sure that the complete width of the relevant copper strip is cut through.

Do not fix the photo-sensors until last since they, almost always, are blessed with thin leads which with little doubt will break off if "man-handled" too frequently!

Mounting of the integrated circuits is best done first; the job is not a particularly difficult one, but it is essential that care be taken to ensure that every one of the 14 leads in each I.C. go through the holes in the circuit board. Attention is drawn to this fact because it is easy to think that all the

leads are poking through the board, when in reality they are not. The trick, if there is one, in fitting the I.C.'s is to ease the seven leads on one side through first, then, with the aid of the three fingers of one hand placed in-line against the edge of the remaining pins, gently locate and press them through the relevant holes. As each I.C. is fitted in this way it is advisable to solder it in place, lest it falls out as the next one is being attached.

Wiring of the circuit boards, and interconnections between them, should be done with thin plastic covered wire. Since the pitch of the holes in the boards is small, the copper lands are necessarily close together and without care it is extremely easy to make accidental bridge-overs. Such errors should be looked for prior to connecting any supplies.

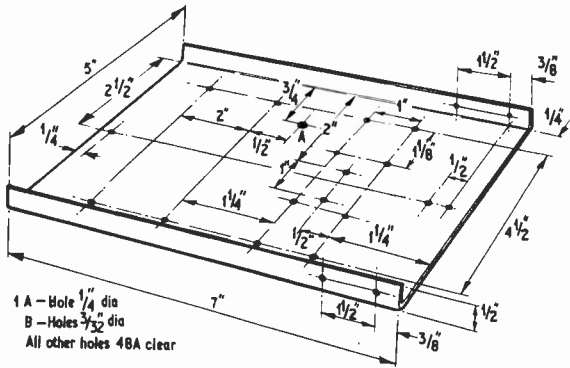


Fig. 11. Chassis details

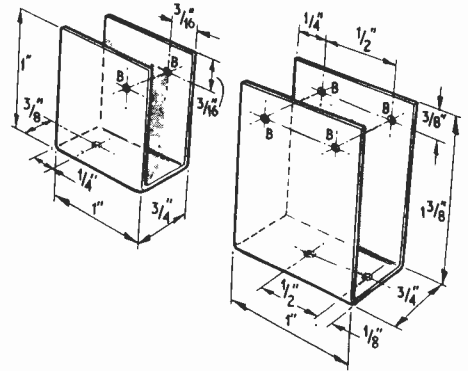
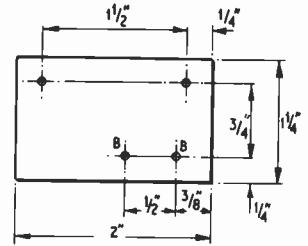
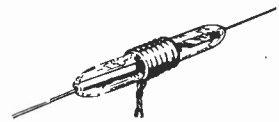
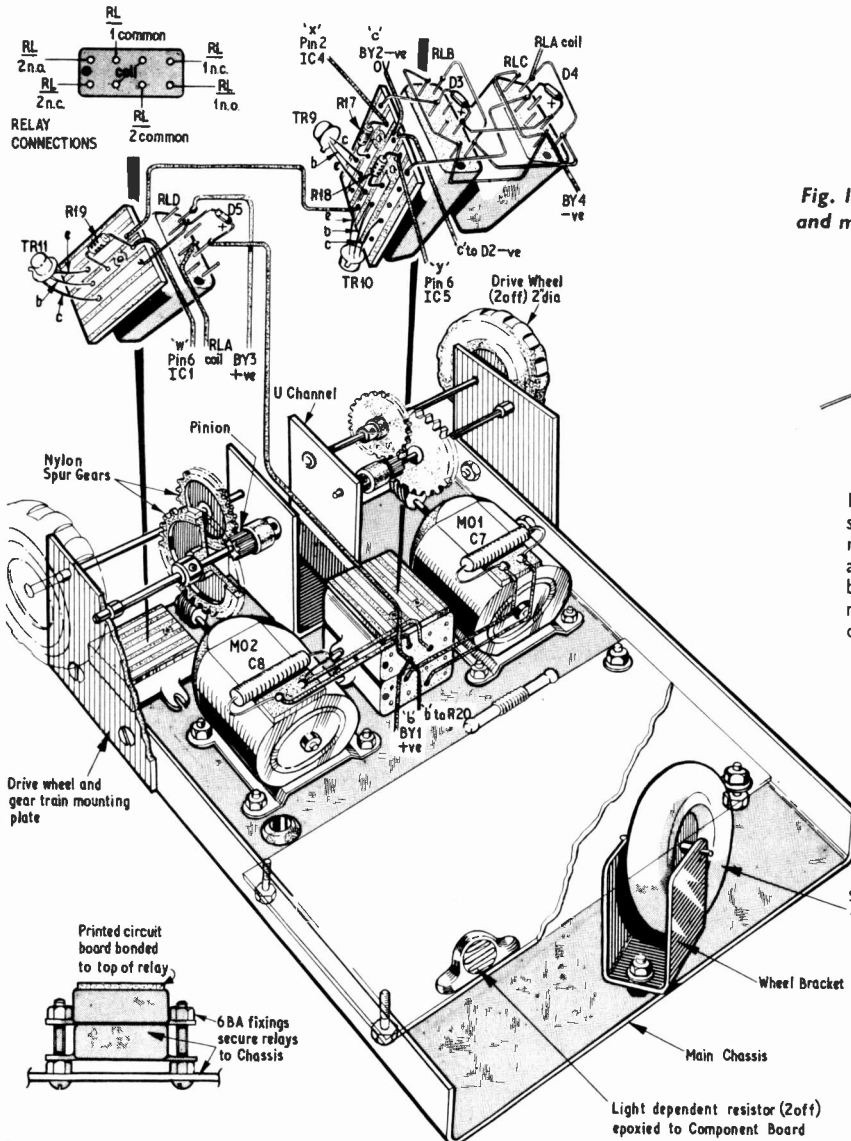


Fig. 10. General layout of XEE and muscle control circuit wiring



In case of difficulty in obtaining the specified relays, any miniature d.p.d.t. relay of the correct voltage, and having a resistance of more than 500 ohm, may be used; although it may prove necessary to mount substitute types on top of the chassis near the batteries.

## LOAD SENSOR

The load sensor, as we previously discussed, employs a reed switch. This is of the 1 inch variety and must have approximately 16 turns of 26 s.w.g. enamel or cotton covered wire wrapped around its middle. The winding should take the form of two eight-turn layers.

During the initial testing the coil will be firmly cemented to the glass envelope of the reed switch, but at this stage the free wire ends to the coil need only be gently twisted together to keep everything from unravelling. An illustration of the complete sensor is shown in Fig. 10.

## OPTICAL SENSORS

The two l.d.r.'s (X1 and X2) should be mounted so that when the board is in position they face forward. If a "body" is to be made for XEE these sensors can be incorporated in the front. Once the l.d.r.'s have been connected-up, an Araldite "fillet" should be made between them and the circuit-board. To ensure a good bond, the board should be roughened with a piece of emery paper just at the places of contact with the epoxy resin.

## INITIAL TESTING

Just before testing, give the boards a visual inspection to make absolutely certain that no dry joints, bridge-overs, or wiring errors exist. The muscle control boards will not need to be checked out now, but will be tested in conjunction with the relays later. Connect points "b" and "c" on the main circuit-board to an 18.0 volt d.c. source; "b" must go to positive, and "c" to the negative. While performing the tests make sure to keep the optical sensors clear from any direct sunlight which could cause ambiguous results.

## RANDOM CONTROL SYSTEM

Connect a voltmeter (set to a range which will measure 6.0V) between earth and pin 13 of the starboard control flip-flop (IC2), and check that approximately every second or so there is a brief flicker shown by the meter. This will be the indication if the clock is functioning correctly. Now disconnect the lead from pin 13 and connect it to pin 10 (IC2). The meter reading should be either a steady 6.0V (logical 1), or very nearly zero (logical 0); this indication should be interrupted about every second by the effect of the clock and noise pulses. It is important that this last reading changes in a random fashion periodically. Next, disconnect the lead from pin 10 and reconnect it to pin 10 on the port flip-flop (IC3). The reading should be similar to the last, to wit, it must change randomly from 1 to 0 every now and then. If no change is observed, then connect the meter between earth and pin 3 of the starboard flip-flop (IC2). In this position it should indicate a regular flickering due to the noise source. If this is not so, the Zener diode D1 should be disconnected and replaced by another one. Sometimes one comes across a particularly "un-noisy" diode, these "good ones" are however no good to us!

## STOP AND REVERSE GATING

Connect the meter between earth and the output of the stop gate. This should periodically change its logical state from 1 to 0, or from 0 to 1. Disconnect

the meter from the stop gate and reconnect it with the output of the inhibit starboard reverse gate. Now disconnect the leads going to pins 5 on the two control flip-flops, and apply the light from a torch to the port optical sensor.

The meter should indicate a logical 1 condition as long as the light remains on. Repeat this test with the meter connected to the output of the inhibit port reverse gate, but with the light applied to the starboard optical sensor. Again the meter should indicate the 1 state all the time that the light remains on. With the light still on, connect the meter to the output of the starboard reverse gate. The meter should again show the logical 1 state. Reconnect the meter with the output of the port reverse gate. This too should be at 1 when the light is transferred to the port sensor. Leave the meter connected for the next test.

## REVERSING FUNCTION

With no light applied to the optical sensors, trigger the reversing bistable by momentarily touching an earth connection on either one of the inputs of G1, IC5 (pins 12 and 13). The meter should immediately indicate a logical 1 condition (if it is not already). This reading should eventually change once the reversing bistable has been reset by the clock pulse and the system returns to the control of the random control section. Connect the meter to the output of the starboard reverse gate. Again trigger the reversing bistable and ensure that the results are the same. Disconnect the meter and the 18.0 volt supply. Reconnect the leads to pins 5 of the control flip-flops.

## CHASSIS CONSTRUCTION

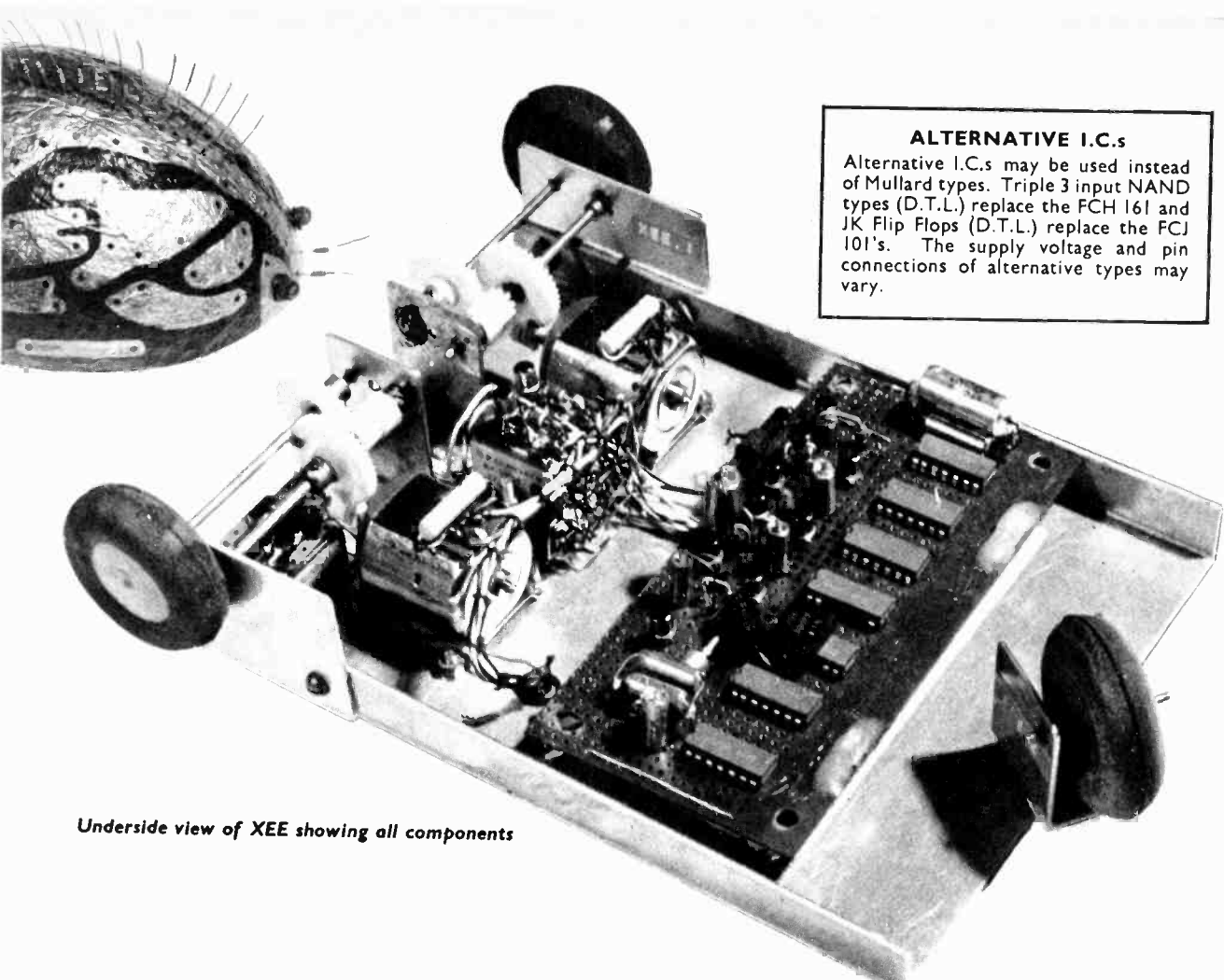
The type of material from which the chassis is fabricated is not particularly critical; for the prototype, 16 gauge aluminium was used. The chassis takes the form of a single piece of material having two  $\frac{1}{4}$  inch right-angle sections folded down the length of its sides. The rear side plates carrying the gear shafts and wheels are mounted on this chassis.

A "U" bracket, situated on the chassis midway between the two side plates, serves to support the inner ends of the gear shafts. A further "U" bracket is utilised for the frontally located castor wheel. All metalwork should be constructed according to Fig. 11. Any bending which is required can be done with the aid of two small pieces of tough wooden plank and a vice.

## MOTORS, GEARS AND WHEELS

As Fig. 10 shows, both motors are situated side-by-side towards the rear of the chassis. Each motor has a friction-fit worm attached to its output shaft, and this is arranged to drive a further shaft at right-angles to it by way of a wormwheel. The gear ratio thus provided is 40:1. This lay-shaft is also fitted with a pinion which, in conjunction with another pinion, on the final drive shaft, results in a further reduction of 3:1. In this way an overall ratio of 120:1 is achieved.

The rear wheels, one attached to each final-drive shaft, are  $1\frac{1}{2}$  inch diameter soft rubber aircraft type. These should have their centres drilled out a little to accommodate  $\frac{3}{8}$  inch shafting, and be secured in position with epoxy resin. In order to achieve improved traction, the rear wheels should have their



**ALTERNATIVE I.C.s**  
 Alternative I.C.s may be used instead of Mullard types. Triple 3 input NAND types (D.T.L.) replace the FCH 161 and JK Flip Flops (D.T.L.) replace the FCJ 101's. The supply voltage and pin connections of alternative types may vary.

*Underside view of XEE showing all components*

tyres "scallop" around the circumference. This is best performed using a pair of small side-cutters, pinching-out the required amount of rubber and nipping it off. The resulting tread is fairly coarse, but serves its purpose, since, on nylon carpet, the wheels would undoubtedly slip.

The castor wheel is the same as the type used at the rear but, naturally, without the tread. The wheel is fitted to a shaft going through offset holes in the "U" bracket which swivels on a 4B.A. screw at the front of the animal.

Shaft retention is obtained either through the use of plastic tubing, or by means of washers soldered to the ends of the shafting. Sometimes the nylon gear-pinions have casting flashes still attached to them; this is particularly noticeable on teeth. The flashes must be removed with a sharp knife, or razor-blade, before the pinions can mesh properly.

**MOUNTINGS**

Four 4B.A. screws secure the main board to the chassis. The screws are initially bolted to the chassis, their nuts serving as spacers to separate the board from the metal body. Once the screws and nuts have been fitted, a layer of insulation tape, approximately the same size as the main board, should be placed directly beneath where the board will be located. This will ensure that no exposed wiring gets shorted out on the chassis. At this stage the supply leads,

outputs w, x and y and the connections to RLA should be connected up and have sufficient length to reach the other areas of the animal to which they will be later connected. The main board can now be fitted.

Relays RLB and RLC are mounted one above the other, secured on a pair of long 6B.A. screws. The Veroboard associated with these relays is mounted on RLB. The board is fixed in place with an impact adhesive.

The remaining relay, RLD, is kept in position with this adhesive, as is its associated component board.

**SYSTEM INTERCONNECTIONS**

The various interconnecting wires are shown in Fig. 10. Once the relays have been connected to their respective boards, the inter-circuit wiring can be completed. The latter, when finished, should be neatly laced up or cleated so that all leads are formed into one common cable-loom. The free ends of the leads going to the batteries should be passed through the grommet in the chassis and terminated in crocodile clips. Constructors may, at this point, choose to include a switch for isolation of the batteries from the rest of the circuit; for both simplicity and minimum cost, however, it was considered sufficient to employ crocodile clips for the purpose at the time.

Before connecting any batteries, do make absolutely certain that there are no wiring mistakes.



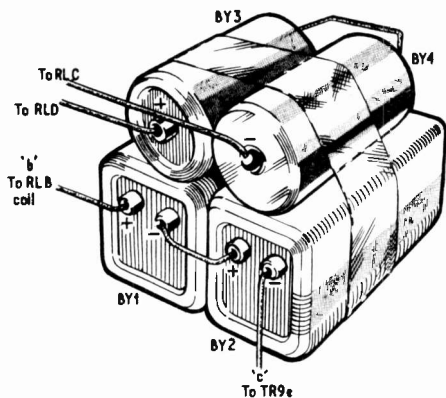


Fig. 12. Battery fixing and wiring details

## BATTERIES

The motors are powered by a pair of type HP11 batteries. These should be strapped together according to Fig. 12 using masking tape or similar material. A link between the positive of one battery and the negative of the other should next be soldered into position. The free ends of the batteries will be available for connection to the motors.

The two PP6 batteries, that provide the circuit supply, should undergo a similar process (see Fig. 12). The batteries are mounted on top of the chassis directly above the motors.

## FINAL TESTING

Connect up the motor supplies first; note that motors do not run. If this is not so, check wiring from relays. Temporarily disconnect the motor supplies if all is satisfactory. Connect the supplies to the logic and muscle control electronics; note that a regular ticking sound is evident from the RLB, RLC and RLD. If this is the case, then reconnect the motor supplies.

With both supplies connected the rear wheels should be either rotating so as to give forward motion of the animal if placed on the floor, or rotating in opposite directions. On no account should the rotation be that which would result in reverse motion. If, occasionally, this reverse action does occur, then disconnect the outer end of RLA operating coil and remove one turn. Reconnect the coil and try again. Repeat the process until conditions are just stable, i.e. motors not going into the reverse state when unloaded.

Apply a load to the rear wheels by attempting to stop them with the fingers; this should be done for a period of at least 1 second, or at least until reverse motion of the wheels occur. If no reverse action is noted short out the contacts of RLA and ensure that reverse action occurs. If this is not so, then check the Schmitt trigger or reversing bistable. Assuming that XEE reverses when RLA contacts are shorted out, then add one turn to the coil and test the function again. Once this function is satisfactory, the coil can be cemented in place. Shine a torch on to the optical sensors, whilst XEE is moving forward, and establish that the motors respond by reversing for the opposite side to that stimulated; this need not happen straight away since the random

function is also involved. The animal can now be placed right way up and begin its life proper, journeying around the chair and table legs in your living room.

## BODY

The constructor may wish to construct a shell for XEE to give it a more animal like appearance. The shell shown on last month's cover and in the various photographs was constructed by inflating a balloon to the required size and covering it with tissue paper or newspaper torn in small pieces and pasted with polycell glue.

The shell is built up layer by layer until it is about  $\frac{1}{16}$  inch thick; it is then left to dry fully before slowly deflating the balloon. The bottom edge of the shell is then trimmed and a thick cardboard base cut to shape so that it fits inside the shell about 1 inch away from the bottom edge. This base is then fixed to the shell using more paper and paste and finally a hole is cut from the centre to accommodate the batteries and XEE is secured to the base.

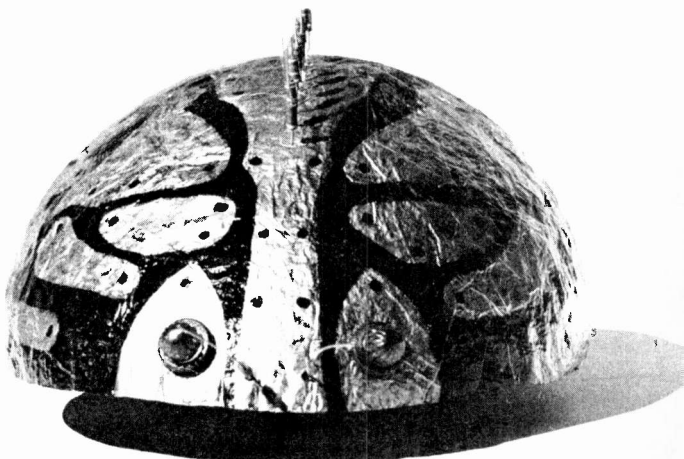
Decoration can be painted on the shell as desired and eyes made from the plastic lamp covers glued on over holes in the shell behind which can be mounted X1 and X2. The prototype XEE utilises a selection of resistors to form a spine and has an on-off switch as a tail!

## CONCLUSION

XEE is only a partially non-deterministic animal. That is to say it does not always respond to stimuli with any predictability. However, despite this, the beast does stand a greater chance of "survival" than, say, one which acts with 100 per cent certainty. Nevertheless, this in no way implies that it has any intelligence, although it does have the chance of reacting as if it did. ★

## ACKNOWLEDGEMENT

The author wishes to acknowledge assistance given by J. Salmon in connection with the mechanical aspects of XEE; also J. D. Pountney who devised and constructed XEE's "body".



THE painting of anything made of metal, particularly a ferrous metal, that is exposed to a marine atmosphere, becomes a process requiring somewhat more than ordinary care.

Air charged with a saline content soon corrodes away metal work not properly protected. Objects immersed in the sea itself, are subject to a great rate of corrosion, this being accelerated by electrolysis acting between dissimilar metals that are touching or in very close proximity to one another.

Even painting the hull of a boat, and we are here concerned only with metal hulls, does not in itself guarantee an indefinite degree of protection, since any imperfections in the paintwork will allow the salt water to come in contact with the metal hull and begin its corrosive work.

## A PAINT PIN-HOLE DETECTOR



was riddled with holes, the existence of these not being known prior to the tests.

## RESISTANCE METER

The detector is essentially a resistance meter that measures the resistance occurring via the pin hole, between the metal and a probe that is passed over the paint work.

This probe, connected to the input of the detector, consists of a length of broom handle to the end of which is clamped a piece of sponge material containing the search wire. In use, the sponge is soaked in water with the addition of a wetting agent. As the probe is passed over the paintwork, the water, its surface tension reduced by the wetting agent, flows into the pin holes and combines the circuit between the metal and the probe.

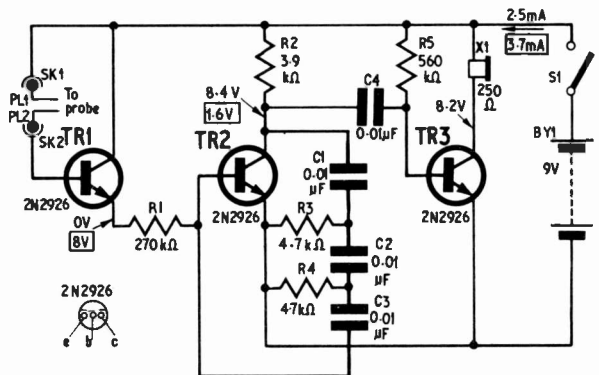


Fig. 1. Circuit diagram of pin hole detector

Visual inspection of the paintwork becomes a boring and laborious process, and will not reveal pin prick holes and hair line cracks that will permit the ingress of the sea water.

## STANDARD COMPARISON

The device that forms the basis of the article is cheap, easy to build and use, and has proved to be of real usefulness. Accurate and reliable testing of such a device is difficult, since "standards" in the form of graduated pin holes in a given thickness of paint, on metal, are not available. One therefore has to resort to comparison with commercial pin hole detectors, and this was the standard used when evaluating the prototype.

The commercial detector utilised a radio frequency generator providing a low current output, at a voltage up to 25 kilovolts. The test piece was the metal partitioning in a block of offices, that visually appeared to be in very good condition. An area was marked off and tests commenced, the home made detector performing first.

The results were extremely pleasing as the commercial detector agreed with the home made detector every time.

It was a revelation to discover that the paintwork

## CIRCUIT ACTION

The circuit of the detector is shown in Fig. 1, and will be seen to be very simple. Transistor TR1 comprises the input stage, TR2 is a simple CR audio oscillator, and TR3 is the output stage feeding a 250 ohm magnetic earpiece.

Under normal circumstances, the base of TR1 will be floating, and only a small leakage current will flow from collector to emitter.

When TR1 is cut off, the leakage current is insufficient to bias TR2 on and it will not oscillate. If the resistance between the base of TR1, and the positive supply line (between which the probe is connected) is such as to allow TR1 to pass sufficient current to bias TR2 on, it will oscillate and the earphone in TR3 collector will emit a whistle.

If the probe is short circuited, TR1 will be bottomed, allowing approximately 8V to appear between TR1 emitter and the negative line.

For this particular application, all we want is a noise to signify pin holes, we don't want Hi-Fi, so TR3 is a very primitive output stage which does provide a very lively whistle when the occasion arises.

The current drawn from a 9V battery is very modest, 2.5mA at quiescent, rising to 3.7mA maximum with the probe short circuited.

## CONSTRUCTION

The prototype was made up on a piece of plain 0.1in pitch peg board, shown in Fig. 2. The components are inserted from one side, and the leads inter-connected on the other side, sleeving being used where appropriate. Any plastic box with dimensions approximating 3in x 3in x 1/4in will provide a suitable housing.

For maximum sensitivity, the transistors should be as specified. Experiments have shown that TR1 can be successfully replaced by a BC109C, and TR2/TR3 by either a BC109 or a BC108.

Depending on components used, R1 may require an alteration in value. With the prototype, a resistance value was found such that vigorous oscillation occurred with the probe short circuited, with a still useful signal available when the probe was replaced

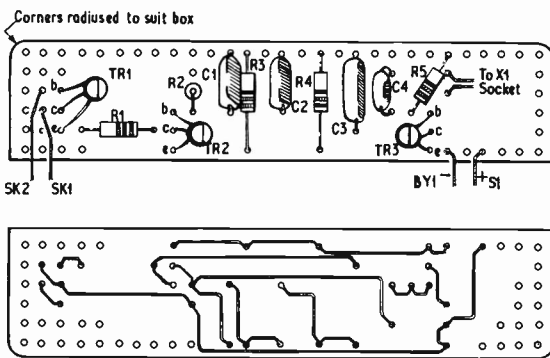
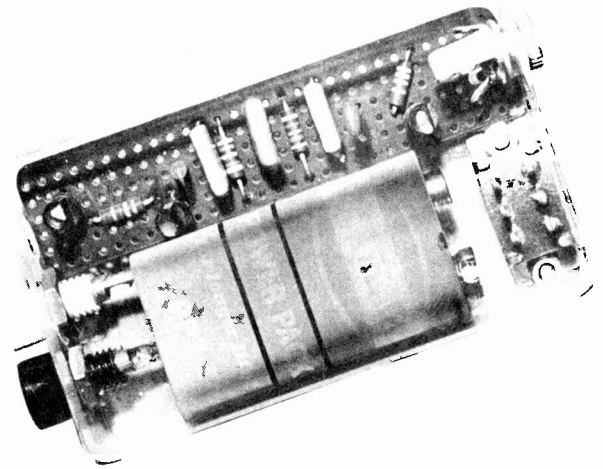


Fig. 2. Board assembly and wiring details

## COMPONENTS . . .

### Resistors

R1 270k R4 4.7k  
R2 3.9k R5 560k  
R3 4.7k  
all 10%, 1/8W

### Capacitors

C1-C4 0.01 polyester (4 off)

### Transistors

TR1, 2, 3 2N2926 green spot (3 off)

### Earpiece

XI 250Ω Magnetic with socket

### Miscellaneous

PL1, 2 Miniature plugs (2 off)  
SK1, 2 Miniature sockets (2 off)  
S1 Single pole on/off slide  
BY1 9V PF3  
Plastics case 3 in x 2 in x 3/4 in

by a string of 10 megohm resistors in series providing a total value of 100 megohms. Construction of the probe is simple as shown in Fig. 3.

When the prototype was completed and performing satisfactorily, the circuit board was isolated from the rest of the components and then encapsulated with a silicone rubber compound, so completely water-proofing it. This is very desirable, if not essential, in equipment that is used with water.

## USING THE DETECTOR

In use, the positive line is clipped to the painted metal, ensuring a good electrical connection. The length of line required will clearly depend upon individual circumstances.

The probe is then dipped into a solution of water and wetting agent (a proper wetting agent is definitely helpful and should be used whenever possible. The use of a saline additive does improve conductivity; however, it may get into holes and cracks and start the very corrosion we are trying to prevent, so its use is not recommended) and passed over the paintwork in slow regular sweeps. As soon as the probe's sponge loses its water it must be recharged.

A steady whistle will indicate a single pin hole, whilst a bleep or series of bleeps will indicate a single pin hole, or a whole colony of pin holes. The suspect

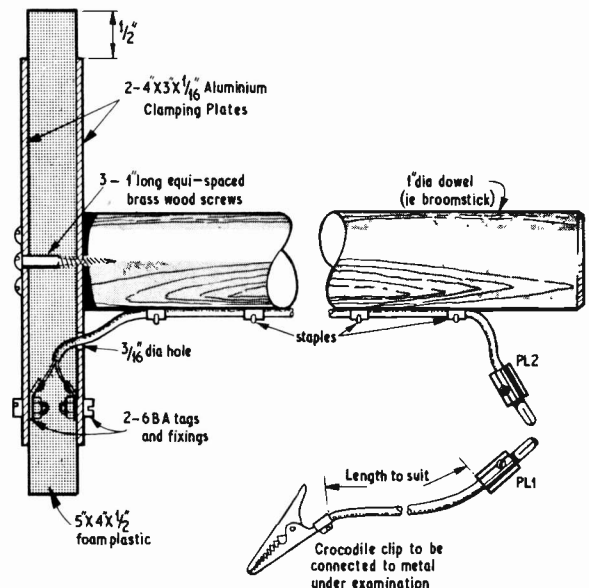
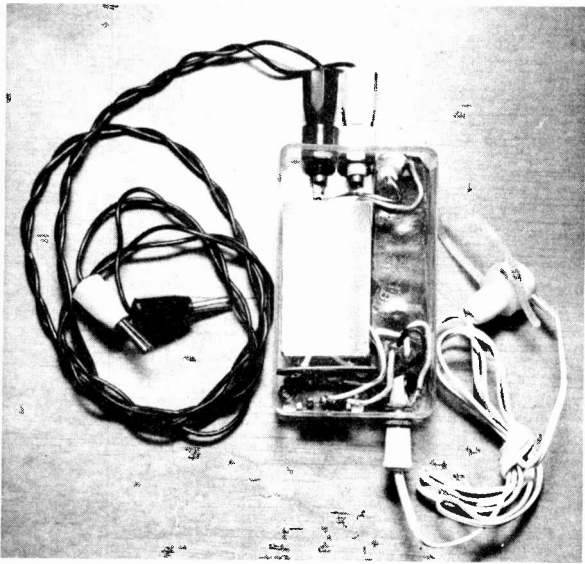


Fig. 3. Probe assembly details



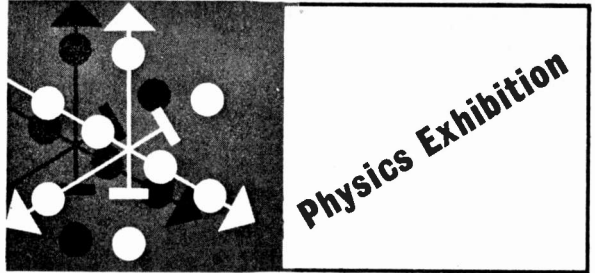
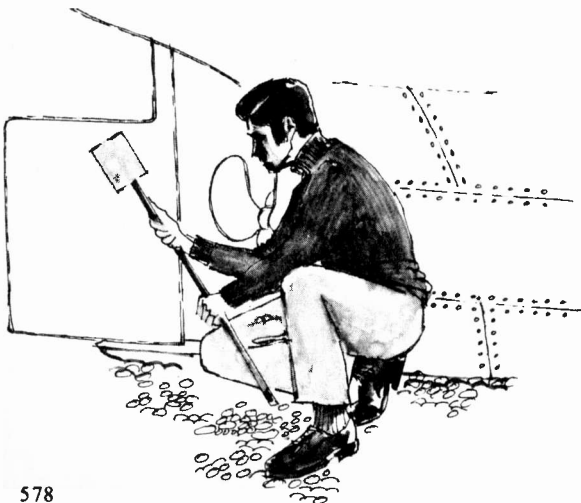
area is then circled with chalk—not grease pencils or “Chinagraphs”, as these may show through when painted over—for subsequent repainting.

### SPURIOUS SIGNALS

As TR1 base is, in effect, floating, it is possible for an electronic charge to build up between the base probe and adjacent components. This charge will cause random bleeps when the probe is used in the described manner, causing the operator to erroneously suspect the presence of non-existent flaws in the paintwork.

A high value resistor, 10 megohms or so, connected between base and the negative line will prevent the building up of such static. This addition may lower the sensitivity though it should not be so low as to affect the detector's usefulness.

The prototype was designed to be slipped into an overall top pocket, with wires terminated in wander plugs permanently attached to the probe's broom handle. The case can be attached to the handle if required, providing a single composite assembly. ★



IT WAS nice to renew a visual acquaintance at least of the magnificent Willis concert organ in the auditorium of Alexandra Palace, the venue of the fifty-fifth Physics Exhibition held during the period April 19-22.

The setting provided by this 19th-century masterpiece well suits the academic and scientific tenor represented by universities, research establishments and industry.

Representation by these various factions provided a full hall of exhibits, the most conspicuous of all being the large central stand organised by the Italian Federation of Scientific and Technical Associations and other bodies. Besides providing a showcase of current developments in instruments and apparatus, there was also a large selection devoted to the history of physics in Italy with career cameos of some of the more distinguished physicists.

Of the exhibits, probably one of the most exciting was the Mullard Research Laboratory's demonstration of microwave television broadcasting using an intermediary satellite transmitter and standard colour television set for reception.

The implications of this are tremendous, as a satellite aerial 20,000 miles above the earth can cover a whole sub-continent.

Complex and expensive ground networks are not required which means that a developing country can be equipped with a service in a fraction of the time necessary to install a conventional television system.

For technical reasons, satellite television systems in advanced countries would probably use the frequency band 11.7GHz to 12.7GHz with either digital or frequency modulation. Commercial success would depend greatly on the availability of cheap, reliable microwave components.

A solid state digital clock with an unusually small readout display proved an arresting item of the Marconi stand. This indicated hours and minutes using four characters each of which consisted of seven tiny electroluminescent bars providing a total character size of 0.185in by 0.125in. (!)

An accompanying exhibit demonstrated the display capabilities of organic nematic crystal materials under the action of an electric field. Requiring only low power, six etched alpha-numeric characters made up on plates of conducting glass containing a thin film of liquid crystal material, were illuminated by a simple keyboard switching.

The advantages of these display elements are low running costs and good resolution and contrast under conditions of high ambient lighting. Perhaps in these materials, we will see the demise of advertising's neon jungles.

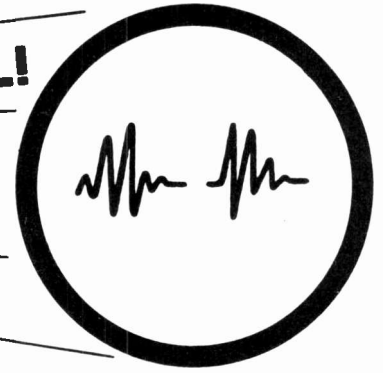
While these display examples represent the research of companies there was a great deal to be seen which will almost certainly be the object of commercial development.

Measurement devices always figure strongly at this exhibition, and this year proved no exception. In this department the Ministry of Defence showed a corrosion monitor for measurement of corrosion rates. Corrosion is a subject of very great technical importance that is still not fully understood and is the subject of research of a number of laboratories.

Every refinement in instrument technique pushes back the frontier of scientific ignorance and it is at this exhibition that this is most manifest.

# LOOK!

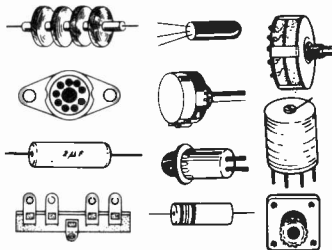
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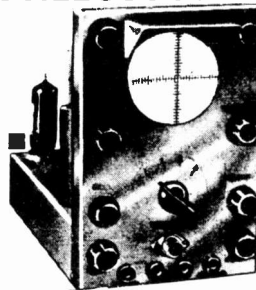
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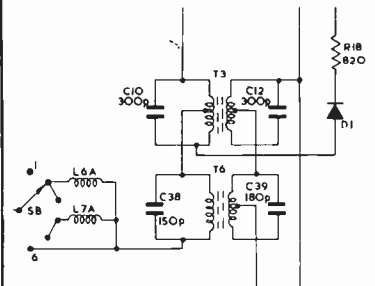


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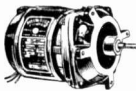
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# Readout —

## A SELECTION FROM OUR POSTBAG

Correspondents wishing to have a reply must enclose a stamped addressed envelope. We regret we are unable to guarantee a reply on matters not relating to articles published in the magazine. Technical queries cannot be dealt with on the telephone.

### Tiresome and uneconomic

Sir—Replying to your comments regarding specialised components has been very difficult. I have tried to offer some constructive suggestions. First, however, I am thoroughly convinced that the onus lies with the various authors writing in your magazine and that your editorial staff should ensure that the specialised components needed for a particular circuit are available to the retail customer.

With respect, I would quote your small independent competitor, *Radio Constructor*, who for years have made a point of advising us in advance that such and such a transistor would be specified. Also we are informed of the approximate publication date and then lay on stock to meet the demand. I have repeatedly suggested this approach to you and to your staff.

I dispute your suggestion that specialised components are not available to the retail public. For years we have supplied specials. However, I would state that this has been done as a service to the customer and has usually resulted in a thoroughly uneconomic transaction. In the last few days I have discussed this matter with several other suppliers of repute and we are all of the opinion that specials are a tiresome and uneconomic matter but which we put up with as a service.

I could go on to stress many examples of costings done on the economics of obtaining special parts for customers, but I think I have said enough on the subject to convince you.

In attempting to make a constructive suggestion, I have thought along the lines of charging a £1 service charge for specials, but the fact is that the enthusiast of today is primarily experimenting for his own enjoyment and has a limited budget, and so such suggestions may not be a proposition.

My company is now distributing the products of Siemens, Newmarket, Marston Excelsior, Schauer semiconductors and many others, and we carry very much larger and extensive stocks of components than we offer for retail.

Our mail order operation has now been carefully examined and we are offering a wide range of popular components at competitive prices and with excellent delivery, and I know beyond any shadow of doubt, merely from the tremendous response of the last month or so, that this is what the customer really wants. We will continue to try and assist customers with specials and very probably continue to make a loss on those specials. However, it is very few companies who will be prepared to do the same.

P. F. Clarke,  
LST Electronic Components Ltd.,  
Brentwood,  
Essex.

### Direct access

Sir—I was interested to read your editorial in the May edition of *PRACTICAL ELECTRONICS* where you discuss the problems encountered by the private constructor in obtaining direct access to components.

As you will no doubt realise from our advertisement in your magazine, we have started a mail order division which is specifically directed towards the requirements of the private constructor, *Distronic Ltd.* is an industrial distributor and a member of A.F.D.E.C. (Association of Franchised Distributors of Electronic Components). We are a very active industrial distributor and recognise the problems encountered by your readers. For this reason we are attempting to do something about it and are hopeful of being able to offer the same service to private individuals as we are currently offering to our industrial customers.

The products we are offering are all supplied by leading manufacturers under guarantee, and we are able to pass on to the private constructor some of the cost advantage we have gained by buying in bulk.

Looking forward to a long and fruitful association with your magazine.

M. H. Jacobs,  
*Distronic Ltd.*,  
Harlow, Essex.

### Workable solution

Sir—I have read the letters on the *Readout* page and also your editorial comment. As an active transmitting amateur I appreciate the problems facing your readers in obtaining specialised components, but the solution to this problem unfortunately lies with the distribution industry rather than the manufacturer. You will, I am sure, appreciate that it is quite impossible for a manufacturer to deal with individuals and in any case it is now usual practice for a minimum order charge to be levied to cover the high cost of order processing.

It would seem to me that the letter in your *Readout* page over the signature of Mr. A. Sproston sets out a workable solution to the problem and I am sure that the usual distribution outlets will be quite willing to deal with such an organisation.

R. R. Adams,  
Sales Manager,  
Resistor Division,  
Painton & Co. Ltd.

### Not all roses!

Sir—We would like to make the following points which we believe are not understood by people outside this trade.

Firstly, the amateur market in the United Kingdom has seen a drastic expansion for its size over the last two years and individuals who have no connections with this industry have proven to be ambitious and professional in their approach to construction.

The quest for improving quality seems never ending, and the number of specialised components required for projects are becoming numerous and more expensive.

The second and perhaps the most important point we would like to bring to your attention is the fact that the trade has no warning of the components which are to be used in the various projects each month and in the case of *PRACTICAL ELECTRONICS*, readers will have to wait two months before they can see an advertisement showing the special components they may require. Also none of the trade are consulted by the authors of the articles, as to the price and ease of availability of components used.

The sad fact of this is obviously to reduce the numbers of potential constructors and, therefore, make many of the articles which are produced purely an academic exercise.

Finally, referring both to the letter published in the magazine by the private individual referring to the inability to obtain I off, and your own comment, we must point

# Readout—

A SELECTION FROM OUR POSTBAG

out that the costs involved both on the part of the manufacturers, or distributors and a concern such as ourselves, are somewhat prohibitive so that an article which would perhaps cost £2 to purchase would end up being sold by the retail customer at anything up to £4, if all concerned are to break even let alone make a profit. We believe that this is the major deterrent to solving this problem in the manner suggested by your reader. However, we must commend his innovation to having personal order forms printed for the real enthusiasts.

Although this is an extremely long letter, it will only scratch the surface of the problem, but we hope that you will publish some of the content, so that the amateur enthusiasts will perhaps realise that all is not roses in this particular garden.

J. Marshall,  
A. Marshall & Son (London) Ltd.,  
London, N.W.2.

## Distribution set-up

Sir—I have read with interest your Editorial concerning specialised components as well as the letters from your readers and can well appreciate the problem of obtaining specialised components which are not normally available from the usual retail outlets for components.

We ourselves are Specialised Distributors of electronic components and from time to time, we do get private individuals approaching us to obtain components. Wherever we can, we do try and help them and since it is normally a cash with order transaction, there is no problem in supplying one or two off to private people and I think you will find that this is not peculiar to ourselves and quite a number of Distributors are quite willing to operate this way.

The problem is, however, in the private individual locating a source of supply for the component that he wants, bearing in mind that at the present time there are well over 80 Distributors of electronic components in this country, many of them specialising in a narrow field of items. For instance, ourselves, we specialise in the supply of Electrolytic Capacitors and Wire-wound Potentiometers as well as a number of other items and in the main, you will find that this is the

pattern of Distributors throughout the United Kingdom.

There are, of course, exceptions to these and there are quite a number of very large Distributors indeed who handle a very wide range of components but because of their size it might well prove difficult for the private individual to purchase from these larger Distributors. Hence it follows that a knowledge of the distribution set-up is necessary if the person is to locate a source of supply for the type of specialised component he is looking for.

Publications are available which list all the Accredited Electronic Component Distributors in the United Kingdom, showing their location, contacts and the range of components that they handle. Using such a publication the private individual should have no great difficulty in obtaining the particular component that he wants.

D. E. Clarke,  
Intercontinental Components,  
Maidenhead,  
Berks.

## Customer relations

Sir—As you perhaps know, in general retail mail order a distributor carries a wide range of components in order that a customer may kit up his project in an order to one address. Certain projects require specialist components obtainable perhaps from only one source which is often indicated in an article. Thus in some cases two or perhaps three suppliers must be contacted. I feel that this situation must always exist since even mail order retail concerns such as mine must keep large quantities of "stock items" to be economical and satisfy the market and to keep small stocks of a wide range of items of uncertain demand is expensive on space, finance and organisation and results in an uncompetitive approach. I may say the problem is much more acute in industry where for a simple project several suppliers may have to be approached for good delivery of all components.

As a company we are quite prepared to order non-stock items from our normal suppliers for retail customers. In certain cases we advise against this and offer substitutes. There is a great problem here in that having ordered a component and given a delivery date as advised by the supplier, it is not uncommon to have the delivery date extended by three or even six months. This causes bad customer relations and although it is possible for us to forward cover our own stock several months ahead for known long delivery items, the retail customer is usually not prepared to suffer this inconvenience.

Until recently it has been our policy to offer components at a catalogue price and offer a discount to all customers, industrial and retail alike, the discount rate depending on order value. We have recently become industrial distributors or stockists for three companies and in addition to the discount arrangement we will be able to offer components at a lower (but net) price for quantities of the same item. This facility will be offered to retail customers on request. Thus we hope to extend our service and provide many items formerly unobtainable.

D. A. Longland,  
Electrovalue,  
Englefield Green,  
Egham, Surrey.

## Your responsibility

Sir—Regarding your leader in the May issue, I think you also have some responsibility regarding the marketing of components.

I recently started building the equipment for the Integrated Circuit Tape Recorder in the January 1968 issue, having had the deck for some time. I now have all the parts except the oscillator pot core, type LA2103. I visited a number of shops in London, and no-one can tell me where this can be obtained. Being retired I do not now have access to the information that might help me to use other cores in my possession.

If we cannot get components to build the equipment described in your magazine, there is little reason to buy your magazine.

H. Boys,  
Weedon, Northampton.

## Mystery of the Ferrites

Sir—With reference to your Editorial in the May 1971 issue, I am at present constructing the "P.E. Gemini" amplifier and having great difficulty in obtaining the ferrite components for it (FX2239 pot cores and DT2178 formers).

During the past year I have built a colour T.V. set from articles in another journal, and had the same difficulty in obtaining the many ferrite components for this, but after much phoning and letter writing I managed to obtain the parts from a number of suppliers. I have referred to these suppliers for components for the "P.E. Gemini" but with no success. Eventually, I phoned Mullard Ltd. direct for assistance and was given a list of local distributors, I then got in touch with some of these and was told they could not trade directly with the public, and I would have to place my order with one of their retailers. When I called at the



# Great new offer from **DIOTRAN**

## TRANSISTORS

### BRAND NEW FULLY GUARANTEED DEVICES

AC107	15p	AF115	17p	BC140	35p	BCY31	22p	BF272	80p	EC403	15p	ORP60	40p	2N918	30p	2N2714	25p	2N3704	15p		
AC113	20p	AF116	17p	BC141	35p	BCY32	22p	BF273	25p	BF274	30p	GET880	27p	ORP61	40p	2N929	22p	2N2904	25p	2N3705	12p
AC115	23p	AF117	17p	BC142	45p	BCY33	17p	BF274	30p	MA100	15p	ST140	15p	ST141	17p	2N930	22p	2N2905	25p	2N3706	12p
AC125	17p	AF118	30p	BC143	40p	BCY34	30p	BF308	35p	MAT101	17p	ST141	17p	ST142	17p	2N931	22p	2N2906	30p	2N3707	13p
AC126	17p	AF124	21p	BC145	45p	BCY70	17p	BF309	37p	MAT120	15p	TIS43	40p	2N1303	17p	2N2906A	27p	2N2906B	27p	2N3708	8p
AC127	17p	AF125	20p	BC147	17p	BCY71	30p	BF316	75p	MAT121	17p	UT46	27p	2N1304	20p	2N2907	25p	2N2907A	25p	2N3709	8p
AC128	17p	AF126	20p	BC148	12p	BCY72	15p	BFW10	55p	MPF102	43p	V405A	25p	2N1305	20p	2N2907A	30p	2N2907B	30p	2N3710	10p
AC141K	17p	AF127	20p	BC149	17p	BCZ11	20p	BFX29	27p	MPF105	43p	V410A	45p	2N1306	22p	2N2907	25p	2N2907C	25p	2N3711	10p
AC142K	17p	AF139	33p	BC150	17p	BD121	85p	BFX84	20p	OC19	30p	2G301	19p	2N1307	19p	2N2907A	30p	2N2907B	30p	2N3712	10p
AC151	15p	AF178	50p	BC151	20p	BD123	85p	BFX85	27p	OC20	30p	2G302	50p	2N1308	27p	2N2908	27p	2N2908A	27p	2N3713	10p
AC154	35p	AF179	50p	BC152	17p	BD124	75p	BFX86	22p	OC22	30p	2G303	19p	2N1309	27p	2N2925	13p	2N2925A	13p	2N3904	27p
AC155	17p	AF180	50p	BC153	27p	BD131	80p	BFX87	25p	OC23	33p	2G304	20p	2N1613	17p	(G)	11p	2N2926	12p	2N3906	27p
AC156	17p	AF191	50p	BC154	30p	BD132	80p	BFX88	22p	OC24	45p	2G306	35p	2N1711	20p	2N2926(Y)	11p	2N2926(Z)	11p	2N4058	15p
AC157	17p	AF186	45p	BC157	20p	BDY20	21p	BFY50	20p	OC25	25p	2G308	35p	2N1889	35p	2N2926	35p	2N2926	35p	2N4059	10p
AC165	17p	AF239	37p	BC158	17p	BF115	22p	BFY51	20p	OC26	25p	2G309	35p	2N1890	45p	(O)	10p	2N2926	35p	2N4060	12p
AC166	17p	AFZ11	37p	BC159	20p	BF117	45p	BFY52	20p	OC28	40p	2G339	17p	2N1893	37p	2N3010	40p	2N3010	40p	2N4061	12p
AC167	20p	AFZ12	45p	BC167	13p	BF118	60p	BFY53	17p	OC29	40p	2G339A	15p	2N2160	60p	2N3011	20p	2N3011	20p	2N4062	12p
AC168	20p	AL102	85p	BC168	13p	BF119	70p	BSX19	15p	OC35	33p	2G344	33p	2N2147	75p	2N3053	20p	2N3053	20p	2N5172	12p
AC169	14p	AL103	85p	BC169	13p	BF152	35p	BSX20	15p	OC36	40p	2G345	15p	2N2148	60p	2N3054	50p	2N3054	50p	2N5459	43p
AC176	23p	ASV26	25p	BC170	12p	BF153	35p	BSY25	15p	OC41	20p	2G371	13p	2N2192	30p	2N3055	63p	2N3055	63p	2S034	75p
AC177	20p	ASV27	30p	BC171	13p	BF154	35p	BSY26	15p	OC42	22p	2G371B	10p	2N2193	30p	2N3391	17p	2N3391	17p	2S301	50p
AC187	30p	ASV28	25p	BC172	13p	BF157	45p	BSY27	15p	OC44	15p	2G374	17p	2N2194	27p	2N3391A	20p	2N3391A	20p	2S302A	45p
AC188	30p	ASV29	25p	BC173	13p	BF158	25p	BSY28	15p	OC45	12p	2G377	27p	2N2217	27p	2N3392	17p	2N3392	17p	2S302B	45p
AC197	15p	ASV50	25p	BC174	13p	BF159	30p	BSY29	15p	OC47	15p	2G378	15p	2N2218	25p	2N3393	15p	2N3393	15p	2S303	60p
AC198	20p	ASV51	25p	BC175	22p	BF160	30p	BSY38	15p	OC71	9p	2G382	15p	2N2219	27p	2N3394	15p	2N3394	15p	2S304	£1.10
AC199	22p	ASV52	25p	BC177	17p	BF162	30p	BSY39	15p	OC72	12p	2G401	30p	2N2220	22p	2N3395	20p	2N3395	20p	2S305	£1.10
AC200	20p	ASV54	25p	BC178	17p	BF163	35p	BSY40	15p	OC74	12p	2G414	30p	2N2221	22p	2N3402	22p	2N3402	22p	2S306	£1.10
AC201	20p	ASV55	25p	BC179	17p	BF164	35p	BSY41	15p	OC75	15p	2G417	25p	2N2222	27p	2N3403	22p	2N3403	22p	2S307	£1.10
AC222	19p	ASV56	25p	BC180	20p	BF165	35p	BSY95	12p	OC76	15p	2N388B	30p	2N2368	17p	2N3404	32p	2N3404	32p	2S321	60p
AC227	18p	ASV57	25p	BC181	22p	BF167	22p	BSY95A	12p	OC77	12p	2N388A	50p	2N2369	50p	2N3405	45p	2N3405	45p	2S322	50p
AC228	18p	ASV58	25p	BC182	19p	BF173	32p	BU105	£3.90	OC81	15p	2N404	22p	2N2369A	15p	2N3414	20p	2N3414	20p	2S322A	45p
AC229	30p	ASV58	25p	BC182L	10p	BF176	35p	CI1E	60p	OC81D	15p	2N404A	30p	2N2411	50p	2N3415	20p	2N3415	20p	2S323	60p
AC230	35p	ASZ21	40p	BC183	10p	BF177	35p	C400	30p	OC82	15p	2N524	55p	2N2412	55p	2N3417	37p	2N3417	37p	2S324	£1.20
AC231	25p	BC107	10p	BC183L	10p	BF178	45p	C407	25p	OC82D	15p	2N527	60p	2N2416	50p	2N3525	74p	2N3525	74p	2S325	£1.20
AC234	18p	BC108	10p	BC184	13p	BF179	50p	C424	17p	OC83	20p	2N696	12p	2N2711	22p	2N3702	12p	2N3702	12p	2S326	£1.20
AC235	18p	BC109	11p	BC184L	13p	BF180	30p	C425	40p	OC84	20p	2N697	15p	2N2712	22p	2N3703	12p	2N3703	12p	2S327	£1.20
AC236	30p	BC113	25p	BC186	27p	BF181	30p	C426	30p	OC139	15p	2N698	24p								
AC240	15p	BC114	30p	BC187	27p	BF182	30p	C428	20p	OC140	17p	2N699	55p								
AC241	30p	BC115	30p	BC207	11p	BF183	30p	C441	27p	OC170	15p	2N706	7p								
AC244	35p	BC116	35p	BC209	11p	BF184	25p	C442	35p	OC171	15p	2N706A	8p	AA119	8p	BYZ11	32p	OA81	7p		
AD140	40p	BC117	35p	BC209	11p	BF185	30p	C444	37p	OC200	25p	2N708	12p	AA120	8p	BYZ12	30p	OA85	7p		
AD142	40p	BC118	25p	BC212L	11p	BF188	30p	C450	17p	OC201	27p	1N709	45p	BA116	22p	BYZ13	25p	OA90	6p		
AD149	43p	BC119	45p	BC213L	11p	BF194	23p	C720	12p	OC202	27p	2N711	40p	BA126	22p	BYZ16	35p	OA91	7p		
AD161	35p	BC125	35p	BC213L	11p	BF195	24p	C722	25p	OC203	35p	2N717	42p	BY100	12p	BYZ17	35p	OA95	7p		
AD162	35p	BC126	35p	BC214L	12p	BF196	30p	C740	25p	OC204	25p	2N718	24p	BY101	12p	BYZ18	30p	OA200	6p		
AD161/162(MP)	63p	BC132	25p	BC225	25p	BF197	35p	C742	17p	OC205	35p	2N718A	50p	BY105	15p	BYZ19	25p	OA202	7p		
AD1140	50p	BC135	30p	BC237	12p	BF222	45p	C744	17p	OC309	35p	2N726	27p	BY114	12p	OA5	17p	SO10	4p		
ADZ11	£2.10	BC136	30p	BC318	12p	BF257	80p	C762	17p	P346A	17p	2N727	35p	BY126	15p	OA10	22p	SO19	4p		
ADZ12	£2.10	BC137	35p	BC319	12p	BF270	25p	C764	60p	OCP71	43p	2N744	45p	BY127	17p	OA47	7p	IN914	6p		
AF114	17p	BC139	45p	BCY30	20p	BF271	17p	EC401	15p	ORP12	43p	2N914	17p	BYZ10	35p	OA79	8p	IN4148	6p		

### DIODES & RECTIFIERS

2N918	30p	2N2714	25p	2N3704	15p
2N929	22p	2N2904	25p	2N3705	12p
2N930	22p	2N2904A	30p	2N3706	12p
2N1131	20p	2N2905	25p	2N3707	13p
2N1302	17p	2N2905A	30p	2N3708	8p
2N1303	17p	2N2906	25p	2N3709	8p
2N1304	20p	2N2906A	27p	2N3710	10p
2N1305	20p	2N2907	25p	2N3711	10p
2N1306	22p	2N2907A	30p	2N3712	10p
2N1307	19p	2N2907B	30p	2N3820	£1
2N1308	27p	2N2925	13p	2N3820A	£1
2N1309	27p	2N2926	12p	2N3903	25p
2N1613	17p	(G)	11p	2N3904	27p
2N1711	20p	2N2926(Y)	11p	2N3905	25p
2N1889	35p	2N2926	35p	2N3906	27p
2N1890	45p	(O)	10p	2N4058	15p
2N1893	37p	2N3010	40p	2N4060	12p
2N2160	60p	2N3011	20p	2N4061	12p
2N2147	75p	2N3053	20p	2N4062	12p
2N2148	60p	2N3054	50p	2N5172	12p
2N2192	30p	2N3055	63p	2N5459	43p
2N2193	30p	2N3391	17p	2S034	75p
2N2194	27p	2N3391A	20p	2S301	50p
2N2217	27p	2N3392	17p	2S302A	45p
2N2218	25p	2N3393	15p	2S302B	45p
2N2219	27p	2N3394	15p	2S303	60p
2N2220	22p	2N3395	20p	2S304	£1.10
2N2221	22p	2N3402	22p	2S305	£1.10
2N2222	27p	2N3403	22p	2S306	£1.10
2N2368	17p	2N3404	32p	2S307	£1.10
2N2369	50p	2N3405	45p	2S321	60p
2N2369A	15p	2N3414	20p	2S322	50p
2N2411	50p	2N3415	20p	2S322A	45p
2N2412	55p	2N3417	37p	2S323	60p
2N2416	50p	2N3525	74p	2S324	£1.20
2N2711	22p	2N3702	12p	2S325	£1.20
2N2712	22p	2N3703	12p	2S326	£1.20
				2S327	£1.20

## INVERTER UNITS

Transistorised for working fluorescent lighting from 12V or 24V car batteries. For caravan lighting, mobile displays, etc. we have 7 types all made by the famous Philips Company all available at about half list price.

**Type No. 126123.** This is for working 3 miniature 6 watt 9in tubes from 12V battery. In sheet steel case. Size: 10in x 2 1/2in x 2in with connection diagram. Price £4.25.

**Type No. 126328** for working one 2ft 20w tube from 12V battery, this is on a metal plate which can also be used to hold the tube (using Terry clips). Price £3.50.

**Type No. 126461** same as 126328 except that it works off 24V battery. Price £4.50.

**Type No. 126345** same as 126328 except that it is for 2in tube off 24V. Price £3.75.

**Type No. 59814** for working up to 6 9in miniature 6W tubes from 24V in pressed steel case. Size: 10in x 2 1/2in x 2in with connection diagram. Price £6.50.

**Type No. 59801** for working one 2ft 20W tube off 24V battery. This is in a pressed steel case. Size: 10in x 2in x 1 1/2in. Price £3.50.

**Type No. YB.** This is a big 24V unit. It weighs about 10lb and measures 10in x 5in x 7in approx. It looks big enough to light a bus. It uses 22 Mullard OC20 power transistors. Input voltage is 24V d.c. and the output 220/240V a.c. Price £20 each, carriage at cost.

**TELESCOPIC AERIAL**

for portable, car radio or transmitter. Chrome plated—six sections, extends from 7 1/2 to 47in. Hole in bottom for 6BA screw. 38p NKTCKLED MODEL FOR F.M. 50p.

**QUICK KUPPA**

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.

**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 £1.78p 1" 75p. P. & P. 33n extra. Spare spools 50p extra. Cassette to hold spool 50p extra. No postage if ordered with tape otherwise 30p extra.

**12 VOLT 1/2 AMP POWER PACK**

This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 mfd/50 smoothing. Price £1.50 plus 20p P. & P.

**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, £1.90 plus 13p post & p.

**3 STAGE PERMEABILITY TUNER**

This Tuner is a precision instrument made by the famous "Cyclon" Company for the equally famous Radiomobile Car Radio. It is a medium wave tuner (but set of longwave coils available as an extra if required) with a frequency coverage 1,620kc/s-252kc/s and intended to operate with an I.F. value of 470kc/s. Extremely compact (size only 2 1/2 x 2 x 1in thick) with reduction gear for fine tuning. Stip price this month 83p, with circuit of front end suitable for car radio or as a general purpose tuner for use with Amplifier. Post Free.

**MAINS TRANSISTOR POWER PACK**

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

**MICRO SWITCH**

5A changeover contacts, 9p each, 15ASR Model 10p each or 15 amp changeover 15p.

**TOGGLE SWITCH**

3A 250V with fixing ring. 75p each, 75p dozen.

**0.005mFd TUNING CONDENSER**

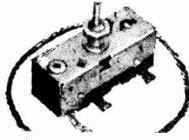
Proved design, ideal for straight or reflex circuits 13p each, £1.20 dozen.

## OUT OF SEASON BARGAIN—TANGENTIAL HEATER UNITS



This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, and two elements comprising 3 heat switching and with thermal safety cut out. Can be fitted into any metal line case or cabinet. Only need control switch. 3KW model £3.50; 2KW model £2.50. Postage and insurance 40p. Control switch 35p.

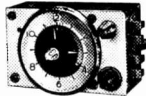
## THERMOSTAT WITH PROBE



This has a sensor attached to a 15A switch by a 14in length of flexible capillary tubing—control range is 20°F to 120°F so it is suitable to control soil heating and liquid heating especially when in buckets or portable vessels as the sensor can be raised or lowered into the vessel. This thermostat could also be used to sound a bell or other alarm when critical temp. is reached in stack or heap subject to spontaneous combustion or if liquid is being heated by gas or other means not controllable by the switch. Made by the famous Teddington Co., we offer these at 65p each. Postage and insurance 14p.

## 20 AMP ELECTRICAL PROGRAMMER

Learn in your sleep: Have Radio playing and kettle boiling as you awake—switch-on lights to ward off intruders—have warm house to come home to. All these and many other things you can do if you invest in an Electrical Programmer. Made by the famous Smiths Instrument Company. This is essentially a 230/240V mains operated Clock and a 20A Switch, the switch-off time of which can be delayed up to 12 hours (continuously variable not stepped). Similarly the switch-on time can be delayed. This is a beautiful unit, size 5 1/2 x 3 1/2 x 2 1/2 in deep. Metal encased, glass fronted with chrome surround. Offered at £2.40 plus postage and insurance 25p.



## THIS MONTH'S SNIP

**AMPLIFIER MAINS TRANSFORMER, 50V, 1 1/2A.** Upright mounting with fixing brackets and metal shrouds to contain magnetic field, 50c/s primary, tapped 110V, 115V, 210V, 230V and 250V. Two secondaries, 50V, 1 1/2A, other 6V, 1A for pilot light, etc. £1.95, postage 30p.

## INSTRUMENT SWITCHES

Miniature precision switches with 1" dia. moulded wafers. Silver plated 5 amp contacts, standard 1" spindle.

No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole	60p	60p	60p	60p	60p	60p	60p	60p	60p
2 poles	60p	60p	60p	60p	60p	60p	60p	60p	60p
3 poles	60p	60p	60p	60p	£1	£1	£1	£1.40	£1.40
4 poles	60p	60p	60p	£1	£1.40	£1.40	£1	£1.60	£1.60
5 poles	60p	60p	£1	£1	£1.40	£1.40	£1.40	£2.00	£2.00
6 poles	60p	£1	£1	£1	£1.40	£1.40	£1.40	£2.00	£2.00
7 poles	60p	£1	£1	£1.40	£1.80	£1.80	£1.80		
8 poles	£1	£1	£1	£1.40	£1.80	£1.80	£1.80		
9 poles	£1	£1	£1	£1.40	£2.20	£2.20	£2.20		
10 poles	£1	£1	£1.40	£1.80	£2.20	£2.20	£2.20		
11 poles	£1	£1.40	£1.40	£1.80	£2.60	£2.60	£2.60		
12 poles	£1	£1.40	£1.40	£1.80	£2.60	£2.60	£2.60		



## SPARTAN Portable RADIO

Long and medium wave, 7 transistors, size 6in x 4in x 1 1/2in with larger than usual speaker giving very good tone. Built-in ferrite aerial and telescopic aerial for distant stations. A real bargain complete with leather case, carry sling, earplug and case. £3.75 plus 25p post and insurance.



## 15/20 AMP CONNECTORS

Polythene insulated 12-way strip, 13p each, £1.20 dozen.



## REED SWITCHES

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

**Miniature.** 1in long x approximately 1/2in diameter. Will make and break up to 1A up to 300V. Price 13p each, £1.20 dozen.

**Standard.** 2in long x 1/2in diameter. This will break currents of up to 1A, voltages up to 250V. Price 10p each, 90p per dozen.

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

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

## Midget Output Transformer

Ratio 140:1. Size approx. 1in x 1in x 1in. Primary impedance 450Ω. Connection by flying leads. 23p each, £2.40 dozen.

## Midget Output Transformer

Ratio 80:1. Size approx. 1 1/2in x 1in x 1in. Primary impedance 132Ω. Printed circuit board connection. 28p each, £3 dozen.

## IGNITION (E.H.T.) TRANSFORMER

Made by Parmeko Ltd. Primary 240V, 50 c.p.s. Secondary 5kV at 23mA. Size approx. 4 1/2in x 3 1/2in x 2 1/2in thick. Price £1.50 + 25p postage.

## 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 25p, two, 33p.



## LIGHT CELL

Almost zero resistant in sunlight, increases to 10kΩ in dark or dull light, epoxy resin sealed. Size approx. 1in dia. by 1in thick. Rated at 500MW wire end, 45p. Suit most circuits.

## CONSTRUCTORS' PARCEL

1. Plessey miniature 2-gang tuning condenser with built-in trimmers and wave gang switch. 2. Ferrite slab aerial with coils to suit the above tuning condenser. 3. Circuit diagram giving all component values for transistor circuit covering full medium wave and the long wave band around Radio 2. The three items for only 40p which is half of the price of the tuning condenser alone.

## 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 2 1/2 x 2 x 2in. £1 each.

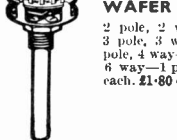


## EXTRACTOR FAN

Cleans the air at the rate of 10,000 cubic ft per hour. Compact, 5 1/2in casing with 3 1/2in fan blades. Kit comprises motor, fan, blades sheet steel casing, pull switch, mains connector and fixing brackets. £2 plus 36p post and ins.

## 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.



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 the 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.

## AUTO-ELECTRIC CAR AERIAL

with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. £6 plus 25p post and insurance.

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Made by Smiths these are AC mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours, 5A changeover contacts will switch circuit on or off during these periods. £2.50, post and ins. 25p. Additional time contacts 50p pair.

## THE FULL-FI STEREO SIX

The amplifier sensation of the year. You will be amazed at the fullness of reproduction and at the added qualities your records or tuner will reproduce. Built into metal cabinet, elegantly styled and teak finished to blend with modern furnishings, this amplifier uses an integrated solid state circuit with an output power of 6W R.M.S. split over the two channels. The amplifier is ideal for use with normal pick-ups and tuners, it has a double wound mains transformer and ganged volume and tone controls—also switching for Mono to Stereo, tuner or pick-up. Other controls include "treble lift and cut", "balance" and separate mains on/off switch. Price is £9 plus 38p post and insurance.

**MICROSONIC KEYCHAIN RADIO**

7 transistor Keychain Radio in very pretty case, size 2 1/2 x 2 1/2 x 1 1/2in—complete with soft leather zippered bag. 7 transistors, 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 plus 13p post and insurance, less batteries. 6 for £7, post free. Pair of rechargeable batteries and charger 85p.



Where postage is not stated then orders over £5 are post free. Below £5 add 20p. Semiconductor 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 1YD

Callers to Electronics (Croydon) Ltd., 102/3 Tamworth Rd., Croydon

Practical Electronics July 1971

# Readout —

A SELECTION FROM OUR POSTBAG

retailers I was told, "Sorry, we do not sell spares". So back to where I started. I would be very grateful to you if you could inform me where these items may be obtained.

Whilst writing, I would like to mention that it would have been of assistance if you had stated in the components list where one could obtain such special items as the pot cores, 6-pole 5-way switch, etc. instead of resistors, capacitors and transistors, as these form the basic component stock of most retailers anyway.

In conclusion, I agree with your view that it is almost impossible to obtain special components. I can say that I have been deterred from embarking on some of the projects in the magazine for this reason.

A. J. Sanders,  
Woking, Surrey.

You should be able to obtain all the Mullard Ferrox components for "P.E. Gemini" from Home Radio Ltd, Mitcham. The switches referred to were quoted as Maka types and are also available from Home Radio.

## No-one wants my order!

Sir—Since "Radiospares", often mentioned as a source of components, supply only trade, those people who are not in the trade can have great difficulty in obtaining such components.

For example, one of the transformers used in the "Digi-Clock" is quoted as available from them, and so far I have found nowhere else which will sell this type.

Moreover, since many places will not take single orders, I cannot order through them from "Radiospares", and I have therefore found it impossible to obtain such a transformer.

Can you suggest any remedy to the situation?

This problem does not only apply to the clock, but also to many other articles.

M. Easterfield,  
London, N.W.11.

## Makers' names

Sir—Interest in your magazine has led me to try my hand at building some of the projects therein. As I am in a strange town and have difficulty in finding the parts, would you please let me know where I may get the kits specified in your projects. I am particularly

interested in the "Digi-Clock" project at the moment and would like that kit first. From that, of course, will lead many other efforts, and I hope with success.

In your components list I see several addresses bracketed (). Does this mean that these components may be got only from these people? e.g. Nixie numerical indicators (Electroniques (S.T.C.) Ltd., Edinburgh Way, Harlow, Essex) or (Midget Mains 250V by Radiospares). Of Radiospares I could find no address and this is what led to the questions.

Thank you for a very interesting magazine, and may all your projects be successful.

F. Lewis,  
Chaddesden, Derby.

Any type of Dekatron or digital number tubes can be used, some of which are available through Henry's Radio, etc. or Z & I Aero Services, 44a Westbourne Grove, London, W.2.

Radiospares do not supply direct to private individuals. Their full range of components is however available to any bona fide retailer or distributor.

## "Most advanced" is now "phased out"

Sir—The receipt of my May 1971 copy of PRACTICAL ELECTRONICS, containing the editorial entitled "Specialised Components" coincided with a letter from ITT Components Group, Europe, regarding the firm Electroniques of Harlow, Essex.

I had written to Electroniques regarding certain components specified for the "Transistor D.C. Multi-meter", appearing in the June, July and August 1970 issues. Presumably, the supply source of the components in question has been quoted since these were considered "specialised components".

The reply, obviously duplicated, stated simply that the Electroniques operation was being phased out and the components were obsolete. In view of this, the sales department of ITT at Harlow regretted that they were unable to assist.

At the bottom of the letter was the cryptic advertisement, "Europe's most advanced distributor, ITT Electronics Services".

This, I feel, is a rather unfortunate example of, to quote, the editorial: "Industrial component distributors by and large are not favourably disposed towards dealings with private individuals".

In view of this experience I wonder if you could help me with the names of distributors from whom I could obtain the following requirements for the project (not all stated as having been available from the now defunct Electroniques): Miniature Mains Transformer, Primary 0-220/240V, Secondary 12-0-12V 40mA (Electroniques

type P9005). 1mA f.s.d. B.P.L. type S40-V1 moving coil meter. 6in × 4in × 3/4in Bakelite. 6in × 8in × 1/2in Bakelite.

I hope that you are interested in my comments and are able to help with the components.

S. R. Fisher,  
Ongar, Essex.

We have had no official notification from Electroniques concerning their intention to cease trading. This information has come to us via readers! Some early warning from this company of their intention to "phase out" the supply of components to private individuals would have enabled us to obviate these current problems, by ceasing to mention Electroniques as a source of supply for various items.

Transformer available from G. W. Smith & Co (Radio) Ltd.—Eagle type MT12 240V primary, 12-0-12V, 50mA secondary.

The meter was originally available from Electroniques, but now the SEW type MR-65p from G. W. Smith & Co will have to be used.

The s.r.b.p. panels should be available from most component stockists.

## WANTED!

*A reward is offered for information leading to the arrest of Eddy Current, charged with the induction of an 18-year-old coil named Milli Henry found induced, half choked and robbed of valuable joules.*


*This unrectified criminal armed with a ferrite rod, escaped from Weston Primary Cell, where he had been clapped in ions since Faraday.*

*With an erg to be free, his escape was carefully planned in three phases. First, he fused the electrolytes, then he climbed through a grid despite the impedance of the warders whose reactance was too slow. Finally, he went to earth in a magnetic field.*

*What seems most likely is that he stole an a.c. motor. This is of low capacity, and he is expected to try to change it for a megacycle, and return by a short circuit to ohm. He may offer series resistance and is a potential killer.*

A. C. Maynes-Humm,  
Sheriff.

J. S. Haggis,  
Congleton, Cheshire



One of the great prominences that have appeared on the sun. It was some 250,000 miles long and extended into space about 50,000 miles. It consists of a great cloud of hot gas some of which becomes detached and travels into space

# RADIO

# ASTRONOMY TECHNIQUES

BY F.W. HYDE · PART 2

**T**HE simplest radio telescope consisting of aerial, receiver, and recorder is known as a "total power" instrument. It is so named because all the energy received by the aerial is continuously recorded. If the aerial is fixed the result on the recorder will be a "drift curve". That is to say the rotation of the earth will carry the aerial across the sky and record the successive changes in level.

If the aerial is, say, a simple full wave dipole with a reflector pointed up into the sky at an angle of 45 degrees then the two powerful sources of radiation Cygnus A and Cassiopeia will be recorded as humps against the normal background of galactic radiation.

(Cygnus A is part of a nebula sometimes called the Veil Nebula. It is an almost circular streamer of gas about 3 degrees across, and has a high level of radiation extending over a range of frequencies from 100MHz to 1,200MHz. Cassiopeia A is also the remnants of a nebulae and was discovered by F. Graham-Smith. It is thought that these are the remnants of a super nova, parts of it are stationary and parts moving at very high speeds. From calculations of the small moving parts of cloud it would suggest that it actually was a star which exploded about 1702.)

The background galactic radiation shows a gradual rise and fall over the normal 24 hour period. It was this particular variation and its

diurnal change that led Jansky, the pioneer in this branch of astronomy, to make this statement "... in conclusion, data have been presented which show the existence of electromagnetic waves in the earth's atmosphere which apparently come from a direction fixed in space. The data obtained give for the co-ordinates of this direction a right ascension of 18 hours and a declination of 10 degrees."

## A TYPICAL RECORDING

A recording made with the simple, fixed aerial described above connected to a pre-amplifier with a gain of 16dB, a CR100 communications receiver and a Record pen recorder is shown in Fig. 2.1. Because it was recorded over a period too long to permit the whole recording to be displayed it has been concentrated in sections. The rise of the background can be clearly seen together with the high power sources as the earth sweeps the beam of the aerial across the sky.

With such a simple low power system only the very few really powerful sources can be recorded and even then there may be smaller sources also making up the level but which cannot be resolved. The sun will show up very well and an example is shown in Fig. 2.2.

The frequency at which these records were made was 27.5MHz.

If the collecting area of the aerial was increased, then there would be an increase in signal level, a narrowing of the aerial beam, and therefore an improvement in resolution. However, this is not the method usually adopted nowadays unless there is a special reason for large areas of collection. Better resolution can be achieved by other means, such as interferometry, which will be described later.

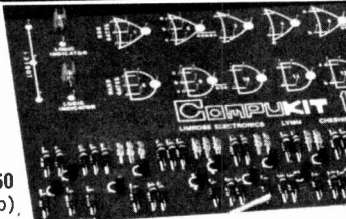
## COMPARISON METHOD

One method adopted to overcome the inherent receiver noise, and so improve the sensitivity, is to

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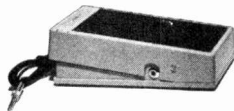
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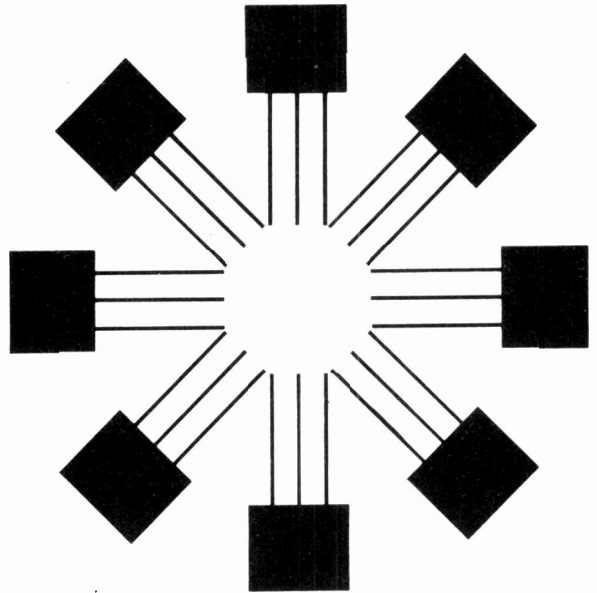
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2N1131	30p	BC115	32p	BYZ12	35p
2N1132	30p	BC116	40p	BYZ13	25p
2N1302	20p	BC16A	15p	BYZ14	15p
2N1303	22p	BC118	37p	GET102	30p
2N1304	25p	BC119	50p	GET111	40p
2N1305	25p	BC134	37p	GET880	37p
2N1306	25p	BC135	30p	GET882	25p
2N1307	25p	BC136	35p	MAT100	25p
2N1308	30p	BC137	40p	MAT101	25p
2N1309	25p	BC138	40p	MAT120	25p
2N1613	22p	BC147	17p	MAT121	30p
2N1711	25p	BC148	12p	MJ2801	£1.37
2N2147	75p	BC149	20p	MJ2901	£2.25
2N2160	65p	BC154	37p	MJE370	97p
2N2218	30p	BC157	20p	MJE520	87p
2N2219	32p	BC158	20p	MJE2955	50p
2N2222	30p	BC159	20p	MJE3055	87p
2N2222A	37p	BC177	25p	MPF102	42p
2N2369	20p	BC178	25p	MPF103	35p
2N2484	35p	BC179	27p	MPF104	37p
2N2646	50p	BCY30	25p	MPF105	40p
2N2904	35p	BCY31	30p	MPT101	25p
2N2905	37p	BCY32	30p	NKT214	15p
2N2906	30p	BCY34	30p	NKT216	37p
2N2906A	32p	BCY38	40p	NKT217	40p
2N2907	37p	BCY39	60p	NKT277	75p
2N2926	12p	BCY40	50p	NKT403	75p
2N3011	25p	BCY41	62p	OA1	10p
2N3053	25p	BCY42	15p	OA5	20p
2N3054	50p	BCY43	20p	OA9	10p
2N3055	75p	BCY58	25p	OA10	25p
2N3525	£1.10	BCY59	25p	OA47	10p
2N3702	12p	BCY70	20p	OA70	10p
2N3703	12p	BCY71	20p	OA71	10p
2N3704	17p	BCY72	15p	OA79	10p
2N3705	15p	BCY78	30p	OA81	10p
2N3710	15p	BCY79	30p	OA85	12p
2N3719	12p	BCZ10	35p	OA90	10p
2N3710	12p	BCZ11	40p	OA91	7p
2N3819	35p	BD112	50p	OA95	7p
2N3820	60p	BD121	50p	OA200	10p
2N4058	17p	BD123	80p	OA202	10p
2N4061	15p	BD124	62p	OC16	50p
2N4547	35p	BD125	50p	OC20	97p
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AA472	15p	BDY62	£1.00	OC42	30p
AAZ13	12p	BF115	25p	OC43	40p
AAZ17	10p	BF152	30p	OC44	17p
AC107	37p	BF154	40p	OC45	15p
AC126	25p	BF158	30p	OC70	12p
AC127	25p	BF159	60p	OC71	97p
AC128	25p	BF167	25p	OC72	25p
AC176	25p	BF170	35p	OC73	30p
AC187	30p	BF173	30p	OC74	30p
AC188	30p	BF177	40p	OC75	25p
AC177	30p	BF178	25p	OC76	25p
AC191	25p	BF180	40p	OC77	40p
AC192	25p	BF181	37p	OC81	25p
AC193	25p	BF182	37p	OC82	25p
AC194	25p	BF183	37p	OC83	25p
AC195	25p	BF184	25p	OC84	25p
AC196	25p	BF185	25p	OC139	25p
AD140	15p	BF140	17p	OC141	62p
AD141	50p	BF195	15p	OC142	62p
AD149	30p	BF196	15p	OC170	25p
AD161	37p	BF197	15p	OC171	30p
AD162	37p	BF200	37p	OC200	40p
AF114	25p	BF274	37p	OC201	60p
AF115	25p	BFW87	25p	OC202	75p
AF116	25p	BFW88	23p	OC203	40p
AF117	25p	BFW89	20p	OC204	40p
AF118	62p	BFW90	22p	OC205	75p
AF124	25p	BFW91	20p	OC206	90p
AF125	20p	BFX13	25p	OC207	90p
AF126	17p	BFX29	30p	OC208	97p
AF127	17p	BFX30	30p	ORP12	50p
AF139	30p	BFX37	32p	ORP60	40p
AF178	47p	BFX84	30p	ORP61	42p
AF179	47p	BFX85	40p	ZTX107	15p
AF180	52p	BFX86	32p	ZTX300	12p
AF181	42p	BFX87	32p	ZTX500	20p
AF186	42p	BFY93	40p	ZTX501	20p
AF239	42p	BFY18	30p	ZTX531	30p
AS276	25p	BFY50	22p		
AS277	32p	BFY51	20p		
AS278	25p	BFY52	22p		
AS279	30p	BFY53	17p		
AS281	47p	BFY64	42p		
AS282	42p	BFY90	25p		
BA115	7p	BSX20	17p	Any one type	
BA164	10p	BSX21	37p	LARGER	
BAX13	6p	BSX76	15p	QUANTITIES	
BAX16	7p	BSY95	15p	PHONE	
BAX31	7p	BSY95A	15p	EXTN.: 4.	

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7402	Quad 2—Input Positive Nor Gate	25p	20p	18p	15p
7404	HEX Inverter	25p	20p	18p	15p
7405	HEX Inverter With Open Collector	25p	20p	18p	15p
7410	Triple 3—Input NAND Gate	25p	20p	18p	15p
7430	Single 8—Input NAND Gate	25p	20p	18p	15p
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7460	Dual 4—Input—Expandable	25p	20p	18p	15p
7470	Single JK Flip Flop—Edge Triggered	40p	35p	30p	25p
7472	Single Master Slave JK Flip Flop	40p	35p	30p	25p
7474	Dual D Flip Flop	45p	40p	35p	30p
7475	Dual Master Slave JK Flip Flop	45p	40p	35p	30p
7476	Dual Master Slave JK Flip Flop With Preset	£0.40	35p	30p	25p
7483	Four Bit Binary Counter	£1.00	90p	80p	75p
7490	BCD Decade Counter	£1.00	90p	80p	75p
7492	Divide by 12. 4 Bit Binary Counter	£1.00	90p	80p	75p
7494	Divide by 16. 4 Bit Binary Counter	£1.00	90p	80p	75p
7495	Dual Entry 4 Bit Shift Register	£1.00	90p	80p	75p
7496	4 Bit Up Down Shift Register	£1.00	90p	80p	75p
7496	5 Bit Shift Register	£1.00	90p	80p	75p

Data available for above in booklet form, price 10p. (Ref. No. 30)  
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**TRIACS GENERAL ELECTRIC**

Type	Volts	rent	1-49	50+	100+	500+
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SC35B	200	3A	95p	80p	70p	65p
SC35D	400	3A	£1.00	85p	75p	70p
SC40A	100	6A	£1.00	85p	75p	70p
SC40B	200	6A	£1.20	£1.00	85p	80p
SC40D	400	6A	£1.25	£1.10	£1.00	90p
SC45A	100	10A	£1.25	£1.10	£1.00	90p
SC45B	200	10A	£1.35	£1.20	£1.10	£1.00
SC45D	400	10A	£1.50	£1.35	£1.20	£1.10
SC50A	100	15A	£1.65	£1.50	£1.40	£1.30
SC50B	200	15A	£1.75	£1.60	£1.45	£1.30
SC50D	400	15A	£2.00	£1.75	£1.60	£1.40
SC40E	500	6A	£1.50	£1.25	£1.10	£1.00
SC45E	500	10A	£1.75	£1.50	£1.35	£1.25
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IN4002	100	9p	8p	7p	5p	4p
IN4003	200	10p	9p	7p	6p	5p
IN4004	400	12p	11p	9p	7p	6p
IN4005	600	10p	9p	8p	7p	6p
IN4006	800	15p	14p	12p	11p	10p
IN4007	1000	20p	16p	13p	12p	10p

**1.5 AMP MINIATURE WIRE ENDED PLASTIC RECTIFIERS**

Type	P.I.V.	1-49	50	100	500	1000
PL4001	50	10p	9p	8p	7p	6p
PL4002	100	11p	10p	9p	8p	7p
PL4003	200	12p	11p	10p	9p	8p
PL4004	400	12p	11p	10p	9p	8p
PL4005	600	15p	13p	11p	10p	9p
PL4006	800	17p	15p	13p	12p	10p
PL4007	1000	20p	17p	15p	13p	11p

**3 AMP PLASTIC WIRE ENDED RECTIFIERS**

Type	P.I.V.	1-49	50	100	500	1000
PL7001	50	20p	18p	17p	16p	14p
PL7002	100	20p	19p	18p	17p	15p
PL7003	200	22p	20p	19p	18p	16p
PL7004	400	25p	23p	21p	20p	18p
PL7005	600	26p	24p	23p	22p	20p
PL7006	800	27p	25p	24p	23p	21p
PL7007	1000	30p	28p	26p	24p	22p

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2002	200	2A	70p	65p	60p	55p
1004	100	4A	70p	60p	55p	50p
2004	200	4A	75p	60p	55p	50p
4004	400	4A	80p	75p	70p	65p
6002	600	2A	90p	80p	75p	70p
6004	600	4A	90p	80p	75p	70p
1006	1000	6A	90p	80p	75p	70p
2006	2000	6A	80p	75p	70p	65p
4006	4000	6A	£1.10	£1.00	90p	80p
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CA3012	90p	CA3039	85p
CA3014	£1.45	CA3041	£1.10
CA3018	£1.10	CA3043	£1.40
CA3020	£1.25	CA3044	£1.25
CA3021	£1.55	CA3046	85p
CA3023	£1.25	CA3048	£2.25
CA3026	£1.40	CA3051	£1.35
CA3028A	£1.20		

Data notes 10p (Ref. No. 30)

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TAD100	Mullard	£2.00
TAD110	Mullard	£2.00
MC1303	Motorola	£2.60
UL900	Fairchild	40p
UL914	Fairchild	40p
UL923	Fairchild	60p
LA709C	Fairchild	75p

compare the incoming signal with a standard level of noise produced electronically by a "noise source."

The earliest form of receiver employed for the comparison method was due to Dicke and is known generally as the Dicke system. The receiver is continuously switched between the aerial system and a "noise source". The latter can be a diode valve or semiconductor. The important requirement is the stability of the noise source, since it is the standard or comparison source with which the aerial output is compared.

The Dicke system is shown in the block diagram Fig. 2.3. In (a) is shown the detected levels of  $T_r + T_a$  (receiver noise plus the aerial noise) and  $T_r + T_o$  (receiver noise plus standard source noise) after the detector and before amplification. In (b) is shown the amplitude after the signals passed through the amplifier which is tuned to the same frequency as that of the switching unit. At this point it is an alternating signal. To bring it to a standard level the output of the amplifier is also switched at the same frequency as the switch. The synchronous switching then brings the two signals into phase and thus the two levels show as a varying signal because the standard level is constant but the input from the aerial varies, as shown in (c).

The final trace on the chart will not of course show the divisions as in the diagram (c) which have been exaggerated to make the method clear. The

frequency of the switch is high enough so that a regular change of level appears on the slowly moving pen recorder. The signal level may vary about the level of the standard noise. If the switch frequency is 1,000Hz then the intervals shown in the diagram will represent 1/1,000 of a second.

In this system the aerial is connected to the receiver for only half the period and this is an obvious disadvantage. On account of this, such a system is not widely used.

A modification to the Dicke system devised by Graham helps to restore the lost time by using a double receiver. A block diagram for this system is shown in Fig. 2.4.

### RYLE AND VONBERG MODIFICATION

A further modification of the comparison receiver is that due to Ryle and Vonberg. This is based on the Dicke principle of using a noise source for calibration.

In this modification the receiver is switched between the aerial and the calibrating noise source in such a way that the difference signal which appears in the output of the receiver is amplified and controls the noise source so that it is always equal to the input to the receiver. Since this is a varying signal this variation can be recorded. The changing level of the radiation that the aerial collects will thus

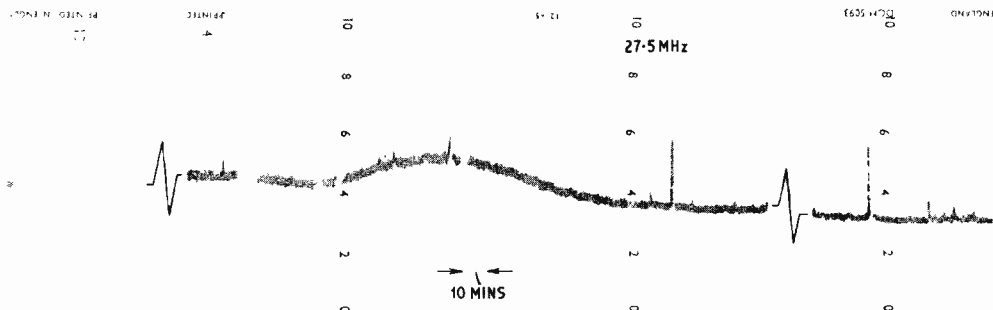


Fig. 2.1. A recording of galactic background made with a simple radio telescope

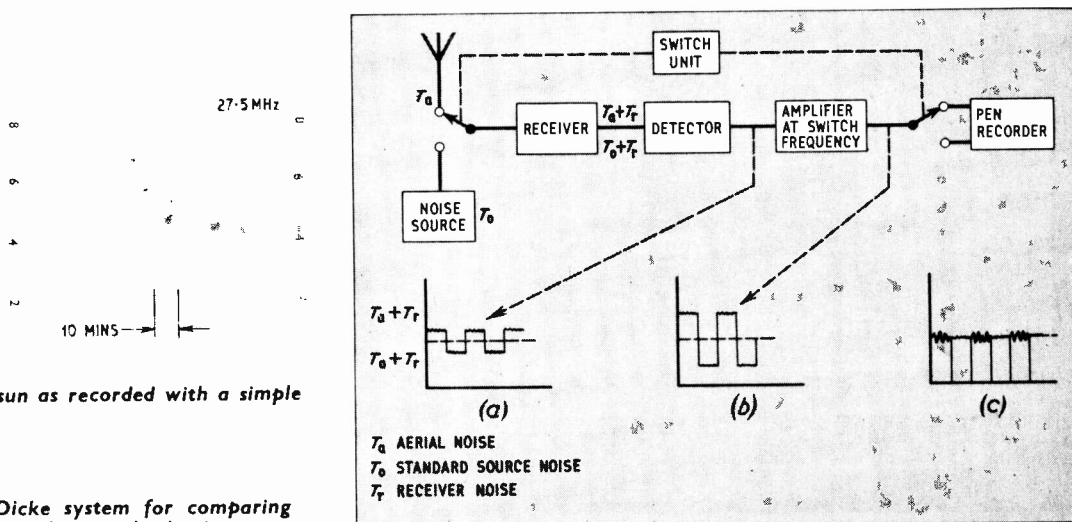


Fig. 2.2. The sun as recorded with a simple radio telescope

Fig. 2.3. The Dicke system for comparing incoming signals with a standard noise source

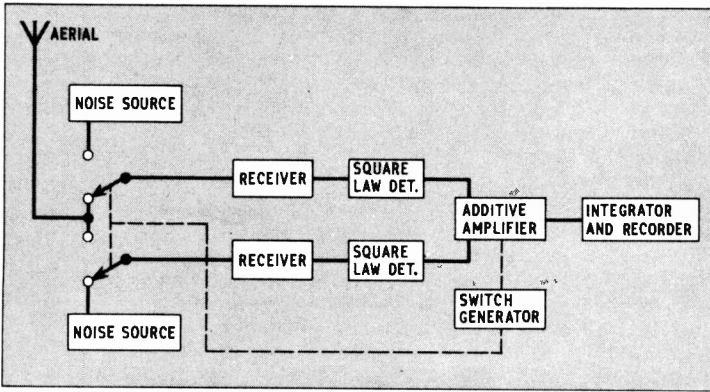


Fig. 2.4. The Graham receiving system, which employs a double receiver

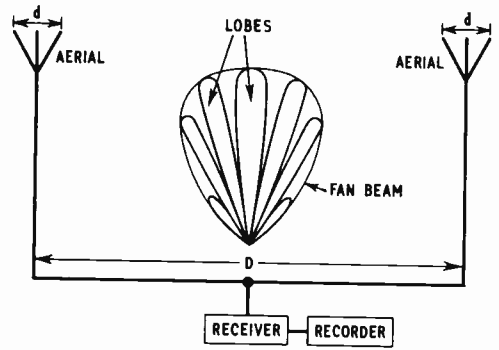


Fig. 2.7. A simple two-aerial interferometer

be followed by the recorder. This system also reduces the problems of stability particularly in the receiver. A block diagram of this system is shown in Fig. 2.5.

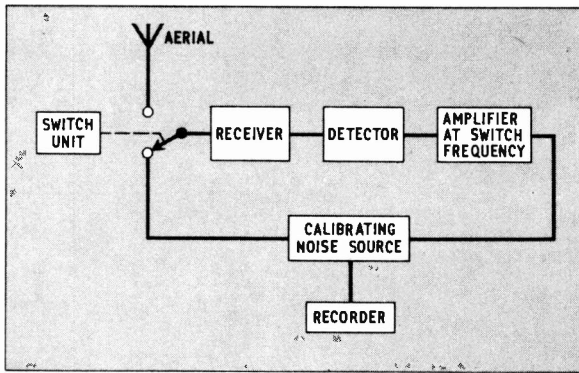


Fig. 2.5. Ryle and Vonberg modification of Dicke system

### LARGE DISH AERIALS

The large parabolic "dish" aerials have enormous collecting areas, and at high frequencies can achieve a very high degree of resolution. For example, the 250ft dish at Jodrell Bank when used at a frequency of 1,425MHz has a beamwidth of about 15 seconds of arc, so that two sources at a separation of, say, 25 seconds of arc would be easily distinguished. However, at a frequency of 300MHz, two sources would have to be more than 45 minutes of arc apart before they could be resolved.

This emphasises what has been said previously about the type of aerial system used: it depends essentially upon the nature of the project.

### INTERFEROMETERS

High resolution and increased sensitivity can be obtained by using aerials as interferometers. There are two principal methods used: one is similar in operation to that of the Lloyd's mirror interferometer used in optical work, and the second is equivalent to the Michelson optical interferometer.

The Lloyd's mirror equivalent was devised by McCready, Payne-Scott and Pawsey of Australia. In this arrangement the sea took the place of the mirror for the aerial system was mounted on a cliff overlooking the sea. Thus a single aerial system was all that was necessary for the application of this ingenious experiment. It does, of course, have limitations in that it is suitable for use with sources rising above the horizon to the zenith only.

The cliff interferometer system is shown in the diagram Fig. 2.6. The wave front is intercepted by the sea at the same time that the aerial receives a direct wave. The intercepted wave is reflected from the sea to the aerial but by reason of the longer path of travel there is a difference in phase or time of arrival. The aerial therefore will be subject to additions or subtractions of signal level according to variations of the phase. This means that the receiver will measure a signal increasing or decreasing in power as the changes of phase occur with rising of the source above the horizon and through the beam of the aerial.

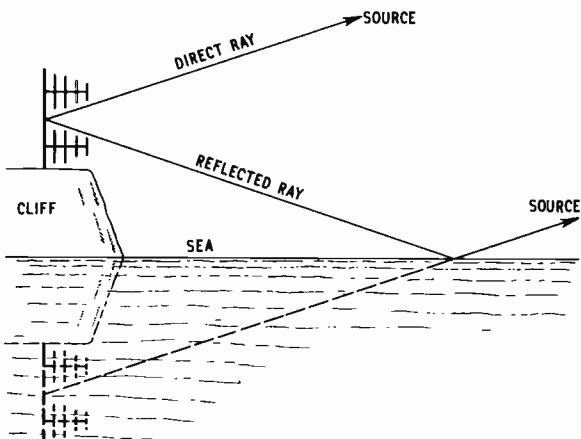


Fig. 2.6. Cliff interferometer, the sea provides a mirror image of the real aerial



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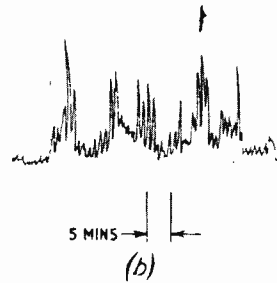
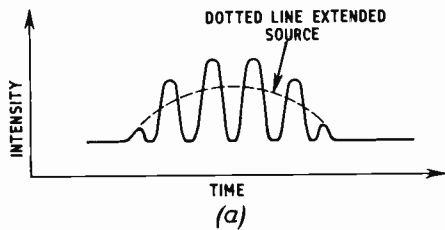


Fig. 2.8 (a). Diagram of simple interferometer fringes

(b). Actual recording from simple interferometer

The system behaves as though there were two aerials, the second being a mirror image of the real aerial. The effective base-line of this system is  $2H$  so that if the centre of the aerial system is 200ft above the sea the baseline will be equal to 400ft.

## TWO-AERIAL INTERFEROMETER

The second type of interferometer and which is similar to the Michelson optical system can be understood by considering first the purpose for which the optical arrangement was designed.

When the resolution of the 100in optical telescope was used for measuring star diameters, its resolution was not good enough to achieve the standard required. Michelson mounted two mirrors 20ft apart on a beam across the aperture of the 100in telescope in such a way that two rays of light were received, one at each mirror reflected through 90 degrees to the two mirrors within the aperture of the telescope which turned each ray through 90 degrees again to illuminate the mirror. As the star moved through the beam, fringes were formed which were alternatively bright and dark. These fringes were caused by the addition and subtraction of the amount of light reaching the main mirror as the two lengths of the ray paths varied. The whole system behaved as though the telescope was in fact 20ft in diameter.

In a similar way this technique was put to use for radioastronomy by Ryle and Vonberg. Two aerials were used spaced from each other by a number of wavelengths, along an east-west baseline. As the earth carried the system round its axis and therefore across the sky, the signal would arrive at each aerial by a path of different length except when the source was midway between the two aerials. Consequently, the signal at the receiver would vary periodically, adding and subtracting as the phase changed. The result appears on a pen recorder in the form of fringes as shown in Fig. 2.8.

The effect of the spaced aerials results in a polar diagram of the form shown in Fig. 2.7. A fan beam is produced which consists of a number of separate lobes. The number of lobes related to the distance between the aerials. If the distance in wavelengths between the aerials is designated  $D$  and the size in wavelength of the individual aerials  $d$  then the

number of lobes will be  $\frac{D}{d}$ . The width of the central fringes will be approximately  $\frac{57\lambda}{D}$ .

If the number of fringes is very large and consequently their width small, there may be some difficulty in correctly identifying the fringe in which the source of radiation appears. In the simple interferometer a diffused source may obscure a smaller one in the same area and a special technique is used to overcome this. The modification is known as phase switching and will be described later.

## LIMITATIONS

One disadvantage of the two aerial interferometer is that the resolution that can be achieved in the north-south direction is not good except when large dishes are used. A dish has the same beamwidth in each mode but the limitations of size imposed by other types of aerial precludes the reduction of the vertical beamwidth to that of the horizontal beamwidth.

For example: at a wavelength of 2 metres four full wavelength dipoles will have a beamwidth of 30 degrees if they are stacked vertically at half-wave spacing. If two of these aerials are spaced 20 wavelengths apart the centre fringe lobe will be a little less than 3 degrees. The area "seen" by such a simple interferometer will be 3 degrees in azimuth and 30 degrees in altitude. Now 40 degrees of sky is wider than the Milky Way which contains a number of sources and it would be difficult to separate them. However, if a study of the sun is to be the object of a project, this system will provide a good deal of data.

## A PRACTICAL RADIO TELESCOPE

At this point it is perhaps appropriate to outline a design which amateurs could put into operation. Three frequencies will be chosen in order that standard equipment can be used. Also the frequencies chosen will enable those with minimum space to at least "have a go"

The three frequencies are 184MHz, 144MHz, and 30MHz. Choice can be made to suit individual needs and preferences and, of course, space limitations. For example it might be easier to raise the frequency of 184MHz since this is channel 7 in band III and converters are on the market with 19MHz outputs which may be coupled to a communications receiver, or alternatively, the television receiver can be used without interfering with its normal performance.

At the lower end, 30MHz is within the communication receiver limit but the physical limit for the

aerial baseline might defeat the aims of the project. At this frequency less than five wavelengths spacing will give rather poor results and might dampen enthusiasm.

The middle frequency 144MHz should appeal to many, for this is standard for communication and converters for this band are available in quite cheap kit form.

## BASIC REQUIREMENTS

The basic requirements, as we have already seen, are the aerials, a pre-amplifier of 20dB gain or more, a receiver which may be converter-plus-communication receiver, and (preferably) a pen recorder. As an alternative to the pen recorder, a tape recorder operating at a low speed (1 1/2 in/sec or preferably 1/8 in/sec) could be used for processing to paper later. These basic requirements are indicated in Fig. 2.9.

## AERIALS

The aerial system allows choice of Yagi's, corner reflectors, or pairs of dipoles, or mattress with dipoles (Kooman array). All of these were illustrated in Part 1 of this series.

The aerials must be aligned east and west. The distance between aerials should be correct to one sixteenth of a wavelength. Also remember that magnetic east and west differs by several degrees from geographic east and west. The following table gives the spacings for each frequency.

TABLE 2.1

$\lambda$	184MHz	144MHz	30MHz
$5\lambda$	21ft	30ft	150ft
$10\lambda$	42ft	60ft	300ft
$20\lambda$	84ft	120ft	600ft

## FEEDERS

The aerial feeders should be of identical length. They can be brought individually direct to the receiver, or they may be connected together by a length of cable tapped exactly in the centre from the feeder to the receiver.

In the case of the higher frequencies the pre-amplifiers should be located at the aerials if possible and they must be fed from stable supplies. If the distance is not too great (say, not more than the distance between aerials) from the aerials to the receiver, then the pre-amplifier can be at the receiver.

At the lower frequency the cable losses will be much smaller so that it will be quite satisfactory if the pre-amplifier is next to the receiver. If the feeder is coaxial cable with an impedance of 75 ohms, then the two cables will need to be matched, either at the junction between the aerials or at the receiver input. A suitable system is shown in Fig. 2.10. The matching section is a length of 50 ohm coaxial, a quarter-wavelength long at the selected frequency.

## PEN RECORDER

Pen recorders vary considerably in type and performance specification. Some are fitted with a rectifier so that both a.c. and d.c. operation is possible. If the input is low impedance the recorder can be connected directly to the output of the audio section of the receiver in place of the loudspeaker.

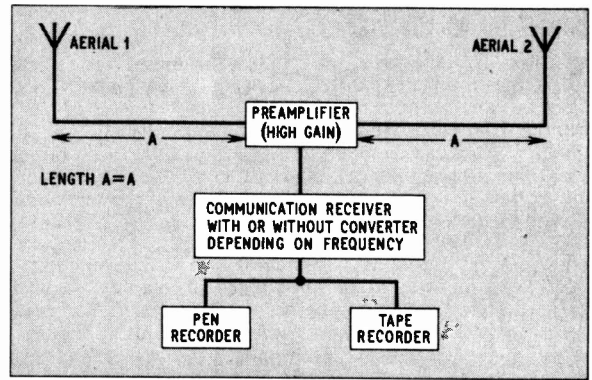


Fig. 2.9. Block diagram of a practical interferometer radio telescope

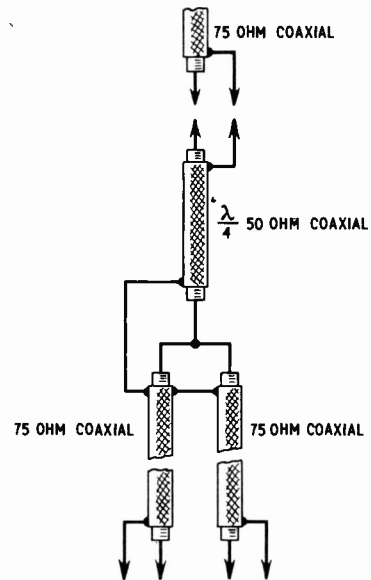


Fig. 2.10. Matching arrangements for aerial coaxial feeders

If the pen recorder is of the potentiometer type then it may be necessary to connect to some stage prior to the output of the receiver. A suitable point could be the a.g.c. line if the recorder has a d.c. input. If it is of the low resistance a.c. direct reading type then an instrument rectifier will need to be fitted.

## PROJECTS TO BE DESCRIBED

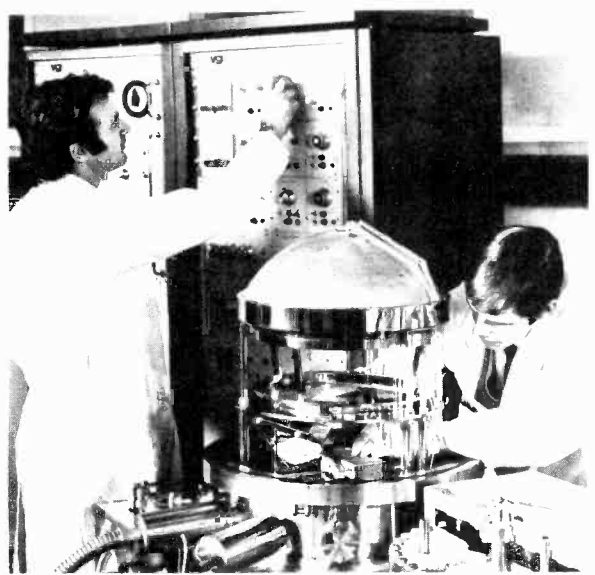
There are a number of radio astronomy projects which can be taken up by individuals or groups working in radio and electronics clubs and schools. Some suitable projects will be introduced in subsequent articles in this series. They will include a study of solar radiation, and radiation from the Galaxy with special attention to the sources of high level such as Cassiopeia, Cygnus A and the Crab Nebula. It will also be possible to use the various arrangements of apparatus to monitor earth satellites.

Following this there will be full details of a project for the study of the radiation from the planet Jupiter. Finally, a special project involving a search for evidence of the effects of gravitational waves.

**Next month: Increasing the resolving power and some special methods of observation**

## Electronic Microscope

SHOWN at the recent Labex exhibition at Earls Court was a new low-cost high-performance electron microscope. The Corinth 275 by GEC-Elliott Automation was shown as the ideal teaching and demonstration instrument with special appeal to biologists requiring a high throughput of routine specimens. The operation of Corinth 275 is very simple with all controls, including a single push-button for the automatic vacuum system, readily to hand. The electron lens system, the vacuum system and all power supplies are self-contained within the single console, requiring a minimum of floor space. The resolution is better than 9A. The photograph shows the complete unit.



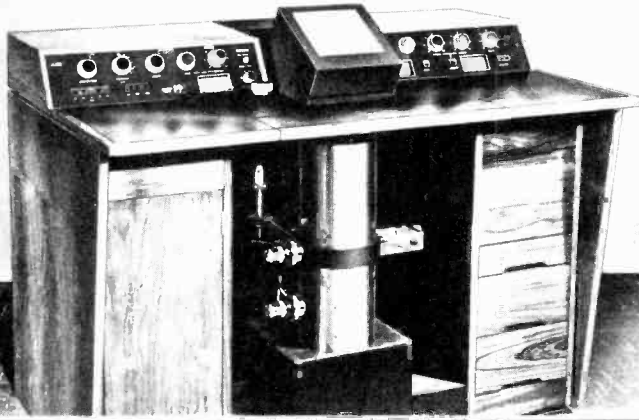
## High Vacuum Evaporator

AN ultra high vacuum evaporator manufactured by Vacuum Generators Limited, the first of its kind in Europe, was recently installed and is now in production use at ITT Semiconductors, Footscray, Kent.

The unit has a special oil free vacuum system to ensure complete absence of the hydrocarbon contamination present in conventionally pumped equipment.

The evaporator is fitted with a 10kW electron beam evaporation source and rotary work holder designed for the deposition of aluminium films on 1½in diameter silicone slices.

During acceptance trials film thickness uniformity and film reliability were both extremely high.



# ELECTRONORAMA

## Electronic Jag

OPUS has been a familiar name to builders of racing engines and cars for a number of years and has now created further interest with the recent announcement of the V12 Jaguar. The application of the Opus system on the Jaguar—the first time an electronic ignition system has been fitted as standard equipment to a volume production car.

Lucas Opus Ignition (Mark 2) is an electronic contact breakerless system which will provide a

spark rate of the order of 100 sparks/second.

The conventional distributor is replaced by a timing rotor assembly mounted on the drive shaft (see photograph) and a stationary passive pick-up module connected to the amplifier unit. The pick-up module is in effect a transformer having two input windings connected in series and an output winding. When ferrite coupling rods embedded in the timing rotor pass the pick-up the balance of the transformer is upset and increased signal from the oscillator—part of the amplifier module—appears at the output coil. This voltage is fed to the amplifier and causes the output transistor to cut off; the ignition coil primary is thus broken and a spark is fanned by the coil in the normal way. The photograph shows:

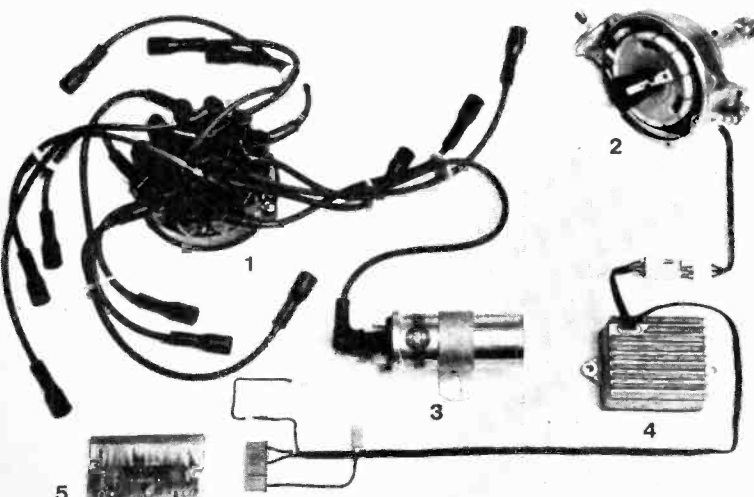
- 1 Distributor h.t. cover
- 2 Distributor
- 3 High performance ignition coil
- 4 Amplifier unit
- 5 Ballast resistor unit

## I.E.E. CENTENARY

A SPECIAL exhibition to commemorate the centenary of the Institution of Electrical Engineers is now open at the Science Museum, London, S.W.7.

The theme of the exhibition is the development of electrical engineering over the last hundred years.

The exhibition will last approximately another two months and museum times are; 10 a.m. to 6 p.m. weekdays, 2.30 to 6 p.m. Sundays.



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1N85	0-88	AC187	0-80	BF184	0-25	GJ7M	0-38	OC44M	0-18
1N253	0-50	AC188	0-80	BF185	0-25	HG1005	0-60	OC45	0-15
1N256	0-50	AC177	0-80	BF194	0-18	HS100A	0-20	OC45M	0-18
1N645	0-25	AC118	0-25	BF195	0-15	MAT100	0-25	OC46	0-28
1N725A	0-20	AC119	0-25	BF196	0-28	MAT101	0-30	OC57	0-60
1N914	0-06	AC120	0-23	BF197	0-28	MAT120	0-25	OC58	0-80
1N4007	0-23	AC121	0-23	BF861	0-28	MAT121	0-30	OC39	0-60
18021	0-20	AC122	0-18	BF899	0-28	MJE250	0-88	OC66	0-50
18113	0-15	AC127	0-25	BFX12	0-28	MJE2935	1-75	OC70	0-13
18130	0-10	AC128	0-18	BFX13	0-23	MJE9055	0-83	OC71	0-15
18131	0-13	AC139	0-55	BFX29	0-30	NKT128	0-30	OC72	0-25
18202	0-23	AC140	0-15	BFX30	0-33	NKT129	0-30	OC73	0-30
2G240	1-96	AC141	0-25	BFX35	0-96	NKT211	0-25	OC74	0-30
2G301	0-18	AC144	0-28	BFX63	0-50	NKT213	0-25	OC75	0-25
2G302	0-22	AD140	0-50	BFX84	0-30	NKT214	0-15	OC76	0-25
2G306	0-20	AD147	0-50	BFX85	0-30	NKT215	0-25	OC77	0-20
2G371	0-22	DI181	0-38	BFX86	0-33	NKT217	0-40	OC78	0-30
2G381	0-25	AD182	0-38	BFX87	0-33	NKT218	0-40	OC79	0-23
2G414	0-30	AF106	0-30	BFX88	0-25	NKT219	0-38	OC81	0-25
2G417	0-23	AF114	0-33	BFY10	1-20	NKT222	0-20	OC81D	0-20
2N214	0-43	AF115	0-30	BFY11	1-25	NKT224	0-23	OC81M	0-20
2N247	0-25	AF116	0-33	BFY17	0-25	NKT231	0-24	OC81DM	0-18
2N250	0-20	AF117	0-25	BFY18	0-25	NKT232	0-23	OC81E	0-55
2N404	0-23	AF118	0-23	BFY19	0-25	NKT272	0-25	OC82	0-25
2N697	0-18	AF119	0-20	BFY24	0-45	NKT273	0-20	OC82D	0-15
2N698	0-43	AF124	0-25	BFY44	1-00	NKT274	0-20	OC83	0-25
2N706	0-10	AF125	0-20	BFY50	0-23	NKT275	0-25	OC84	0-25
2N708A	0-18	AF126	0-18	BFY51	0-20	NKT277	0-20	OC14	0-28
2N708	0-18	AF127	0-18	BFY52	0-23	NKT278	0-25	OC19	0-25
2N709	0-38	AF139	0-30	BFY53	0-18	NKT301	0-30	OC123	0-50
2N711	0-38	AF178	0-48	BFY64	0-43	NKT304	0-35	OC139	0-25
2N987	0-53	AF179	0-48	BFY90	0-68	NKT403	0-75	OC140	0-38
2N1090	0-30	AF180	0-53	BBX27	0-50	NKT404	0-63	OC141	0-68
2N1091	0-33	AF181	0-43	BBX60	0-33	NKT678	0-30	OC169	0-20
2N1131	0-30	AF186	0-40	BGX76	0-25	NKT713	0-25	OC170	0-25
2N1132	0-30	AF119	1-13	BSY26	0-18	NKT718	0-25	OC171	0-30
2N1302	0-20	AF211	0-63	BSY27	0-20	NKT777	0-38	OC200	0-38
2N1303	0-23	AF212	0-75	BSY31	0-60	OR78B	0-38	OC201	0-48
2N1304	0-25	AS226	0-25	BSY95A	0-15	OA5	0-15	OC202	0-38
2N1305	0-25	AS227	0-33	BSY95	0-15	OA6	0-13	OC203	0-38
2N1306	0-25	AS228	0-25	BT102/500R	0-75	OA7	0-10	OC204	0-40
2N1307	0-25	AS229	0-30	BTY42	0-93	OA71	0-10	OC205	0-63
2N1308	0-30	AS236	0-25	BTY79/100R	0-75	OA73	0-10	OC206	0-75
2N1309	0-25	AS230	0-18	BTY79/100R	0-75	OA74	0-10	OC207	0-75
2N1420	0-33	AS231	0-20	BTY79/400R	0-75	OA79	0-10	OC208	0-20
2N1507	0-28	AS232	0-20	BY100	1-75	OA81	0-10	OC211	0-98
2N1526	0-38	AS233	0-20	BY100	1-75	OA82	0-13	ORP12	0-38
2N1599	0-25	AS234	0-25	BY126	0-15	OA86	0-15	ORP60	0-40
2N2147	0-75	AS235	0-38	BY127	0-20	OA90	0-10	ORP61	0-43
2N2148	0-60	AS221	0-43	BY127	0-20	OA91	0-08	819T	0-30
2N2160	0-63	AS223	0-75	BY182	0-75	OA95	0-08	SAC40	0-25
2N2218	0-30	AUY10	0-98	BY213	0-25	OA290	0-08	SFT308	0-38
2N2219	0-33	AU101	1-60	BYZ10	0-40	OA292	0-10	ST792	0-38
2N2287	0-08	BC107	0-18	BYZ10	0-40	OA210	0-25	ST7231	0-63
2N2297	0-30	BC108	0-13	BYZ11	0-35	OA211	0-35	SX68	0-20
2N2369A	0-20	BC109	0-13	BYZ12	0-30	AZ200	0-55	SX631	0-20
2N2613	0-28	BC113	0-25	BYZ13	0-25	AZ201	0-50	SX633	0-20
2N2646	0-53	BC115	0-33	BYZ15	1-00	AZ202	0-43	SX640	0-25
2N2712	0-25	BC116	0-40	BYZ15	1-00	AZ203	0-43	SX641	0-25
2N2784	0-50	BC116A	0-40	BYZ16	0-63	AZ204	0-43	SX642	0-25
2N2846	0-25	BC118	0-25	BYZ88C3	0-38	AZ205	0-43	SX644	0-48
2N2848	0-43	BC121	0-25	C111	0-65	AZ206	0-43	SX645	0-75
2N2904	0-30	BC122	0-20	CRS1/05	0-25	AZ207	0-48	V15/30P	0-50
2N2904A	0-33	BC125	0-68	CRS1/40	0-48	AZ208	0-33	V30/201P	0-38
2N2906	0-30	BC126	0-65	CR4B	0-55	AZ209	0-38	V60/201P	0-38
2N2907	0-38	BC140	0-18	CS103	0-18	AZ210	0-25	V60/201P	0-38
2N2924	0-33	BC147	0-18	DD000	0-15	AZ211	0-33	XA101	0-10
2N2925	0-18	BC148	0-13	DD003	0-15	AZ222	0-40	XA102	0-18
2N2926	0-13	BC149	0-20	DD006	0-18	AZ223	0-40	XA151	0-15
2N3054	0-50	BC149	0-20	DD007	0-40	AZ224	0-38	XA152	0-15
2N3055	0-75	BC137	0-20	DD008	0-38	AZ241	0-23	XA161	0-25
2N3702	0-13	BC138	0-20	GD3	0-33	AZ242	0-25	XA162	0-25
2N3703	0-15	BC160	0-63	GD4	0-05	AZ244	0-25	XB101	0-43
2N3706	0-23	BC169	0-13	GD5	0-33	AZ246	0-23	XB102	0-18
2N3707	0-15	BCY31	0-30	GD8	0-25	AZ290	0-38	XB102	0-10
2N3709	0-13	BCY32	0-50	GD12	0-05	OC16	0-43	XB103	0-25
2N3710	0-13	BCY33	0-20	GET102	0-30	OC18T	0-28	XB113	0-10
2N3711	0-13	BCY33	0-20	GET103	0-23	OC19	0-38	XB121	0-43
2N3819	0-35	BCY34	0-25	GET113	0-20	OC20	0-98	ZR24	0-63
2N3820	0-38	BCY38	0-30	GET115	0-20	OC22	0-48	Z8170	0-10
2N3823	0-75	BCY39	0-45	GET114	0-15	OC29	0-50	Z8271	0-18
2N5027	0-53	BCY40	0-43	GET115	0-45	OC28	0-50	ZT21	0-25
2N5083	0-33	BCY42	0-16	GET116	0-50	OC24	0-25	ZT43	0-25
28005	0-75	BCY70	0-20	GET120	0-25	OC25	0-38	ZTX107	0-15
28301	0-43	BCY71	0-30	GET172	0-30	OC26	0-25	ZTX108	0-15
28304	0-63	BCZ10	0-30	GET175	0-25	OC28	0-63	ZTX107	0-15
28501	0-38	BD121	0-38	GET180	0-25	OC29	0-63	ZTX108	0-15
28703	0-63	BD121	0-85	GET181	0-25	OC29	0-63	ZTX107	0-15
AA129	0-20	BD123	0-68	GET182	0-25	OC30	0-40	ZTX300	0-13
AAZ12	0-30	BD124	0-68	GET185	0-20	OC35	0-50	ZTX304	0-28
AAZ13	0-13	BDY11	1-63	GEX44	0-08	OC36	0-63	ZTX500	0-15
AAZ17	0-38	BF115	0-25	GEX49/1	0-08	OC41	0-25	ZTX503	0-20
AC107	0-38	BF117	0-50	GET941	0-13	OC42	0-30	ZTX531	0-80
AC126	0-25	BF197	0-25	GJ3M	0-25	OC42	0-30	ZTX531	0-80

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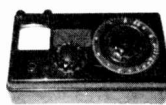


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Specification. Type: Moving Coil Galvanometer. Ranges: 1, 0-05 to 5 ohms. 2, 0-5 to 50 ohms. 3, 5 to 500 ohms. 4, 50 to 5,000 ohms. 5, 500 to 50,000 ohms. Scales: Switched. Slidewire: 0-5 to 50. Galvanometer Scale: 10-100. Case: Moulded plastic. Internal Source: 4V Dry battery. Dimensions: 200 x 110 x 60mm. Weight: 0-9kg. List price £25. Our price £9.

**NUMICATOR PRICE LIST**

End Reading	Quantity	Price each (less base)
1-3	1	£1.40
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38m/Lead (Red)	1	£1.10
6m/Lead (Red)	1	£1.10
6m/Lead (Clear)	1	£1.10
38m/Lead (Red)	1	£1.10
38m/Lead (Amber)	1	£1.10

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Lift lid once stays open. Lift twice catch releases and allows lid to close. Closed length 7in, open length 10in. Finished dull plating brand new. 4 for £1. Post free.

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Similar principle to above closed length 1 1/2in, open length 3 1/2in. 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.

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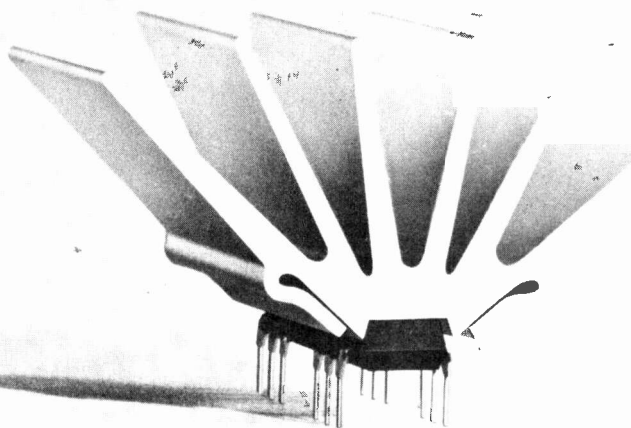
230V, 50Hz, 0-65A, 1/20 h.p., 2,850 r.p.m. Cont. rated. Shaft 3/16 in dia x 1/2 in long. Circular clamp mounting. £3.50. Post free.

**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. 2 1/2 in x 1 1/

# new

## Super IC-12



### High fidelity Monolithic Integrated Circuit Amplifier

Two years ago Sinclair Radionics announced the World's first monolithic integrated circuit Hi-Fi amplifier, the IC.10. Now we are delighted to be able to introduce its successor the Super IC.12. This 22 transistor unit has all the virtues of the original IC.10 plus the following advantages:

1. Higher power.
2. Fewer external components.
3. Lower quiescent consumption.
4. Compatible with Project 60 modules.
5. Specially designed built-in heat sink. No other heat sink needed.
6. Full output into 3, 4, 5 or 8 ohms.
7. Works on any voltage from 6 to 28 volts without adjustment.
8. NEW 22 transistor circuit.

**Output power** 6 watts RMS continuous (12 watts peak).

**Frequency Response** 5 Hz to 100KHz  $\pm$  1 dB.

**Total Harmonic Distortion** Less than 1% (Typical 0.1%) at all output powers and all frequencies in the audio band.

**Load Impedance** 3 to 15 ohms.

**Power Gain** 90dB (1,000,000,000 times) after feedback.

**Supply Voltage** 6 to 28 volts (Sinclair PZ-5 or PZ-6 power supplies ideal).

**Size** 22 x 45 x 28 mm including pins and heat sink.

**Input Impedance** 250 Kohms nominal.

**Quiescent current** 8mA at 28 volts.

**Price:** including FREE printed circuit board for mounting. **£2.98** Post free

With the addition of only a very few external resistors and capacitors the Super IC.12 makes a complete high fidelity audio amplifier suitable for use with pick-up, F.M. tuner etc. Alternatively, for more elaborate systems, modules in the Project 60 range such as the Stereo 60 and A.F.U. may be added. The comprehensive manual supplied with each unit gives full circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include car radios, oscillators etc. The very low quiescent consumption makes the Super IC.12 ideal for battery operation.

Sinclair Radionics Ltd., London Rd, St. Ives  
Huntingdonshire PE17 4HJ  
Telephone St Ives (048 06) 4311

**sinclair**

# Sinclair Project 60



the world's most advanced high fidelity modules

**Sinclair Project 60** presents high fidelity in such a way that it meets every requirement of performance, design, quality and value and now that the remarkable phase lock loop stereo FM tuner is available, it becomes the most versatile of high fidelity systems. With Project 60, it is possible to start with a

modest mono record reproducer and expand it to a sophisticated stereophonic radio and record reproducing system of fantastically good quality to hold its own with any other equipment, no matter how expensive. Project 60 is a unique high fidelity module system where compactness and ease of assembly are combined with

circuitry that is far in advance of any other manufacturer in the world. Thus it is extraordinarily easy to assemble any combination of modules using nothing more complicated than the simplest of tools, and you certainly do not have to be experienced to build with complete confidence. The 48 page manual free with Project 60 equipment makes everything easy and you can house your assembly in an existing cabinet, motor plinth, free standing cabinet or virtually any arrangement you wish. Once you have completed your assembly you will have superlatively good equipment to give you years of service and enjoyment. You will have obtained superb value for money because Project 60 is the best selling modular system in Europe and can therefore be produced at extremely competitive prices and with excellent quality control.

Sinclair Radionics Ltd., London Road, St. Ives, Huntingdonshire PE17 4HJ.  
Tel: St. Ives (048 06) 4311

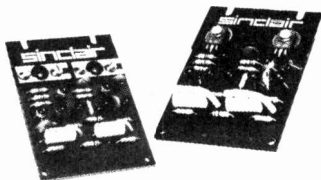
**sinclair**

System	The Units to use	together with	Cost of Units
A Simple battery record player	<b>Z.30</b>	Crystal P.U., 12V battery volume control	<b>£4.48</b>
B Mains powered record player	<b>Z.30, PZ.5</b>	Crystal or ceramic P.U. volume control etc.	<b>£9.45</b>
C 20+20W. R.M.S. stereo amplifier for most needs	<b>2 x Z.30s, Stereo 60, PZ.5</b>	Crystal, ceramic or mag. P.U., most dynamic speakers, F.M. tuner etc.	<b>£23.90</b>
D 20+20W. R.M.S. stereo amplifier with high performance spkrs.	<b>2 x Z.30s, Stereo 60, PZ.6</b>	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	<b>£26.90</b>
E 40+40W. R.M.S. deluxe stereo amplifier	<b>2 x Z.50s, Stereo 60 PZ.8, mains transformer</b>	As for D	<b>£34.88</b>
F Outdoor P.A. system	<b>Z.50</b>	Mic., up to 4 P.A. speakers controls, etc.	<b>£5.48</b>
G Indoor P.A.	<b>Z.50, PZ.8, mains transformer</b>	Mic., guitar, speakers, etc., controls	<b>£19.43</b>
H High pass and low pass filters	<b>A.F.U.</b>	C, D or E	<b>£5.98</b>
J Radio	<b>Stereo F.M. Tuner</b>	C, D or E	<b>£25.00</b>



# 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.

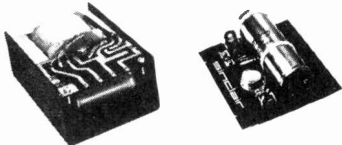
**Frequency response:** 30 to 300 000 Hz  $\pm$  1dB.  
**Distortion:** 0.02% into 8 ohms.

**Signal to noise ratio:** better than 70dB un-weighted.  
**Input sensitivity:** 250mV into 100 Kohms.  
 For speakers from 3 to 15 ohms impedance.  
 Size  $3\frac{1}{2} \times 2\frac{1}{4} \times \frac{1}{2}$  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



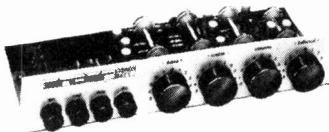
Designed specially for use with the Project 60 system of your choice. Illustration shows PZ.5 to left and PZ.8 (for use with Z.50s) to the right. Use PZ.5 for normal Z.30 assemblies and PZ.6 where a stabilised supply is essential.

**PZ-5 30 volts un-stabilised £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 perfectly 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  $\pm$  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.

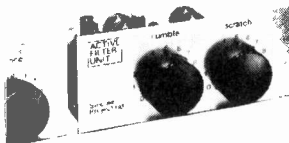
**Front panel:** brushed aluminium with black knobs and controls.

**Size:**  $8\frac{1}{2} \times 1\frac{1}{2} \times 4$  ins.

Built, tested and guaranteed.

**£9.98**

## Active Filter Unit

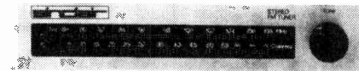


For use between Stereo 60 unit and two Z.30s or Z.50s, and is easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and 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

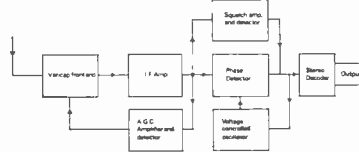


### first in the world to use the phase lock loop principle

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:** 2 $\mu$ V for 30dB quieting; 7 $\mu$ V for full limiting.  
**Squelch level:** 20 $\mu$ V.  
**A.F.C. range:**  $\pm$ 200 KHz  
**Signal to noise ratio:**  $\geq$ 65dB  
**Audio frequency response:** 10Hz—15kHz ( $\pm$ 1dB)  
**Total harmonic distortion:** 0.15% for 30% modulation  
**Stereo decoder operating level:** 2 $\mu$ V  
**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:** 25-30VDC  
**Size:** 3.6 x 1.6 x 8.15 inches; 91.5 x 40 x 207 mm



Price: **£25** built and tested. Post free

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P.E. 7

# Sinclair Q16/Micromatic

## Q16 High fidelity loudspeaker

The Q16 employs the well proven acoustic principles specially developed by Sinclair in which a special driver assembly is meticulously matched to the characteristics of the uniquely designed cabinet. In reviewing this exclusive Sinclair design, technical journals have justly compared the Q16 with much more expensive loudspeakers. Its shape enables the Q16 to be positioned and matched to its environment to much better effect than is the case with conventionally styled enclosures. A solid teak surround with a special all-over cellular foam front is used as much for appearance as its ability to pass all audio frequencies without loss.

This elegantly designed shelf mounting speaker brings genuine high fidelity within reach of every music lover.

## Specifications:

**Construction:** Special sealed seamless sound or pressure chamber with internal baffle.

**Loading:** up to 14 watts RMS.

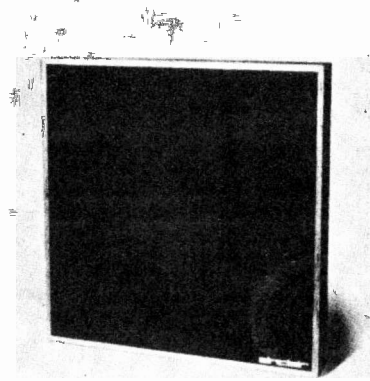
**Input Impedance:** 8 ohms.

**Frequency response:** From 60 to 16,000 Hz. confirmed by independently plotted B and K curve.

**Driver unit:** Special high compliance unit having massive ceramic magnet of 11,000 gauss, aluminium speech coil and special cone suspension for excellent transient response.

**Size and styling:** 9½ in. square on face x 4½ in. deep with neat pedestal base. Black all over cellular foam front with natural solid-teak surround.

**Price £8.98.**



## Britain's smallest radio

Considerably smaller than an ordinary box of matches, this is a multi-stage AM receiver brilliantly designed to provide remarkable standards of selectivity, power and quality for its size. Powerful AGC counteracts fading from distant stations; bandspread at higher frequencies makes reception of Radio 1 easy. The plug-in magnetic earpiece provided, matches the Micromatic's output to give wonderful standards of reproduction. Everything including the special ferrite rod aerial and batteries is contained within the minute attractively designed case. Whether you build a Micromatic kit or buy this amazing receiver ready built and tested, you will find it as easy to take with you as your wrist watch, and dependable under the severest listening conditions.

## Specifications:

**Size:** 36 x 33 x 13 mm (1.8 x 1.3 x 0.5 in.)

**Weight:** including batteries, 28.4 gm (1 oz.)

**Case:** Black plastic with anodised aluminium front panel and spun aluminium dial.

**Tuning:** medium wave band with bandspread at higher frequencies (550 to 1,600 KHz).

**Earpiece:** Magnetic type.

**On/off switching:** By inserting and withdrawing earpiece plug.

Kit in pack with earpiece, case, instructions and solder **£2.48.**

Ready built, tested and guaranteed, with earpiece **£2.98.**

*Two Mallory Mercury batteries type RM675 required from radio shops, chemists, etc.*



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50	0.23	0.25	0.47	0.50	0.53	1.15						
100	0.25	0.33	0.53	0.66	0.83	1.40						
200	0.35	0.37	0.57	0.81	0.75	1.60						
400	0.43	0.47	0.67	0.75	0.93	1.75						
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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	0.65	2.50							
1200		0.33		0.33	0.57	0.75								

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T8 8 2G378 OC78  
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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
U21	30 A.F. germanium alloy transistors 2G300 series & OC71	0.50
U23	30 Mat's like MAT series PNP transistors	0.50
U24	20 Germanium 1-Amp rectifiers GJM up to 300 PIV	0.50
U25	25 300Mc's NPN silicon transistors 2N708, BSY27	0.50
U26	30 Fast switching silicon diodes like 1N914 micro-min	0.50
U28	Experimenters' assortment of integrated circuits, untested. Gates, flip-flops, registers, etc., 8 assorted pieces	1.00
U29	10 1-Amp SCR's TO-5 can up to 600 PIV CRS1/25-600	1.00
U31	20 Sil. Planar NPN trans. low noise amp 2N3707	0.50
U32	25 Zener diodes 400mW D07 case mixed volts, 3-18	0.50
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U35	25 Sil. planar trans. PNP TO-18 2N2906	0.50
U36	25 Sil. planar NPN trans. TO-5 BPY50/51/52	0.50
U37	30 Sil. alloy trans. SO-2 PNP, OC200 2S322	0.50
U38	20 Fast switching sil. trans. NPN, 400Mc's 2N3011	0.50
U39	30 RF germ. PNP trans. 2N1303/5 TO-5	0.50
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U41	25 RF germ. trans. TO-1 OC45 NKT72	0.50
U42	10 VHF germ. PNP trans. TO-1 NKT967 AF117	0.50

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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Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACEMENTS FOR—  
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3028, 2N250A, 2N456A-457A-458A, 2N511 A & B, 2G290-222, ETC.

### SPECIFICATION

V<sub>CEO</sub> 80V V<sub>CE0</sub> 50V I<sub>C</sub> 10A Pt. 30 WATTS HFE 30-170.  
PRICE 1-24 25-99 100 up  
43p each 40p each 36p each

## GENERAL PURPOSE SILICON NPN POWER TRANSISTORS

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

### SPECIFICATION

V<sub>CEO</sub> 100V V<sub>CE0</sub> 60V. I<sub>C</sub> 15AMPS. Pt. 115 WATTS. Hfe 20-100. FTI MHZ.  
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VEB8 hFE15-45  
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Q3 4 OC77 type trans.	0.50
Q4 6 Matched trans. OC44/45/81/81D	0.50
Q5 4 OC75 transistors	0.50
Q6 4 OC72 transistors	0.50
Q7 4 AC128 trans. PNP high gain	0.50
Q8 4 AC126 trans. PNP	0.50
Q9 7 OC81 type trans.	0.50
Q10 7 OC71 type trans.	0.50
Q11 2 AC127/128 comp. pairs PNP/NPN	0.50
Q12 3 AF116 type trans.	0.50
Q13 3 AF117 type trans.	0.50
Q14 3 OC171 H.F. type trans.	0.50
Q15 3 2N2926 sil. epoxy trans.	0.50
Q16 2 GET880 low noise germ. trans.	0.50
Q17 3 NPN 1 ST141 & 2 ST140	0.50
Q18 4 Mat's 2 MAT 100 & 2 MAT 120	0.50
Q19 3 Mat's 2 MAT 101 & 1 MAT 121	0.50
Q20 4 OC44 germ. trans. A.F.	0.50
Q21 3 AC127 NPN germ. trans.	0.50
Q22 30 KRC trans. A.F. R.F. coded	0.50
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Q31 6 Sil. switch trans. 2N708 NPN	0.50
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Q34 7 Sil. NPN trans. 2N3669, 500MHZ.	0.50
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BP04 = 7404	Hex Inverters	0-23	0-20	0-15
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BP74 = 7474	Dual D type flip-flop	0-43	0-40	0-37
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BP83 = 7483	Quad full adder	0-87	0-77	0-67
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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
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UIC00 = 12 x 7400N	50p	14	UIC80 = 5 x 7480N	50p
UIC01 = 12 x 7401N	50p	14	UIC81 = 5 x 7481N	50p
UIC02 = 12 x 7402N	50p	14	UIC82 = 5 x 7482N	50p
UIC03 = 12 x 7403N	50p	14	UIC83 = 5 x 7483N	50p
UIC04 = 12 x 7404N	50p	14	UIC84 = 5 x 7484N	50p
UIC05 = 12 x 7405N	50p	14	UIC85 = 5 x 7485N	50p
UIC10 = 12 x 7410N	50p	14	UIC90 = 5 x 7490N	50p
UIC20 = 12 x 7420N	50p	14	UIC91 = 5 x 7491N	50p
UIC40 = 12 x 7440N	50p	14	UIC92 = 5 x 7492N	50p
UIC41 = 5 x 7441AN	50p	14	UIC93 = 5 x 7493N	50p
			UIC94 = 5 x 7494N	50p
			UIC95 = 5 x 7495N	50p
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BP 701C—8L701C	TO-9	8	OP Amp	68p
BP 702C—8L702C	TO-9	8	OP Amp Direct OP	68p
BP 702—72702	D.I.L.	14	G.P. OP Amp (Wide Band)	68p
BP 709—72709	D.I.L.	14	High OP Amp	58p
BP 709P— $\mu$ A709C	TO-9	8	High Gain OP Amp	58p
BP 711— $\mu$ A711	TO-5	10	Dual comparator	58p
BP 741—72741	D.I.L.	14	High Gain OP Amp (Protect)	58p
$\mu$ A 703C— $\mu$ A703C	TO-5	6	R.F.—I.F. Amp	75p
TAA 283	TO-72	4	A.F. Amp	75p
TAA 288—	TO-74	10	G.P. Amp	80p

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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	25p 20p 15p
BP948	Master-slave JK or RS	35p 32p 29p
BP954	Monostable	90p 85p 80p
BP962	Triple 3-input NAND	23p 20p 15p
BP969	Dual Master-slave JK with separate clock	80p 75p 70p
BP969A	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

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UIC930 = 12 x $\mu$ A 930	50p	14	UIC948 = 8 x $\mu$ A 948	50p
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UIC933 = 12 x $\mu$ A 933	50p	14	UIC961 = 12 x $\mu$ A 961	50p
UIC935 = 12 x $\mu$ A 935	50p	14	UIC983 = 5 x $\mu$ A 983	50p
UIC936 = 12 x $\mu$ A 936	50p	14	UIC984 = 5 x $\mu$ A 984	50p
UIC944 = 12 x $\mu$ A 944	50p	14	UIC987 = 5 x $\mu$ A 987	50p
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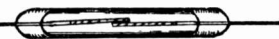
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	plug	socket
Loudspeaker	2-pole	12p 10p
Audio	3-pole	13p 10p
Audio	4-pole	14p 12p
Audio	5-pole 180deg.	15p 12p
Audio	5-pole 240deg.	15p 12p
Audio	6-pole	15p 13p

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Code	Power	Tolerance	Range	Values available	1 to 9 (see note below)	10 to 99	100 up
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C	1/8W	5%	4.7Ω-330KΩ	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, Electrofilm TR5, ultra low noise. WW=wire wound, Plessey.

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

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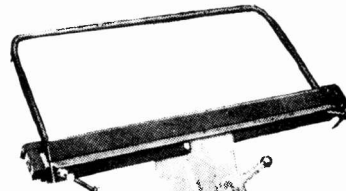
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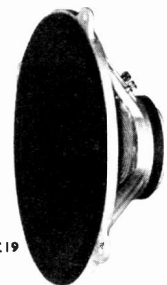
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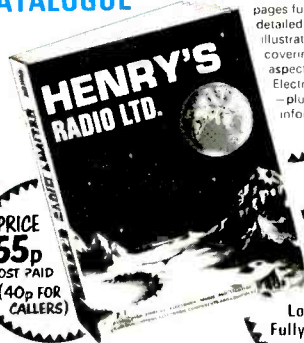


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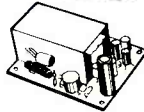
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Z30 9TR 30V 20W	£3-75
PA25 10TR (Special) 25W	£7-50
Z50 30V 40W	£5-47
PA50 12TR (Special) 50W	£9-50
100 100W with power supply	£45

post 45p

### OPTIONAL POWER SUPPLIES

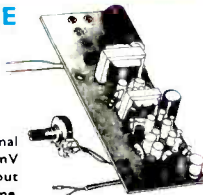
P500 (One or Two) for 104, 304	£2-62
PS210 (One or Two) for PA7	£3-47
MU24/40 (One or Two) for MPA12/3 or MPA12/15	£4-50
PZ5 for Z30 £3-97 or PZ6 for Z30	£6-97
PZ8 for Z50 £5-97 Transformer	£2-25
P11 for 608 £2-87 P15 for 410	£2-62
MU442 for 1 or 2 PA25 or 1 only PA50	£6-50



Post, etc., 20p

### NEW MINIATURE LOW COST AMPLIFIER MODEL 4-300

9V operated or mains unit optional transformer (MT98 70p), 1-10mV adjustable sensitivity. P/P output for 3-8 ohms. Fitted volume control and leads. Size 5½in x 1½in x ¾in. Thousands of uses—takes magnetic, dynamic and crystal inputs direct. Output 300mW—very high gain—built in rectifier circuit.



**Price £1-75**

P.P. 15p. Complete with FREE leaflet No. 8.

### HI-FI TO SUIT EVERY POCKET



### CHOOSE 100 STEREO SYSTEMS FROM

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### GARRARD TAPE DECK



9V operated 2-speed tape deck fitted Record/Replay track and Erase/Bias Osc. Head. Complete with Oscillator/Record head circuit. Unit size 9in x 6½in x 1½in and 2½in below motor board. Takes up to 4in spools. Supplied Brand New.

**Price £9-97**

P.P. 33p. 3½in. tape 300ft.) and spool 40p.



### HENELEC EQUIPMENT

(as previously advertised)

#### SELF-POWERED SILICON PRE-AMPLIFIERS

FET154 Stereo £16-50, post 25p.  
FET154 Mono with mike mixer £12-50, post 20p.

#### SILICON POWER AMPLIFIERS FOR USE WITH ABOVE

PA25 25W into 8Ω £7-50, post 20p.  
PA50 50W into 4Ω £9-50, post 20p.  
MU442 power supply for 1 or 2 PA25's or 1 only PA50 £6, post 20p.

#### PACKAGE DEALS

FET9/4 plus PA25 plus MU442 £25, post 40p.  
FET9/4 plus PA50 plus MU442 £27, post 40p.  
FET154 plus 2 x PA25 plus MU442 £36, post 50p.  
FET154 plus 2 x PA50 plus 2 x MU442 £40, post 50p.

No soldering—just edge connectors and din plugs/sockets.

Free Brochure No. 25.

### BUILD YOURSELF A QUALITY RADIO



Excellent printed circuit design with full power output. Fully tunable on both MW/LW bands. 7 Mullard transistors. Fitted 5in speaker. Room filling power. Easy to build with terrific results. Two colour leathercloth cabinet with silvered front. All local and continental stations. Complete detailed instructions.

Total cost £6-98, p.p. 35p. All parts sold separately. Ask for Leaflet No. 1.

#### PROJECT 60 PACKAGE DEALS

2 x Z30 amplifier, stereo 60 pre-amp. PZ5 power supply, £16-75, Carr. 40p. Or with PZ6 power supply, £18-25, Carr. 40p. 2 x Z50 amplifier, stereo 60 pre-amp. PZ8 power supply, £20-25, p.p. 40p. Transformer for PZ8 £2-25 extra. Any of the above with Active Filter unit add £4-75 or with pair Q16 speakers add £15. Also NEV FM TUNER, £21.

### BUILD THIS VHF FM TUNER

5 MULLARD TRANSISTORS 300kc/s BANDWIDTH. PRINTED CIRCUIT. HIGH FIDELITY REPRODUCTION. MONO AND STEREO. A popcession VHF FM Tuner for quality and reception of mono and stereo. There is no doubt about it—VHF FM gives the REAL sound. All parts sold separately. Free Leaflet Nos. 3 and 7. **TOTAL £6-97**, p.p. 20p. Cabinet £1, Decoder Kit £5-97. Tuning meter £1-75. Mains unit (optional) Model PS900 £2-47. Mains unit for Tuner and Decoder PS1200 £2-62.



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