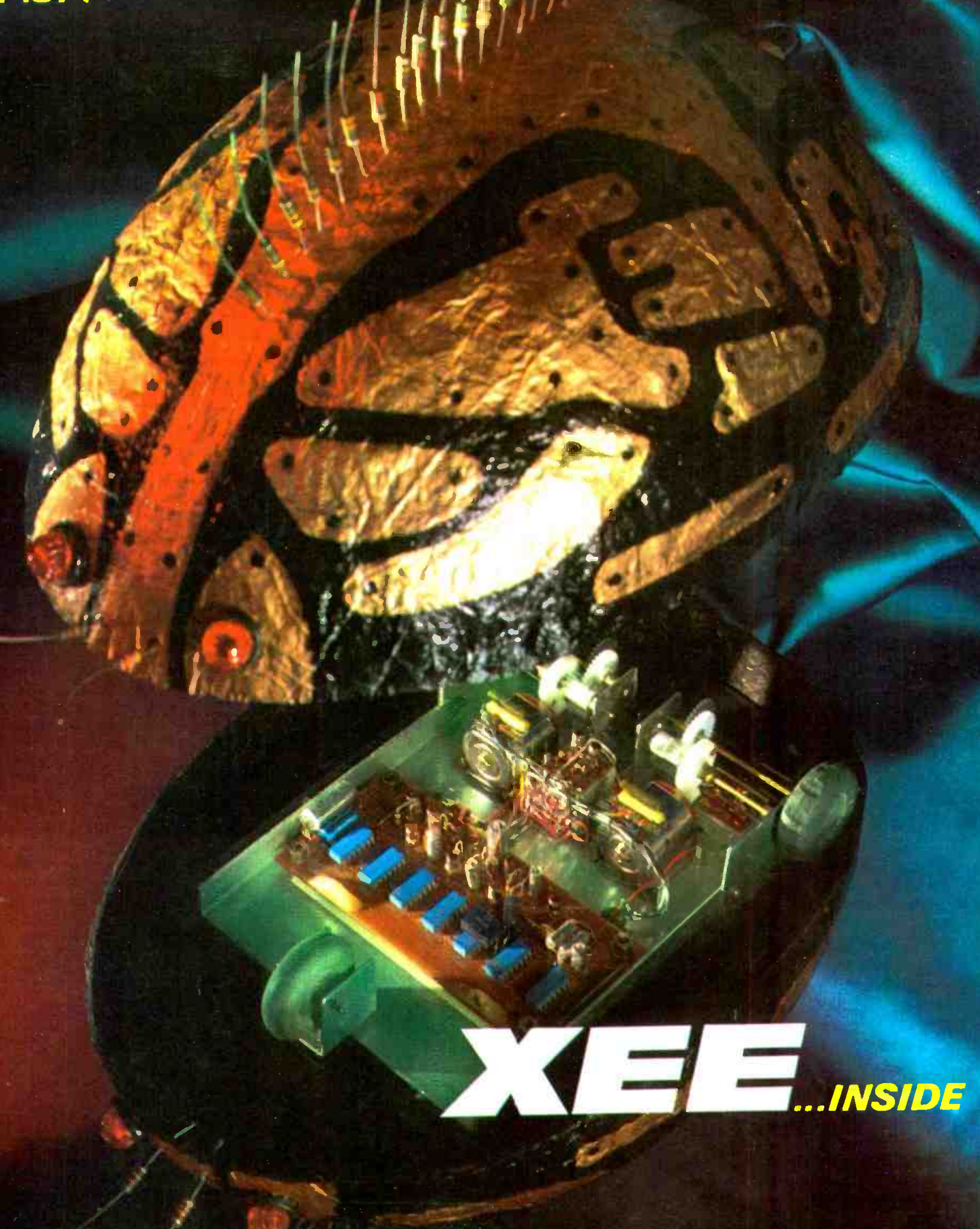
PRACTICAL

ELECTRONICS

JUNE 1971

20p



XEE ...INSIDE

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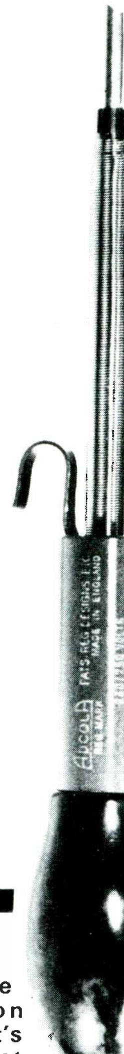

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- B 38 1/8" — 3.2 mm CHISEL FACE
- B 14 3/32" — 2.4 mm CHISEL FACE
- B 24 3/16" — 4.75 mm SCREWDRIVER FACE
- B 12 3/16" — 4.75 mm EYELET BIT
- B 58 1/4" — 6.34 mm CHISEL FACE

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- B 42 LL 3/16" — 4.75 mm CHISEL FACE
- B 38 LL 1/8" — 3.2 mm CHISEL FACE
- B 14 LL 3/32" — 2.4 mm CHISEL FACE
- B 44 LL 3/16" — 4.75 mm SCREWDRIVER FACE

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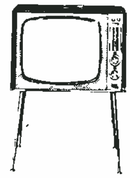

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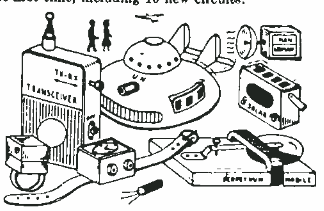

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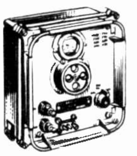
Battery operated, fully transistorised. Sensitivity 100mΩ/v. Measures AC/DC Voltages 12mV to 1,200v. AC/DC Current 12uA to 1.2 Amp. Resistance 12 ohm to 120 mΩ HF, VHF, UHF. Voltage with multiplier 4v to 400v up to 50 Mc/s, 40mV to 4V up to 1,000 Mc/s. Offered in perfect condition. £55 each. Carr. 50p.

CRYSTAL CALIBRATORS No. 10

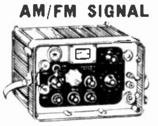


Small portable crystal controlled wavemeter. Size 7" × 7½" × 4". Frequency range 500 Kc/s. 10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300 V.D.C. 15mA and 12 V.D.C. 0.3A. Excellent condition. £3·47½. Carr. 37½p.

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

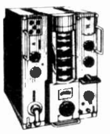


Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airmec. Frequency coverage 20–80Mc/s. AM C.W./FM. Incorporates precision dial, level meter, precision attenuator 1µV-100mV. Operation from 12V d.c. or 0/110/200/250V a.c. Size 12 × 8½ × 9in. Supplied in brand new condition complete with all connectors fully tested. £45. Carr. £1.

AVO CT.38 ELECTRONIC MULTIMETERS

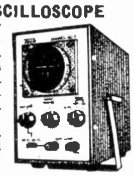
High quality 97 range instrument which measures a.c. and d.c. Voltage. Current, Resistance and Power Output Ranges d.c. volts 250mV-10,000V (10 megΩ-110 megΩ input). D.c. current 10µA-25A. Ohms. 0-1,000 megΩ a.c. volt 100mV-250V (with R.F. measuring head up to 250MHz) a.c. current 10µA-25A. Power output 50 microwatts-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 Murphy. 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 2 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 19½ 13½ × 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 CPS-1 MHZ. Input imp. 2 megΩ 25 P.F. Illuminated scale. 2in. tube. 115 × 180 230mm. Weight 8lb. 220/240 V a.c. Supplied 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 25pF X amp. sensitivity 0·9V p-p/CM. Bandwidth 1·5cps -800KHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps-300KHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½lb 220/240V. A.C. Supplied brand new with handbook. £37·50. Carr. 50p.

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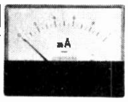
CLEAR PLASTIC METERS — TYPE SW. 100 — 100 x 80 mm



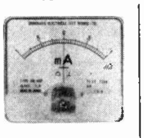
50µA	£3·47½	500µA	£3·12½
50-0-50µA	£3·37½	1mA	£2·97½
100µA	£3·37½	20V d.c.	£2·97½
100-0-100µA	£3·25	50V d.c.	£2·97½
		300V d.c.	£2·97½
		1A d.c.	£2·97½
		5A d.c.	£2·97½
		300V a.c.	£2·97½
		VU Meter	£3·75

BAKELITE PANEL METERS — TYPE S-80 — 80 mm square fronts

50µA	£3·12½	1A d.c.	£2·47½
50-0-50µA	£2·97½	5A d.c.	£2·47½
100µA	£2·97½	300V a.c.	£2·62½
100-0-100µA	£2·87½	VU Meter	£3·37½
500µA	£2·82½		
1mA	£2·47½		
20V d.c.	£2·47½		
50V d.c.	£2·47½		
300V d.c.	£2·47½		

"SEW" CLEAR PLASTIC METERS

Type MR.85P. 4¼in × 4¼in fronts.



50µA	£3·60	50mA	£2·60
50-0-50µA	£3·10	100mA	£2·60
100µA	£3·10	500mA	£2·60
100-0-100µA	£3·10	1A	£2·60
200µA	£2·87½	5A	£2·60
500µA	£2·75	15A	£2·60
500-0-500µA	£2·60	30A	£2·60
1mA	£2·60	20V d.c.	£2·60
1-0-1mA	£2·60	50V d.c.	£2·60
5mA	£2·60	150V d.c.	£2·60
10mA	£2·60	300V d.c.	£2·60
		15V a.c.	£2·60
		300V a.c.	£2·60
		S Meter 1mA	£2·87½
		VU Meter	£3·60
		1A a.c.*	£2·60
		5A a.c.*	£2·60
		10A a.c.*	£2·60
		20A a.c.*	£2·60
		30A a.c.*	£2·60

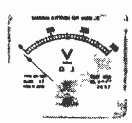
Type MR.52P. 2½in square fronts.

50µA	£3·10	20V d.c.	£2·00
50-0-50µA	£2·60	50V d.c.	£2·00
100µA	£2·60	300V d.c.	£2·00
100-0-100µA	£2·37½	15V a.c.	£2·00
500µA	£2·25	300V a.c.	£2·00
1mA	£2·00	S Meter 1mA	£2·10
5mA	£2·00	VU Meter	£3·10
10mA	£2·00	1A a.c.*	£2·00
50mA	£2·00	5A a.c.*	£2·00
100mA	£2·00	10A a.c.*	£2·00
500mA	£2·00	20A a.c.*	£2·00
1A	£2·00	30A a.c.*	£2·00
5A	£2·00		
10V d.c.	£2·00		

Type MR.65P. 3½in × 3¼in fronts.

50µA	£3·37½	20V d.c.	£2·10
50-0-50µA	£2·75	50V d.c.	£2·10
100µA	£2·75	150V d.c.	£2·10
100-0-100µA	£2·60	300V d.c.	£2·10
200µA	£2·60	15V a.c.	£2·10
500µA	£2·37½	50V a.c.	£2·10
500-0-500µA	£2·10	150V a.c.	£2·10
1mA	£2·10	300V a.c.	£2·10
5mA	£2·10	500V a.c.	£2·10
10mA	£2·10	S Meter 1mA	£2·37½
50mA	£2·10	VU meter	£3·37½
100mA	£2·10	50mA a.c.*	£2·10
500mA	£2·10	100mA a.c.*	£2·10
1A	£2·10	200mA a.c.*	£2·10
5A	£2·10	500mA a.c.*	£2·10
10A	£2·10	1A a.c.*	£2·10
15A	£2·10	5A a.c.*	£2·10
20A	£2·10	10A a.c.*	£2·10
30A	£2·10	20A a.c.*	£2·10
50A	£2·37½	30A a.c.*	£2·10
3V d.c.	£2·10		
10V d.c.	£2·10		

Type MR.38P. 1 21/32in square fronts.



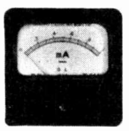
50µA	£2·00	150mA	£1·37½
50-0-50µA	£1·87½	200mA	£1·37½
100µA	£1·87½	300mA	£1·37½
100-0-100µA	£1·75	500mA	£1·37½
200µA	£1·75	750mA	£1·37½
500µA	£1·50	1A	£1·37½
500-0-500µA	£1·37½	2A	£1·37½
1mA	£1·37½	5A	£1·37½
1-0-1mA	£1·37½	10A	£1·37½
2mA	£1·37½	3V d.c.	£1·37½
5mA	£1·37½	10V d.c.	£1·37½
10mA	£1·37½	15V d.c.	£1·37½
20mA	£1·37½	20V d.c.	£1·37½
50mA	£1·37½	100V d.c.	£1·37½
100mA	£1·37½	150V d.c.	£1·37½
		300V d.c.	£1·37½
		500V d.c.	£1·37½
		750V d.c.	£1·37½
		15V a.c.	£1·37½
		50V a.c.	£1·37½
		150V a.c.	£1·37½
		300V a.c.	£1·37½
		500V a.c.	£1·37½
		S Meter 1mA	£1·60
		VU meter	£2·10

Type MR.45P. 2in square fronts.

50µA	£2·25	10V d.c.	£1·50
50-0-50µA	£2·10	20V d.c.	£1·50
100µA	£2·10	50V d.c.	£1·50
100-0-100µA	£1·87½	300V d.c.	£1·50
200µA	£1·87½	15V a.c.	£1·50
500µA	£1·60	300V a.c.	£1·50
500-0-500µA	£1·50	S Meter 1mA	£1·87½
1mA	£1·50	VU Meter	£2·25
5mA	£1·50	1A a.c.*	£1·50
10mA	£1·50	5A a.c.*	£1·50
50mA	£1·50	10A a.c.*	£1·50
100mA	£1·50	20A a.c.*	£1·50
500mA	£1·50	30A a.c.*	£1·50
1A	£1·50		
5A	£1·50		

"SEW" BAKELITE PANEL METERS

Type MR.65 3½in square fronts.



25µA	£3·50	500mA	£1·75
50µA	£2·37½	1A	£1·75
50-0-50µA	£2·25	5A	£1·75
100µA	£2·25	15A	£1·75
100-0-100µA	£2·25	30A	£1·75
500µA	£2·10	50A	£1·75
1mA	£1·75	5V d.c.	£1·75
1-0-1mA	£1·75	10V d.c.	£1·75
5mA	£1·75	20V d.c.	£1·75
10mA	£1·75	50V d.c.	£1·75
50mA	£1·75	150V d.c.	£1·75
100mA	£1·75	300V d.c.	£1·75
		30V a.c.*	£1·75
		50V a.c.*	£1·75
		150V a.c.*	£1·75
		300V a.c.*	£1·75
		500mA a.c.*	£1·75
		1A a.c.*	£1·75
		5A a.c.*	£1·75
		10A a.c.*	£1·75
		20A a.c.*	£1·75
		30A a.c.*	£1·75
		50A a.c.*	£1·75
		VU meter	£3·10

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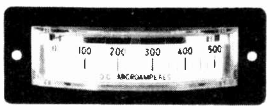
Type ED.107. Size overall 100mm × 90mm × 108mm. A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working. Available in the following ranges:

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

EDGWISE METERS



PE.70 3 17/32in × 1 15/32in × 2½in deep.

50µA	£3·00	500µA	£2·60
50-0-50µA	£2·87½	1mA	£2·37½
100µA	£2·87½	300V a.c.	£2·37½
100-0-100µA	£2·75	VU meter	£3·25
200µA	£2·75		

MARCONI TF142E DISTORTION FACTOR METERS. Excellent condition. Fully tested. £20. Carr. 75p.

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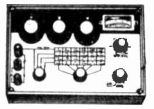

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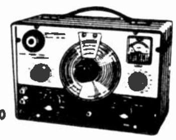
MARCONI TF885 VIDEO OSCILLATORS. 0-5MHz. Sine Square Wave. £45. Carr. £1.

LAFAYETTE TE46 RESISTANCE CAPACITY ANALYSER



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

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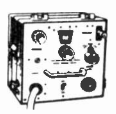

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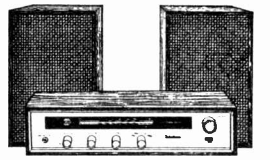

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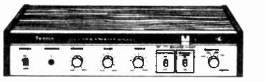

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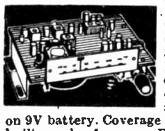

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Carr. 37½p extra each item
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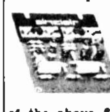

All other Sinclair products in stock. 2,000 amplifier, £25. Carr. 37½p. 3000 Amplifier £35. Carr. 37½p. Neoteric amplifier £45·97½. Carr. 37½p.

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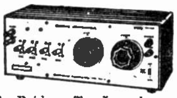
RUSSIAN C1-16 DOUBLE BEAM OSCILLOSCOPES

5MHz Pass Band. Separate Y1, Y2 amplifiers. Calibrated triggered sweep from 0·2μsec to 100msec/cm. Supplied complete with all accessories and instructions. £37, Carr. paid.

MARCONI CT44/ TF956 AF ABSORPTION WATTMETER

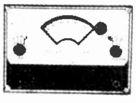
1 μ/watt to 6 watts. £20. Carr. £1.



TE111. DECADE RESISTANCE ATTENUATOR

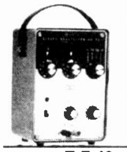
Variable range 0–111dB. Connections. Unbalanced T and Bridge T. Impedance 600Ω range (0·1dB × 10) + (1dB × 10) + 10 + 20 + 30 + 40dB. Frequency: d.c. to 200kHz (−3dB). Accuracy: 0·05dB. +indication dB × 0·01. Maximum input less than 4W (50V). Built in 600Ω load resistance with internal/external switch. Brand new £27·50. P. & P. 25p.

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



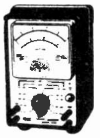
Sine 18–200,000Hz; Square 18–50,000Hz. Output max +10dB (10kΩ). Operation internal batteries. Attractive two-tone case 7½in × 5in × 2in. Price £17·50. Carr. 17½p.

BELCO DA-20 SOLID STATE DECADE AUDIO OSCILLATOR



New high quality portable instrument. Sine 1Hz to 100kHz. Square 20Hz to 20kHz. Output max. +10dB (10kΩ). Operation 220/240V a.c. Size 215mm × 150mm × 120mm. Price £27·50. Carr. 25p.

T.E.40 HIGH SENSITIVITY A.C. VOLTMETER



10 meg. input 10 ranges: ·01 / ·003 / ·1 / ·3 / 1 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s.-1·2Mc/s. Decibels −40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V a.c. £17·50. Carr. 25p.

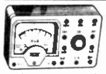
TE-65 VALVE VOLTMETER

High quality instrument with 28 ranges. D.c. volts 1·5–1,500V. A.c. volts 1·5–1,500V. 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. £2·12½. 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.

MULTIMETERS *for EVERY purpose!*



TECH PT-34. 1,000 O.P.V. 0/10/50/250/500/1,000V a.c. and d.c. 0/1/100/500mA. d.c. 0/100K. £1·97½. P. & P. 12½p.

MODEL TE-200. 20,000 O.P.V. Mirror scale, overload protection. 0/5/25/125/1,000V d.c. 0/10/50/250/1,000V a.c. 0/50μA/250MA. 0/60K/6 meg. −20 to +62dB. £3·75. P. & P. 15p.

MODEL 500. 30,000 O.P.V. with overload protection, mirror scale 0/·5/2·5/10/25/100/250/500/1,000 V d.c. 0/2·5/10/25/100/250/500/1,000 V. a.c. 0/50 μA/5/50/500 mA. 12 amp. d.c. 0/60K/6 Meg./60 Meg Ω. £8·87½. 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, 250, 500mA, 5, 10A. Resistance: 10K, 100K, 1 meg., 10 meg. Decibels: −20 to +81·5dB. £8·87½. P. & P. 17½p.

TE-900 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 d.c. 02K/200K/20 meg. ohm. £15. P. & P. 25p.

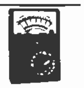
MODEL 5025. 57 ranges, giant 5¼in meter, polarity reverse switch. Sensitivity: 50K/Volt d.c. 5K/Volt a.c. D.c. Volts: 0·125, 0·25, 1·25, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.c. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.c. current: 25, 50μA, 2·5, 5, 25, 50, 250, 500mA, 5, 10A. Resistance: 2K, 10K, 100K, 1 meg, 10 meg. Decibels: −20 to +85dB. £12·50. P. & P. 17½p.

MODEL TE12. 20,000 O.P.V. 0/0·6/30/120/600/1,200 / 3,000 / 6,000V d.c. 1/6/30/120/600/1,200V a.c. 0 / 60μA / 6 / 60 / 600MA. 0 / 6K / 600K / 6meg./60. Megohm 50PF. 2 MFD £5·97½. P. & P. 17½p.

FTC-401 TRANSISTOR TESTER

Full capabilities for measuring A, B and ICO, *npn* or *pnp*. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads. £6·97½. 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 +22dB. 10–0, 100 mfd. 0-100·0·1 mfd. £3·47½. 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. 0/3/30/120/600/1,200V a.c. 0/30μA / 6mA / 60mA / 300mA/600mA. 0/8K/80K/800K/8 meg. −20 to +63dB. £5·97½. P. & P. 15p.

MODEL PL436. 20kΩ/Volt d.c. 8kΩ/Volt a.c. Mirror scale. 0·6/3/12/30/120/600V d.c. 3/30/120/600V a.c. 50/600μA/60/600mA. 10/100K/1 Meg/10 meg Ω. −20 to + 46dB. £6·97½. P. & P. 12½p.

MODEL TE-90. 50,000 O.P.V. Mirror scale, overload protection. 003/13/60/300/600/1,200V d.c. 0/6/30/120/300/1,200V d.c. 0·03/6/60/600mA. d.c. 16K/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. currents: 0–0·05, 0·5, 5, 50, 500mA. Resistance: 0–5K, 50K, 0–500K, 5 meg. Decibels: −20 to +52dB. £11·50. P. & P. 17½p.

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/6/60/300mA/12A. 0/2K/200K/2M/200M. −20 to +17dB. £12·50. P. & P. 17½p.

TMK LAB TESTER. 100,000 O.P.V. 6½in 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 7½in × 6¾in × 3¼in. £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 20uA/6/60/600mA. Resistance 10K/100K/1Meg/10 Meg. Decibels −20 to +57db. £7·50. P. & P. 15p.

270° WIDE ANGLE 1mA METERS

MW1-6 60mm square £3·97½. MW1-8 80mm square £4·97½. 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. 37½p.

WS62 TRANSCEIVERS

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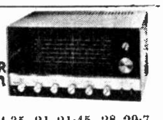
4 Bands covering 55KHz-30MHz. FET, 8 Meter, Variable BFO for SSB. Built in Speaker, Bandspread, Sensitivity Control. 220/240V a.c. or 12V d.c. 12¾in × 4½in × 7in. Brand new with instructions. £25. Carr. 37½p.

LAFAYETTE HA-600 RECEIVER

General coverage 150-400KHz, 550KHz-30MHz. FET front end, 2 mech. filters, product detector, variable B.F.O., noise limiter, S Meter, Bandspread. RF Gain. 15in × 9½in × 8¼in. 18lb. 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, S Meter, 100KHz calibrator. 220/240V a.c. or 12V d.c. 15in × 9½in × 8¼in. 18lb. Brand new with instructions. £57·50. Carr. paid (100KHz Crystal £1·97½ extra).

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EDDYSTONE VHF RECEIVERS MODEL 770R. 19–165 Mc/s. Excellent condition. £150.

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2N697	0·18
2N698	0·43
2N706	0·10
2N706A	0·13
2N708	0·15
2N709	0·63
2N711	0·38
2N987	0·53
2N1090	0·30
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2N1306	0·25
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2N1308	0·30
2N1309	0·25
2N1420	0·93
2N1507	0·23
2N1526	0·38
2N1909	2·25
2N2147	0·75
2N2148	0·60
2N2160	0·63
2N2218	0·30
2N2219	0·33
2N2287	1·03
2N2297	0·30
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2N2646	0·53
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2N2846	2·25
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2N2926	0·13
2N3054	0·50
2N3055	0·75
2N3702	0·13
2N3705	0·15
2N3706	0·23
2N3707	0·15
2N3709	0·13
2N3710	0·13
2N3711	0·13
2N3819	0·35
2N3820	0·88
2N3823	0·75
2N5027	0·53
2N5088	0·33
2S005	0·75
2S301	0·43
2S304	0·63
2S501	0·38
2S703	0·63
AA129	0·20
AAZ12	0·30
AAZ13	0·13
AC107	0·38
AC126	0·25

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AC127	0·25
AC128	0·25
AC187	0·30
AC188	0·30
ACY17	0·30
ACY18	0·25
ACY19	0·25
ACY20	0·23
ACY21	0·23
ACY22	0·18
ACY27	0·25
ACY28	0·18
ACY39	0·55
ACY40	0·15
ACY41	0·25
ACY44	0·38
AD140	0·50
AD149	0·50
AD161	0·38
AD162	0·38
AF106	0·30
AF114	0·33
AF115	0·30
AF116	0·33
AF117	0·25
AF118	0·63
AF119	0·20
AF124	0·25
AF125	0·20
AF126	0·18
AF127	0·18
AF139	0·30
AF178	0·48
AF179	0·48
AF180	0·53
AF181	0·43
AF186	0·40
AFY19	1·13
AFZ11	0·63
AFZ12	0·75
ASY26	0·25
ASY27	0·33
ASY28	0·25
ASY29	0·30
ASY36	0·25
ASY50	0·18
ASY51	0·40
ASY53	0·20
ASY55	0·20
ASY62	0·25
ASY86	0·33
ASZ21	0·43
ASZ23	0·75
AUY10	0·98
AU101	1·50
BC107	0·13
BC108	0·13
BC109	0·13
BC113	0·25
BC115	0·33
BC116	0·40
BC116A	0·45
BC118	0·38
BC121	0·20
BC122	0·20
BC125	0·68
BC126	0·65
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BC148	0·13
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BC157	0·20
BC158	0·20
BC160	0·63
BC169	0·13
BCY31	0·30
BCY32	0·50
BCY33	0·20
BCY34	0·25
BCY38	0·30
BCY39	0·48
BCY40	0·43
BCY42	0·15
BCY70	0·20
BCY71	0·30
BCZ10	0·30
BCZ11	0·38
BD121	0·65
BD123	0·83
BD124	0·63
BDY11	1·63
BF115	0·25
BF117	0·50
BF167	0·25

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BF173	0·30
BF181	0·33
BF184	0·25
BF185	0·25
BF194	0·18
BF195	0·15
BF196	0·28
BF197	0·28
BFS61	0·28
BFS98	0·28
BFX12	0·28
BFX13	0·23
BFX29	0·30
BFX30	0·33
BFX35	0·98
BFX63	0·50
BFX84	0·30
BFX85	0·40
BFX86	0·33
BFX87	0·33
BFX88	0·25
BFY10	1·00
BFY11	1·25
BFY17	0·25
BYF18	0·25
BFY19	0·25
BFY24	0·45
BFY44	1·00
BFY50	0·23
BFY51	0·20
BFY52	0·23
BFY53	0·18
BFY64	0·43
BFY90	0·68
BSX27	0·50
BSX60	0·93
BSX76	0·15
BSY26	0·18
BSY27	0·20
BSY51	0·50
BSY95A	0·15
BSY95	0·15
BT102/500R	0·75
BTY42	0·93
BTY79/100R	0·75
BTY79/400R	1·75
BY100	0·18
BY126	0·15
BY127	0·20
BY182	0·75
BY213	0·25
BYZ10	0·40
BYZ11	0·35
BYZ12	0·30
BYZ13	0·25
BYZ15	1·00
5YZ16	0·68
BYZ88C3V3	0·18
C111	0·65
CRS1/05	0·25
CRS1/40	0·48
CS4B	2·50
CS10B	3·13
DD000	0·15
DD003	0·15
DD006	0·18
DD007	0·40
DD008	0·38
GD3	0·33
GD4	0·05
GD5	0·33
GD8	0·25
GD12	0·05
GET102	0·30
GET103	0·23
GET113	0·20
GET114	0·15
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GET120	0·25
GET872	0·30
GET875	0·25
GET880	0·38
GET881	0·25
GET882	0·25
GET885	0·20
GEX44	0·08
GEX45/1	0·08
GEX941	0·15
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GJ4M	0·38
GJ5M	0·25
GJ7M	0·38
HG1005	0·50
HS100A	0·20
MAT100	0·25
MAT101	0·30
MAT120	0·25
MAT121	0·30
MJE520	0·83
MJE2955	1·75
MJE3055	0·93
NKT128	0·30
NKT129	0·30
NKT211	0·25
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NKT214	0·15
NKT216	0·38
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NKT222	0·20
NKT224	0·23
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NKT278	0·25
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NKT403	0·75
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NKT678	0·30
NKT713	0·25
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NKT777	0·38
O78B	0·38
OA5	0·15
OA6	0·13
OA47	0·10
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OA71	0·10
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OA74	0·10
OA79	0·10
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OA85	0·13
OA86	0·15
OA90	0·10
OA91	0·08
OA95	0·08
OA200	0·08
OA202	0·10
OA210	0·25
OA211	0·38
OAZ200	0·55
OAZ201	0·50
OAZ202	0·43
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OAZ222	0·40
OAZ223	0·40
OAZ224	0·38
OAZ241	0·23
OAZ242	0·23
OAZ244	0·23
OAZ246	0·23
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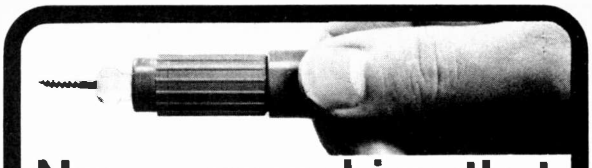

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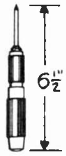

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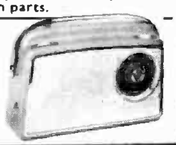

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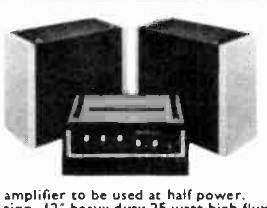

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Overload Factor—Better than 26dB.
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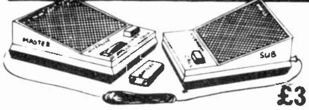

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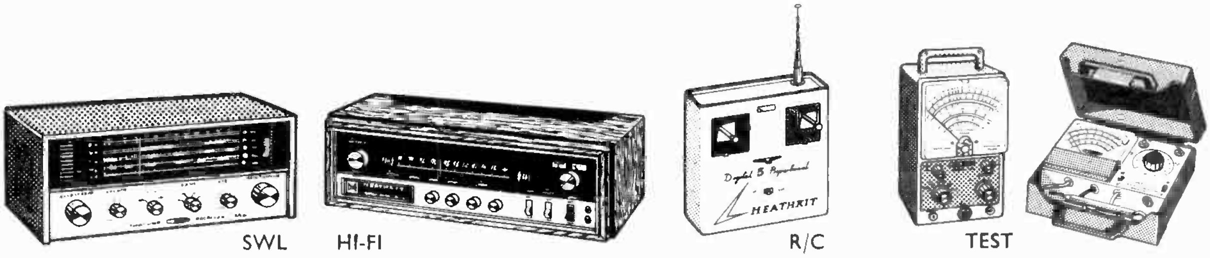

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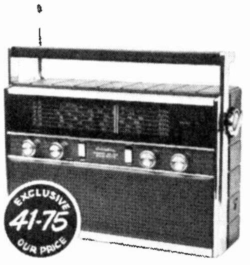

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6AL5	0·11	30L17	0·73	EBF80	0·38	GZ30	0·37	PL81	0·46	UCL82	0·35
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6AT6	0·22	30P19	0·65	ECC82	0·23	KT41	0·77	PL83	0·35	UF89	0·33
6AU6	0·22	30PL1	0·63	ECC83	0·35	KT61	0·55	PL84	0·33	UL41	0·60
6BA6	0·22	30PL13	0·85	ECC85	0·28	KT66	0·83	PL500	0·65	UL44	1·00
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6V6G	0·23	CCH35	0·67	EF39	0·28	PCC84	0·32	PY801	0·37	AF116	0·20
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6X4	0·23	CY31	0·33	EF80	0·24	PCC88	0·45	R20	0·65	AF118	0·48
6X5GT	0·28	DAC32	0·36	EF85	0·31	PCC89	0·47	U25	0·63	AF125	0·17
10P13	0·60	DAF91	0·21	EF86	0·31	PCC189	0·51	U26	0·65	AF127	0·17
12AH8	2·25	DAF96	0·36	EF89	0·26	PCC805	0·65	U47	0·63	OC26	0·25
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12AU6	0·23	DF91	0·16	EF183	0·29	PCF82	0·32	U50	0·39	OC45	0·12
12AU7	0·23	DF96	0·36	EF184	0·32	PCF86	0·47	U52	0·31	OC71	0·12
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PRACTICAL ELECTRONICS

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MAPS, PLANS, AND NEWFANGLED THINGS

In those areas concerned principally with small signal operations, the integrated circuit is fast assuming the role of the most important circuit building block. Coincident with startling reduction in material size is the greatly magnified electronic function of the typical IC. Not just one active circuit but maybe a dozen or more stages are concealed within some tiny prosaic plastic body. And this is not to mention medium-scale, let alone large-scale integration. The future drift is quite obvious. The scaling down in terms of physical size for a given number of circuit configurations will proceed apace, while the staggering possibilities presented by the use of agglomerations of these tiny items bemuse one. Or they do so at the present time. In a couple of years it will all be perfectly normal and acceptable. We will be quite blasé about the whole business.

But what of today. At each new stage of IC development (or further miniaturisation, which amounts to the same thing) the boundaries of possible involvement for the individual designer and constructor are pushed out still further. The complexity of the devices, in terms of fundamental circuit elements, will ever expand but the space they need occupy will continue to diminish.

It is to this world of Lilliputian Electronics that we should now be adjusting ourselves. A world where small scale maps charting the contours of large areas will often suffice, since we will be mainly concerned with only the major topographical features. But even so we will still have to make recourse on occasions to large scale plans for finding our way around certain local areas which may have particular interest or significance.

Yes, while we can most profitably attune ourselves to the "system" approach, and become further accustomed to block diagrams and logic diagrams, we must still keep our eye in for reading and correctly interpreting the finer detail of the conventional circuit diagram. Not even the most sanguine advocate of IC's would declare that all discrete circuit components are ultimately expendable. Electronic circuit building is likely to remain a very mixed affair—much main assembly work with prefabricated circuit blocks, plus the odd bit of jobbing work with individual semiconductors, resistors, and capacitors. Make no mistake, this "odd jobbing" may indeed prove all important; and here the builder may have to be his own architect as well. So it is essential to keep one's hand in with the older traditional skills of circuit design and construction, while at the same time acquiring the knack of dealing with these newfangled things.

F.E.B.

THIS MONTH

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RADIO ASTRONOMY TECHNIQUES

BY F. W. HYDE · PART 1

Shown above is a spiral nebula in the constellation of Canis Venatici (The hunting dogs) known as M51 (NGC 5194). This is between 10 and 15 light years from the solar system and receding from it at some 320km sec

Radio astronomy has enabled astronomers to detect the existence of sources of radiation in the atmosphere and outer space which would never have been discovered by optical means. It has opened up an entirely new avenue of research and already extended our knowledge of the Universe in a manner not foreseen by the early pioneers.

During the course of these articles various practical projects will be outlined and details will be given of the apparatus required. It will become apparent that a simple radio telescope in the back-garden is quite a feasible proposition. It should also be mentioned that there are certain studies and investigations that might well be undertaken as a nation-wide co-operative effort among keen amateur radio astronomers.

MANY people when hearing the words "radio telescope" think of the 250ft dish at Jodrell Bank. Perhaps this is natural since it nearly resembles the rather more familiar optical reflector used by visual astronomers. The word telescope implies something that is "looked through" and many people have actually requested the opportunity to "look through" a radio telescope.

So, straightaway, we must make clear what exactly is meant by radio astronomy, and provide some details of the origin of this comparatively young branch of science and technology.

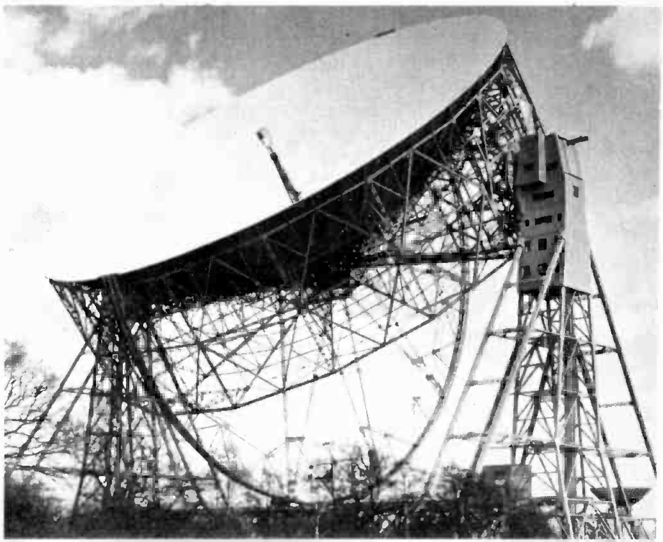
HISTORICAL BACKGROUND

Radio Astronomy has now completed some 40 years of its existence. Although not called radio astronomy until after the Second World War, it had its beginnings between the years 1928 and 1932.

In 1927 Karl Guthe Jansky, a graduate from the University of Wisconsin, joined the staff of the Bell Telephone Company, and undertook the task of investigating the cause of the interference on trans-oceanic telephone links.

Jansky noted certain peculiarities about the noises he received; he observed there was a rise in the noise when his aerial was pointed in a certain direction, between the frequencies of 20 and 21Mhz. He developed a large steerable aerial—which he called his "merry-go-round"—and in 1929, after many trials, was able to start some positive observations.

The world's largest fully steerable radio telescope at Jodrell Bank—by permission University of Manchester



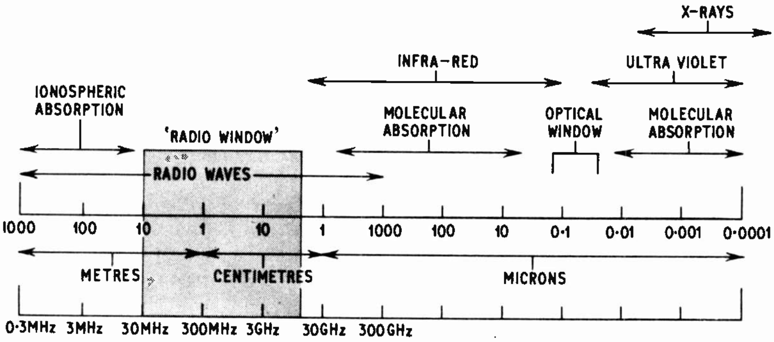


Fig. 1.1. Electromagnetic spectrum, indicating the "radio window" usable for radio astronomy

At first Jansky was under the impression that the radiations he was receiving were coming from the Sun, but as time went on he found that the point from which he could detect the radiations moved further and further away from the Sun until he could detect them in the night. He concluded that they came from outside the earth and from stars in the direction of the Milky Way.

AMATEUR ENTERPRISE

It is impossible to stress too much the importance of Jansky's discoveries, and although the noises he heard were broadcast at the time, no serious attention was given to them by professional astronomers. It was left to the amateurs, in particular one, Grote Reber, to carry on where Jansky left off.

Reber decided to start at very high frequencies as he assumed he would have a better chance of receiving such signals. Though the theory of this reasoning was sound, it did not work out well in practice, and this was due to the inefficiency of the apparatus at his disposal. He eventually decided that the frequencies at which he was working were too high and designed and constructed for himself a 30ft diameter "dish" aerial. With this apparatus he worked at a frequency of 160Mhz and was thus able to repeat Jansky's work. Reber suggested that the radiations were thermally generated by collision between free electrons and positive ions in the interstellar matter ionised by light.

It was Reber's 30ft dish that was called the first "radio telescope". With this he made the first radio map of the sky which is, today, still a reasonably accurate picture of extra-terrestrial radiations.

Reber had proved once again that the activities of the amateur had made their mark upon the history of man's quest for knowledge and opened up an ever expanding field of research. Karl G. Jansky unfortunately did not live to see the extent to which his early discoveries would be pursued.

BASIS OF A SOUND TELESCOPE

In fact, *any* aerial system may form part of a radio telescope. The simplest form of radio telescope consists of an aerial system, a receiver, and a recording device.

Thus even the ordinary television set shows (when the normal television transmission has ceased) "noise" in the form of scintillating points or flashes of light on the screen. A tape recorder could be used to store this "noise" which could then be analysed to show on a pen recorder the various components of the "noise" and their values. The recorder could be connected directly to the receiver, as is more frequently the case in radio astronomy.

NOISE FROM SPACE

The "noise" on this very crude telescope would consist of sources of noise in the receiver itself due to components such as resistors, capacitors, transistors and valves, and poor joints. There would also be the noise due to the aerial itself, and finally the noise signal arriving at the aerial from the atmosphere and outer space. The tiny amount of noise from space is the radiation on which the astronomer focuses his attention.

The improvements in techniques have largely been directed toward the more efficient detection of the infinitesimal noise signal of a finite source of radiation from the background radiation always present in space.

THE RADIO WINDOW

On earth, the limits of the "radio window" (see Fig. 1.1) through which the universe may be observed are determined by the terrestrial environment. Although this radio window theoretically extends from less than 1Mhz to 30Ghz, it is not possible efficiently to use this whole range. Generally speaking, the lower frequencies below 6Mhz are not used, though there are special circumstances where they have been and are being used. From 6MHz to 40MHz the effect of the earth's ionosphere has a considerable influence and has to be taken into account. This very effect is used to provide data about the ionosphere itself.

When the higher frequencies above 10GHz are considered, there are other factors due to the atmosphere of the earth that have to be taken into account and these limitations are also used to determine the conditions of the terrestrial environment.

The term radio astronomy therefore has become generally accepted as referring to those observations using radio techniques in that part of the electromagnetic spectrum between frequencies of 6MHz and 30GHz.

VARIOUS AERIAL SYSTEMS

Within this frequency range the types of aerial systems used and the projects undertaken are many and varied. Aerials may range from a single dish to arrays of dishes; from simple Yagis to groups of Yagis; from small corner reflectors to large units nearly a mile in length; from pairs of dipoles to acres of dipoles; and from single helical units to large groups of up to a 100 in one large unit.

The type of aerial system is dictated by the nature of the project involved, and may be of any combination of those that have been mentioned. Sometimes a small unit may be used as a pilot scheme to test the feasibility of a certain line of observation. As an example, an actual project whose object was a closer study of interplanetary scintillation using the quaser 3C48 will be described.

A quaser is a body which is very small in size but whose radiation both in the visible spectrum and the radio spectrum is much greater than would be expected. Since these bodies do not conform to the normal definition of stars, they were given the name of quasi-stellar objects which has become shortened to quaser.

INTERPLANETARY SCINTILLATION

Prof. A. Hewish, F.R.S., whose team discovered the phenomena, established that the plasma clouds radiating from the sun caused scintillation of the radiation from small objects which were radio sources. Large sources were unaffected by these plasma clouds because radiation was always at a level over an area such that the source showed no marked changes.

Now quasers, though powerful sources of radiation, are small in size and in consequence the variation in the density of the interplanetary medium caused twinkling or scintillation in the same way that a faint star twinkles due to the variation of the density of the atmosphere. It was decided to make a special study of 3C48 because it showed certain characteristics, one of them being a large amount of scintillation.

QUASER STUDY PROJECT

To this end three aerials were planned for three different sites which were so situated so that they formed an equilateral triangle. One was at the Mullard Radio Astronomy Observatory at Cambridge, one at Thetford, and the third at the writer's observatory at Little Clacton.

At each site was a special arrangement of two sets of aerials, consisting of a double line of full-wave dipoles with a reflecting screen. This arrangement constituted an "integrated interferometer" some 700 feet long and oriented in an east-west direction.

The outputs from these three aerials were combined at the Cambridge observatory, the outputs from Thetford and Little Clacton being taken over land line to Cambridge. An example of the recording taken at Little Clacton is shown in Fig. 1.2.

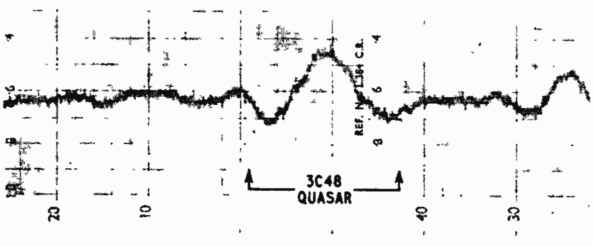


Fig. 1.2. Pen recording of Quaser 3C48. Note scintillation causing rapid variation of trace

This pilot scheme was successful and the next step was to operate from an even larger triangle. This was based on locations at Cambridge, Jodrell Bank and Malvern. The Cambridge aerial was in this case very much larger than that used with the first scheme and covered an acre of ground.

DISCOVERY OF THE PULSAR

It was with this latter aerial that the discovery of the first pulsar was made. (The pulsar, the latest discovery in radio astronomy, is thought to be a rotating neutron star.) So once again, as has happened so many times in the history of radio astronomy, a new discovery was made during the pursuit of a different kind of object. (These two discoveries and his work on the solar wind and interplanetary scintillation earned Dr. Hewish his fellowship of the Royal Society and the Eddington Gold Medal of the Royal Astronomical Society.)

The aerials used in the experiments described were of very simple construction and modest in cost compared with the value of the results obtained. This is one of the advantages of working at frequencies (in this case 81·5MHz) which allow considerable tolerance in mechanical construction. It also allows the amateur with modest resources to enter this exciting field as a participant observer.

To sum up then, a radio telescope can be divided into three principal sections: (1) the aerial system, (2) the receiver, and (3) the recording system.

ELECTROMAGNETIC WAVES

The aerial is a collector of energy and is the link between the receiving system and the free electromagnetic waves in space. The energy impinging on the collector sets up voltages which can be synthesised and evaluated by the receiving system to which it is connected.

The velocity of propagation of electromagnetic waves is 300,000,000 metres (approximately) per second. Thus a wavelength of 300 metres has a frequency of one megahertz. Before the agreement by the principal countries in the world to the use of scientific terms standardised among them, the term for frequency would have been in cycles per second so that 300 metres would have been one megacycle (Mc/s). Both terms are in use still, and all publications prior to 1964 on the subject of radio astronomy are in cycles.

Other terms are also in use to signify various parts of the radio spectrum studied by astronomers and these are: decametre (tens of metres) wavelength, metre wavelengths, decimetre (tenths of metres) wavelengths, centimetre wavelengths, and millimetre wavelengths. The principal reason for this classification is that the various sections each have certain characteristics that differ from the others when looking at an overall spectrum of radiation. Some of these points will emerge from the examples that will be quoted later in this series.

PLAN OF POLARISATION

In the radio part of the electromagnetic spectrum the greater part of the radiation is produced by the interaction of electrons with ions or with magnetic fields. There are certain special exceptions which will be dealt with separately later.

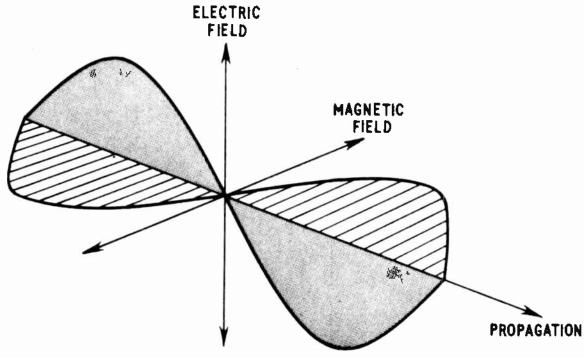


Fig. 1.3a. Radio wave in space, showing the alternating electric and magnetic fields

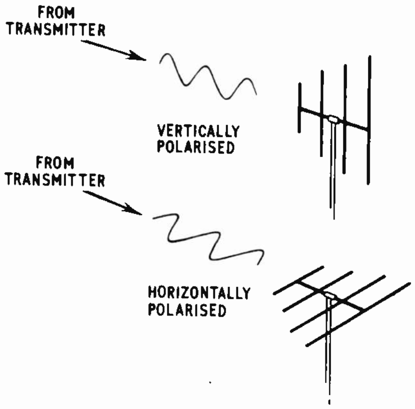


Fig. 1.3b. Vertically and horizontally polarised aerials, such as typically used for television reception

The normal undisturbed radio wave propagated from a transmitter can be represented by an alternating electric and magnetic field. Each of these fields is at any instant, in an isotropic medium, perpendicular to the direction of propagation, see Fig. 1.3a.

The plane in which the electric field vibrates is called the plane of polarisation. This is an important quality for it determines whether or not an aerial will absorb energy from the field. If the aerial is not parallel to the electric field, no current will be induced in it and the radiation would not be detected. This is the reason why in radio communication it is necessary for the receiving aerial to have the same orientation as the transmitter aerial.

In practice, of course, a horizontally polarised aerial will absorb some energy from a vertically polarised transmitter if the power level at the aerial is high enough. The most familiar examples of this are the vertical and horizontal types of aerial for television reception, see Fig. 1.3b.

SUBJECTED TO VARIATION

Most of the radiation from space is randomly polarised, and depending upon the source and the medium through which it travels, may be subjected to considerable variation. It may be modified in passing through a magnetic field, and at certain frequencies will be modified very considerably as it passes through the ionosphere.

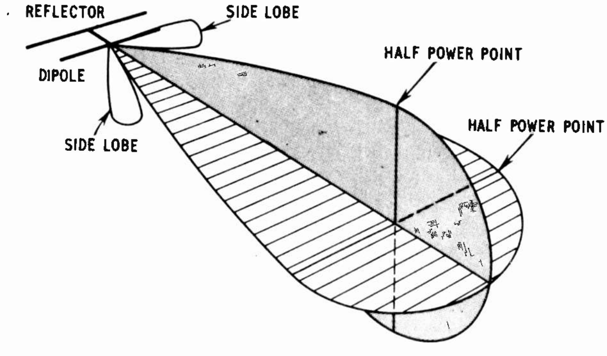


Fig. 1.4. The directional pattern of a simple dipole and reflector

It is possible to determine the amount by which the wave will be polarised by the ionosphere if the frequency, the length of the path through the ionosphere, and number of electrons in that path, are known. Conversely, it is possible to calculate the electron density from the amount by which a wave is modified in polarisation. The source of the radiation may be polarised and it is possible in such cases to determine the strength of the magnetic field by measuring that polarisation.

AERIAL PARAMETERS

Aerial systems for radio astronomy are directly related to the particular project of observation that is to be carried out, but there are certain parameters of aerials which specify the properties required. The most important of these parameters are the directional pattern beamwidth, the effective area, the gain, the directivity, and the bandwidth.

Directional Pattern

The directional pattern of a simple aerial in the form of a dipole and reflector is shown in Fig. 1.4. It is three dimensional and shows the half-power points. There are certain subsidiary or side lobes shown, and if the reflector were not there the aerial would have a second main lobe at 180 degrees from the one shown in the diagram.

Only one main lobe is required for the purposes of radio astronomy. The side lobes are reduced to their smallest practical patterns. It is very important to know the exact effect of these side lobes for in the early days of radio astronomy quite a number of "new sources" proved to be the effect of side lobes.

Beamwidth

The half-power point is indicated in Fig. 1.4. and the beamwidth of the main lobe where the received power is half that of what it would be in the direction of maximum power.

Effective Area

The effective area is a measure of the wavefront area from which the aerial can absorb power. The effective area varies between 0·5 and 0·9 of the physical area of an aerial. It is also a function of direction since it depends on arrival of the radiation along the main lobe axis.

Directivity and Gain

The directivity and the gain of an aerial are similar. They represent the extent to which the received radiation is selected from a given direction, and should be down the centre of the main lobe.

The maximum directivity is defined as the ratio of the flux density produced at a great distance to that that would be received if the total power of the source was radiated in all directions.

The gain of an aerial is nearly the same. The maximum gain is the ratio of the flux density received along the main lobe axis to that which would be produced at the same distance if the power supplied to the receiver terminals was the same in all directions.

The only real difference between these two properties is that caused by the loss of energy used in heating up the aerial.

Half-Power Bandwidth

The gain of an aerial of a particular dimension varies with the variation of frequency, being greatest usually at the resonant frequency. The half-power bandwith is the difference between the two frequencies at which the gain is half as great as it is at the frequency of resonance.

The formula for gain is $G = 4\,A/\lambda^2$, where G is the direction of the main lobe axis where A is the effective area.

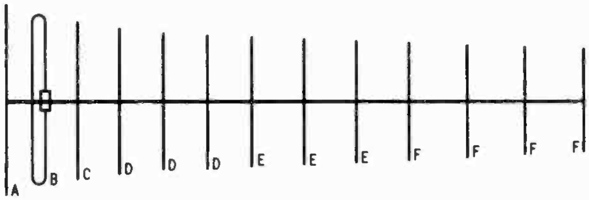


Fig. 1.5a. Yagi array, with dimensions of elements and spacing between them (photo below shows Yagi's on steerable mount)

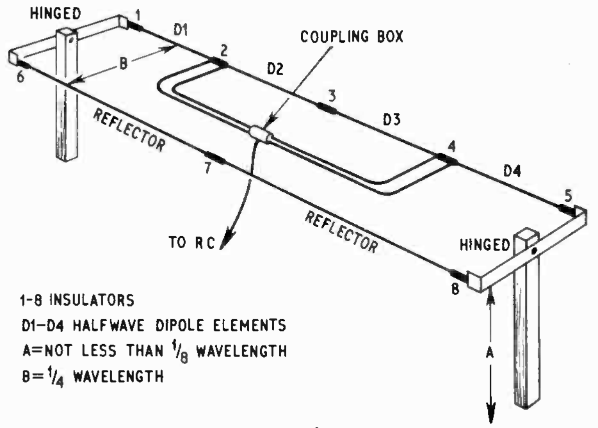


Fig. 1.5b. A pair of full wave dipoles with reflector, steerable in altitude

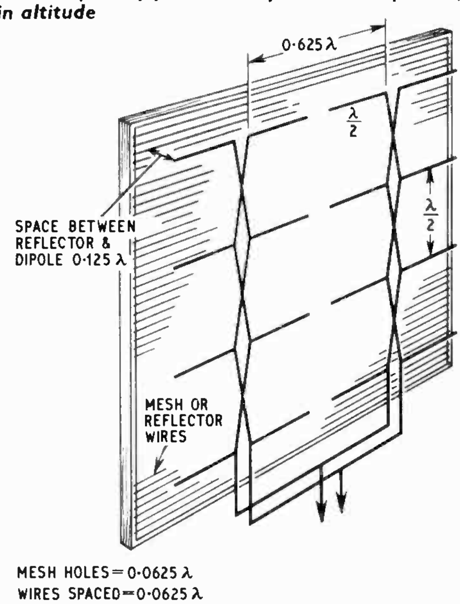
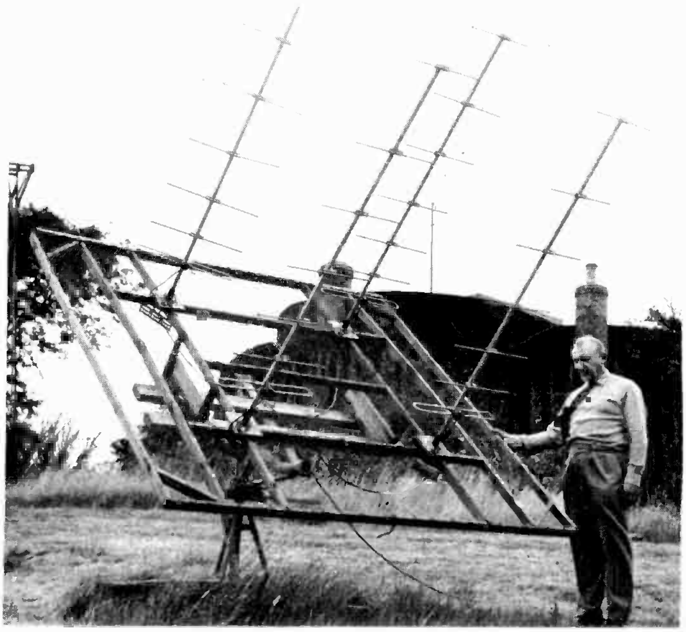
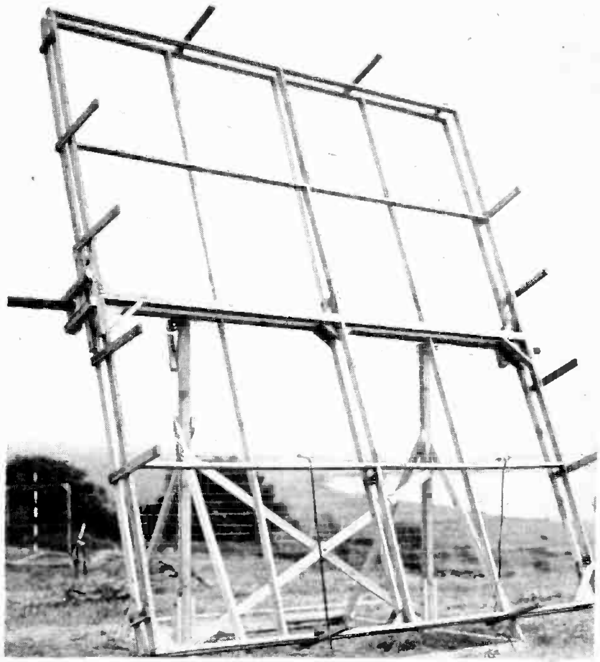


Fig. 1.5c. A modified Kooman array (and photo below)





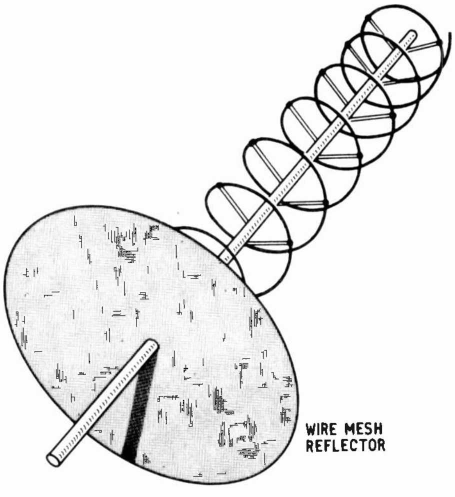


Fig. 1.5d. A helical aerial

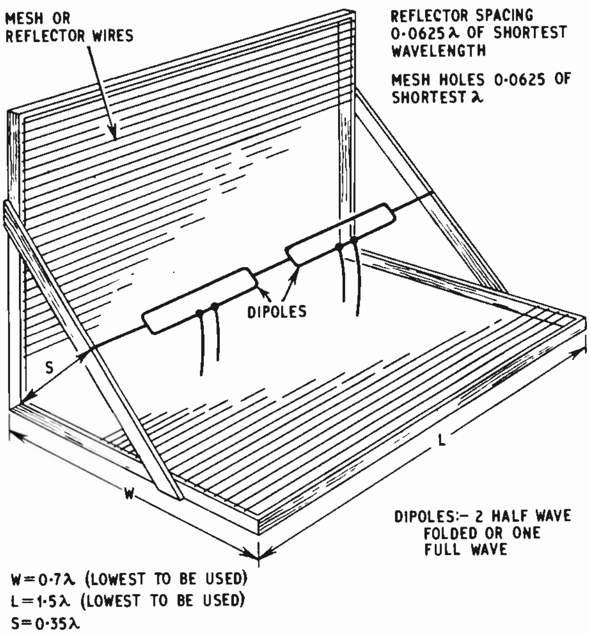
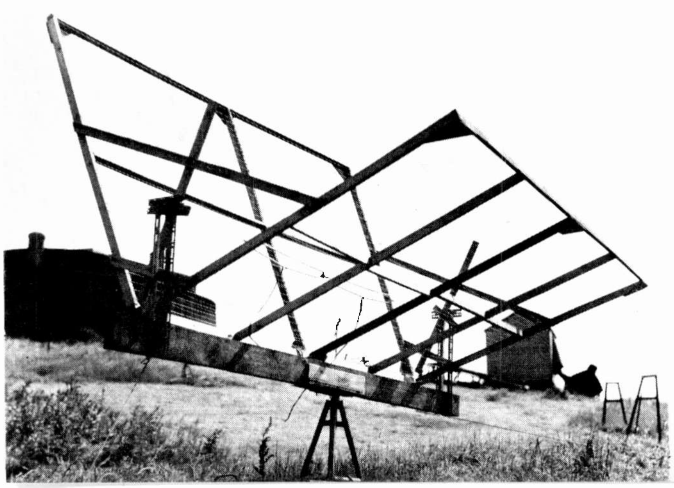


Fig. 1.5e. Corner reflector aerial (and photo below)



VARIOUS DESIGNS

The principles that have been described apply to all designs of aerials and to all the various arrangements that will be given in this series.

So far the simple dipole has been used to illustrate the basic principles. The main differences in aerials are in the reflectors or directors used in association with the dipole. Other differences are the use of horn aerials at high frequencies and the use of helical aerials at certain frequencies, usually above 80MHz.

Various types of aerials will now be briefly described.

YAGI ARRAYS

Yagi arrays are very useful, though their frequency range in any one range is limited. But for a long term project at a definite frequency, the Yagi array has advantages, since it is compact and mechanically simple, see Fig. 1.5a.

The individual design will depend on the parameters that need to be emphasised. The directivity pattern of the simple dipole and reflector apply here and more elements up to about 13 increase gain and directivity, although they reduce very critically the bandwidth. It is easy to mount Yagis on a steering unit.

PAIRS OF DIPOLES

When used singly, dipoles have a wide angle of acceptance. They can also be used in interferometer arrays consisting of two or more pairs of dipoles, Fig. 1.5b. The angle of acceptance is then extremely narrow.

A group of dipoles with a reflecting sheet of netting or parallel wires—known as a modified Kooman array—is an easy mechanical assembly, Fig. 1.5c. This was known sometimes as the "pine tree" aerial. It is very suitable for amateur construction.

HELICAL AERIAL

There are some special properties relating to helical aerials that make them a desirable choice for certain fields of study. The two important properties from the point of view of radio astronomy are that they accept circular polarisation and the other that they are effective over a 2 to 1 range of frequency. See Fig. 1.5d.

CORNER REFLECTOR

The corner reflector (Fig. 1.5e) has been a great favourite with many radio astronomers and has proved its versatility as well as providing much of the most useful and original data, some of which will be specially noted in the next article.

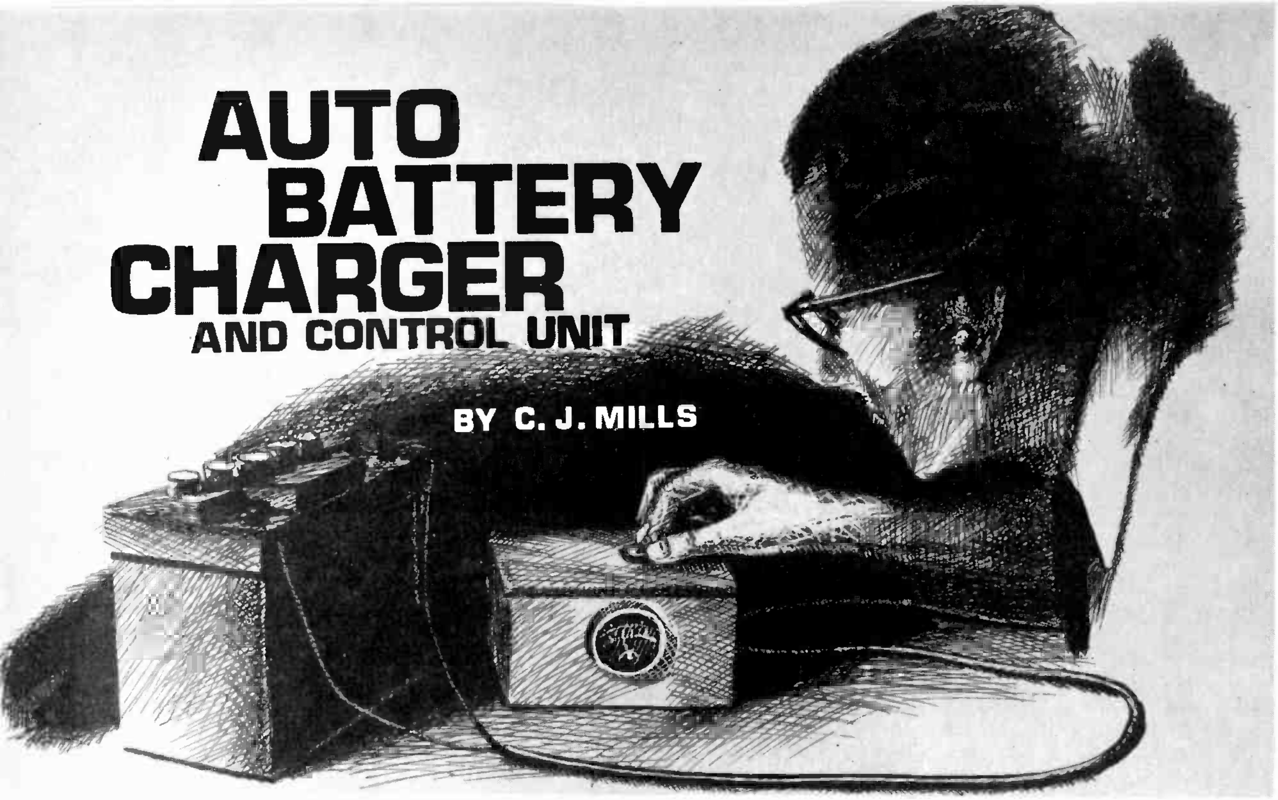
The gain of a corner reflector is high compared with dipole groups or Yagis. A corner reflector of 90 degrees with a full wave dipole at 0·35 of a wavelength from the apex and sides of one wavelength will have a gain in excess of 12dB.

A corner reflector can operate at a number of frequencies and requires only the changing of the dipoles. This again is a comparatively simple mechanical assembly and can be made fully steerable.

Next month: Various radio telescope systems will be described and a design suitable for amateur work outlined.

AUTO BATTERY CHARGER
AND CONTROL UNIT

BY C. J. MILLS



Automatic control of a battery charger can be very useful both for protection of the battery against overcharging and for maintaining a fully charged battery in emergency power supplies.

Any battery charger can be made automatic by modification of the existing circuit to incorporate the control circuitry or by adding an external automatic control.

In this article constructional details for both a self-contained automatic battery charger and an automatic charger control unit will be given.

BATTERY CHARGER CIRCUIT

The circuit for the automatic battery charger is shown in Fig. 1. Based on a Motorola design, this presents some unusual features.

The battery to be charged provides the supply for the unijunction transistor oscillator circuit. Here, C1 charges via R1 until the trigger voltage of TR1 is reached. The capacitor then discharges producing a pulse at T2 primary which is reflected at the secondary to turn SCR1 on.

The rate, or frequency, at which this takes place depends primarily on the time constant product C1R1. While the unijunction transistor oscillator is running, the thyristor acts as a half wave rectifier for the charger.

As the battery voltage rises, the trigger voltage of TR1 increases until it exceeds the Zener voltage of D1 when the oscillator stops. The voltage at which this occurs can be set by adjusting the b_2 voltage of TR1 by means of VR1. Once the potentiometer has been correctly set, the charger will switch off when

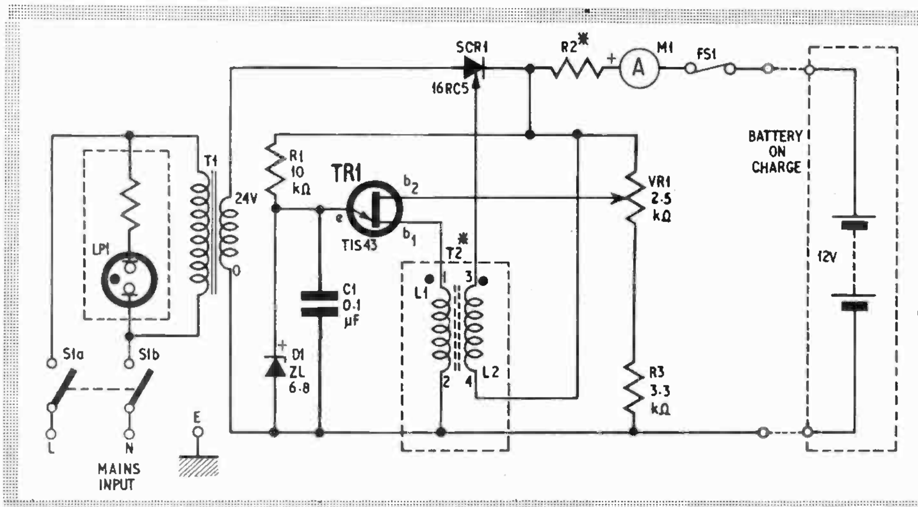


Fig. 1. Circuit diagram of half wave battery charger

HALF WAVE CHARGER

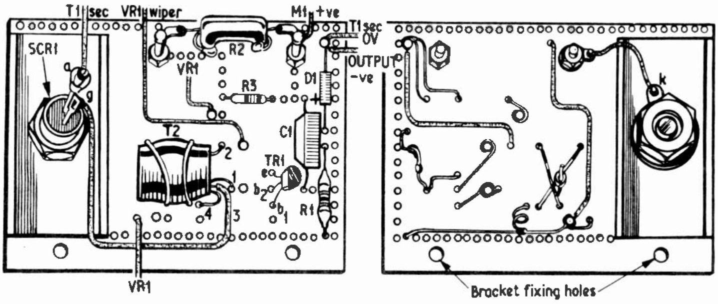


Fig. 2. Layout and wiring details of half wave battery charger components

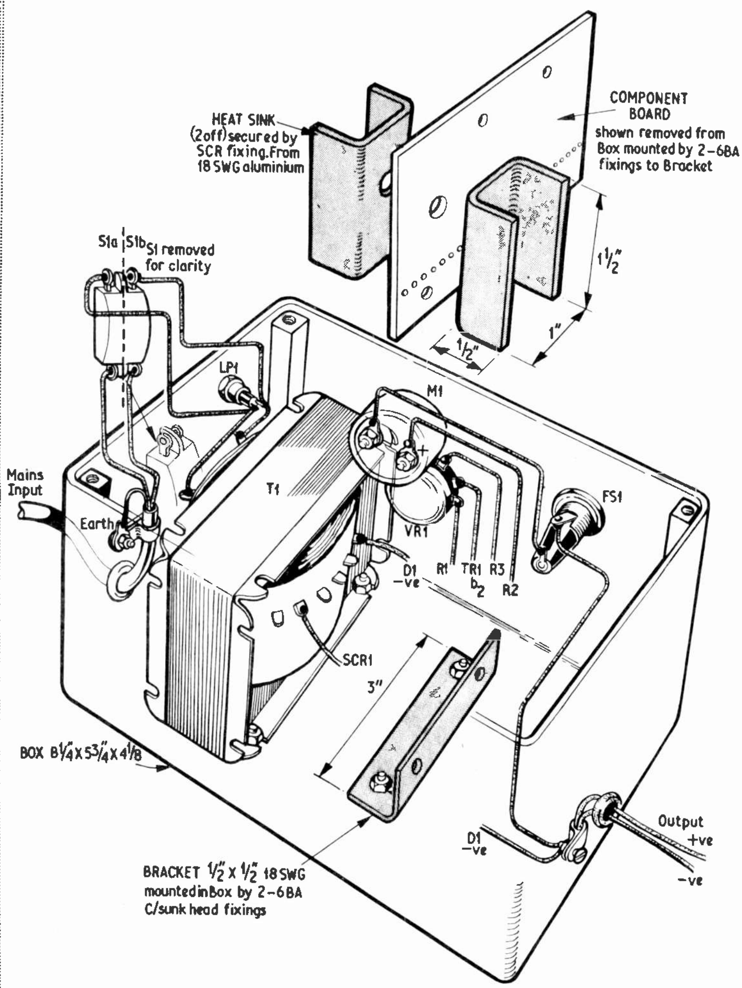


Fig. 3. Heatsink assembly and interwiring details of the half wave charger

COMPONENTS . . .

HALF WAVE CHARGER

Resistors
R1 10kΩ $\frac{1}{4}$W
R2* see text
R3 3·3kΩ $\frac{1}{4}$W

Capacitors
C1 0·1µF polyester

Potentiometer
VR1 2·5kΩ wirewound

Semiconductors
TR1 TIS43
SCR1 16RC5 (International Rectifier)
D1 ZL 6·8 1W Zener

Transformers
T1 Douglas MT117AT primary 0–230/240 secondary 30V, 6A
T2* see text

Miscellaneous
M1 0–5A battery charger ammeter 2in round (G. W. Smith Ltd)
FS1 7A cartridge fuse and panel fuse holder
LP1 Mains neon. Diecast box $8\frac{1}{4}$in × $5\frac{3}{4}$in × $4\frac{5}{32}$in

the battery is fully charged and switch on again when the battery voltage drops.

If the battery leads are disconnected, shorted or reverse connected, no charging current can flow so that neither the battery nor the charger can be damaged.

CONSTRUCTION

For charging a 12V battery at 5 amp, a mains transformer with an output of 18 to 24 volts at not less than 6 amp is required and the thyristor rating should be 6 amp mean and not less than 15 amp peak.

The pulse transformer T2 is made up on a 1½in length of ferrite aerial rod. First wind on 100 turns of 26 s.w.g. enamelled copper wire, being very careful not to damage the insulation. Next wind on a layer of plastic tape.

Over this wind 150 turns of 26 s.w.g. enamelled copper wire in the same direction, or sense, of the first winding. A final protective layer of plastic tape fixed with Selotape completes the transformer.

The circuit components are mounted on a 3in × 2in piece of plain perforated board, as shown in Fig. 2. All junction wiring should be done with Veropins.

A substantial aluminium heat sink should be used when mounting the thyristor. For efficient heat dissipation a piece should be mounted either side of the board, the whole lot being fixed by the thyristor stud nut.

The ammeter and control potentiometer VR1 are mounted on an 8¼in × 5¼in × 4 5/32in diecast box as in Fig. 3. The perforated board assembly is vertically mounted on a piece of aluminium angle adjacent to the transformer. With all components in position, final wiring should be completed.

Finally, to assist in ventilation, a few holes should be drilled in the sides and top of the case.

BALLAST RESISTOR

A ballast resistor, R2, is required in series with the ammeter to limit the charging current when a discharged battery is put on charge. The value of this is found experimentally.

Start with something like a 3 ohm, 10 watt resistor and adjust the control potentiometer for maximum current. The ballast resistance is then reduced until the required charging current is reached with the potentiometer again adjusted for maximum current if necessary.

The final current setting of the potentiometer can be found by connecting a fully charged battery and adjusting until the cut-off point of the oscillator is found.

FULL WAVE CIRCUIT

In Fig. 4 the previous circuit is modified for full wave rectification. Here the centre tapped transformer, T1, provides an alternating half cycle voltage input to the thyristors SCR1 and SCR2 to give a charging current of 5 amp.

The principle of gating the thyristors is exactly as before except that the pulse transformer T2 now has two secondary windings.

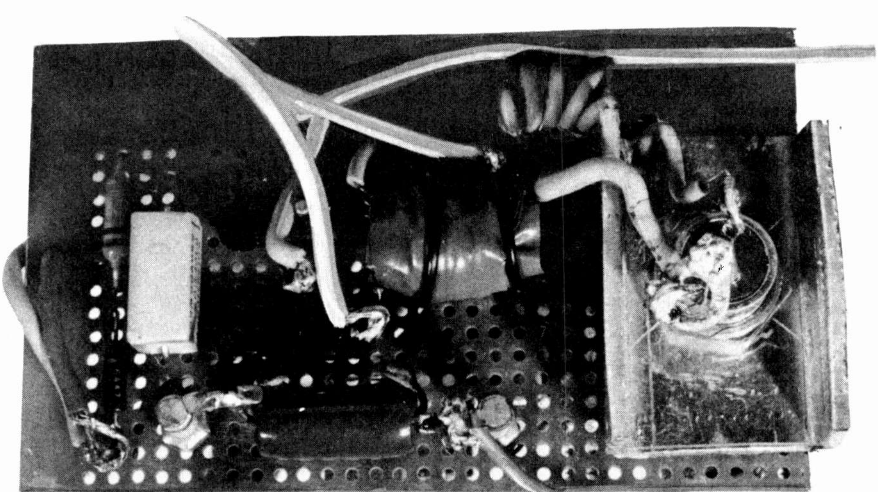
If the coils are wound on an LA1 Ferroxcube bobbin, L1 of T2 should first be layer wound, using 30 turns of 26 s.w.g. enamelled copper wire. L2 is next, this being wound in the same direction as shown by the phasing dots in Fig. 3. Here 45 turns of 26 s.w.g. enamelled copper wire are used.

The final layer, L3, consists of the same number of turns and gauge of wire but is wound in the opposite directions. All three windings should be separated by single layers of plastic tape. To identify the start of each winding they should be marked with a dab of paint.

A cheaper core can be made up from a 1½in piece of ferrite rod. For this, L1 primary should consist of 100 turns of 26 s.w.g. enamelled copper wire. The L2 and L3 secondaries are made up of 150 turns of 26 s.w.g. enamelled copper wire, the winding direction of each is again in opposition with each winding separated from the other with a single layer of plastic tape.

The method of construction for the full wave circuit is similar to the half wave version except that smaller heat sinks can be used for the two thyristors which now share the charging current.

The mains transformer secondary voltage taps to be used are shown in the circuit diagram.



Photograph of half wave charger assembly board. Pulse transformer is retained with lengths of insulated wire

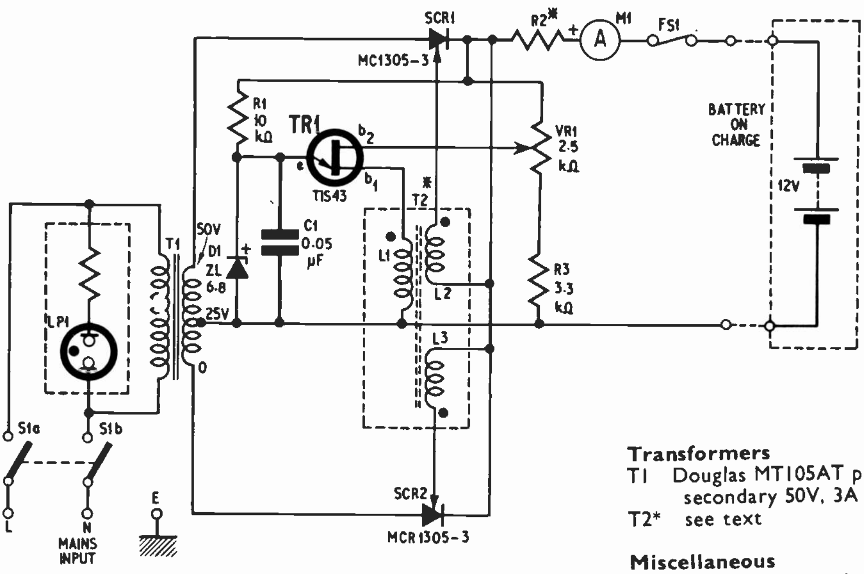


Fig. 4. Circuit diagram of full wave battery charger

COMPONENTS . . .

FULL WAVE CHARGER

Resistors
R1 10kΩ ¼W
R2* see text
R3 3·3k ¼W

Capacitors
C1 0·05μF polyester

Potentiometer
VR1 2·5kΩ wirewound

Semiconductors
TR1 TIS43
SCR1, SCR2 MCR 1305—3 Motorola (2 off)
D1 ZL 6·8 1W Zener

Transformers
T1 Douglas MT105AT primary 0–230/240V secondary 50V, 3A
T2* see text

Miscellaneous
M1 0–5A battery charger ammeter 2in round (G. W. Smith Ltd)
FS1-7A Cartridge fuse and panel fuse holder
LP1 Mains neon.
Diecase box 8¼in × 5¾in × 4 5/32 in

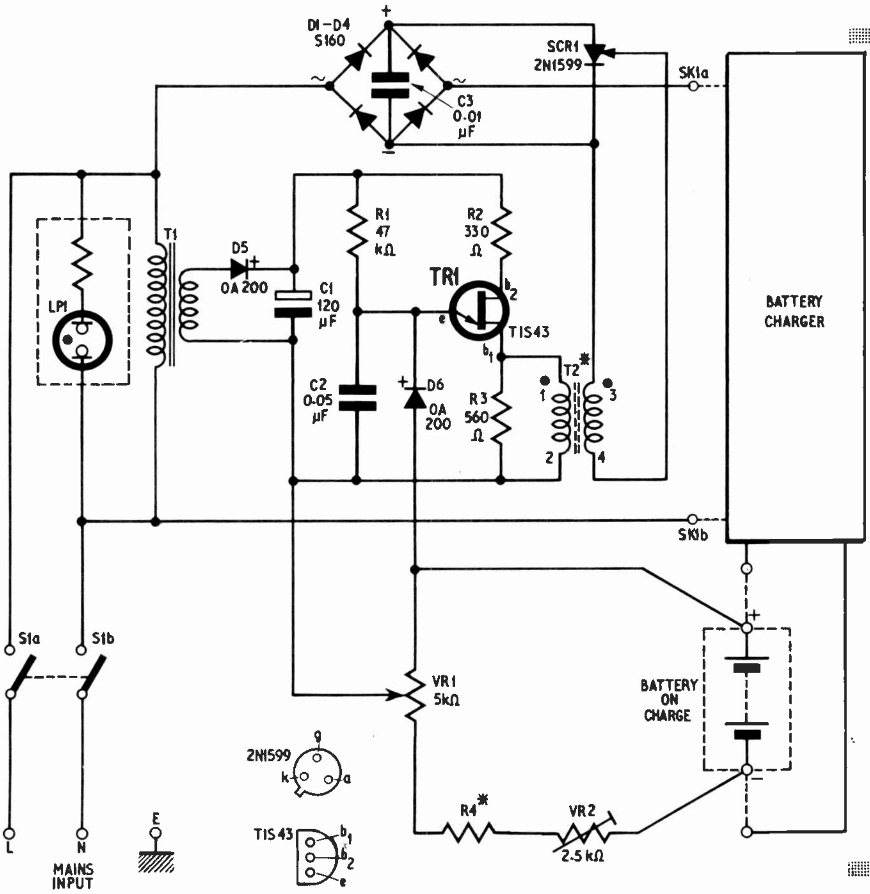


Fig. 5. Circuit diagram of automatic control unit for use with a conventional battery charger

Note: R3 should be connected to b_2 and not to b_1

CHARGER CONTROLLER

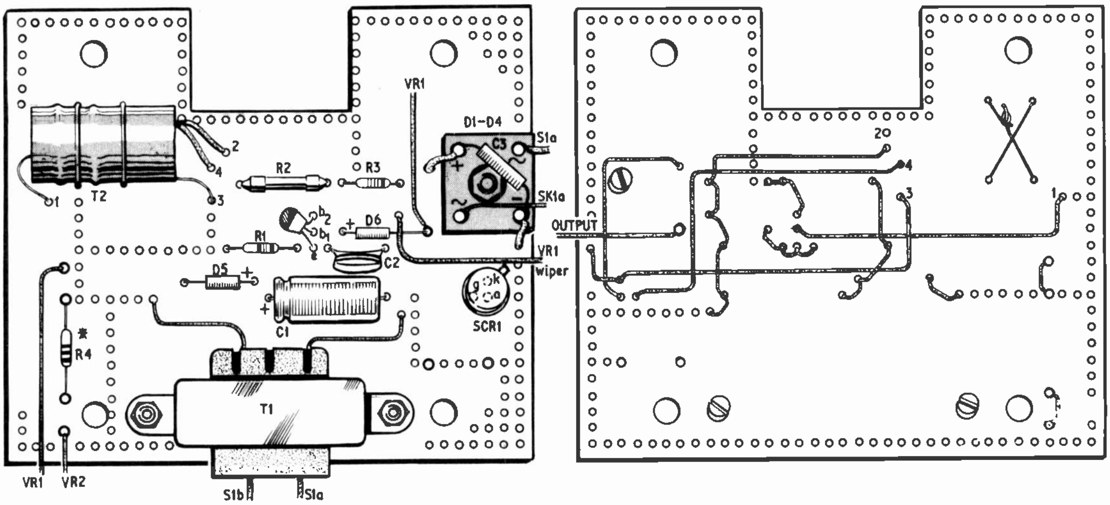


Fig. 6. Layout and wiring diagram of automatic control unit

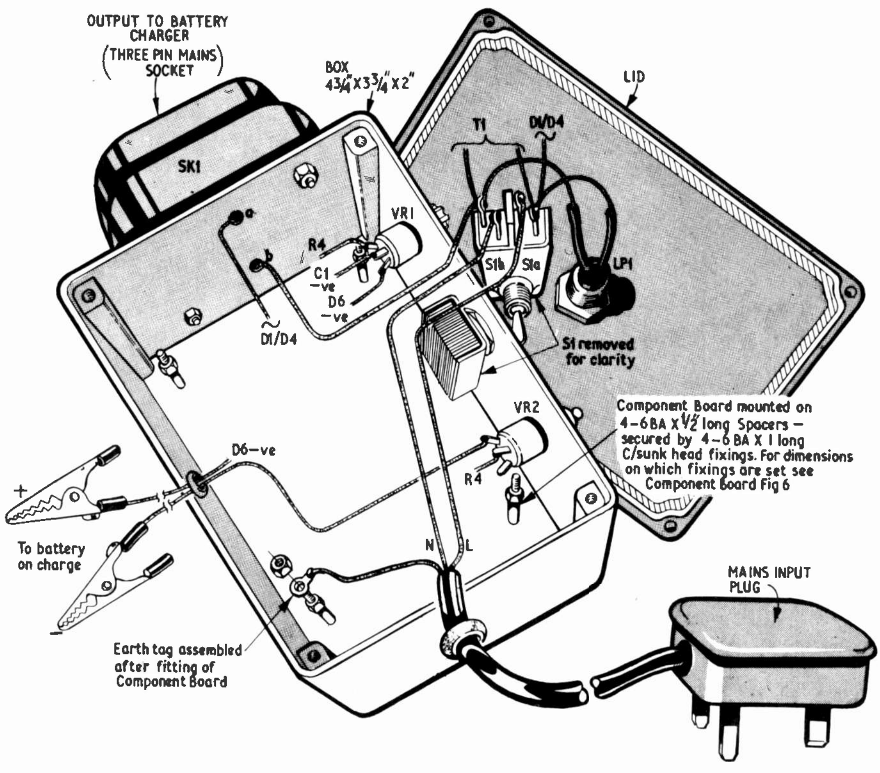
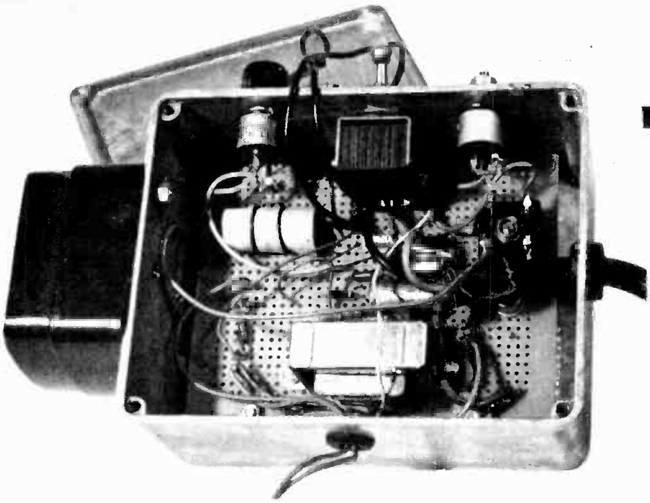
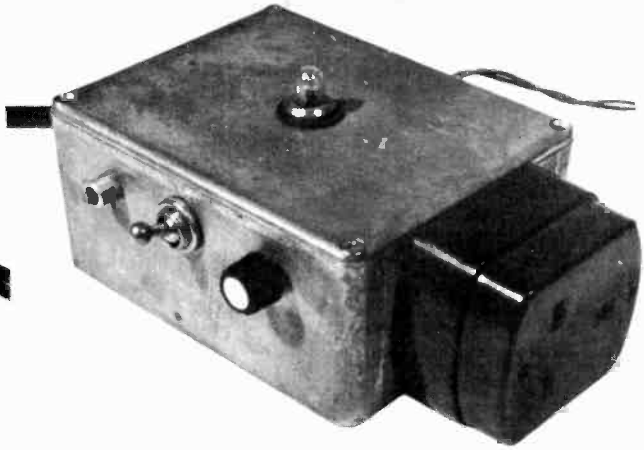


Fig. 7. Interwiring details for the automatic control unit





The completed control unit

AUTOMATIC CHARGING CONTROL

For automatic control of a conventional battery charger, the circuit of Fig. 5 can be used. It has the advantage that even a flat battery can be recharged because the control oscillator has an independent power supply, and no modification is required to the charger.

The thyristor, SCR1, is connected across a 1 amp bridge rectifier and in series with the input to the charger. The control circuit, comprising TR1, gates this thyristor to switch the charger on and off as required. Power for the transistor oscillator is provided by the filament transformer T1 and the rectifier D5.

COMPONENTS . . .

BATTERY CHARGER CONTROL UNIT

Resistors
R1 47kΩ ¼W
R2 330Ω ¼W
R3 560Ω ¼W
R4* see text

Capacitors
C1 120μF elect 25V
C2 0·05 polyester
C3 0·01 polyester 600V

Transformers
T1 Filament transformer primary 0–230/240V, secondary 6·3V 50mA
T2* see text

Bridge Rectifier
D1–D4 600V 1A type S160 (A. Marshall Ltd)

Semiconductors
D5–D6 OA200 (2 off)
TR1 T1S43
SCR1 2N1599 Texas

Potentiometers
VR1 5kΩ wirewound
VR2 2·5kΩ preset

Miscellaneous
S1 Double pole mains on/off, LP1—Mains neon, Diecast box 4¾in by 3¾in by 2 5/32in.

TRIGGER CONTROL

The circuit is so arranged that the trigger voltage for TR1 is less than 6 volts. A portion of the battery under charge voltage is applied to the emitter of TR1 via D6, so that if the battery voltage is low, then the tapped proportion to the emitter will be less than the trigger voltage; TR1 cannot be held on, so oscillation is maintained.

As the battery charges, the voltage at the emitter increases until it exceeds the trigger voltage. At this point oscillation and charging ends.

Ideally, the output of the control unit should be fused as a short circuit of the battery clips will damage the rectifier circuitry.

CONSTRUCTION

Components for the charger control unit are mounted on a piece of 4in by 3in perforated board as shown in Fig. 6. Junction connections are made with Veropins.

The rectifier bridge and thyristor should be mounted adjacent to each other and separate from the rest of the circuit so as to isolate the mains wiring from the low voltage control circuit.

As the power transfer is low no heat sinks are required, but a capacitor is connected across the bridge rectifier to protect the thyristor from high voltage pulses. Complete interwiring details for the control unit are given in Fig. 7.

CALIBRATION

To set the unit up it is only necessary to fix the oscillator cut off point. This requires a fully charged 6V or 12V battery being connected across the resistor chain VR1, R4 and VR2. With a 6V battery R4 and VR2 should be shorted out and VR1 is then adjusted so that the oscillator is turned off and no charging current is passed to the battery. With the potentiometer setting marked, the unit is now ready for use.

For a 12V battery R4 should be 5·6 kilohm and the short across R4 and VR2 removed. VR2 is now adjusted to find the new cut-off point without altering VR1 setting.

The unit is now ready for control of a 6 or 12V charger. The short across R4 and VR2 can be replaced by a link or switch if required. ★

SOUND '71

The Association of Public Address Engineers held their annual exhibition—Sound '71—at Camden Town Hall from Tuesday, March 16 to Friday, March 19. The exhibition was officially opened by Mr Bob Danvers-Walker who's voice must be one of the best known in broadcasting.

Full use was made of the hall, stage and even behind-stage room, for exhibits. Radio London took up a large part of the stage with a studio from which their mid-day request programme was broadcast, via a transmitting car parked outside the exhibition.

Part of the behind-stage room was occupied by P.E.; the P.E. Gemini and P.E. Aurora were demonstrated. The remaining area behind the stage was used by the Chimes Organisation to demonstrate their range of discotheque equipment, including various lighting effects systems. Light with sound was also a feature on D.J. Products' stand in the main hall.

Another stand displaying equipment not directly concerned with public address was Electronic Music Studio (London) Ltd., who were demonstrating a very impressive looking—and sounding—piece of equipment called the VCS 3 Electronic Music Studio. The complexities of this system are such that they will not be discussed here; suffice to say that this is a type of Moog instrument that can be used to build up a programme on tape or as a live performance instrument.

Westrex launched a new range of public address equipment at the exhibition. This range includes solid state amplifiers of 30 watts and 100 watts, a 5-channel integrated amplifier and a variety of modular control cabinets. The new Westrex range of two-way communications control equipment was also demonstrated.

Megaphones were displayed on some stands and Eagle International showed three new types among the 25 other new products on their stand. The three megaphones were the MV20S, MV8S and MV3—as the names suggest they have 20 watt, 8 watt and 3 watt outputs and range in price from £30 to £14. The MV3 is designed for use in small areas such as gymnasiums.

Many other interesting items were displayed on the numerous other stands; unfortunately, we do not have room to mention more than the most interesting in this column. Almost 40 exhibitors displayed anything from records to 300 watt amplifiers within the comparatively small area of the hall.

The A.P.A.E. have made a provisional booking for exhibition space at the Bloomsbury Centre Hotel, London, for next year's exhibition. At the exhibitors' meeting of Sound '71, it was recommended to pursue this course of action in order to gain a much larger exhibition area with the opportunity of erecting demonstration rooms with air conditioning.

These rooms could be similar to those used at the Olympia Audio Fair, with adjoining display space.

It was also agreed that the exhibition should be confined to three days, closing at 6 p.m. each day.

This is a friendly exhibition run by a very likeable and courteous group of p.a. engineers and we hope that it will thrive at its new venue.

NEWS BRIEFS

Qualified Manpower in the Industry

A serious shortage of technicians in the electronics industry is one of the main points made in a report "Qualified Manpower in the Electronics Industry" published by the industry's Economic Development Committee. The report by the EDC's manpower working group, under Professor G. D. Simms, makes 18 recommendations for action by the EDC, industry, government, education and professional institutions.

The report stresses the need for improved awareness on the part of school-leavers of the growing potential of a career in technician engineering. The universities and the polytechnics are asked as a matter of urgency to develop combined courses in production engineering and electronics to meet a serious shortage of graduate production engineers in the industry.

The importance of innovation in the industry is highlighted. Innovation is defined, in broad terms, from the end of the applied research stage, through development, design and production to the delivery of the first acceptable product to the customer. The rapid rate of innovation stems not simply from the continual flow of new ideas and techniques at the technical level, which lead to rapid product obsolescence, but also from the strong international competition which is a characteristic of the industry. The committee have no doubts, however, that a better use of manpower, better management, and control of projects could all make very substantial contributions to more effective innovation.

Digital T.V. Line-store Converter

An experimental digital line-store converter was recently demonstrated by the BBC at their Research Department, Kingswood Warren, Surrey.

Line-store converters are used by the BBC and the ITA to derive 405-line signals for their v.h.f. television transmitters from 625-line signals provided through the television distribution networks. The BBC uses some 29 of these converters which are located at main transmitter sites. As it is likely that the 405-line service will continue beyond the useful life of the converters used at present, a programme of work is being carried out by the BBC's Research and Designs Departments to provide a replacement converter with a good performance and high reliability at a reasonable cost.

Since the existing converters were designed, considerable progress has been made in the application of digital techniques to television signals and it has been decided that the new form of converter will process the television signal in digital rather than analogue form, thus providing greater reliability and operational simplicity, compared with earlier converters.

Television Projector

A large screen television projector which enables television signals to be displayed on cinema type screens has been introduced by Top Rank Television.

With its large screen viewing, the projector—the Teledidaker—overcomes the disadvantages of grouping sections of a large audience around conventional monitors.

Moderately priced, it enables television signals to be displayed on cinema type screens up to a maximum size of 6ft × 8ft.

The Teledidaker will accommodate signals from off-air receivers, television cameras and television tape recorders. It works to very high standards of performance and is conservatively under-rated for long life and reliability. It may be easily adapted for rear projection.

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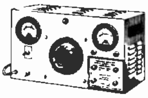

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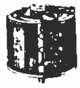

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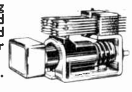

Complete with mounting bracket, push knob and lenses (green, amber, red or clear—state colour preference).
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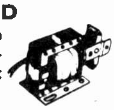

Extremely powerful with approx. 14lb. pull, 1" travel. Fitted with mounting feet. Size: 4" long, 2¾" wide, 3" high. £2·00 incl. P. & P.

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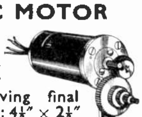

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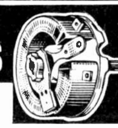

100 WATT. 1 ohm, 10A; **5 ohm,** 4·7A; **10 ohm,** 3A; **25 ohm,** 2A; **50 ohm,** 1·4A; **100 ohm,** 1A; **250 ohm,** 0·7A; **500 ohm,** 0·45A; **1 kΩ,** 280 mA; **1·5 kΩ,** 230 mA; **2·5 kΩ,** 2A; **5kΩ,** 140 mA. Diameter 3¼in Shaft length ⅞in, dia. 11/64in. All at **£1·50** each. P. & P. 5p.
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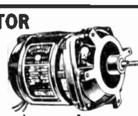

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TREMULANT SYSTEMS

BY F. C. JUDD

PART TWO MECHANICAL AND ELECTRONIC

THE rotary horn speaker system described in part 1 requires an enclosure with open sides, front and top. The arrangement shown in Fig. 9 consists of a substantial base board of ½ inch or ¾ inch thick wood onto which a framework made from 2 inch by ½ inch batten is assembled. If the framework is constructed to the dimensions given in Fig. 9 the horn and speaker unit can easily be inserted or removed as a whole, via the back of the enclosure.

ENCLOSURE FINISH

When the unit is installed within the frame it must be secured to the base board and to a batten across the top of the frame. The front width of the frame is 20 inches which gives ample side clearance for the speaker unit. It is most important to put felt or foam packing between the speaker and the back panel of the cabinet; this can be seen in the photograph which also shows the completed enclosure framework.

The enclosure framework can be covered with any open weave fabric, such as Tygan although this particular material is very expensive. The hardboard back panel must be removable.

The 8 inch loudspeaker should be one of fairly high sensitivity with an impedance to match that of the amplifier to which it will be connected.

Remember that a tremulant system of this kind will be connected additionally to the existing speaker system which must, of course, remain in operation. It is also necessary to reduce the bass response of the tremulant speaker as the tremulant itself must be confined to the treble range of the musical instrument, e.g. the keyboard manuals of an organ or the normal range of a plectrum guitar.

MATERIALS . . .

For construction detailed in this part only.
- Batten 2in × ½in × 17ft 6in
- Base board 20in × 15in × ¾in (ply or chipboard)
- Back panel 25in × 20in × ⅛in (hardboard)
- Cabinet legs 12in long
- Foam or felt packing
- C1 and C2 500μF elect. 12V capacitors (2 off)
- Tygan or similar covering
- Wire, screws and glue

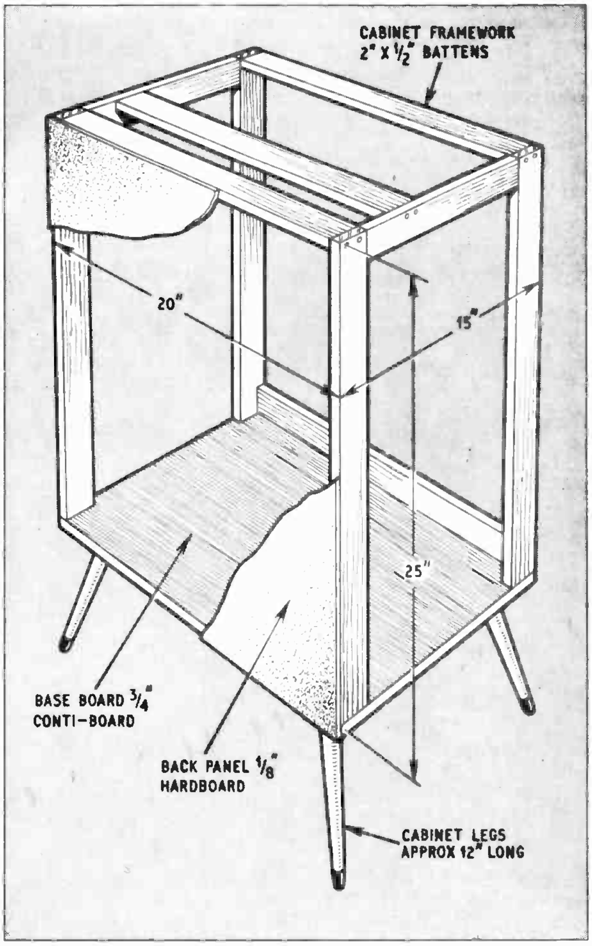


Fig. 9. Details of the enclosure framework for the rotating horn speaker shown from the back

The tremulant effect produced by these systems is quite unsuitable for organ or guitar bass. The speaker of the rotary unit must therefore, be connected to the main amplifier via a simple bass filter consisting of two reverse connected capacitors in series as shown in Fig. 10. This produces a quite substantial roll off in bass response but if the bass should appear too predominant or cause overloading at high volume, then one of the series capacitors may be reduced in value.

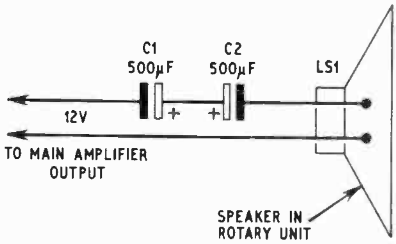


Fig. 10. The series capacitor bass filter (see text regarding adjustment)

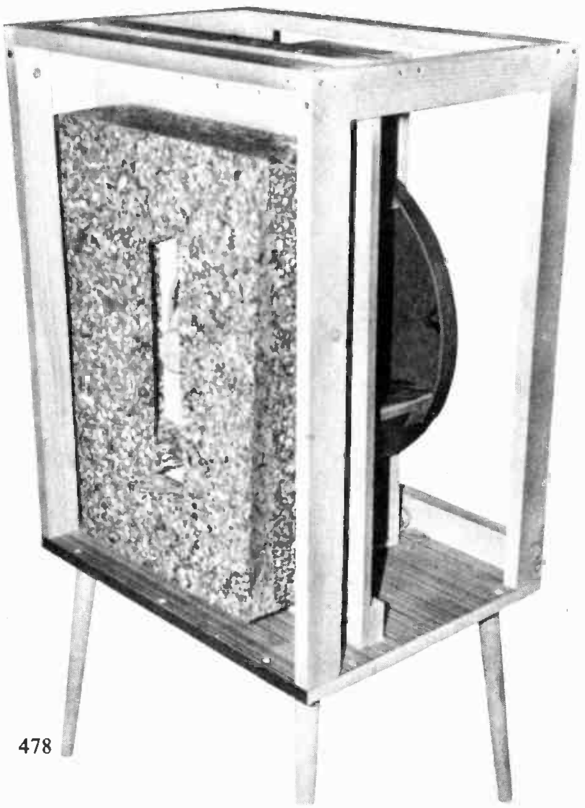
ANALYSES OF ROTARY SYSTEMS

It was mentioned in part 1 that the acoustical nature and that as far as rotating horns or deflectors loudspeaker systems was one of a very complex nature and that as far as rotating horns or deflectors are concerned, there is no pitch fluctuation due to Doppler effect. With rotating horn systems it will be realised that the sound is projected through 360 degrees in a vertical plane. Sound is, therefore, heard by the listener from many directions, i.e. directly from the system and by reflection from walls and ceiling. Thus the sound arrives at the listener either in, or out of phase, depending on the length of the path of both the direct and reflected sound. Remember that natural hearing cannot distinguish phase shift by itself. We hear only the product of phase shift caused by the difference in path length from the ears to two sources reproducing the same sound. That product is amplitude variation whereby in phase signals cause an audible increase in volume and out of phase signals a decrease.

With rotary speaker or horn systems both the fundamental notes and their harmonics therefore undergo complex amplitude changes for each revolution of the system. It is these changes in amplitude that produce the unusual tremulant waveform which can be quite different for every note played.

The oscillogram in Fig. 11 shows a tremulant waveform from the rotary system for which constructional details have been given. The lower trace is the continuous note from an organ and the upper trace shows one complete cycle of the complex tremulant envelope. The oscillogram in Fig. 12 shows 3 cycles of the tremulant waveform obtained whilst playing a different note.

Many tests with a number of rotary speaker systems all showed the same complex tremulant



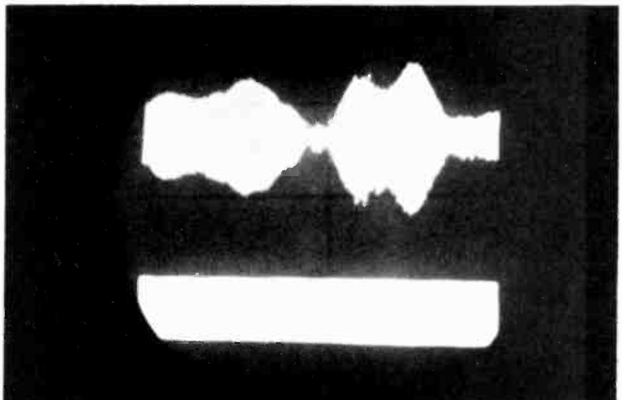


Fig. 11. Upper trace—one cycle of the tremulant waveform from a rotary horn speaker system. Lower trace—steady note from electronic organ

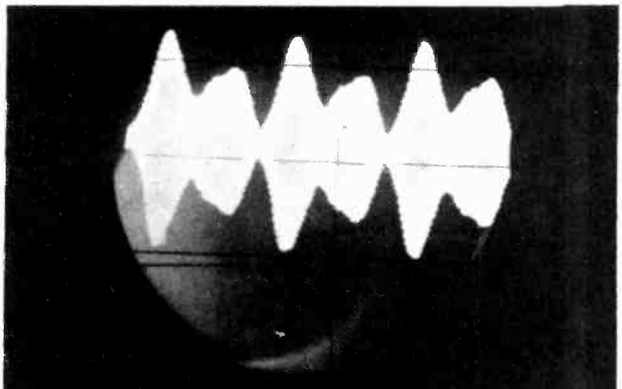


Fig. 12. Three cycles of the tremulant waveform from a rotating horn speaker. The pitch of the note being played is different from that producing the waveform shown in Fig. 11

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AC126	25	BSY95A	15	NKT80215	75	2G371	15
AC127	25	BY100	20	NKT80216	75	2G374	25
AC128	20	BYX10	15			2N174	80
AC176	25	BYZ10	40	OA5	20	2N385A/	
AC187	30	BYZ12	30	OA10	25	2N388A	75
AC188	30	BYZ13	20	OA47	8	2N404	23
ACY17	29	BZY88 Series		OA70	8	2N696	15
ACY18	20	3.3V to 30V	15	OA73	8	2N697	17
ACY19	20			OA79	8	2N698	30
ACY20	19	D13T1	45	OA81	8	2N706	10
ACY21	19	MJE520	75	OA85	8	2N706A	12
ACY22	19	MJ480	97	OA90	8	2N708	16
ACY40	15	MJ481	1.25	OA91	8		
ACY41	15	MJ490	1.00	OA95	8	2N711	37
AD140	55	MJ491	1.35	OA200	10	2N711A	37
AD149	57	MPF102	43	OA202	10	2N911	50
AD161	37	MPF103	37	OC19	37	2N914	20
AD162	37	MPF104	37	OC20	97	2N918	42
AF114	25	MPF105	40	OC22	47	2N1090	30
AF115	25			OC23	60	2N1091	33
AF116	25	NKT124	30	OC24	60	2N1131	30
AF117	25	NKT125	40	OC25	37	2N1132	30
AF118	44	NKT126	37	OC26	33	2N1302	20
AF124	25	NKT128	25	OC28	60	2N1303	20
AF126	17	NKT135	26	OC29	75	2N1304	25
AF139	37	NKT137	32	OC35	50	2N1305	25
		NKT210	25	OC36	63	2N1306	30
AF186	40	NKT211	25	OC41	25	2N1307	30
AF239	37	NKT212	25	OC42	30	2N1308	34
ASY26	25	NKT213	25			2N1309	31
ASY27	30	NKT214	23	OC44	15	2N1507	23
ASY28	22	NKT215	21	OC45	15	2N1613	22
ASY29	30	NKT216	46	OC71	15	2N1711	25
ASZ21	37	NKT217	50	OC72	23	2N2147	82
AUY10	1.50	NKT218	25	OC75	23	2N2148	63
BA115	8	NKT219	25	OC76	25	2N2160-	62
BC107	12	NKT223	27	OC77	40	2N2368	17
BC108	12	NKT224	25	OC81	23	2N2369	17
BC109	12	NKT225	21	OC81D	20		
BC147	15	NKT229	29	OC81Z	55	2N2369A	20
BC148	15	NKT237	31	OC82	25	2N2646	50
BC149	15	NKT238	19	OC82D	15	2N2904	44
BC158	17	NKT239	23	OC83	23	2N2904A	49
BC169C	19	NKT240	20	OC84	25	2N2905	65
BC182	12	NKT241	21	OC139	25	2N2905A	75
BC182L	10	NKT242	15	OC140	35	2N2906	44
BC183	9	NKT243	56	OC170	25	2N2906A	54
BC183L	9			OC171	30	2N2926, all	
BC184	15	NKT244	17	OC200	37	colours	10
BC184L	15	NKT245	17	OC201	47	2N3053	25
BC212	17	NKT261	21	OC202	63	2N3054	63
BC212L	12	NKT262	19	OC203	37	2N3055	75
BCY30	25	NKT264	21	OC204	40	2N3702	11
BCY31	48	NKT271	18	OC205	65	2N3703	10
		NKT272	17	OC206	75	2N3704	11
BCY32	50	NKT274	18	OC207	75	2N3705	10
BCY33	20	NKT275	23	OCP71/M	47	2N3706	9
BCY34	25	NKT279A	12			2N3707	11
BCY38	30	NKT281	29	ORP12	50	2N3708	7
BCY70	19	NKT302	87	ORP60	60	2N3709	9
BCY71	37	NKT304	79	ORP61	40	2N3710	9
BCY72	16	NKT351	75	P346A	19	2N3711	9
BD121	1.10	NKT401	71	ST140	15	2N3819	35
BD123	1.10	NKT402	77	ST141	20	2N3820	60
BD124	1.03	NKT403	65	TD716	60	2N3826	30
BDY20	1.05	NKT404	60	TIP31A	62		
BF115	25	NKT405	79	TIP32A	74	2N4058	17
BF163	40	NKT406	62	V405A	46	2N4060	20
BF167	25	NKT420	1.83			2N4061	20
BF173	30	NKT451	58	ZTX108	11	2N4062	20
BF178	52	NKT452	54	ZTX300	13	2N4284	15
BF180	37	NKT453	50	ZTX302	18	2N4287	15
BF181	37	NKT603F	30	ZTX303	18	2N4289	15
BF184	25	NKT613F	30	ZTX304	27	2N4871	40
BF185	25	NKT674F	30	ZTX314	11	3N84	1.30
BF194	17	NKT676F	30	ZTX320	30	3N128	69
BF195	15			ZTX330	18	3N140	76
BF196	15	NKT677F	28	ZTX500	16	3N141	73
BF200	35	NKT713	29	ZTX501	16	3N152	86
BFX13	25	NKT717	44	ZTX502	20	40250	55
BFX29	31	NKT734	26	ZTX503	17	40309	33
		NKT736	32	ZTX504	40	40310	45
BFX84	26	NKT773	25	1N34A	20	40312	48
BFX85	34	NKT781	29	1N60	20	40320	36
BFX86	25	NKT10339	25	1N64	20	40360	43
BFX87	30	NKT10419	19	1N82A	47	40361	48
BFX88	25	NKT10439	27	1N87A	23	40362	58
BFY50	23	NKT10519	22	1N914	7	40406	56
BFY51	19	NKT20329/		1N4001	7	40407	39
BFY52	20	0013	31	1N4002	7	40408	51
BFY53	16	NKT80111	67	1N4003	10	40409	54
BFY90	67	NKT80112	83	1N4004	10	40468A	35
BSX19	16	NKT80113	1.00	1N4005	12	40600	58
BSX20	16	NKT80211	75	1N4006	15	40601	55
BSX21	37	NKT80212	75	1N4007	20	40602	40
BSY27	20	NKT80213	75	1N4148	7	40603	49

TERMS: Cash with order please. Postage and packing: 10 Np Inland, 25 Np Europe, 60 Np elsewhere. All goods guaranteed. ALL ORDERS DISPATCHED WITHIN ONE WORKING DAY OF RECEIPT. **1971 Retail Catalogue now available: 5 Np stamp for postage appreciated.**

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RESISTORS
Carbon Film ¼ & ½ Watt 5%
2 Np each
Packs of 10 (of one value/wattage)
15 Np per pack.

PRESETS
P.C. Type 0.3 Watt
Standard size **7 Np**
Sub-miniature **5 Np**
(Available vertical or horizontal mounting)
Usual values 100 ohms to 5 Meg

POTENTIOMETERS
Log or Lin Less switch – **17 Np**
Log or Lin DP switch – **27 Np**
Log or Lin Stereo L/S – **50 Np**
Values: 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1 Meg, 2 Meg

CAPACITORS
Mullard Miniature Electrolytic – C426 Series

Mfd.	Volt Wkg.	
2.5	16	**8 Np**
10	16	**6 Np**
20	16	**6 Np**
40	16	**6 Np**
80	16	**6 Np**
1.6	25	**8 Np**
6.4	25	**6 Np**
12.5	25	**6 Np**
25	25	**6 Np**
50	25	**6 Np**
80	25	**6 Np**
1	40	**8 Np**
4	40	**6 Np**
8	40	**6 Np**
16	40	**6 Np**
32	40	**6 Np**
50	40	**6 Np**

Mullard Metallised Polyester 250v

Mfd.		Mfd.	
.01	**3 Np**	.22	**5 Np**
.015	**3 Np**	.33	**7 Np**
.022	**3 Np**	.47	**8 Np**
.033	**3 Np**	.68	**11 Np**
.047	**4 Np**	1.0	**14 Np**
.068	**4 Np**	1.5	**20 Np**
.1	**4 Np**	2.2	**24 Np**
.15	**5 Np**		

Mullard Electrolytic – C437 Series

Mfd.	Volt.Wkg.	
250	16	**9 Np**
400	16	**12 Np**
640	16	**15 Np**
1000	16	**18 Np**
160	25	**9 Np**
250	25	**12 Np**
400	25	**15 Np**
640	25	**18 Np**
100	40	**9 Np**
160	40	**12 Np**
250	40	**15 Np**
400	40	**18 Np**

Mullard Sub-Miniature Ceramic Plate – C333 Series
63 volt working. Range 1.8pf to 220pf (usual pref. values)
Packs of 6 (any values) – **30 Np**

NEONS
Miniature neon bulbs: 0.6mA 65vac 90vdc. Pack of 5 for **30 Np**
Panel neon indicators, mains voltage. Red lenses – round, square or arrow-shaped faces Each **20 Np**

VEROBOARD

2.5" × 17" × .15"	**57 Np**
2.5" × 5" × .15"	**23 Np**
2.5" × 3.75" × .15"	**19 Np**
3.75" × 17" × .15"	**79 Np**
3.75" × 5" × .15"	**30 Np**
3.75" × 3.75" × .15"	**22 Np**
2.5" × 5" × .1"	**25 Np**
2.5" × 3.75" × .1"	**23 Np**
Spot face cutters –	**38 Np**
Veropins: pack of 50 for	**21 Np**

Bargain Pack, 36 square inches of various sizes. .15" &/or .1" **50Np**

HEATSINKS
T0-5 (Clip-on) pack of 4 for **15 Np**
FINNED type for 2 × TO-3 ready drilled at **43 Np**
FINNED type undrilled for plastic power at **34 Np**

BOOKS

G.E. Transistor Manual	£1.47
R.C.A. Transistor Manual	£1.40
Designers' Guide to British Transistors (data book)	£1.25
R.C.A. Hobby Circuits Manual	£1.40
110 Semiconductor Projects (Marston)	£1.25
Zener Diode Handbook	84 Np
Photocell & Solarcell Handbook	84 Np
Thyristor (S.C.R.) Handbook	£1.00

NEW! SN74N SERIES TTL LOGIC

NOW FROM L.S.T. – FULL SPECIFICATION TEXAS INDUSTRIAL INTEGRATED CIRCUITS AT ECONOMY PRICES

		1–49	50–99	100
SN7400N	Quad 2-input NAND gate			
SN7401N	Quad 2 input NAND gate open collector	32	27	22
SN7402N	Quad 2-input NOR gate			
SN7403N	Quad 2-input NAND gate open collector	35	30	25
SN7404N	Hex Inverter	32	27	22
SN7410N	Triple 3-input NAND gate			
SN7413N	Schmidt Trigger	45	40	35
SN7420N	Dual 4-input NAND gate			
SN7430N	8-input NAND gate	32	27	22
SN7440N	Dual 4-input NAND Buffer			
SN7442N	BCD to decimal decoder TTL output	£1.12	£1.00	88
SN7450N	Expandable Dual 2-wide 2-input AND–OR–INVERT gate			
SN7453N	Expandable 4 wide 2-input AND–OR–INVERT gate	32	27	22
SN7460N	Dual 4-input expander			
SN7470N	J–K Flip-flop	45	40	35
SN7472N	J–K Master-Slave Flip-flop			
SN7473N	Dual J–K Master-Slave Flip-flop	50	45	43
SN7474N	Dual D-type Edge-Triggered Flip-flop			
SN7475N	Quadruple Bistable Latch	65	60	55
SN7476N	Dual J–K Master-Slave Flip flop with Preset & Clear	55	50	47
SN7483N	Four-bit Binary Full-Adder	£1.30	£1.20	£1.10
SN7490N	Decade Counter			
SN7492N	Divide-by-12 Counter	£1.12	£1.00	87
SN7493N	Four-bit Binary Counter			
SN74141N	BCD to decimal Decoder/Driver (Replaces the obsolete SN7441AN)	£1.45	£1.30	£1.15

MIX PRICES: Devices may be mixed to qualify for quantity price
Larger quantities – prices on application

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CA3011	75
CA3013	£1.05
CA3014	£1.25
CA3018	85
CA3020	£1.30
CA3028A	75
CA3035	£1.25
CA3043	£1.40
CA3044	£1.20
CA3046	75
CA3047	£1.40
CA3048	£2.05
CA3049	£1.60
CA3052	£1.65

BARGAIN OP-AMPS!!

LM709CN – **60 Np** (DIL high gain op-amp)
LM741CN **95 Np** (equiv. SN72741P)

PC1006/1 Multimeter Sensitiser packaged circuit KIT includes all accessories £7.55

FAIRCHILD

	1–11	12–24	25
μL900	**40 Np**	**35 Np**	**32 Np**
μL914	**40 Np**	**35 Np**	**32 Np**
μL923	**53 Np**	**50 Np**	**47 Np**

Devices may be mixed to qualify for quantity price

G.E. (USA)

PA230	Pre amp	£1.10
PA234	1 Watt Amp	£1.00
PA237	2 Watt Amp	£1.87
PA246	5 Watt Amp	£2.63
PA424	Zero Volt Switch	£2.45

MISCELLANEOUS

TH9013P	Toshiba 20 Watt Hybrid IC Amp	£4.47
IC10	Sinclair	£2.75
SL403A	Plessey New Design	£2.12

MULLARD

TAA263	Linear Amp	75 Np
TAA293	General Purpose Amp	£1.00
TAA310	Record/Playback Amp	£1.50
TAA320	MOS LF Amp	65 Np
TAD100	IC Receiver	£1.97
TAD110	AM/FM Receiver	£1.97

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Operate at 40kc/s. Can be used for remote control systems without cables or electronic links. Type 1404 transducers can transmit and receive. **FREE:** With each pair our complete transmitter and receiver circuit. PRICE £5.90 Pair
(Sold only in pairs)

IOR

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DD170	Bargain pack of five 1 Watt Zener diodes	97 Np
DD175	4 pieces 100 PRV Rectifiers 500mA	50 Np
DD176	2 pieces 200 PRV Rectifiers 500mA	30 Np
DD177	2 pieces 400 PRV Rectifiers 500mA	50 Np
DD180	Bargain Transistor pack 2 AF – RF	57 Np
DD184	Assortment of RF, audio & power transistor solar cell & diode	£1.67
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EP50A	Solar motor (operates from S4M)	£1.97
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CS120	Cadmium Sulphide photoconductive cell	98 Np

Only part of the International Rectifier "Diamond Line" range are listed
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TRIACS

2N5756	2.5A (RMS) 400 PIV TO-5 Mod	95 Np
40486	6 Amp (RMS) 400 PIV TO-5 Mod	£1.20
40430	6 Amp (RMS) 400 PIV TO 66	£1.01
40432	6 Amp (RMS @ 75° Amb.) 400 PIV*	£1.50
40512	2.2 Amp (RMS @ 25° Amb.) 400 PIV*	£1.45

*These types have integral triggering

40576	15A (RMS) 400 PIV TO-66	£1.70
SC146B	10 Amp 200 PIV Plastic Flat-pack	£1.25
SC146D	10 Amp 400 PIV Plastic Flat-pack	£1.75
ST2	Bi-lateral avalanche trigger diode	47 Np

ZENER DIODES

400mW 10% GLASS CASE TEXAS Mfr

1S2036	3.6 volt	1S2082	8.2 volt
1S2039	3.9 volt	1S2100	10 volt
1S2043	4.3 volt	1S2110	11 volt
1S2047	4.7 volt	1S2120	12 volt
1S2056	5.6 volt	1S2160	16 volt
1S2062	6.2 volt	1S2180	18 volt
1S2068	6.8 volt	1S2270	27 volt
1S2075	7.5 volt	1S2300	30 volt

Prices 1-24 **15Np** 25-99 **11Np** 100+ **9Np**

THYRISTORS

CR1/051C	1 Amp 50 PIV TO-5	**40 Np**
CR1/401C	1 Amp 400 PIV TO 5	**50 Np**
2N3525	5 Amp 400 PIV TO 66	**£1.09**
40739	10 Amp 400 PIV Stud Mtg	**£1.65**

ENCAPSULATED BRIDGES

Type No	Current	Rms Volts	
W005	1 Amp	50	**50Np**
W06	1 Amp	600	**65Np**

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT

NEW IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED PRINTED CIRCUIT BOARD FOR EASY CONSTRUCTION

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

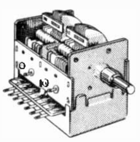
PRICES AMPLIFIER KIT, **£10·50** P. & P. 15p.
POWER PACK KIT, **£3** P. & P. 30p.
CABINET, **£3** P. & P. 30p.

(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, **£20·50.** Post Free.

Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

FANTASTIC 'POLY PLANAR' WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size only 11¾" × 14⁵⁄₁₆" × 1³⁄₁₆" deep. Weight only 19 ozs. Can replace cone speakers in any application and is particularly useful for those with limited space. Extremely rugged and shockproof. Operating temperature −20°F to +175°F. Power handling 10 watts rms (20 watts peak). Impedance 8 ohm only. Response 40 Hz—20 KHz. Can be mounted on ceilings, walls, doors, under tables, etc. and used with or without baffle. Send S.A.E. for full details. Only **£5·75** each. P. & P. 25p.

SPECIAL PURCHASE OF MANUFACTURER'S SURPLUS! All Transistor F.M. tuner head with twin A.M. Gang incorporated. Beautifully engineered with precision geared reduction drive. F.M. Transistor oscillator/Mixer and first I.F. stage (10.7 Mc/s output) with optional AFC connection. Built on printed circuit panel and fully screened. Extremely stable over range 88-108 Mc/s. Brand new and pre-aligned. Size 2⅛in H. × 1⅝in W. × 2⅛in D. For 6V D.C. @ 2.8mA. A.M. Gang fitted with trimmers which can be connected to standard A.M. aerial and oscillator circuits if required. LIMITED NUMBER. Only **£2·25** post free. Connection details supplied.



HIGH GRADE COPPER LAMINATE BOARDS
8×6×¹⁄₁₆in. FIVE for **50p.** P. & P. 13p.

PIANO KEY TYPE SWITCHES. 8 press buttons plus 1 cancel button. Each of the 8 sections contains 6 s.p.c.o. (total 40 s.p.c.o.). Brand new—limited quantity only. Original manufacturing cost £1·37½. **OUR PRICE 75p.** P. & P. 13p (3 or more post free).

SPECIAL OFFER! PLESSEY TYPE 29 TWIN TUNING GANG. 400pF + 146pF. Fitted with trimmers and 5:1 integral slow motion. Suitable for nominal 470 kc/s. I.F. Size approx. 2 × 1 × ¾in. Only **43p.** P. & P. 13p.

HONEYWELL MICROSWITCHES S/P. C/O. Push-button action. Rating 250v. AC at 15 amps. Size approx. 1⅛in. × ⅝in. × ⅜in. **25p** each. P. & P. 5p (6 or more post free).

TELESCOPIC AERIALS WITH SWIVEL JOINT. Can be angled and rotated in any direction. 6 section Lacquered Brass. Extends from 6in. to approx. 22½in. Maximum diameter ⅜in. **25p** each. P. & P. 5p.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-0-10, 20-0-20, 30-0-30V, at 2 amps full wave. Size 3inL × 3½inW × 3inD. Price **£1·75.** P. & P. 30p.

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

SPECIAL OFFER!!
HI-FI LOUDSPEAKER SYSTEM

Beautifully made teak finish enclosure with most attractive Tygan-Vynair front. Size 16¼in high ×10¼in wide×5½" deep. Fitted with E.M.I. Ceramic Magnet 13in×8in bass unit, two H.F. tweeter units and crossover. Power handling 10W. Available 3, 8 or 15 ohm impedance.

Our Price £8·40 Carr. 65p.

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

LOUDSPEAKER BARGAINS
3in 4 ohm **50p.** P. & P. 13p. 5in 3 ohm **80p.** P. & P. 15p. 7 × 4in 3 ohm **£1·05**, P. & P. 20p. 10 × 6in 3 or 15 ohm **£1·90**, P. & P. 30p. E.M.I. 8×5in 3 ohm with high flux magnet **£1·62**, P. & P. 20p. E.M.I. 13¼ × 8in 3 ohm with high flux ceramic magnet **£2·10** (15 ohm **£2·25**). P. & P. 30p. E.M.I. 13×8in, 3 or 8 or 15 ohm with two inbuilt tweeters and crossover network **£4·20.** P. & P. 30p. E.M.I. 13"×8" twin cone (parastatic tweeter) 8 ohm **£2·25.** P. & P. 30p.

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

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12in "RA" TWIN CONE LOUDSPEAKER
10 watts peak handling. 3 or 15 ohm, **£1·88.** P. & P. 30p. **35 ohm SPEAKERS 3".** ONLY **63p.** P. & P. 13p.

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

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

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

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

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

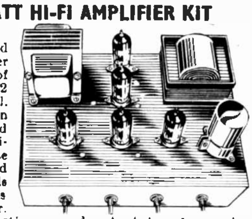
GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER. For P.U. Tape, Mike, Guitar, etc., and suitable for use with valve or transistor equipment. 9-18V. Battery or from H.T. line 200/300V. Frequency response 15Hz-25KHz. Gain 26dB. Solid encapsulation size 1⅜ × 1⅜ × ⅝in. Brand new — complete with instructions. Price **88p.** P. & P. 13p.

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

QUALITY RECORD PLAYER AMPLIFIER MK II
A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × 3 d. × 6 h. Ready built and tested. PRICE **£3·75.** P. & P. 40p. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE **£4·88.** P. & P. 50p.

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

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **13p** (Free with parts). **All parts sold separately.** ONLY **£7·97.** P. & P. 55p. Also available ready built and tested complete with std. input sockets, **£9·97.** P. & P. 55p.

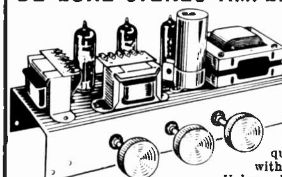
BRAND NEW TRANSISTOR BARGAINS. GET 15 (Matched pair) **75p**; V15/10p, **50p**; OC71 **25p**; OC76 **30p**; AF117 **18p**; 2G339 (NPN) **15p.**
Set of Mullard 6 transistors OC44, 2—OC45, AC128D, matched pair AC128 **£1·25**; ORP12 Cadmium Sulphide Cell **53p.** All post free.

SPECIAL PURCHASE!
SPEAKER CABINET FROM FAMOUS MAKER!

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

LIMITED NUMBER ONLY £1·38 Post Free.

DE LUXE STEREO AMPLIFIER



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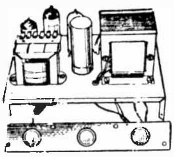

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TREMULANT SYSTEMS CONTINUED

waveforms which are effected not only by the pitch of the notes being played but also very much by the environment of the system. Nevertheless, the tremulant from rotary speaker systems is very pleasing and hence nearly all domestic electronic organs and external tone cabinets, for home and theatre type electronic organs, are fitted with them.

DOPPLER EFFECT

Physically rotating loudspeakers do produce a small change in pitch due to Doppler effect and experiments carried out in 1881 and again in 1927 have proved that the pitch of a sound from a source rotating on a radius of approximately 3 feet at 3 revolutions per second can be changed, because of Doppler effect, by as much as a whole musical tone. However, various tests have subsequently shown that whatever pitch fluctuation may occur with rotating organ loudspeakers, it is masked almost completely by the greater amplitude variations which occur in both the fundamentals and their harmonics.

The amplitude variations of the fundamentals may be as much as 20dB and a large increase in the volume of sound can cause a listener to hear an apparent change in pitch.

ELECTRONIC SIMULATION

Since the tremulant produced by rotary speaker systems is predominantly one of amplitude variation of both the fundamental notes being played and their harmonics, it might appear relatively easy to produce the effect electronically with fairly simple circuitry. It must be remembered however, that the overall effect is a complex acoustical one, in which phase shift, the reflection of sound and natural hearing play a great part. The aural effect might also be described as a spatial one, not unlike that of stereophonic reproduction from two loudspeakers, which also relies upon phasing. Thus, the tremulant from a rotating speaker or horn system cannot be exactly simulated via a single static loudspeaker.

Electronically produced amplitude variation of both the fundamental tones and their harmonics is not difficult to produce, but first a tremulant waveform generator is required that will not introduce a thumping noise due to its own harmonics. Direct voltage control from a low frequency sinewave oscillator is therefore undesirable.

In part 1 a block diagram was given illustrating the use of a light dependent resistor (l.d.r.), which, under control from a fluctuating light source provides a rapidly varying resistance with a range of approximately 100 ohms to 100 kilohms or higher, depending on the rate at which variation is required. L.D.R.'s are commonly used in audio equipment as light operated volume controls and all that is required to producing a tremulant control voltage is a means of actuating one or more l.d.r.'s sinusoidally at between 5 and 10Hz.

POLAROID VARIATION

One method that will sinusoidally actuate one or more l.d.r.'s simultaneously is shown in Fig. 13. Here two steady light sources are employed which are sinusoidally interrupted by means of a rotating disc of Polaroid. Each lamp shines through a small Polaroid window mounted on the lamp housing and then through the rotating Polaroid onto the l.d.r. As the Polaroid disc rotates the light on the l.d.r. varies from zero to maximum perfectly sinusoidally and as a consequence the resistance of the l.d.r. will also vary sinusoidally.

The system can be used in various ways—two l.d.r.'s could be used to control an amplifier gain and its frequency response simultaneously or to produce a rapid "panning" effect between two stereo channels. Either of these applications might well provide a new sound effect for pop groups! By rotating the Polaroid windows in front of the l.d.r.'s the phase relationship between the outputs may be varied.

ELECTRONIC TREMULANT

An extension of the idea mentioned above but without the rotating Polaroid and electric motor can be used to produce a tremulant effect akin to that

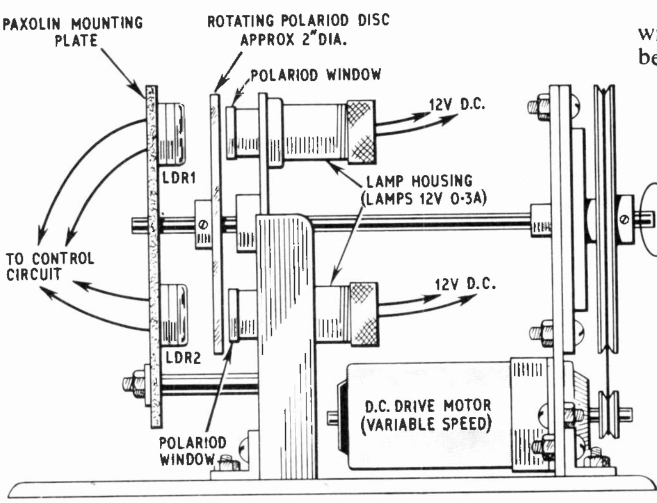


Fig. 13. An optical/mechanical system for producing sinusoidal resistance variation in one or more light dependent resistors

produced by a rotary horn or speaker system. A practical circuit is given in Fig. 14, which could be modified in various ways to produce different kinds of tremulant effect. As it stands it can be connected between an electronic organ (from the keyboard output) and the main amplifier or between an electric guitar and its amplifier. However, it must be emphasised that the circuit is an experimental one that may require modification to match up with other equipment. Also an oscilloscope and a square-wave generator covering the audio range are necessary for checking the harmonic filter circuits and the performance of the circuit generally.

CIRCUIT OPERATION—PRE-AMPLIFIER

The pre-amplifier (TR1 and TR2) has an input impedance of around 100 kilohms and a sensitivity of approximately 50 millivolts with VR2 at minimum resistance. With VR2 all in circuit the gain of the pre-amplifier is much lower but the input signal can then be as high as 300 millivolts. With VR2 set at about half resistance, the input sensitivity will be around 100 millivolts. This setting will ensure maximum treble lift from the tone control VR3. The input volume control VR1 can be used to attenuate an otherwise too high input signal.

The output across R27, with the tremulant circuit switched off, will be approximately 500 millivolts. The average output shown on a valve voltmeter with the tremulant running, will be about 300 millivolts, but remember that the peaks of the tremulant waveform may allow the signal amplitude to rise as high as 1 volt (r.m.s.).

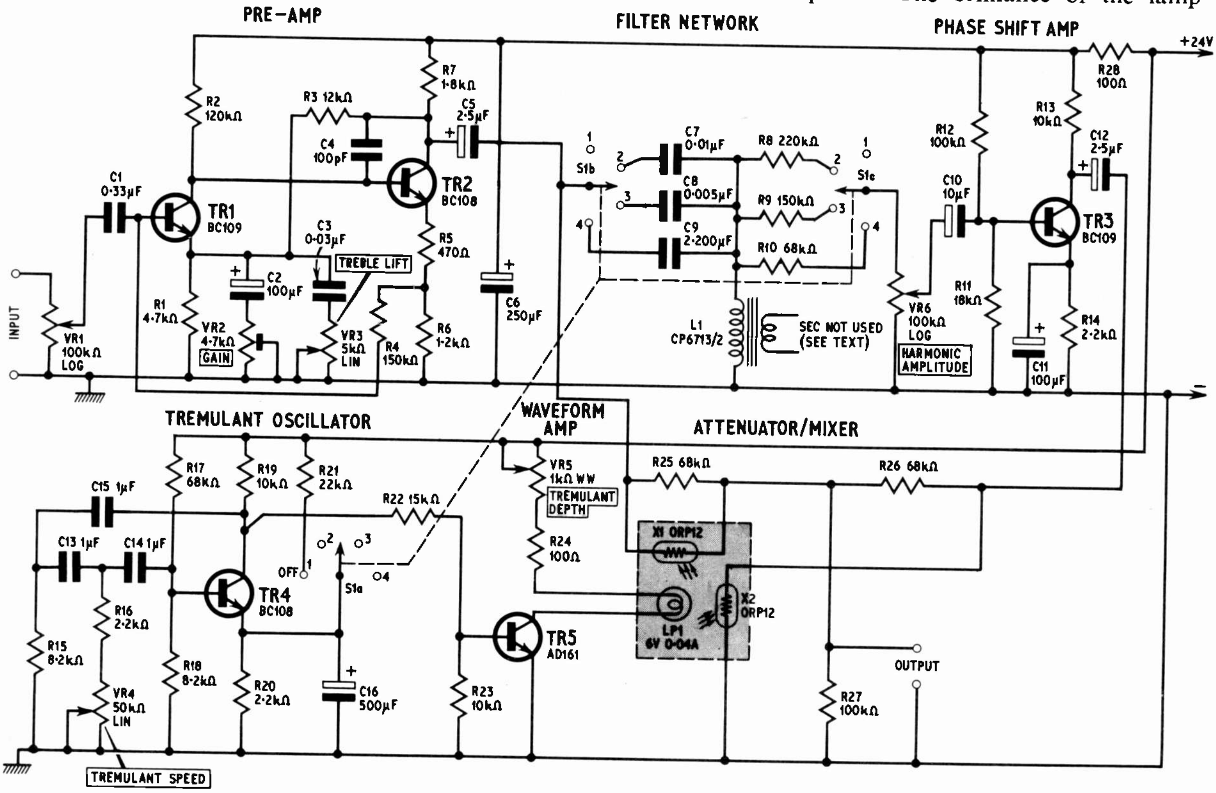
The output signal from the pre-amplifier, at the collector of TR2, is fed through a filter network and thence to the input of the phase shift amplifier TR3. It is also taken to the attenuator/mixing network comprised of R25, X1 and R27. When the tremulent oscillator TR4 is operating the control lamp actuates X1 and produces the requisite amplitude variation of the fundamental together with its harmonics.

HARMONICS

With the tremulant circuit in operation—S1 at positions 2, 3 or 4—the input signal is also fed into the filter circuit. Here the harmonic structure is considerably altered by new harmonics being added and by some being removed. The resultant signal is passed into the phase shift amplifier TR3, and from there to the attenuator/mixing network R26, X2 and R27 where the harmonics may be either in or out of phase with those of the original signal.

The function of the whole unit is such that the harmonics present in the fundamental are made to vary completely at random much as they are with a rotary speaker system. As the two l.d.r.'s are opposed in circuit the amplitude of the fundamental and its original harmonics will be varying in opposition to the signals from the filter and phase shift amplifier circuit; when one is increasing the other will be decreasing. The resultant tremulant waveform is therefore, a complex, similar to that from a rotary system but lacking the aurally spatial effect.

The tremulant oscillator TR4 produces a sinewave which can be varied from about 2 to 8Hz by means of VR4 (tremulant speed). The signal from this is used to drive a small power transistor VR5, the collector of which is taken to the positive line via the control lamp P1. The brilliance of the lamp



is controlled by VR5 which determines the depth of the tremulant.

FILTER CIRCUIT

The function of the filter circuit is such that the three positions of S1 allow some variation in the range of harmonics passed by the phase shift amplifier and it is important that this part of the circuit is checked with an oscilloscope and a square-wave signal generator. First a square-wave of between 300 and 400Hz of suitable amplitude is fed to the pre-amplifier input. The control lamp must be disconnected or removed so that it does not light and the treble control turned off. Connect the oscilloscope to C5 negative, the waveform at this point should be an almost uniform square-wave. Now transfer the oscilloscope to C12 negative. The waveforms for position 2, 3 and 4 of S1 should be as shown in Fig. 15. Variation of the valves of capacitors C7, C8 or C9 will alter the shape of these curves.

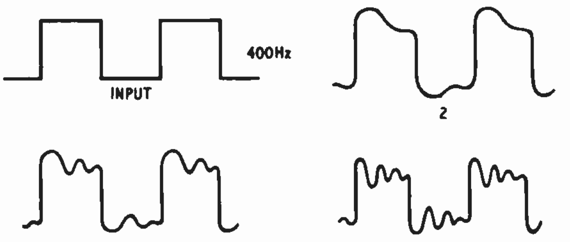


Fig. 15. The waveforms produced by the filter circuit in Fig. 14 for positions 2, 3 and 4 of S1. The numbers under each waveform refer to the switch position

Failure to produce the correct waveform can be due to both capacitor and inductor values; L1 is the primary of a small transformer type CP6713/2 sold by Henrys Radio Limited. This has a d.c. resistance of approximately 500 ohms and therefore, a fairly high a.c. impedance. The 100 kilohm potentiometer VR6 marked "harmonic amplitude" should be set near maximum for all the above tests.

SETTING UP

In use the input volume control VR1 should be adjusted according to the input level to avoid overloading the pre-amplifier and the main amplifier, to which the tremulant unit is connected. The harmonic amplitude control VR6 should be used discreetly, for if this is turned too high it can introduce distortion. If the control lamp appears to be over brilliant when the tremulant depth control VR5 is set for maximum depth, then the series resistor R24 (100 ohms) should be increased in value.

The prototype unit was found to be very effective with an electric guitar, the unit producing a pleasing and completely noise free tremulant quite unlike the usual crude, so called, vibrato systems incorporated in guitar amplifiers. With an electronic organ care must be taken to avoid overloading the input circuit and the use of too much harmonic amplitude. Excessive tremulant depth can also introduce distortion or spoil the original voicing of the organ.

Although the electronic unit provides a tremulant which is similar, it cannot exactly simulate that from a rotating horn or speaker system. ★

XEE HERE!

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

THERE has been a considerable amount of correspondence relating to "electronic animals" following the earlier series on Bionics and the articles about EMMA last year. Readers' letters, in the main, have emphasised the need for less expensive drive systems in these "animals" and, among other things, pointed to the shortcomings of the noise cell arrangement used in EMMA.

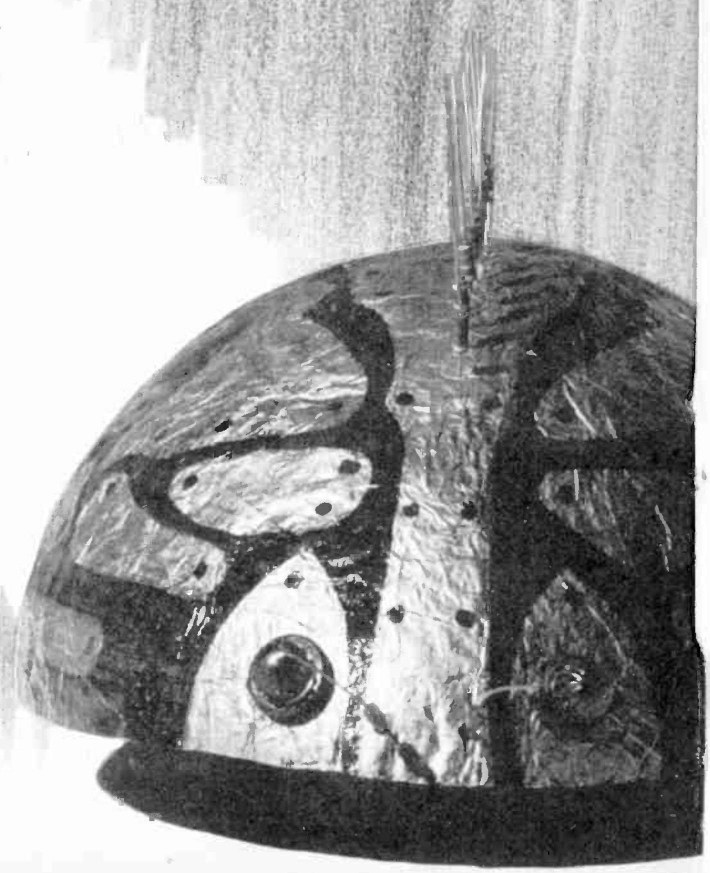
Unlike the earlier models, XEE employs integrated-circuitry for all its control logic, using discrete components only where it is more simple and cheaper to do so. Further differences include the embodiment of relays in the muscle control circuitry, rather than transistors which only afford a modicum of isolation between logic and drive systems, and which, because of their relatively high V_{ce} lose volts that could be usefully driving motors.

Related to EMMA, XEE is mechanically a sort of "middi" version; indeed, this new animal represents just the beginning of others which, physically, will tend towards the "mini". We will examine the anatomy of this latest "bug" which, not inappropriately, got its name from a computer that had been programmed to generate random letter and word sequences.

SYSTEM CONCEPT

Basically, XEE has two senses; one, an electro-optical sense provided by a pair of photo-sensitive resistors; and the other, a load monitoring arrangement associated with the muscle control circuitry. How XEE ultimately decides to respond as a result of inputs to these senses is determined by a sub-system employing a clock and random generator.

Several degrees of freedom are provided permitting turning to the right, turning to the left, driving forward, driving in reverse, and stopping. These functions, over which there is a fair amount of random control, thus provide XEE with a reasonably lifelike repertoire of responses. The response to optical inputs is additionally in part controlled by a random function, but more about this later on.



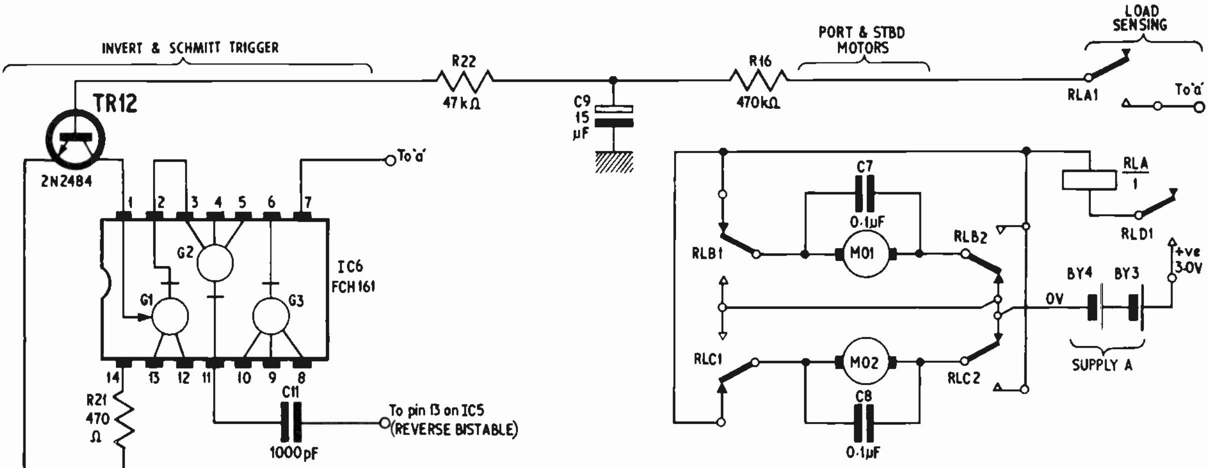


Fig. 1. Circuit diagram of the load sensing, delay and Schmitt trigger and muscle sections of XEE

CIRCUIT DESCRIPTION—LOAD SENSING

The circuit description will have as a basis only those areas which involve either totally, or in part, discrete components. This will be so since it is the *function* of the i.c.s that we will be concerned with rather than their internal circuitry. As a consequence, once the "loose ends" have been tied together, we shall consider in detail the system in an entirely logical form.

In order that XEE can sense both direct loads applied to its "body" and be aware of the presence of objects in its path, some means of tactile sensing is necessary. An extremely positive response can be obtained using a "feeler" and microswitch arrangement, but this scheme has the unfortunate disadvantage that the probe, or whatever, is all too easily snapped off!

A better idea, albeit one which displays a somewhat intractable sensitivity, is motor current sensing. No extra "appendages" are required when the latter set-up is embodied, but it does mean the need for a little more electronics.

The sensor itself is the humble reed-switch. Around its circumference are wrapped a few turns of relatively heavy-gauge wire which serve as the operating coil and pass the total motor current.

If, during operation of XEE, some maximum current level is exceeded, the reed switch will close to indicate that the motor load has increased. The switch is shown as RLA in Fig. 1 and its construction will be discussed later in the article.

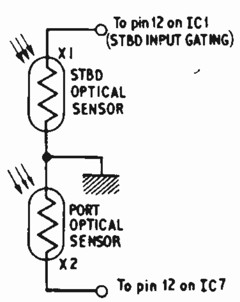


Fig. 2. Connection of the two l.d.r.'s to the logic circuitry

DELAY AND SCHMITT TRIGGER

Although the load sensing system works well, it might almost be said that it works too well because whenever there is a rise in current, as when the motors change direction (stall current), the reed switch operates. We thus require some way of permitting the load sense to differentiate between transient loads and continuous loads. This can be met quite simply by way of a time-constant circuit (R16/C9) included after the reed switch, providing just long enough a delay to determine a real load. If such a load is present the switch will be closed for a longer time and hence C9 will receive a greater charge. This capacitor is connected across the input of a buffer amplifier controlling a Schmitt trigger. The latter switches whenever the input voltage to the buffer rises above about 0·6 volts. At such times the output of the Schmitt will go towards earth, the required condition for triggering the reversing bistable—mentioned in the section under logical operation.

The Schmitt is formed by coupling a pair of gates within a Mullard FCH161 integrated circuit and connecting a 470 ohm resistor (R21) in the negative supply lead. Since the FCH161 is a "triple-gate," this treatment does have the disadvantage that one of the gates will remain unused. The gates also have a very low input impedance which means that in order to get a delay with the sort of time-constant required, the capacitor used has either got to be very large, or a buffer must separate the delay from the Schmitt. As we have seen, XEE employs a buffer.

OPTICAL SENSE

XEE has a bilateral optical system; one starboard and one port sensor. The sensors, which are light dependent resistors (l.d.r.'s), are each connected to their respective logical invertors which serve both to amplify and establish the correct logic levels into the remainder of the system (Fig. 2).

NOISE SOURCE

In an earlier article, randomness was generated by the use of an electrochemical noise cell; this, as I feel sure many readers will appreciate, proved to be a very unreliable source of noise after it had been in service for only a short time. It was therefore imperative that some other scheme be adopted;

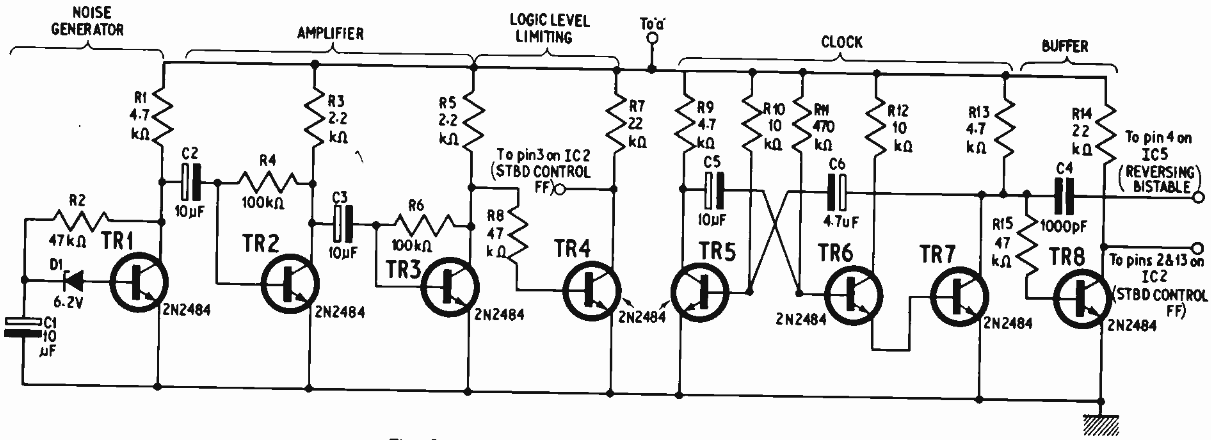


Fig. 3. Noise generator and clock circuitry

the result is shown in Fig. 3. Here, a Zener diode has been enlisted to generate the required noise.

Zener diodes are inherently noisy, particularly when run at very low currents, and it is this characteristic that is exploited here. The amplitude of the noise current, however, is fairly small and so requires some amplification. This is provided by transistors TR1, TR2 and TR3. The resultant noise spikes appearing at the collector of TR3 are taken to a further stage, TR4, which ensures that they are limited, both top and bottom, to levels required by the logic which they will be driving. Thus the spikes will either be there, or not be there; a logical 1 or a 0 is thus made available.

The noise pulses, although having quite a random time relationship, cannot be employed directly because their occurrence rate is far too high, typically 2×10^3 to 5×10^4 pulses per second. Their further processing is described in the functioning of the system logic.

CLOCK

Certain areas of the system logic are controlled by a clock or astable. Strictly, this is not performing a true clock function, but it is convenient to refer to it as such, since a number of actions occur which must either have given durations, or which must be initiated at particular times.

The clock, Fig. 3, is, in essence, a kind of "heartbeat" for XEE and comprises a slow-running astable. This circuit is highly asymmetrical; that is to say its output waveform has a large mark to space ratio. The reason for this is that one of the time periods (the random mode) is comparatively short, about 20ms, while another (the action mode) occupies a period of a little greater than one second. The circuit employs TR5, TR6 and TR7.

Transistor TR6 forms a super-alpha pair with TR7 and permits large time constants to be achieved without the need for large capacitors. In this way TR7 can effectively tolerate quite a sizeable base resistor whilst in no way jeopardising the long time requirement. A further buffer stage has been added after the clock to prevent it being overloaded. This is formed by TR8.

MUSCLE CONTROL

Control over XEE's motors, or "muscles", is under the direction of three transistor-controlled relays; these are RLB, RLC, and RLD shown in Fig. 4. The relays employed here, in fact, decided the choice of supply voltage, which, although a trifle on the high side, was considered justified in view of the relatively low price of the relays (available on ex-computer circuit boards).

Each relay is connected as the collector load of its associated transistor and incorporates a parallel, reverse-connected diode to minimise the chances of back e.m.f. damaging the transistor. In the energised state, RLD1 contacts ensure that the supply is fed to the motors. At these times, if relays RLB and RLC are not energised, their contacts connect both the motors to run forward. It will be noticed that double pole changeover contacts are employed on

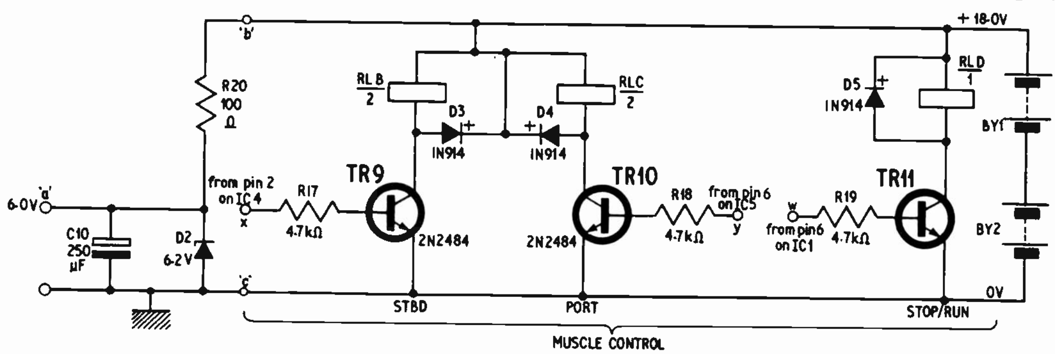
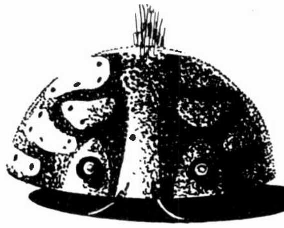


Fig. 4. Muscle control and power supply stabilisation circuitry



INSIDE XEE!

COMPONENTS . . .

Resistors

R1	4·7kΩ	R12	10kΩ
R2	47kΩ	R13	4·7kΩ
R3	2·2kΩ	R14	22kΩ
R4	100kΩ	R15	47kΩ
R5	2·2kΩ	R16	470kΩ
R6	100kΩ	R17	4·7kΩ
R7	22kΩ	R18	4·7kΩ
R8	47kΩ	R19	4·7kΩ
R9	4·7kΩ	R20	100Ω 5W ±10% w.w.
R10	10kΩ	R21	470Ω
R11	470kΩ	R22	47kΩ

All $\frac{1}{16}$W, ±10% except where stated

Capacitors
C1 10μF elect. 10V
C2 10μF elect. 10V
C3 10μF elect. 10V
C4 1,000pF
C5 10μF elect. 10V
C6 4·7μF elect. 10V
C7 0·1μF
C8 0·μ1F
C9 15μF elect. 10V
C10 250μF elect. 10V
C11 1,000pF

Diodes
D1 6·2V Zener SZ62A *or* OAZ202
D2 6·2V Zener SZ62A *or* OAZ202
D3 IN914
D4 IN914
D5 IN914

Transistors
TR1 to TR12 2N2484 (12 off)

Relays
RLA see text
RLB to RLD Claire, 700 ohm, DPDT (ex-computer type—3 off)

Motors
MO1 and MO2 Johnson 150 Type, available from Ripmax Ltd (2 off)

Integrated Circuits
IC1, 4–7 FCH161 Mullard (5 off)
IC2, 3 FCJ101 Mullard (2 off)

Miscellaneous
X1 and X2 5SP5, *or* ORP12 (2 off)
BY1 and BY2 PP6 (2 off)
BY3 and BY4 HP11 (2 off)
Veroboard $2\frac{1}{2}$in × $4\frac{7}{8}$in × 0·1in matrix
Veroboard $\frac{3}{4}$in × $\frac{3}{4}$in × 0·1in matrix (2 off)

Hardware
26 s.w.g. d.c.c. wire for RLA
Brass rod, two lengths of $\frac{3}{32}$in diameter
Gear pinions, 10 tooth, Ripmax Ltd (2 off)
Gear pinions, 30 tooth, Ripmax Ltd (2 off)
Worm and wormwheel, Ripmax Ltd (2 off)
Plastic tubing, approx. $\frac{3}{32}$in internal diam
Aircraft wheels, $1\frac{1}{2}$in, rubber tyred, Ripmax Ltd
Aluminium sheet, see text
4B.A. and 6B.A. screws, nuts and washers.

the relays to obviate the need for a larger, centre-tapped, battery supply.

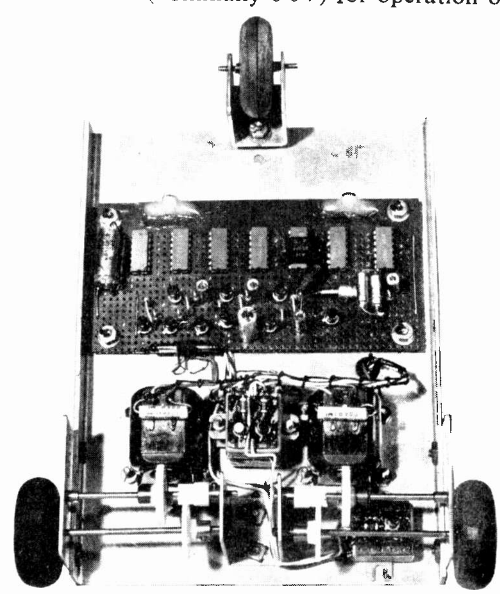
If either RLB or RLC only are energised, the starboard or port motors respectively will be caused to reverse, thus allowing XEE to turn right or left. When the relays are energised together, the model reverses. The remaining relay RLD provides a stop function only when de-energised. In this mode the system logic is arranged to inhibit any existing inputs to TR9 or TR10, thus RLB and RLC are de-energised and so unnecessary current drain, due to the relays, is avoided.

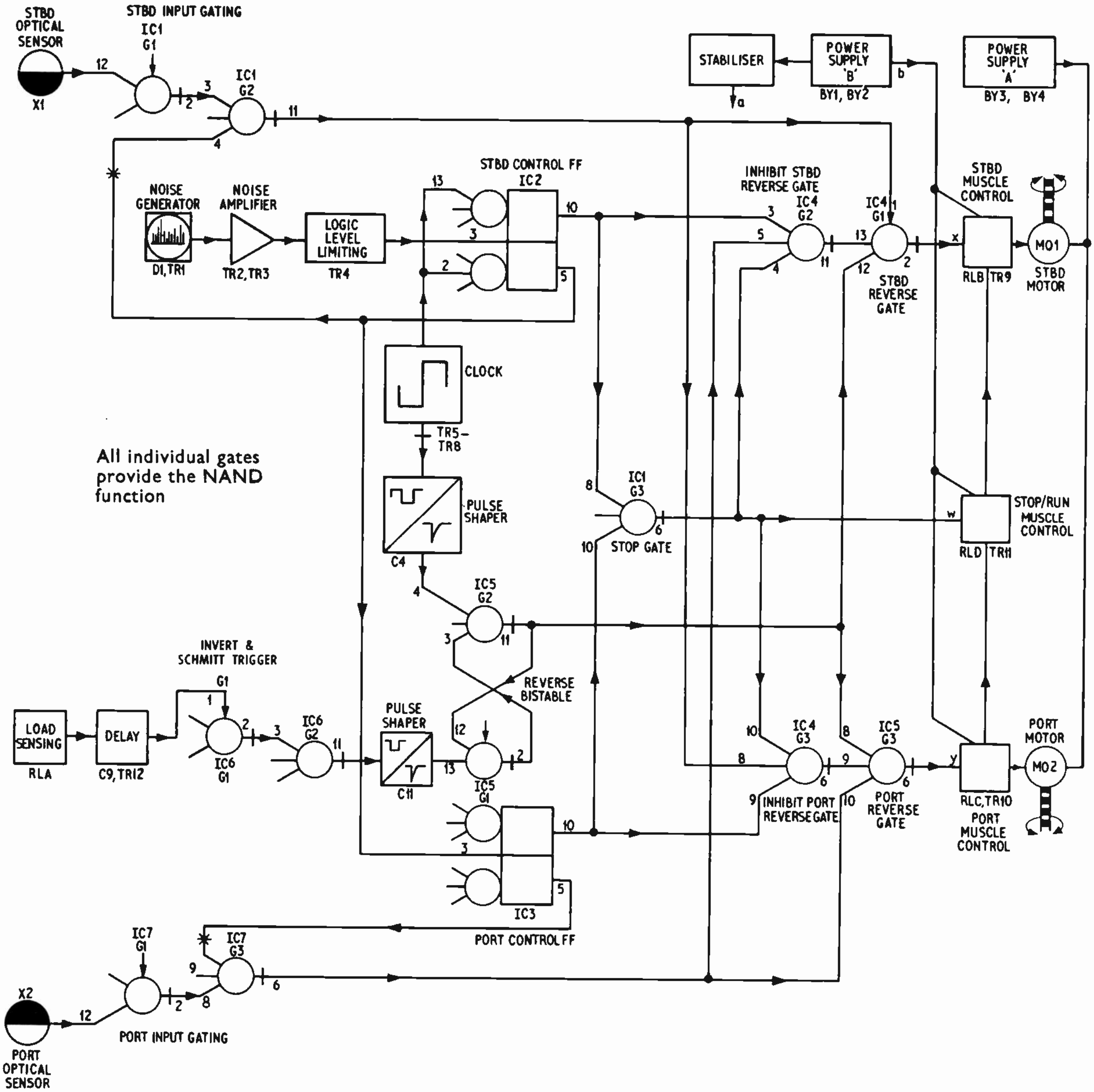
Both motors are of the fairly inexpensive Japanese variety and each has a nominal stall current of 450mA. Under running conditions the current drawn is in the region of 700mA for the pair. Since the motors are run from a separate power supply to the rest of the circuit, most of the electrical noise is isolated to the motor circuit and hence has little chance to interfere elsewhere. However, to prevent any trouble from radiated noise affecting i.c.s which, incidentally, are easily triggered in this way, each motor is equipped with its own suppression capacitor (C7 and C8).

POWER SUPPLIES

Quite a number of factors helped to govern the ultimate choice of power supplies; indeed, the final outcome is more compromise than choice! Since, economically, the model's cost must be kept as low as possible, such luxuries as expensive gear-boxes and small-current motors cannot be permitted. And yet the motors used must be capable of developing sufficient drive-torque to carry an all-up weight of approximately 1lb 10oz for, at least, long enough to allow satisfactory observation of the animal's characteristics. The batteries employed give fairly tolerable operation for about 20 minutes of intermittent use.

Motor supplies are provided by a pair of series-connected HP11 type batteries, while the electronics derive their various needs from two series-connected PP6 batteries. The respective voltages available from this set-up are 3·0V and 18·0V. The latter supplies the muscle control circuitry direct, but is taken to a suitable level (nominally 6·0V) for operation of the





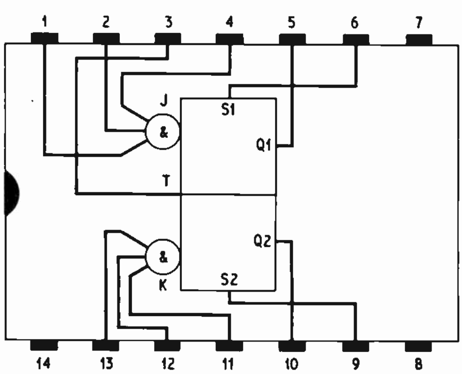


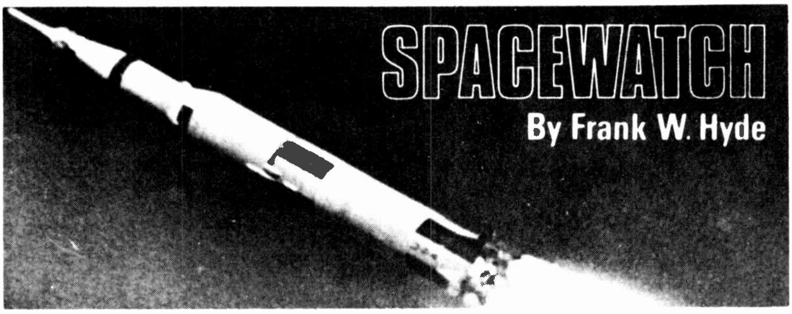
Fig. 5. Logic diagram of XEE. This shows the complete system and indicates the positions of the various gates and i.c.s. Also shown are the JK flip-flop connections for the FCJ101 i.c.s.

i.c.s and remaining electronics. This last supply is maintained by the Zener diode, D2, and its attendant components, R20 and C10.

LOGIC OPERATION

For an overall understanding of the system logic, the reader is referred to Fig. 5. From this it will be noticed that the sensory and control sub-systems have a hierarchy which is ordered effectively from the load-sensing, which takes priority over all except the clock. The random function is the next down the list of priorities, and finally, at the bottom of the list comes the optical sense.

Next month: logic system explanation and constructional details



TOPSIDE SOUNDINGS

Space scientists from the Soviet Union have entered the field of "Topside Sounding" of the ionosphere. The Canadians were the pioneers in this field during the years 1962, 1965 and 1969. They used the *Alouette* and *Isis* satellites for this work.

The Russian satellite, *Cosmos 381*, is in a near circular orbit some 625 miles above the earth. The ionosonde techniques are employed at frequencies between 2·0MHz and 13·4MHz.

Signals are bounced off the outer layers of the ionosphere by sweeping the transmission between the two frequencies. The reflections provide data about the density and distribution of the electrons in the medium and the manner in which these factors vary.

The majority of this work has in the past been done from ground based stations and apart from the Canadian groups the technique of topside sounding has not been very widely applied. The entry of the Russians into this area of observations is another point of co-operation in research.

MONITORING PLATFORMS

The *Explorer-43* spacecraft is in the class of *Explorers* called interplanetary monitoring platforms. They are characterised by the fact that they operate in extremely elliptical orbits from close to the earth at perigee and halfway to the moon at apogee.

Launched on March 13, 1971, the *Explorer-43* moves in a path from 244km at perigee to 206,049km at apogee. Each orbit takes four days and the path traced out will provide a cross section of space weather activity.

Twelve sets of instruments are carried and these have been devised by seven universities and three government departments. The particular combination of sensors that are being flown in this spacecraft has not been used in such a path on a single spacecraft. The sensors will correlate the behaviour of space radiation, solar radiation, magnetic fields, and electric fields.

STAR PROBE

The target for a concentrated attack from observational astronomers has been the object known as Sco X-1. Over some ten years now the study of this peculiar object has yielded data over a wide spectrum. This detailed survey has extended from radio frequencies, infra-red, and optical. To this are added soft and hard X-ray frequencies.

There does not appear to be correlation between the radio and optical observations, in regard to the variation of intensity. In the last search no optical flares appeared and this may be because the object is slowly decreasing in intensity optically, though it continues to be active in the radio region. This lack of correlation between optical and radio measurements suggest that the radio envelope is large compared with the central source and is energised only directly by the X-ray source.

The latest picture that emerges is that of a small dense star in a low density gas which contains many energetic electrons. It has already been established that the falling of this low density gas on to the star can produce energetic X-rays.

NEW DISCOVERY

Much work has been done over the years by astronomers on the evolution of ordinary stars. When something different from the usual appears there is a tendency to dismiss the matter by saying that it is a peculiar object. However, when this happens to what is otherwise a perfectly ordinary star, the matter cannot be so easily dismissed.

Such is the case with the "White Dwarf" star R548. This star has been found to behave somewhat out of character, for it has a periodic variation over a period of some 200 seconds. This new feature was discovered by B. Lasker and J. Hessor of the Chilean observatory at Cerro Tololo.

It was thought by astronomers that the "White Dwarfs" were well understood and previous theories have predicted that any pulsations that might occur would be of the order of once in twenty seconds and could be discounted. The new discovery which shows a rate ten times longer than the predictions may have Pulsar characteristics.

A new name will have to be found, for the term Pulsar is now generally accepted as applying to rotating neutron stars. No doubt there will be a concentration of observations to discover if there are more of these objects.

MOON GAS

Results from the instruments left behind on the Moon by the astronauts indicate that the Moon is far from being dead. Escaping gas has been detected and this may be the cause of moonquakes, or the cracks resulting from moonquakes may allow the gas to escape.

The latest findings come from the instruments left in the Fra Mauro area by astronauts Shepard and Mitchell. The instruments involved are part of the nuclear powered unit in which is included a seismometer and a "cold-cathode" ion gauge.

A burst of gas which occurred on February 22 was thought, by mission control at Houston, Texas, to have been gas escaping from the landing stage of *Antares*, the part of the lunar module that was left behind by *Apollo 14*. This had to be dismissed as the cause, because about 14 hours after the first event another burst of gas was detected. This gas did not disperse for some nine hours.

At the time the second burst was recorded the seismometer nearby showed a moonquake. The gas clouds seem to be directly related to the seismic activity, and it has been noted that the events increase in frequency and intensity every time the Moon makes its closest approach to the Earth. The Earth/Moon system does in fact move in a rather special way; it revolves round what is known as the barycentre, which is about a thousand miles below the Earth's surface.

The result of this interaction of the two masses raises strains in both the Earth and the Moon, and the gravitational stresses set up on the Moon would seem to be the cause of the opening up of the surface of the Moon, allowing the gas to escape. On the other hand, the moonquakes may be the result of the force of the gas escaping.

In order to check this the space centre has asked all observers of the Moon to keep watch in future for signs of a blue glow or any flashes of light. In particular, they were asked to check their records to see if any event was noted at 16.38 GMT on February 22.

There have in the past, long before spaceflights, been many reports by amateurs of seeing such phenomena.

ELECTRONORAMA

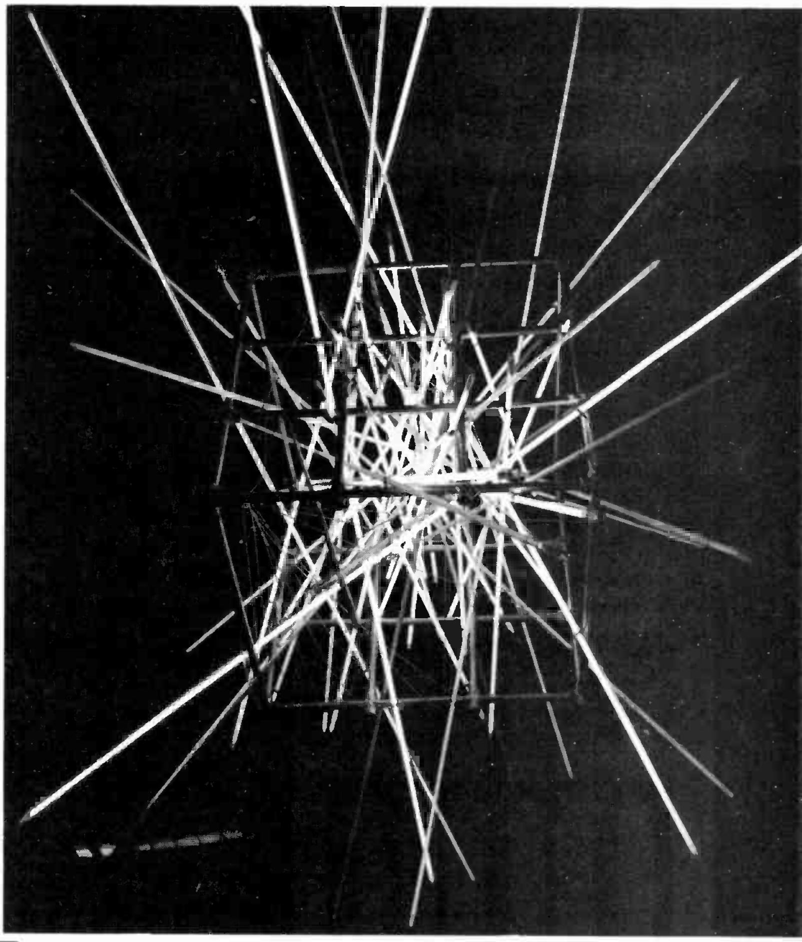
VISITS THE ELECTRIC THEATRE

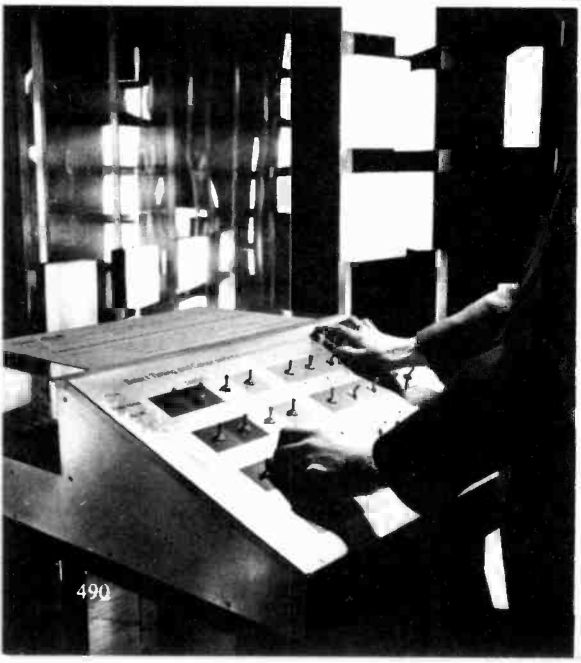
ALL THE world is a stage and the players are merely the people thereon. But the stage setting or scenery can be altered by the players, hence the environment is created. The player in the "Electric Theatre", an exhibition of contemporary creativity at the Institute of Contemporary Arts, was the visitor, but the stage was already set for him.

The environment was sub-divided on two levels to avoid inter-action between the exhibition pieces. The lighting was subdued but sensibly harnessed. Any player with a fear for the unknown was lured into a sense of tranquillity, often directly related to his own actions.

Of course, in a production such as this there are no words, but prompters appear in the form of description cards made available to any player. In some acts sound effects are provided, some of which cannot be described, but they do add to the mysticism of the particular settings.

Electronics played an important role in this venture; without it the effect would have been as of a graveyard in moonlight. The most creditable part of the exhibition was not so much any one particular setting, but in the co-ordination and continuity of all the items into a two-tier production. The visitor on completion of his tour, is brought gradually back to reality through the materialistic, but indispensable cup of tea (or coffee) in the integrated indoor "tea garden", with his environment still influenced by the distant sounds and lights.





Electronic Switching

Creations of lighting effects must be supported by physical structures, some of which were extremely ingenious, others open to perhaps a better interpretation of the idea. Gerry Duff's illuminated opal plastic boxes was a good demonstration of electronic switching at preselected speeds selecting any combination of four colours. The visitor is in full control with a bank of switches bringing in electronic digital circuits. But the method of displaying the lighting could have been more subtle. The plastic boxes were immediately present in a similarly random, but confused arrangement—see photograph left.

The "living room" made use of a geometric structure based on an equilateral triangle. In each of six corners is a small loudspeaker, emitting what seemed like garbled whispering. The sound increases discreetly as the activity of several persons within the area increases. Electronic feedback arrangements control the sound.

Photo-sensitive Shapes

"Soft-boiled egg" is the name of the suspended creation by Roger Dainton involving a tubular steel framework with coloured neon tubes. The apparent movement of coloured light is achieved when the visitor interferes with a photo-electric light beam. A fascinating piece this, but why such a description—see photograph left.

"Super Shadow", by Bruce Lacey, is a clever gimmick which amuses all ages. Here the visitor is being mocked and imitated by a wall of cadmium sulphide photocells which pick up his shadow and cast it aside in lights adjacent to him. The photocells correspond in position to the lights so that the shadow is "reversed" into intense light.

This is bound to make the self-conscious beat a retreat into the adjacent room, where the strains of a Mozart symphony are accompanied by and used to drive our own "P.E. Aurora", commissioned from and created by Mike Leonard. The electronic matrix switching array, designed by Mike Hughes, acted as a useful back-up when mirrored in the walls. The music may seem to be out of context to some, being some 200 years old, but strangely blended to provide a soothing background.

Stereo "Synthi"

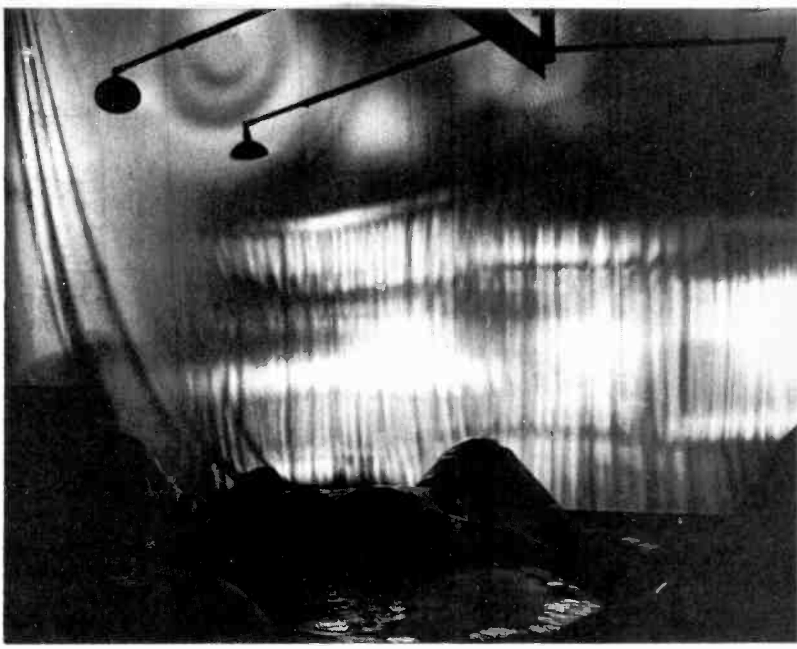
In stark contrast, the back projected light mural (top right) also created by Mike Leonard was accompanied by ultra modern electronic music, pulsating in rhythm and growing in strength, emanating from a stereo tape recording. In character with the setting the sounds, created on the "Synthi VCS3" from Electronic Music Studios (London) Ltd., gave an impression of spaciousness, remote from the down to earth activities outside. An eight minute programme of sound and coloured light was programmed continuously by an electric timer.

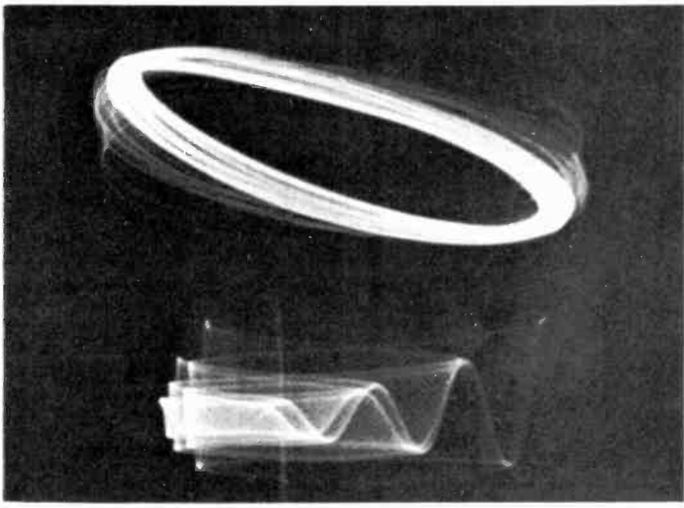
The Gallery

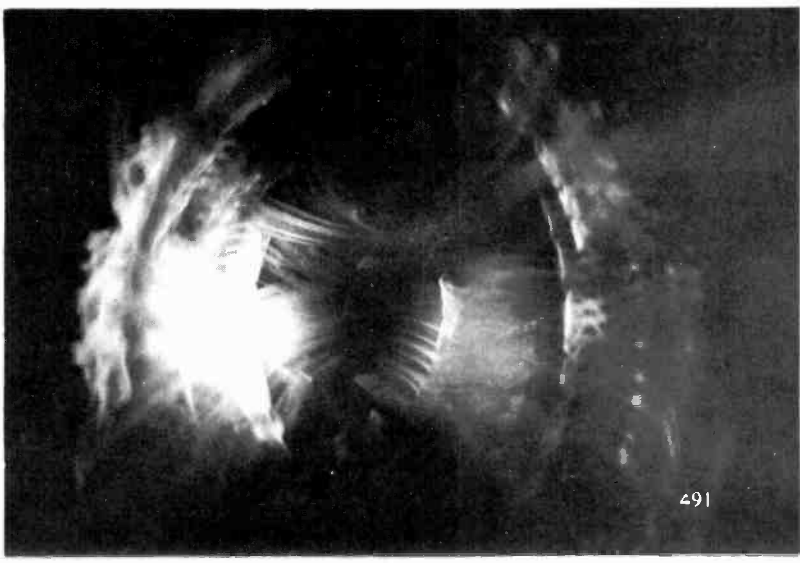
The "Dreamscreen" (bottom right), a form of which is now commercially available, is a large box about 6ft by 4ft by 1ft containing individually styled light reflector heads, which rotate as the lights are turned on at each side. Wispy patterns of changing colour appear at the centre of the screen, while music is fed to thyristor lamp controllers, varying the intensity of light projected. The display can be altered in basic character by operating "colour" and "shape" switches.

Lasers must be the most exciting source of light display recently developed. By modulating the laser, the projected beam can be made to move and produce simple patterns. This was illustrated by a contact board, made from printed circuit board, etched so that contact between the main horizontal "string" on the contacts changed the pitch of the tone fed to the laser, so changing the pattern (centre right).

The organisers of "Electric Theatre" must be complimented for attempting such an exhibition of viewer participation. Let us hope that they may do something like it again sometime and tidy up some of the regrettable gaps in the gallery.







AUDIO TRENDS

By F. C. JUDD

THE first "Sonex" audio exhibition last year at the Skyway Hotel, near London Heathrow airport, which was sponsored by the Federation of British Audio, attracted some 6,000 visitors from the trade and more than 40,000 members of the public and was considered highly successful.

On the strength of this a second exhibition, "Sonex 71", was recently held at the same venue and attracted an even greater number of visitors to see and hear the performance of audio equipment by an even greater number of exhibitors. This year the exhibition occupied nearly 150 rooms on three floors of the hotel.

An hotel room is, as the exhibition organisers put it, "a boon very much appreciated by visitors to an exhibition of sound equipment". What they presumably mean is that visitors can listen to hi fi equipment operating in an acoustic environment closely resembling that of their own living room. Perhaps they should have added—"providing the demonstrators keep the doors closed and the volume controls turned down"!

CASSETTE SYSTEMS

However, those who were able to enjoy demonstrations of the latest in hi fi, with the door closed, were no doubt intrigued by the considerable advancement in the use of tape cassette (or cartridge) systems as a hi fi signal source, the increasing popularity of multiple channel stereo systems, and the integration of noise reduction systems (originating at the Dolby Laboratories) with tape record/replay units now being marketed by various prominent audio manufacturers.

One manufacturer, Bell and Howell, makes the claim that their design 1700 tape cassette unit with a built-in Dolby noise reduction system, has a performance equal to that obtainable from an LP disc record and transcription unit. They even go so far as to question the future of the gramophone record.

The Design 1700 will record with the noise reduction system in use, as well as replay pre-recorded conventional music tapes. The unit is expensive, however, at £106·50 (including purchase tax) and it still requires a hi fi amplifier and speakers for reproduction.

The Wharfedale Dolby DC9 cassette deck also incorporates the Dolby system and will record with noise reduction, or play conventional music tapes that have not been treated for noise. Like other units of its kind it has inputs for microphone and line signal sources such as a radio tuner and takes standard BASF C90 tape cassettes. Recording or replay is quarter-track mono or stereo.

Two of the greatest aids (apart from the Dolby noise reduction system) to achieving hi fi performance from the DC9 tape cassette units is the use of 1 micron head gaps and specially designed tape drive mechanisms, which have enabled wow and flutter to be reduced to better than 0·2% at 7⅞ in/second. The Wharfedale Dolby DC9 unit retails at £115 including purchase tax, but requires an amplifier and speaker system for full replay.

SEEN AT SONEX–71 AUDIO EXHIBITION

Dolby system incorporated in the Bell & Howell type 1700

JVC Nivico MCA V7E four channel stereo amplifier

COMPLETE RECORDER

The only British made complete tape recorder on show at Sonex 71, and a fairly new one at that, was the Brenell Mark 6 stereo unit. It retails at £190·85 and features the new Brenell three motor tape deck with four operating speeds.

The Mark 6 has A-B switching for on- or off-tape monitoring, completely separate stereo record and replay channels, twin VU meters and mixing facilities. The recorder is available for quarter or half-track recording and has an electrical and mechanical performance bordering that expected for professional studio use. The Brenell Mk 6 deck is also available separately with or without tape heads for those who like adding their own electronic equipment.

FOUR CHANNEL STEREO

Now that one can completely surround oneself with sound from a two channel or four channel signal source, it is inevitable that Japanese equipment, such as the Nivico MCA-V7E amplifier would appear. This amplifier has four separate channels, four VU meters and four loudspeaker outputs each capable of providing 50 watts r.m.s. to an 8 ohm loudspeaker.

The amplifier has been designed for signals from four channel pre-recorded stereo tapes and discs and, if the BBC ever get around to it, 4-channel f.m. radio. It features SFC (sound field composer) the function of which the sales leaflet does not make very clear, but with "all systems go" claims to create the acoustic atmosphere of the concert hall in your own living room. This is providing, of course, it is large enough to accommodate the amplifier, four separate loudspeakers and a four-channel tape recorder.

The Nivico Model MCA V7E amplifier brochure can be obtained from Denham and Morley (Overseas) Ltd., Denmore House, 453 Caledonian Road, London, N.7.

"SURROUND STEREO"

Among the Akai products handled by Rank was their new "surround stereo" simultaneous four-track tape recorder—yes four separately useable tracks!

The recorder is designed for operating convenience with vertical tape deck and control panel. Each channel has its own VU meter. Two erase heads are fitted, one two-channel and one full tape width, providing compatibility with two-channel stereo machines. The channels are designated front and rear, left and right, for easy identification. Nominal tape speeds are 7½ and 3¾ in/second at better than 0·15%. Four line output jacks are provided and two headphone jacks. Inputs are available for microphones (0·4mV) and 40mV line.

The recorder is distributed by Rank Audio Products, P.O. Box 70, Great West Road, Brentford, Middlesex. The Akai "surround stereo" recorder model 1730 SS has been designed for operation with their AA 6100 "surround stereo" amplifier, but can be used for conventional mono or two-track stereo recording and playback.

Another four-channel stereo tape system is the Sansui-QS1, which actually has a knob with a position marked "concert hall". The makers call their system a "quadphonic synthesiser" in which the electronics have been designed to simulate all kinds of acoustic listening conditions from normal two-channel stereo to surround sound. The QS1 is a self-contained unit but requires the addition of two stereo amplifiers and four loudspeakers.

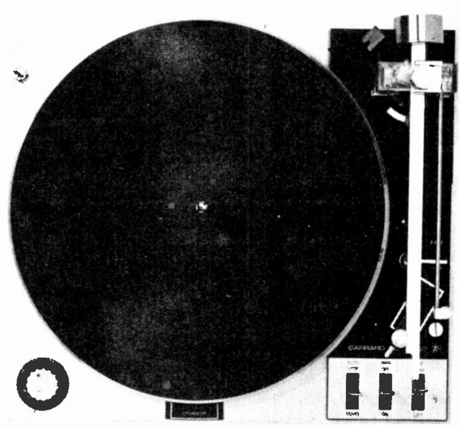
Altogether expensive if you want synthesised sound distribution as well as high quality. Full technical details and prices of matching amplifiers, loudspeakers and tape recorders to use with it are available from Vernitron Limited, Thornhill, Southampton SO9 5QF.

PARALLEL ARM PICK-UP UNIT

A new transcription unit, the Garrard "Zero-100" made its debut at Sonex although it will not be on sale in the U.K. until September. The "zero" means zero tracking error due to a new pick-up arm incorporating a pivoting head. As the arm moves across the record the head pivots, maintaining a true tangential angle to the radius over the whole tracking distance.

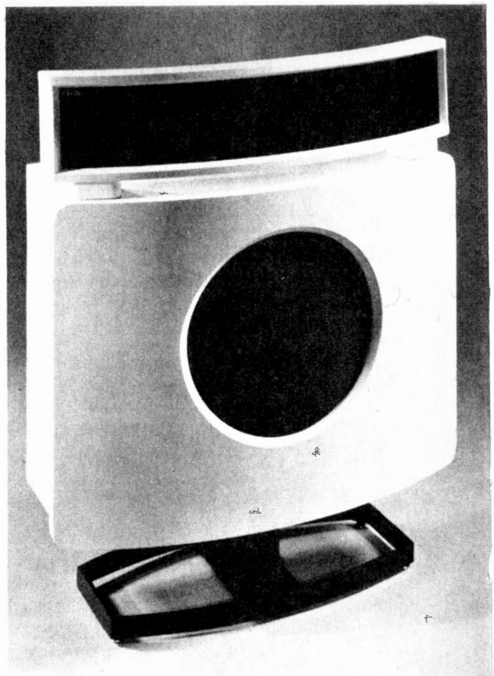
Apart from the elimination of tracking error, the "Zero-100" offers a good overall mechanical perfor-

Akai "Surround Stereo" four channel tape recorder with the matching AA6100 four channel amplifier

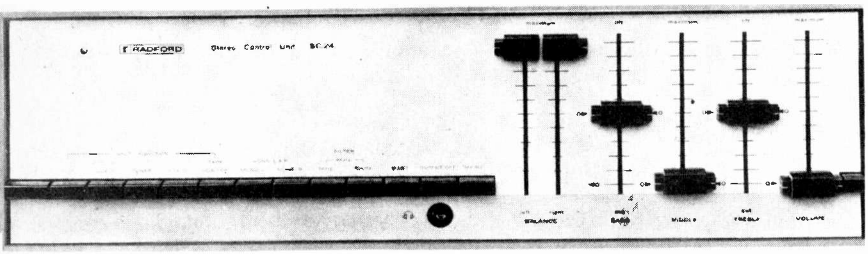


Garrard Zero-100 transcription turntable with parallel arm tangential tracking pick-up

Philips GA308 turntable unit



Bowers and Wilkins B & W Model 70 Continental style with satin white finish



Radford SC24 stereo control unit with slider controls and push button function selection

mance and various other facilities, such as a built-in stroboscope, touch tab controls, automatic play of up to six records, a fine speed control and a wow performance of better than 0·1%. The price has not yet been announced but it looks like being a very popular auto transcription unit, especially suited to package deal systems.

Philips' new two-speed record player GA308 operates at 33 and 45 rev/min. and is supplied with plinth and Perspex cover. It will be available without a cartridge but will accept almost any cartridge with half-inch between fixing screw centres. It will retail at £39 including tax and has a counter-balanced pick-up arm with low friction bearings, a damped lifting and lowering device, and adjustable side thrust compensation. At the end of a record the pick-up arm is raised automatically and the motor is switched off.

Goldring introduced a new turntable unit Model 705/P which uses belt drive and is aimed at the "popular" market.

Cosmocord showed a new ceramic stereo transcription cartridge with a single stylus assembly for fine groove records. This is their type 104 and it will operate with RIAA corrected inputs of low impedance or linear inputs of 1 Megohm impedance.

AMPLIFIERS

Radford were showing a brand new stereo control unit SC24 for use with matching power amplifiers such as their own PA50 or PA25 models. The technical specification of the SC24 is impressive and the control over input signals with regard to selection and correction is fairly extensive. This is a rather expensive product at £80 but then it seems that most of the new and more versatile equipment on show this year was up in the higher price brackets.

One new exhibitor, Amstrad, was catering for those with limited spending with their Stereo 8000 amplifier at approximately £25·95 and their "Apollo 8" matching speaker system for £13·50 per loudspeaker. The amplifier circuitry has been simplified to a considerable degree but the specified performance provides good value within the generally accepted requirements for hi fi. Further details from Amstrad Electronics Limited, 34/35 Great Sutton Street, London, E.C.1.

LOUDSPEAKERS

Following the success of the Ditton 15 and Ditton 25, Rola Celestion showed the new Ditton 120, which received a warm reception at the Audio Fair last October. Also at that Audio Fair, but not found sufficient space at the time was the Bowers and Wilkins (B. & W.) Model 70. It appeared again at Sonex 71, styled into what is called the "Continental" version with satin white finish and pedestal stand. The unit consists of a bass radiator which does show the listener that 40Hz can really be heard. The electrostatic mid- and h.f. range unit on the top of the main cabinet is designed to give excellent results above 400Hz. In all, this is a superb speaker system, as it should be for the price—£159·50, although one should not be detracted from the excellent performance of the B. & W. DM3 at £63 or £69·50 in rosewood or satin white finish.

Poly-planar wafer speakers are a new range of loudspeakers without cones, but which have a wide variety of applications, particularly where space is limited. Details from Highgate Acoustics, 184 Gt. Portland Street, London, W.1.

IN BRIEF

Koss stereo headphones are widely known although fairly expensive. They introduced a new set type K711 at Sonex which are lightweight, have a wide response and are less expensive. Koss headphones are usually of very high quality, this being maintained in the K711, which retails at £10 and will be available through hi fi dealers soon.

The Bib audio accessory range is already comprehensive but Multicore Solders Ltd. introduced another six new items at Sonex. Two recording care kits, a stylus balance, a cassette tape case, high quality splicing tape and a cassette salvage kit.

From Quad (Acoustical Manufacturing Co. Ltd.) a new stereo tuner retailing at £58·00 plus £15·95 purchase tax. This is the FM3 and features MOSFET's and integrated circuits. ★

P.E. AURORA

MUSIC INSPIRED LIGHT AND COLOUR

PART 3 EIGHT-CHANNEL FILTER By M.J. HUGHES M.A.

THE filter unit incorporated in the "P.E. Aurora" controlled light display system has been designed to achieve realistic proportional control of lamp intensity versus audio level and frequency.

It soon becomes apparent after some experimentation that there is considerable difference between the responsive ranges of the ear and the eye, i.e. the ear is able to detect and distinguish small variations in an extremely wide range of audio levels, whereas under normal conditions the eye is only able to differentiate between comparatively wide changes in light level.

8-CHANNEL FILTER

To achieve sufficiently wide variations in light intensity from an audio signal the dynamic range of the light source can be rapidly exceeded. The net result is that audio controlled light sources (as found in some discotheques) tend to drive the lamps on or off with very little control in the linear region between these two states. While the flashing result achieved may very well be acceptable in that environment there are, perhaps, other times when a less violent display is required.

The filter unit to be described here accepts a wide range of audio signals, compresses the dynamic range, separates the amplitudes of the various frequencies into eight discrete channels, and provides a d.c. output level in the order of 0 to 3V from each channel suitable for driving the lamp controller that was described in the last two issues.

Fig. 13 shows the overall filter system in simplified form. The constant level amplifier has a high input impedance, therefore it can be connected to various audio signal sources, although it is recommended that in general the loudspeaker terminals of an amplifier be used. This unit has been used successfully on equipment ranging from a 500mW record player amplifier to the 30W "P.E. Gemini" at full output, using the lamp controller to drive the display.

CONSTANT LEVEL AMPLIFIER

The circuit of the constant level amplifier (or dynamic range compressor) is shown in Fig. 14. Emitter follower TR6 provides a high impedance input; VR3 is a course gain control which has to be adjusted for the equipment in question to ensure that the drive into the base of TR6 is of the order 30 to 500mV (this is the effective range over which the amplifier gives a constant level output).

Transistor TR7 is an f.e.t. which in this circuit operates as a voltage sensitive resistor in series with the base of TR8. It receives its control signal via the

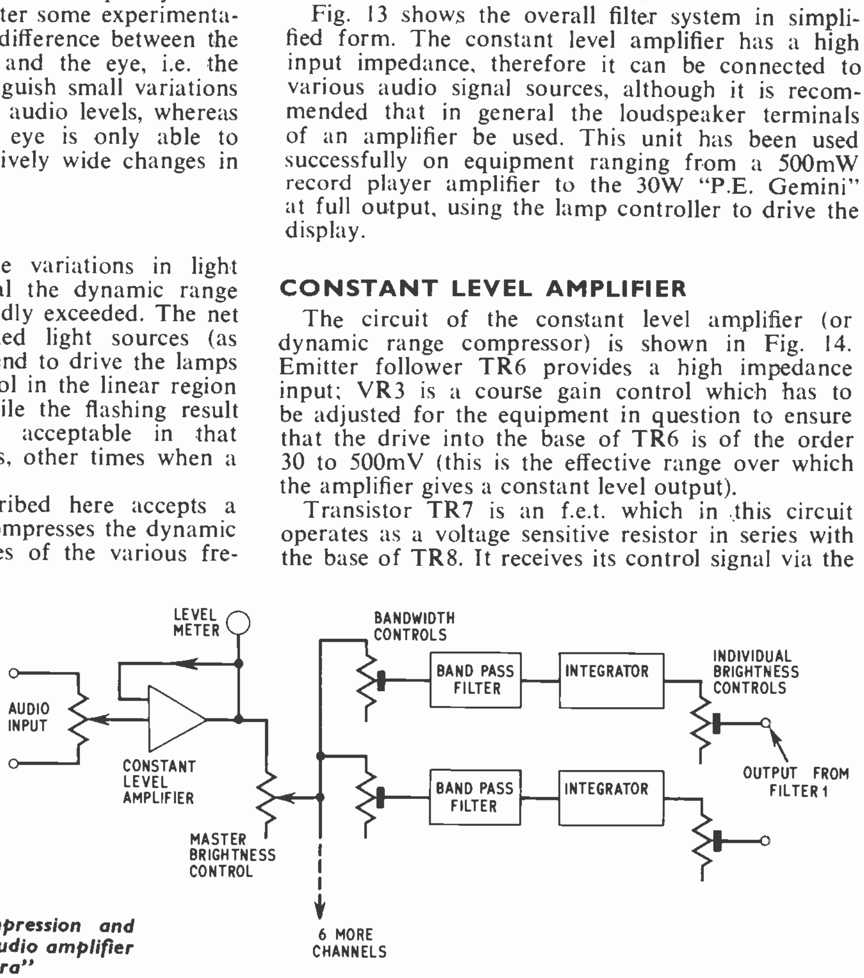


Fig. 13. Block diagram of compression and filtering system used between an audio amplifier and lamp controller for "P.E. Aurora"

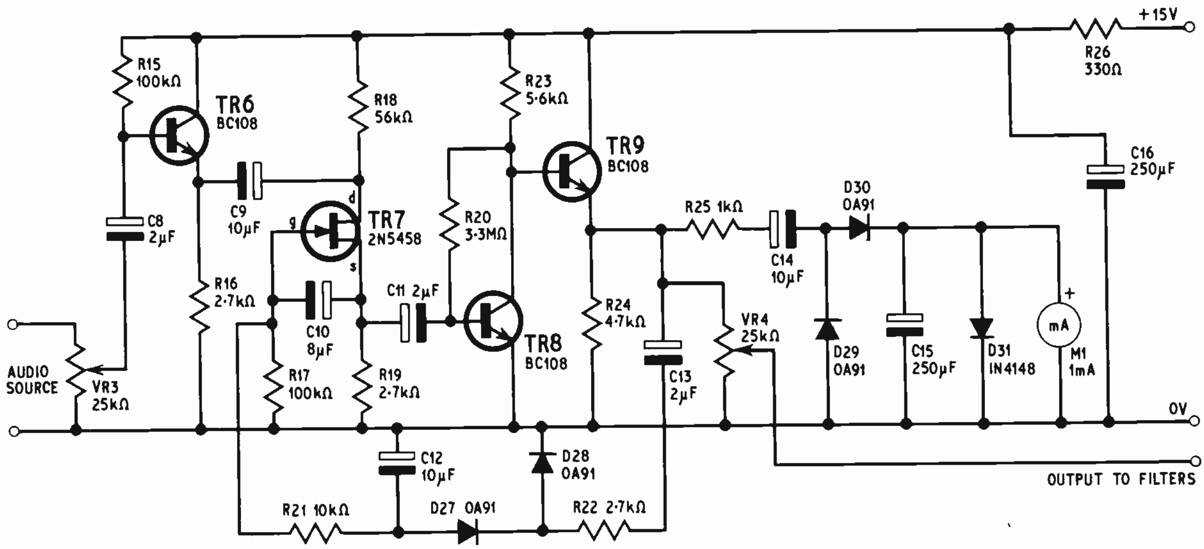


Fig. 14. Constant level pre-amplifier (dynamic range compressor) with level monitoring meter. If desired, the input impedance can be reduced by omitting TR6, R15, C8, R16, and connecting VR3 wiper direct to C9.

feedback loop containing C13, R22, and R21. Diodes D27 and D28 provide a d.c. bias level for TR7. The level of this is integrated by C12 to provide a delay to prevent total loss of signal character (associated with heavy negative feedback).

The more negative the level of the control signal, i.e. the higher the output level, the higher the effective resistance between source and drain of TR7; this, coupled with the shunting effect of R19, reduces the level of audio applied to TR8. If the audio into TR7 falls below 30mV the output level of the whole amplifier falls proportionally, but from 30mV to approximately 500mV the output is more or less constant.

If the input level exceeds 500mV, distortion is likely to occur.

Although not essential it was felt that a monitor of the output level of the amplifier would be useful —especially as the prototype was to be used with a wide variety of amplifier equipment. This is provided by a 1mA meter driven via the detector circuit D29 and D30. Diode D31 is included to provide meter protection in the event of a switch-on surge.

The audio signal at the emitter of TR9 should always have a mean value of approximately 1V. This is greatly in excess of the input requirements of the eight filters, so VR4 is included as an overall brightness level control raising or lowering the signal level to all filters in exact proportion.

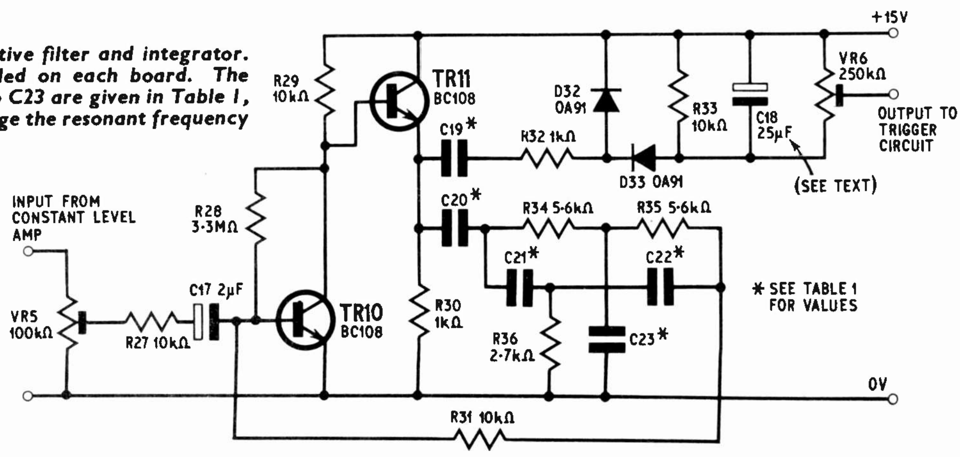
FILTERS

Active parallel-T filters are used to provide very narrow pass bands for the eight sound channels used in the prototype, but of course this can be increased or decreased as desired. Fig. 15 shows the circuit of a single channel; all others are identical apart from the capacitor values in and around the twin-T network.

A proportion of the constant level output of the amplifier is fed to TR10 via VR5 which in effect controls the bandwidth of the filter over a reasonable range. TR11 provides a low output impedance to the feedback loop comprising the twin-T circuit.

The frequency determining components are C21, C22, C23, R34, R35 and R36. The nominal frequency of operation can be calculated at $1/(2\pi CR)$ where R is the value of one of the series resistors in ohms and C is the value of one of the series capacitors in farads. In practice, other components influence the exact frequency of operation, therefore the following

Fig. 15. Circuit of one active filter and integrator. Two of these are assembled on each board. The values suggested for C19 to C23 are given in Table 1, but may be altered to change the resonant frequency of the filter



empirical table may be used in determining values for frequencies other than those suggested (see Table 1).

In determining these values for the capacitors, R34 and R35 were fixed at 5·6kΩ and R36 at 2·7kΩ throughout the range of frequencies. Readers should not expect to obtain frequencies exactly corresponding to those obtained theoretically because with preferred value components and normal production tolerances it is difficult to provide the precise ratio of component values to satisfy the theory for such a circuit.

The filtered audio at the emitter of TR11 is detected by the combination of D32 and D33 and the negative going waveform is integrated by C18 which has a constant bleed R33. The voltage on the negative terminal of C18 is a mean d.c. level corresponding to the amplitude of audio at the frequency of the filter.

If the capacitance of C18 is increased the response time of the circuit will be slower, but produce a more gentle variation of signal level; reducing its value will do the converse and hence will make the lights more prone to "flash" or "strobe" in time with the music. Readers may like to experiment with different values for C18 to see the damping effect on the light display. Some delay is inevitable with C18, so an optimum compromise must be made between display character and delay effects with the value chosen for the type of music to be used.

At peak signal levels (obviously dependent on the settings of VR4 and VR5) the level at C18 can be as high as 3 volts negative with respect to the +15V rail. For linear control the lamp controller requires levels in the range of −0·5 to −1·0V, therefore a preset control VR6 is included to provide a degree of balance in sensitivity between channels.

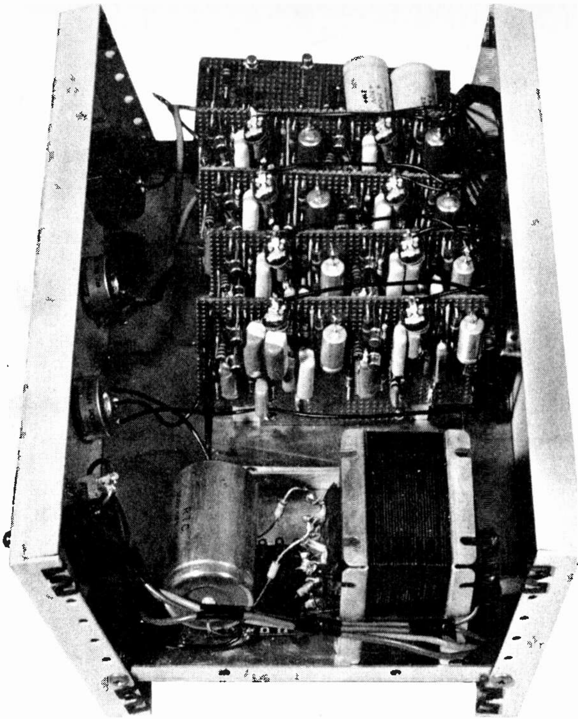
FILTER CHARACTERISTICS

It is worth considering the characteristic of the active filters—the response curves for two frequency bands are shown in Figs. 16a and 16b. It can be seen that the filters respond to fundamentals below the actual tuned frequency.

This is not such a disadvantage as it might seem because, due to the very narrow band of the filter, it is conceivable that in some passages of music the fundamental frequency of the filter might not be hit exactly. This sensitivity to sub-harmonic frequencies provides a degree of overlap although this is not excessive. It can be seen that the relative amplitude of the output decreases by a factor of two (6dB) for each sub-harmonic.

Table 1. CAPACITOR VALUES FOR THE TWIN-T FILTER

Channel	Nominal Frequency (hertz)	Capacitors (μF) C19	C20	C21 & C22	C23
x1	160	0·68	0·68	0·22	0·47
x2	480	0·068	0·47	0·068	0·15
x3	1,100	0·068	0·47	0·033	0·068
x4	2,400	0·068	0·47	0·015	0·033
y1	220	0·22	0·47	0·15	0·33
y2	800	0·068	0·47	0·047	0·1
y3	1,600	0·068	0·47	0·022	0·047
y4	3,700	0·068	0·47	0·01	0·022



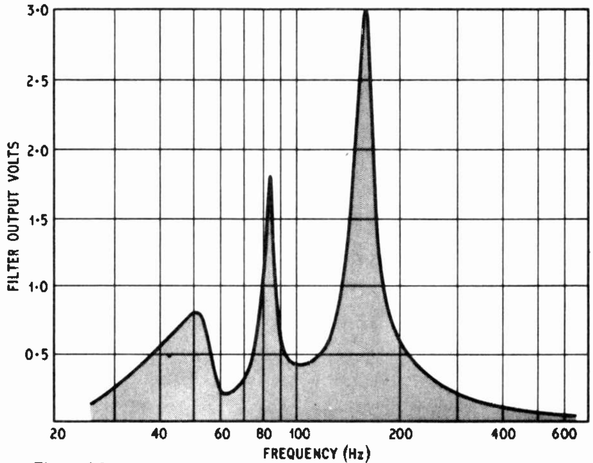


Fig. 16a. Frequency response of 160Hz active filter. The output voltage was measured across C18 as a d.c. level for a constant level sine wave input

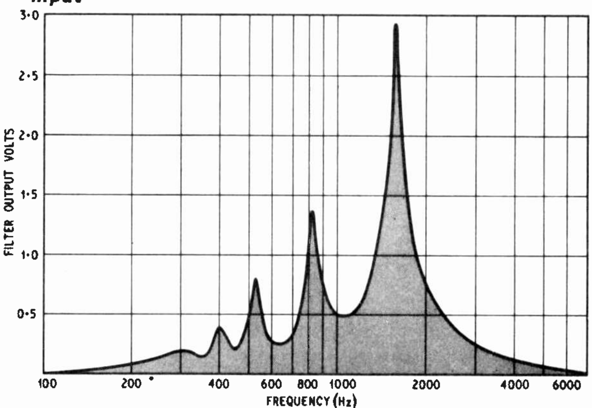


Fig. 16b. Frequency response of 1,600Hz active filter. Both this and the curve above show the relative susceptibility of the filters to lower frequencies

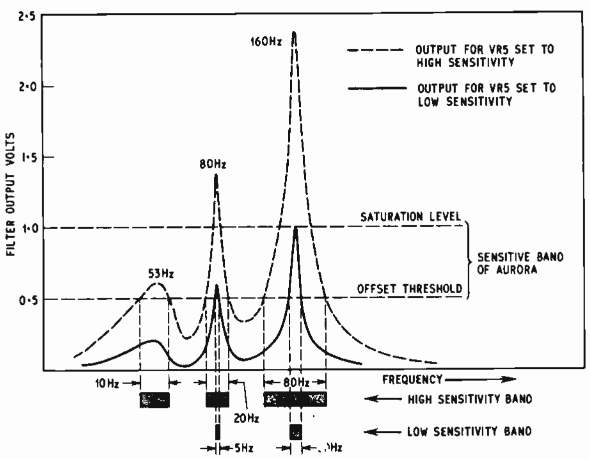


Fig. 17. Relationship between filter sensitivity and bandwidth for the 160Hz active filter

BANDWIDTH CONTROL

As mentioned earlier, VR5 has the effect of varying the effective bandwidth of the filter. This is not quite true in the pure sense. Fig. 17 shows the characteristics of the 160Hz filter for two settings of VR5. This control adjusts the sensitivity of the filter and, due to the high slopes, broadens the band which enters the sensitive voltage band of the light controller.

Naturally when set to high sensitivity (i.e. a broad bandwidth) there will be a tendency to saturate if a frequency exactly on the fundamental of the filter is encountered. Adjustment of VR6 will have a similar effect but is not so dramatic on the bandwidth. When in use both these controls have to be set carefully to ensure a desirable effect. As the effect is purely subjective it is difficult to give precise rules, but one way of setting up will be described later.

POWER SUPPLY

There is no reason why the filter unit should not be run off the same supply as the controller. For the purposes of this article it was felt that some readers might prefer to make the controller first and then use various control circuits as optional extras. Thus it was assumed that the options ought to be entirely self sufficient regarding their power requirements. The supply used on the prototype was the simplest possible (shown in Fig. 18).

If it is desired to use the controller power supply, it would be sensible to introduce a degree of decoupling, but this should not be excessive. If the decoupling introduces more than 0·5V drop into the filter positive supply line, it will be impossible to ensure that the lights go off in the absence of signal. This is due to the coupling arrangement between the filter and the controller, using the positive supply line.

The experienced constructor will realise that this problem can be overcome by placing the series decoupling resistor in the negative supply rail between filter and controller. A reasonable value for this resistor would be approximately 100 ohm and the capacitor approximately 500μF should be across the supply lines of the filter. Having said this, however, the constructional details which follow will assume an independent supply for each unit and no decoupling for the filter itself.

CONSTRUCTIONAL DETAILS

The constructional technique is very similar to that of the controller. The constant level preamplifier and meter drive circuit are assembled on one piece of Veroboard, the layout of which is shown in Fig. 19. Layout is not critical if alternative techniques are used but it should be noted that the audio input lead ought to be screened owing to the relatively high input impedance of the amplifier. Apart from this there should be no troubles using unscreened wire for the remainder of the system.

Two filter channels, together with the integration components, are assembled on each of four boards. Fig. 20 shows the layout. If preferred the circuits may be built individually by ignoring the layout on one side of the dotted line. It should be noted that the wiper connection to VR6 is not soldered to the copper strip on the board but directly to a flying lead taken to the output socket. Some difficulty

COMPONENTS . . .

8-CHANNEL FILTER UNIT

POWER SUPPLY

One of each of following except where stated

Transformer
T3 Mains transformer. Pri. 230V; sec. 12V at 500mA

Diodes
D34 to D37 1N4004 (4 off) or 25V 1A bridge rectifier

Capacitor
C24 5,000μF elect. 25V

Miscellaneous
S2 Double pole, on/off, toggle switch
LP2 Neon indicator with ballast resistor for 250V a.c. mains
Tag component board
3-core mains cable
Contil Mod-2 type C case (West Hyde Developments)

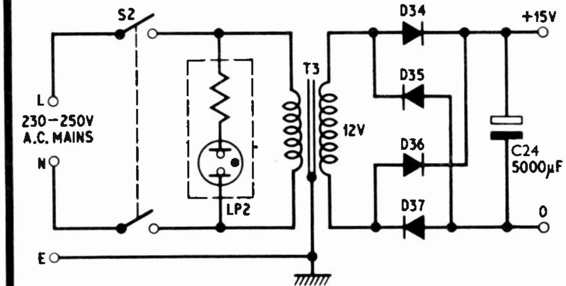


Fig. 18. Suggested circuit for a simple 15V power supply for feeding the filters

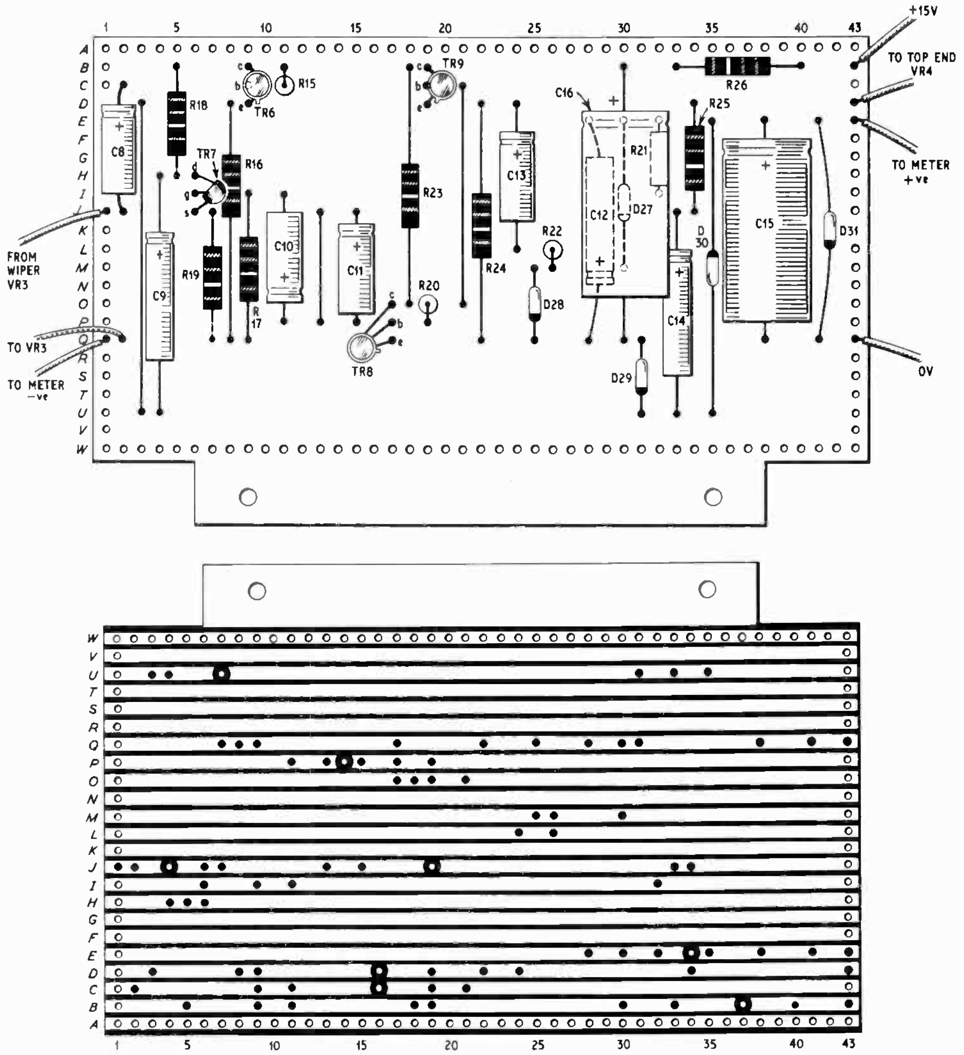


Fig. 19. Layout and wiring of the constant level pre-amplifier on Veroboard H

COMPONENTS . . .

PRE-AMPLIFIER

One of each of the following except where stated

Resistors

R15 100k Ω	R19 2·7k Ω 10%	R23 5·6k Ω
R16 2·7k Ω 10%	R20 3·3M Ω	R24 4·7k Ω
R17 100k Ω	R21 10k Ω 10%	R25 1k Ω
R18 56k Ω	R22 2·7k Ω 10%	R26 330 Ω 10%, ½W

All ±5%, ¼W carbon except where stated

Potentiometer

*VR3 25k Ω linear control
*VR4 25k Ω linear control

Capacitors

C8 2μF elect. 15V	C13 2μF elect. 15V
C9 10μF elect. 15V	C14 10μF elect. 15V
C10 8μF elect. 15V	C15 250μF elect. 25V
C11 2μF elect. 15V	C16 250μF elect. 25V
C12 10μF elect. 15V	

Transistors

TR6 BC108
TR7 2N5458 or any general purpose *n*-channel f.e.t.
TR8 BC108
TR9 BC108

Diodes

D27 to D30 OA91 (4 off)
D31 1N4148 or any small signal silicon type

Miscellaneous

*Veroboard 0·1in matrix 4¼in × 2¾in
*Meter, 1mA "level" indicator
*Knobs for VR3, VR4. 3-pin DIN socket
*Aluminium angle strip for Veroboard

All components above mounted on Veroboard H (Fig. 19) except those shown (*) which are mounted on chassis or case (Fig. 21).

8-CHANNEL FILTER UNIT

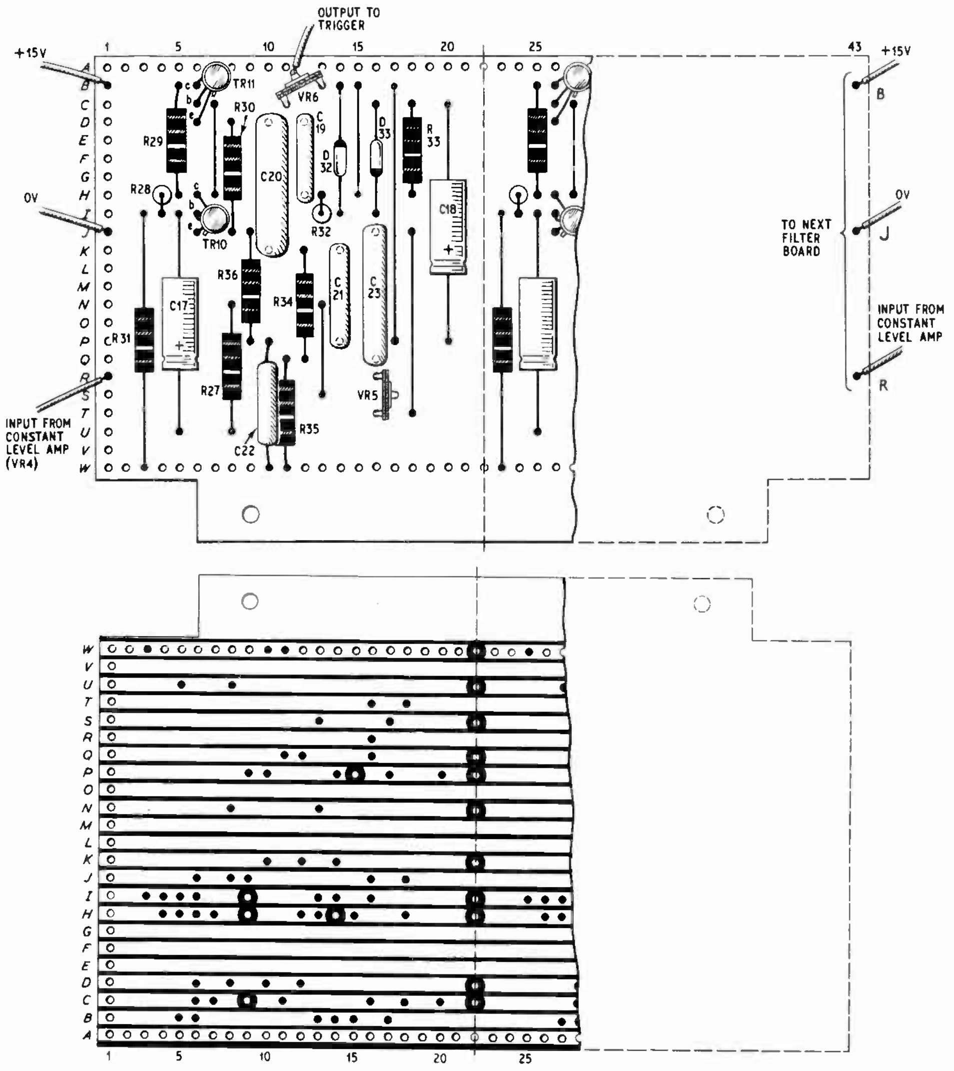


Fig. 20. Layout and wiring of two of the filters on one board

COMPONENTS . . .

FILTER BOARDS

Eight of each of following except where stated

Resistors

R27 10k Ω
R28 3·3M Ω 5%
R29 10k Ω
R30 1k Ω 5%
R31 10k Ω
R32 1k Ω 5%
R33 10k Ω
R34 5·6k Ω 5%
R35 5·6k Ω 5%
R36 2·7k Ω

All ±10%, ¼W carbon except where stated

Potentiometers

VR5 100k Ω skeleton preset miniature
VR6 250k Ω skeleton preset miniature

Capacitors

C17 2μF elect. 15V
C18 100μF elect. 6V
C19 to C23 See Table 1 for values (polyester types)

Transistors

TR10 BC108
TR11 BC108

Diodes

D32 OA91
D33 OA91

Miscellaneous

*Veroboard 0·1in matrix 4¼in × 2¾in (4 off)
*5-pin DIN sockets (2 off)
*Aluminium angle strip for Veroboard

All components above mounted on Veroboards 1 to L, two channels per board (Fig. 20), except those shown (*) which are mounted on chassis or case (Fig. 21).

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TRANSISTORS

BRAND NEW FULLY GUARANTEED DEVICES

AC107	15p	AF115	17p	BC140	35p	BCY31	22p	BF272	80p	EC403	15p	ORP60	40p
AC113	20p	AF116	17p	BC141	35p	BCY32	25p	BF273	30p	GET880	27p	ORP61	40p
AC115	23p	AF117	17p	BC142	45p	BCY33	17p	BF274	30p	MAT100	15p	ST140	12p
AC125	17p	AF118	30p	BC143	40p	BCY34	20p	BF308	35p	MAT101	17p	ST141	17p
AC126	17p	AF124	21p	BC145	45p	BCY70	17p	BF309	37p	MAT120	15p	TIS43	40p
AC127	17p	AF125	20p	BC147	17p	BCY71	30p	BF316	75p	MAT121	17p	UT46	27p
AC128	17p	AF126	20p	BC148	12p	BCY72	15p	BFW10	55p	MPF102	43p	V405A	25p
AC141K	17p	AF127	20p	BC149	17p	BCZ11	20p	BFX29	27p	MPF105	43p	V410A	45p
AC142K	17p	AF139	33p	BC150	17p	BD121	85p	BFX84	20p	OC19	30p	2G301	19p
AC151	15p	AF178	50p	BC151	20p	BD123	85p	BFX85	27p	OC20	50p	2G302	19p
AC154	15p	AF179	50p	BC152	17p	BD124	75p	BFX86	22p	OC22	30p	2G303	19p
AC155	17p	AF180	50p	BC153	27p	BD131	80p	BFX87	25p	OC23	33p	2G304	20p
AC156	17p	AF191	50p	BC154	30p	BD132	80p	BFX88	22p	OC24	45p	2G306	35p
AC157	17p	AF186	45p	BC157	20p	BDY20	£1	BFY50	20p	OC25	25p	2G308	35p
AC165	17p	AF239	37p	BC158	17p	BF115	22p	BFY51	20p	OC26	25p	2G309	35p
AC166	17p	AFZ11	37p	BC159	20p	BF117	45p	BFY52	20p	OC28	40p	2G339	17p
AC167	20p	AFZ12	45p	BC167	13p	BF118	60p	BFY53	17p	OC29	40p	2G339A	15p
AC168	20p	AL102	85p	BC168	13p	BF119	70p	BSX19	15p	OC35	33p	2G344	15p
AC169	14p	AL103	85p	BC169	13p	BF152	35p	BSX20	15p	OC36	40p	2G345	15p
AC176	23p	ASY26	25p	BC170	12p	BF153	35p	BSY25	15p	OC41	20p	2G371	13p
AC177	20p	ASY27	30p	BC171	13p	BF154	35p	BSY26	15p	OC42	22p	2G371B	10p
AC187	30p	ASY28	25p	BC172	13p	BF157	45p	BSY27	15p	OC44	15p	2G374	17p
AC188	30p	ASY29	25p	BC173	13p	BF158	25p	BSY28	15p	OC45	12p	2G377	27p
ACY17	25p	ASY50	25p	BC174	13p	BF159	30p	BSY29	15p	OC70	15p	2G378	15p
ACY18	20p	ASY51	25p	BC175	22p	BF160	30p	BSY38	15p	OC71	9p	2G382	15p
ACY19	22p	ASY52	25p	BC177	17p	BF162	30p	BSY39	15p	OC72	12p	2G401	30p
ACY20	20p	ASY54	25p	BC178	17p	BF163	35p	BSY40	30p	OC74	12p	2G414	30p
ACY21	20p	ASY55	25p	BC179	17p	BF164	35p	BSY41	35p	OC75	15p	2G417	25p
ACY22	19p	ASY56	25p	BC180	20p	BF165	35p	BSY95	12p	OC76	15p	2N388	30p
ACY27	18p	ASY57	25p	BC181	22p	BF167	22p	BSY95A	12p	OC77	25p	2N388A	50p
ACY28	19p	ASY58	25p	BC182	10p	BF173	22p	BU105	£3·90	OC81	15p	2N404	22p
ACY29	30p	ASY58	25p	BC182L	10p	BF176	35p	C111E	60p	OC81D	15p	2N404A	30p
ACY30	25p	ASZ21	40p	BC183	10p	BF177	35p	C400	30p	OC82	15p	2N524	55p
ACY31	25p	BC107	10p	BC183L	10p	BF178	45p	C407	25p	OC82D	15p	2N527	60p
ACY34	18p	BC108	10p	BC184	13p	BF179	50p	C424	17p	OC83	20p	2N696	12p
ACY35	18p	BC109	11p	BC184L	13p	BF180	30p	C425	40p	OC84	20p	2N697	15p
ACY36	30p	BC113	25p	BC186	27p	BF181	30p	C426	30p	OC139	15p	2N698	24p
ACY40	15p	BC114	30p	BC187	27p	BF182	30p	C428	20p	OC140	17p	2N699	55p
ACY41	18p	BC115	30p	BC207	11p	BF183	30p	C441	27p	OC170	15p	2N706	7p
ACY44	35p	BC116	35p	BC209	11p	BF184	25p	C442	35p	OC171	15p	2N706A	8p
AD140	40p	BC117	35p	BC209	11p	BF185	30p	C444	37p	OC200	25p	2N708	12p
AD142	40p	BC118	25p	BC212L	11p	BF188	30p	C450	17p	OC201	27p	1N709	45p
AD149	43p	BC119	45p	BC213L	11p	BF194	23p	C720	12p	OC202	27p	2N711	40p
AD161	35p	BC125	35p	BC213L	11p	BF195	24p	C722	25p	OC203	25p	2N717	42p
AD162	35p	BC126	35p	BC214L	12p	BF196	30p	C740	25p	OC204	25p	2N718	24p
AD161/		BC132	25p	BC225	25p	BF197	35p	C742	17p	OC205	35p	2N718A	50p
162(MP)	63p	BC134	30p	BC226	35p	BF200	45p	C744	17p	OC309	35p	2N726	27p
ADT140	50p	BC135	30p	BC317	12p	BF222	80p	C760	17p	P346A	17p	2N727	27p
ADZ11	£2	BC136	30p	BC318	12p	BF257	35p	C762	17p	P397	45p	2N743	17p
ADZ12	£2·10	BC137	35p	BC319	12p	BF270	25p	C764	60p	OCP71	43p	2N744	17p
AF114	17p	BC139	45p	BCY30	20p	BF271	17p	EC401	15p	ORP12	43p	2N914	17p

2N918	30p	2N2714	25p	2N3704	15p
2N929	22p	2N2904	25p	2N3705	12p
2N930	25p	2N2904A	30p	2N3706	12p
2N1131	20p	2N2905	25p	2N3707	13p
2N1132	22p	2N2905A	30p	2N3708	8p
2N1302	17p	2N2906	25p	2N3709	8p
2N1303	17p	2N2906A	27p	2N3710	10p
2N1304	20p	2N2907	25p	2N3711	10p
2N1305	20p	2N2907A	30p	2N3819	40p
2N1306	22p	2N2923	13p	2N3820	£1
2N1307	22p	2N2924	13p	2N3903	25p
2N1308	27p	2N2925	13p	2N3904	27p
2N1309	27p	2N2926		2N3905	25p
2N1613	17p	(G)	12p	2N3906	27p
2N1711	20p	2N2926(Y)	11p	2N4058	15p
2N1889	35p	2N2926		2N4059	10p
2N1890	45p	(O)	10p	2N4060	12p
2N1893	37p	2N3010	80p	2N4061	12p
2N2160	60p	2N3011	20p	2N4062	12p
2N2147	75p	2N3053	20p	2N5172	12p
2N2148	60p	2N3054	50p	2N5459	43p
2N2192	30p	2N3055	63p	2S034	75p
2N2193	30p	2N3391	17p	2S301	50p
2N2194	27p	2N3391A	20p	2S302A	45p
2N2217	20p	2N3392	17p	2S302	45p
2N2218	25p	2N3393	15p	2S303	60p
2N2219	27p	2N3394	15p	2S304	£1·10
2N2220	22p	2N3395	20p	2S305	£1
2N2221	22p	2N3402	22p	2S306	£1·10
2N2222	27p	2N3403	22p	2S307	£1·10
2N2368	17p	2N3404	32p	2S321	60p
2N2369	15p	2N3405	45p	2S322	50p
2N2369A	15p	2N3414	20p	2S322A	45p
2N2411	50p	2N3415	20p	2S323	60p
2N2412	50p	2N3417	37p	2S324	£1·20
2N2646	55p	2N3525	74p	2S325	£1·20
2N2711	22p	2N3702	12p	2S326	£1·20
2N2712	22p	2N3703	12p	2S327	£1·20

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AA119	8p	BYZ11	32p	OA81	7p
AA120	8p	BYZ12	30p	OA85	7p
BA116	22p	BYZ13	25p	OA90	6p
BA126	22p	BYZ16	35p	OA91	7p
BY100	15p	BYZ17	35p	OA95	7p
BY101	12p	BYZ18	30p	OA200	6p
BY105	15p	BYZ19	25p	OA202	7p
BY114	12p	OA5	17p	SO10	4p
BY126	15p	OA10	22p	SO19	4p
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BY130	15p	OA70	7p	IN916	6p
BYZ10	35p	OA79	8p	IN4148	6p

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Price: 500 £7·50; 1,000 £13

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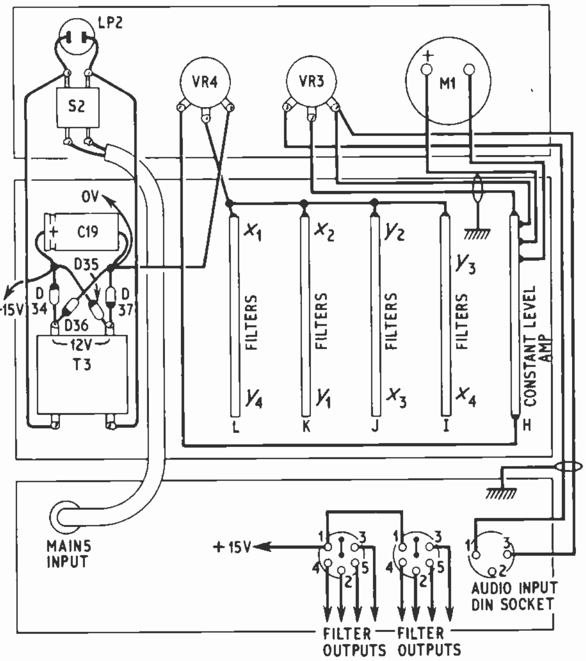
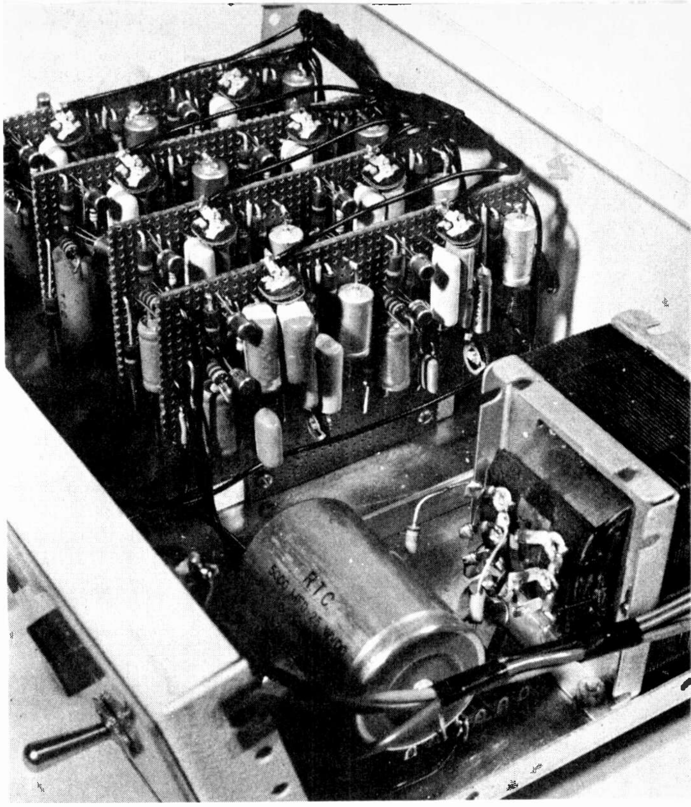


Fig. 21. Layout of chassis and case mounted components with the filter boards



might be encountered in fitting C19 and C20 on to the 160Hz filter board as they are larger components than used in other channels, but careful bending of the leads facilitates this.

Final assembly is made in a Contil Mod-2 type C cabinet. The individual boards are mounted on ⅛in aluminium angle bolted or riveted to the sub-chassis supplied with the case. The layout shown in Fig. 21 shows a blank position; this can be used for any other board that may be required to extend the system.

The output connections from the filter boards are taken to two 5-pin DIN sockets on the rear panel. Pin 1 is commoned to the positive rail and the individual output pins are connected direct to the wipers of VR6. If both output sockets are to be used, only one of the common line connections to +15V through pin 1 on one socket should be used. This will avoid the possibility of hum loop effects. The power supply components are mounted between the mains transformer and a component tagstrip adjacent to it.

It should be noted that while the chassis of the cabinets of both cases are earthed for safety, the common supply line should not under any circumstances be grounded or connected to the chassis. Apart from hindering the operation of the system, a grounded rail might cause damage to the power amplifier which is used to drive the system.

TESTING AND SETTING-UP

The following paragraphs are most important to achieve the best results; apparent poor response can usually be attributed to inadequate or incorrect setting-up.

Undoubtedly an audio signal generator and an oscilloscope would be useful in testing the circuits but nevertheless the following details should be of help to those without these facilities. It is, however, assumed that the reader has access to a simple multivibrator audio frequency square wave generator (if not, a very simple one can be built in a few minutes from details in other articles published from time to time). Ideally, testing should be carried out before the boards are assembled within the cabinet otherwise access to some preset potentiometers may be difficult.

CONSTANT LEVEL AMPLIFIER

The constant level amplifier should be tackled first. Apply power and note any deflection of the meter. There should be no indication apart from perhaps an initial "flick", but after this the meter should settle slowly back to zero.

Set VR3 to maximum sensitivity and touch the finger on the live audio input terminal. Over a period of a few seconds the meter should indicate approximately half scale deflection which is hum pick-up due to an open input.

If a signal generator is to hand, set it for any frequency in the range 100Hz to 5kHz (1kHz is a common reference) and connect across the input terminals. Slowly increase the signal level from zero volts.

Up to an input of approximately 30mV the meter should respond in proportion to the signal but from here on up to approximately 500mV the meter will show half scale deflection. Above 500mV the meter may show a drop back due to clipping and other forms of distortion. This is quite normal.

While carrying out this test allow time for the meter needle to stabilise as it is very heavily damped by C15 and may take a second or two to display the correct level.

FILTERS

Now connect the output of the pre-amplifier through VR4 to each of the filters in turn. Set VR4 and VR3 halfway and the signal generator to an output of 500mV (approx)—the meter should still show half scale deflection.

Connect a voltmeter (4V full scale) across the wiper of VR6 and the positive rail and set VR6 to maximum (i.e. wiper is at negative end of track).

Adjust the frequency of the generator to match that of the filter; set VR5 to maximum sensitivity. The voltmeter should now read up to approximately 3V, but if not, slowly adjust the frequency of the generator until this happens. It should be found that a full output of 3V is obtained for reasonable wide frequency ranges.

Now try reducing the sensitivity by adjusting VR5. The same 3V should still be obtained but over a narrower range of frequencies. It is difficult at this stage to set the bandwidth because we have no visual indication of any subjective effect; nevertheless it is worth setting VR5 approximately halfway as a start point.

Tune the generator to give maximum output at VR6 and then reduce the output level by adjusting the latter until the voltmeter reading is approximately 1·5V.

This procedure should be carried out for each filter in turn, and when satisfactorily completed, permanently wire each board into the case. In the prototype the outputs of the 160, 480, 1,100 and 2,400Hz filters were taken to one socket (for the x-axis on the matrix system) and the 220, 800, 1,600 and 3,700Hz to the other (for the y-axis).

IN-LINE OPERATION WITH THE LAMP CONTROLLER

It was explained in the articles on the lamp controller that there are two modes of operation of the lamp controller and lighting display: (a) in-line and (b) in-matrix. Operation in-line is the simplest when all that is necessary is to connect each output of the filter unit to a corresponding channel on the lamp controller. Eight light channels can thus be controlled each one reacting to the amplitude output of its associated filter. In this mode setting up is fairly straightforward.

Connect the input of the filter unit to the loudspeaker terminals of the amplifier (no effect of loading on the audio output should be noticed) and switch on both the filter unit and the controller. All the manual controls of the controller should be turned down, as should the front panel controls of the filter unit.

Feed an audio signal (e.g. from a record) into the amplifier and set the volume of the amplifier to normal listening level; slowly turn up VR3 until the meter reads half scale then test the effect of the constant level amplifier by varying the volume of the main amplifier to extreme limits.

If necessary readjust VR3 until the meter continuously reads half scale throughout the full range of volume level. Obviously there are practical limits to this setting and the best compromise should be accepted.

High quality amplifiers might exceed the range of control owing to their wide dynamic range. It is stressed that adjustment of VR3 should be carried out slowly because it takes a few seconds for the integrating components within the system to respond.

Having set VR3 (which is much quicker than this explanation might suggest) slowly advance VR4 until the lamps start to respond to the audio signals. The level of VR4 should be set so that on the loudest signals the lamps should just be fully on.

It is now necessary to carry out a final adjustment to the preset control on the top of the filter boards.

Firstly, adjust VR5 to a low sensitivity so that it will just about maintain some response from the lamps (this has the effect of reducing the bandwidth and will ultimately give the best frequency discrimination between filters). While doing this the level of illumination from the lamps will diminish; this can be recovered by adjustment of VR6.

Careful adjustment of each of these components for each filter will produce completely different balance and colour movement effects and some experimentation is worthwhile. Once set for a particular amplifier it is not necessary to readjust this balance unless, of course, a completely different overall effect is required. Under normal circumstances occasional adjustment of VR3 and VR4 allow for wide variations in amplifier volume and overall brightness required from the lamps.

MATRIX OPERATION WITH THE LAMP CONTROLLER

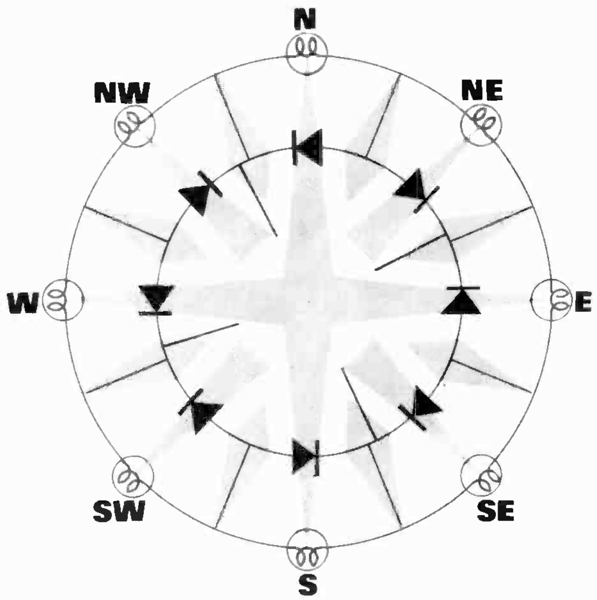
When operating in matrix mode there are many alternatives open to the user. One which can be used immediately is to matrix frequency bands on one axis against frequency bands on the other by feeding alternate filters (in ascending order) to the X and Y of the controller. If the DIN sockets have been wired up exactly as explained this must happen. To obtain any output at the lamps we must ensure a signal on both the X and Y axes at the same time. If the filter pass bands are too narrow we might be so selective in frequency that this is unlikely to happen, hence it is necessary to broaden the pass bands by increasing the sensitivity of each filter using VR5.

Another method of operation in matrix mode is to use four of the filters feeding, say, the X axis of the display. The four possibilities of Y axis could be represented by sets of lamps spacially separated and by using the manual Y axis controls it is possible to select (at the turn of a knob) any set of lamps to respond to the audio and at the same time the maximum level of illumination is set by the level of the manual control. Naturally in this mode it is possible to have all the Y controls set to maximum in which case the user will have four sets of four lamps operating identically.

FINALLY

This equipment has been designed to give a gentle variation in light level and although some sense of music rhythm will be seen through the display, this is not too harsh to the eyes. If a more dramatic effect is required (e.g. for discotheques) the integrating capacitor on each filter should be reduced in value (for example to 10μF) but the best value will be found by experiment. If too fast a response is obtained the matrix mode of operation might not be satisfactory owing to the fact that there may not be coincident signals on both the X and Y axes when operating frequency versus frequency.

Next month: Some ideas and suggestions on lighting effects in conjunction with the electronic system so far described.



WIND DIRECTION INDICATOR

By C. RICHMOND

A DISADVANTAGE of most ordinary windvanes is that one has to be in a position to see them! It is not very pleasant looking up through a rainstorm and trying to estimate which way the vane is pointing. To get round this, the windvane can be arranged to drive some form of indicator which can be put in a handy position indoors. One obvious possibility is a magslip or similar generator on the mast, connected to a compass-type repeater indoors. However, this arrangement is relatively complicated and expensive and the components are not easily obtainable by the experimenter.

Another possibility is to use an ordinary single pole 12 way switch, connected to eight neon indicator lamps as shown in Fig. 1. The switch is modified so that it can rotate freely, rather than clicking round between stops.

If the neons all have resistors included, resistor R1 will not be needed, but if they do not have resistors, R1 will serve for all of them since only one neon is alight at any time.

The value of R1 is not critical, say 100kΩ; it is chosen to give a reasonable brightness. Its value will depend on the operating voltage of the neons, and on the supply voltage, which may be 100 to 250 volts a.c. or d.c.

However, this system needs a 9 core cable between the mast head unit and the indicator. Such cable could be expensive if a long distance is involved and care must be taken with the installation because of the voltage concerned and the all weather capability of the unit; hence a second system was devised.

ULTIMATE SYSTEM

This system uses low voltage bulbs and switching and only requires a 6 core cable between mast head and display.

Let us deal with the indicator end first. Small filament lamps are used, which are brighter than neons. They are connected in series in a ring as shown in Fig. 2, with a diode across each, alternating in polarity. Any type of diode which will pass the bulb current (in the forward direction) will do.

In the prototype 6 volt 0·06 amp bulbs are used, and ZS10A diodes—simply because these were to hand, and will pass a current of 100 milliamps in the forward direction.

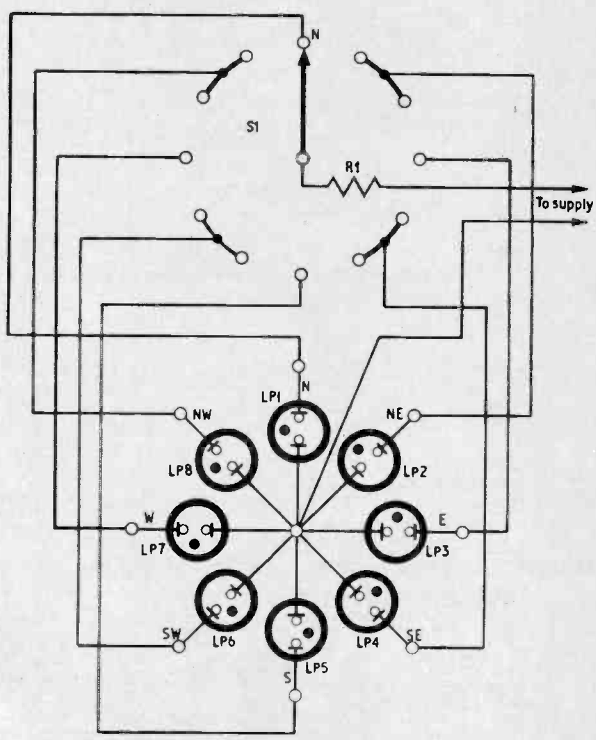


Fig. 1. Original system using Neon indicators

If 6 volts d.c. is applied between A and B, only one of the bulbs will light, depending on whether A or B is positive. The other bulb is, in effect, shorted by its diode. The remaining six bulbs will have less than two volts across each and so will not be visibly lit. It is quite easy now to arrange the switching system to apply 6 volts across AB, BA, BC, CB, CD, DC, DA, AD, as necessary to light the appropriate bulb.

The switch, shown in Fig. 3, has two wafers, each one pole, 12 way, modified for easy rotation by removing the spring position selector either by cutting it off or bending it free.

The switch connections are as shown in Table 1; the four leads marked A, B, C and D go to A, B, C and D respectively, on the indicator unit (Fig. 2).

POWER SUPPLY

A further two leads, from the switch poles, go to the supply. A 6 volt battery could be used for the supply, but if the unit is to be left on continuously such a battery would not last long. Hence a small 6V filament transformer and rectifier is used to produce the necessary voltage from the mains supply, see Fig. 4.

It is not necessary to smooth the rectified output and the supply does not need to be anywhere near the indicator or the mast head unit. The power

TABLE 1

Switch Position		positive pole	negative pole
N	1	B	A
NE	2	A	B
	3	A	B
E	4	C	B
SE	5	B	C
	6	B	C
S	7	D	C
SW	8	C	D
	9	C	D
W	10	A	D
NW	11	D	A
	12	D	A

supply should be mounted in a metal case and wired up as shown in Fig. 5. The display could be incorporated in the lid of this case.

MAST HEAD UNIT

To weatherproof the mast head unit, the prototype switch was installed in a small aluminium screw top tin mounted upside down. The connecting cable

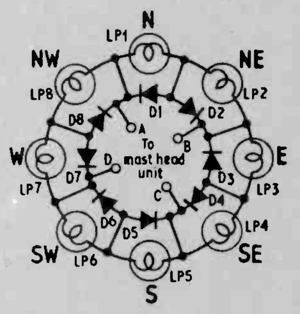


Fig. 2. Indicator system using low voltage bulbs and a four way connection to the mast head unit

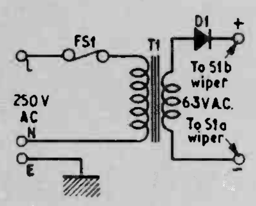


Fig. 4. Simple mains power supply for the low voltage bulbs

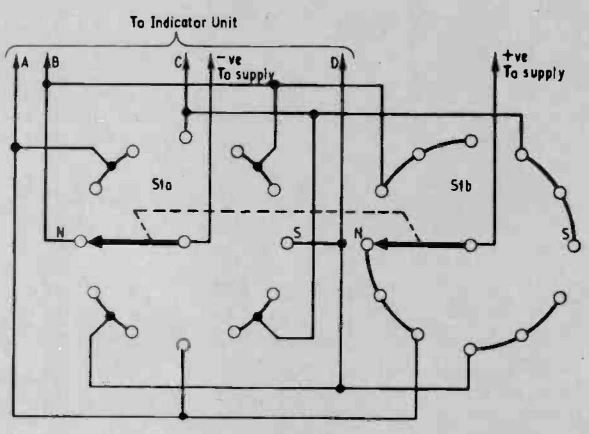


Fig. 3. Wiring diagram of the mast head unit switch for the indicator shown in Fig. 2

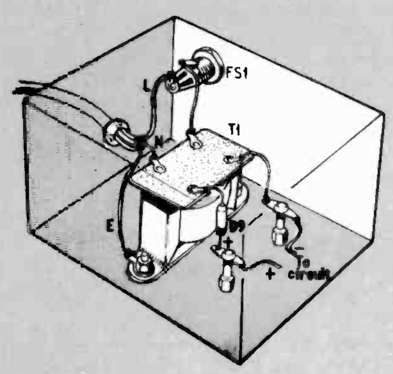


Fig. 5. Wiring diagram of the power supply mounted in a metal case

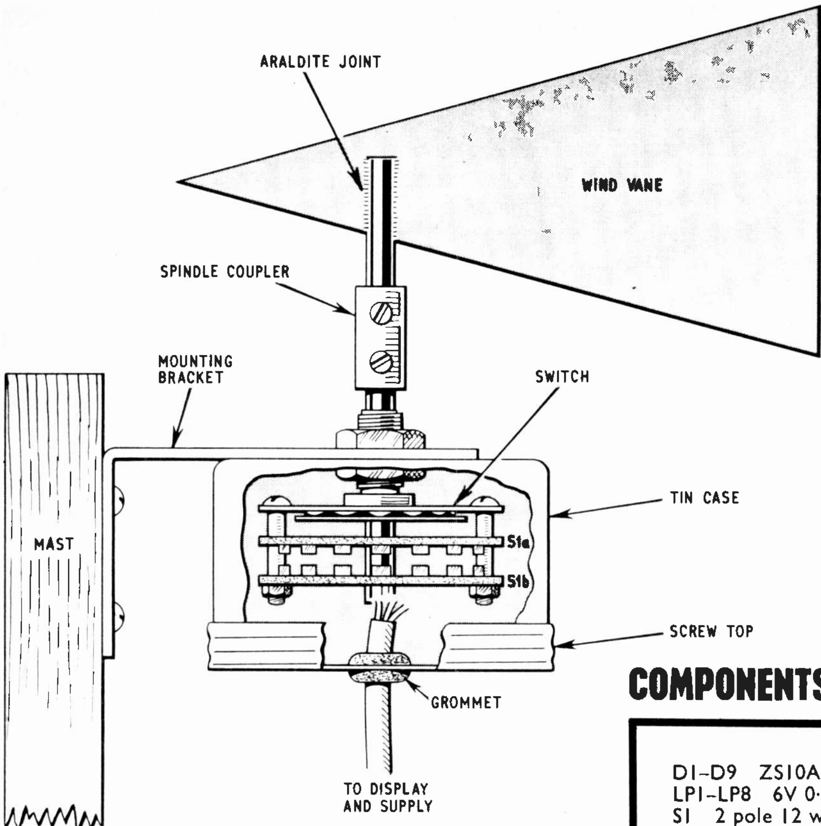


Fig. 6. Construction of the mast head unit—for wiring of S1 see Fig. 3

COMPONENTS . . .

D1–D9 ZS10A diodes (9 off)
LP1–LP8 6V 0·06A bulbs and holders (8 off)
S1 2 pole 12 way wafer switch
T1 mains transformer, secondary 6·3V at 100mA
FS1 100mA fuse
Spindle coupler
Metal case for supply and indicator lamps
Small screw top tin for mast head unit case
Mounting bracket
Metal for wind vane
Mains cable, 3 core. Connecting cable, 6 core, length as required

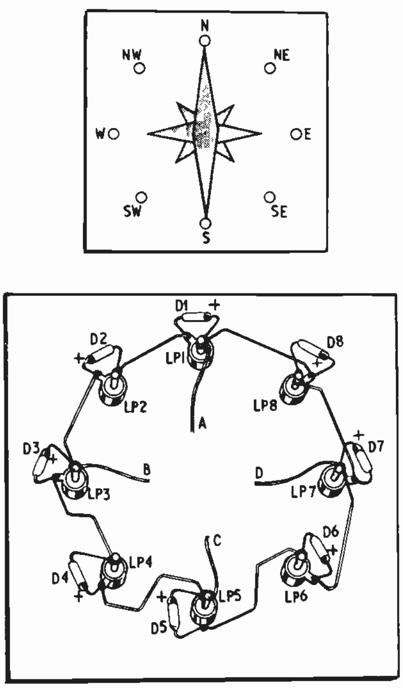


Fig. 7. Wiring of the indicator, wires A, B, C and D go to the corresponding positions on the mast head unit

is led out through a grommet in the lid (Fig. 6). The switch spindle bush should be greased before installation.

A standard ¼ inch spindle coupler joins the switch shaft to the vane, which can be whatever design one likes, so long as it is large enough to rotate the switch in light airs, and is not so heavy as to distort the tin when it is mounted to the mast. All metal parts should be painted, before using the unit, to protect them from the elements.

INDICATOR

The indicator bulbs can be mounted on a suitable panel in any way one likes and labelled N, NE, E, SE, S, SW, W, and NW, corresponding to LP1, 2, 3, etc. Such a display is shown in Fig. 7.

The mast head unit must be lined up so that the correct bulbs come on as the vane is turned. This is easily accomplished by aligning the vane to point to the north—using a small compass—and revolving the tin and switch until the lamp indicating "N" comes on. The tin can then be fixed to its permanent mounting either by a large capacitor type clip or by a bracket as shown in Fig. 6. ★

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200	0·05	0·09	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·23	0·34	0·45	1·85
800	0·10	0·17	0·13	0·25	0·37	0·55	2·00
1000	0·11	0·25	0·15	0·30	0·46	0·63	2·50
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Q25	6 IN914 sil. diodes 75PIV 75mA	0·50
Q26	8 OA95 germ. diodes sub-min. 1N69	0·50
Q27	2 10A 600PIV sil. rects. IS45R	0·50
Q28	2 Sil. power rects. BYZ13	0·50
Q29	4 Sil. trans. 2 × 2N696, 1 × 2N697, 1 × 2N698	0·50
Q30	7 Sil. switch trans. 2N706 NPN	0·50
Q31	6 Sil. switch trans. 2N708 NPN	0·50
Q32	3 PNP sil. trans. 2 × 2N1131, 1 × 2N1132	0·50
Q33	3 Sil. NPN trans. 2N1711	0·50
Q34	7 Sil. NPN trans. 2N2369, 500MHZ	0·50
Q35	3 Sil. PNP TO-5 2 × 2N2904 & 1 × 2905	0·50
Q36	7 2N3646 TO-18 plastic 300MH2 NPN	0·50
Q37	3 2N3053 NPN sil. trans.	0·50
Q38	7 PNP trans. 4 × 2N3703, 3 × 2N3702	0·50
Q39	7 NPN trans. 4 × 2N3704, 3 × 2N3705	0·50
Q40	7 NPN amp. 4 × 2N3707, 3 × 3N3708.	0·50
Q41	3 Plastic NPN TO-18 2N3904	0·50
Q42	6 NPN trans. 2N5172	0·50
Q43	7 BC107 NPN trans.	0·50
Q44	7 NPN trans. 4 × BC108, 3 × BC109	0·50
Q45	3 BC113 NPN TO-18 trans.	0·50
Q46	3 BC115 NPN TO-5 trans.	0·50
Q47	6 NPN high gain 3 × BC167, 3 × BC168	0·50
Q48	4 BCY70 NPN trans. TO-18	0·50
Q49	4 NPN trans. 2 × BFY51, 2 × BFY52	0·50
Q50	7 BSY28 NPN switch TO-18	0·50
Q51	7 BSY95A NPN trans. 300MH2	0·50
Q52	8 BY100 type sil. rect.	1·00
Q53	25 Sil. & germ. trans. mixed all marked new	1·50

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BP02 = 7402	Quadruple 2-input positive NOR gates	0·23	0·20	0·15
BP03 = 7403	Quadruple 2-input positive NAND gates (with open-collector output)	0·23	0·20	0·15
BP04 = 7404	Hex Inverters	0·23	0·20	0·15
BP10 = 7410	Triple 3-input positive NAND gates	0·23	0·20	0·15
BP13 = 7413	Dual 4-input Schmitt trigger	0·35	0·32	0·29
BP20 = 7420	Dual 4-input positive NAND gates	0·23	0·20	0·15
BP30 = 7430	8-input positive NAND gates	0·23	0·20	0·15
BP40 = 7440	Dual 4-input positive NAND buffers	0·23	0·20	0·15
BP41 = 7441	BCD to decimal nixie driver	0·87	0·77	0·67
BP42 = 7442	BCD to decimal decoder (4–10 lines, 1 of 10)	0·87	0·77	0·67
BP47 = 7447	BCD-seven-segment decoder/drivers (15V outputs)	1·40	1·30	1·20
BP50 = 7450	Expandable dual 2-input and-or-invert	0·23	0·20	0·15
BP51 = 7451	Dual 2-wide 2-input and-or-invert gates	0·23	0·20	0·15
BP53 = 7453	Quad 2-input expandable and-or-invert	0·23	0·20	0·15
BP54 = 7454	4-wide 2-input and-or-invert gates	0·23	0·20	0·15
BP60 = 7460	Dual 4-input expander	0·23	0·20	0·15
BP70 = 7470	Single-phase J-K flip-flop	0·35	0·32	0·29
BP72 = 7472	Master-slave J-K flip-flop	0·35	0·32	0·29
BP73 = 7473	Dual master slave J-K flip-flop	0·43	0·40	0·37
BP74 = 7474	Dual D type flip-flop	0·43	0·40	0·37
BP75 = 7475	Quad latch	0·47	0·45	0·43
BP76 = 7476	Dual J-K with pre-set and clear	0·47	0·45	0·43
BP80 = 7480	Gated full adders	0·87	0·77	0·67
BP81 = 7481	16-bit read/write memory	1·35	1·25	1·15
BP82 = 7482	2-bit binary full adders	1·30	1·20	1·00
BP83 = 7483	Quad full adder	0·87	0·77	0·67
BP86 = 7486	Quad 2-input exclusive or gates	0·80	0·70	0·60
BP90 = 7490	BCD decade counter	0·87	0·77	0·67
BP91 = 7491	8-bit shift registers	1·21	1·00	0·87
BP92 = 7492	Divide-by-twelve counters	0·87	0·77	0·67
BP93 = 7493	4-bit binary counters	0·87	0·77	0·67
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BP95 = 7495	4-bit up-down shift register	0·87	0·77	0·67
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BP151 = 74151	8-bit data selectors (with strobe)	1·40	1·30	1·20
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BP191 = 74191	Binary counter reversible	3·50	3·25	3·00

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

NOTE THESE PRICES

I.C's DTL 930 SERIES LOGIC

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

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

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

Pak No.		Pak No.	
UIC930 = 12 × μA 930	50p	UIC948 = 8 × μA 948	50p
UIC932 = 12 × μA 932	50p	UIC951 = 5 × μA 951	50p
UIC933 = 12 × μA 933	50p	UIC961 = 12 × μA 961	50p
UIC935 = 12 × μA 935	50p	UIC9093 = 5 × μA 9093	50p
UIC936 = 12 × μA 936	50p	UIC9094 = 5 × μA 9094	50p
UIC944 = 12 × μA 944	50p	UIC9097 = 5 × μA 9097	50p
UIC945 = 8 × μA 945	50p	UIC9099 = 5 × μA 9099	50p
UIC946 = 12 × μA 946	50p	UIC×925 Assorted 930 Series	£1·50

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

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UIC00 = 12 × 7400N	50p	UIC42 = 5 × 7450N	50p	UIC80 = 5 × 7480N	50p
UIC01 = 12 × 7401N	50p	UIC50 = 12 × 7450N	50p	UIC82 = 5 × 7482N	50p
UIC02 = 12 × 7402N	50p	UIC51 = 12 × 7451N	50p	UIC83 = 5 × 7483N	50p
UIC03 = 12 × 7403N	50p	UIC60 = 12 × 7460N	50p	UIC86 = 5 × 7486N	50p
UIC04 = 12 × 7404N	50p	UIC70 = 8 × 7470N	50p	UIC90 = 5 × 7490N	50p
UIC05 = 12 × 7495N	50p	UIC72 = 8 × 7472N	50p	UIC92 = 5 × 7492N	50p
UIC10 = 12 × 7410N	50p	UIC73 = 8 × 7473N	50p	UIC93 = 5 × 7493N	50p
UIC20 = 12 × 7420N	50p	UIC74 = 8 × 7474N	50p	UIC94 = 5 × 7494N	50p
UIC40 = 12 × 7440N	50p	UIC75 = 8 × 7475N	50p	UIC95 = 5 × 7495N	50p
UIC41 = 5 × 7441AN	50p	UIC76 = 8 × 7476N	50p	UIC96 = 5 × 7496N	50p

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

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

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ST4	30	PNP Germ. VHF-2G407L—AF117—OC170 uncoded	1·00
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ST9	30	2N708 NPN Sil. Trans.	1·00
ST10	30	BSY28 NPN Sil. Trans.	1·00
ST11	25	2N3703 PNP Sil. Trans.	1·00
ST12	25	TIS48—2N2368 NPN 400m/cs	1·00
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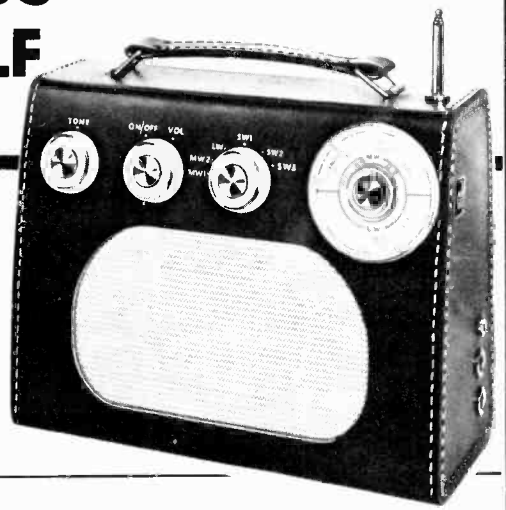

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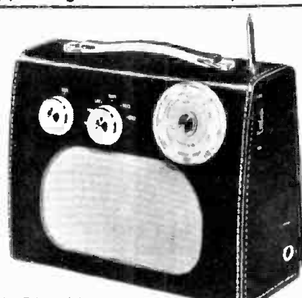

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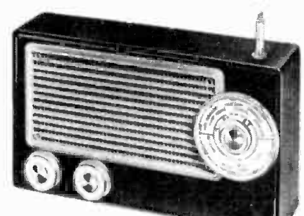

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Attractive case in black with red grille and black knobs and dial with spun brass inserts. Size 9 × 5½ × 2½in. approx. Tunable on Medium and Long Waves, 3 Short Waves and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial 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).

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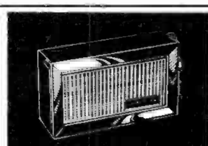

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER

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Total building costs £2·23

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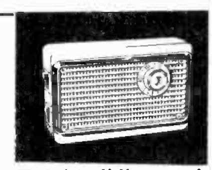

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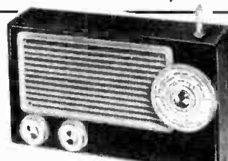

SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive black case with red grille and black knobs and dial with spun brass inserts. Size 9 × 5½ × 2½in. approx. Tunable on Medium and Long Waves, two Short Waves, Trawler Band plus an extra M.W. band for easier tuning of Luxembourg, etc. Sensitive ferrite rod aerial and latest telescopic aerial for Short Waves. Improved circuit. 8 stages—6 transistors and 2 diodes including Micro-Alloy R.F. Transistors, etc. Easy build plans and parts price list 10p (FREE with parts).
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2N1306	25p	BC135	30p	GET882	25p
2N1307	25p	BC136	35p	MAT100	25p
2N1308	30p	BC137	40p	MAT101	30p
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2N2904	30p	BCY31	30p	MPF105	40p
2N2904A	32p	BCY32	50p	NKT213	25p
2N2905	37p	BCY33	25p	NKT214	15p
2N2906	30p	BCY34	30p	NKT216	37p
2N2906A	32p	BCY38	40p	NKT217	40p
2N2907	37p	BCY39	60p	NKT277	20p
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2N3011	25p	BCY41	15p	NKT404	62p
2N3053	25p	BCY42	15p	OA5	20p
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2N3704	17p	BCY72	15p	OA79	10p
2N3705	15p	BCY78	30p	OA81	10p
2N3707	15p	BCY79	30p	OA85	12p
2N3709	12p	BCZ10	35p	OA90	10p
2N3710	12p	BCZ11	40p	OA91	7p
2N3819	35p	BD112	50p	OA95	7p
2N3820	60p	BD121	65p	OA200	7p
2N4058	17p	BD123	80p	OA202	10p
2N4061	15p	BD124	62p	OC16	50p
2N5457	35p	BD125	50p	OC20	97p
2N5458	37p	BD131	75p	OC22	50p
2N5459	50p	BD132	85p	OC23	60p
2S301	50p	BD153	62p	OC24	60p
2S302	50p	BD156	57p	OC25	37p
2S303	60p	BDY10	£1·25	OC26	25p
2S304	75p	BDY11	£1·62	OC28	62p
40250	50p	BDY17	£1·50	OC29	62p
40361	55p	BDY18	£1·75	OC35	50p
40362	60p	BDY19	£1·97	OC36	62p
AAY30	10p	BDY61	£1·25	OC41	25p
AAY42	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	15p
AC128	25p	BF167	25p	OC72	25p
AC176	25p	BF170	35p	OC73	30p
AC187	30p	BF173	30p	OC74	30p
AC188	30p	BF177	40p	OC75	25p
ACY17	30p	BF178	25p	OC76	25p
ACY18	25p	BF179	40p	OC77	40p
ACY19	25p	BF180	37p	OC81	25p
ACY20	22p	BF181	37p	OC82	25p
ACY21	22p	BF182	32p	OC83	25p
ACY22	17p	BF184	25p	OC84	25p
ACY39	50p	BF185	25p	OC139	25p
ACY40	15p	BF194	17p	OC140	37p
AD140	50p	BF195	15p	OC141	62p
AD149	50p	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	OCP71	97p
AF127	17p	BFX30	32p	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	40p	BFX88	30p	ZTX503	20p
AF239	42p	BFY18	30p	ZTX531	30p
ASY26	25p	BFY50	22p		
ASY27	32p	BFY51	20p		
ASY28	25p	BFY52	22p		
ASY29	30p	BFY53	17p		
ASY67	47p	BFY64	42p		
ASZ21	42p	BFY90	65p		
BA115	7p	BSX20	17p		
BA164	10p	BSX21	37p		
BAX13	6p	BSX76	15p		
BAX16	7p	BSY95	15p		
BAY31	7p	BSY95A	15p		

DISCOUNTS
10% 12+
15% 25+
20% 100+
Any one type

LARGER QUANTITIES PHONE EXTN: 4.

HENRY'S LOW COST INTEGRATED CIRCUITS

WE OFFER FROM STOCK AN EXCLUSIVE RANGE OF BRAND NEW CERAMIC FULL SPECIFICATION LOW COST TTL 7400 RANGE OF INTEGRATED CIRCUITS

Part No.	Description	Price 1–49	Price 50–99	Price 100+	Price 500+
7400	Quad 2—Input Nand Gate	25p	20p	18p	15p
7401	Quad 2—Input Nand Gate Open Collector	25p	20p	18p	15p
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
7440	Dual 4-Input Buffer Gate	25p	20p	18p	15p
7441	BCD To Decimal Decoder and NIX Driver	£1·00	90p	80p	75p
7442	BCD To Decimal Decode (TTL)	£1·00	90p	80p	75p
7450	Dual 2-Input And/Or/Not Gate—Expandable	25p	20p	18p	15p
7453	Single 8-Input And/Or/Not Gate—Expandable	25p	20p	18p	15p
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
7473	Dual Master Slave JK Flip Flop	45p	40p	35p	30p
7474	Dual D Flip Flop	45p	40p	35p	30p
7475	Quad Bistable Latch	£1·00	90p	80p	75p
7476	Dual Master Slave Flip Flop With Preset	50p	45p	40p	35p
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
7493	Divide by 16. 4 Bit Binary Counter	£1·00	90p	80p	75p
7494	Dual Entry 4 Bit Shift Register	£1·00	90p	80p	75p
7495	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)
Larger quantity prices, Extn. 4. Dual Inline 14-pin Sockets 30p each. 16-pin 35p each.

TRIACS GENERAL ELECTRIC

(All stud mounting)

Type	P.I. Volts	Current	1–49	50+	100+	500+
SC35A	100	3A	90p	75p	65p	60p
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	£1·35	£1·20
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
SC50E	500	15A	£2·25	£2·00	£1·75	£1·55
DIAC ST2			20p			

Larger Quantity Prices on Application, Ext. 4.

SILICON RECTIFIERS

1 AMP MINIATURE WIRE ENDED PLASTIC RECTIFIERS

Type	P.I.V.	1–49	50 +	100 +	500 +	1000 +
IN4001	50	8p	7p	6p	5p	4p
IN4002	100	9p	8p	7p	5½p	4½p
IN4003	200	10p	9p	7½p	6p	5p
IN4004	400	10p	9p	8p	7p	6p
IN4005	600	12p	10p	9p	7½p	7p
IN4006	800	15p	14p	12p	11p	9p
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

POTTED BRIDGE RECTIFIERS (SILICON) SIZE ½in × ½in × ½in

Type	P.I.V.	Current	1–49	50+	100+	500+
1002	100	2A	60p	55p	50p	45p
2002	200	2A	70p	65p	60p	55p
4002	400	2A	80p	75p	70p	65p
1004	100	4A	70p	60p	55p	50p
2004	200	4A	75p	70p	65p	60p
4004	400	4A	80p	75p	70p	65p
6002	600	2A	90p	80p	75p	70p
6004	600	4A	90p	80p	75p	70p
1006	100	6A	75p	70p	65p	60p
2006	200	6A	80p	75p	70p	65p
4006	400	6A	£1·10	£1·00	90p	80p
6006	600	6A	£1·25	£1·10	£1	90p

R.C.A. INTEGRATED CIRCUITS—LINEAR TYPES

CA3005	£1·20	CA3035	£1·25
CA3011	75p	CA3036	90p
CA3012	90p	CA3039	85p
CA3014	£1·45	CA3041	£1·10
CA3018	£1·20	CA3043	£1·40
CA3020	£1·25	CA3044	£1·25
CA3021	£1·55	CA3046	85p
CA3023	£1·25	CA3048	£2·25
CA3026	£1·00	CA3051	£1·35
CA3028A	£1·20		

Data notes 10p (Ref. No. 30)

INTEGRATED CIRCUITS

PA246	5 Watt	£2·65
TAA263	Mullard	75p
TAD100	Mullard	£2·00
TAD110	Mullard	£2·00
MC1303	Motorola	£2·60
UL900	Fairchild	40p
UL914	Fairchild	40p
UL923	Fairchild	60p
LA709C	Fairchild	75p
MC1304	Motorola	£2·75

ZENER DIODES

400M/W 5% MINIATURE
BZY88 range all voltages 3·3V–33V 15p each
25 + 12p
100 + 10p
500 + 9p
1000 + 8p
any one type

1 WATT 5% PLASTIC WIRE ENDS
6·8V all voltages to 100V 25p each
25 + 20p
100 + 18p
500 + 16p
1000 + 15p
any one type

3 WATT PLASTIC WIRE ENDS 5%
All voltages 6·8–100V 30p each
25 + 27p
100 + 25p
500 + 23p
1000 + 21p
any one type

7 WATT STUD MOUNTING 5%
All voltages 5·1V–100V 40p each
25 + 35p
100 + 30p
any one type

POWER RECTIFIERS

SILICON RECTIFIERS STUD MOUNTING 6 AMP RANGE

	P.I.V.	1–49	50+	100+
BYZ10	800	40p	35p	30p
BYZ11	600	35p	30p	25p
BYZ12	400	30p	25p	20p
BYZ13	200	25p	20p	17p
10 AMP RECTIFIERS				
SK103	100	45p	40p	37p
SK203	200	50p	45p	42p
SK403	400	55p	50p	45p
SK603	600	60p	55p	50p
SK803	800	75p	70p	65p
15 AMP RECTIFIERS				
SL1	100	55p	50p	45p
SL2	200	60p	55p	50p
SL4	400	65p	60p	55p
SL6	600	75p	70p	65p
SL8	800	90p	85p	80p

SEMICONDUCTORS

LOOK AT THESE PRICES FOR QUANTITIES FROM STOCK

AF114 Mullard 25p
25 + 20p
100 + 17p
500 + 15p

AF116 Mullard 25p
25 + 20p
100 + 17p
500 + 15p

2N3055 75p
Mullard 115W Silicon Power
25 + 55p
100 + 50p

BFY90 65p
1000MC/S
25 + 60p
100 + 55p
500 + 50p

AF139 30p
Siemens V.H.F.
25 + 25p
100 + 22p
500 + 19p

OC170 Mullard 25p
25 + 21p
100 + 17p
500 + 15p

OC171 Mullard 30p
25 + 27p
100 + 22p

BY127 20p
Mullard 1,000V 1 amp Plastic
25 + 17p
100 + 15p
500 + 13p

BC113 SGS 25p
25 + 20p
100 + 17p
500 + 15p

OA202 10p
SILICON Diodes
25 + 8p
100 + 6p
500 + 5p
1000 + 4p

OC42 Mullard 30p
25 + 25p
100 + 23p
500 + 21p
1000 + 18p

OC45 Mullard 15p
25 + 13p
100 + 12p
500 + 10p
1000 + 8p

OC75 Mullard 25p
25 + 21p
100 + 17p
500 + 15p
1000 + 13p

OC20 97p
Mullard 100V
25 + 85p
100 + 80p
500 + 75p

OC44 Mullard 17p
25 + 15p
100 + 13p
500 + 11p
1000 + 10p

OC139 Mullard 25p
25 + 20p
100 + 17p
500 + 15p

OC81 Mullard 25p
25 + 20p
100 + 17p
500 + 15p

AF115 Mullard 25p
25 + 20p
100 + 17p
500 + 15p

AF117 Mullard 25p
25 + 20p
100 + 17p
500 + 15p

2N3819 Texas 35p
25 + 30p
100 + 25p
500 + 23p
1000 + 20p

2N2646 50p
Motorola Unijunction
25 + 44p
100 + 37p
500 + 33p

AF186 40p
Mullard V.H.F.
25 + 35p
100 + 30p
500 + 25p

BYZ13 25p
Mullard 6A 200V
25 + 20p
100 + 17p
500 + 15p

BC107, BC108 BC109 12p each
I.T.T. Planars
25 + 11p
100 + 10p
500 + 8p
1000 + 6p

OCP71 97p
Mullard Photo
25 + 85p
100 + 80p
500 + 75p

OC28 62p
Mullard Power
25 + 55p
100 + 50p
500 + 42p
1000 + 40p

OC71 Mullard 15p
25 + 12p
100 + 10p
500 + 8p

ORP12 Mullard 50p
25 + 45p
100 + 42p
500 + 40p

2N930 25p
25 + 23p
100 + 20p
500 + 17p
1000 + 15p

OC72 Mullard 25p
25 + 20p
100 + 17p
500 + 15p
1000 + 13p

OC83 25p
25 + 20p
100 + 17p
500 + 15p
1000 + 13p

OC84 25p
25 + 20p
100 + 17p
500 + 15p
1000 + 13p

AF239 42p
25 + 35p
100 + 30p
500 + 25p
1000 + 20p

HENRY'S RADIO LTD. SEMI-CONDUCTOR DEPARTMENT
303 EDGWARE RD., LONDON, W2. TEL: 01-723 1008/9
CALLERS 356 EDGWARE ROAD W2.

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We respectfully ask customers to include a minimum £1.00 per order, it helps to plan ahead & saves postage as well.

500K. EDGEWISE CONTROL POT-METER. Morganite, approximately 1¼in dia. useful size and standard replacement in many TV sets, 12p; £1·20 per doz.

PRE-SET POT METERS—with integral bakelite control knob, all by Morganite, Welwyn or similar quality makers. Standard size (approximately 1in dia.) suitable for pre-set or variable circuits. Low values are wire wound. The following values are in stock. 22ohm, 33ohm, 300ohm, 1K, 5K, 50K, 100K, 10p each; £1 per doz.

1 WATT TRANSISTOR AMPLIFIER. Japanese made, very good quality, panel size approx. 5½ × 2in, 5 transistor, 3–8ohm output, operated from 9V battery or from mains with 12V transformer, £1·25.

SEE AND BE SEEN WITH A THORN DIP DIM UNIT. Designed to dip headlights, 12V 50/40 watt or 65/45 watt and 6V 45/35 or 36/36 watts. Supplied complete with simple instructions and wiring diagram, not suitable for vehicles with sealed ignition system or a diesel powered vehicle without a master switch. Comprises of relay coil with switch in metal can and limiting resistor, mounted on metal chassis with one hole fixing. 75p.

30 SECOND DELAY UNIT. This requires 24V a.c. or d.c. to operate. A higher or lower voltage would decrease or increase the delay time within limits. The switch, which is isolated from the operating voltage, is normally open and closes after delay. It will remain closed for a period of 30 to 60 seconds depending upon how long the delay voltage is applied and the external condition which delays cool down. Made by A.E.I., these have many uses, i.e. to delay switching on fan of central heating switching until the boiler has properly fired. Price 75p. If you wish to delay the switching off instead of the switching on then use a relay. We can supply suitable one at 62p.

MAINS SOLENOID OPERATED WATER VALVE. Normally closed opens when activated. Nylon body as used in many automatic washing machines. The mains solenoid is completely embedded in a resin jacket thus making it absolutely waterproof. Many uses include automatic control of plant watering. Model 1 for 2 small hose connectors, Model 2 for one small and one large hose connector. Price 95p. £10 per dozen.

MAINS SOLENOID OPERATED WATER VALVE. Normally open, closes when activated. This is made by Asco their type No. 8030 A2. This is a heavier and somewhat superior water valve with an all metal body suitable for connecting in line with ⅜in pipe. The solenoid is not waterproofed but is enclosed in a metal casing with ⅝in conduit entry. To facilitate electrical connection the solenoid casing may be rotated through 360 deg. Well made, should give years of trouble free service. Price £1·75, post and insurance 30p.

AMPLIFIER MAINS TRANSFORMER, 50V 1½ AMP. Upright mounting with fixing brackets and metal shrouds to contain magnetic field, 50Hz primary, tapped 110V, 117V, 210V, 230V and 250V. Two secondaries, one 50V, 1½ amp, other 6V 1 amp for pilot light, etc. £2·50, postage 30p.

MAINS TRANSFORMER, 25-0-25V 2 amps, 50 c.p.s. primary tapped 200/250V, in 10V steps. Separate screen, 2 secondaries, one 25-0-25V, at 2 amps and the other 110V, at 10 MA. Open construction with mounting feet. £2·25, post 30p.

MULTI-RANGE TEST METER. Handy slip-in-your-pocket size, but angled movement gives wide easily read scale, 8 ranges, d.c. volts 0–15–150–1000, a.c. volts 0–15–150–1000, OC current 0–150MA. Resistance 0–100k. A very well made tester, 100-o.p.v. ideal for most jobs. Japanese made, of course, and very robust. Buy one of these and save your expensive instruments for precision jobs. Price £2, post and insurance 20p.

AIR SPACED TUNING CONDENSER 2 gang with slow motion spindle (standard ¼ size). Exact capacity not known, but estimated at approximately 300 p.f. and 250 p.f. 45p. £5 per doz.

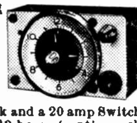
MICRO SWITCH. REFERENCE RW18. An ultra sensitive switch operated by spring lever only slightest pressure needed to operate. Contacts rated at 10 amps. Price 20p.

PUSH BUTTON SWITCH. TYPE 14 D.M.G. A very fine switch made by Honeywell. The switch is intended for mounting on panel through oblong hole. No screws required for fixing, it's sprung clips secure it quite firmly. The operating button is approximately 1in dia, round and dished for ease of operation. Has 2 sets of 10 amp c/o contacts. Sprung loaded, returns to normal when pressure released. Ideal for instrument or quality gear. Price 40p. £4 per doz.

12V FLUORESCENT LIGHT. This uses 12in 8 watt tube, is energised by transistor inverter thus gives maximum light for minimum battery drain. Ideal for caravan, boat or van interior light. Not a kit, but made up on aluminium body and ready to install. Complete with tube £4, post 20p.

SEW-TRIC PUMP MOTOR. Very powerful series wound so easily controllable from speed point of view, size 3½in × 3in approx. For mains working, price £1·75 plus 30p post and insurance.

20 AMP ELECTRICAL PROGRAMMER



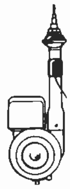
Learn in your sleep: Have Radio playing and kettle boiling as you awake—switch-on lights to ward off intruders—have warm house to come home to. All these and many other things you can do if you invest in an Electrical Programmer. Made by the famous Smiths Instrument Company. This is essentially a 230/240 volt mains operated Clock and a 20 amp 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 5¾ × 3¾ × 2¼in. deep. Metal encased, glass fronted with chrome surround. Offered at £2·40 plus postage and insurance 23p.

INSTRUMENT SWITCHES

Miniature ⅝in. dia. wafers, silver plated 5 amp. std. ¼in. 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	33p	33p	33p	33p
2 poles	60p	60p	60p	60p	60p	33p	33p	55p	55p
3 poles	60p	60p	60p	60p	£1	55p	55p	75p	75p
4 poles	60p	60p	60p	£1	£1	55p	55p	95p	95p
5 poles	60p	60p	£1	£1	£1·40	75p	75p	£1·15	£1·15
6 poles	60p	£1	£1	£1	£1·40	75p	75p	£1·35	£1·35
7 poles	60p	£1	£1	£1·40	£1·80	95p	95p		
8 poles	£1	£1	£1	£1·40	£1·80	95p	95p		
9 poles	£1	£1	£1	£1·40	£2·20	£1·15	£1·15		
10 poles	£1	£1	£1·40	£1·80	£2·20	£1·15	£1·15		
11 poles	£1	£1·40	£1·40	£1·80	£2·60	£1·35	£1·35		
12 poles	£1	£1·40	£1·40	£1·80	£2·60	£1·35	£1·35		

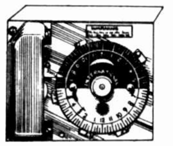
AUTO-ELECTRIC CAR AERIAL



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

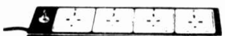
INTEGRATED CIRCUIT BARGAIN

A parcel of integrated circuits made by the famous Plessey Company. A one-in-a-lifetime offer of Micro-electronic devices well below cost of manufacture. The parcel contains 5 ICs all new and perfect, first-grade device, definitely not sub-standard or seconds. 4 of the ICs are single silicon chip GP amplifiers. The 5th is a monolithic NPN matched pair. Regular price of parcel well over £5. Full circuit details of the ICs are included and in addition you will receive a list of many different ICs available at bargain prices 25p upwards with circuits and technical data of each. Complete parcel only £1 post paid. *DON'T MISS THIS TERRIFIC BARGAIN.*



24-HOUR TIME SWITCH

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, 5 amp changeover contacts will switch circuit on or off during these periods. £2·50, post and ins. 23p. Additional time contacts 50p pair.

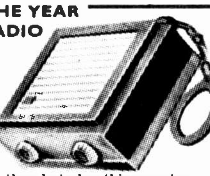


DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 7 feet of heavy cable. Wired up ready to work, £2 less plug, £2·25 with fitted 13 amp plug; £2·40 with fitted 15 amp plug, plus 23p P. & I.

BARGAIN OF THE YEAR

MICROSONIC KEYCHAIN RADIO

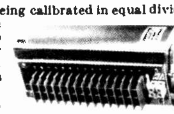


7 transistor Key chain Radio in very pretty case, size 2½ × 2½ × 1¼in—complete with soft leather zipped bag. Specification:—
Circuit: 7 transistor superheterodyne.
Frequency range: 530 to 1,600 Kc/s.
Sensitivity: 5 mv/m. Intermediate frequency: 465Kc/s or 455Kc/s. Power output: 40mW. Antenna: ferrite rod.
Loudspeaker: Permanent magnet type.
In transit from the East these sets suffered slight corrosion as the batteries were left in them but when this corrosion is cleared away they should work perfectly—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.

4 AMP VARIAC CONTROLLERS

With this you can vary the voltage applied to your circuit from zero to 270 volts without generating undue heat. One obvious application therefore is to dim lighting. Ex equipment but little used—as good as new offered at approx. half price—£5 plus 75p post and ins.

HONEYWELL PROGRAMMER



This is a drum type timing device, the drum being calibrated in equal divisions for switch setting purposes with trips which are infinitely adjustable for position. They are also arranged to allow 2 operations per switch per rotation. There are 15 changeover micro switches each of 10 amp type operated by the trips thus 15 circuits may be changed per revolution. Drive motor is mains operated 5 revs per min. Some of the many uses of this timer are Machinery control, Boiler firing, Dispensing and Vending machines, Display lighting animated and signs, Signalling, etc. Price from Makers probably over £10 each. Special snip price £5·75 plus 25p post and insurance. Don't miss this terrific bargain.

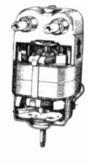
DRILL CONTROLLER

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. *NEW 1KW MODEL*

BALANCED ARMATURE UNIT

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

MULTI-SPEED MOTOR



Replacement in many well known food mixers. Six speeds are available 500, 850, and 1,100 r.p.m. from either or both of the nylon sockets (where the beaters of the food mixers normally go) and 8,000, 12,000 and 15,000 r.p.m. (ideal polishing speeds) from the main drive shaft. Very powerful and useful motor size approx. 2in. diameter 5in. long. Price 90p plus 23p post and ins.

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 2¼ × 2 × 2in. £1 each.

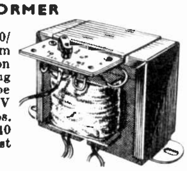
COMPUTER TAPE

2,400ft of the best magnetic tape money can buy. Made by E.M.I., 1in. wide almost unbreakable and on a 10½in. metal computer spool. Users have claimed successful results with video as well as sound recordings £1 plus 33p post. Cassette to hold spool 50p extra.

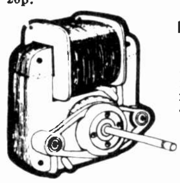
EMERGENCY SWITCH

A heavy duty switch, ideal as an emergency stop switch machine flow-line, etc. To operate the switch you simply push the centre, but this is protected against accidental switching by an extended metal flange. Two pair contacts, one pair open other pair close as switch pressed, 65p.

MAINS TRANSFORMER



output variable 24/38V.
50 c.p.d. primary 230/240V. Voltage from secondary depends upon the setting of a plug connector and may be varied from 24V to 38V approximately in 4 stops. Secondary rated at 40 watts. Price 95p, post 20p.

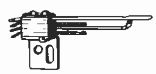


MAINS MOTOR

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

NEED A SPECIAL SWITCH?

Double Leaf Contact



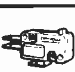
Very slight pressure closes both contacts, 6p each, 60p doz. Plastic push-rod suitable for operating, 5p each, 45p doz.

MINIATURE WAFER SWITCHES

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

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

MICRO SWITCH



5 amp. changeover contacts, 9p each, £1 doz. 15 amp Model 10p each or £1·05 doz.

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

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Callers to 102/3 Tamworth Road, Croydon

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TRANSISTORS

Type	Price
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2G303	20p
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2G309	30p
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2G374	20p
2G381	22½p
2N404	22½p
2N696	20p
2N697	20p
2N698	25p
2N706	12½p
2N706A	12½p
2N708	15p
2N709	62½p
2N718	25p
2N726	30p
2N727	30p
2N914	17½p
2N916	17½p
2N918	30p
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2N930	27½p
2N1090	22½p
2N1091	22½p
2N1131	25p
2N1132	25p
2N1302	17½p
2N1303	17½p
2N1304	22½p
2N1305	22½p
2N1306	25p
2N1307	25p
2N1308	30p
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2N2193	40p
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2N2220	25p
2N2221	25p
2N2222	30p
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2N2297	30p
2N2368	17½p
2N2369	17½p
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2N2924	15p
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2N5030	42½p
2N5172	12½p
2N5174	52½p
2N5175	52½p
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2N5365	47½p
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40314	37½p
40320	47½p
40323	32½p
40324	47½p
40326	37½p
40329	30p
40344	27½p
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40360	42½p
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40407	40p
40408	52½p
40410	62½p
40467A	57½p
40468A	35p
40600	57½p
40673	£1·25
AC107	30p
AC126	20p
AC127	25p
AC128	20p
AC154	22½p
AC176	25p
AC187	62½p
AC188	37½p
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AD140	52½p
AD149	57½p
AD150	62½p
AD161	37½p
AD162	37½p
AF106	42½p
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AF115	25p
AF116	25p
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BC167	15p
BC168B	14p
BC168C	15p
BC169B	14p
BC169C	15p
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BC175	22½p
BC182	12½p
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BC184	• 15p
BC212L	12½p
BCY30	27½p
BCY31	30p
BCY32	50p
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BD116	£1·12½
BD121	85p
BD123	82½p
BD124	82½p
BD131	75p
BD132	85p
BDY10	£1·37½
BDY11	£1·62½
BDY17	£1·50
BDY18	£1·75
BDY19	£1·97½
BDY20	£1·12½
BDY38	97½p
BDY60	£1·25
BDY61	£1·25
BDY62	£1
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BF163	37½p
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BF238	22½p
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BFX43	37½p
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BFX68	67½p
BFX84	25p
BFX85	32½p
BFX86	25p
BFX87	27½p
BFX88	25p
BFX89	62½p
BFX93A	70p
BFY10	32½p
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BFY17	22½p
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BFY19	32½p
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BFY24	45p
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BFY26	20p
BFY29	50p
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BFY43	62½p
BFY50	22½p
BFY51	22½p
BFY52	22½p
BFY53	17½p
BFY56A	57½p
BFY75	30p
BFY76	42½p
BFY77	57½p
BFY90	67½p
BPX25	£1·85
BPX29	£1·80
BPY10	£1·45
BRY39	47½p
BSW41	42½p

Type	Price
BSW70	27½p
BSX19	17½p
BSX20	17½p
BSX21	37½p
BSX26	45p
BSX27	47½p
BSX28	32½p
BSX60	82½p
BSX61	62½p
BSX76	22½p
BSX77	27½p
BSX78	27½p
BSX78	27½p
BSY10	27½p
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BSY56	90p
BSY78	47½p
BSY79	45p
BSY82	52½p
BSY90	57½p
BSY95A	12½p
C111	75p
C424	27½p
C425	55p
C426	40p
C428	37½p
C744	30p
D13T1	62½p
D16P1	37½p
D16P2	40p
D16P3	37½p
D16P4	40p
GET102	30p
GET113	20p
GET114	20p
GET118	20p
GET119	20p
GET120	52½p
GET873	12½p
GET880	30p
GET887	20p
GET889	22½p
GET890	22½p
GET896	22½p
GET897	22½p
GET898	22½p
MJ400	£1·07½
MJ420	£1·12½
MJ421	£1·12½
MJ430	£1·02½
MJ440	95p
MJ480	97½p
MJ481	£1·25
MJ490	£1
MJ491	£1·37½
MJ1800	£2·17½
MJE340	62½p
MJE520	87½p
MJE521	87½p
MJE2955	£1·27½
MJE3055	57½p
MPF102	42½p
MPF103	37½p
MPF104	37½p
MPF105	37½p
MPS3638	32½p
NKT0013	47½p
NKT124	42½p
NKT125	27½p
NKT126	27½p
NKT128	27½p
NKT135	27½p
NKT137	32½p
NKT210	30p
NKT211	30p
NKT212	30p
NKT213	30p
NKT214	22½p
NKT215	22½p
NKT216	37½p
NKT217	42½p
NKT219	30p
NKT223	27½p
NKT224	25p
NKT225	22½p
NKT229	30p
NKT237	35p

Type	Price
NKT238	25p
NKT240	27½p
NKT241	27½p
NKT242	20p
NKT243	62½p
NKT244	17½p
NKT245	20p
NKT261	20p
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NKT453	47½p
NKT603F	32½p
NKT613F	32½p
NKT674F	30p
NKT677F	30p
NKT713	20p
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NKT10419	30p
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NKT10519	32½p
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NKT80216	92½p
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OC23	60p
OC24	60p
OC25	50p
OC26	27½p
OC28	62½p
OC29	62½p
OC35	50p
OC36	62½p
OC41	22½p
OC42	25p
OC44	20p
OC45	12½p
OC46	15p
OC70	15p
OC71	12½p
OC72	12½p
OC74	32½p
OC75	22½p
OC76	22½p
OC77	30p
OC81	20p
OC81D	22½p
OC83	25p
OC84	25p
OC139	32½p
OC140	32½p
OC170	30p
OC171	30p
OC200	40p
OC201	60p
OC202	75p
OC203	42½p
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OC205	90p
OC207	75p
OCP71	42½p
ORP12	62½p
ORP61	50p
P346A	22½p
TIP29A	50p
TIP30A	60p
TIP31A	62½p
TIP32A	75p
TIP33A	£1·05
TIP34A	£2·05
TIS34	62½p
TIS43	40p
TIS44	12½p
TIS45	12½p
TIS46	12½p
TIS47	12½p
TIS48	12½p
TIS49	12½p
TIS50	17½p
TIS51	12½p
TIS52	12½p
TIS53	22½p
TIS60	22½p
TIS61	25p
TIS62	27½p

Matching charge (audio transistors only 12½p extra per pair.
Post & Packing 12½p per order. Europe 25p. Commonwealth (Air) 65p Minimum.
Prices subject to alteration without prior notice.

PANEL METERS

38 Series—FACE SIZE 42 × 42mm. All Prices for 1–9 pieces. All meters d.c. 50μA, £1·87½; 100μA, £1·75; 200μA, £1·62½; 500μA, £1·37½; 50-0-50μA, £1·75; 100-0-100μA, £1·62½; 500-0-500μA, £1·25; 1MA, £1·25; 5MA, £1·25; 10MA, £1·25; 50MA, £1·25; 100MA, £1·25; 500MA, £1·25; 1A, £1·25; 5A, £1·25; 10V, £1·25; 20V, £1·25; 50V, £1·25; 300V, £1·25; 500V, £1·25.

SILICON RECTIFIERS

PIV	50	100	200	400	600	800	1000	1200
1A	10p	12½p	15p	16p	17½p	19p	20p	—
3A	15p	—	—	22½p	—	30p	—	—
6A	—	—	25p	30p	32½p	35p	50p*	—
10A	—	52½p	57½p	65p	77½p	87½p	97½p	£1·25
17A	—	57½p	62½p	77½p	90p	97½p	£1·20	£1·57½

* 5A only; 1A are plastic encapsulation.

DIODES & RECTIFIERS

IN914	7½p	IS940	7½p	BAX13	12½p	BYZ12	30p
IN916	7½p	AA119	10p	BAX16	12½p	BYZ13	25p
IN4007	22½p	AA129	10p	BAY18	17½p	OA5	17½p
IN4148	7½p	AAZ13	10p	BAY31	7½p	OA9	10p
IN5145	£2·37½	AAZ15	12½p	BAY38	25p	OA10	22½p
IS44	10p	AAZ17	12½p	BY100	17½p	OA47	7½p
IS113	15p	BA100	15p	BY103	22½p	OA70	7½p
IS120	15p	BA102	22½p	BY122	37½p	OA73	10p
IS121	17½p	BA110	32½p	BY124	15p	OA79	9p
IS130	12½p	BA115	7½p	BY126	15p	OA81	7½p
IS131	12½p	BA141	32½p	BY127	17½p	OA85	7½p
IS132	15p	BA142	32½p	BY164	57½p	OA90	7½p
IS920	7½p	BA144	12½p	BYX10	22½p	OA91	7½p
IS922	7½p	BA145	20p	BYZ10	35p	OA95	7½p
IS923	7½p	BA154	12½p	BYZ11	32½p	OA200	10p

MAINS TRANSFORMERS

1 amp Charger. Sec. 0–3·5–9–18V 97½p
2 amp Charger. Sec. 0–3·5–9–18V .. .. £1·27½
1 amp (Douglas) MT103 Sec. tappings from 6V to 50V .. .. £1·62½
2 amp (Douglas) MT104 Sec. tappings from 6V to 50V .. .. £2·12½
Post and packing 22½p.
5 amp (Douglas) MT107 Sec. tappings from 6V to 50V .. .. £5·50
Post and packing 37½p.
Various other Transformers ranging from ½A to 5A in stock (details in catalogue).

TRIACS

SC41A	£1	SC35D	£1·10½
SC41B	£1·10	SC36D	£1
SC41D	£1·20	SC40D	£1·50
SC50D	£2·05	SC45D	£1·62½
40430	97½p	SC46D	£1·42½
40486	95p	40429	90p
40512	£1·45	40432	£1·37½

Economy Range Triacs

TC4/10 (Pressfit) 4 amp 100 PIV	65p		
TC4/20 (Pressfit) 4 amp 200PIV	75p		
TC4/40 (Pressfit) 4 amp 400 PIV	87½p		
ST2 DIAC	16p		

DIACS

MPT20	40p
MPT28	37½p
MPT32	37½p
MPT36	37½p

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WE ARE NOW ABLE TO SUPPLY FROM STOCK LOWEST PRICE TTL's. BRAND NEW AND GUARANTEED. SEE FACING PAGE. WHOLE RANGE OF MOTOROLA, MULLARD AND RCA IC's STOCKED.

THYRISTORS

PIV	50	100	200	300	400
1A	25p	27½p	37½p	40p	47½p
4A	47½p	55p	57½p	—	75½p
5A	—	55p	65p	—	75p
7A	—	55p	65p	—	97½p

TIC47 0·6A 200 PIV 55p
Also 12A 100 PIV, 75p; 2N3525 at £1·27½

VEROBOARD

	0·15 Matrix	0·1 Matrix
2½in × 3¾in	17½p	20p
2½in × 5in	21p	24p
3¾in × 3¾in	21p	24p
3¾in × 5in	27½p	27½p
5in × 17in (plain)	65p	—

Vero Pins (bag of 50), 25p; (bag of 100), 40p.
Vero cutter, 45p; Pin insertion Tools (0·1 and 0·15 matrix) at 55p.

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RESISTORS

Carbon Film
⅛ watt 5%, 1p.
¼ watt 5%, 1½p.
½ watt 5%, 2p.
1 watt 10%, 2½p.
2 watt 10%, 6p.

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A large and comprehensive range available: Electrolytic, Polyester, Ceramic, Polystyrene, Silver Mica, Tantalum, Trimmers, Tuners.
Examples:
2,000mF 25V, 37½p
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5,000mF 50V, 97½p

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5 watt 5% (up to 8·2kΩ only), 10p.
10 watt 5% (up to 25kΩ only), 12½p.

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Wire-wound Pots (3W), 37½p.
Twin Ganged Stereo Pots, Log. and Lin., 40p.

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0·1 Watt 6p
0·2 Watt 6p
0·3 Watt 7½p

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Mullard Thermistors also in stock. Please inquire.

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2N1302	**19p**	2N3703	**13p**	ACY20	**20p**	BC168	**11p**	MPS6531	**35p**
2N1303	**19p**	2N3074	**13p**	ACY22	**16p**	BC169	**13p**	MPS6534	**30p**
2N1304	**23p**	2N3075	**13p**	AD140	**56p**	BC177	**17p**	NKT211	**25p**
2N1305	**23p**	2N3706	**13p**	AD142	**50p**	BC178	**15p**	NKT212	**25p**
2N1306	**33p**	2N3707	**13p**	AD149	**60p**	BC179	**17p**	NKT214	**23p**
2N1307	**33p**	2N3708	**13p**	AD161	**40p**	BC182L	**13p**	NKT274	**18p**
2N1308	**36p**	2N3709	**13p**	AD162	**40p**	BC183L	**11p**	NKT403	**65p**
2N1309	**36p**	2N3710	**13p**	AF114	**30p**	BC184L	**13p**	NKT405	**79p**
2N1613	**23p**	2N3711	**13p**	AF115	**30p**	BC212L	**25p**	OC71	**29p**
2N1711	**26p**	2N3819	**35p**	AF117	**28p**	BC213L	**25p**	OC81	**25p**
2N1893	**54p**	2N3904	**35p**	AF124	**30p**	BC214L	**25p**	OC81D	**25p**
2N2147	**95p**	2N3906	**35p**	AF127	**28p**	BCY70	**19p**	ZTX300	**12p**
2N2218	**34p**	2N4058	**20p**	AF139	**48p**	BCY71	**33p**	ZTX301	**16p**
2N2218A	**43p**	2N4059	**20p**	AF239	**49p**	BCY72	**15p**	ZTX302	**22p**
2N2219	**38p**	2N4060	**20p**	ASY26	**27p**	BF115	**23p**	ZTX303	**22p**
2N2219A	**53p**	2N4061	**20p**	ASY28	**27p**	BF167	**27p**	ZTX304	**27p**
2N2270	**62p**	2N4062	**20p**	BC107	**14p**	BF173	**31p**	ZTX500	**18p**
2N2369A	**19p**	2N4124	**18p**	BC108	**12p**	BF194	**17p**	ZTX501	**21p**
2N2483	**35p**	2N4126	**27p**	BC109	**14p**	BF195	**18p**	ZTX502	**25p**
2N2484	**42p**	2N4284	**15p**	BC125	**15p**	BFX29	**31p**	ZTX503	**22p**
2N2646	**54p**	2N4286	**15p**	BC126	**22p**	BFX84	**25p**	ZTX504	**52p**
2N2904A	**42p**	2N4289	**15p**	BC147	**15p**	BFX85	**34p**		

RESISTORS

Code	*Power*	*Tolerance*	*Range*	*Values available*	*1 to 9*	*10 to 99* (see note below)	*100 up*
C	1/20W	5%	82Ω–220KΩ	E12	**7**	**6·5**	**6**
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, Electrosil TR5, ultra low noise.
WW = wire wound, Plessey.

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

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

ZENER DIODES 5% full range E24 values: 400mW: 2·7V to 30V, **15p each**; 1W: 6·8V to 82V, **27p each**; 1·5W: 4·7V to 75V, **60p each.**
Clip to increase 1·5W rating to 3 watts (type 266F), **4p.**

CARBON TRACK POTENTIOMETERS, long spindles. Double wiper ensures minimum noise level.
Single gang linear 100Ω to 2·2MΩ, **12p; Single gang** log. 4·7KΩ to 2·2MΩ, **12p; Dual gang** linear 4·7KΩ to 2·2MΩ, **42p**; Dual gang log. 4·7KΩ to 2·2MΩ, **42p**; Log/antilog, 10K, 47K, 1MΩ only **42p**; Dual antilog, 10K only, **42p.** Any type with ½A D.P. mains switch, **12p** extra.
Only decades of 10, 22 and 47 available in ranges quoted.

CARBON SKELETON PRE-SETS
Small high quality, type PR, linear only: 100Ω, 220Ω, 470Ω, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M2, 5M, 10MΩ. Vertical or horizontal mounting, **5p each.**

COLVERN 3 watt Wire-wound Potentiometers. 10Ω, 15Ω, 25Ω, 50Ω, 100Ω, 250Ω, 500Ω, 1K, 1·5K, 2·5K, 5K, 10K, 15K, 25K, 50K. **32p each.**

MULLARD polyester C280 series
250V 20%: 0·01, 0·022, 0·033, 0·047 **3p each**; 0·068, 0·1, **4p each**; 0·15, **4p**; 0·22, **5p.** 10%: 0·33, **7p**; 0·47, **8p**; 0·68, **11p**; 1μF, **14p**; 1·5μF, **21p**; 2·2μF, **24p.**

MULLARD SUB-MIN ELECTROLYTICS
C246 range, axial lead .. .. .. **6p each**
Values (μF/V): 0·64/64; 1/40; 1·6/25; 2·5/16; 2·5/64; 4/10; 4/40; 5/64; 6·4/6·4; 6·4/25; 8/4; 8/40; 10/2·5; 10/16; 10/64; 12·5/25; 16/40; 20/16; 20/64; 25/6·4; 25/25; 32/4; 32/10; 32/40; 32/64; 40/16; 40/2·5; 50/6·4; 50/25; 50/40; 64/4; 64/10; 80/2·5; 80/16; 80/25; 100/6·4; 125/4; 125/10; 125/16; 160/2·5; 200/6·4; 200/10; 250/4; 320/2·5; 320/6·4; 400/4; 500/2·5.

LARGE CAPACITORS
High ripple current types: 1000/25, **28p**; 1000/50, **41p**; 1000/100, **82p**; 2000/25, **37p**; 2000/50, **57p**; 2000/100, **£1·44**; 2500/64, **77p**; 2500/70, **98p**; 5000/25, **62p**; 5000/50, **£1·10**; 5000/100, **£2·91**; 10000/25, **£1·40**; 10000/50, **£2·40.**

COMPONENT DISCOUNTS
10% on orders for components for £5 or more.
15% on orders for components for £15 or more.
(No discount on nett items.)

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Free on orders over £2. Please add 10p if orders under £2.
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Designed by Peter Baxandall. Superb reproduction for its size. Handles 10W with ease. Uses ELAC 15Ω 59RM109 speaker unit. Kit **£13·90** nett; built **£19·40** nett.

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RCA/SGS designed main amplifier kits. Input sensitivity 500–700mV for full output into 8Ω.

Power	*Kit price including components*	*Suitable unreg. power supply kit*
12W	**£8·40** nett	**£4·82**
25W	**£9·75** nett	**£5·92**
40W	**£10·50** nett	**£6·03**
70W	**£12·60** nett	**£6·87**

30 WATT BAILEY AMPLIFIER PARTS

Sensitivity 1·2V for full output into 8Ω.
Transistors and PCB for one channel **£6·46**
Transistors and PCBs for two channels **£12·92**
Capacitors and resistors (metal oxide), **£2·00** per channel.
Complete unregulated power supply pack, **£4·75**
Suitable heatsink 10DN space 400C, **55p**
Suitable heatsink 10DN 400C, **55p**

INTEGRATED CIRCUITS

PLESSEY SL403A 3 watts into 7·5 ohms. **£2·10** nett
SINCLAIR IC.10 as advertised, complete with instructions and applications manual **£2·95** nett.
Components pack for stereo inc. transformer, controls, etc., **£4·75** nett.

S-DeCs put an end to birds nesting
Components just plug in—saves time—allows re-use of components. S-Dec (70 points), **£1·00**
Complete T-Dec, may be temperature-cycled (208 points), **£2·50** Also μ-Decs and IC carriers.

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NEON chrome bezel, round red NR/R, **24p**; chrome bezel, round amber NR/A, **24p**; chrome bezel, round clear NR/C, **24p.** Neon, square red type LS5C/R, **17p**; amber type LS5C/A, **17p**; clear type LS5C/C, **17p.** All above are for 240V mains operation. **Filament types:** 6V, 0·04A square red type LS5C/R-6V, **20p**; 6V, 0·04A amber type LS5C/A-6V, **20p**; 6V 0·04A clear type LS5C/C-6V, **20p**; 6V 0·04A green type LS5C/G-6V, **20p**; 12V 0·04A LS5C/R-12V, **23p**; 28V 0·04A LS5C/R-28V, **28p.**

DIN CONNECTORS

			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**

CORED SOLDER—64/40 alloy, 20 s.w.g. 8oz reel, **65p**, 1lb reel, **£1.20.**

ELECTROVALUE DEPT. P.E.671, 28 ST. JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY
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PREMIER STEREO SYSTEM "ONE" Consists of an all transistor stereo amplifier. Garrard 2025 T/C auto/manual record player unit fitted stereo/mono cartridge and mounted in teak finish plinth with perspex cover and two matching teak finish loudspeaker systems. Absolutely complete and supplied ready to plug in and play. The 10 transistor amplifier has an output of 5 watts per channel with inputs for pick-up, tape and tuner also tape output socket. Controls: Bass, Treble, Volume, Balance, Selector. Power on/off switch. Brushed aluminium front panel. Solid teak cabinet: Size 12 × 4½ × 3½in. high (Amplifier available separately if required **£14·95.** Carr. 40p).

PREMIER STEREO SYSTEM "TWO"

As system "ONE" above but with Garrard SP25.

PREMIER PRICE £47 Carr. £1·75

PREMIER QUALITY MICROPHONES

MKC52

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

FANON MKC52 DYNAMIC WITH BUILT-IN VOLUME CONTROL
Frequency response 50–13,000Hz. Dual impedance 50kΩ (−52dB) and 150 ohms (−71dB). Cardioid uni-directional. On/off volume control. Die cast body satin chrome finish. Complete with 20ft cable and stand adaptor. **PREMIER PRICE £7·97.** P. & P. 20p.

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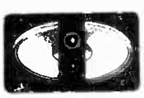
Frequency response 60–13,000Hz. Impedance 50kΩ (−59dB). Can be used with stand, hand held or around neck. Die cast body satin chrome finish. Features removable windscreen. Complete with 8ft cable, stand adaptor and Lavalier cord. **PREMIER PRICE £5·97.** P. & P. 20p.

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

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

MKC55 MKC54 MK047 MK045

E.M.I. 13×8in. HI-FI SPEAKERS



Fitted two 2½in tweeters and crossover network. Available with 8 or 15 ohm impedance. Handling capacity 10W. Brand new.

£3·47 P. & P. 40p

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Designed to the highest possible standard. Fitted 2½in. speaker units with soft padded ear muffs. Adjustable headband. 8 ohm impedance. Complete with 6ft. lead and stereo jack plug.

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MONO STETHOSCOPE SET Lowimp. 52p. P. & P. 10p

VERITAS V–49 MIXER

Battery operated 4-channel audio mixer providing four separate inputs. Size 6×3×2in. suitable for crystal microphone, low impedance microphone with transformer, radio, tape, etc. Max. input 1·5V, max. output 2·5V, gain 6dB. Standard jack plug socket inputs, phonoplugs output. Attractive teak wood grain finish case.

Mono Model £3 **Stereo Model** £3·47 P. & P. 12p

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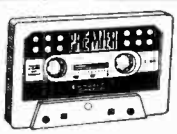
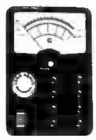


C60 (60 min.) 37p 3 for £1·05
C90 (90 min.) 62p 3 for £1·80
C120 (120 min.) 87p 3 for £2·55

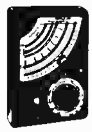
P. & P. 5p

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

METER BARGAINS



MODEL GT800 MULTIMETER
A precision made pocket sized test meter, ideally suited for testing electronic circuits or electronic appliances. Supplied complete with test lead and batteries.
Ranges—D.C. voltages: 10, 50, 250, 1,000V (1,000 O.P.V.). A.C. voltages: 10, 50, 250, 1,000V (1,000 O.P.V.). D.C. current: 1mA, 100mA. Resistance: 0-150 kohms. Decibels: −10 to +22dB (at a.c. 10V range).
£2·47. P. & P. 17p.



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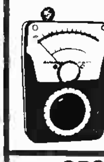

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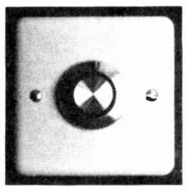

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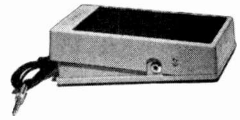

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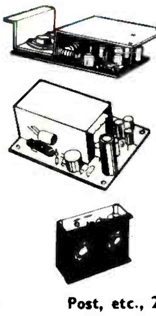

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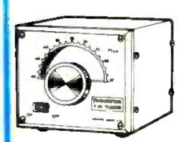

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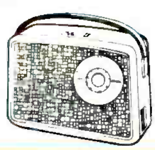

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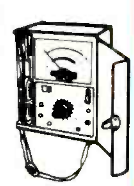

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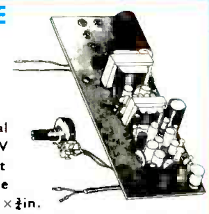

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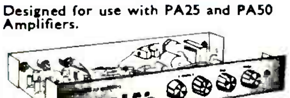

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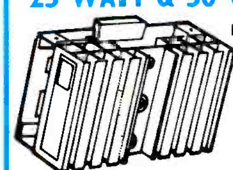

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