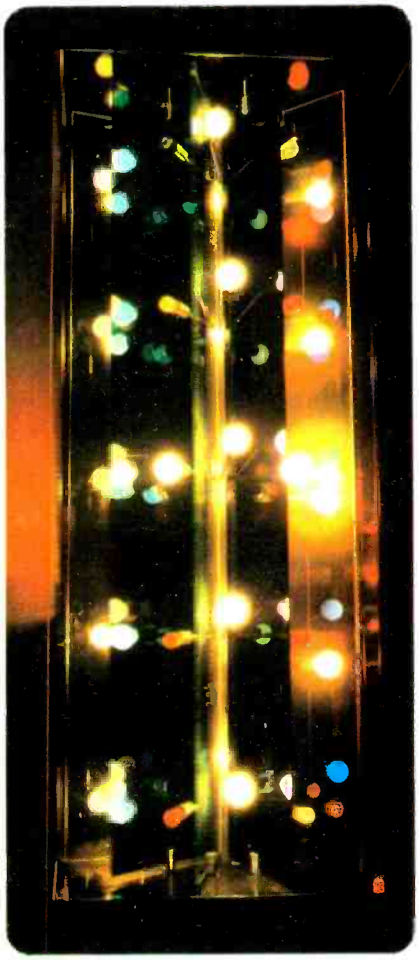
PRACTICAL

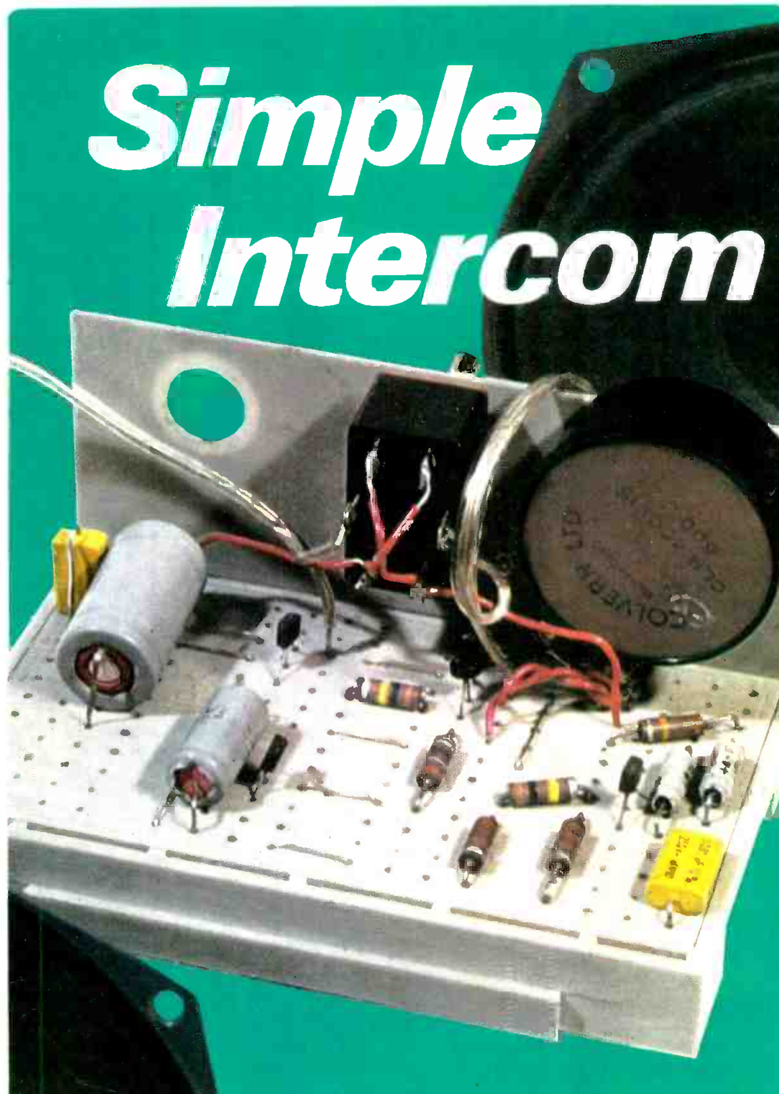
ELECTRONICS

JULY 1971

20p



Simple Intercom



PE AURORA

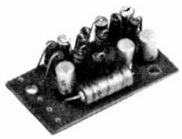
LIGHTING DISPLAYS DESCRIBED

This Month

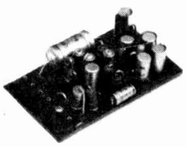
New expanded 1971 range of ready-to-use electronic circuit modules

Complete pre-tested sub-assemblies requiring only soldering iron, pliers and screwdriver to install in equipment. Ideal for lab "one-off's," prototypes and pilot marketing short runs.

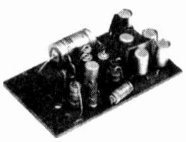
A data sheet is packaged with each unit.



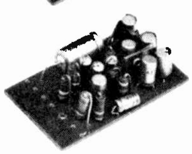
PC1
LOW CONSUMPTION HEADPHONE AMPLIFIER
for hearing aids, loop paging receivers, monitor amps, bridge null detectors, signal tracers, A.C. level meters, etc.
Price £1·46 (£1.9.3)



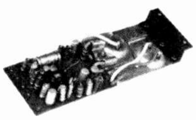
PC2
SENSITIVE $\frac{1}{2}$W, 15 OHM SPEAKER AMPLIFIER
for telephone pick-ups, intercom systems, talkback amps, alarm systems, frequency meters, G.P. audio amps and oscillators.
Price £2·14 (£2.2.9)



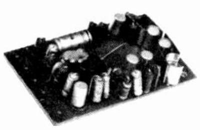
PC3
MEDIUM IMPEDANCE VERSION OF PC2
for similar applications but where a higher input resistance (typically 2500 ohms) is required.
Price £2·14 (£2.2.9)



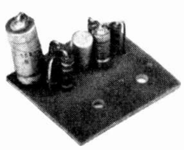
PC4
EXTRA HIGH IMPEDANCE VERSION OF PC2
with 220 kohms input resistance for capacitive or high resistance signal sources such as crystal/ceramic pick-ups and microphones.
Price £2·14 (£2.2.9)



PC5
HIGH POWER 4·5W, 3 OHM SPEAKER AMPLIFIER
for A.C. servo amplifiers, workshop intercoms, electronic megaphones, transmitter modulators, audio visual systems, etc. Price £3·97 (£3.19.6)



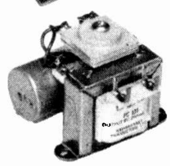
PC7
MEDIUM POWER 1W, 8 OHM SPEAKER AMPLIFIER
for higher power applications similar to PC2 or where standard 8 ohm speaker is to be used or wider bandwidth required.
Price £3



PC9
HIGH INPUT RESISTANCE AF PREAMPLIFIER
with 1 megohm input and 600 ohm output to match capacitive or crystal/ceramic transducers to amps like PC1, 2, 5, 7, etc.
Price 95p (19s.)

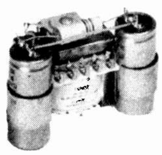
PC10

MAGNETIC TAPE REPLAY PREAMPLIFIER
using self-compensating circuit that adjusts itself to different tape speeds without switching, usable with PC1, 2, 5, 7. Price **£1·87 (£1.17.6)**



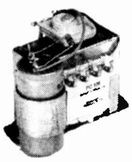
PC101

COMPACT 9V, 200mA, D.C. POWER SUPPLY UNIT
General replacement for 9V batteries. Suitable PC1, 2, 3, 4, 7, 9, 10, 1006 source for Zener-stabilised 5V digital IC supply. Price **£1·73 (£1.14.6)**



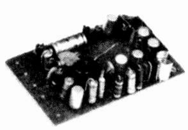
PC102

VERSATILE 21V, 330mA D.C. POWER SUPPLY UNIT
with separate 21V winding for optional extra D.C. output, suitable 3W 15 ohm transformerless amps and as source for 12–18V stabilised supply.
Price **£3**



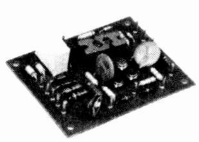
PC106

USEFUL 12V, $\frac{1}{2}$A D.C. POWER SUPPLY UNIT
General replacement for 12V batteries, suitable PC5, 712. Source for Zener-stabilised supplies replacing 6 and 9V batteries.
Price **£2·47 (£2.9.6)**



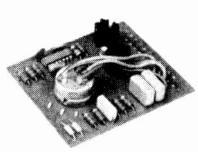
PC712

MEDIUM POWER SPEAKER AMPLIFIER (1W, 15 OHM)
For higher power applications similar to PC2 but using 12V supply and standard 15 ohm speaker; driver for higher power amplifiers.
Price **£3**



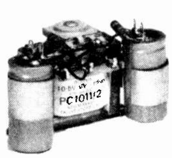
PC1006 and PC1006K

MULTIMETER SENSITISER (1μA, 10mV FULL SCALE)
Multiplies sensitivity of standard multimeter or 50μA D.C. meter fifty times. PC1006 amp or PC1006K assembly kit. Price PC1006 **£6·05 (£6.1.1)** and PC1006K **£1·50 (£1.10.0)**



PC1010

BALANCED INPUT LINE MONITOR AMP (3W, 8 OHM)
Designed for 600 ohm line but can be used as general purpose monitor/talkback amp powered by two batteries or PC1011 supply.
Price **£6·67 (£6.13.4)**



PC1011

DOUBLE D.C. (±10V, $\frac{1}{2}$A) POWER SUPPLY UNIT
Useful general purpose double power supply. Source for Zener-stabilised rails for linear IC's. Suitable PC1010.
Price **£4·17 (£4.3.4)**

distributors

Coventry Factors Ltd.,
Coronet House,
Upper Well Street,
Coventry CV1 4AF,
Warwickshire.
Tel: 0203-21051/5
Telex: 311243

Eastern Areo Electrical Services Ltd.,
Building 202,
Enfield Road,
London (Heathrow) Airport,
Hounslow, Middlesex.
Tel: 01-759 1314

G.S.P.K. (Sales) Ltd.,
Hookstone Park,
Harrogate,
Yorkshire.
Tel: Harrogate 96258
Telex: 57962

Hird-Brown Electronics Ltd.,
Lever Street,
Bolton BL3 6BJ,
Lancashire.
Tel: Bolton 27311
Telex: 63478

I.T.T. Electronic Services Ltd.,
Edinburgh Way,
Harlow, Essex.
Tel: 02796-26777
Telex: 81146

L.S.T. Electronic Components Ltd.,
7 Coptfold Road,
Brentwood,
Essex.
Tel: Brentwood 226470
Telex: 99443

Lugton & Co. Ltd.,
209-212 Tottenham Court Road,
London W1A 2BN.
Tel: 01-636 3261/9
Telex: 25618

S.D.S. (Portsmouth) Ltd.,
Hilsea Industrial Estate,
Portsmouth PO3 5JW,
Hampshire.
Tel: 0715-65311
Telex: 86114

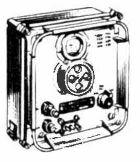
TRANSISTORISED TWO-WAY TELEPHONE INTERCOM

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

TE15 TRANSISTORISED GRID DIP METERS

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

CRYSTAL CALIBRATORS No. 10



Small portable crystal controlled wavemeter. Size 7" × 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.

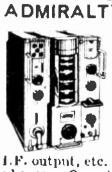
AM/FM SIGNAL GENERATORS

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

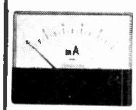
3in tube. Y amp. Sensitivity 0·1V p-p/CM. Bandwidth 1·5 cps-1·5MHz. Input imp. 2 megΩ 25pF X amp. sensitivity 0·9V p-p/CM. Bandwidth 1·5cps -800KHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps-300KHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½lb 220/240V. A.C. Supplied brand new with handbook. £37·50. Carr. 50p.

SEW PANEL METERS

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

NEW "SEW" DESIGNS!

CLEAR PLASTIC METERS . BAKELITE PANEL METERS



TYPE SW. 100 100 x 80 mm

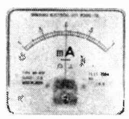
50µA	£3·47½	500µA	£3·12½
50-0-50µA	£3·37½	1mA	£2·97½
100µA	£3·37½	20V d.c. ..	£2·97½
100-0-100µA	£3·25	50V d.c. ..	£2·97½
		300V d.c.	£2·97½
		1A d.c. ..	£2·97½
		5A d.c. ..	£2·97½
		300V a.c.	£2·97½
		VU Meter	£3·75

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	£2·62½		
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

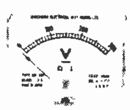
Type MR.52P. 2½in square fronts.

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
5V 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

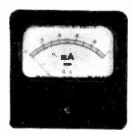
Type MR.45P. 2in square fronts.

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		

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

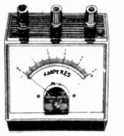
"SEW" BAKELITE PANEL METERS

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

"SEW" EDUCATIONAL METERS



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/5Ad.c.	£4·25
1A d.c.....	£3·97	5V/50V d.c.	£4·25
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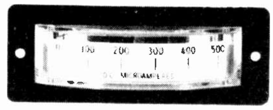

PE.70 3 17/32in × 1 15/32in × 2½in deep.

50µA	£3·00	500µA	£2·60
50-0-50µA	£2·87½	1mA......	£2·37½
100µA ...	£12·87½	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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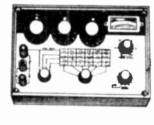

A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω-11·1 megΩ 6 Ranges ±1%. L.1 µH - 111 HENRYS 6 Ranges ±2%. C. 10pF ±1110mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000-1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100µA. Meter indication. Attractive 2 tone metal case. Size 7¾ × 5 × 2in. £20. P. & P. 25p.

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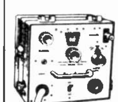
2pF-2,000 mfd 2 ohms-200 megohms. Also checks impedance, turns ratio, insulation, 200/250V a.c. **Brand New £17·50** Carr. 37½.

CLASS D WAVEMETERS



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2N2924	17p	BCY42	15p	OC44	17p
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2N2926G	12p	BCY71	30p	OC46	27p
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2N3709	12p	BF195	15p	OC169	20p
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12BA6	35p	EF92	40p	UF41	60p
12BE6	35p	EF183	30p	UF80	35p
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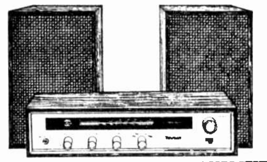

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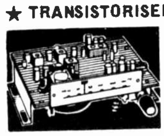

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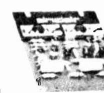
SINCLAIR EQUIPMENT



Project 60. Package offers. 2 × Z30 amplifier, stereo 60 pre-amp. PZ5 power supply, £16·75. Carr. 37½p. Or with PZ6 power supply, £18·85. Carr. 37½p. 2 × Z50 amplifier, stereo 60 pre-amp, PZ8 power supply, £20·25. Carr. 37½p. Transformer for PZ8, £2·97½ extra. Add to any of the above £4·87½ for active filter unit and £16 for a pair of Q16 speakers. Project 60 FM Tuner £20·97½. Carr. 37½p.
All other Sinclair products in stock. 2,000 amplifier, £25. Carr. 37½p. 3000 Amplifier £35. Carr. 37½p. Neoteric amplifier £45·97½. Carr. 37½p.

← See previous page ● **G. W. SMITH & CO. (RADIO) LTD.** ● See opposite page →

RUSSIAN C1-16 DOUBLE BEAM OSCILLOSCOPES

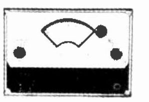
5MHz Pass Band. Separate Y1, Y2 amplifiers. Calibrated triggered sweep from 0·2μsec to 100msec/cm. Supplied complete with all accessories and instructions. £87. Carr. paid.

MARCONI CT44/ TF956 AF ABSORPTION WATTMETER

1 μ/watt to 6 watts. **£20.** Carr. £1.

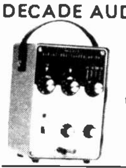
TE111. DECADE RESISTANCE ATTENUATOR Variable range 0-111dB. Connections. Unbalanced T and Bridge T. Impedance 600Ω range (0·1dB × 10) + (1dB × 10) + 10 + 20 + 30 + 40dB. Frequency: d.c. to 200kHz (−3dB). Accuracy: 0·05dB. +indication dB × 0·01. Maximum input less than 4W (50V). Built in 600Ω load resistance with internal/external switch. Brand new **£27·50.** P. & P. 25p.

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



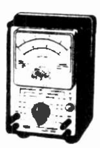
Sine 18-200,000Hz: Square 18-50,000Hz. Output max +10dB (10kΩ). Operation internal batteries. Attractive two-tone case 7¾in × 5in × 2in. Price **£17·50.** Carr. 17½p.

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

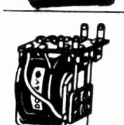


10 meg. Input 10 ranges: ·01 / ·003 / ·1 / ·3 / 1 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s.-1·2Mc/s. Decibels −40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V a.c. **£17·50.** Carr. 25p.

TE-65 VALVE VOLTMETER

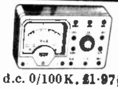
High quality instrument with 28 ranges. D.c. volts 1·5-1,500V. A.c. volts 1·5-1,500V. Resistance up to 1,000 megohms. 220/240V a.c. operation. Complete with probe and instructions. **£17·50.** P. & P. 30p. Additional Probes available: R.F. **£2.12½.** H.V. **£2.50.**

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 MegΩ. **£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.

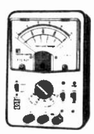
TMK MODEL TW-50K. 46 ranges, mirror scale. 50K/Volt d.c. 5K/Volt a.c. D.c. volts: 0·125, 0·25, 1·25, 2·5, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.c. volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.c. current: ·25, 50μA, 2·5, 5, 25, 50, 250, 500mA, 5, 10A. Resistance: 10K, 100K, 1 meg., 10 meg. 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 5½in 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.

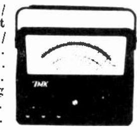
FTC-401 TRANSISTOR TESTER



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. 0/6/30/120/600/1,200V a.c. 0/30μA / 6mA / 60mA / 300mA/600mA. 0/8K/80K/800K/8 meg. −20 to +63dB. **£5·97½.** P. & P. 15p.

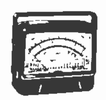


MODEL PL436. 20kΩ/Volt d.c. 8kΩ/Volt a.c. Mirror scale. 0·6/3/12/30/120/600V d.c. 3/30/120/600V a.c. 50/600μA/60/600mA. 10/100K/1 Meg/10 meg Ω. −20 to +46dB. **£6·97½.** P. & P. 12½p.

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.

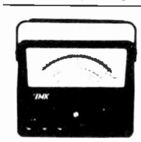
TMK MODEL TW-20CB. Features Resettable Overload Button. Sensitivity: 20KΩ/Volt d.c. 5KΩ/Volt a.c. D.c. volts: 0-0·5, 2·5, 10, 50, 250, 1,000V. A.c. volts: 0-2·5, 10, 50, 250, 1,000V. D.c. currents: 0-0·05, 0·5, 5, 50, 500mA. Resistance: 0-5K, 50K, 0-500K, 5 meg. Decibels: −20 to +52dB. **£11·50.** P. & 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

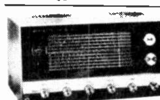
4 Bands covering 550KHz-30MHz. B.F.O. Built in Speaker 220/240V a.c. Brand new with instructions. **£15·75.** Carr. 37½p.

WS62 TRANSCEIVERS

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

UR-1A SOLID STATE COMMUNICATION RECEIVER

4 Bands covering 55KHz-30MHz. FET, 8 Meter, Variable BFO for SSB. Built in Speaker, Bandspread, Sensitivity Control. 220/240V a.c. or 12V d.c. 12½in × 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 × 9¼in × 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).

FULL RANGE OF TRIO EQUIPMENT

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

VOLTAGE STABILISER TRANSFORMERS
180-260V input. Output 230V. Available 150W or 225W. **£12.50.** Carr. 25p.

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0/115/230v. Step up or step down. Fully shrouded.

150W.	£2·37½	P. & P. 17½p.
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1,000W.	£7·25.	P. & P. 37½p.
1,500W.	£8·97½.	P. & P. 42½p.
5,000W.	£36·00.	P. & P. £1.

SOLID STATE VARIABLE A.C. VOLTAGE REGULATORS

Compact and panel mounting. Ideal for control of lamps, drills, electrical appliances, etc. Input 230/240V a.c. Output continuously variable from 20V to 230V. Model MR2305 5A 68 × 46 × 43mm, **£8·37½.** Model MR2310 10A 90 × 68 × 60mm, **£11·97½.** Postage 12½p.

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range ex-stock Single hole fixing, ¼in. dia. shafts. Bulk quantities available.

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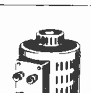
100 WATT. 1/5/10/25/50/100/250/500/1,000 or 2,500 ohms, **£1·37½.** P. & P. 7½p.

"YAMABISHI" VARIABLE VOLTAGE TRANSFORMERS



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8A	£14·50
10A	£18·50
12A	£21·00
20A	£37·00

MODEL S-260 B Panel Mounting

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2·5A	£6·62½

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ALL MODELS INPUT 230 VOLTS, 50/60 CYCLES, OUTPUT VARIABLE 0-260 VOLTS
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VM79. UHF MILLIVOLT METER. 100 Kc/s to 1,000 Mc/s. a.c. 10 mV to 3V. D.c. 10 mV to 3V. Current 0·01 μA to 0·3 mA. Resistance 1 ohm to 10 megohm. **£125.**
TT15. TRANSISTOR TESTER. Full range of facilities for testing PNP or NPN transistors in or out of circuit. **£37·50.**
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2G306	42½p	2N3416	37½p	40320	47½p	BC183	12½p	BSX21	37½p	NKT242	20p
2G308	30p	2N3417	37½p	40323	32½p	BC184	15p	BSX26	45p	NKT243	62½p
2G309	30p	2N3570	£1·25	40324	47½p	BC212L	12½p	BSX27	47½p	NKT244	17½p
2G371	15p	2N3572	97½p	40326	37½p	BCY30	27½p	BSX28	32½p	NKT245	20p
2G374	20p	2N3605	27½p	40329	30p	BCY31	30p	BSX60	82½p	NKT261	20p
2G381	22½p	2N3606	27½p	40344	27½p	BCY32	50p	BSX61	62½p	NKT262	30p
2N404	22½p	2N3607	22½p	40347	57½p	BCY33	25p	BSX76	22½p	NKT264	20p
2N696	20p	2N3702	12½p	40348	52½p	BCY34	30p	BSX77	27½p	NKT271	20p
2N697	20p	2N3703	12½p	40360	42½p	BCY38	40p	BSX78	27½p	NKT272	20p
2N698	25p	2N3704	17½p	40361	47½p	BCY39	60p	BSX78	27½p	NKT274	20p
2N706	12½p	2N3705	15p	40362	57½p	BCY40	50p	BSY10	27½p	NKT275	20p
2N706A	12½p	2N3706	12½p	40370	32½p	BCY42	15p	BSY11	27½p	NKT281	27½p
2N708	15p	2N3707	15p	40406	57½p	BCY43	15p	BSY24	15p	NKT401	87½p
2N709	62½p	2N3708	9p	40407	40p	BCY54	32½p	BSY25	15p	NKT402	90p
2N718	25p	2N3709	10p	40408	52½p	BCY58	22½p	BSY26	17½p	NKT403	75p
2N726	30p	2N3710	11p	40410	62½p	BCY59	22½p	BSY27	17½p	NKT404	62½p
2N727	30p	2N3711	12p	40467A	57½p	BCY60	97½p	BSY28	17½p	NKT405	75p
2N914	17½p	2N3715	£2·22½	40468A	35p	BCY70	20p	BSY29	17½p	NKT406	62½p
2N916	17½p	2N3716	£2·90	40600	57½p	BCY71	42½p	BSY32	25p	NKT451	62½p
2N918	30p	2N3791	£2·75	40673	£1·25	BCY72	17½p	BSY36	25p	NKT452	62½p
2N929	22½p	2N3819	35p	AC107	30p	BCZ10	27½p	BSY37	25p	NKT453	47½p
2N930	27½p	2N3823	97½p	AC126	20p	BCZ11	42½p	BSY38	22½p	NKT603F	32½p
2N1090	22½p	2N3854	27½p	AC127	25p	BD116	£1·12½	BSY39	22½p	NKT613F	32½p
2N1091	22½p	2N3854A	27½p	AC128	20p	BD121	65p	BSY40	32½p	NKT674F	30p
2N1131	25p	2N3855	27½p	AC154	22½p	BD123	82½p	BSY51	32½p	NKT677F	30p
2N1132	25p	2N3855A	30p	AC176	25p	BD124	82½p	BSY52	32½p	NKT713	25p
2N1302	17½p	2N3856	30p	AC187	62½p	BD131	75p	BSY53	37½p	NKT781	30p
2N1303	17½p	2N3856A	35p	AC188	37½p	BD132	85p	BSY54	40p	NKT10419	30p
2N1304	22½p	2N3858	25p	ACY17	27½p	BDY10	£1·37½	BSY56	90p	NKT10439	37½p
2N1305	22½p	2N3858A	30p	ACY18	25p	BDY11	£1·62½	BSY78	47½p	NKT10519	32½p
2N1306	25p	2N3859	27½p	ACY19	25p	BDY17	£1·50	BSY79	45p	NKT20329	47½p
2N1307	25p	2N3859A	32½p	ACY20	25p	BDY18	£1·75	BSY82	52½p	NKT20339	37½p
2N1308	30p	2N3860	30p	ACY21	25p	BDY19	£1·97½	BSY90	57½p	NKT80111	77½p
2N1309	30p	2N3866	£1·50	ACY22	20p	BDY20	£1·12½	BSY95A	12½p	NTK80112	97½p
2N1507	17½p	2N3877	40p	ACY28	20p	BDY38	97½p	C111	75p	NKT80113	£1·12½
2N1613	25p	2N3877A	40p	ACY40	20p	BDY60	£1·25	C424	27½p	NKT80211	92½p
2N1631	35p	2N3900	37½p	ACY41	25p	BDY61	£1·25	C425	55p	NKT80212	92½p
2N1632	30p	2N3900A	40p	ACY44	40p	BDY62	£1	C426	40p	NKT80213	92½p
2N1637	30p	2N3901	97½p	AD140	52½p	BF115	25p	C428	37½p	NKT80214	92½p
2N1638	27½p	2N3903	35p	AD149	57½p	BF117	47½p	C744	30p	NKT80215	92½p
2N1671B	£1	2N3904	35p	AD150	62½p	BF163	37½p	D13T1	62½p	NKT80216	92½p
2N1711	25p	2N3905	37½p	AD161	37½p	BF167	25p	D16P1	37½p	OC20	75p
2N1889	32½p	2N3906	37½p	AD162	37½p	BF173	32½p	D16P2	40p	OC22	50p
2N1893	37½p	2N4058	17½p	AF106	42½p	BF177	30p	D16P3	37½p	OC23	60p
2N2147	82½p	2N4059	10p	AF114	25p	BF178	30p	D16P4	40p	OC24	60p
2N2148	57½p	2N4060	12½p	AF115	25p	BF179	30p	GET102	30p	OC25	50p
2N2160	57½p	2N4061	12½p	AF116	25p	BF180	35p	GET113	20p	OC26	27½p
2N2193	40p	2N4062	12½p	AF117	25p	BF181	32½p	GET114	20p	OC28	62½p
2N2193A	42½p	2N4244	47½p	AF118	62½p	BF184	25p	GET118	20p	OC29	62½p
2N2194A	30p	2N4285	17½p	AF119	20p	BF185	42½p	GET119	20p	OC35	50p
2N2217	27½p	2N4286	17½p	AF124	32½p	BF194	17½p	GET120	52½p	OC36	62½p
2N2218	32½p	2N4287	17½p	AF125	20p	BF195	20p	GET873	12½p	OC41	22½p
2N2219	32½p	2N4288	17½p	AF126	20p	BF196	42½p	GET880	30p	OC42	25p
2N2220	25p	2N4289	17½p	AF127	17½p	BF197	42½p	GET887	20p	OC44	20p
2N2221	25p	2N4290	17½p	AF139	37½p	BF198	42½p	GET889	22½p	OC45	12½p
2N2222	30p	2N4291	17½p	AF178	42½p	BF200	52½p	GET890	22½p	OC46	15p
2N2287	£1·07½	2N4292	12½p	AF179	72½p	BF224	20p	GET896	22½p	OC70	15p
2N2297	30p	2N4303	47½p	AF180	52½p	BF225	20p	GET897	22½p	OC71	12½p
2N2368	17½p	2N5027	52½p	AF181	42½p	BF237	22½p	GET898	22½p	OC72	12½p
2N2369	17½p	2N5028	57½p	AF239	42½p	BF238	22½p	MJ400	£1·07½	OC74	32½p
2N2369A	17½p	2N5029	47½p	AF279	47½p	BF244	32½p	MJ420	£1·12½	OC75	22½p
2N2410	42½p	2N5030	42½p	AF280	62½p	BFW58	27½p	MJ421	£1·12½	OC76	22½p
2N2483	27½p	2N5172	12½p	AFZ11	32½p	BFW59	25p	MJ430	£1·02½	OC77	30p
2N2484	32½p	2N5174	52½p	ASY26	25p	BFW60	25p	MJ440	95p	OC81	20p
2N2539	22½p	2N5175	52½p	ASY27	37½p	BFW61	47½p	MJ480	97½p	OC81D	22½p
2N2540	22½p	2N5176	45p	ASY28	27½p	BFX12	22½p	MJ481	£1·25	OC83	25p
2N2613	35p	2N5232A	20p	ASY29	27½p	BFX13	22½p	MJ490	£1	OC84	25p
2N2614	30p	2N5245	45p	ASY36	25p	BFX29	30p	MJ491	£1·37½	OC139	32½p
2N2646	52½p	2N5246	42½p	ASY50	25p	BFX30	30p	MJ1800	£2·17½	OC140	32½p
2N2696	32½p	2N5249	67½p	ASY51	32½p	BFX43	37½p	MJE340	62½p	OC170	30p
2N2711	25p	2N5265	£3·25	ASY54	25p	BFX44	37½p	MJE520	87½p	OC171	30p
2N2712	25p	2N5266	£2·75	ASY86	32½p	BFX68	67½p	MJE521	87½p	OC200	40p
2N2713	27½p	2N5267	£2·62½	ASZ21	42½p	BFX84	25p	MJE2955	£1·27½	OC201	60p
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2N2865	62½p	2N5306	40p	BC107	12½p	BFX86	25p	MPF102	42½p	OC203	42½p
2N2904	30p	2N5307	37½p	BC108	12½p	BFX87	27½p	MPF103	37½p	OC204	42½p
2N2904A	32½p	2N5308	37½p	BC109	12½p	BFX88	25p	MPF104	37½p	OC205	90p
2N2905	37½p	2N5309	62½p	BC113	20p	BFX89	62½p	MPF105	37½p	OC207	75p
2N2905A	40p	2N5310	42½p	BC115	27½p	BFX93A	70p	MPS3638	32½p	OCP71	42½p
2N2906	25p	2N5354	27½p	BC116A	27½p	BFY10	32½p	NKT0013	47½p	ORP12	62½p
2N2906A	27½p	2N5355	27½p	BC118	32½p	BFY11	42½p	NKT124	42½p	ORP61	50p
2N2907	30p	2N5356	32½p	BC121	20p	BFY17	22½p	NKT125	27½p	P346A	22½p
2N2923	15p	2N5365	47½p	BC122	20p	BFY18	32½p	NKT126	27½p	TIP29A	50p
2N2924	15p	2N5366	32½p	BC125	35p	BFY19	32½p	NKT128	27½p	TIP30A	60p
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2N2926		2N5457	37½p	BC140	37½p	BFY21	42½p	NKT137	32½p	TIP32A	75p
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2N3011	30p	2S103	25p	BC152	17½p	BFY29	50p	NKT213	30p	TIS43	40p
2N3014	32½p	2S104	25p	BC157	20p	BFY30	50p	NKT214	22½p	TIS44	12½p
2N3053	25p	2S501	32½p	BC158	17½p	BFY41	50p	NKT215	22½p	TIS45	12½p
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2N3135	25p	3N140	77½p	BC168C	15p	BFY53	17½p	NKT224	25p	TIS50	17½p
2N3136	25p	3N141	72½p	BC169B	14p	BFY56A	57½p	NKT225	22½p	TIS51	12½p
2N3390	25p	3N142	55p	BC169C	15p	BFY75	30p	NKT229	30p	TIS52	12½p
2N3391	20p	3N143	67½p	BC170	12½p	BFY76	42½p	NKT237	35p	TIS53	22½p
2N3391A	20p	3N152	87½p	BC171	15p	BFY77	57½p			TIS60	22½p
2N3392	17½p	R.C.A.:—				BFY90	67½p			TIS61	25p
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6A	—	—	25p	30p	32½p	35p	50p*	—
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IS120	15p	BA102	22½p	BY122	37½p	OA73	10p
IS121	17½p	BA110	32½p	BY124	15p	OA79	9p
IS130	12½p	BA115	7½p	BY126	15p	OA81	7½p
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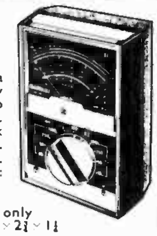

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PRACTICAL ELECTRONICS

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THAT SPECIAL PROBLEM

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

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

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

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

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

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

continued on page 559

THIS MONTH

Our August issue will be published on Friday, July 16

Practical Electronics, Fleetway House Farringdon St., London, E.C.4. Phone: *Editorial* 01-634 4452; *Advertisements* 01-634 4202

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

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

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

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

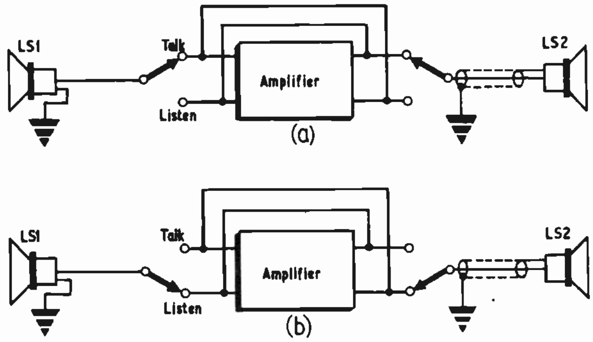
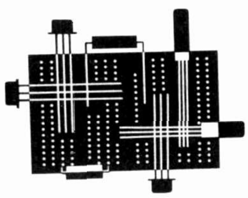


Fig. 1 (a). In the "Talk" position master loudspeaker LS1 acts as a microphone. LS2 functions normally as a loudspeaker (b). In the "Listen" position, slave loudspeaker now functions as the microphone and initiates the call. Ideally screened lead should be used for LS2 to eliminate noise influences

SIMPLE INTERCOM



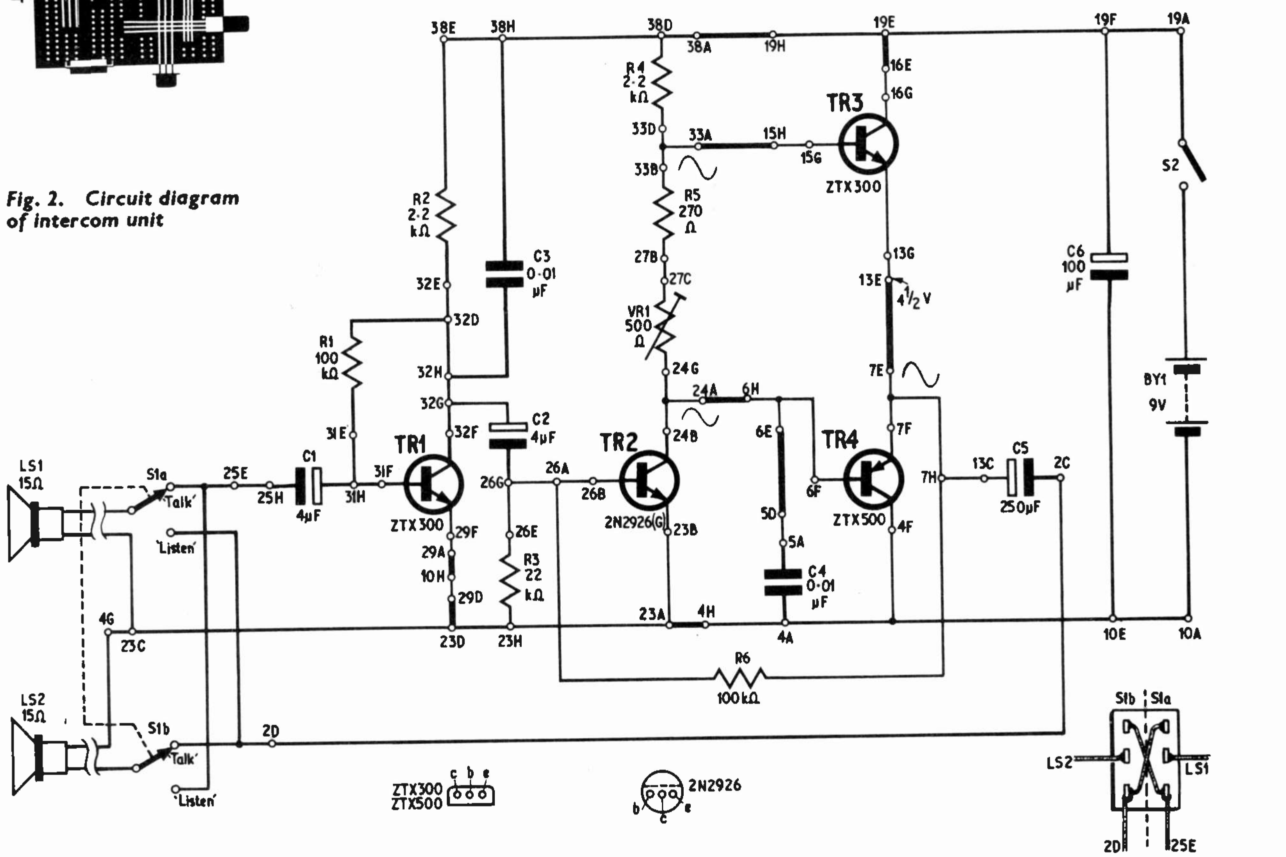


Fig. 2. Circuit diagram of intercom unit

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

COUNTING THE COST

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

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

The cost of the unit to build should be around £1·50. This excludes the price of the loudspeakers.

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

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

CIRCUIT ACTION

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

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

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

Components . . .

Resistors
- R1 100kΩ
- R2 2·2kΩ
- R3 22kΩ
- R4 2·2kΩ
- R5 270Ω
- R6 100kΩ
- All 10% ½ watt carbon

Capacitors

C1	4μF	elect. 15V
C2	4μF	elect. 15V
C3	0·01μF	polyester
C4	0·01μF	polyester
C5	250μF	elect. 15V
C6	100μF	elect. 15V

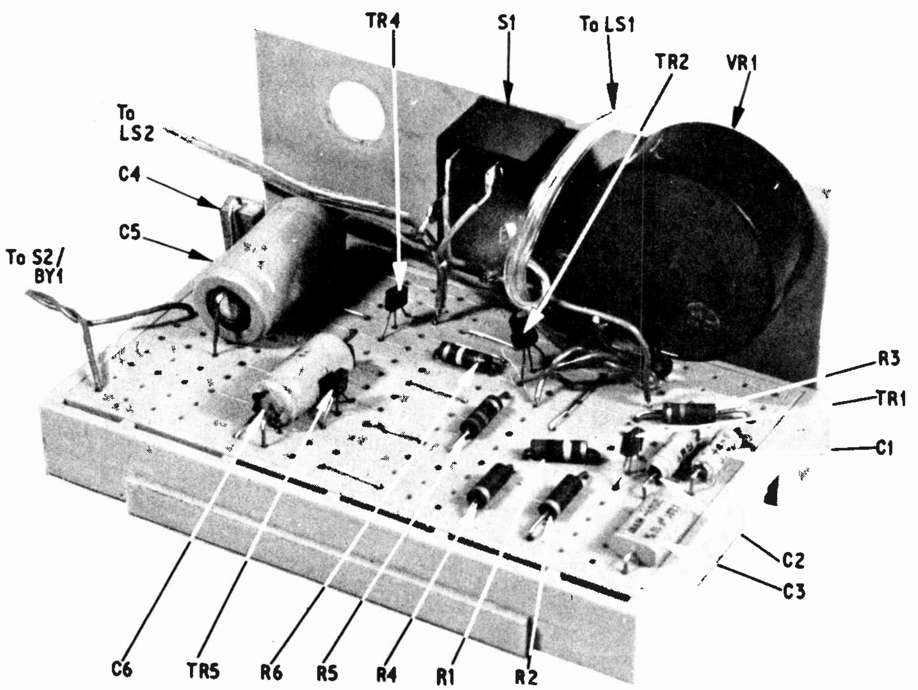
Transistors

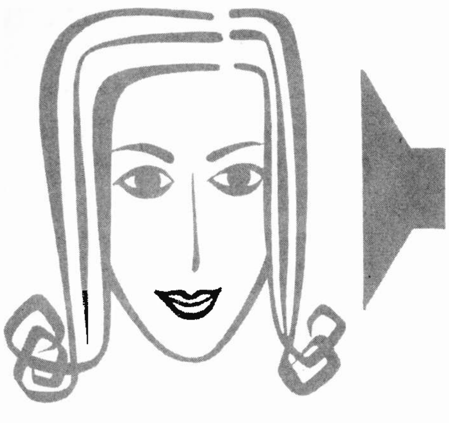
TR1	ZTX 300
TR2	2N2926 green spot
TR3	ZTX 300
TR4	ZTX 500

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

Loudspeakers
- LS1, LS2 5in, 15Ω (2 off)

Miscellaneous
- BY1—9V
- T-Dec, connecting wire





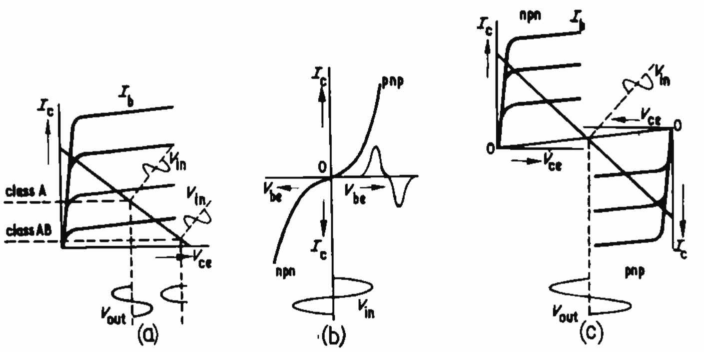


Fig. 3 (a). Transistor output characteristic showing two common bias conditions (b) How input characteristic non-linearity produces cross-over distortion with zero biased input signal (c) slight forward bias for the complementary transistors gives a clean output voltage (V_{out})

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

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

CLASS AB

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

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

CROSSOVER DISTORTION

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

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

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

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

NOISE

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

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

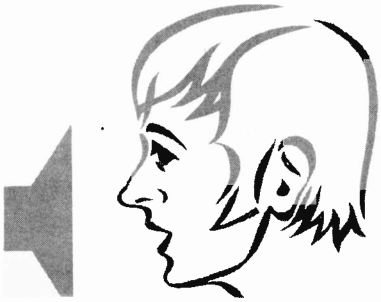
Spontaneous high frequency oscillation can also be a nuisance so decoupling capacitors C3 and C5 are included.

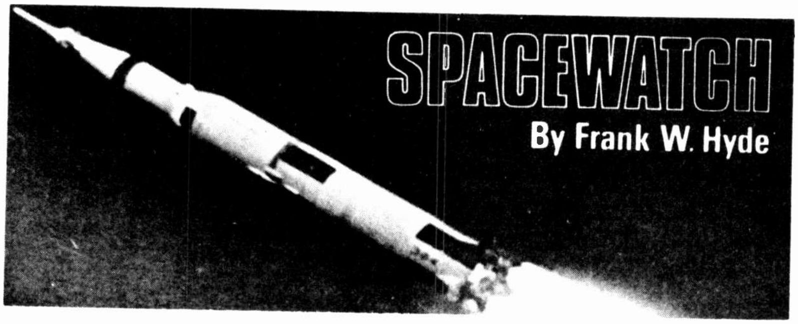
SETTING UP

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

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

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





CANADIAN SATELLITE

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

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

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

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

TRACKING CENTRE

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

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

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

Other data provided by these satellites will include information of the effect of the sun on the earth's atmosphere and may lead to the solution of how atmospheric pollutants are disposed, and how and what mechanism might be available naturally for dispersal.

LUNAR NAVIGATION

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

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

LUNAR LOPE

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

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

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

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

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

ROCK COLLECTION

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

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

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

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

MOON BIRTH

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

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

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

P.E. AURORA

MUSIC INSPIRED LIGHT AND COLOUR

PART 4 · LIGHT DISPLAYS BY M. LEONARD A.R.I.B.A.

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

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

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

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

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

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

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

MATRIX DISPLAYS

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

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

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

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

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

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

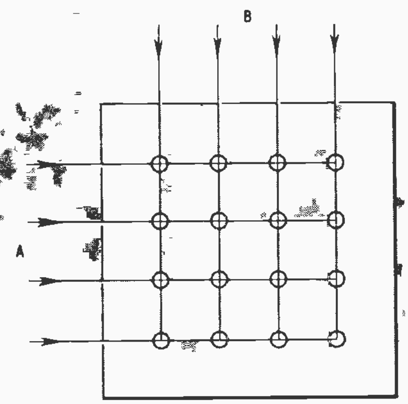


Fig. 1. Basic matrix of 16 lamps triggered from an eight-channel controller

BULB SELECTION

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

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

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

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

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

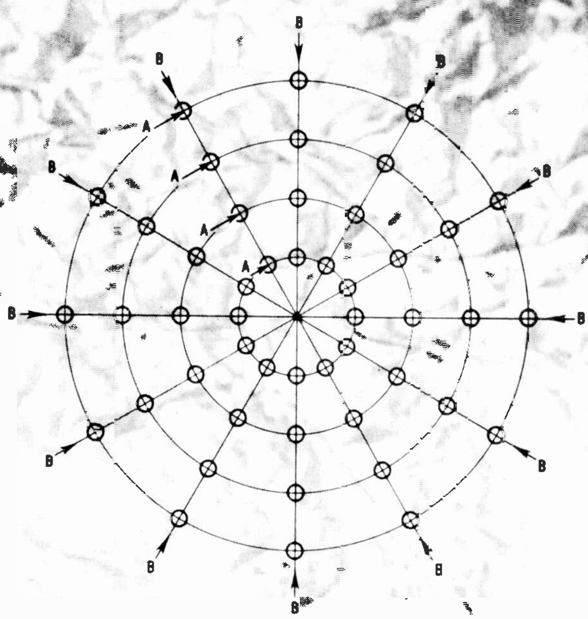


Fig. 2. Two-dimensional display taking in four concentric channels and 12 radial channels (total 48 lamps, 16 control channels)

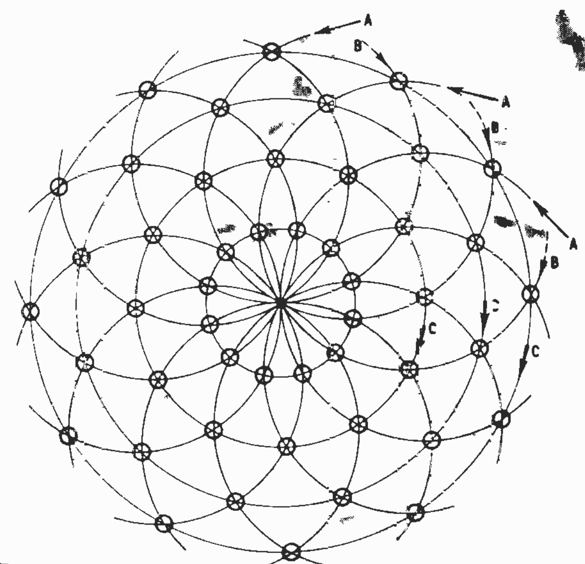


Fig. 3 (right). Three-dimensional display taking in four concentric channels, 12 A radial channels, and 12 B radial channels (total 48 lamps, 2 · 16 control channels)

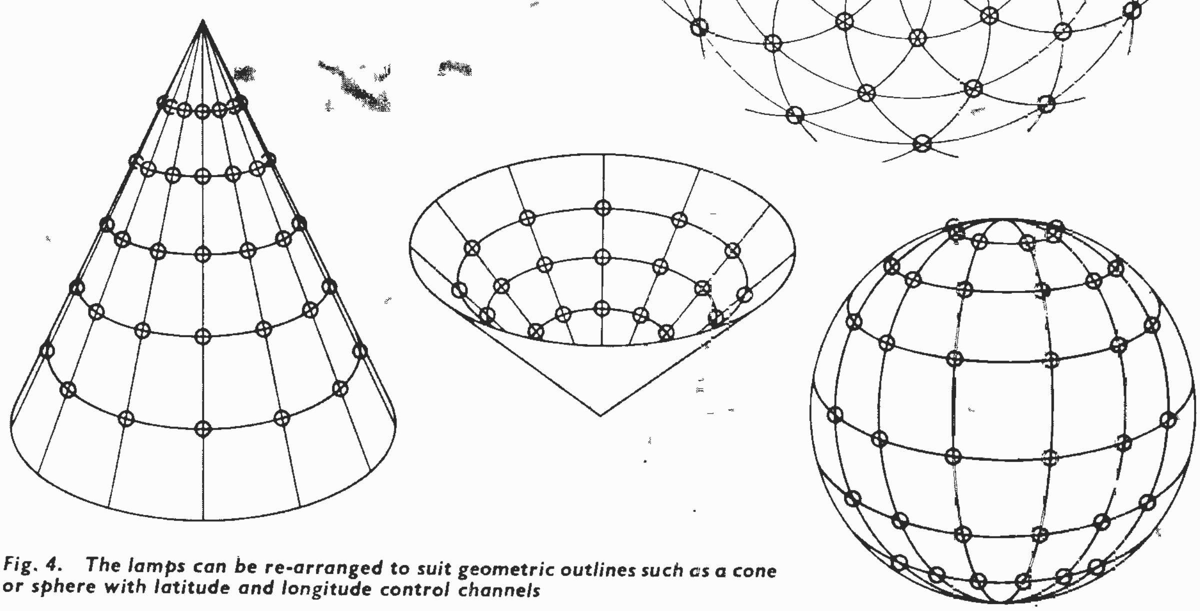


Fig. 4. The lamps can be re-arranged to suit geometric outlines such as a cone or sphere with latitude and longitude control channels

DISPLAY CABINET

In the final display cabinet, as illustrated on the front cover and in Fig. 6, the bulbs used were 40 watt 240 volt "continental" fittings, of 1$\frac{3}{4}$in diameter. These were "pearl" in finish and were left exposed, creating perfect spheres of white light.

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

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

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

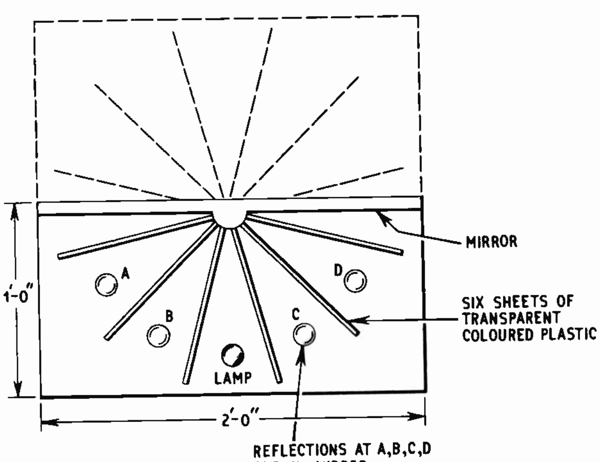


Fig. 5. One bulb can supply a large number of images by reflections in Perspex panels in the shape of a fan

COLOUR MIXING

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

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

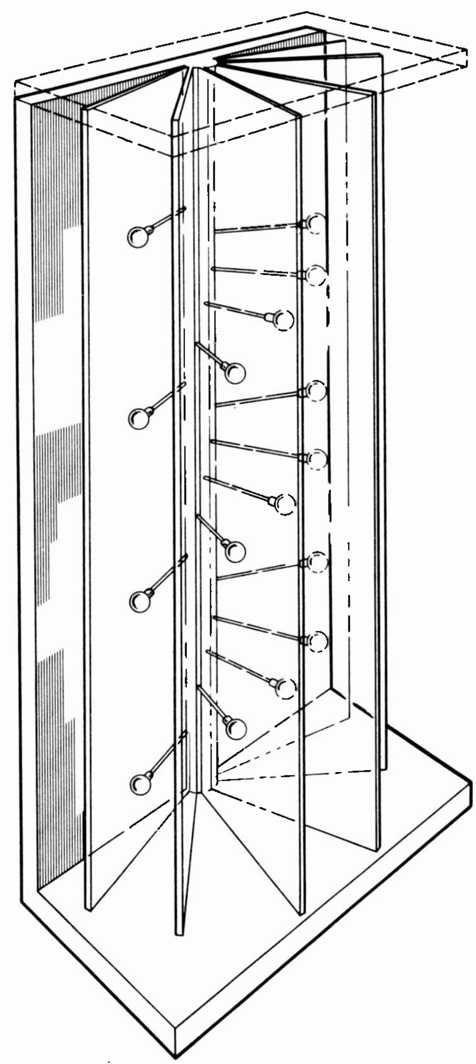


Fig. 6. The finished display cabinet was built around a central trunk with radiating fins of coloured Perspex and a mirror at the back. Matrix wiring is used as in Part I, the diodes being mounted on the back panel

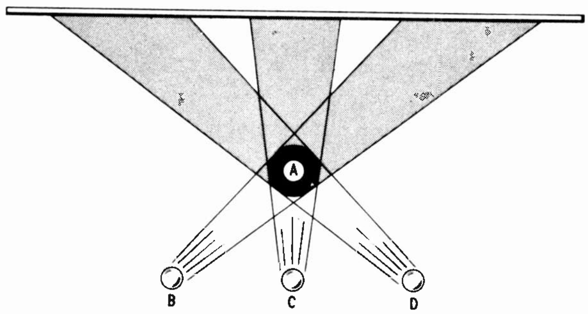


Fig. 7. Tri-colour shodow casting technique

COLOUR LIGHT MIXING

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

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

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

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

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

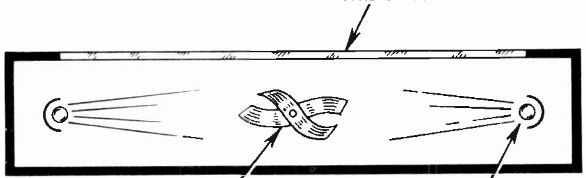


Fig. 8. Colour reflecting from the idea shown in Fig. 7. The coloured light is projected onto a translucent screen of opal finish

LIGHT MURALS

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

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

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

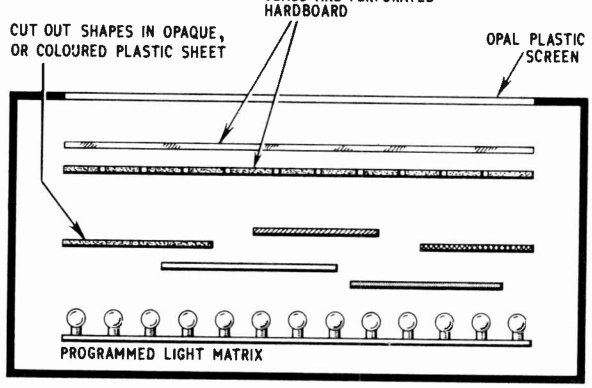


Fig. 9. Back projection onto an opal finish screen through layers of translucent material or perforated sheet

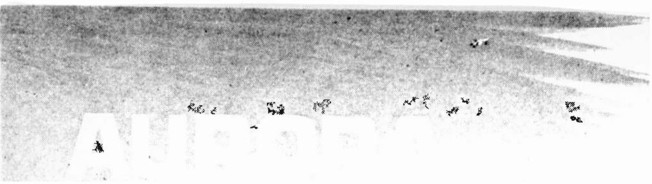
The final layer is an opal screen. A simple framework will be needed to allow the planes to be suspended, and the distance between the elements easily varied.

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

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

PLAN A SYSTEM

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



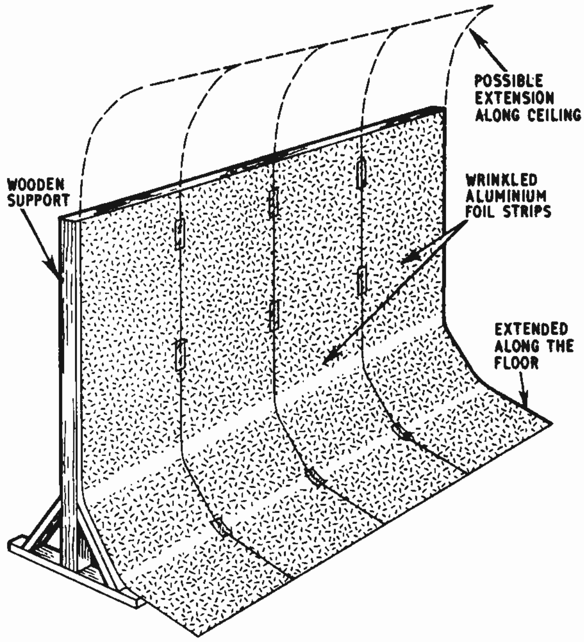


Fig. 10. Simple wall of wrinkled aluminium foil for direct front projection of coloured light

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

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

ALUMINIUM WALL OR SCREEN

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

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

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

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

EIGHT CHANNEL OPERATION

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

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

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

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

ADDING VARIANTS

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

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

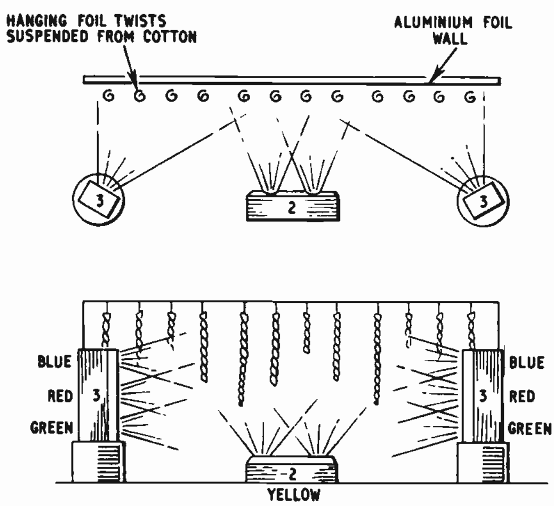


Fig. 11. Suggested positions of the eight coloured lamps in relation to the aluminium wall

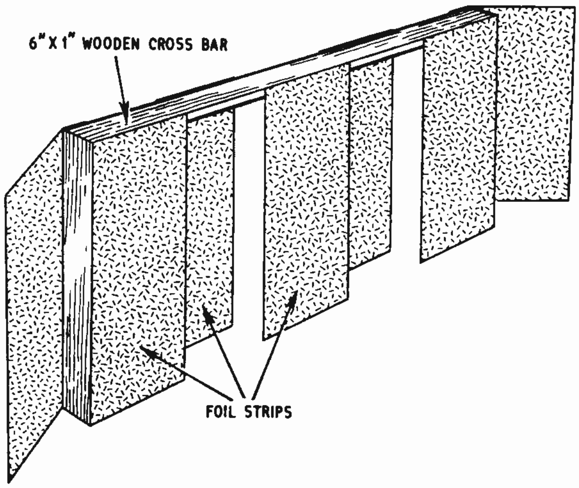


Fig. 12. Staggered foil strips on a 6in wide supporting batten

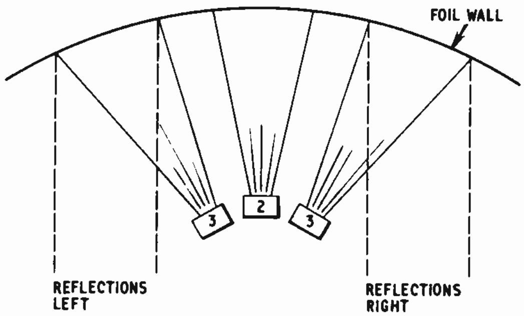


Fig. 13. "Cinemascope" concave mirror of foil

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

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

SUBTLE CHANGES

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

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

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

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

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

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

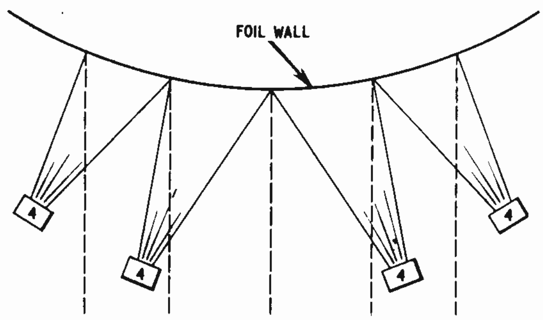


Fig. 14. Convex side projection

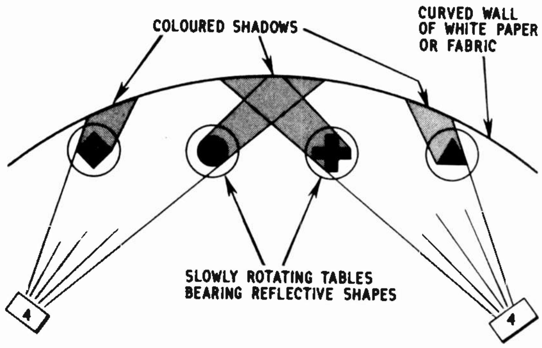


Fig. 15. Rotating reflective shapes in front of a curved white screen

Gerry Brown . . .

ON THE FRINGE

BITTER SWEET

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

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

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

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

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

CHICKEN

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

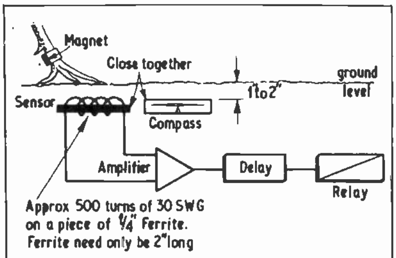


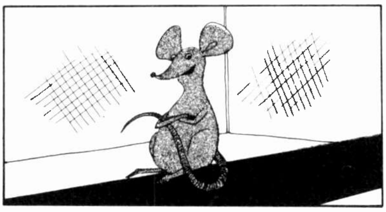
Fig. 1

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

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

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

I understand that this fowl plan was eminently successful!



PSI EFFECT

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

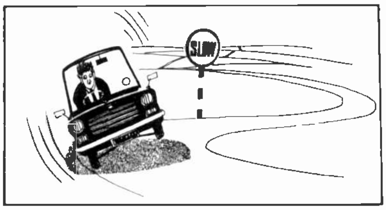
Because the rules of human studies in the ESP (extra sensory perception) field have proved so indeterminate, he has chosen to use mice in his studies.

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

Statistically they ought to be correct 50 per cent of the time, but (mice being what they are) this worked out to be 54 per cent! Precognition? Rhine seems to think so; in fact he goes so far as to say that he believes the whole of the animal world may have this power. Who can say; certainly it's beginning to look as though there might just be something in what he says.

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

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



ROUND THE BEND

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

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

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

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

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

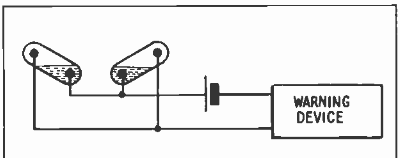
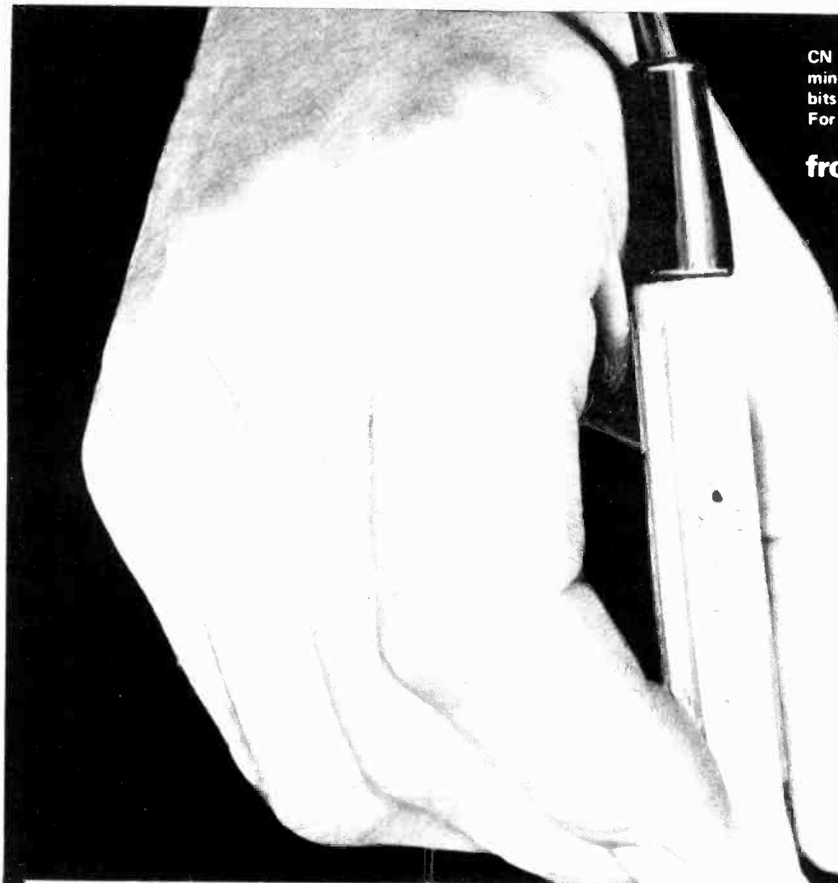


Fig. 2



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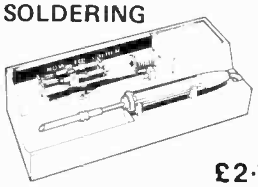

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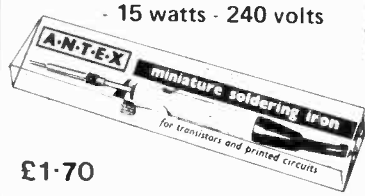

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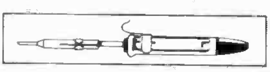

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THAT SPECIAL PROBLEM

continued from page 545

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

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

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

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

F.E.B.

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

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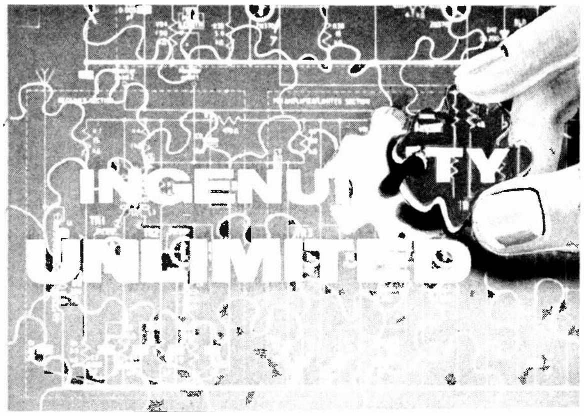

A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.
This is YOUR page and any idea published will be awarded payment according to its merit.

TEMPERATURE CONTROLLER

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

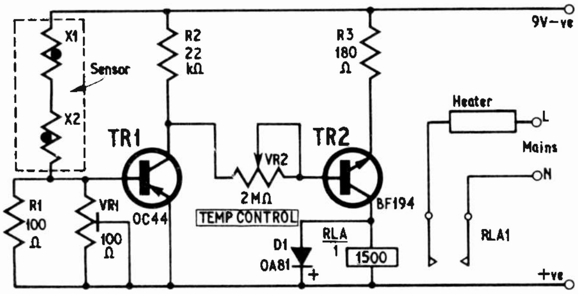

Fig. 1. Circuit diagram of the temperature controller. The thermistors X1 and X2 are types VA1070 as used in television heater chains and are rated at 0·3A

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

The relay was the only one available at the time, its working voltage was 20V, although it pulled in at 7·5V and the coil resistance was 1·5 kilohm. A relay of a lower working voltage would obviously improve the performance of the circuit.

When setting up the controller, the end of VR2 connected to the collector of TR1 should be disconnected and a voltmeter connected between the collector and the positive line. VR1 should be adjusted to give a meter reading of 7·5V. When VR1 has been adjusted to give the correct setting the meter should be removed and VR2 reconnected —the controller is now ready for use.

It should not be difficult to replace the relay with a thyristor. This should be done by omitting RLA1 and D1, replacing this with a 1·5 kilohm resistor. The collector of TR2 could then operate the gate of a thyristor to switch on the heater. This has not been tried in practice.

A. D. Huff,
Dagenham,
Essex.

POWER SUPPLY CUT-OUT

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

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

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

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

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

$$R1 = \frac{0{\cdot}6}{\text{Limiting current}} \text{ Ohms}$$

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

G. H. Birkinshaw,
Brimington,
Chesterfield.

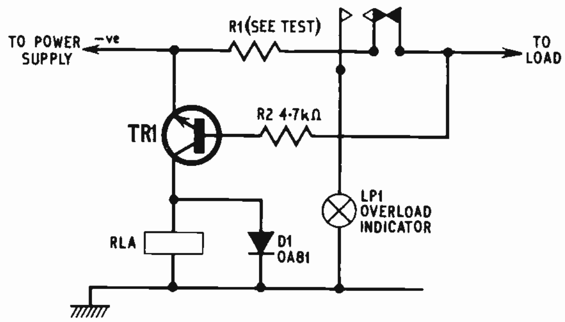

Fig. 2. Circuit diagram of the power supply cut-out

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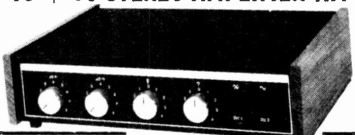

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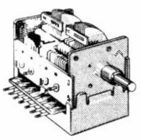

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HI-FI LOUDSPEAKER SYSTEM

Beautifully made teak finish enclosure with most attractive Tygan-Vynair front. Size 16½in high × 10½in 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.

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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 1¾ × 1¼ × ⅝in. Brand new — complete with instructions. Price **88p.** P. & P. 13p.

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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.

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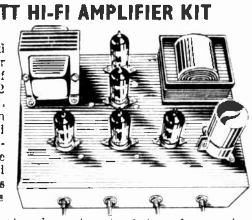
10/14 WATT HI-FI AMPLIFIER KIT



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.

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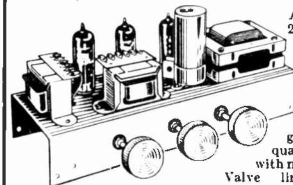
Beautifully made all-wooden construction cabinet with medium walnut finish front, gold anodised expanded aluminium grille and dark sides. Approx. size overall 11½" high × 5" deep × 13½" wide at base. Easily removable baffle cut out for 8" speaker. Fibre board back. Could accommodate amplifier or radio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

LIMITED NUMBER ONLY £1·38 Post Free.

DE LUXE STEREO AMPLIFIER



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

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Mains models. All brand new in maker's packing.
LATEST B.S.R. C109/A21 4-SPEED AUTOCHANGER. With latest mono compatible cartridge **£6·97.** Carr. 50p. With stereo cartridge **£7·97.** Carr. 50p.
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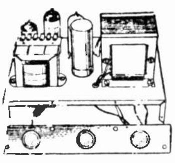
3-VALVE AUDIO AMPLIFIER HA34 MK II



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in w. × 4in. d. × 4¾in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4·75.** P. & P. 35p.

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

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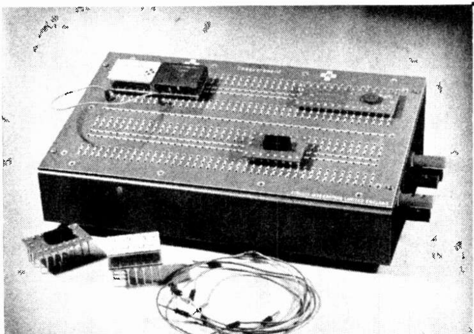
MARKET PLACE

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

EXPERIMENTER'S BOARD

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

The patchboards, which can accommodate from 12 up to 48 14-pin carriers according to size, consist of a series of sockets on ⅛in centres into which the carriers are plugged. The arrangement of these sockets is such that each pin of the carrier has two further sockets connected to it, so that interconnections can be made with the patchcords provided.



Chequerboard by Circuit Integration

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

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

A wide variety of 14 and 16-pin carriers is available. The 14 and 16-pin DIL, 8 and 10-pin TO5, and flat-pack i.c.'s can all be accommodated, either by soldering to a blank carrier or, more usefully, by plugging into carriers which have the appropriate sockets on them. A plain carrier enables units to be constructed from discrete components. A very good point is that provision is made on each carrier for decoupling the supply lines.

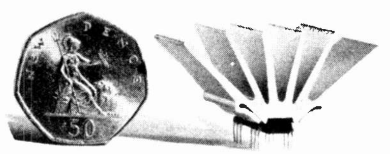
The system also includes a number of pre-wired modules which include a switch unit, a pulse generator, an indicator unit with three filament lamps, and several TTL gates and flip-flops. It would perhaps be less confusing if the indicator unit followed the normal positive logic convention, i.e. lamp ON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

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

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

SUPER I.C.

After two highly successful years, the **Sinclair** IC-10 integrated circuit amplifier has had to give way to a successor.



IC-12 marketed by Sinclair Radionics

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

The output claimed is 6W r.m.s. continuous (12 watts peak). Frequency response is quoted as 5Hz to 100kHz ±1dB. The total harmonic distortion is claimed to be less than 1 per cent (typically 0·1 per cent) at all output powers and all frequencies in the audio band. The quiescent current stated is 8mA at 28V. Input impedance is 250 kilohms nominal and the load impedance is 3 to 15ohms.

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

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

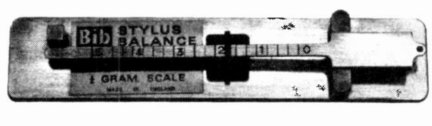
The price of the Super IC-12 is £2·98 including a printed circuit board for mounting.

STYLUS BALANCE

Calibrated in ¼ gram divisions, the **Bib** Model 32 stylus balance is claimed to be the first balance designed for determining the pressures of modern cartridges.

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

The price of the Bib model 32 stylus balance is £1·80 and as the balance will only be used occasionally, it is packed in a robust plastics case.



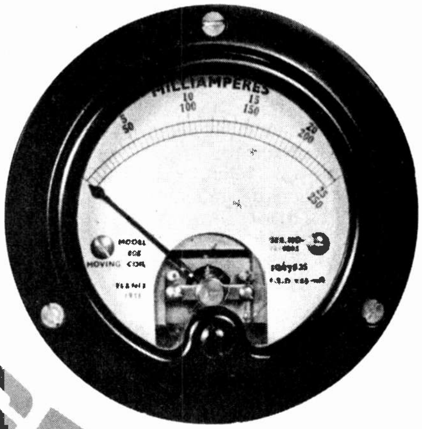
Bib Model 32 stylus balance from Multicore Solders

LITERATURE

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

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

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



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

VOLTAGE STABILISER

By
A. J. Ewins

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

The stabiliser can accept input voltages of up to 85 volts d.c. (depending on the output voltage setting) and provide a fully variable stabilised output voltage from 0 to 30 volts d.c. at up to 250mA load current. To obtain a stabilised output voltage the input voltage must exceed the required level by 2 volts. The stabiliser draws virtually no current from the external supply and is completely self-contained. Automatic current limiting is built into the unit and can be set to any one of five values, namely, 10, 25, 50, 100 or 250mA.

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

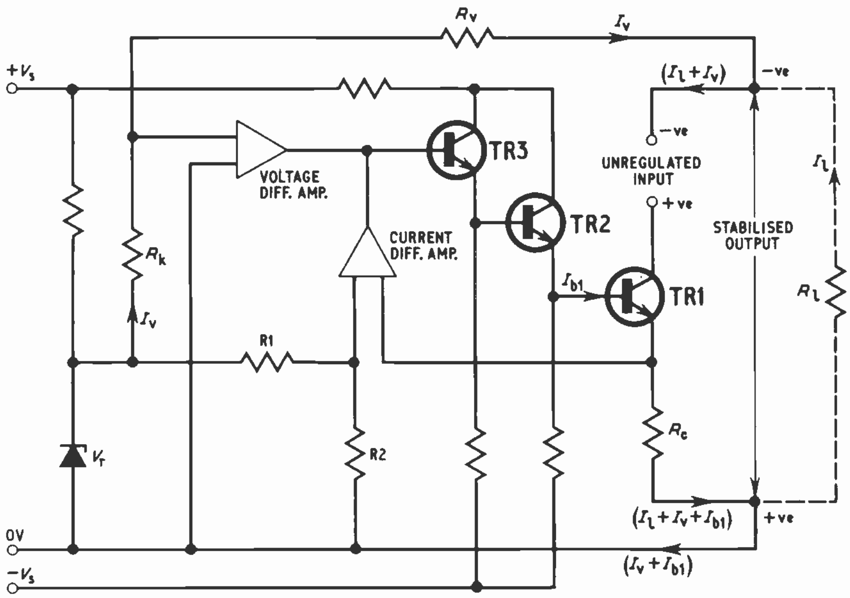
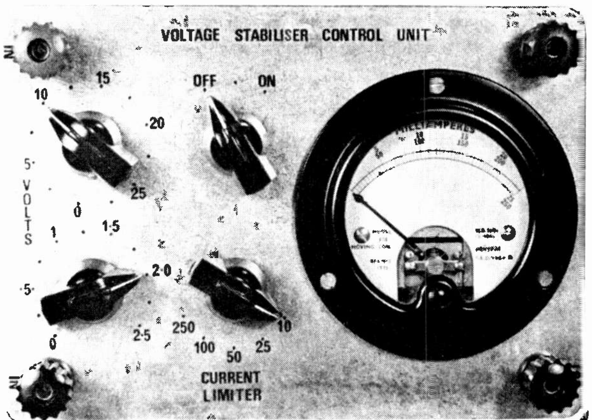


Fig. 1. Block diagram showing fundamental stabiliser

PRINCIPLE OF OPERATION

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



SPECIFICATION . . .

Stabilised Voltage Output: 0 to 30 volts in switched steps of 2·5 volts, plus 0 to 2·5 volts, fully variable. Input voltage must be between 2 and 55V in excess of output level required.

Constant Current Capability: 250µA to 250mA, continuously variable.

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

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

Stabilised Voltage Stability:
(a) ±0·1 per cent for variations in the input voltage of from 2 to 35 volts in excess of the output voltage.
(b) ±0·1 per cent for variations in the external load from 0 to 250 mA.
(c) ±1 per cent for normal room temperature variations
(d) ±0·1 per cent for variations of ±10 per cent of the unit's internal battery supply voltages.

Output Impedance: Less than 0·03 ohms over audio frequency range (No current limiting).

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

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

When the output current nears its limiting value, the voltage developed across R_c nears the reference voltage level fed to the current differential amplifier, which is equal to $V_r.R2/(R1 + R2)$. The result of this is that current is drawn away from the base of TR3 by the current differential amplifier thus reducing the output voltage in order to maintain a constant current through R_c.

When completely current limiting the current differential amplifier has full control over the current flowing into the base of TR3, the voltage across R_c is stabilised at a value equal to $V_r.R2/(R1 + R2)$ and the current flowing through R_c is maintained at a constant value equal to $V_r.R2/(R1 + R2)R_c$. Because the currents I_{b1} and I_v are flowing through R_c in addition to the load current, I_l, the output current in the limiting condition is given by the expression:

$$I_l = V_r.R2/R_c.(R1 + R2) - I_{b1} - I_v$$

Now, the current flowing through R_c is also equal to the emitter current of TR1, I_{e1}, which is equal to $(\beta_1 + 1).I_{b1}$, where β_1 is the current gain of TR1. Thus $I_{b1} = I_{e1}/(\beta_1 + 1)$ and I_l becomes:

$$I_l = \beta_1.V_r.R2/R_c\,(R1 + R2)\,(\beta_1 + 1) - I_v$$

Thus, providing β_1 is very much greater than one, I_l is approximately equal to:

$$V_r.R2/R_c.(R1 + R2) - I_v$$

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

GENERAL CIRCUIT DESCRIPTION

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

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

When the output voltage is stabilised (i.e. no current limiting) transistor TR6 is cut-off since its base voltage is below the value of the base voltage of TR5 with the result that all of the 100µA constant current, except that which flows into the base of TR7, flows through the collector of TR3. Any change in output voltage is inversely reflected at the base of TR2. A drop in the output voltage raises the voltage at the base of TR2 above zero and hence raises its emitter voltage. As the base of TR3 is connected to the zero volt line, by way of R20, a rise in its emitter voltage starts to cut the transistor off directing more of its collector current into the base of TR7. This in turn increases the current into the bases of TR8 and the series regulator, TR9, reducing TR9's effective resistance and therefore the voltage dropped across it. The output voltage is thus restored to its original stable value.

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

REFERENCE VOLTAGE

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

The silicon diodes, D3 and D4, protect the base of TR2 from any large voltage swings. D2 also prevents the base of TR2 from going more than 0·6 volts positive when current limiting takes place. Any low current type of silicon diode is suitable in these positions.

REMAINING COMPONENT FUNCTIONS

The 0·47µF capacitor, C2, in parallel with the resistors around S2 and VR2, effectively increases the loop gain of the stabiliser to alternating voltages at the output, with the result that the ripple content is reduced as is the output impedance of the unit.

The 0·001µF capacitor, C3, and the 22 kilohm resistor, R19, connected in series between the collector and base of TR3 reduce the loop gain of the amplifier at high frequencies and prevent instability that would otherwise occur.

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

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

The total consumption of the 9V positive rail is approximately 11mA. Two 4·5V pocket lamp batteries (No. 1289) were chosen for this supply rail because of their large capacity and convenient size.

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

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

COMPONENTS . . .

Resistors

R1–R11 10kΩ—see text (11 off)

R12	1·1kΩ	R23	2kΩ
R13	510Ω	R24	16kΩ
R14	16kΩ	R25	47kΩ
R15	680Ω	R26	100kΩ
R16	20kΩ	R27	100kΩ
R17	43kΩ	R28	4Ω (see text)
R18	24kΩ	R29	10Ω
R19	22kΩ	R30	20Ω
R20	680Ω	R31	40Ω (see text)
R21	16kΩ	R32	100Ω
R22	5·1kΩ	Rs see text	

All ± 5% $\frac{1}{8}$W, carbon high stabs.

Capacitors

C1 10µF elect. 12V
C2 0·47µF polyester
C3 0·001µF polyester
C4 10µF elect. 12V
C5 50µF elect. 100V
C6 0·1µF polyester 250V
C7 10µF elect. 12V

Potentiometers

VR1 5kΩ skeleton preset
VR2 10kΩ wire wound
VR3 5kΩ skeleton preset

Semiconductors

TR1 2N4289
TR2, 3 2N3707 (matched pair)
TR4 2N4058
TR5, 6 2N3707 (matched pair)
TR7 2N3707
TR8 BC168
TR9 B5041
D1 3V, 400mW Zener diode
D2 4·7V, 400mW Zener diode
D3, 4 any good low current silicon diode (2 off)

Miscellaneous

M1 25mA moving coil meter (2½in diameter case)
S1 4 pole 3 way rotary switch
S2 Single pole 12 way rotary switch
S3 4 pole 5 way rotary switch (only 3 poles used)
SK1, SK4 Red screw terminals (2 off)
SK2, SK3 Black screw terminals (2 off)
BY1, BY2 No. 1289 4½V battery (2 off)
BY2 PP3, 9V battery
Veroboard 5¼in × 2in × 0·15in matrix
Die-cast box 6¾in × 4¾in × 2¼in
4B.A. fixings, connecting wire, knobs for VR2, S1 to S3, material for battery fixing.

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

RANGE SWITCHING

The sensing current, I_v (see Fig. 1) is designed to be 250μA, which gives a value for R_v of 4 kilohms per volt. The maximum output from the unit is 30 volts giving a total resistance for R_v of 120 kilohms. A 10 kilohm wire-wound control (VR2) provides 0 to 2·5 volts fully variable and a twelve position rotary switch (S2), switching in successively eleven 10 kilohm fixed resistors (R1 to R11), provides 0 to 27·5 volts in 2·5 volt steps. The rotary switch used for this operation is a single-pole 12-way wafer type. Eleven 10 kilohm fixed resistors are required for the construction of the switched ranges; 1 per cent, high-stability types could be used, but they are invariably large and expensive. The author found it more convenient, and cheaper, to use $\frac{1}{8}$ watt, 5 per cent, high-stabs. of 11 kilohms in value and shunt them, as required, with 5 per cent resistors of values 100 kilohms, 200 kilohms, 390 kilohms and 820 kilohms. This method enables them to be matched to the value of the wire-wound control which is unlikely to be within 1 per cent of its nominal value.

Next month: construction details

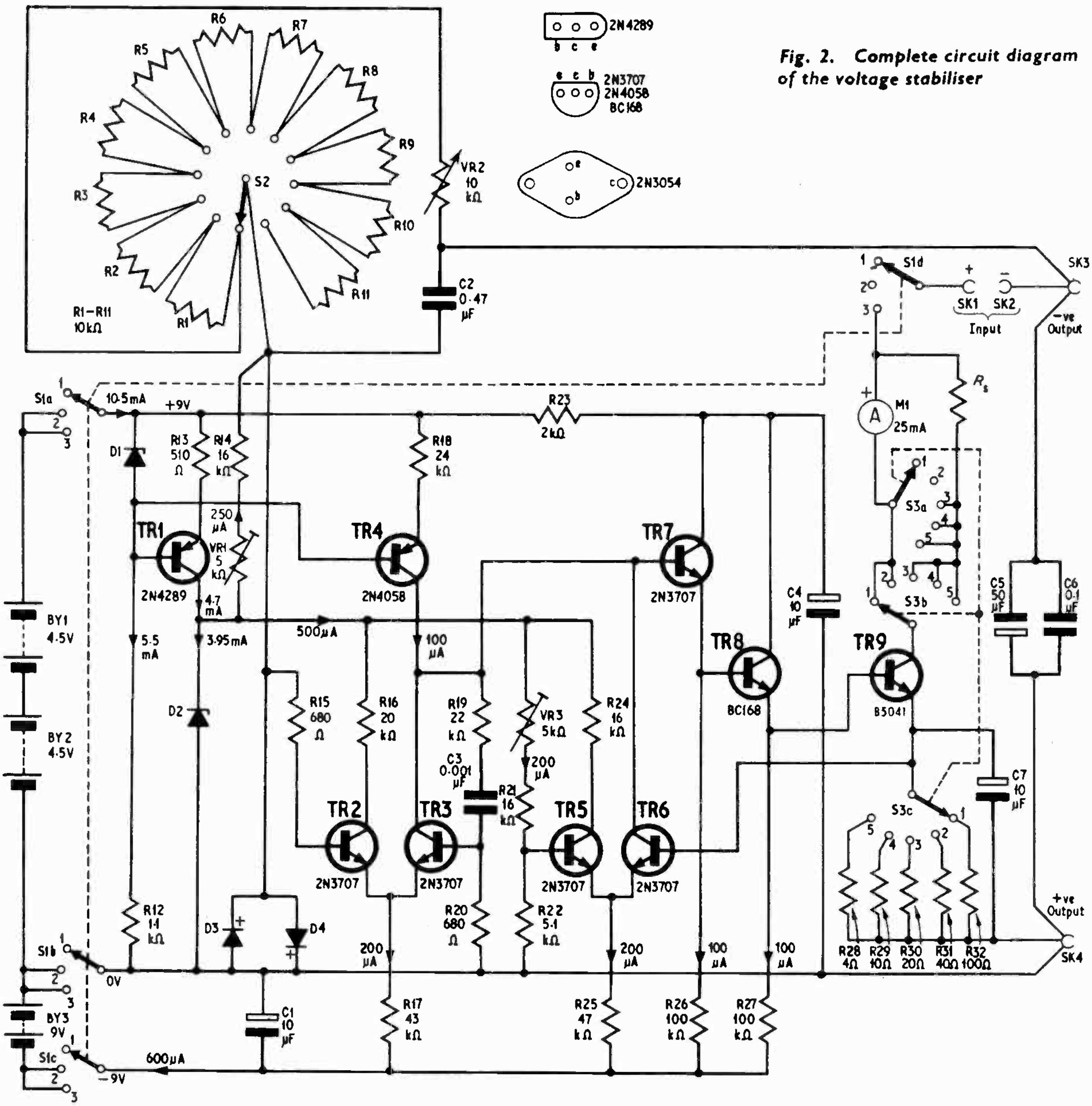


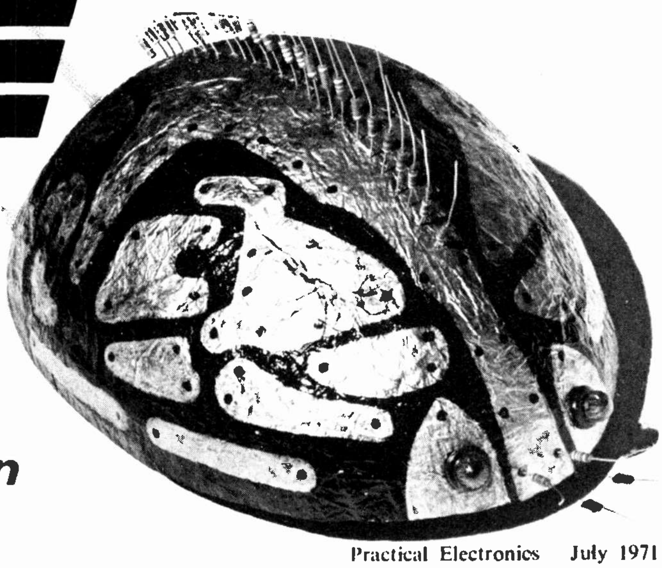
Fig. 2. Complete circuit diagram of the voltage stabiliser

XEE

PART 2

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

By G. Brown



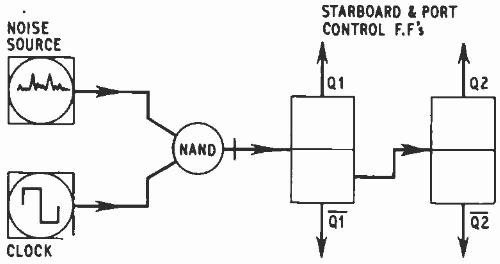


Fig. 6. Basic principle of the noise processing

In Part 1 we considered the theoretical aspects of XEE's operational characteristics. This month, in the second and final part, we look at the system logic, construct the animal and perform the various tests.

RANDOM CONTROL SYSTEM

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

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

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

NOISE PROCESSING

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

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

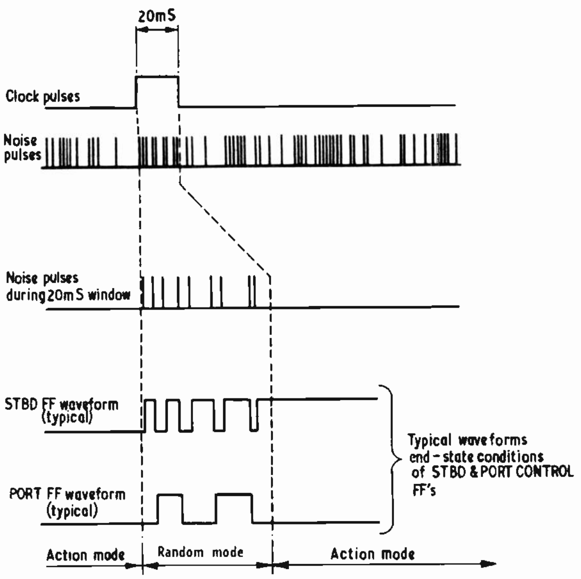


Fig. 7. Waveforms associated with random control system

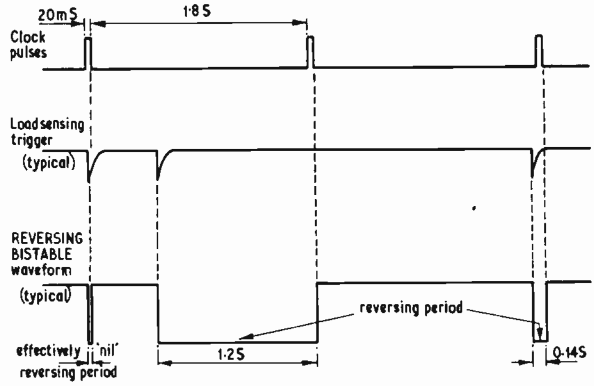


Fig. 8. Waveforms associated with load sensing and reversing bistable

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

REVERSE GATING

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

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

INHIBIT REVERSE GATING

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

STOP GATING

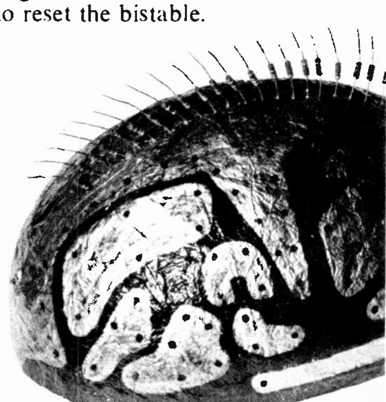
The stop function, overriding all other functions, is available through the agency of gate G3 (IC1). If both its inputs are at logical 1 then the output is at 0, with the result that all motor supplies are disconnected and the animal stops. If, on the other hand, either or both inputs are at 0, then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

AVOIDANCE FUNCTION

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

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

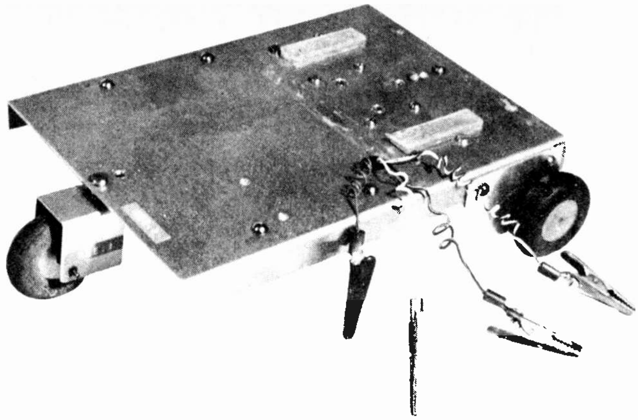
For operation of the reversing bistable it is convenient to think of it being first reset by the clock. Since, at the clock pulse, a 0 is fed to G2 (IC5) its output will go to logical 1. As a result, G1 (IC5) will have one input at the same level, and because its other input is connected to a capacitor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



OPTICAL SENSE AND RANDOM FUNCTION

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

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



DIRECT SENSING

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

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

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

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

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

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

RANDOM CONTROL

If the inputs to G2 (IC1) and G3 (IC7) are left connected to the starboard and port control flip-flops, the optical sense displays quite different characteristics. One interesting point is that XEE no longer shows quite the same zest for mounting walls when in the reverse mode!

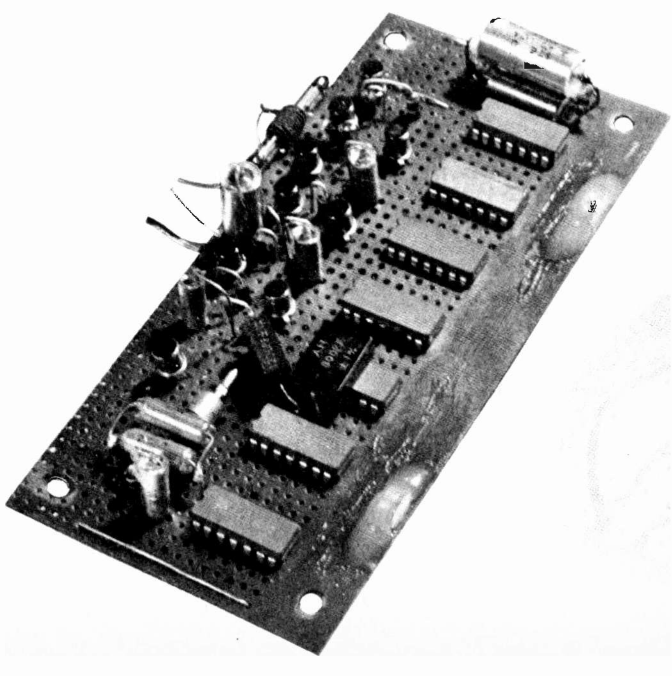
Optical sensing under random control permits XEE to extricate itself from powerful light sources. This is achieved by means of the control over the input gates. As a consequence, even though an input may be present at either of the sensors, unless the relevant gate is in receipt of a 1 from its associated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

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

CONSTRUCTION

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

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



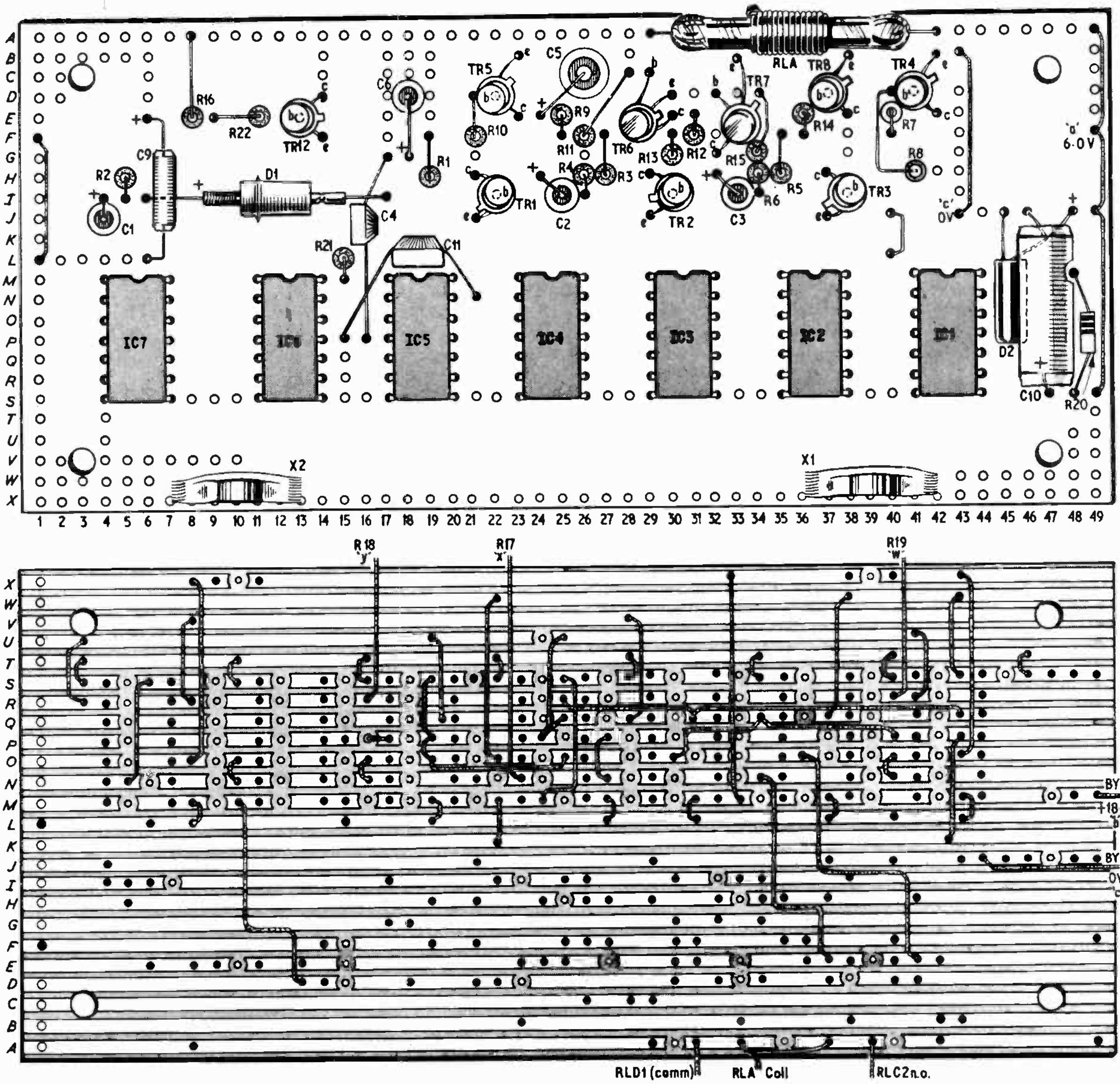


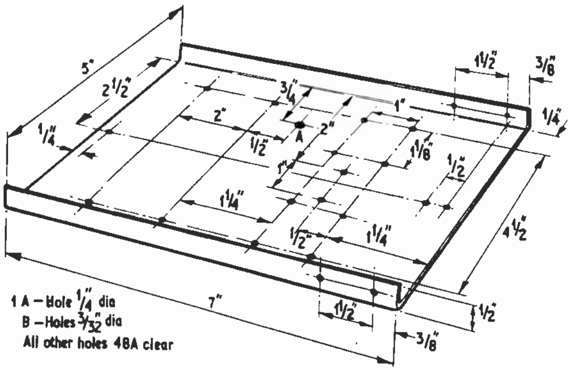
Fig. 9. Layout and wiring of the circuit board

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

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

Mounting of the integrated circuits is best done first; the job is not a particularly difficult one, but it is essential that care be taken to ensure that every one of the 14 leads in each I.C. go through the holes in the circuit board. Attention is drawn to this fact because it is easy to think that all the leads are poking through the board, when in reality they are not. The trick, if there is one, in fitting the I.C.'s is to ease the seven leads on one side through first, then, with the aid of the three fingers of one hand placed in-line against the edge of the remaining pins, gently locate and press them through the relevant holes. As each I.C. is fitted in this way it is advisable to solder it in place, lest it falls out as the next one is being attached.

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



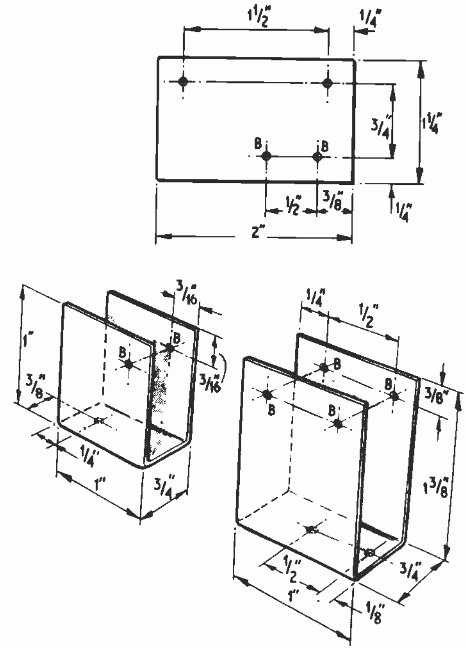


Fig. 11. Chassis details

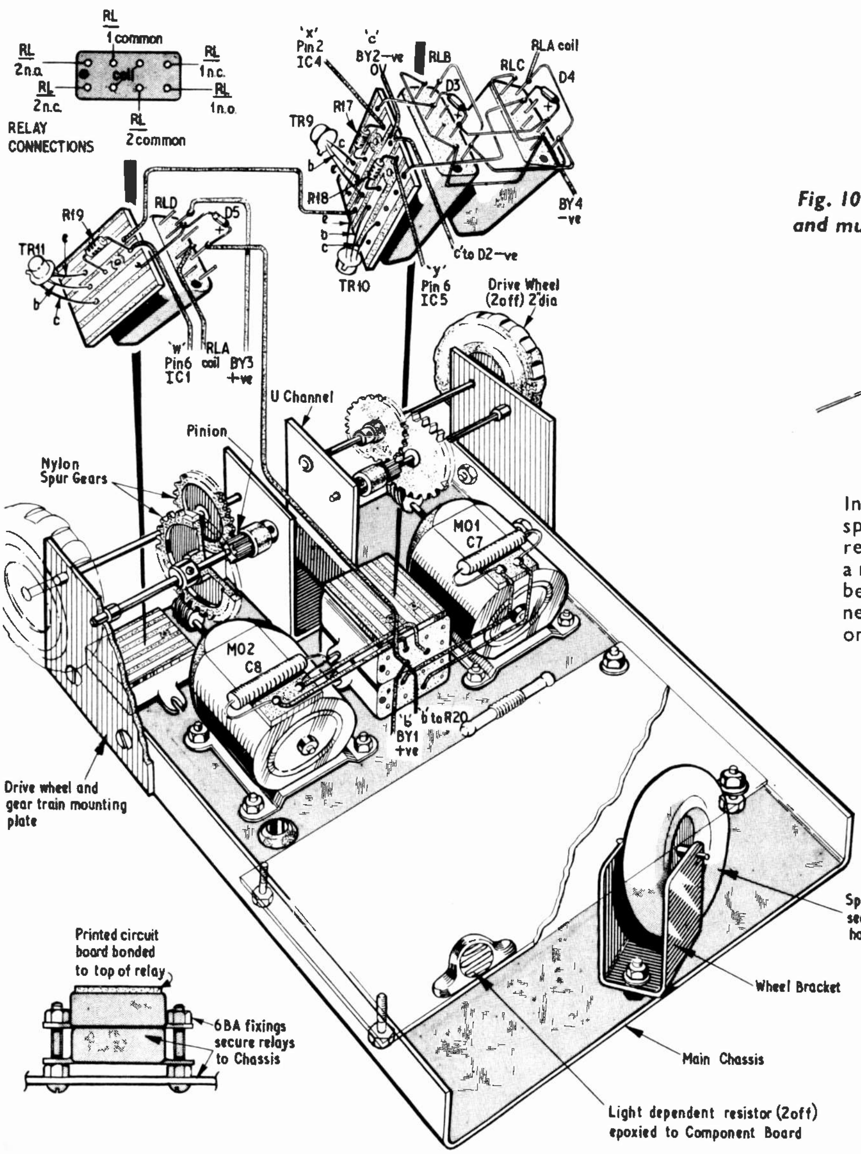
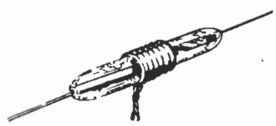


Fig. 10. General layout of XEE and muscle control circuit wiring



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

LOAD SENSOR

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

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

OPTICAL SENSORS

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

INITIAL TESTING

Just before testing, give the boards a visual inspection to make absolutely certain that no dry joints, bridge-overs, or wiring errors exist. The muscle control boards will not need to be checked out now, but will be tested in conjunction with the relays later. Connect points "b" and "c" on the main circuit-board to an 18·0 volt d.c. source; "b" must go to positive, and "c" to the negative. While performing the tests make sure to keep the optical sensors clear from any direct sunlight which could cause ambiguous results.

RANDOM CONTROL SYSTEM

Connect a voltmeter (set to a range which will measure 6·0V) between earth and pin 13 of the starboard control flip-flop (IC2), and check that approximately every second or so there is a brief flicker shown by the meter. This will be the indication if the clock is functioning correctly. Now disconnect the lead from pin 13 and connect it to pin 10 (IC2). The meter reading should be either a steady 6·0V (logical 1), or very nearly zero (logical 0); this indication should be interrupted about every second by the effect of the clock and noise pulses. It is important that this last reading changes in a random fashion periodically. Next, disconnect the lead from pin 10 and reconnect it to pin 10 on the port flip-flop (IC3). The reading should be similar to the last, to wit, it must change randomly from 1 to 0 every now and then. If no change is observed, then connect the meter between earth and pin 3 of the starboard flip-flop (IC2). In this position it should indicate a regular flickering due to the noise source. If this is not so, the Zener diode D1 should be disconnected and replaced by another one. Sometimes one comes across a particularly "un-noisy" diode, these "good ones" are however no good to us!

STOP AND REVERSE GATING

Connect the meter between earth and the output of the stop gate. This should periodically change its logical state from 1 to 0, or from 0 to 1. Disconnect the meter from the stop gate and reconnect it with the output of the inhibit starboard reverse gate. Now disconnect the leads going to pins 5 on the two control flip-flops, and apply the light from a torch to the port optical sensor.

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

REVERSING FUNCTION

With no light applied to the optical sensors, trigger the reversing bistable by momentarily touching an earth connection on either one of the inputs of G1, IC5 (pins 12 and 13). The meter should immediately indicate a logical 1 condition (if it is not already). This reading should eventually change once the reversing bistable has been reset by the clock pulse and the system returns to the control of the random control section. Connect the meter to the output of the starboard reverse gate. Again trigger the reversing bistable and ensure that the results are the same. Disconnect the meter and the 18·0 volt supply. Reconnect the leads to pins 5 of the control flip-flops.

CHASSIS CONSTRUCTION

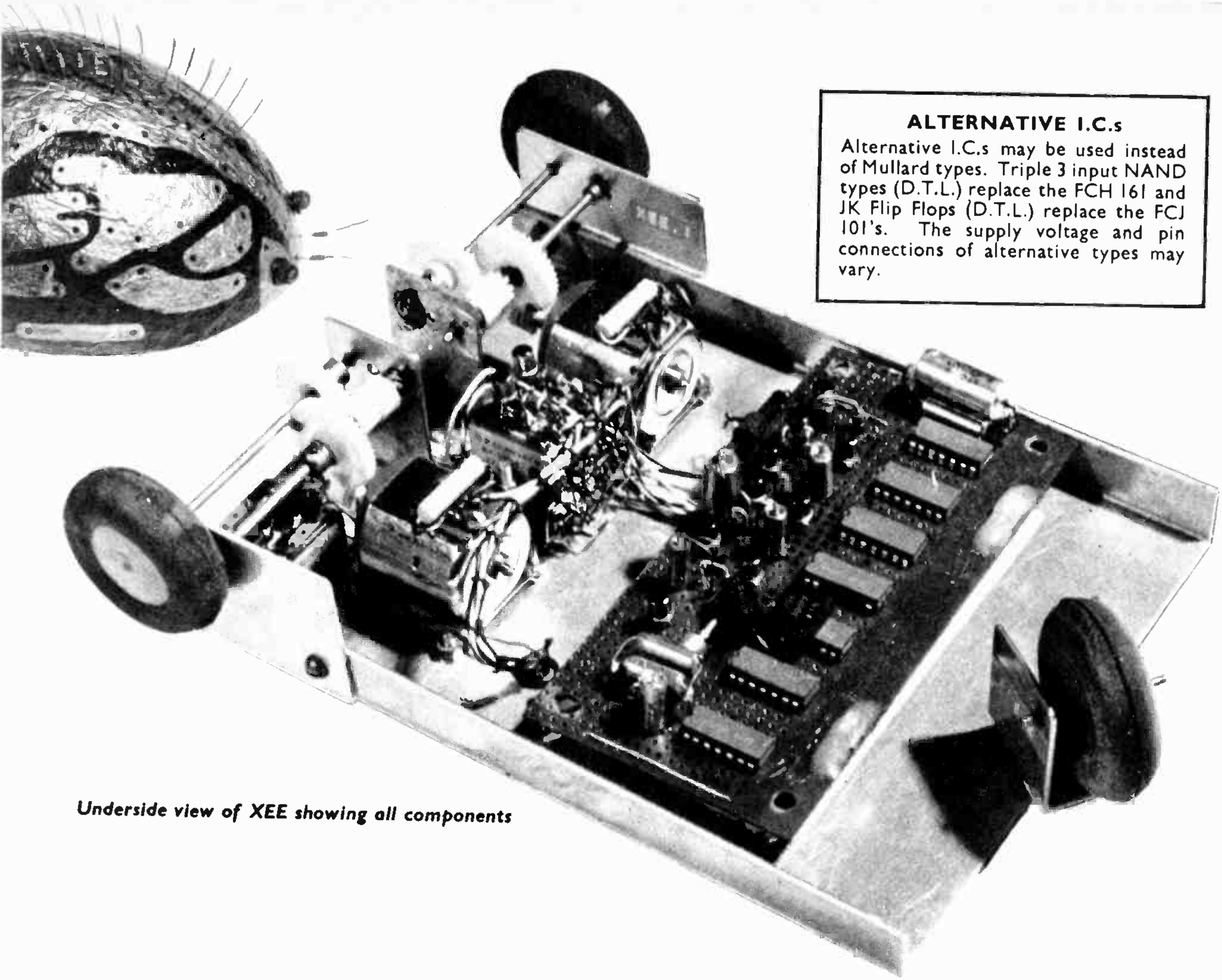
The type of material from which the chassis is fabricated is not particularly critical; for the prototype, 16 gauge aluminium was used. The chassis takes the form of a single piece of material having two $\frac{3}{4}$ inch right-angle sections folded down the length of its sides. The rear side plates carrying the gear shafts and wheels are mounted on this chassis.

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

MOTORS, GEARS AND WHEELS

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

The rear wheels, one attached to each final-drive shaft, are $1\frac{1}{2}$ inch diameter soft rubber aircraft type. These should have their centres drilled out a little to accommodate $\frac{3}{32}$ inch shafting, and be secured in position with epoxy resin. In order to achieve improved traction, the rear wheels should have their



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

Underside view of XEE showing all components

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

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

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

MOUNTINGS

Four 4B.A. screws secure the main board to the chassis. The screws are initially bolted to the chassis, their nuts serving as spacers to separate the board from the metal body. Once the screws and nuts have been fitted, a layer of insulation tape, approximately the same size as the main board, should be placed directly beneath where the board will be located. This will ensure that no exposed wiring gets shorted out on the chassis. At this stage the supply leads, outputs w, x and y and the connections to RLA should be connected up and have sufficient length to reach the other areas of the animal to which they will be later connected. The main board can now be fitted.

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

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

SYSTEM INTERCONNECTIONS

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

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

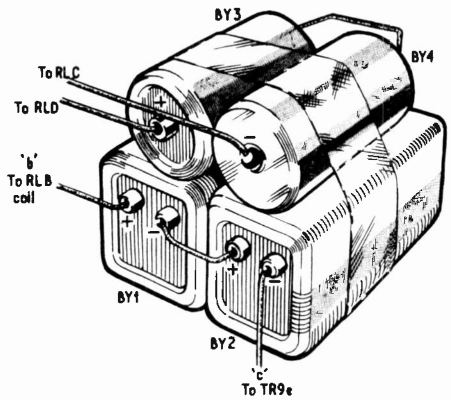


Fig. 12. Battery fixing and wiring details

BATTERIES

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

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

FINAL TESTING

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

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

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

BODY

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

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

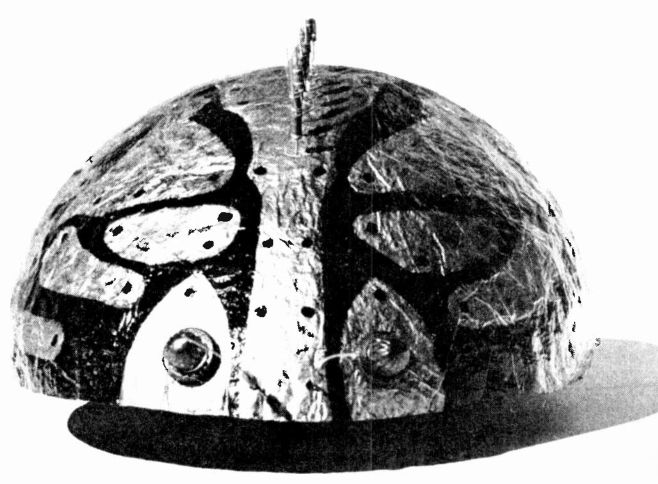
Decoration can be painted on the shell as desired and eyes made from the plastic lamp covers glued on over holes in the shell behind which can be mounted X1 and X2. The prototype XEE utilises a selection of resistors to form a spine and has an on-off switch as a tail!

CONCLUSION

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

ACKNOWLEDGEMENT

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



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

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

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

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

RESISTANCE METER

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

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

A PAINT PIN-HOLE DETECTOR

The PIPSQUEAK

By H. T. KITCHEN

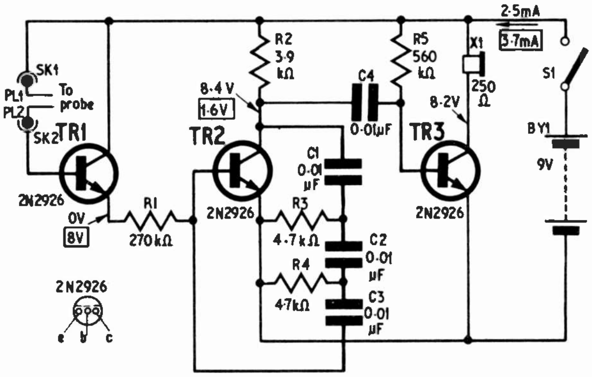


Fig. 1. Circuit diagram of pin hole detector

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

STANDARD COMPARISON

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

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

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

It was a revelation to discover that the paintwork

CIRCUIT ACTION

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

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

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

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

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

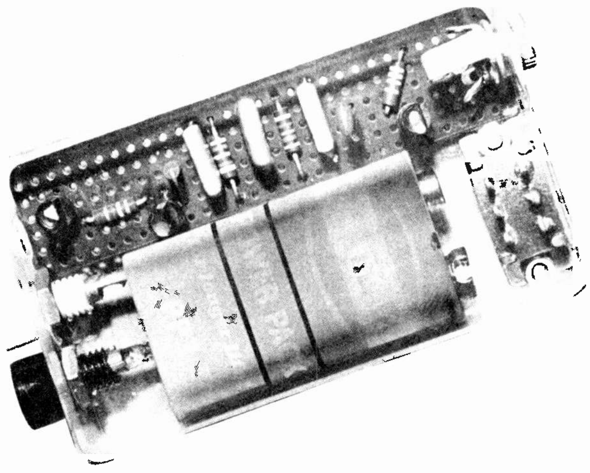
The current drawn from a 9V battery is very modest, 2·5mA at quiescent, rising to 3·7mA maximum with the probe short circuited.

CONSTRUCTION

The prototype was made up on a piece of plain 0·1in pitch peg board, shown in Fig. 2. The components are inserted from one side, and the leads interconnected on the other side, sleeving being used where appropriate. Any plastic box with dimensions approximating 3in × 3in × ¾in will provide a suitable housing.

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

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



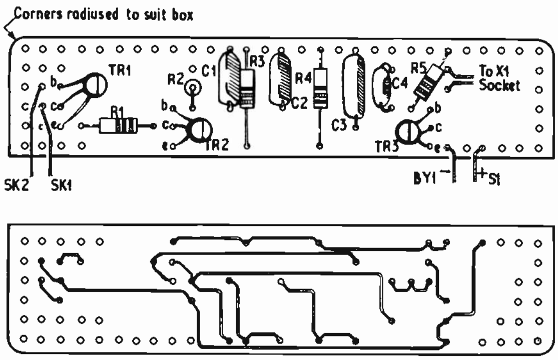


Fig. 2. Board assembly and wiring details

COMPONENTS . . .

Resistors
R1 270k
R2 3·9k
R3 4·7k
R4 4·7k
R5 560k
all 10% ⅛W

Capacitors
C1–C4 0·01 polyester (4 off)

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

Earpiece
X1 250Ω Magnetic with socket

Miscellaneous
PL1, 2 Miniature plugs (2 off)
SK1, 2 Miniature sockets (2 off)
S1 Single pole on/off slide
BY1 9V PF3
Plastics case 3 in × 2 in × ¾ in

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

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

USING THE DETECTOR

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

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

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

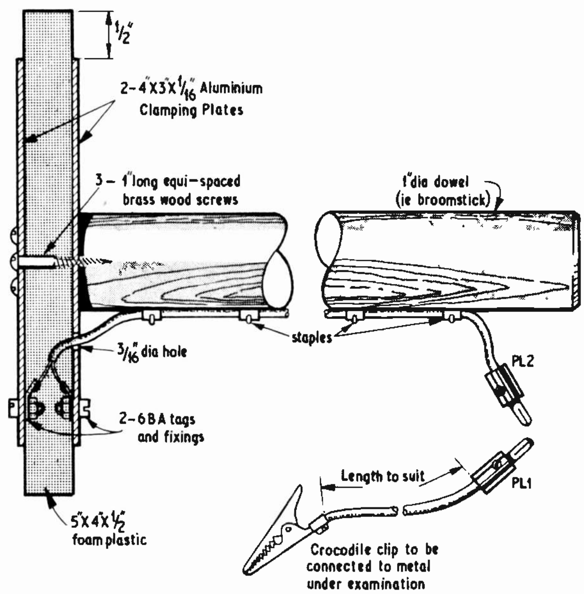
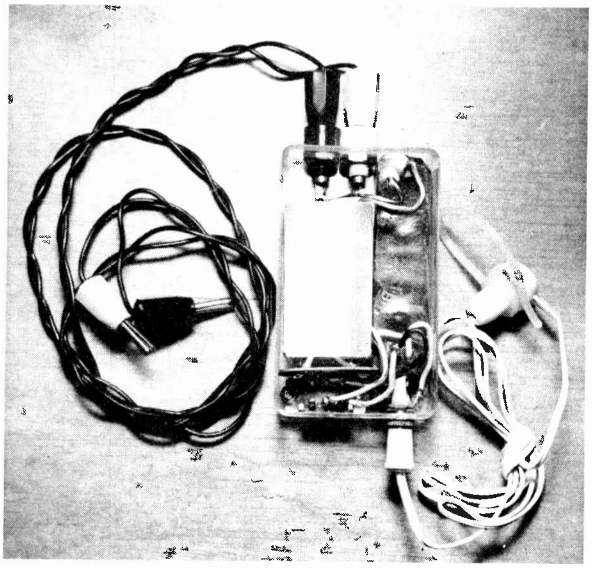


Fig. 3. Probe assembly details



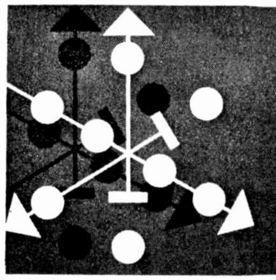
area is then circled with chalk—not grease pencils or "Chinagraphs", as these may show through when painted over—for subsequent repainting.

SPURIOUS SIGNALS

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

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

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



Physics Exhibition

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

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

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

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

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

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

For technical reasons, satellite television systems in advanced countries would probably use the frequency band 11·7GHz to 12·7GHz with either digital or frequency modulation. Commercial success would depend greatly on the availability of cheap, reliable microwave components.

A solid state digital clock with an unusually small readout display proved an arresting item of the Marconi stand. This indicated hours and minutes using four characters each of which consisted of seven tiny electro-luminescent bars providing a total character size of 0·185in by 0·125in. (!)

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

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

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

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

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

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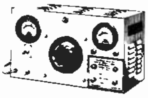

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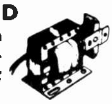

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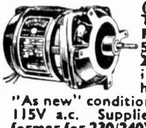

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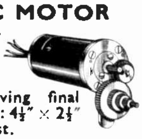

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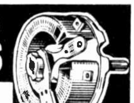

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230	9–12	4 c/o	78p*	2,500	36–45	6M	63p*
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Readout—
A SELECTION FROM OUR POSTBAG

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

Tiresome and uneconomic

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

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

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

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

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

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

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

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

Direct access

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

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

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

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

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

Workable solution

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

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

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

Not all roses!

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

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

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

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

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

Finally, referring both to the letter published in the magazine by the private individual referring to the inability to obtain 1 off, and your own comment, we must point

Readout—
A SELECTION FROM OUR POSTBAG

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

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

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

Distribution set-up

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

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

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

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

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

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

Customer relations

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

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

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

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

Your responsibility

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

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

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

H. Boys,
Weedon, Northampton.

Mystery of the Ferrites

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

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

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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
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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
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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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Clearance of manufacturers' seconds, selected in types and guaranteed no open or short circuit units. Ideal cheap transistors for radio enthusiasts, manufacturers, schools and colleges.

TYPE STN18. Silicon Planar Transistors npn TO-18 Metal Can. Types similar to: 2N706, 2N2220, BSY27-95A, BSX44-76-77.
Price: **500 £9, 1,000 £15**

TYPE STP18. Silicon Planar Transistors pnp TO-18 Metal Can. Types similar to: BCY70-72, 2N2906-7, 2N2411 and BC186-7. Also used as complementary to the above npn type device type STN18.
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TYPE STNL. Silicon Plastic Epitaxial Planar Transistors TO-92 case. I.C. 200mA, 300mW medium to high gain, available in npn or pnp and types similar to: *NPN*2N2926—2N2711—2N3391—2N3707 — 2N3711 — BC167-8-9.
Price: **500 £7 50; 1,000 £13**

TYPE STPL. As above but in pnp and similar to types 2N5354-56, 2N4058-2N4061 and 2N3702-3. Also used as complimentary to the above npn devices type STNL.
Price: **500 £7·50; 1,000 £13**

TYPE STNK. Silicon Planar Plastic Transistor npn with TO-18 pin circular lead configuration, I.C. 200mA, 300mW and similar to BC107-8-9, BC170, BC173, BC182-184, BC237-8-9 and BC337-8.
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100	£1·50	10,000	£90·00
500	£6·00	50,000	£400.00
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LINEAR INTEGRATED CIRCUIT 709/PC S.G.S.

TO-5 can 8 lead. Full specification high gain Operational Amplifier data supplied. Lowest ever price.

***QUANTITY:* 1-9, 10-24, 25-99, 100-999, 1,000+**

***PRICE EACH:* 37p, 34p, 30p, 25p.**

INVERTER UNITS

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

Type No. 126123. This is for working 3 miniature 6 watt 9in tubes from 12V battery. In sheet steel case. Size: 10in × 2¼in × 2in with connection diagram. Price **£4·25.**

Type No. 126328 for working one 2ft 20 watt tube from 12V battery, this is on a metal plate which can also be used to hold the tube (using Terry clips). Price **£3·50.**

Type No. 126461 same as 126328 except that it works off 24V battery. Price **£4·50.**

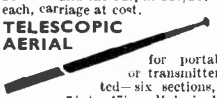
Type No. 126345 same as 126328 except that it is for 21in tube off 24V. Price **£3·75.**

Type No. 59814 for working up to 6 9in miniature 6W tubes from 24V in pressed steel case. Size: 10in × 2¼in × 2in with connection diagram. Price **£6·50.**

Type No. 59801 for working one 2ft 20W tube off 24V battery. This is in a pressed steel case. Size: 10½in × 2in × 1½in. Price **£3·50.**

Type No. YB. This is a big 24V unit. It weighs about 60lb and measures 24in × 8in × 7in approx. It looks big enough to light a bus. It uses 22 Mullard OC20 power transistors. Input voltage is 24V d.c. and the output 220/240V a.c. Price **£20** each, carriage at cost.

TELESCOPIC AERIAL



for portable, car radio or transmitter. Chrome plated—six sections, extends from 7¼ to 47in. Hole in bottom for 6BA screw. **38p** KNUCKLED MODEL FOR F.M. **50p.**

QUICK CUPPA

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

THYRISTOR LIGHT DIMMERS

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

COMPUTER TAPE

2,400ft of the best magnetic tape money can buy. Almost unbreakable and on a metal computer spool. Users have claimed successful results with video as well as sound recordings. 1" wide **£1.** ¾" **88p** ½" **75p.** P. & P. 33p extra. Spare spools **50p** extra. Cassette to hold spool **50p** extra. No postage if ordered with tape otherwise 30p extra.

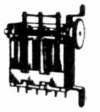
12 VOLT 1½ AMP POWER PACK

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

DRILL CONTROLLER
NEW IKW MODEL

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£1·50** plus 13p post and insurance. Made up model also available, **£1·90** plus 13p post & p.

3 STAGE PERMEABILITY TUNER



This Tuner is a precision instrument made by the famous "Cyldon" Company for the equally famous Radiomobile Car Radio. It is a medium wave tuner (but set of longwave coils available as an extra if required) with a frequency coverage 1,620kc/s–525kc/s and intended to operate with an I.F. value of 470kc/s. Extremely compact (size only 2¾ × 2 × ½in thick) with reduction gear for fine tuning. Snip price this month **63p,** with circuit of front end suitable for car radio or as a general purpose tuner for use with Amplifier. Post Free.

MAINS TRANSISTOR POWER PACK

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

MICRO SWITCH

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

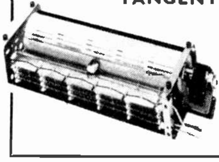
TOGGLE SWITCH

3A 250V with fixing ring. **7½p** each, **75p** dozen.

0·005mFd TUNING CONDENSER

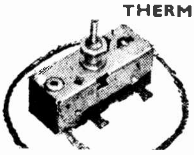
Proved design, ideal for straight or reflex circuits **13p** each, **£1·20** dozen.

OUT OF SEASON BARGAIN
TANGENTIAL HEATER UNITS



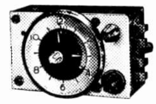
This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, and two elements allowing 3 heat switching and with thermal safety cut out. Can be fitted into any metal line line case or cabinet. Only need control switch. 3kW model **£3·50;** 2kW model **£2.50.** Postage and insurance 40p. Control switch 35p.

THERMOSTAT WITH PROBE



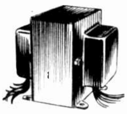
This has a sensor attached to a 15A switch by a 14in length of flexible capillary tubing—control range is 20°F to 150°F so it is suitable to control soil heating and liquid heating especially when in buckets or portable vessels as the sensor can be raised out and lowered into the vessel. This thermostat could also be used to sound a bell or other alarm when critical temp. is reached in stack or heap subject to spontaneous combustion or if liquid is being heated by gas or other means not controllable by the switch. Made by the famous Teddington Co., we offer these at **65p** each. Postage and insurance 14p.

20 AMP ELECTRICAL PROGRAMMER



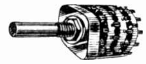
Learn in your sleep: Have Radio playing and kettle boiling as you awake—switch-on lights to ward off intruders—have warm house to come home to. All these and many other things you can do if you invest in an Electrical Programmer. Made by the famous Smiths Instrument Company. This is essentially a 230/240V mains operated Clock and a 20A Switch, the switch-off time of which can be delayed up to 12 hours (continuously variable not stepped). Similarly the switch-on time can be delayed. This is a beautiful unit, size 5¾ × 3¾ × 2¼in deep. Metal encased, glass fronted with chrome surround. Offered at **£2·40** plus postage and insurance 23p.

THIS MONTH'S SNIP



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

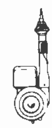
INSTRUMENT SWITCHES



Miniature precision switches with 1" dia. moulded wafers. Silver plated 5 amp contacts, standard ¼" spindle.

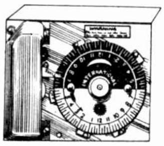
No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole	60p	60p	60p	60p	60p	60p	60p	60p	60p
2 poles	60p	60p	60p	60p	60p	60p	60p	£1	£1
3 poles	60p	60p	60p	60p	£1	£1	£1	£1·40	£1·40
4 poles	60p	60p	60p	£1	£1	£1	£1	£1·80	£1·80
5 poles	60p	60p	£1	£1	£1·40	£1·40	£1·40	£2·20	£2·20
6 poles	60p	£1	£1	£1	£1·40	£1·40	£1·40	£2·60	£2·60
7 poles	60p	£1	£1	£1·40	£1·80	£1·80	£1·80		
8 poles	£1	£1	£1	£1·40	£1·80	£1·80	£1·80		
9 poles	£1	£1	£1	£1·40	£2·20	£2·20	£2·20		
10 poles	£1	£1	£1·40	£1·80	£2·20	£2·20	£2·20		
11 poles	£1	£1·40	£1·40	£1·80	£2·60	£2·60	£2·60		
12 poles	£1	£1·40	£1·40	£1·80	£2·60	£2·60	£2·60		

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 insurance.

24-HOUR TIME SWITCH

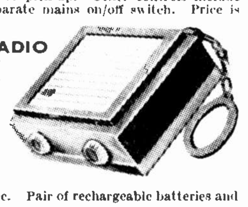


Made by Smiths these are AC mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours, 5A changeover contacts will switch circuit on or off during these periods. **£2·50,** post and ins. 23p. Additional time contacts **50p** pair.

THE FULL-FI STEREO SIX
The amplifier sensation of the year

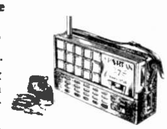
You will be amazed at the fullness of reproduction and at the added qualities your records or tuner will reproduce. Built into metal cabinet elegantly styled and teak finished to blend with modern furnishings, this amplifier uses an integrated solid state circuit with an output power of 6W R.M.S. split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

MICROSONIC KEYCHAIN RADIO



7 transistor Key chain Radio in very pretty case, size 2¾ × 2¼ × 1¼in—complete with soft leather zipped bag. 7 transistors, ferrite rod loudspeaker. In transit from the East these sets suffered corrosion as the batteries were left in them but when this corrosion is cleared away they should work—offered without guarantee except that they are new. Price only **£1·25** plus 13p post and insurance, less batteries. 6 for **£7,** post free. Pair of rechargeable batteries and charger **85p.**

SPARTAN Portable RADIO



Long and medium wave, 7 transistor, size 6in × 4in × 1¾in with larger than usual speaker giving very good tone. Built-in ferrite aerial and telescopic aerial for distant stations. A real bargain complete with leather case, carry sling, earplug and case. **£3·75** plus 25p post and insurance.

15/20 AMP CONNECTORS

Polythene insulated 12-way strip. **13p** each, **£1·20** dozen.

REED SWITCHES

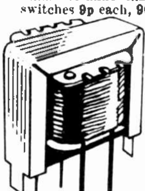
Glass encased, switches operated by external magnet—gold welded contacts. We can now offer 3 types:

Miniature. 1in long × approximately ⅛in diameter. Will make and break up to ½A up to 300V. Price **13p** each, **£1·20** dozen.

Standard. 2in long × 3/16in diameter. This will break currents of up to 1A, voltages up to 250V. Price **10p** each, **90p** per dozen.

Flat. Flat type, 2in long, just over 1/16in thick, flattened out, so that it can be fitted into a smaller space or a larger quantity may be packed into a square solenoid. Rating 1A 200V. Price **30p** each, **£3** per dozen.

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



Midget Output Transformer

Ratio 140:1. Size approx. 1in × ¾in × ¾in, primary impedance 450Ω. Connection by flying leads. **23p** each, **£2·40** dozen.

Midget Output Transformer

Ratio 80:1. Size approx. 1¼in × 1in × ¾in. Primary impedance 132Ω. Printed circuit board connection. **28p** each, **£3** dozen.

IGNITION (E.H.T.) TRANSFORMER

Made by Parmeko Ltd. Primary 240V, 50 c.p.s. Secondary 5kV at 23mA. Size approx. 4¼in × 3½in × 2¼in thick. Price **£1·50** + 23p postage.

PAPST MOTORS

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

LIGHT CELL

Almost zero resistant in sunlight, increases to 10kΩ in dark or dull light, epoxy resin sealed. Size approx. 1in dia. by ¼in thick. Rated at 500MW wire ended, **43p.** Suit most circuits.

CONSTRUCTORS' PARCEL

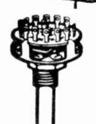
1. Plessey miniature 2-gang tuning condenser with built-in trimmers and wave gang switch. 2. Ferrite slab aerial with coils to suit the above tuning condenser. 3. Circuit diagram giving all component values for 6-transistor circuit covering full medium wave and the long wave band around Radio 2. The three items for only **40p** which is half of the price of the tuning condenser alone.

MAINS OPERATED CONTACTOR

220/240V, 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10A. Extremely well made by a German Electrical Company. Overall size 2¾ × 2 × 2in. **£1** each.

EXTRACTOR FAN

Cleans the air at the rate of 10,000 cubic ft per hour. Compact, 5¾in casing with 5¼in fan blades. Kit comprises motor, fan blades sheet steel casing, pull switch, mains connector and fixing brackets. **£2** plus 36p post and ins.



MINIATURE WAFER SWITCHES

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

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

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

J. BULL (ELECTRICAL) LTD.

Dept P.E., 7 Park Street, Croydon, CRO 1YD

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

Readout— A SELECTION FROM OUR POSTBAG

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

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

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

A. J. Sanders,
Woking, Surrey.

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

No-one wants my order!

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

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

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

Can you suggest any remedy to the situation?

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

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

Makers' names

Sir—Interest in your magazine has led me to try my hand at building some of the projects therein. As I am in a strange town and have difficulty in finding the parts, would you please let me know where I may get the kits specified in your projects. I am particularly interested in the "Digi-Clock" project at the moment and would like that kit first. From that, of course, will lead many other efforts, and I hope with success.

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

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

F. Lewis,
Chaddesden, Derby.

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

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

"Most advanced" is now "phased out"

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

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

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

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

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

In view of this experience I wonder if you could help me with the names of distributors from whom I could obtain the following requirements for the project (not all stated as having been available from the now defunct Electroniques): Miniature Mains Transformer, Primary 0-220/240V, Secondary 12-0-12V 40mA (Electroniques type P9005). 1mA f.s.d. B.P.L. type S40-VI moving coil meter. 6in × 4in × ⅛in Bakelite. 6in × 8in × 1/16in Bakelite.

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

S. R. Fisher,
Ongar, Essex.

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

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

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

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

WANTED!

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

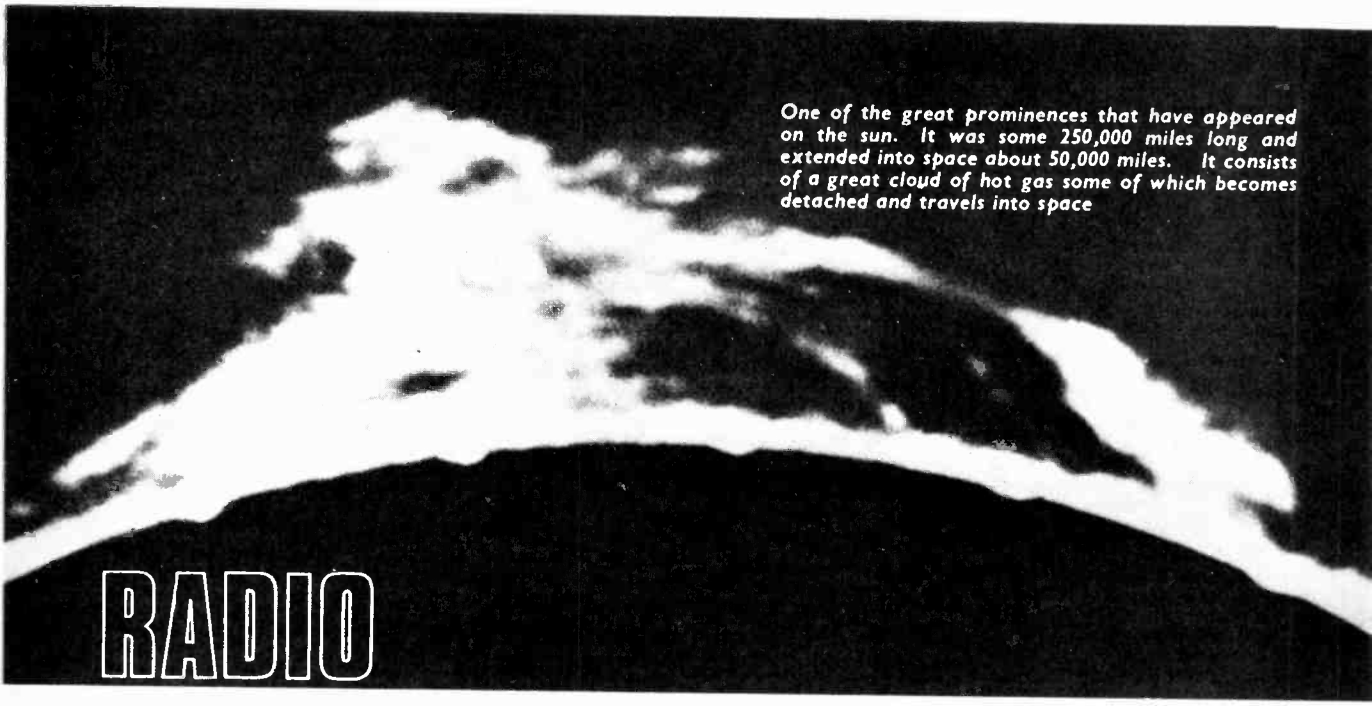
This unrectified criminal armed with a ferrite rod, escaped from Weston Primary Cell, where he had been clupped in ions since Faraday.

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

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

A. C. Maynes-Humm,
Sheriff.

J. S. Haggis,
Congleton, Cheshire



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

RADIO ASTRONOMY TECHNIQUES

BY F. W. HYDE · PART 2

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

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

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

The background galactic radiation shows a gradual rise and fall over the normal 24 hour period. It was this particular variation and its diurnal change that led Jansky, the pioneer in this branch of astronomy, to make this statement ". . . in conclusion, data have been presented which show the existence of electromagnetic waves in the earth's atmosphere which apparently come from a direction fixed in space. The data obtained give for the co-ordinates of this direction a right ascension of 18 hours and a declination of 10 degrees."

A TYPICAL RECORDING

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

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

The frequency at which these records were made was 27·5MHz.

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

COMPARISON METHOD

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

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

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

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

The final trace on the chart will not of course show the divisions as in the diagram (c) which have been exaggerated to make the method clear. The frequency of the switch is high enough so that a regular change of level appears on the slowly moving pen recorder. The signal level may vary about the level of the standard noise. If the switch frequency is 1,000Hz then the intervals shown in the diagram will represent 1/1,000 of a second.

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

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

RYLE AND VONBERG MODIFICATION

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

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

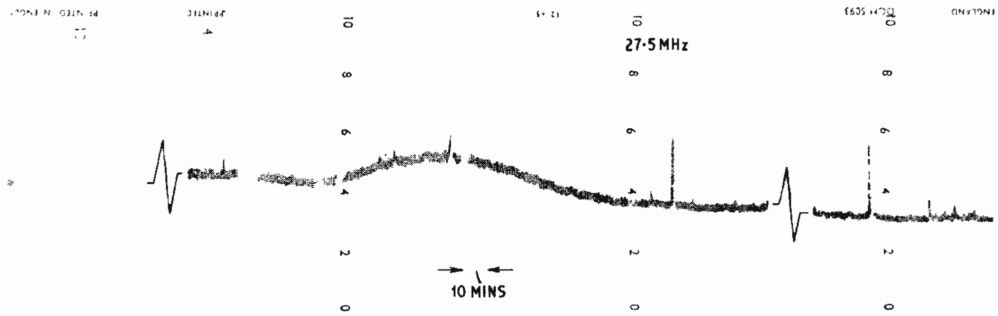


Fig. 2.1. A recording of galactic background made with a simple radio telescope

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

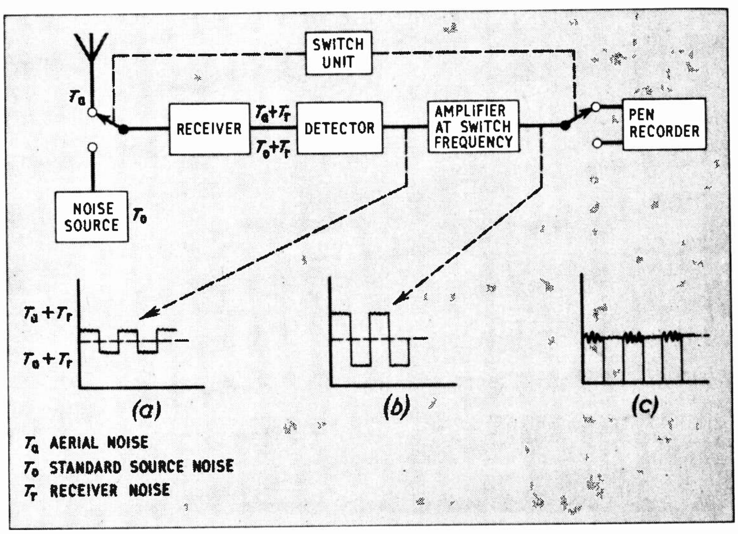


Fig. 2.3. The Dicke system for comparing incoming signals with a standard noise source

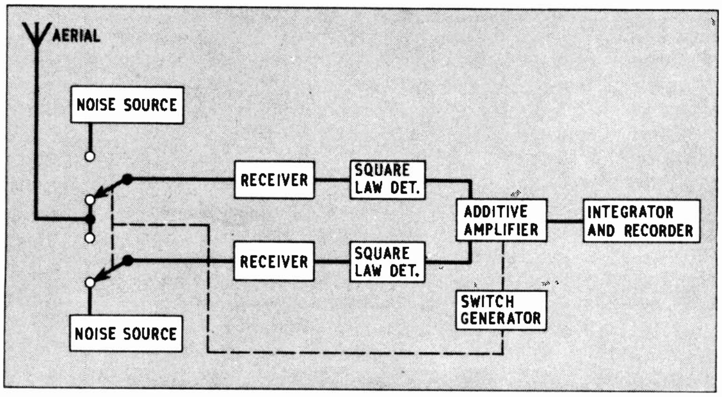


Fig. 2.4. The Graham receiving system, which employs a double receiver

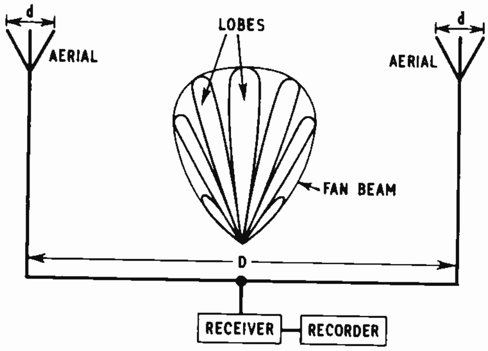


Fig. 2.7. A simple two-aerial interferometer

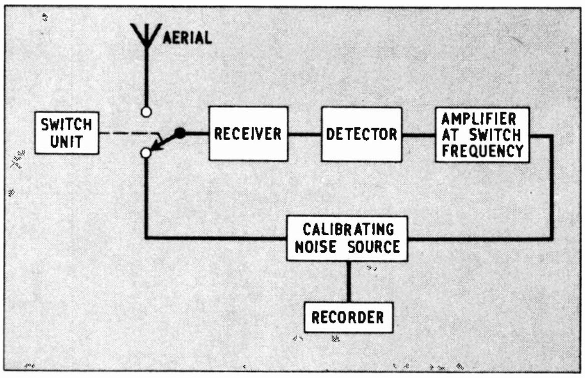


Fig. 2.5. Ryle and Vonberg modification of Dicke system

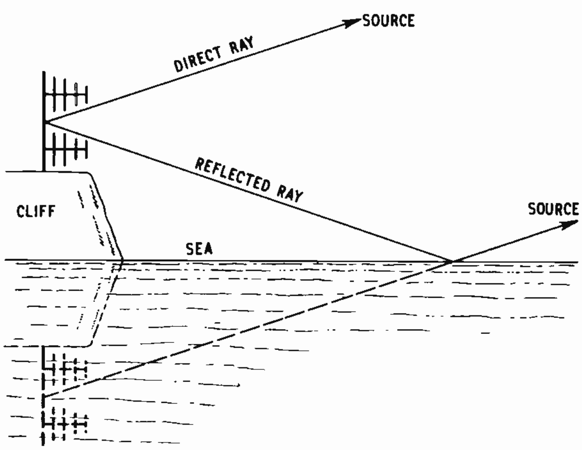


Fig. 2.6. Cliff interferometer, the sea provides a mirror image of the real aerial

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

LARGE DISH AERIALS

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

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

INTERFEROMETERS

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

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

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

	£/Np
AC107	37
AC126	25
AC127	25
AC128	20
AC176	25
AC187	30
AC188	30
ACY17	29
ACY18	20
ACY19	20
ACY20	19
ACY21	19
ACY22	19
ACY40	15
ACY41	15
AD140	55
AD149	57
AD161	37
AD162	37
AF114	25
AF115	25
AF116	25
AF117	25
AF118	44
AF124	25
AF126	17
AF139	37
AF186	40
AF239	37
ASY26	25
ASY27	30
ASY28	22
ASY29	30
ASZ21	37
AUY10	1.50
BA115	8
BC107	12
BC108	12
BC109	12
BC147	15
BC148	15
BC149	15
BC158	17
BC169C	19
BC182	12
BC182L	10
BC183	9
BC183L	9
BC184	15
BC184L	15
BC212	17
BC212L	12
BCY30	25
BCY31	48
BCY32	50
BCY33	20
BCY34	25
BCY38	30
BCY70	19
BCY71	37
BCY72	16
BD121	1.10
BD123	1.10
BD124	1.03
BDY20	1.05
BF115	25
BF163	40
BF167	25
BF173	30
BF178	52
BF180	37
BF181	37
BF184	25
BF185	25
BF194	17
BF195	15
BF196	15
BF200	35
BFX13	25
BFX29	31
BFX84	26
BFX85	34
BFX86	25
BFX87	30
BFX88	25
BFY50	23
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2N3709	9
2N3710	9
2N3711	9
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12.5	25	6 Np
25	25	6 Np
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80	25	6 Np
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8	40	6 Np
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32	40	6 Np
50	40	6 Np

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Mfd.		Mfd.	
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.015	3 Np	.33	7 Np
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.047	4 Np	1.0	14 Np
.068	4 Np	1.5	20 Np
.1	4 Np	2.2	24 Np
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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
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Type No	Current	Rms Volts	
W005	1 Amp	50	50Np
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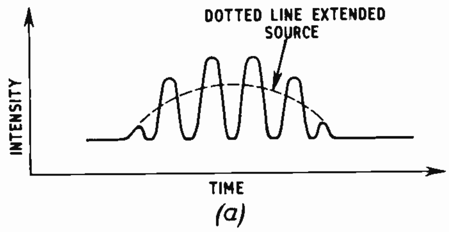


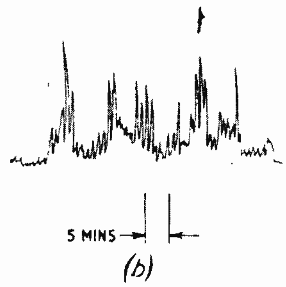


Fig. 2.8 (a). Diagram of simple interferometer fringes *(b). Actual recording from simple interferometer*

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

TWO-AERIAL INTERFEROMETER

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

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

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

The effect of the spaced aerials results in a polar diagram of the form shown in Fig. 2.7. A fan beam is produced which consists of a number of separate lobes. The number of lobes related to the distance between the aerials. If the distance in wavelengths between the aerials is designated D and the size in wavelength of the individual aerials d then the number of lobes will be $\frac{D}{d}$. The width of the central fringes will be approximately $\frac{57\lambda}{D}$.

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

LIMITATIONS

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

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

A PRACTICAL RADIO TELESCOPE

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

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

At the lower end, 30MHz is within the communication receiver limit but the physical limit for the aerial baseline might defeat the aims of the project. At this frequency less than five wavelengths spacing will give rather poor results and might dampen enthusiasm.

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

BASIC REQUIREMENTS

The basic requirements, as we have already seen, are the aerials, a pre-amplifier of 20dB gain or more, a receiver which may be converter-plus-communication receiver, and (preferably) a pen recorder. As an alternative to the pen recorder, a tape recorder operating at a low speed ($1\frac{7}{8}$in/sec or preferably $\frac{15}{16}$in/sec) could be used for processing to paper later. These basic requirements are indicated in Fig. 2.9.

AERIALS

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

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

TABLE 2.1

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

FEEDERS

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

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

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

PEN RECORDER

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

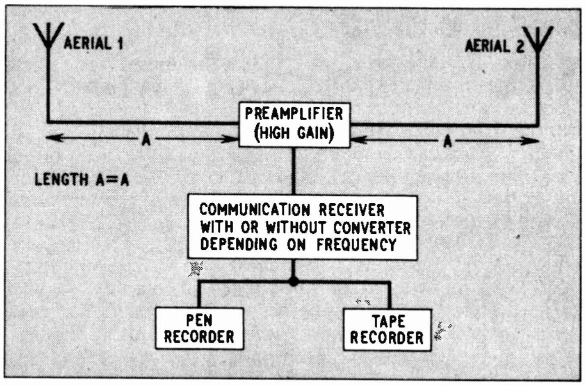


Fig. 2.9. Block diagram of a practical interferometer radio telescope

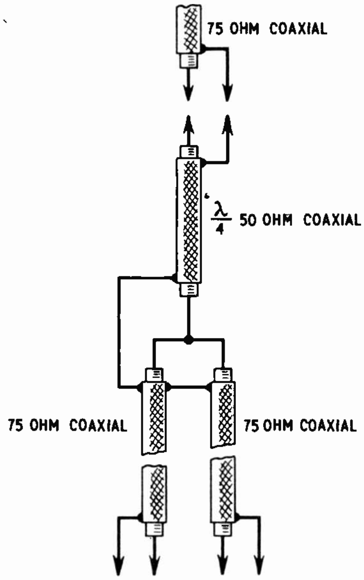


Fig. 2.10. Matching arrangements for aerial coaxial feeders

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

PROJECTS TO BE DESCRIBED

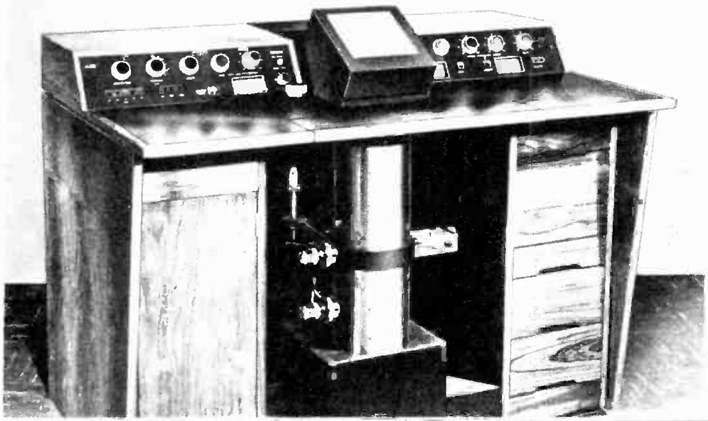
There are a number of radio astronomy projects which can be taken up by individuals or groups working in radio and electronics clubs and schools. Some suitable projects will be introduced in subsequent articles in this series. They will include a study of solar radiation, and radiation from the Galaxy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

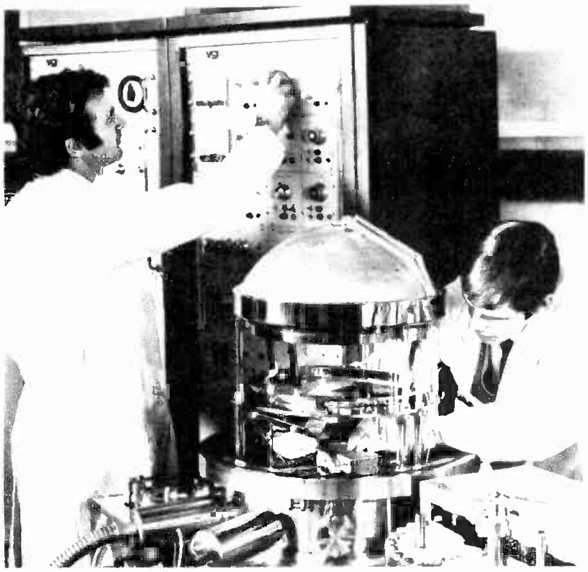
Following this there will be full details of a project for the study of the radiation from the planet Jupiter. Finally, a special project involving a search for evidence of the effects of gravitational waves.

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

Electronic Microscope

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





High Vacuum Evaporator

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

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

The evaporator is fitted with a 10kW electron beam evaporation source and rotary work holder designed for the deposition of aluminium films on 1¼in diameter silicone slices.

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

ELECTRONORAMA

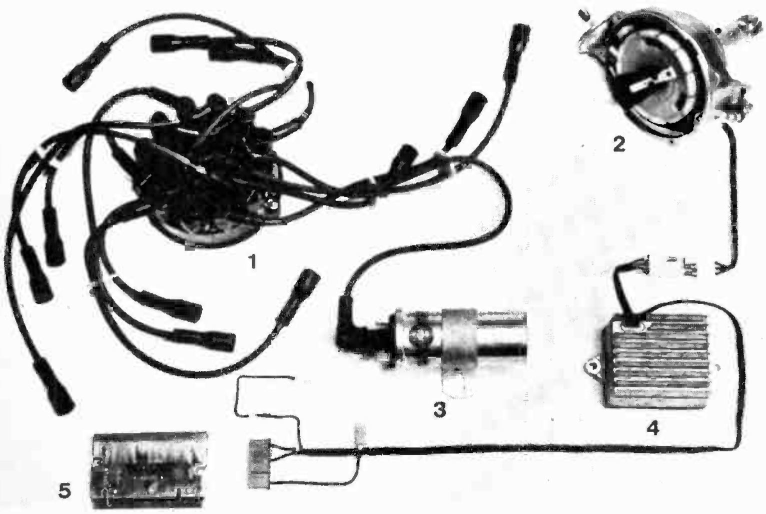
Electronic Jag

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

Lucas Opus Ignition (Mark 2) is an electronic contact breakerless system which will provide a spark rate of the order of 100 sparks/second.

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

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



I.E.E. CENTENARY

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

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

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

Sinclair Project 60

the world's most advanced high fidelity modules

Sinclair Project 60 presents high fidelity in such a way that it meets every requirement of performance, design, quality and value and now that the remarkable phase lock loop stereo FM tuner is available, it becomes the most versatile of high fidelity systems. With Project 60, it is possible to start with a modest mono record reproducer and expand it to a sophisticated stereophonic radio and record reproducing system of fantastically good quality to hold its own with any other equipment, no matter how expensive. Project 60 is a unique high fidelity module system where compactness and ease of assembly are combined with circuitry that is far in advance of any other manufacturer in the world. Thus it is extraordinarily easy to assemble any combination of modules using nothing more complicated than the simplest of tools, and you certainly do not have to be experienced to build with complete confidence. The 48 page manual free with Project 60 equipment makes everything easy and you can house your assembly in an existing cabinet, motor plinth, free standing cabinet or virtually any arrangement you wish. Once you have completed your assembly you will have superlatively good equipment to give you years of service and enjoyment. You will have obtained superb value for money because Project 60 is the best selling modular system in Europe and can therefore be produced at extremely competitive prices and with excellent quality control.

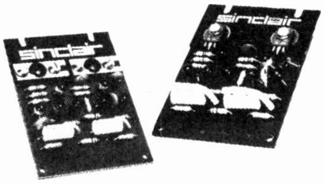
	System	The Units to use	together with	Cost of Units
A	Simple battery record player	**Z.30**	Crystal P.U., 12V battery volume control	**£4.48**
B	Mains powered record player	**Z.30, PZ.5**	Crystal or ceramic P.U. volume control etc.	**£9.45**
C	20+20 W. R.M.S. stereo amplifier for most needs	**2 x Z.30s,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

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

sinclair

Sinclair Project 60

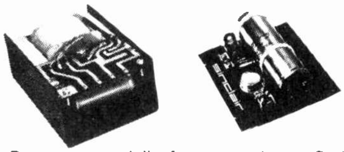
Z.30 & Z.50 power amplifiers



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

SPECIFICATIONS ***(Z50 units are interchangeable with Z.30s in all applications).***
Power Outputs
Z.30 15 watts R.M.S. into 8 ohms using 35 volts: 20 watts R.M.S. into 3 ohms using 30 volts.
Z.50 40 watts R.M.S. into 3 ohms using 40 volts: 30 watts R.M.S. into 8 ohms, using 50 volts.
Frequency response: 30 to 300 000 Hz ±1dB.
Distortion: 0.02% into 8 ohms.
Signal to noise ratio: better than 70dB unweighted.
Input sensitivity: 250mV into 100 Kohms.
For speakers from 3 to 15 ohms impedance.
Size 3½ x 2¼ x ½ in.
Z.30
Built tested and guaranteed with circuits and instructions manual **£4.48**
Z.50
Built, tested and guaranteed with circuits and instructions manual. **£5.48**

Power Supply Units

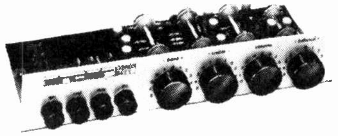


Designed specially for use with the Project 60 system of your choice.
Illustration shows PZ.5 to left and PZ.8 (for use with Z.50s) to the right. Use PZ.5 for normal Z.30 assemblies and PZ.6 where a stablised supply is essential.
PZ-5 *30 volts unstabilised* **£4.98**
PZ-6 *35 volts stabilised* **£7.98**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

Guarantee

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

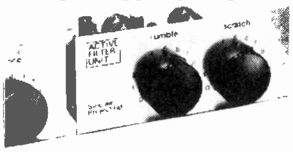
Stereo 60 pre-amp/control unit



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

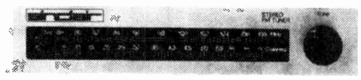
SPECIFICATIONS
Input sensitivities: Radio–up to 3mV. Mag. p.u. 3mV. correct to R.I.A.A. curve ± 1dB: 20 to 25,000 Hz. Ceramic p.u.–up to 3mV: Aux–up to 3mV.
Output: 250mV
Signal-to-noise ratio: better than 70dB.
Channel matching: within 1dB.
Tone controls: TREBLE + 15 to —15dB at 10KHz. BASS + 15 to—15dB at 100Hz.
Front panel: brushed aluminium with black knobs and controls.
Size: 8¼ x 1½ x 4 ins.
Built, tested and guaranteed. **£9.98**

Active Filter Unit



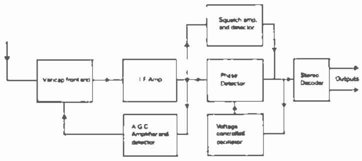
For use between Stereo 60 unit and two Z.30s or Z 50s, and is easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and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

Stereo FM Tuner



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

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



Price: £25 built and tested. Post free

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

Please send

for which I enclose cash/cheque/money order.

Name

Address

P.E. 7

Sinclair Q16/Micromatic

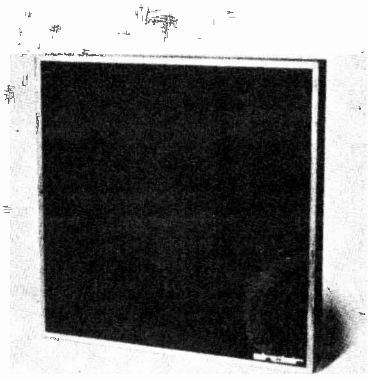
Q16 High fidelity loudspeaker

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

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

Specifications:

Construction: Special sealed seamless sound or pressure chamber with internal baffle.
Loading: up to 14 watts RMS.
Input Impedance: 8 ohms.
Frequency response: From 60 to 16,000 Hz. confirmed by independently plotted B and K curve.
Driver unit: Special high compliance unit having massive ceramic magnet of 11,000 gauss, aluminium speech coil and special cone suspension for excellent transient response.
Size and styling: 9¾ in. square on face x 4¾ in. deep with neat pedestal base. Black all over cellular foam front with natural solid teak surround.
Price £8.98.



Britain's smallest radio

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

Specifications:

Size: 36 x 33 x 13 mm (1.8 x 1.3 x 0.5 in.)
Weight: including batteries, 28.4 gm (1 oz.)
Case: Black plastic with anodised aluminium front panel and spun aluminium dial.
Tuning: medium wave band with bandspread at higher frequencies (550 to 1,600 KHz).
Earpiece: Magnetic type.
On/off switching: By inserting and withdrawing earpiece plug.
Kit in pack with earpiece, case, instructions and solder **£2.48.**
Ready built, tested and guaranteed, with earpiece **£2.98.**
Two Mallory Mercury batteries type RM675 required from radio shops, chemists, etc.

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

Please send ____________

____

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for which I enclose cash/cheque/money order

Name ____________

Address ____________

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

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The largest selection

NEW LOW PRICE TESTED S.C.R.'s

PIV	1A TO-5	3A TO-66	7A TO-66	10A	16A TO-48	30A TO-48
	£p	£p	£p	£p	£p	£p
50	0·23	0·25	0·47	0·50	0·53	1·15
100	0·25	0·33	0·53	0·58	0·63	1·40
200	0·35	0·37	0·57	0·61	0·75	1·60
400	0·43	0·47	0·67	0·75	0·93	1·75
600	0·53	0·57	0·77	0·87	1·25	—
800	0·63	0·70	0·90	1·20	1·50	4·00

SIL. RECTS. TESTED

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

TRIACS

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

SILICON HIGH VOLTAGE RECTIFIERS

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

DIACS

FOR USE WITH TRIACS BR100 . . . . **37p** each

2A POTTED BRIDGE RECTIFIERS 200V 50p

UNIJUNCTION

UT46. Eqvt. 2N2646, Eqvt. TIS43. BEN3000 **27p** each, 25–99 **25p** 100 UP **20p**.

NPN SILICON PLANAR

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

FREE

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

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

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2N 3819	**35p**
2N 3820	**93p**
MPF105	**40p**

CADMIUM CELLS

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

PHOTO TRANS.

OCP71 Type. **43p**

SIL. G.P. DIODES £p

300mW	30	0·50
40PIV (Min.)	100	1·50
Sub-Min.	500	5·00
Full Tested	1,000	9·00

Ideal for Organ Builders.

D13D1 Silicon Unilateral switch 50p each.

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

AD161 *NPN* AD162 *PNP*

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

2N3055 115 WATT SIL. POWER NPN

OUR PRICE **63p** EACH

FULL RANGE OF ZENER DIODES VOLTAGE RANGE 2-33V.

400mV (DO-7 Case) **13p** ea. 1½W (Top-Hat) **18p** ea. 10W (SO-10 Stud) **25p** ea. All fully tested 5% tol. and marked. State voltage required.

BRAND NEW TEXAS GERM. TRANSISTORS

Coded and Guaranteed

Pak No.			EQVT
T1	8	2G371A	OC71
T2	8	2G374	OC75
T3	8	2G3744A	OC81D
T4	8	2G381A	OC81
T5	8	2G382T	OC82
T6	8	2G344A	OC44
T7	8	2G345A	OC45
T8	8	2G378	OC78
T9	8	2G399A	2N1302
T10	8	2G417	AF117

All **50p** each pak

2N2060 NPN SIL. DUAL TRANS.

CODE D1699 TEXAS. Our price **25p** each.

120 VCB NIXIE DRIVER TRANSISTOR.

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

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

EX-EQUIPMENT MULLARD

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

KING OF THE PAKS Unequalled Value and Quality

SUPER PAKS — NEW BI-PAK UNTESTED SEMICONDUCTORS

Satisfaction GUARANTEED in Every Pak, or money back.

Pak No.	Description	£p
U1	120 Glass sub-min. general purpose germanium diodes	0·50
U2	60 Mixed germanium transistors AF/RF	0·50
U3	75 Germanium gold bonded diodes sim. OA5, OA47	0·50
U4	40 Germanium transistors like OC81, AC128	0·50
U5	60 200mA sub-min. Sil. diodes	0·50
U6	30 Silicon planar transistors NPN sim. BSY95A, 2N706	0·50
U7	16 Silicon rectifiers Top-Hat 750mA up to 1,000V	0·50
U8	50 Sil. planar diodes 250mA. OA/200/202	0·50
U9	20 Mixed volts 1 watt Zener diodes	0·50
U11	30 PNP silicon planar transistors TO-5 sim. 2N1132	0·50
U13	30 PNP-NPN sil. transistors OC200 & 28104	0·50
U14	150 Mixed silicon and germanium diodes	0·50
U15	25 NPN Silicon planar transistors TO-5 sim. 2N697	0·50
U16	10 3-Amp silicon rectifiers stud type up to 1000 PIV	0·50
U17	30 Germanium PNP AF transistors TO-5 like ACY 17-22	0·50
U18	8 6-Amp silicon rectifiers BYZ13 type up to 600 PIV	0·50
U19	25 Silicon NPN transistors like BC108	0·50
U20	12 1·5-Amp silicon rectifiers Top-Hat up to 1,000 PIV	0·50
U21	30 A.F. germanium alloy transistors 2G300 series & OC71	0·50
U23	30 Madt's like MAT series PNP transistors	0·50
U24	20 Germanium 1-Amp rectifiers GJM up to 300 PIV	0·50
U25	25 300Mc/s NPN silicon transistors 2N708, BSY27	0·50
U26	30 Fast switching silicon diodes like 1N914 micro-min	0·50
U28	Experimenters' assortment of integrated circuits, untested. Gates, flip-flops, registers, etc., 8 assorted pieces	1·00
U29	10 1-Amp SCR's TO-5 can up to 600 PIV CRS1/25-600	1·00
U31	20 Sil. Planar NPN trans. low noise amp 2N3707	0·50
U32	25 Zener diodes 400mW D07 case mixed volts, 3–18	0·50
U33	15 Plastic case 1 amp silicon rectifiers 1N4000 series	0·50
U34	30 Sil. PNP alloy trans. TO-5 BCY26, 28302/4	0·50
U35	25 Sil. planar trans. PNP TO-18 2N2906	0·50
U36	25 Sil. planar NPN trans. TO-5 BFY50/51/52	0·50
U37	30 Sil. alloy trans. SO-2 PNP, OC200 28322	0·50
U38	20 Fast switching sil. trans. NPN, 400Mc/s 2N3011	0·50
U39	30 RF germ. PNP trans. 2N1303/5 TO-5	0·50
U40	10 Dual trans. 6 lead TO-5 2N2060	0·50
U41	25 RF germ. trans. TO-1 OC45 NKT72	0·50
U42	10 VHF germ. PNP trans. TO-1 NKT667 AF117	0·50

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

NEW QUALITY TESTED PAKS

Pak	Description	Price £p
Q1	20 Red spot trans. PNP AF	0·50
Q2	16 White spot R.F. trans. PNP	0·50
Q3	4 OC77 type trans.	0·50
Q4	6 Matched trans. OC44/45/81/81D	0·50
Q5	4 OC75 transistors	0·50
Q6	4 OC72 transistors	0·50
Q7	4 AC128 trans. PNP high gain	0·50
Q8	4 AC126 trans. PNP	0·50
Q9	7 OC81 type trans.	0·50
Q10	7 OC71 type trans.	0·50
Q11	2 AC127/128 comp. pairs PNP/NPN	0·50
Q12	3 AF116 type trans.	0·50
Q13	3 AF117 type trans.	0·50
Q14	3 OC171 H.F. type trans.	0·50
Q15	5 2N2926 sil. epoxy trans.	0·50
Q16	2 GET880 low noise germ. trans.	0·50
Q17	3 NPN 1 ST141 & 2 ST140	0·50
Q18	4 Madt's 2 MAT 100 & 2 MAT 120	0·50
Q19	3 Madt's 2 MAT 101 & 1 MAT 121	0·50
Q20	4 OC44 germ. trans. A.F.	0·50
Q21	3 AC127 NPN germ. trans.	0·50
Q22	20 NKT trans. A.F. R.F. coded	0·50
Q23	10 OA202 sil. diodes sub-min.	0·50
Q24	8 OA81 diodes	0·50
Q25	6 1N914 sil. diodes 75PIV 75mA	0·50
Q26	8 OA95 germ. diodes sub-min. 1N69	0·50
Q27	2 10A 600PIV sil. rects. 1S45R	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 300MHZ 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. 300MHZ	0·50
Q52	8 BY100 type sil. rect.	1·00
Q53	25 Sil. & germ. trans. mixed all marked new	1·50

PRINTED CIRCUITS—EX-COMPUTER

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BP 702—72702	D.I.L.	14	G.P. OP Amp (Wide Band)	53p	45p	40p
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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
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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
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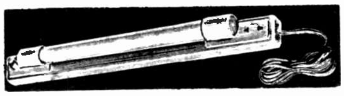

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Code	Power	Tolerance	Range	Values available	1 to 9 (see note below)	10 to 99	100 up
C	1/20W	5%	82Ω–220KΩ	E12	7	6·5	6
C	1/8W	5%	4·7Ω–330KΩ	E24	1	0·8	0·7
C	1/4W	10%	4·7Ω–10MΩ	E12	1	0·8	0·7
C	1/2W	5%	4·7Ω–10MΩ	E24	1·2	1	0·9
C	1W	10%	4·7Ω–10MΩ	E12	2·5	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

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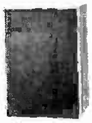

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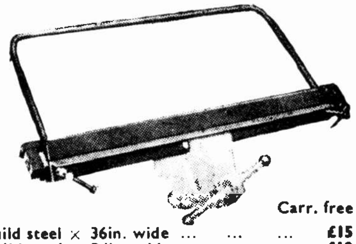

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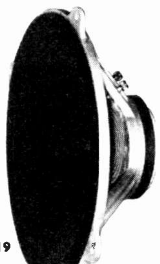

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