PRACTICAL

ELECTRONICS

MAY 1971

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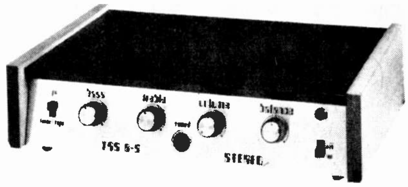
DIGITAL INTEGRATED CIRCUIT TESTER

NEW FROM TRS



This money saving STEREO 8 + 8 AMPLIFIER in a new PRE-ASSEMBLED MODULAR PRESENTATION

A new conception in modular assembly which makes construction even easier then ever and results even better. Two pre-amp and two power amp modules, factory built, tested and guaranteed by a world famous maker come to you ready mounted with mains power unit on chassis forming part of the attractive TRS cabinet which simply need wiring for immediate use. A generous 8 watt RMS output per channel into 3–5 ohms is assured. Cabinet with aluminium front, charcoal grey top and wood sides measures 12in × 8½in × 2¾in. Very attractive appearance.

- Frequency resp.: 50Hz–16kHz ±3dB.
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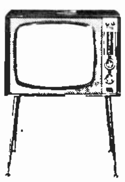

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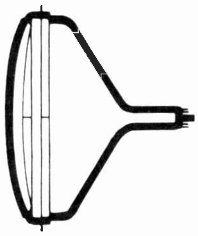

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5in.	600ft.	**45p**	5in.	1,200ft.	**75p**
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7in.	1,200ft.	**63p**	7in.	2,400ft.	**£1·35**
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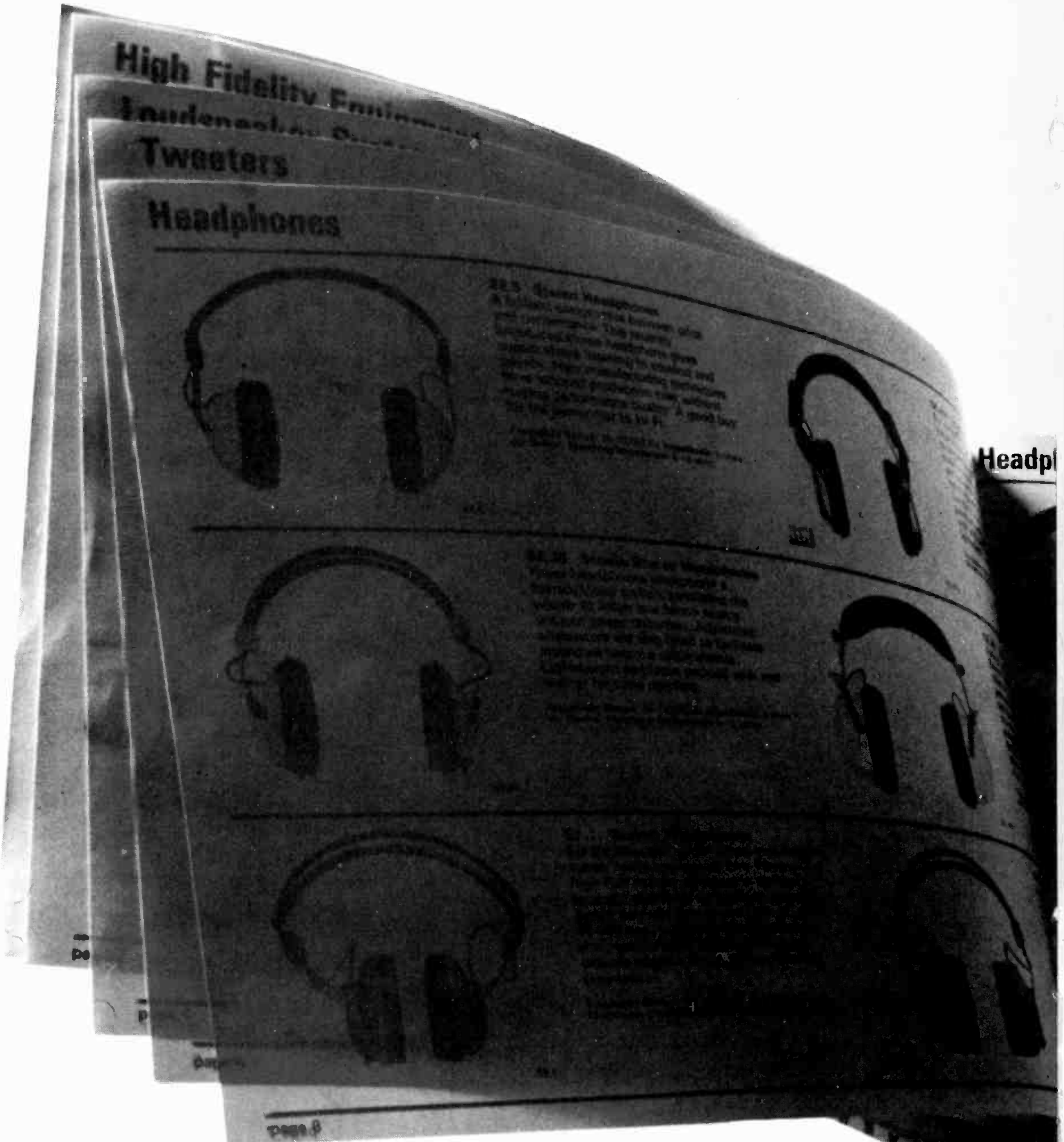
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160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, **3p.** 0·1μF, 0·15μF, 0·22μF, **4p.** 0·33μF, **6p.** 0·47μF, **7½p.** 0·68μF, **11p.** 1·0μF, **12½p.**

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Carbon track 5kΩ to 1MΩ, log or linear (log ½W, lin ¼W).
Single, **12½p.** Dual gang (stereo), **40p.**

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Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0·1 matrix).
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AC127	15p	BSY56	30p	OC82	15p	2N3702	15p
AC128	15p	BSX21	25p	ORP12	47½p	2N3703	14p
AD140	40p	BY124	7½p	1N4001	7½p	2N3704	17½p
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AF117	17½p	BYZ13	20p	1N4003	11p	2N3706	12p
BC107	14p	OA85	7½p	1N4004	12½p	2N3707	18½p
BC108	10p	OA91	7½p	1N4005	14p	2N3708	10p
BC109	10p	OA202	7½p	1N4006	15p	2N3709	11p
BFY50	22p	OC71	15p	1N4007	16p	2N3710	12p
BFY51	19p	OC72	15p	2N2926	11p	2N3711	14p

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	0·1	0·15		0·15	0·1
2½ × 3¾	22p	16p	17 × 3¾ (plain)	52½p	—
2½ × 5	24p	24p	17 × 2½ (plain)	37½p	—
3¾ × 3¾	24p	24p	2½ × 5 (plain)	17½p	—
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2P2W, 1P12W, 2P6W, 3P4W, 4P3W, **22½p.**

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Standard ¼in insulated	14p	3·5mm insulated	7½p
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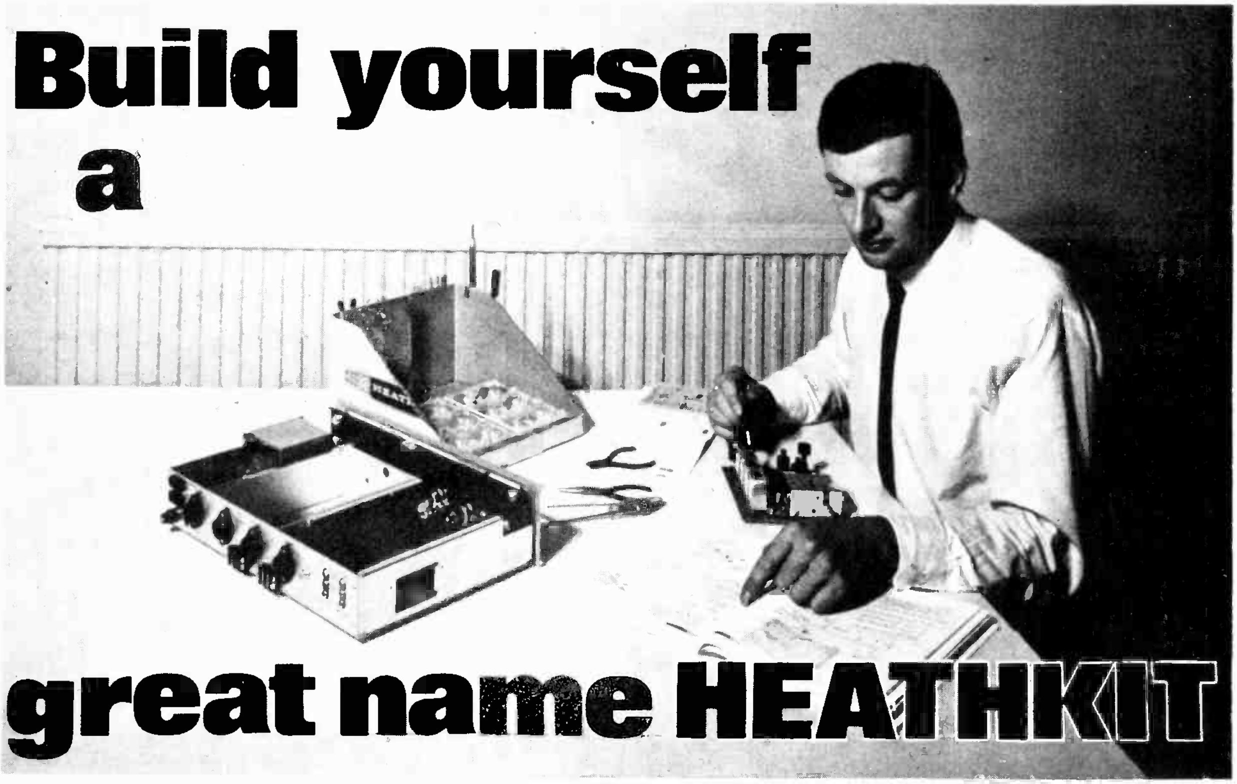

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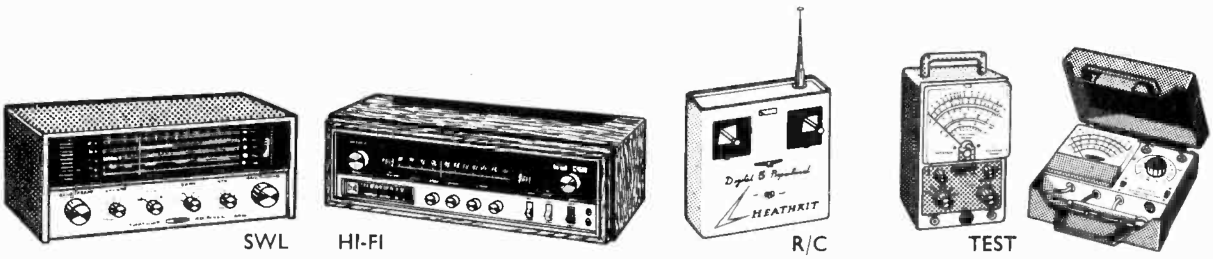

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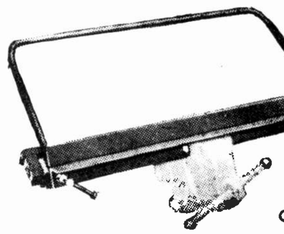

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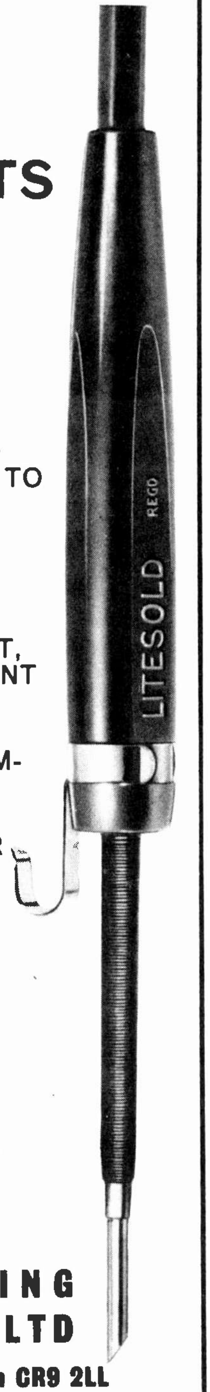

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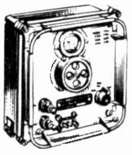


Small portable crystal controlled wavemeter. Size 7" × 7½" × 4". Frequency range 500 Kc/s. 10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300 V.D.C. 15mA and 12 V.D.C. 0.3A. Excellent condition. **£3·47½**. Carr. 37½p.

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.

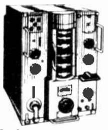
AM/FM SIGNAL GENERATORS

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

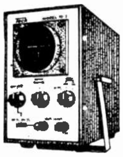
High quality 97 range instrument which measures a.c. and d.c. Voltage. Current, Resistance and Power Output Ranges d.c. volts 250mV-10,000V (10 megΩ-110 megΩ input). D.c. current 10µA-25A. Ohms. 0-1,000 megΩ a.c. volt 100mV-250V (with R.F. measuring head up to 250MHz) a.c. current 10µA-25A. Power output 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

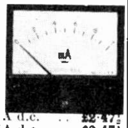
USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES, ETC. ● LOW COST ● QUICK DELIVERY ● OVER 200 RANGES IN STOCK ● OTHER RANGES TO ORDER

NEW "SEW" DESIGNS!

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

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

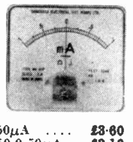
BAKELITE PANEL METERS — TYPE S-80, 80 mm square fronts



50µA	£3·12½	1A d.c.	£2·47½
50-0-50µA	£2·97½	5A d.c.	£2·47½
100µA	£2·97½	300V a.c.	£2·62½
100-0-100µA	£2·87½	VU Meter	£3·37½
500µA	£2·62½		
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
		8 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

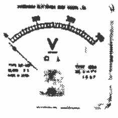
Type MR.52P. 2½in square fronts.

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	8 Meter	
5mA	£2·00	1mA	£2·10
10mA	£2·00	VU Meter	£3·10
50mA	£2·00	1A a.c.*	£2·00
100mA	£2·00	5A a.c.*	£2·00
500mA	£2·00	10A a.c.*	£2·00
1A	£2·00	20A a.c.*	£2·00
5A	£2·00	30A a.c.*	£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	8 Meter	
50mA	£2·10	1mA	£2·37½
100mA	£2·10	VU meter	£3·37½
500mA	£2·10	50mA a.c.*	£2·10
1A	£2·10	100mA a.c.*	£2·10
5A	£2·10	200mA a.c.*	£2·10
10A	£2·10	500mA a.c.*	£2·10
15A	£2·10	1A a.c.*	£2·10
20A	£2·10	5A a.c.*	£2·10
30A	£2·10	10A a.c.*	£2·10
50A	£2·37½	20A a.c.*	£2·10
5V d.c.	£2·10	30A a.c.*	£2·10
10V d.c.	£2·10		

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



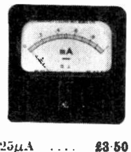
50µA	£2·00	150mA	£1·37½
50-0-50µA	£1·87½	200mA	£1·37½
100µA	£1·87½	300mA	£1·37½
100-0-100µA	£1·75	500mA	£1·37½
200µA	£1·75	750mA	£1·37½
500µA	£1·50	1A	£1·37½
500-0-500µA	£1·37½	2A	£1·37½
1mA	£1·37½	5A	£1·37½
1-0-1mA	£1·37½	10A	£1·37½
2mA	£1·37½	3V d.c.	£1·37½
5mA	£1·37½	10V d.c.	£1·37½
10mA	£1·37½	15V 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
		8 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	8 Meter	
1mA	£1·50	1mA	£1·87½
5mA	£1·50	VU Meter	£2·25
10mA	£1·50	1A a.c.*	£1·50
50mA	£1·50	5A a.c.*	£1·50
100mA	£1·50	10A a.c.*	£1·50
500mA	£1·50	20A a.c.*	£1·50
1A	£1·50	30A a.c.*	£1·50
5A	£1·50		

"SEW" BAKELITE PANEL METERS

Type MR.65 3½in square fronts.



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

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"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/5A d.c.	£4·25
1A d.c.	£3·97	5V/50V d.c.	£4·25
5A d.c.	£3·97	Triple range	
10V d.c.	£3·97	1mA/10mA/100mA	£4·62

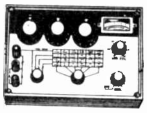
EDGEWISE METERS

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

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

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



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω–11·1 megΩ 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.

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

TE-16A Transistorised Signal Generator. 5 ranges 400 kHz–30 mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide, easy to read scale. 800 kHz modulation. 5¼ × 5¼ × 3½. Complete with instructions and leads. **£7·97½**. P. & P. 20p.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

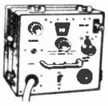
Frequency 0·20 Kc/s on 2 ranges. Output 600Ω or 5kΩ. Operation 200/250V. A.C. Supplied in perfect order. **£12·50**. Carr. 50p.

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

LAFAYETTE TE46 RESISTANCE CAPACITY ANALYSER

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

CLASS D WAVEMETERS



A crystal controlled heterodyne frequency meter covering 1·7–8 Mc/s. Operation on 6V d.c. Ideal for amateur use. Available in good used condition. **£5·97½**. Carr. 37½p. or brand new. **£7·97½**. Carr. 37½p.

MARCONI TF195M BEAT FREQUENCY OSCILLATORS. 0-40KHz. **£20**. Carr. £1·50.

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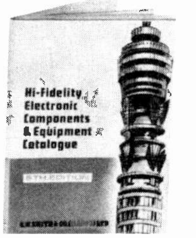
Our latest edition giving full details of a comprehensive range of HI-FI EQUIPMENT COMPONENTS, TEST EQUIPMENT and COMMUNICATIONS EQUIPMENT. FREE DISCOUNT COUPONS VALUE 50p (10/-). 248 pages, fully illustrated and detailing thousands of items at bargain prices.



SEND NOW— ONLY 37½p P. & P. 10p

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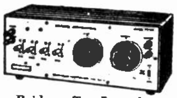
Also see next two pages

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.

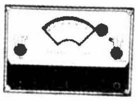
MARCONI CT44/TF956 AF ABSORPTION WATTMETER

1 μ/watt to 6 watts. £30. Carr. £1.



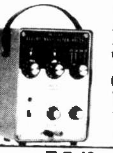
TE111. DECADE RESISTANCE ATTENUATOR Variable range 0–111dB. Connections. Unbalanced T and Bridge T. Impedance 600Ω range (0·1dB × 10) + (1dB × 10) + 10 + 20 + 30 + 40dB. Frequency: d.c. to 200kHz (—3dB). Accuracy: 0·05dB. +indication dB × 0·01. Maximum input less than 4W (50V). Built in 600Ω load resistance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

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



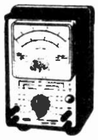
Sine 18–200,000Hz; Square 18–50,000Hz. Output max +10dB (10kΩ). Operation internal batteries. Attractive two-tone case 7½in × 5in × 2in. Price £17·50. Carr. 17½p.

BELCO DA-20 SOLID STATE DECADE AUDIO OSCILLATOR



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

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



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

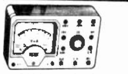
TE-65 VALVE VOLTMETER

High quality instrument with 28 ranges. D.c. volts 1·5–1,500V. A.c. volts 1·5–1,500V. Resistance up to 1,000 megohms, 220/240V a.c. operation. Complete with probe and instructions. £17·50. P. & P. 30p. Additional Probes available: R.F. £2·12½. H.V. £2·50.

230 VOLT A.C. 50 CYCLES RELAYS

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

MULTIMETERS for EVERY purpose!



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

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

MODEL 500. 30,000 O.P.V. with overload protection, mirror scale 0/·5/2·5/10/25/100/250/500/1,000 V d.c. 0/2·5/10/25/100/250/500/1,000 V. a.c. 0/50 μA/5/50/500 mA. 12 amp. d.c. 0/60K/6 Meg./60 Meg Ω. £8·87½. Post paid.

MODEL TE-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200V d.c. 0/6/30/120/600/1,200V a.c. 0/30μA/3/30/300mA. 0/16K/160K/1·6M/16 meg. £5·50. P. & P. 15p.

TMK MODEL TW-50K. 46 ranges, mirror scale. 50K/Volt d.c. 5K/Volt a.c. D.c. volts: 0·125, 0·25, 1·25, 2·5, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.c. volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.c. current: 25, 50μA, 2·5, 5, 25, 50, 250, 500mA, 5, 10A. Resistance: 10K, 100K, 1 meg., 10 meg. Decibels: —20 to +81·5dB. £8·87½. P. & P. 17½p.

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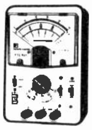

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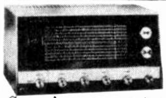

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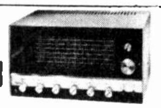

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PRACTICAL ELECTRONICS

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SPECIALISED COMPONENTS

THE private constructor needs more ready and direct access to certain types of components, apart from those general purpose parts and semiconductor devices which we must agree are not at all difficult to obtain. But in order to exploit these latter devices fully, it is sometimes necessary to obtain certain special items. Maybe a special kind of semiconductor; some unusual passive component like perhaps a ferrite pot core; or an electro-mechanical part such as an uncommon type of switch, connector, or relay. By "special" we mean an item not normally carried in stock by the average retailer, but listed in a manufacturer's "industrial" or "professional" catalogue. In effect, this usually means that this particular class of component or device is restricted to equipment makers and component distributors, who can order in the requisite large quantity demanded by the manufacturer.

Industrial component distributors by and large are not favourably disposed towards dealings with private individuals. Some will, it is true, supply direct, but they have to insist on a certain minimum order—either in quantity or value. Such a procedure works well enough for the particularly dedicated and prolific constructor who makes a point of finding his way through the distribution network, and has probably established good personal relations with one or more distributors. But countless other constructors would like the opportunity to gain access to a wider range of components, on perhaps less frequent occasions, but without the inconvenience of hunting around for an obliging distributor for each particular special need.

Retail component stockists are the natural source of supply for individual constructors. Through the mail order business many retail firms have established good links with the amateur, wherever he may live. The point has now arisen whether retailers could not improve and expand their service by stocking a more varied range of electronic components including some special items obtainable from the industrial distributors; or at anyrate, be prepared to order such special items upon request.

In *Readout* this month we publish two letters relating to this subject, but from different aspects. Firstly, one of our contributors appeals to component manufacturers and trade distributors to consider the needs of amateurs, and also suggests how the latter may further their own cause. Secondly, one of our advertisers offers fellow retailers membership of a co-operative scheme for purchasing special components in reasonable quantities from manufacturers or main distributors. We await with interest any comments on this topic from industry, trade, or individual readers. F.E.B.

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TREMULANT SYSTEMS

BY F. C. JUDD

PART ONE ELECTRO-MECHANICAL

THE popularity of electrically amplified and electronic musical instruments such as the electronic organ has resulted in the invention of all kinds of tremulant and vibrato systems as well as a host of other effects such as artificial echo, reverberation and the so called phasing or skying effect.

No effect has ever been produced that enhances musical sound so well as tremulant, which has been used ever since musical instruments, that could be made to produce it, were invented and even longer by anyone able to sing or whistle a musical phrase.

DEFINITIONS

There is some confusion between the terms tremulant, tremolo and vibrato which are defined by music encyclopædias as follows: *Tremulant* generally refers to the effect of making a note rapidly softer or louder i.e., a rapid amplitude variation. *Vibrato* is the effect of altering the pitch of a note rapidly by a very small degree i.e., it is a rapid frequency variation. Some may choose to differ on these definitions but for the sake of clarity, tremulant and vibrato will be used accordingly for the purpose of this article. *Tremolo* normally indicates the rapid repetition of one or more notes.

APPLICATION

The vibrato effect, or rapid pitch fluctuation, is normally produced on instruments like the violin and guitar by the player. The effect can be produced electronically on instruments with electronic tone generators i.e., electronic organs, in which case a low frequency (5 to 10Hz) sinewave is employed to produce a small variation in the tuning of the tone generators. The tremulant effect can also be produced on certain non-electronic musical instruments by making the sound rapidly softer or louder, depending on the nature and playing technique of the instrument. With electronic organs and any amplified instrument like the guitar, a tremulant can be introduced by rapidly altering the gain of one stage of the amplifier. This is generally accomplished by employing a low frequency sinewave as a voltage control e.g., to control the bias voltage of a valve or transistor.

L.D.R. CONTROL

On most guitar amplifiers this facility is usually wrongly called vibrato and bias control of this kind generally introduces an obnoxious thumping noise, due to harmonics from the low frequency control oscillator. A far better method is to use a light dependent resistor (l.d.r.) as shown in Fig. 1. The lamp is connected in the collector circuit of a voltage level detector, which is driven by a low frequency sinewave oscillator. The sinusoidal fluctuation of light produces a sinusoidal variation in the resistance of the l.d.r.; this method is free from thump.

A novel idea for a tremulant pre-amplifier employing l.d.r.'s, which can be used for portable electronic organs or guitars, will be given in part 2.

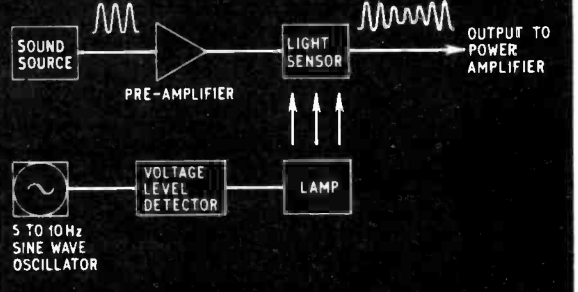


Fig. 1. Block diagram showing method of employing an l.d.r. to obtain tremulant from an amplifier

The Leslie rotary horn loudspeaker as fitted to many modern electronic organs

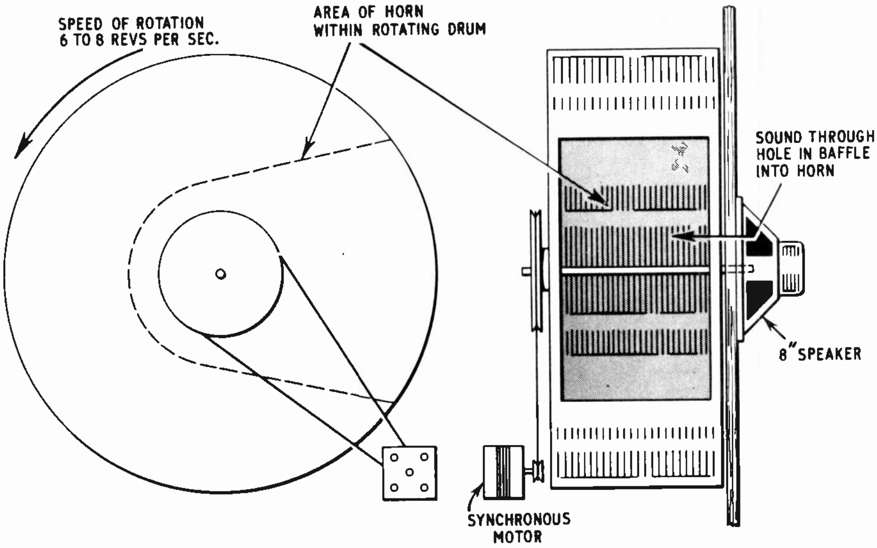


Fig. 2. Mechanical arrangement of rotating horn loudspeaker

ELECTRO-MECHANICAL SYSTEMS

There are several electro-mechanical methods of producing a pleasing tremulant from electronic organs and amplified electric guitars. These employ either rotating loudspeakers or rotating horns or deflectors and many of the systems currently in use are due to Don Leslie and bear his name.

Some manufacturers and users of rotating horn and deflector systems are, however, wrongly under the impression that pitch variation is produced by these devices because of the Doppler effect. Tests made by the author have disproved this, but have shown that the tremulant waveform from such systems is a very complex one. Systems in which the loudspeakers themselves are rotated do produce the Doppler effect as in this case the sound source itself is moving.

VARIATIONS IN MECHANICAL SYSTEMS

The exact acoustical function of rotary horn or loudspeaker tremulant systems will be dealt with in part 2; meanwhile it may be worth examining the various designs currently in use. The most common type employed in smaller electronic organs is the Leslie rotating horn system (see photograph). As can be seen from Fig. 2, the loudspeaker is fixed on a baffle board but "looks" into the rotating horn. These units are installed so that the sound can only come out of the revolving horn. The acoustical nature of the tremulant is mainly one of amplitude fluctuation of the fundamental notes but with considerable variation of their harmonic structure.

Another method, based on the rotating horn system, is one using a rotating deflector as shown in Fig. 3, this is generally used with large loudspeakers. This arrangement is sometimes used in conjunction with the small twin rotating horn system shown in Fig. 4, both assemblies being used together in external tone cabinets with built-in amplifiers and frequency crossover networks (Leslie organ tone cabinets). The small twin horn system shown in Fig. 4 rotates above the sound transducer the sound following the path shown by the arrows.

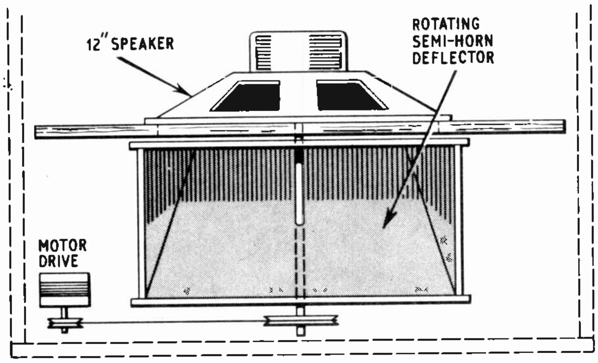


Fig. 3. The rotating deflector system used in Leslie tone cabinets

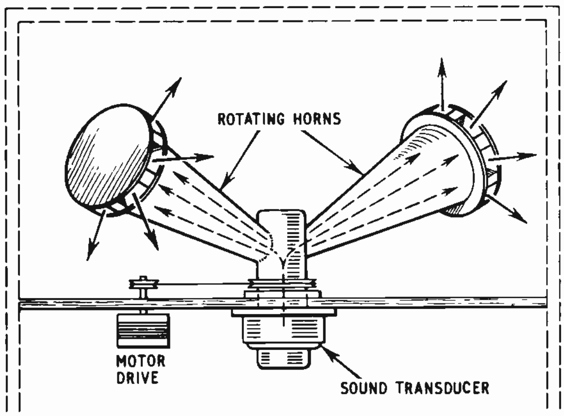


Fig. 4. Rotating twin horn system used in Leslie tone cabinets

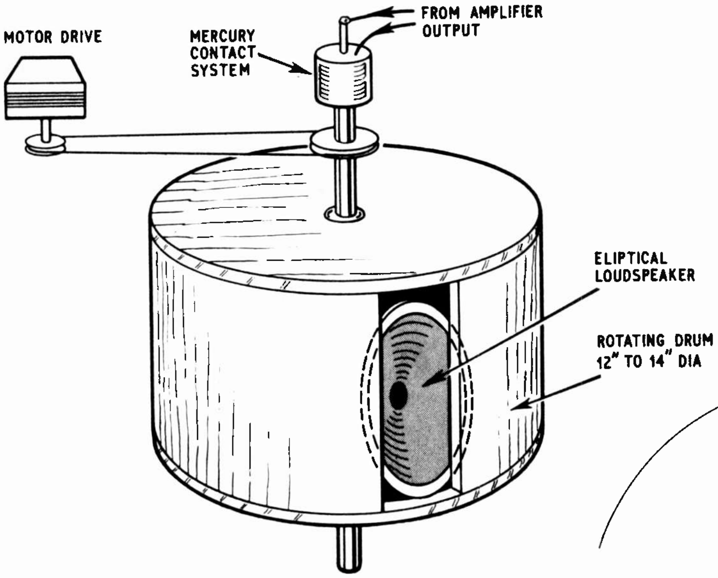


Fig. 5. The rotating speaker drum

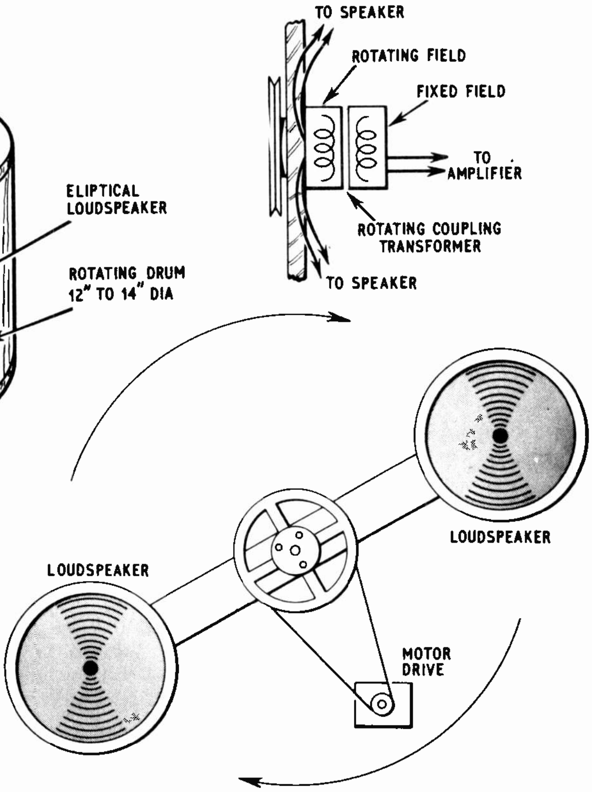


Fig. 6. Rotating twin loudspeaker system

Rotary horn or speaker systems are driven by a synchronous motor with a belt drive and a pulley diameter ratio suitable for turning the system at between five and ten revolutions per second; the usual speed is seven revolutions per second. Sometimes an additional motor or an alternative pulley ratio is used so that the system can be run at about one revolution per second to produce what is known as the "Celeste" effect (slow Leslie) which audibly, is a slow undulation not unlike the slow rise and fall in level heard from an organ in a large church.

ROTATING SPEAKER

Systems in which the loudspeakers themselves rotate present the problem of electrically coupling the speaker to the amplifier. Slip rings and contacts have been found unsatisfactory because of the low impedance so, as in the example shown in Fig. 5, a mercury contact system is used. The loudspeaker itself is a small eliptical type mounted in a rotating drum. In addition to complex amplitude variation, this system produces a small amount of pitch fluctuation due to Doppler effect.

The arrangement shown in Fig. 6 is used in various ways. In small electronic organs two speakers, normally not larger than eight inches in diameter are mounted one at each end of a rotating arm about 18 to 20 inches across. A special rotating coupling transformer, or mercury contact system, is used to connect the speakers to the amplifier. The system produces pitch variation due to Doppler effect but as with all rotating speaker systems this tends to be masked by the large amplitude fluctuations that are produced.

A variation of this system is also used in large tone cabinets for Church organs to produce the "Celeste" effect in which case four or more loudspeakers are made to rotate slowly on a radius of approximately 24 inches; the speakers themselves are spaced about four feet apart.

A ROTARY TREMULANT SYSTEM

In order to analyse the tremulant effect produced by a rotating horn system, the model shown in the photographs was constructed to the dimensions given in Figs. 7 and 8. A system of this kind can be used with any electronic organ or a guitar amplifier. As the photograph shows the completed assembly (without external covering) consists of the main baffle board on which is mounted an eight inch loudspeaker, the rotating horn drum and its synchronous drive motor and the framework forming the enclosure. The unit is finally covered with an open weave fabric.

Padding is used between the rear of the loudspeaker baffle and the hardboard back of the cabinet to prevent sound coming from the rear of the speaker. All the sound must therefore radiate, via the rotating horn, through 360 degrees on a vertical plane around it, hence the reason for covering the enclosure with open weave fabric.

ROTATING HORN

The rotating horn drum is not as difficult to make as it might at first appear. Accuracy is important, however, as the drum must rotate smoothly and almost silently at six to seven revolutions per second. Any mis-alignment of the bearings or distortion in the drum itself will cause vibration and noise.

The drum is constructed from $\frac{1}{8}$ inch thick hardboard to the dimensions given in Fig. 7. First the two discs are cut to 15 inches diameter, one with a centre hole approximately $6\frac{1}{4}$ inches in diameter. The main bearing supports (C)—one on each drum—could be cut from seven inch diameter discs of aluminium, but large holes must be cut in the one fitted on the loudspeaker side. A Ferrograph metal tape spool which comes apart quite easily, thus providing two accurately and ready made supports, was used in the prototype. The actual bearings (A, Fig 8) for the drum were $\frac{3}{8}$ inch bushes with $\frac{1}{4}$ inch holes, extracted from old potentiometers. These are inserted through the spool cheeks.

DRUM WALL

The drum wall is best made by first cutting a piece of hardboard six inches wide and approximately 45 inches long. This must be gradually rolled up, loosely at first, until the roll is finally down to around 12 inches in diameter. Heat will help, but the rolling up must be done in stages, allowing the hardboard to settle for a while by tying a piece of string around it. When it is down to a small roll, leave it tied up, at least over night. It should then remain rolled to approximately the right diameter for the drum faces. Next cut the material so that the ends coincide with the $8\frac{1}{2}$ inch wide mouth of the horn as shown in Fig. 7.

HORN WALL

The horn wall is made from thin plywood, or thick cardboard, rolled carefully to prevent it cracking. This is glued to one face of the drum with impact adhesive and also secured with small wood blocks, glued around the outside as shown. The ends of the horn must also be glued to the ends of the drum wall. The space between the drum wall and the horn wall can be filled with soft loosely packed paper or foam rubber.

The remaining side of the drum is then glued in position and the two straps (E) glued and screwed in place as shown in Figs 7 and 8. Note that the bearing plates (C) and bearings must be fitted before the drum itself is put together. The pulley should be approximately $3\frac{1}{2}$ inches in diameter and fitted so as to stand off the face of the drum by approximately $\frac{1}{2}$ inch as in Fig. 8. It is most important that the drum and its pulley are perfectly aligned and that there is no encentricity. It might be mentioned here that for the construction of the horn drum and its fittings the usual range of hand tools, plus power drill will be adequate and that the drum and its frame were completed and assembled in a weekend.

FINAL ASSEMBLY

The final stage of assembly is that of the speaker baffle and the drum supporting frame as shown in

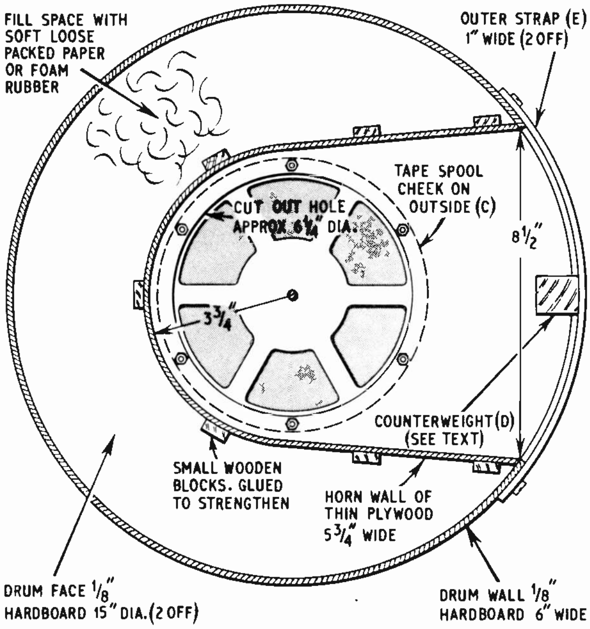
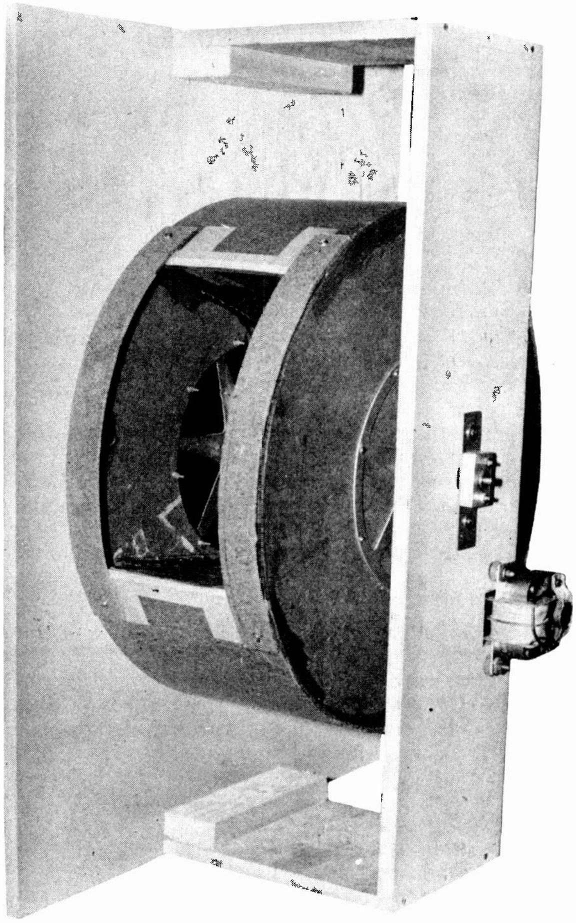


Fig. 7. Construction of the rotating horn drum. This drawing shows the drum with one side removed



The completed rotary horn and drive system mounted in its supporting frame

TREMULANT SYSTEMS CONTINUED

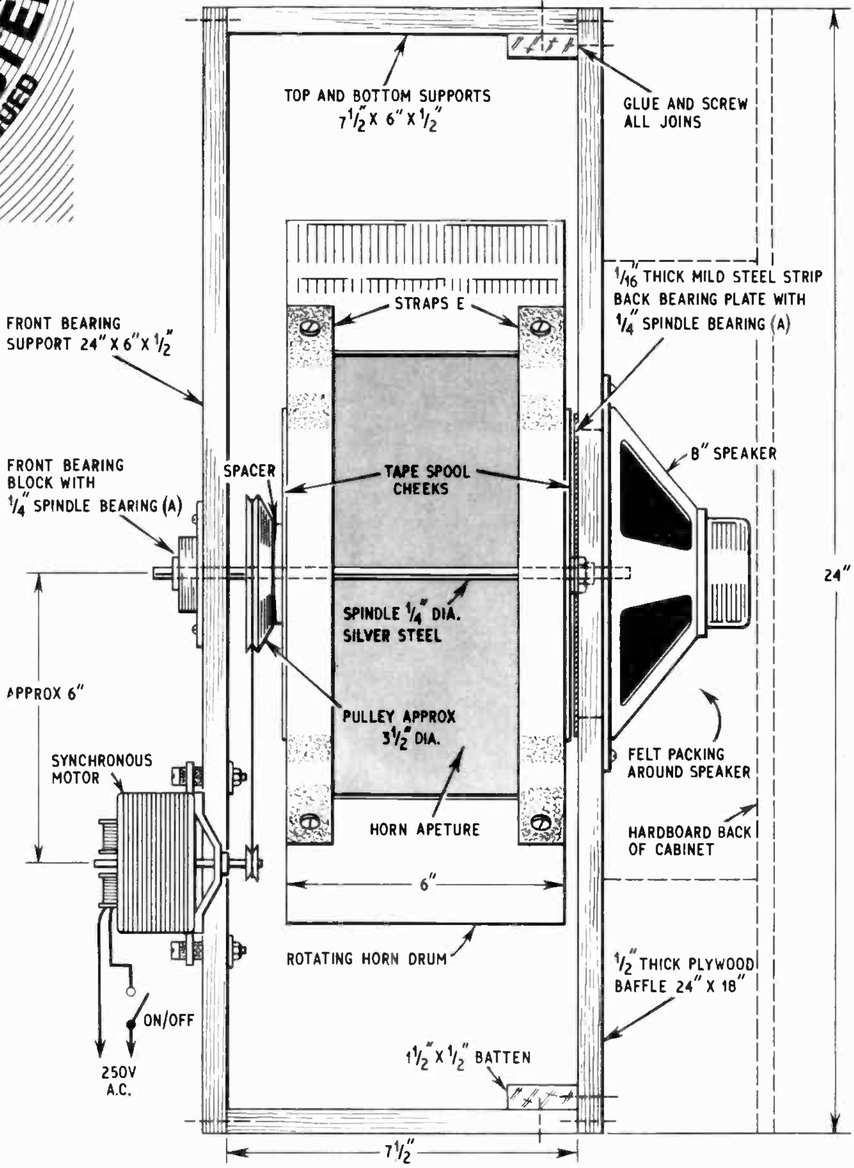


Fig. 8. Completed assembly of rotary horn system in its supporting frame with the drive motor fitted

MATERIALS . . .

(For the construction detailed in this part only)
Hardboard $\frac{1}{8}$in thick—15in × 15in (2 off)
45in × 6in
11in × 1in (2 off)
Plywood $\frac{1}{2}$in thick—24in × 18in
24in × 6in
$7\frac{1}{2}$in × 6in (2 off)
Thin plywood or stout card 27in × $5\frac{3}{4}$in
Hardwood 6in × $1\frac{1}{2}$in × $\frac{1}{2}$in (2 off)
Small hardwood blocks
Ferrograph tape spool, 7in diameter metal type

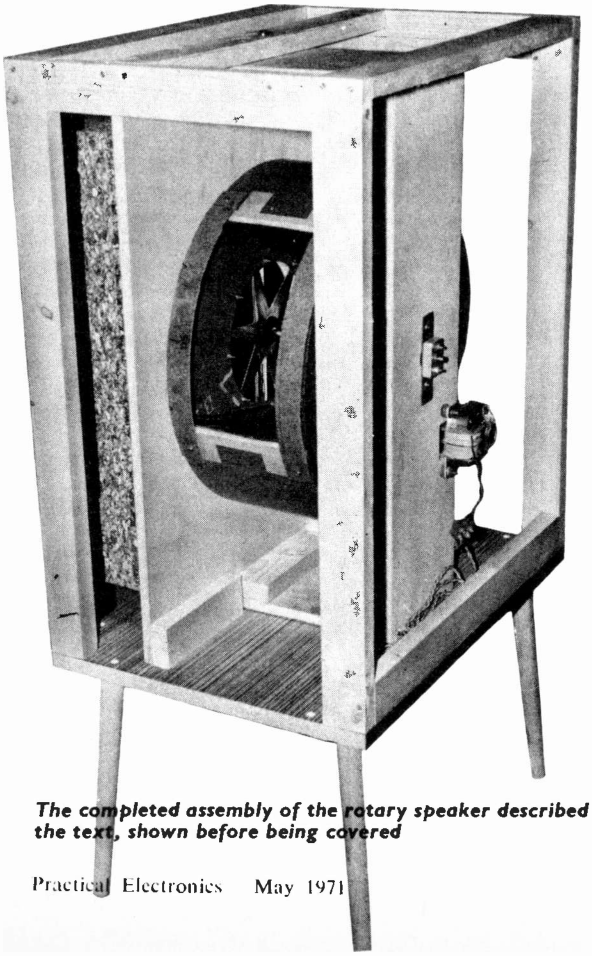
Silver steel rod $\frac{1}{4}$in diameter × $7\frac{1}{2}$in
Brass or steel, approx 1in × 1in × $\frac{1}{4}$in (2 off), 8in × 1in × $\frac{1}{4}$in and 4in × 1in × $\frac{1}{4}$in
Pulley $3\frac{1}{2}$in diam. and spacer to suit (see Fig. 8)
Bushes $\frac{1}{4}$in internal diameter (4 off)
Synchronous mains motor with small pulley (see text)
Loudspeaker 8in diameter with impedance and handling capability to suit amplifier used
Rubber belt
Screws, glue, 4BA fixings and grommets

Fig. 8. Note the position of the back bearing plate, with a $\frac{1}{8}$ inch bush ($\frac{1}{4}$ inch internal hole) across the speaker opening. The front bearing block on the vertical support comprises a metal plate approximately 4 inches × 1 inch with a bush (from an old potentiometer) to take the $\frac{1}{4}$ inch diameter spindle that goes right through the drum.

The drive motor may be almost any synchronous tape recorder drive motor, mounted as shown in Fig. 8 on rubber bushes (grommets will do). The diameter of the small drive pulley on the motor may require some thought and experiment, but will normally be $\frac{3}{8}$ to $\frac{1}{2}$ an inch in diameter. A rubber belt of suitable length is used for coupling the motor to the drum pulley.

When the whole assembly (except the speaker) has been completed as shown in Fig. 8, make absolutely sure that it turns freely and accurately. Without the counterweights (shown in Fig. 7) it should revolve freely if pushed and come to rest with the horn mouth uppermost. The counterweights are fitted one each side under the straps E and consist of a small square of brass or mild steel, glued securely in place. When these are fitted, check that the balance is correct, in which case the drum should come to rest at any random point. Under power, the drum will reach speed slowly but should continue to revolve smoothly and quietly. Although a small amount of vibration may be set up in the frame, this should disappear almost completely when the unit is finally secured within the framework of the enclosure.

Next month: the construction of the enclosure frame, and electronic simulation of rotary speaker tremulant systems.



The completed assembly of the rotary speaker described in the text, shown before being covered

MAKING THE MOST OF LOGIC IC's

PART ELEVEN—By R. W. COLES

EMITTER COUPLED LOGIC— Concluding Article

HIGH SPEED LOGIC, HSL, is the last family of integrated circuits to be discussed in this series. The name is a very general one to allow for the fact that there are really two sub-families which use very different circuitry to achieve the same goal of very short propagation times, and thus high operating speeds.

This type of logic is, of course, mainly intended for use in computers and other high speed data handling equipment, where its application allows simple operations (addition for example) to be carried out in less time than would be necessary if, say, RTL were employed to carry them out. Looking at this from a different viewpoint, HSL enables one to build a computer which will carry out more complicated tasks in a realistic time than could be carried out by its predecessors.

Some new areas which are now being exploited by computers which possess this super-speed capability are: the reading of written characters which are not in a special "stylised" fount, including signature recognition; the control and real-time analysis of airborne "terrain" radar information, and the ability of "general purpose" computers to handle several jobs or programmes simultaneously.

APPLICATION AREAS

While it is true that computer requirements lead to the development of high speed logic, and will eventually be responsible for the lowering of its price by virtue of the huge volume of devices which will be employed in these machines, it is also true that small quantities of HSL will be found very useful in application areas that are economically within the amateur's reach.

How about an f.m. tuner which is set to the desired channel by a crystal controlled frequency synthesiser with just one crystal? Or a digital frequency counter which will display directly the frequency of a signal as high as 300MHz? These circuits and many others will become feasible when HSL is used.

SUB-FAMILIES

One technique for increasing the operating speed of digital circuits is that of "current-steering" and this solution to the speed problem was used even before it became available in integrated form, where it now reigns supreme. The basic gate is quite simple in conception and utilises a "longtail pair" as a current switch.

The other solution, which has only recently been introduced, uses a specially modified TTL circuit which includes Shottky barrier diodes as anti-saturation clamps. This last solution is a very exciting development because unlike the current-steering circuits the devices are directly compatible with slower saturated logic forms like DTL and TTL, whose power requirements they share.

CURRENT STEERING LOGIC

This family has many names, and apart from CSL it is also referred to as CML (current mode logic), EECL or E^{2}CL (emitter-emitter coupled logic) and, most popular of all, ECL (emitter coupled logic). The basic ECL gate is shown in Fig. 11.1.

Excellent high speed performance is assured by using a differential amplifier (longtail pair) in which the component transistors do not enter saturation during operation, eliminating transistor storage time prevalent in TTL, DTL and the other saturating logic families. Emitter followers are used as output drivers to provide a high current drive which is capable of a fan-out of 15 ECL gate input loads.

An unusual feature is the provision of both a true and a complementary output which enables the simple gate shown to be used as either an OR or as a NOR gate (or both), in the positive logic convention. By assuming negative logic inputs, this gate becomes either an AND or a NAND, which makes this circuit a universal building brick capable of performing all the basic logic decisions.

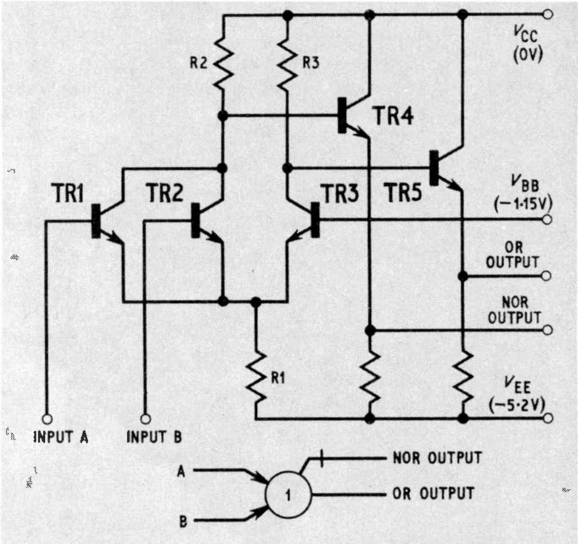


Fig. 11.1. Basic ECL gate (showing positive logic) Logic level 1 = −0·75V, logic level 0 = −1·55V

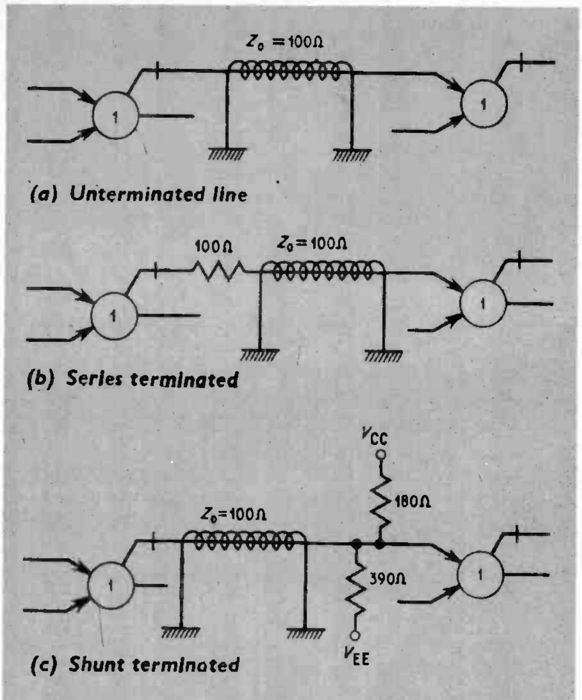


Fig. 11.2 Making use of high-speed interconnection characteristics in the systems design

The dual outputs are provided first because the cascading of gates to turn a NOR into an OR is unacceptable on the grounds of increased propagation delay in high speed systems, and secondly because this useful addition is very easy to incorporate in the circuit where complementary outputs are inherently available from the longtail pair.

OPERATION

The power line voltages are specified quite closely by manufacturers, and Fig. 11.1 gives a typical example where the V_{CC} line is grounded, and the V_{EE} line is run at $-5{\cdot}2$V.

The V_{BB} line is used only to bias the longtail pair, providing a reference about which the logic swing is centred, and as such could be provided by a potential divider from the other power rails, a technique which is incorporated in some manufacturers ranges of ECL.

In operation, voltages of either plus or minus 400mV (with respect to V_{BB}) are applied to inputs A and B. If both inputs are more negative than V_{BB}, then TR3 will steer the current from R1 through R3, which will have a drop of 800mV across it. The 750mV V_{be} drop of TR5 will subtract from this to give a final OR output of $-1{\cdot}55$V (a positive logic 0).

Meanwhile, because very little current will flow through R2, a voltage equal to V_{CC} is present at the base of TR4, giving a final NOR output after the V_{be} drop, of -750mV. This re-establishes the input levels of plus or minus 400mV with respect to V_{BB}, ready to drive further gates. In this example the two logic 0 in gave a logic 0 out on the OR pin, and a logic 1 on the NOR pin, just as required.

If any of the inputs become more positive than V_{BB}, then its associated transistor will divert the current from R1 through R2, reversing the situation in the first example, and giving a 1 out of the OR pin, and a 0 out of the NOR pin.

The uncluttered simplicity of the circuit, coupled with its non-saturating operation, and the use of transistors with very high cut-off frequencies (f_{hfb}), gives propagation delays of only one to three nanoseconds, compared with the ten nanosecond performance of the relatively fast TTL gate.

NOISE PERFORMANCE

As the current drawn by a gate is constant no matter what state it is in, very little power line noise is generated by switching transients.

Since the threshold of a gate input is about plus or minus 150mV (with respect to V_{BB}), and since the worst case output levels are about plus or minus 350mV, a d.c. noise immunity of about 200mV (from both 0 or 1) is to be expected.

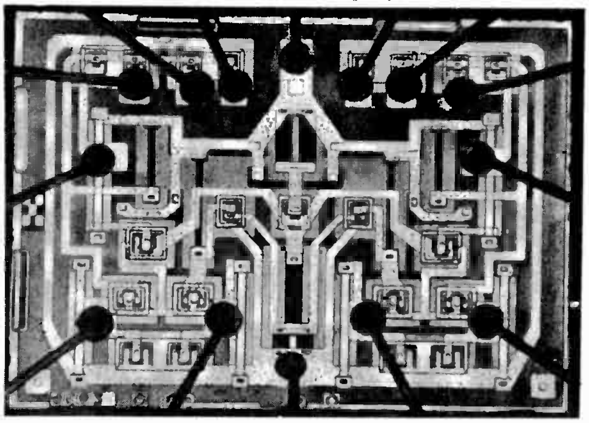
The main noise problem which arises with logic operating at these speeds is due to ringing and reflections generated by very high frequencies present in the square edges of dynamic gate outputs. The frequencies present, when ECL gates switch, extend into the gigahertz region, making even an inch or so of interconnecting wire act as a significant inductor.

The only solution to problems of this nature is to treat interconnections as transmission lines, using twisted pair for wiring up, and terminating each line in its characteristic impedance which is between 90 to 150 ohms. Professional designers working with printed circuits usually design around 50 ohm lines using multi-layer boards with ground planes.

Fig. 11.2 shows three methods of interconnecting ECL. Using unterminated lines of a twisted pair, interconnections of several inches can be safely handled and fan-out from the end of the line is unrestricted (11.2a). To drive longer lines, termination is necessary to reduce reflections, and there are two methods of achieving this.

Fig. 11.2b shows the simplest terminating arrangement where a resistor equal to the (estimated) Z_0 is placed in series with the line at the driving end; unfortunately, logic swings are of course reduced by half, and noise immunity suffers as a result. This and the next system can be used to drive lines several feet long.

By placing a resistance equal to Z_0 in shunt with the line at the remote end, very good driving characteristics can be achieved, with the disadvantage that either a separate supply must be used to terminate the resistor, or a parallel combination such as that shown in Fig. 11.2c must be employed.



Photomicrograph of an E²CL double logic gate

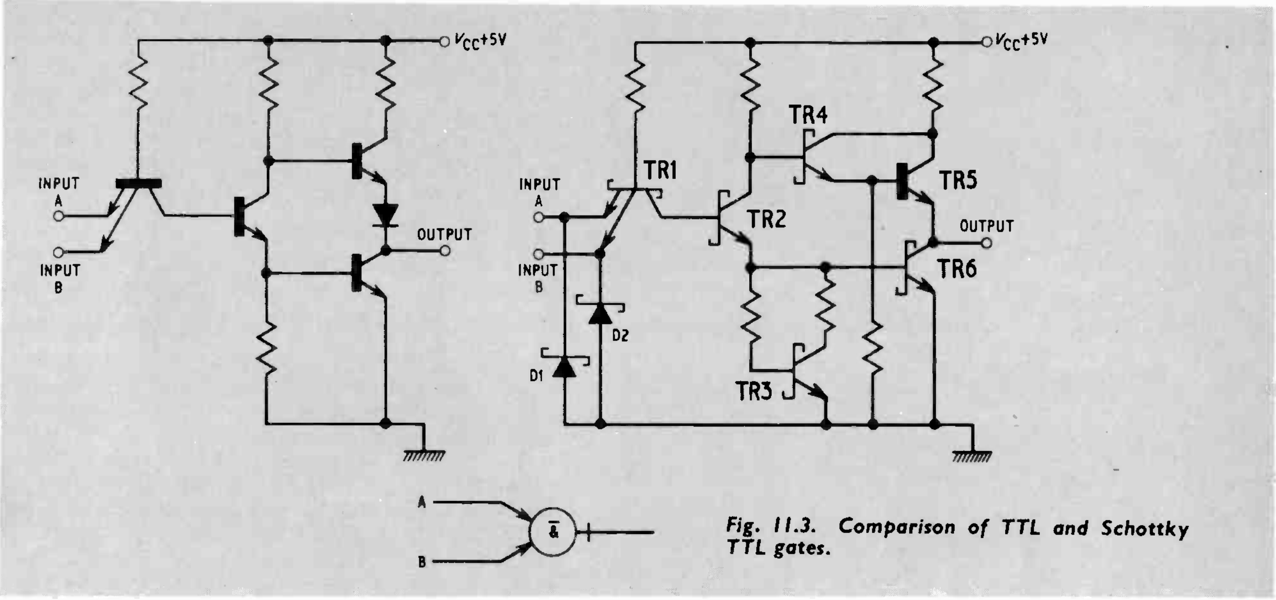


Fig. 11.3. Comparison of TTL and Schottky TTL gates.

FLIP-FLOPS AND MSI

It is likely that the most useful ECL devices for amateur applications will be the flip-flops. At present various ranges are available from different manufacturers to cover the toggle frequency range of 100 to 350MHz. To build counters using ECL flip-flops is relatively easy if binary multiples are required.

If an input frequency is, say, 160MHz, after three ECL flip-flops it is possible to build the rest of the counter with a slower (and cheaper) logic form such as TTL. After three ECL stages the frequency will be down to 20MHz which is within the capability of TTL, although a logic-level interface will be necessary between the two families.

ECL is also produced in the medium scale integration (MSI) form, and although the variety available is not as great as with TTL, a useful range of counters, decoders, and especially arithmetic units, is now available.

One particularly advanced example from the Motorola MECL III range will add together two eight-bit words; the delay from carry in (from a possible previous stage) to carry out (to a possible following stage) is an incredible 10 nanoseconds, or in other words it could add together a hundred million pairs of numbers in one second.

PACKAGES

ECL is available in either the Dual-in-line plastic package or the hermetically sealed (and very expensive) flat-pack.

SHOTTKY CLAMPED TTL

The basic TTL family has become increasingly popular in the last few years, and is without doubt the mainstay of the data-processing industry. TTL is available in the widest number of package functions, and the range is continuously expanding.

The price of this versatile family continues to fall, and it is already cheaper than the less useful DTL devices, prices as low as 10p for a quad 2-input gate package being reported on some large orders. TTL is also available in a wide variety of MSI packages including quad adders and eight-bit shift registers, making it the only logical choice for medium speed applications (below 50MHz) in new designs.

In our investigation of this family, we concerned ourselves only with the 74 series of devices, which are the most popular; but in parallel with this series are the 74L and 74H devices which extend the usefulness of TTL respectively down and up in the speed range.

Type 74L uses a standard 74 type gate but with larger resistance values to reduce power consumption, whereas 74H uses a slightly modified 74 type gate with lower resistance values to optimise the circuit for high speed operation up to 50MHz.

NEW SERIES 74S

To extend the usefulness of TTL into the speed range above 50MHz, which has always been reserved for ECL devices, is clearly an inviting proposition, despite the technical difficulties involved. This breakthrough has now been made, and Texas Instruments offer several devices using Shottky-clamp technology, in a new series labelled 74S.

Although still in its infancy this new series is set for a great future along with its other TTL relations, with which it is fully compatible in every respect.

A counter which has an input frequency of 100MHz and which is required to divide by 256, can now be built using the combination of two 74S flip-flops, two 74H flip-flops, two 74 flip-flops, and finally two 74L flip-flops. Using slower devices in the succeeding stages in this way gives a dramatic power saving, and is simple to carry out because no interface circuitry is required.

BASIC GATE

The basic STTL gate is shown in Fig. 11.3, alongside the standard 74 series gate for comparison purposes. The basic 74 series gate operates in the saturated logic mode, which means that when any of the component transistors is turned on with a positive voltage on its base, it will "bottom" or saturate, which means, among other things, that its

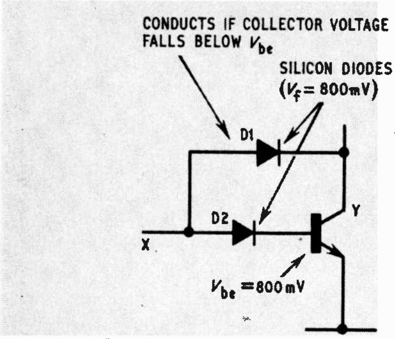


Fig. 11.4. Anti-saturation clamp using common diodes

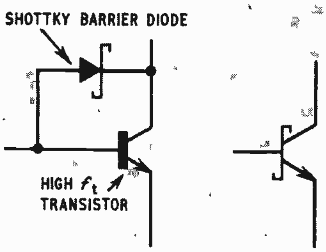


Fig. 11.5. Schottky barrier diode used as an anti-saturation clamp

collector voltage will be lower than its base voltage. Typical values here woud be 800mV on the base with 200mV on the collector.

When operated in this manner, transistors are speed limited by the stored charge which has to be removed before the transistor can be turned off. As we have already seen, operating transistors in what is effectively "class A" (ECL) prevents saturation, but techniques of this kind cannot yield a gate which would be compatible with the rest of the TTL family, and therefore must be ruled out.

By connecting an ideal diode from the collector to the base of a transistor, it would be possible to divert base current if the collector voltage fell below V_{be}, and thus to prevent saturation.

This is just fine except for the problem that available diodes are not "ideal", and have a forward voltage similar to the V_{be} of a transistor, but a modification to this idea has been used in the past, and is shown in Fig. 11.4. With the transistor turned on, the voltage at point X will be about 2 × 800mV, or 1·6V.

The diode D2 offsets the V_f of diode D1, so that it will conduct and divert base current if the voltage at point Y falls any lower than 800mV, preventing true saturation of the transistor. The problem with this arrangement is that the silicon diodes used increase storage time effects, and tend to cancel the anti-saturation advantage gained.

SHOTTKY DIODE

In these days of new semiconductor devices seeming to turn up every few weeks, readers may have missed the Shottky-barrier diode, which has proved very useful in microwave applications. The importance of this type of device is that first it has a low forward voltage (V_f) of only 200mV, and second that it has no stored charge because there are no minority carriers. These two characteristics make it ideal for use as an anti-saturation clamp, and in an STTL gate it is used to great advantage across all transistors but one.

Fig. 11.5 shows the way the diode is connected, and also shows the symbol used to denote a clamped transistor of this type. Other improvements to the 74 type gate include the provision of Shottky input clamp diodes to suppress line ringing and undershoot, which in high speed operation must be minimised.

A compound emitter follower is used in the "active pull-up" section of the output, although this is not new, and is used in the 74H series to give improved performance when driving capacitive lines. Also an extra transistor (TR3), has been incorporated to provide an active "turn-off" for TR6.

Combining saturating and non-saturating design features in this way gives a useful power reduction for the same performance. A measure of this improvement is given by the speed/power product; this could be 10 to 20mW per nanosecond for ECL; is only about 7mW per ns with STTL.

One of the most interesting claims made by the manufacturers of the 74S series is that controlled impedance terminated lines are not required for on-board interconnections, but it is recommended that any constructor using this series uses twisted pairs for such connections.

NOISE PERFORMANCE

Noise immunity of STTL is down on that for the 74 series by about 100mV because of the higher logic 0 level at the output introduced by the non-saturation of TR6.

Fan-out and TTL compatibility are not affected by this increase in level, and an STTL gate will handle ten other 74S inputs or twelve 74 series loads.

At present only a few devices are available in this range, as follows:

SN74S00	quad, 2-input NAND
SN74S20	dual, 4-input NAND
SN74S112	dual edge-triggered JK flip-flop (with preset and clear)

The gates exhibit a propagation delay of typically 3ns and the flip-flops will toggle at 100MHz (typical).

COMPARISON

For the very ultimate in speed performance, ECL still holds the field, and is likely to continue to do so despite the large bite taken out of its slower end by the new STTL. STTL does, however, make a very useful extension to the ever widening application area of the standard TTL, and will soon be found in many frequency counters and synthesisers as well as the inevitable computer arithmetic sections.

I.C. APPLICATIONS TECHNOLOGY

This concludes a long and extensive series of articles on logic i.c.s; some of the devices mentioned in the series are currently obtainable from advertisers, while it is to be hoped that more advanced types will appear later when quantity production is stepped up.

Examples of applications are extremely diverse—some have already been described in this magazine; others will follow. One thing is certain: while the series has been running, the range of devices available and the number of suppliers have increased.

The future of integrated circuits is not in killing off the range of circuitry that can be devised—but in harnessing new technology to the ever demanding requirements of application techniques. This new science is as exciting a prospect as transistors were 20 years ago. ★

FISH BITE ALARM

By D. R. HAYES

A FISH bite indicator that uses an exposed relay for alarm switching will inevitably run foul of such complications as contact corrosion with exposure to moisture, or line entanglement with the relay. The device to be described has none of these shortcomings, as a sealed reed switch is used.

In principle the switch contacts are held closed by a small permanent magnet which breaks the supply to a multivibrator alarm circuit.

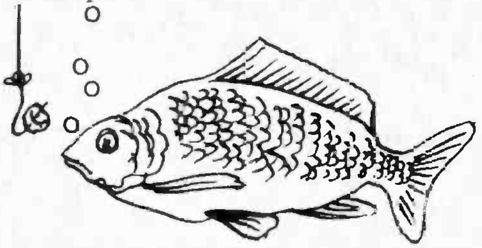
The fishing line is passed between the reed switch and magnet, the latter being free standing. With a bite, the line moves and displaces the magnet so that the supply and alarm are turned on.

OPERATION

The alarm circuit of Fig. 1 consists of a multivibrator circuit, TR1, TR2, the frequency of which is set by C1, R2, R3 and C2.

Square waves produced are applied to the emitter follower TR3 which matches the relatively high output impedance of TR2 to the low impedance of the loudspeaker.

The alarm frequency was determined from experiments designed to discover the most penetrating frequency which would be the least likely to be masked by extraneous sounds. A 1kHz note was finally decided upon.



Changes in line voltage have an effect on frequency; a rise in volts causing a rise in frequency and vice versa. However, this tonal variation is not critical and batteries of from 6 to 15 volts are quite acceptable.

CHOICE OF REED SWITCH

Cheap dry reed switches have normally open contacts so they are not much use for direct supply switching in this application. Unfortunately, the cost of a changeover reed switch is about three times

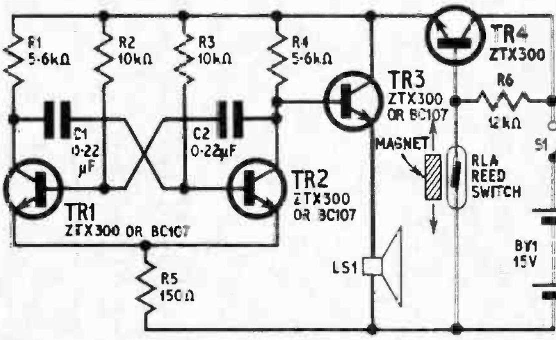


Fig. 1. Circuit of fish bite alarm

COMPONENTS . . .

Resistors
R1 5·6kΩ
R2 10kΩ
R3 10kΩ
R4 5·6kΩ
R5 150Ω
R6 12kΩ
All 10%, ½ watt carbon

Capacitors
C1 0·22μF polyester
C2 0·22μF polyester

Transistors
TR1–TR4 ZTX300 *or* BC107 (4 off)

Loudspeaker
LS1 80Ω, 1½in diameter

Switches
S1 On/off slide switch
RLA Dry-reed switch type 6-RSR with short magnet (Radiospares)

Miscellaneous
Diecast box (Eddystone) 4½in × 3½in × 2in, BY1–15V battery, Bakelite sheet 3½in × 4½in, aluminium 4¼in × 3in, copper clad s.r.b.p. board 2⅛in × 2in
⅜in, 6B.A. tapped stand-off pillars (2 off), ¼in, 6B.A. countersunk screws to suit (4 off), stand-off insulators (2 off)

higher, so some additional circuitry is justified to enable the cheaper switch to be used.

One extra transistor TR4, and its feed resistor, R6, are placed in the supply line so that with the magnet positioned near to the reed switch, this is closed, clamping the base of TR4 to the negative line so that it does not conduct.

When the magnet is disturbed by the line, the reed switch contacts open so that TR4 is biased on via R6.

In the stand-by condition there is a small current drain but, as this is in microamps, it can be ignored.

The circuit will work over a wide range of transistor types, and the remainder of the components can have wide tolerances.

Speaker impedances can range from 3–80 ohms with little performance variation.

CONSTRUCTION

The prototype unit was assembled on a printed circuit board, the etched pattern and wiring details of which are shown in Fig. 2. Apart from the reed switch mounting, component layout is not critical so Veroboard could be used as an alternative.

Since, in the final assembly, a Bakelite lid is interposed between the reed switch and the magnet, it is most important that the former be mounted as close as possible to the lid. With the components specified, the maximum operating distance of the magnet is about 1in.

Two ½in, 8BA stand-off insulators are used to mount the reed switch which appears on the opposite side of the board's small component assembly.

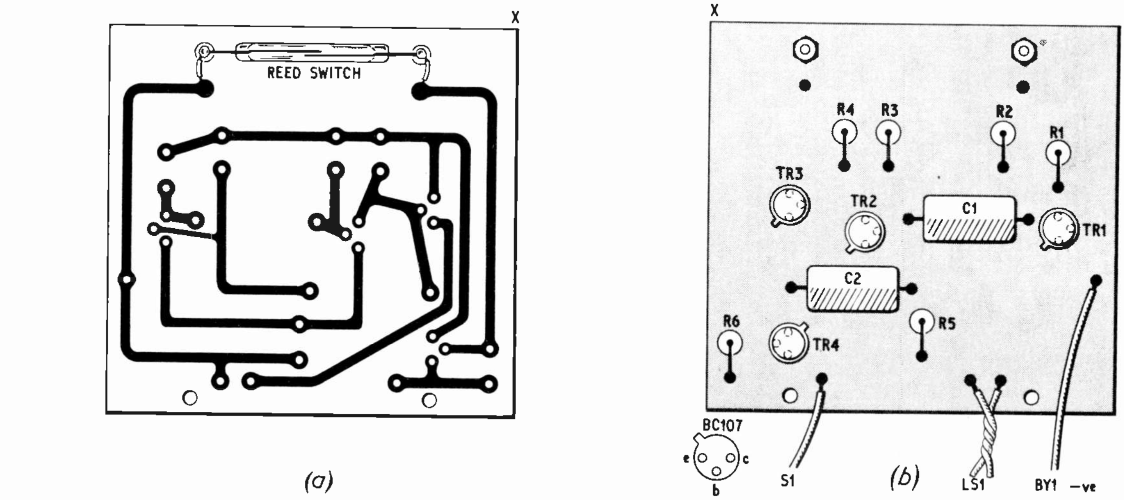


Fig. 2(a). Etching pattern for copper clad board. (b) The topside of the board with components in position

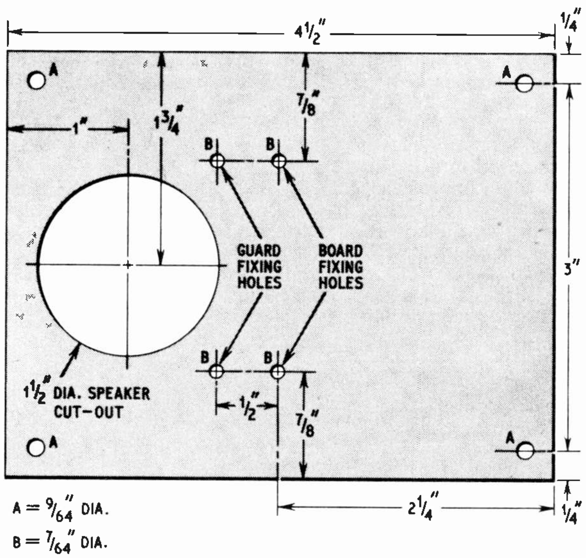


Fig. 3 (above). Drilling details of Bakelite lid

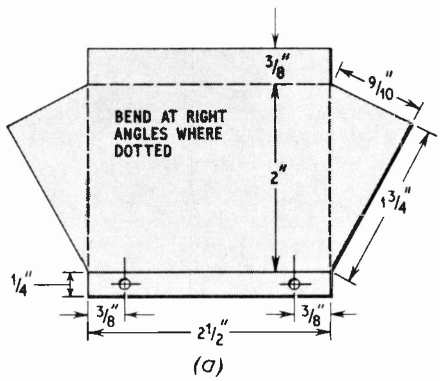


Fig. 4a (above right). Pattern for cutting and bending aluminium water shield

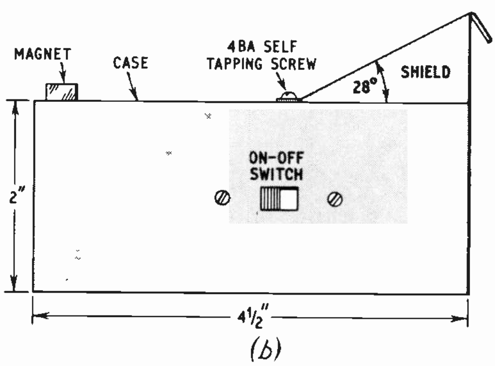
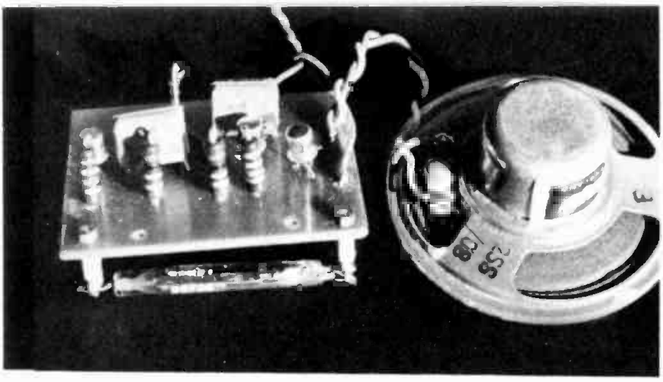


Fig. 4b (right). Profile of completed unit



Other small reed switches can be used if preferred, as the contact current rating requirement is extremely small.

LID MOUNTING

With the wiring of the printed circuit board completed, a 3½in by 4½in Bakelite sheet should be cut out and drilled as in Fig. 3. This will serve as a non-magnetic lid for mounting the board and loudspeaker.

Two ⅜in, 6B.A. tapped pillars with ¼in countersunk screws are used for fixing the board. With this in position the area over the reed switch on the Bakelite lid should be scratched to provide a future marker for the magnet.

As the device will spend a good part of its life in the open air it is a good idea to fit some form of shield to protect the loudspeaker from the ingress of water. How this is achieved is given in Fig. 4 which provides constructional and mounting details of an aluminium water shield. Two 4B.A. self tapping screws are used to retain this to the lid.

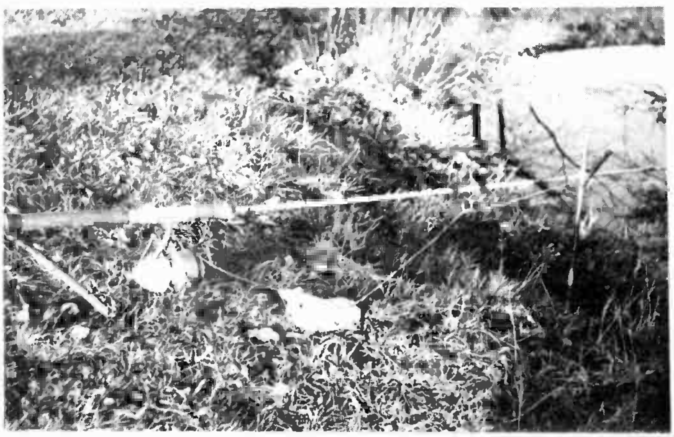
Interwiring can now proceed according to Fig. 2. With this completed the unit should be functionally tested.

An Eddystone diecast box supports the lid assembly and contains the battery. This should be drilled for S1 and the switch mounted. The battery should now be connected and a final test carried out before securing the lid.

EASILY SEEN

When completed, the indicator should be painted in some bright, easily visible colour, so that it will not be accidentally trodden on or left behind when fishing is completed.

The operating magnet should also be painted and a small piece of cloth glued to its base to supply the necessary friction between it and the fishing line. Green baize is an ideal choice here. ★



NEWS BRIEFS

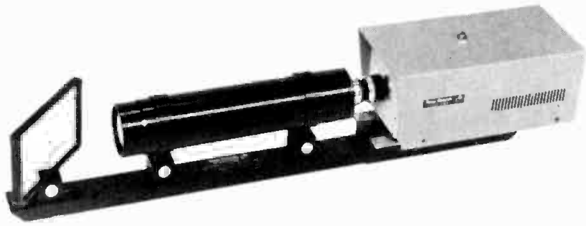
Cine to Television

HIGH quality T.V. pictures can be taken from cinefilm being shown on a normal large screen by a novel simultaneous projection unit, designed by Top Rank T.V. This replaces the ineffective technique of pointing a T.V. camera at the screen.

The unit can be mounted on most standard 35 mm cine projectors to deflect a proportion of the projected light, through a specially computed optical system, into a television camera (see photograph).

It is designed for professional 35 mm projectors but a variant for use with professional 16 mm machines is available to special order.

The optical system provides matching to 1 inch vidicon or plumbicon picture formats, and has accommodation for balancing neutral density filters. It can be used with either mono-chrome or colour television cameras.

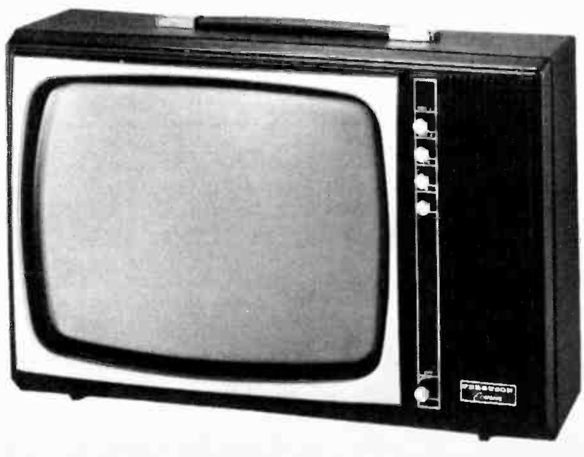


Portable Television

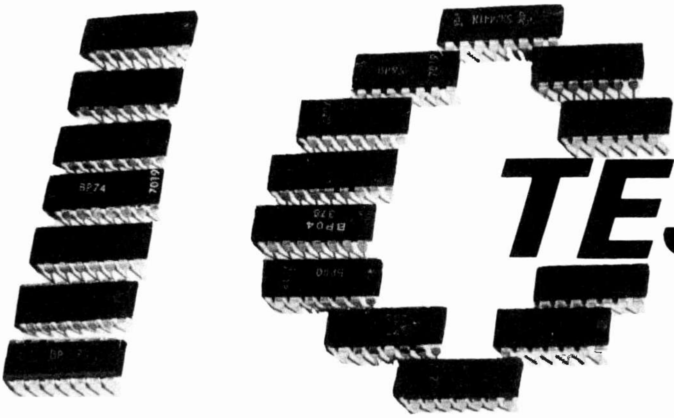
A NEW single standard (625 lines) 12-inch monochrome portable T.V. has been introduced by B.R.C. under the brand name Ferguson. Of its type the Courier—as the set is to be known—is the only portable on the U.K. market that is British made and has push-button selection. The set cost £58·60, less than any other comparable set.

The Courier shown below weighs only 16½ lbs. is mains operated, has an adjustable loop aerial and is enclosed in a plastics case.

Other unique aspects of the Ferguson 12-inch Courier include technical innovations not usual in small portables. There is a four-stage, transistorised, high gain I.F. amplifier with amplified AGC applied to the first two stages. The horizontal line timebase is flywheel controlled to avoid misregistration of lines under poor reception conditions.



DIGITAL



TESTER

By D. Burn Ph.D

Provides a rapid functional check-out for digital 'dual-in-line' integrated circuits

RECENT articles on digital integrated circuits in this magazine have stimulated a considerable interest in these fascinating devices. Added to the fact that they are now available to the amateur at low prices, many readers will doubtless wish to experiment with them.

When using transistors, particularly the low-cost bargain variety, the wise experimenter will have carried out a few simple tests on each one before incorporating it into his circuit. The same precaution is advisable to an even greater extent when using i.c.s, for trouble-shooting a complex system is difficult enough without the added complication of one or more dud i.c.s.

The tester to be described will carry out fairly simple go-no go tests on a wide variety of i.c.s., and is particularly aimed at the TTL dual-in-line series which is currently available with the largest choice of functions. However, both RTL and DTL can be checked, and simple adaptors could be devised for other types of i.c. package.

FLEXIBILITY

The major problem with an instrument of this type is to provide sufficient flexibility to enable any one of a very large range of possible logic functions to be checked, from a simple two input NAND gate to a complex four bit binary adder. The key to this problem lies in the use of patch-cords, which, although perhaps somewhat untidy, offers an economical solution.

The i.c. to be tested is plugged into a 16 pin socket, every pin of which is wired to a single pole, four-way switch. These switches enable each pin to be connected either to 0 volts, a logical 1 voltage, the supply voltage or, via a patch-cord socket, to some other input or output function.

The input is provided by a versatile pulse generator, while the output may be a voltmeter, an indicator lamp or an oscilloscope.

POWER SUPPLY

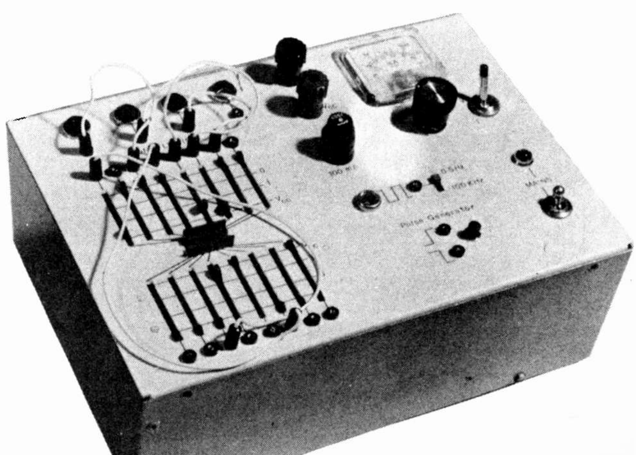
The circuit may conveniently be divided into two parts, a power supply with associated meter circuit, and a pulse generator with associated indicator lamps.

In the power supply circuit (Fig. 1) the output of transformer T1 is rectified by diodes D1 to D4, smoothed by C1 and fed to R1 and the Zener diode D5 to provide a fixed supply of 5·1 volts for the pulse generator and the indicator lamps.

Diode D6 provides a 12 volt source, part of which, selected by VR1, is fed to the base of the series transistor TR1.

The output from the emitter of TR1 is a voltage which may be varied from zero up to about 10V and forms the supply to the i.c. under test. In the prototype, a 2N3055 was used here, but it is probable that a transistor of a lower rating could be substituted.

Capacitor C3 further smooths the output, while C4 is a decoupling capacitor to prevent instability.



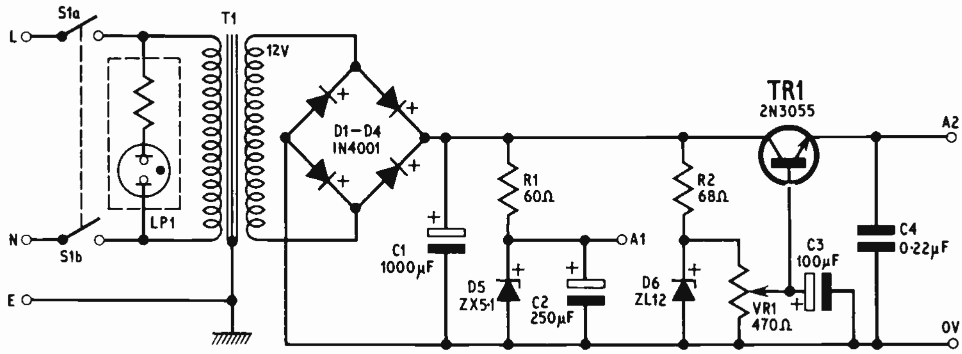


Fig. 1. Circuit diagram of power supply for the I.C. tester

METER CIRCUIT

Meter M1 (Fig. 2) is calibrated to read 0–100mA and 0–10 volts. Here a 1mA meter with a multiplier resistance R3 of about 10kΩ is used. The shunt R4 is made from a piece of resistance wire from an electric fire element. Both of these resistors should be chosen by experiment to suit the meter.

S2 is a single pole, biased, change over switch which may be either toggle or push-button. In the normally closed position, the power unit output voltage V_{CC} is read. In the normally open position, the current being drawn by the i.c. under test is metered.

Both the 0 volt and V_{CC} output are routed to take-off terminals SK1 and SK2 so that the 0 volt line is available as an earth return when an oscilloscope is being used, and the V_{CC} line is available when an external load, required by some i.c.s, has to be connected.

PULSE GENERATOR

In Fig. 3, TR3 and TR4, together with their associated components, form a simple multivibrator.

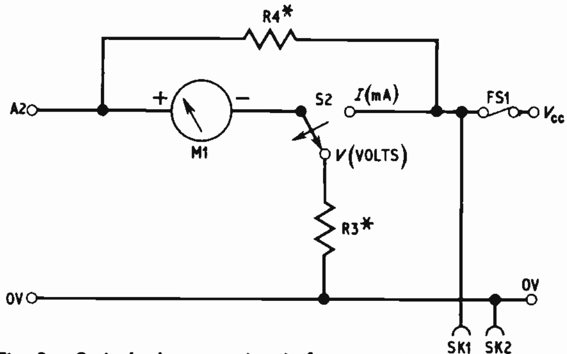


Fig. 2. Switched meter circuit for providing power supply current and voltage readings

With switch S3 open, C5 and C8 give a frequency of about 100kHz. Closing S3 connects C7 and C6 across C5 and C8 and results in a pulse rate of about 1Hz.

Since digital i.c.s, and particularly the TTL type, require clock waveforms having rise and fall times of the order of 10 to 20nS for reliable operation, the multivibrator output is sharpened up by gates G1 and G2 of IC1, connected as a Schmitt trigger.

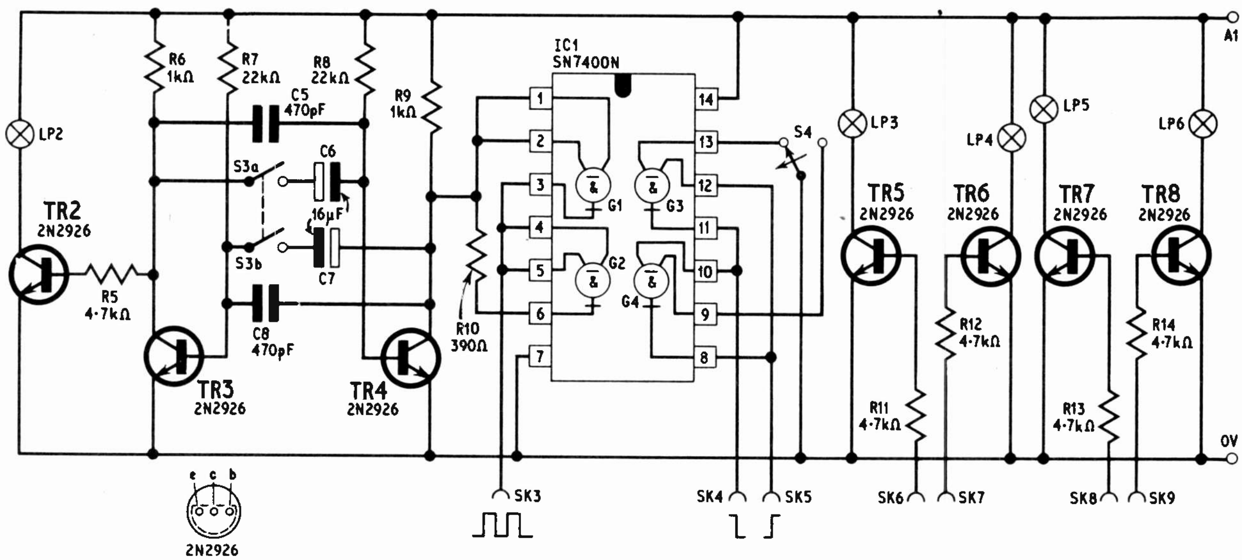


Fig. 3. Pulse generator and lamp indicator circuits

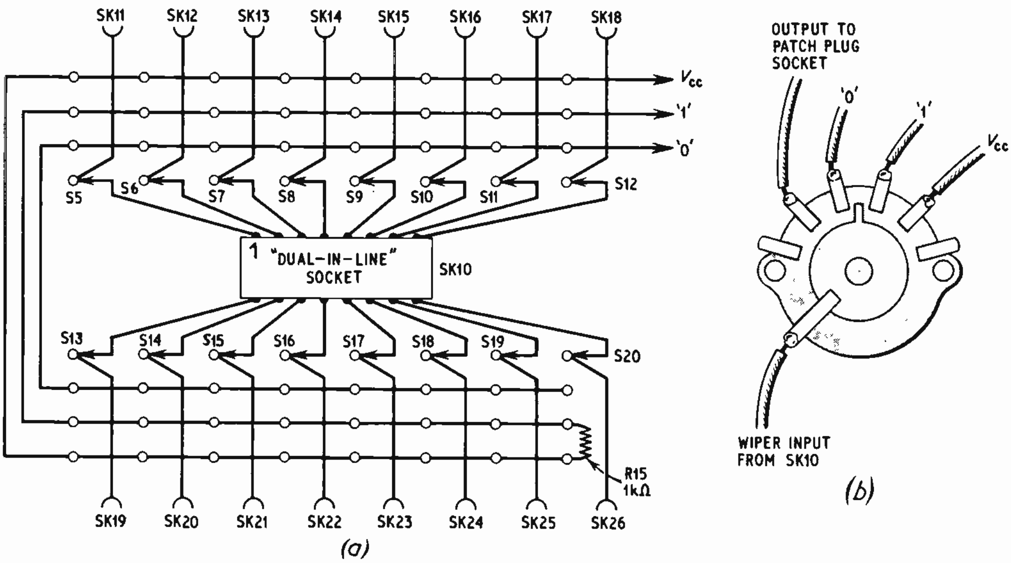
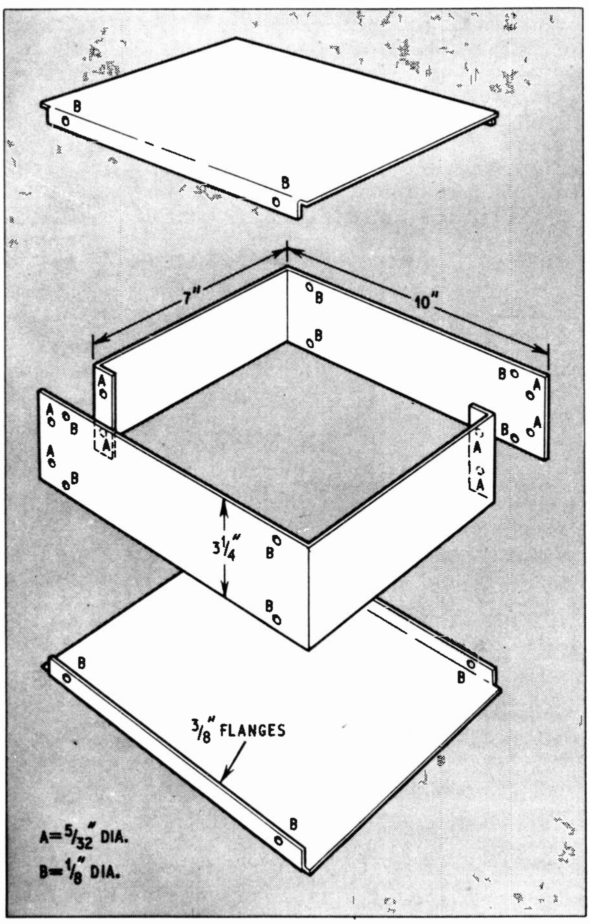


Fig. 4. (a) Wiring layout of i.c. test socket and pin switches. (b) Wiring pattern for all switch wafers. Note that only one half of the wafer is used. This figure should be consulted when assembling and wiring the switch banks

Fig. 5. Constructional details for assembling the aluminium case. Binder screws for fixing the side panels should be 2B.A. The upper and lower plates are fixed with 4B.A. screws



The wiring adopted for the pulse generator and its indicator lamp is such that the lamp LP2 follows the clock pulse, i.e. it is on when the clock is at a logical 1, but it does not load the output of the Schmitt and thus avoids possible degradation of the rise time.

The lower pulse rate allows the operation of an i.c. to be followed with the indicator lamps, while the fast pulse checks the operation of the i.c. at high speed, and is intended to be used with an oscilloscope.

The other two gates of IC1 are connected as a simple flip-flop which is used, in conjunction with the change-over switch S4, to provide single rising or falling waveforms for manual operation. This system is essential to avoid the multiple pulses that would otherwise be produced by the inevitable contact-bounce of the switch.

Four indicator lamps, LP3–LP6, and their associated amplifiers TR5–TR8, are provided for monitoring the operation of an i.c. under test. Resistors R11–R14 limit the current drawn from the i.c. output, and are wired to the patch-cord sockets SK6–SK9 so that any pin may be connected to any indicator.

The wiring of the i.c. 'dual-in-line', 16-way socket SK10, the 16 single-pole four-way switches S5–S20, and the associated patch-cord sockets SK11–SK25, is shown in Fig. 4a. Notice that the logical 1 level is derived from V_{CC} via a 1kΩ resistor R15. This ensures that the 1 level cannot exceed V_{CC}, a condition which would result in the instantaneous destruction of the i.c.

CONSTRUCTION

The instrument is built in a case measuring 10in by 7in by 3¼in. This may be constructed from 16s.w.g. aluminium following the dimensions of Fig. 5.

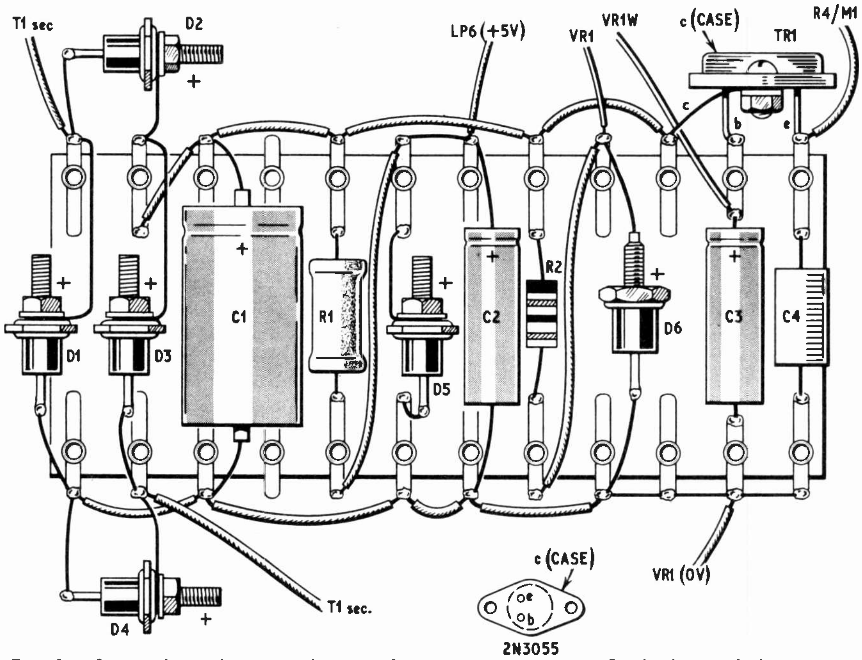
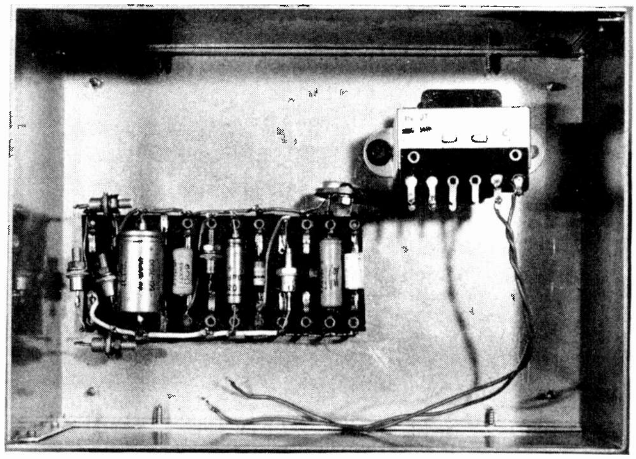


Fig. 6. Assembly and wiring details of power supply unit. Both this and the mains transformer are mounted on the chassis base plate (see photograph below)

The power unit is constructed on a 12-way piece of standard tag-board as in Fig. 6. Since TR1 is operating well within its capabilities, no heat sink is required, and it is soldered directly to the tags.

The unit is mounted on the chassis base by means of 6B.A. bolts and suitable spacers to ensure that all the components are isolated from the case. The mains transformer is also mounted on the base. The relative positioning of these units can be seen in the photograph.

The pulse generator (Fig. 7) and the lamp amplifiers (Fig. 8 and Fig. 9) are built on pieces of 0·1in matrix perforated board. Most of the wiring utilises the component leads which are passed through the board and soldered together as required.



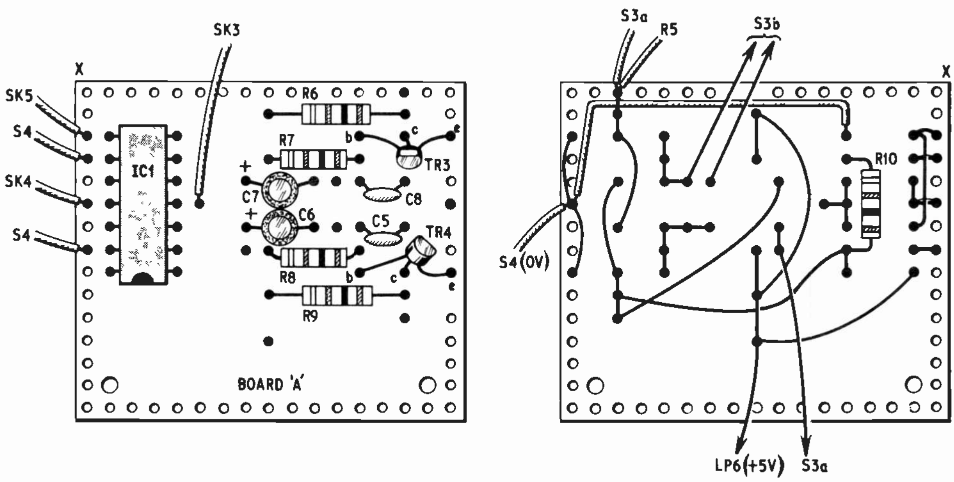


Fig. 7. Assembly and wiring details of pulse generator (Board 'A'). Veropins should be used where connecting flying leads

COMPONENTS . . .

Resistors

R1	60 Ω, 5W	R7	22k Ω
R2	68 Ω, ½W	R8	22k Ω
R3*	See text	R9	1k Ω
R4*	See text	R10	390 Ω
R5	4·7k Ω	R11–R14	4·7k Ω (4 off)
R6	1k Ω		

All 10%, ¼ watt carbon except where stated.

Capacitors

C1	1,000μF	elect. 25V
C2	250μF	elect. 10V
C3	100μF	elect. 15V
C4	0·22μF	polyester
C5	470pF	polystyrene
C6	16μF	elect. 10V
C7	16μF	elect. 10V
C8	470pF	polystyrene

Potentiometers
VR1 470 Ω

Diodes
D1–D4 1N4001 *or* RS3OAF (4 off)
D5 ZX5·1 5·1V, 10W, Zener
D6 ZL12 12V, 1·5W Zener

Transistors
TR1 2N3055
TR2–TR8 2N2926 (G) (7 off)

Integrated Circuit
IC1 SN7400N

Switches
S1 Double pole, mains on/off
S2 S.p.c.o., biased toggle
S3 D.p.c.o., slide
S4 S.p.c.o., biased toggle
S5–S20 Double-pole, 6 way, break-before-make 'Maka-switch' wafers (Radiospares) (16 off)

Miscellaneous
T1 Mains transformer, 12V 1A Secondary, M1—1mA moving coil meter 1¾in square face, SK1, SK2 Insulated terminals, FS1—100mA fuse with panel fuseholder, LP1—Mains neon. LP2–LP6 Panel Mounting M.E.S. lamp holders with 6V, 0·06A bulbs (5 off). SK3–SK9 Miniature sockets with miniature single pin plugs to suit (9 off) (Radiospares). SK10–16 way, 'Dual-in-line' socket (Radiospares), Aluminium, 8B.A. threaded rod, washers, spacers. SK11–SK26 miniature sockets (16 off) (Radiospares).

The boards are mounted on the front panel with small brackets.

SWITCH ASSEMBLY

All the other components of the instrument are mounted on the front panel and present no great difficulty, except, that is, the 16 four-way switches S5 to S20 of Fig. 4.

In spite of considerable efforts, the author was unable to track down any suitable commercial items for this job. Ordinary wafer switches could perhaps have been used, but were rejected since a row of eight would require a panel space of some 10in. Finally, the two switch banks were constructed from 16 Radiospares 'Maka-Switch' wafers, each bank requiring only 3¼in of panel space.

First, switch levers are cut from Paxolin or similar material, and a hole drilled at one end (Fig. 10). This hole should be countersunk deeply so that the screw head is flush with the surface of the material. Also, when the lever has been bolted to the wafer, the excess bolt length should be cut off and filed flush with the nut, because there is very little space between the wafers.

Next, the brackets should be made up (Fig. 11) and the wafers, together with the washers and spacers, should be assembled on threaded rods before finally bolting the whole lot firmly together to form a rigid unit. Note that the unused tags on the side of the wafers that are towards the front panel must be bent over otherwise they will foul it.

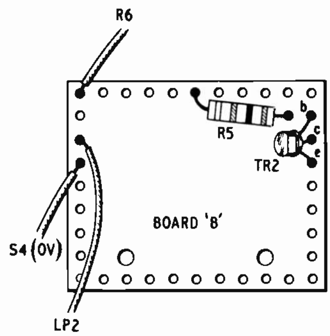


Fig. 9. Assembly and wiring detail of pulse generator lamp amplifier (Board 'B'). Clad Veroboard is used for this with none of the copper strips cut

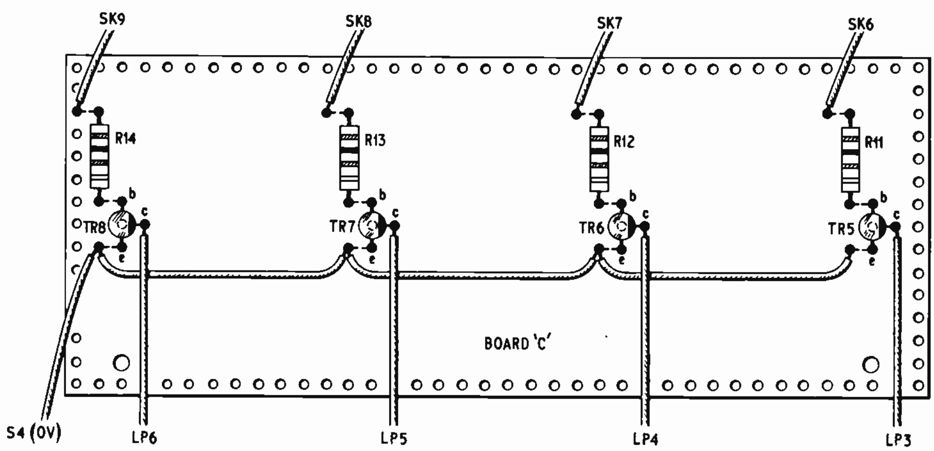


Fig. 8. Assembly and wiring details of function lamp amplifier (Board 'C')

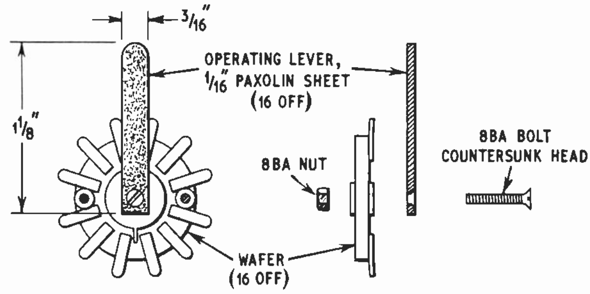


Fig. 10. Assembly details of switch levers

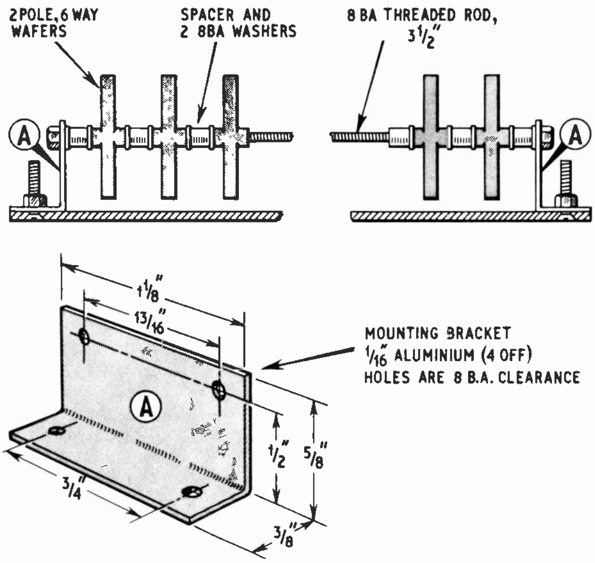
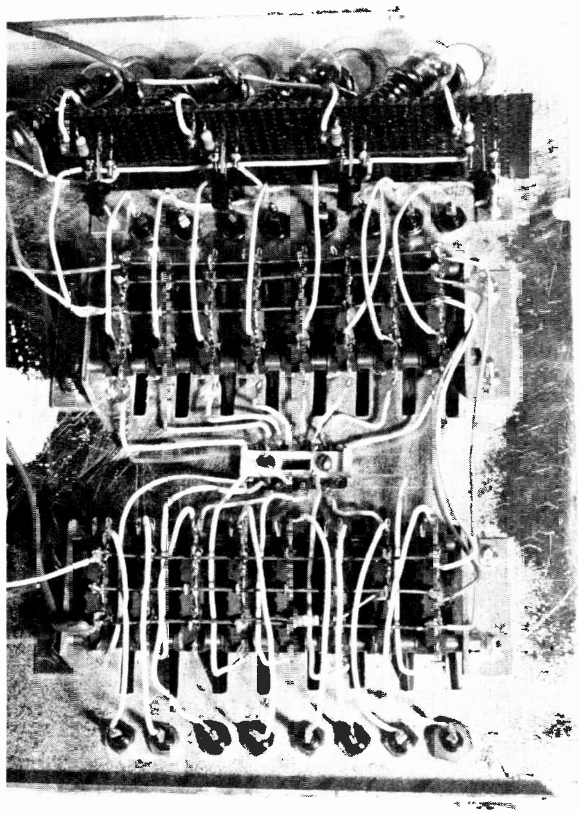


Fig. 11. Showing how eight switch wafers are assembled in a single unit. Two such banks are required



Switch banks in position. Here and in Fig. 13 some of the wafers in the lower switch banks have been reversed which accounts for asymmetric wiring. Ideally all wiring should follow the pattern of Fig. 4b. The unused underside wafer tags should be bent back to prevent chassis fouling

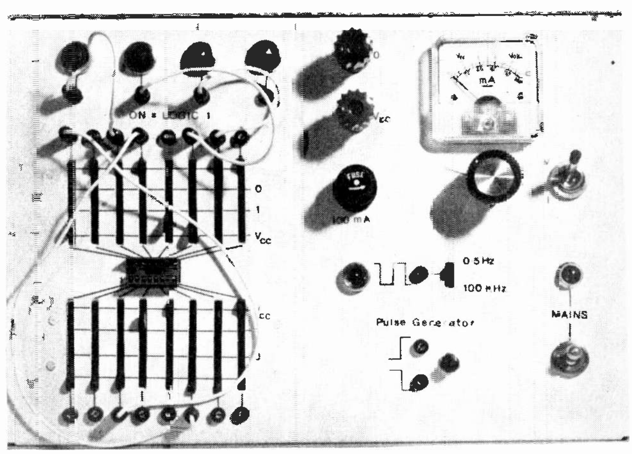
FRONT PANEL ASSEMBLY

The front panel of the case can now be cut and drilled. A suitable layout is illustrated in Fig. 12, but it is emphasised that this is not critical and may be modified to suit available components. For the same reason, drill sizes are not given, although it is recommended that the specified sockets are used for the patch-cords, in which case the holes should be 2B.A. clearance.

The only part that needs fairly accurate work is that concerned with the switch units, and the quoted dimensions should be followed closely or the switch levers may not pass freely through the slots. When the wafers are used in this way, the usual indexing employed in wafer switches is not present, and it may be thought that difficulty would be experienced in finding the correct positions. In fact, the wafer contacts are quite a tight fit on the moving contact and it is very easy to feel when the lever is in the correct position.

Before the components are finally mounted on the panel, it is a good idea to paint it and add the legends. The author used a matt white spray and added the lettering with Letraset, which gives a very neat appearance.

A coat of Letraset protective lacquer will prevent the letters being rubbed off.



The completed front panel with all the legends in position and fixed with a protective lacquer

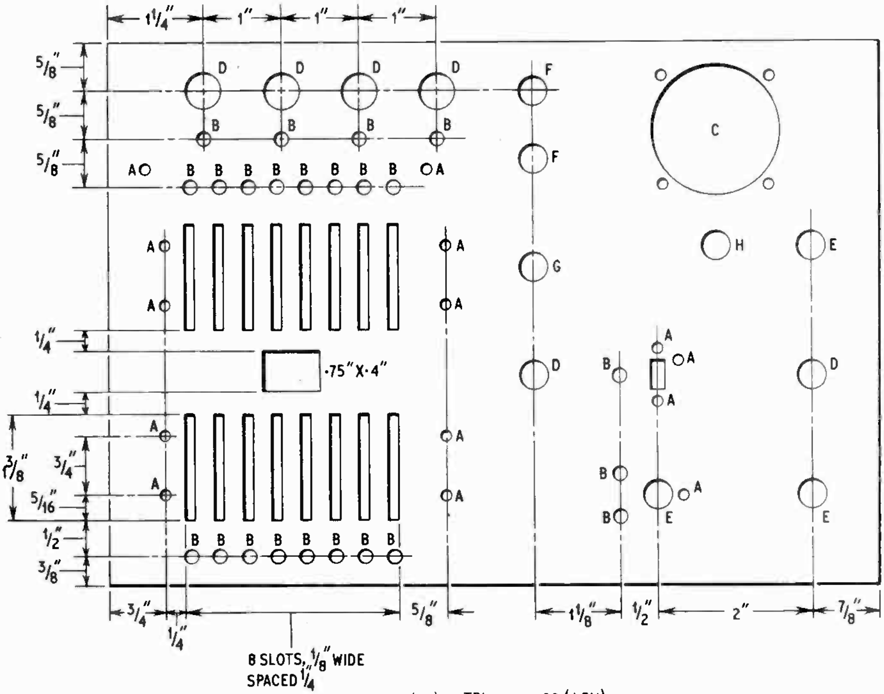


Fig. 12. Drilling details for the front panel of the tester

DRILLING DETAILS

A — 8BA Clearance
B — 2BA Clearance
C — Panel Meter
D — Panel Lamps
E — Supply Switches
F — Supply Terminals
G — Fuseholder
H — Supply Potentiometer

Holes C — H to suit components used

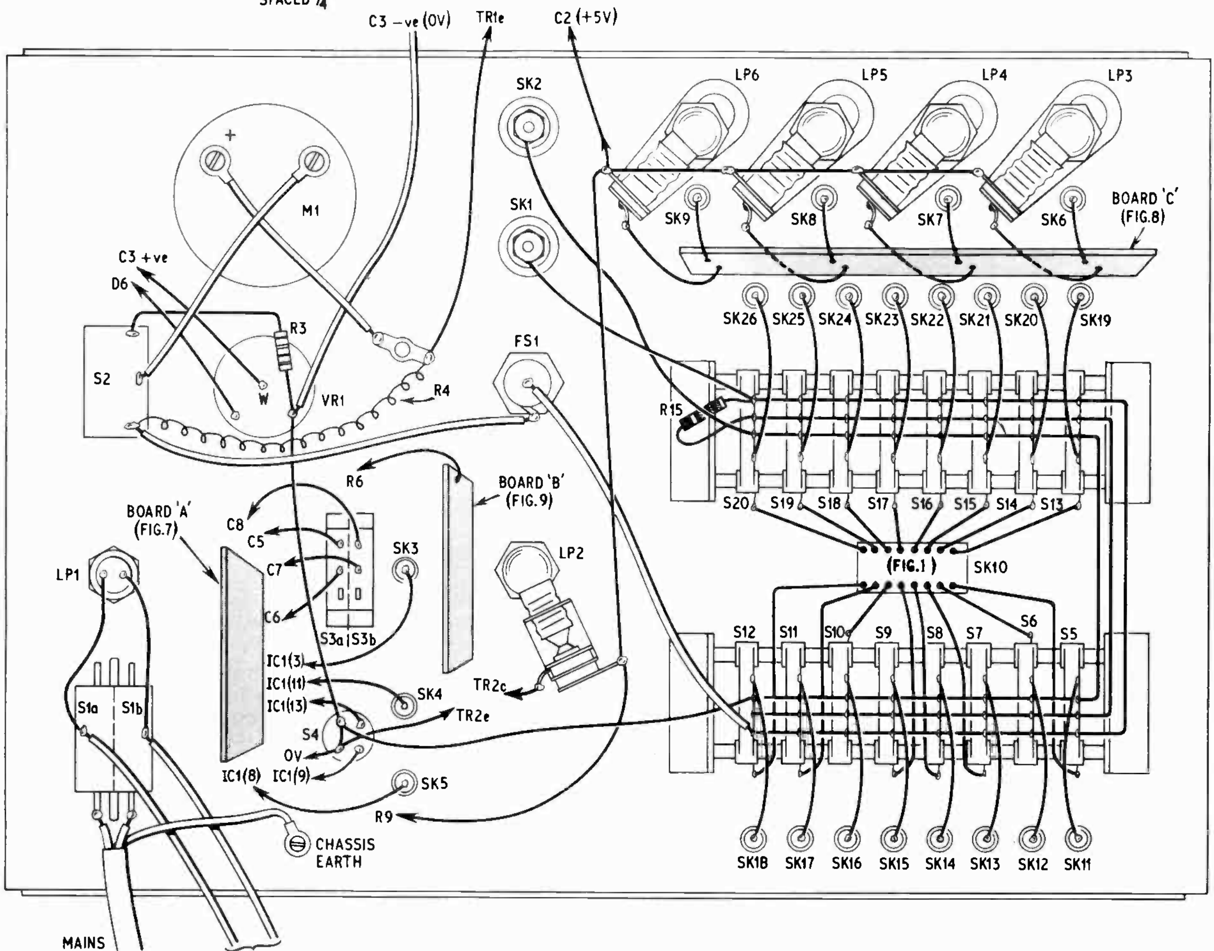
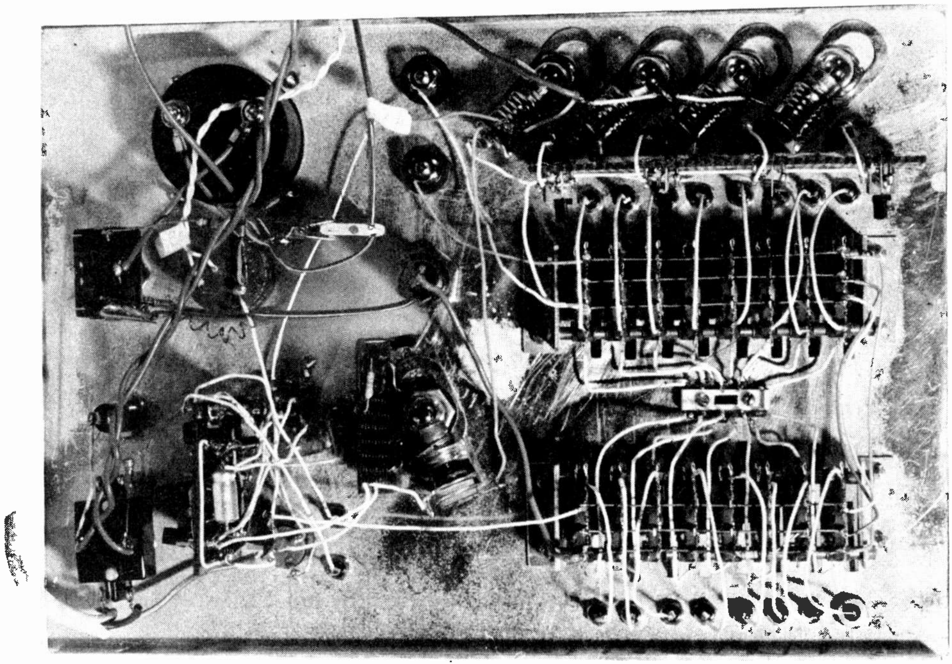


Fig. 13. Assembly and wiring details of the front panel. For switch bank wiring see also Fig. 4. Note that meter positive and shunt terminate at a stand-off insulator



PANEL WIRING

The wiring of the panel is shown in Fig. 13. Reference should be made to Fig. 4b when wiring the switch banks as all connections should follow this pattern.

The mains cable is led in through a hole in the back of the case which should be fitted with a grommet to prevent damage to the insulation. This cable is wired directly to the mains switch S1, with the earth lead being anchored to the case by a solder tag fixed with a nut and bolt. Note that no other part of the circuit should be connected to the case.

The leads from the power unit are made longer than necessary so that it is possible to work on the panel wiring.

Values of the meter shunt and multiplier resistances must be found by experiment, for which a multimeter is required. First check that the power unit is working correctly before it is connected to the rest of the circuit. The potential at the junction of R1 and D5 is about +5 volts with respect to the 0 volt line. The potential at the emitter of TR1 should next be measured, and it should vary from 0 to a maximum of some +10 volts as VR1 is turned from one extreme to the other.

Complete the wiring and connect the multimeter across V_{CC} and 0 volts. With a 10kΩ resistor temporarily wired in for R3, check that the two meters give the same reading. If the meter reads low, reduce the multiplier and vice versa, until agreement between the two meters is obtained.

To find the value of the shunt resistor R4, the multimeter and a resistor of about 500 ohms should be connected in series across the V_{CC} and 0 volt lines with V_{CC} set at about 5 volts. A short piece of electric fire element resistance wire, say 2in, is temporarily connected across the meter. S2 is switched to the current position and the unit is switched on. The multimeter should now read about 10mA, while the instrument meter will probably be giving a very low reading.

The length of the resistance wire should be gradually increased until the two meters give the same reading, then the shunt can be permanently wired into place.

CHECK OUT

Some patch-cords should be made up, say four about 3in long and six about 10in. Since it is occasionally necessary to make two connections to a socket, it is convenient to have two or three cords with a plug at one end and a loop, just large enough to fit over the plug pin, at the other.

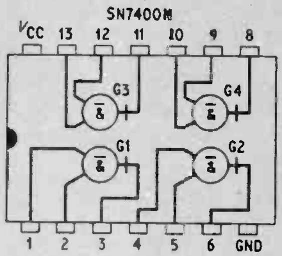
The pulse generator and lamp amplifiers can now be checked. Switch on, and the slow speed operation of the pulse generator will be obvious by the indicator lamp LP2 pulsing. The high speed operation will require an oscilloscope, plugged into socket SK3, to follow its operation.

The manual pulse can be checked with the meter; a patch-cord from SK1 to either SK4 or SK5 will give a meter reading of about 2·5–3 volts, changing to 0 volts (or vice versa) as S4 is switched.

The lamps should turn on by connecting a patch-cord between SK1 and, one by one, the sockets SK6 to SK9.

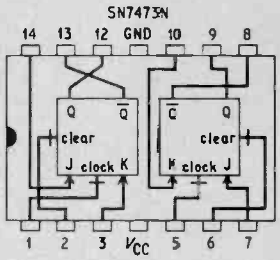
THE INSTRUMENT IN USE

It is not possible to lay down hard and fast rules for a tester of this type, since a test schedule must be devised for each type of i.c. to be examined. It follows that the type of i.c. must be known—unmarked devices are virtually useless. Once the type is known, its function, pin connections and truth table can be determined and appropriate tests worked out.



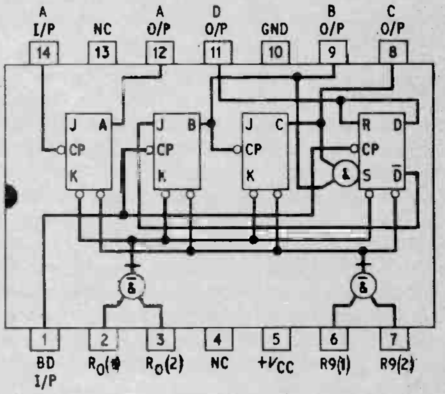
TRUTH TABLE EACH GATE		
INPUTS A	B	OUTPUT
0	0	1
1	0	1
0	1	1
1	1	0

Fig. 14. Pin diagram and truth table of a SN7400N quad two input gate. Note that this is a top view of the package



TRUTH TABLE EACH FLIP-FLOP		
J	K	Q
0	0	Qn
0	1	0
1	0	1
1	1	$\bar{Q}$n

Fig. 15. Pin diagram (top view) and truth table for a SN7473N dual J-K flip-flop



SN7490N

COUNT	OUTPUTS A	B	C	D
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

(a)

COUNT	OUTPUTS B	C	D
0	0	0	0
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1

(b)

COUNT	OUTPUTS A	B	C	D
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	$^0/_0$	$^1/_0$	$^1/_0$	$^0/_0$

(c)

Fig. 16. Pin diagram (top view) and truth tables for an SN7490N decade counter

It is a wise precaution first to ensure that there is no internal short circuit across the supply pins. To do this, the device should be plugged into the test socket SK10, the appropriate pin switches set to 0 and V_{cc}, and the supply voltage increased slowly from 0 while monitoring the current. If all is well, the test can proceed.

To illustrate the method of use, detailed test procedures for three TTL devices from the currently available range will be given.

QUAD TWO-INPUT GATE

The pin diagram of a SN7400N quad two-input gate and truth table are shown in Fig. 14.

First set pin switch S11 (i.e. pin 7 of the i.c.) to 0 and S13 (pin 14) to V_{CC}. Check for a short circuit. Set all gate inputs to 0, that is, S5, 6, 8, 9, 14, 15, 17 and 18, and connect a patch-cord from the output of gate 1 (SK13) to one of the indicator lamps.

It is a wise precaution in this, and all other tests, to start with all the switches in the outside position, and only move those where a pin is to be connected to 0, logic 1, or V_{CC}. This will ensure that no pin will have the wrong voltage applied to it, and that when a patch-cord is used, it will automatically be connected to the corresponding i.c. pin.

To continue with the testing of gate 1, pin switches S5 and S6 should now be operated so as to apply 0/0, 0/1, 1/0 and 1/1 levels in turn to its inputs, pins 1 and 2. The truth table tells us that the lamp should remain on for the first three pairs of inputs, and turn off at the fourth. If any other response is observed, then the gate is faulty.

Now move the patch-cord to the outputs of the other three gates in turn and repeat the procedure with the appropriate input switches. Of course, should one or more of the gates prove to be faulty, it does not mean that the i.c. has to be discarded, for the other gates can still be used.

It is a good idea to cut off the pins of any faulty gates to make sure that they are not accidentally wired into a circuit.

The tester may also be used to demonstrate some possible applications of these gates. For example, if one of the inputs to a gate is connected by a patch-cord to SK3 of the pulse generator, it can be shown that the gate will pass the clock pulses when its other input is at 1, but will block them if it is at 0.

It will also be noticed that the clock pulses are inverted by this arrangement, and that by connecting the output of this gate by a patch-cord to both the inputs of another gate, the output of the second gate follows exactly the clock pulse.

DUAL J-K FLIP-FLOP

The pin diagram and truth table for an SN7473N, dual J-K flip-flop are shown in Fig. 15.

Set the pin switch S16 to 0 and S8 to V_{CC} and carry out the usual short circuit test. Before testing of this and related flip-flops can begin, it is important to note that the truth table only applies if the clear (and preset, if present) input is at a logical 1. The clear input overrides all others, and if it is at 0, the Q output will be forced to 0, irrespective of the states of any other input. Thus S6 and S10 should first be set to 1.

Set J and K (S13 and 7) to 0 and connect a patch cord from SK11 to SK4 of the pulse generator.

Line 1 of the truth table tells us that if J and K are both 0, the flip-flop does not change state on receipt of a clock pulse, so that operating S4 will simply leave the output in its initial form.

It is perhaps helpful to connect both the Q (SK21) and the $\bar{Q}$ (SK20) outputs to the indicator lamps and verify that they are always in opposite states.

Moving to the second line of the truth table, set K to 1 and operate S4. Whatever its initial state, Q should now go to 0, and remain there for subsequent clock pulses. Set J to 1 and K to 0 and verify that Q now goes to 1 and stays there (line 3).

Finally, set both J and K to 1; line 4 tells us that after a clock pulse, Q will be in the state opposite to that before the clock pulse, in other words, the flip-flop will divide by two. The second flip-flop should now be checked in exactly the same way.

As with the SN7400N, we can also demonstrate a simple application of the SN7473N. Set J and K of both flip-flops to 1; connect a patch-cord from the Q output (SK21) of the first to the clock input of the second (SK15), and one from the pulse generator (SK3) to the clock input of the first (SK11). The combination will now divide by four, and an indicator connected to the Q output of the second flip-flop (SK24) will turn on once for every four clock pulses.

If a double beam oscilloscope is available, this can also be demonstrated at the fast pulse rate by connecting one beam to the pulse generator, and the other to the output of the second flip-flop. The 0 volt terminal should be used for the earth return to the oscilloscope.

DECADE COUNTER

The SN7490N decade counter is included as an example of medium scale integration, that is, a device containing several individual circuits interconnected so as to carry out a complex function, all in one package.

In the case of the SN7490N, four flip-flops and some additional gating are wired so as to provide a complete decade counter, with the full binary coded decimal count available at its outputs. In order to increase its versatility further, the counter is in two parts, a divide by two and a divide by five section, which may either be used separately or externally connected for use as a divide by ten unit.

The pin connections and truth tables are shown in Fig. 16, and each mode of operation will be checked in turn.

First, set S9 to V_{CC}, S17 to 0 and carry out the short circuit check. Install patch-cords from the four outputs to the indicator lamps so that the A output (SK21) goes to the left-hand lamp, the B output (SK24) goes to the next and so on—the lamps now correspond to the order shown in the truth tables.

The counter has two reset modes, each one having two AND-gated inputs. To reset the counter to 0, both the R_0 inputs must be at a logical 1, so if S6 and S7 are set to 1, none of the lamps should be on.

The counter may also be reset to binary nine, i.e. 1001, so if both S10 and S11 are set to 1, the first and last lamps should be on.

As in the case of the J-K flip-flop, these reset inputs override all others so that the truth tables will only be followed if at least one of each pair of rest inputs is at a logical 0. The two sections of the SN7490N will now be checked individually.

TWO SECTION CHECK

By connecting a patch-cord from SK5 of the pulse generator to the A input (SK19), the A output should change state once for every two input pulses. Change the input pulse to the BD input (SK11) and the B, C, and D lamps should now follow the truth table of Fig. 16b, that is, the D output gives one pulse for every five input pulses.

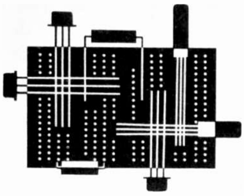
In order to check the full decade count, the A output must be connected to the BD input, and input pulses applied to the A input; the counter should now follow the truth table shown in Fig. 16a. It can be seen that the D output provides 1 output pulse for every ten input pulses.

The usefulness of the two-gated reset inputs may be demonstrated in the following way. Install patch-cords from the B and C outputs (SK24 and 25) to the R_0 inputs (SW12 and 13), the remaining connections being as for the decade count. Now when the count reaches six, i.e. binary 0110, both reset inputs will be at 1 and therefore force the counter to reset to 0, skipping the rest of the decade count sequence.

This is shown in the truth table of Fig. 16c, from which it can be seen that a divide by six function is available at the B or C outputs.

Other division ratios may also be obtained on the same way, providing the required ratio does not have more than two 1's in its binary number.

The above examples have shown how a test schedule may be devised for any one of three widely different types of TTL i.c. Using the same techniques, the reader may readily devise suitable tests for any of the currently available TT1 devices, and with only minor modifications, devices of the RTL and DTL ranges. ★



F.E.T. VOX

A VOICE OPERATED SWITCH FOR THE BEGINNER

IN this series every effort has been made to permit the continued use of the same semiconductor devices in the projects devised since the T-Dec, plug-in assembly method, makes for easy retrieval of parts if no permanent fabrication is intended.

This article is no exception as the entire semiconductor complement has previously been called up, one of these being the 2N3819 field effect transistor.

MATCHING

Designing a voice operated switch, or more commonly, a Vox, calls for a high input impedance pre-amplifier if a crystal microphone is to be used. In the circuit of Fig. 1 the 2N3819 *n*-channel f.e.t., TR1, is used in the first stage to match the high input impedance of the microphone X1.

This transducer has an output impedance of a few megohms and to connect this into a preamplifier of low input impedance would result in both a sacrifice of frequency response and an effective decrease in microphone sensitivity.

EQUIVALENT CIRCUIT

To understand why this should be look at Fig. 2. This gives the equivalent circuit of a crystal microphone which is, in effect, a voltage generator when excited, with internal resistance *R* and capacitance *C* which is typically a few hundred picoforads.

The load it is working into is indicated by the impedance *Z*.

With the arrival of sound waves the generator produces signal voltages which will divide according to the impedance proportions of the microphone and load. If *Z* is large compared to the microphone impedance most of the voltage developed appears across the load so the microphone can be said to be working efficiently.

At medium and high frequencies the capacitive element plays very little part in contributing to the microphone impedance, but at bass frequencies, because reactance varies inversely with frequency this addition becomes significant, so once again a high impedance load is important, but this time for a good low frequency response.

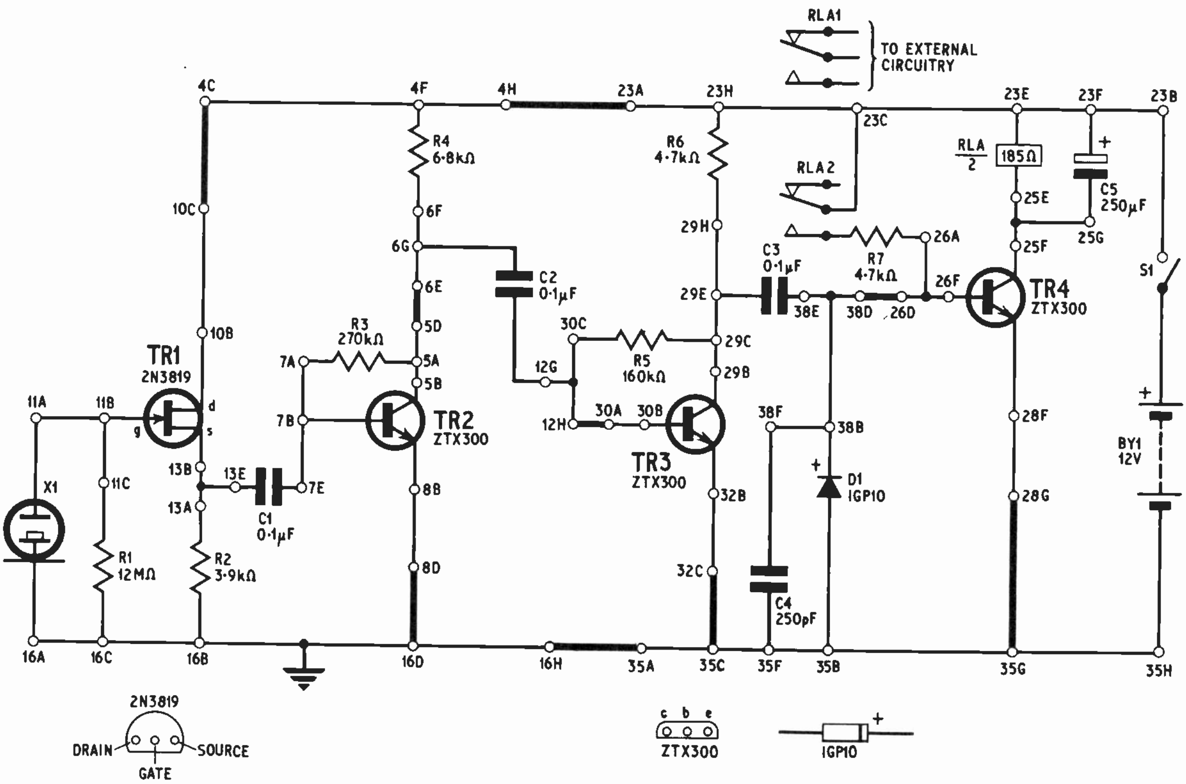


Fig. 1. Circuit diagram of the voice operated switch

SOURCE FOLLOWER

The gate resistor R1 (Fig. 1) provides the high input impedance requirement as the gate to source current of TR1 is exceedingly small, in the order of nanoamperes (10^{-9}A).

The function of the f.e.t. stage is to act as a transformer, impedance matching the microphone X1 with the low input impedance of TR2. This source follower, so called because the output at R2 "follows", in phase, the input, feeds TR2 the first of a pair of simple cascaded amplifiers.

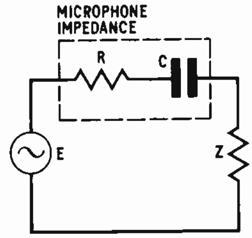


Fig. 2. Equivalent circuit of crystal microphone working into a load Z

Components . . .

Resistors
- R1 12MΩ
- R2 3·9kΩ
- R3 270kΩ
- R4 6·8kΩ
- R5 160kΩ
- R6 4·7kΩ
- R7 4·7kΩ

All 10% ½ watt carbon

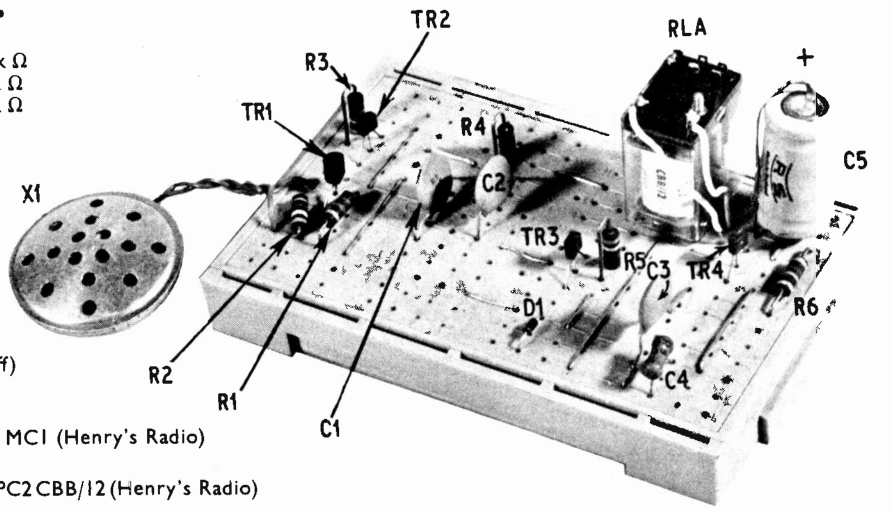
Capacitors
- C1 0·1μF polyester
- C2 0·1μF polyester
- C3 0·1μF polyester
- C4 250pF mica
- C5 250μF elect. 15V

Semiconductors
- TR1 2N3819
- TR2–TR4 ZTX300 (3 off)
- D1 1GP10

Microphone
- X1 Crystal insert Type MC1 (Henry's Radio)

Relay
- RLA 2 Pole 2 way Type PC2 CBB/12 (Henry's Radio)

Miscellaneous
- BY1—12V (Two PP1 6V batteries). T-Dec, connecting wire, S1—on/off toggle switch



Overall gain over the three stages is about a 1,000 when TR3 is not loaded. The inclusion of the relay driver, TR4, does reduce this figure but the output is more than adequate to drive it.

CLAMPING DIODE

When a waveform is passed through a capacitor any d.c. level which might have been part of it is blocked. This means that signals passing across C3 are equally balanced about earth.

To get back a positive d.c. level necessary to switch TR4, diode D1 clamps the base of the alternating quantity to ground to provide a fluctuating d.c. quantity. The introduction of a reservoir capacitor before the base of TR4 for smoothing would, in fact, reduce this level, so instead an electrolytic capacitor is connected across the relay to provide a positive contact action.

With a high input sensitivity of less than 0·1mV r.m.s., and high input impedance it is inevitable that stray noise, produced by radiation influences, might well be troublesome.

In the prototype this problem was eliminated by the bypass capacitor C4. Under conditions of test, the Vox was surrounded by mains operated test equipment and not once was there any spurious activation.

If other construction methods are attempted the important thing is to keep all wiring short and direct to lessen the chance of stray noise pickup.

Ideally, the unit should be contained in a metal box screen with this properly earthed.

APPLICATIONS

Whilst many applications of the Vox may occur to the constructor, the most obvious is its use as a baby alarm or a voice command switch for the remote switching of lights or equipment.

The current consumption on standby is only 2mA so it is very economical. In terms of sensitivity, the relay will act when the microphone is four feet away from a low voiced conversation, so it is well suited to the aforementioned uses.

The relay specified is a two pole, two way type and for command switching it will be necessary to use a pair of these contacts for latching TR4 on. In Fig. 1, RLA2 is used for this with R7 as the biasing resistor. The other set of contacts, RLA1, should be routed to whatever alarm indicator is chosen, whether lamp or bell.

If this facility is used, switch S1 must be added so that the Vox can be restored to its quiescent state.

For impact photography, a flash-gun can be connected to RLA1 contacts. The Vox now takes the role of a flash trigger where action can be frozen photographically at the moment of impact.

In this last application it should be noted that the range of the Vox is very much increased with impulsive sounds such as bangs, whistles or horns which should point the way to some other uses.

P.E. AURORA

MUSIC INSPIRED LIGHT AND COLOUR

PART 2 LAMP CONTROLLER

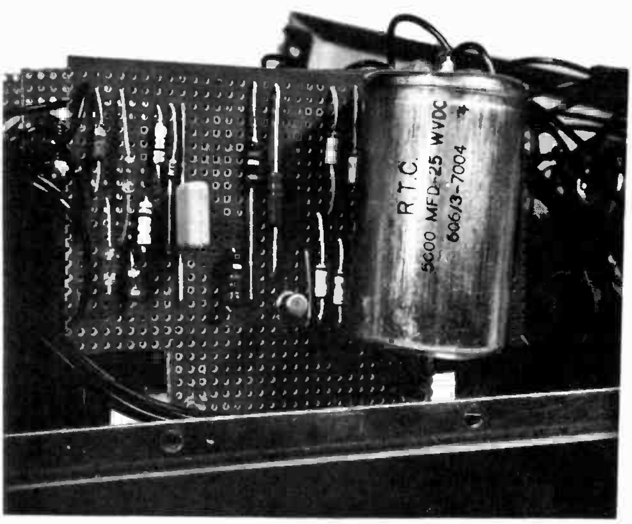
BY M. J. HUGHES M.A.

THIS second part continues the description with construction and setting up details of the thyristor lamp controller. It was mentioned last month that either straight operation with eight lamps can be achieved with this design, or a more ambitious sixteen lamp matrix system using the same amount of electronic circuitry.

It is assumed that most constructors would like to experiment with the matrix, thus the constructional part of this article shows four thyristors mounted with common cathodes and four with common anodes. In-line operation of eight channels can still be effected although one has to be careful with the connections of mains line and neutral, see Fig. 10 later.

CONSTRUCTION

To facilitate stage-by-stage construction, and possible expansion of the system later, all circuits are mounted on individual cards which are assembled together in a Contil cabinet. Layout presents no special problems as there are few parts of the system which interact. While it would be fairly straightforward to design printed circuit boards for the various stages, perforated s.r.b.p. board or Veroboard is quite suitable. Only three different circuit boards are required for the lamp controller.



(a) Power supply and sync pulse generator, Fig. 8 (1 required);
(b) Trigger circuits, Fig. 9—each board carries two channels (4 required);
(c) Thyristor arrays, Fig. 10 (2 required).

Layout of the Veroboard has been arranged so that the minimum number of strips have to be cut. All the boards should be wired up except the flying lead interconnections (shown in Fig. 11 as looms); these will be added during the final assembly into the cabinet.

SYNC PULSE GENERATOR

It is suggested that this unit is built first as it can then be used to check the functioning of the other boards. Fig. 8 shows the layout; there are no special problems to be encountered with this part of the circuit except the general point about 0·1in matrix-board. It is imperative that care is taken to prevent solder running between strips as short circuits can be disastrous.

The unit can very quickly be checked out by wiring up to the mains transformer and making sure that +15V is present at point *39A*. If the reader has an oscilloscope it is worth checking the waveforms at points *6J*, *8C* and *39P*, which should be as shown in Fig. 4b, c, and d respectively, except that as the unit is not on load the waveform at the collector of TR1 will have a much faster rise time with an amplitude of approximately 10V. The unit should be left wired up to the transformer as it will form a useful power source for testing the trigger channels later.

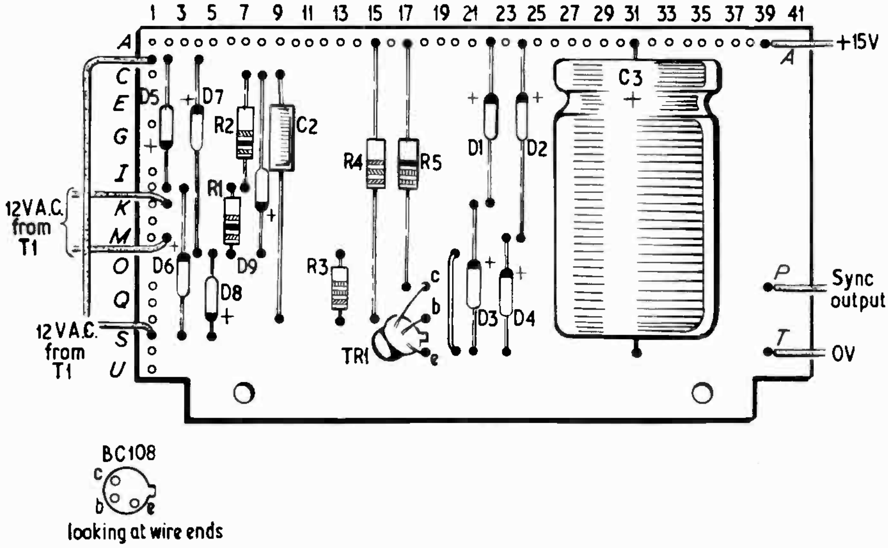


Fig. 8. Layout of components on 0·1in matrix Veroboard for the power supply and sync pulse generator. No copper strips are cut. Do not connect the zero volts line to chassis.

COMPONENTS . . .

POWER SUPPLY AND SYNC PULSE GENERATOR

One of each of following except where stated

Resistors
R1 1kΩ
R2 1kΩ
R3 5·6kΩ
R4 100kΩ
R5 2·7kΩ
All ±10%, ¼ watt carbon

Capacitors
*C1 0·47μF polyester 1,000V
C2 0·1μF polyester 125V
C3 5,000μF elect. 25V

Transformer
*T1 Mains transformer, Primary 230-250V; secondary 1 12V 500mA min; Secondary 2 12V 500mA min.

Inductors
*L1, L2 Wound on Ferrite ring cores or pot cores —see text (2 off)

Transistor
TR1 BC108 or any medium gain *npn* silicon transistor

Diodes
D1 to D4 1N4004 (4 off) or 25V 1A min. rated bridge rectifier
D5 to D 8 OA91 (4 off) or any small signal germanium diodes 25V min.
D9 1N4148 or any small signal silicon diode 25V min.

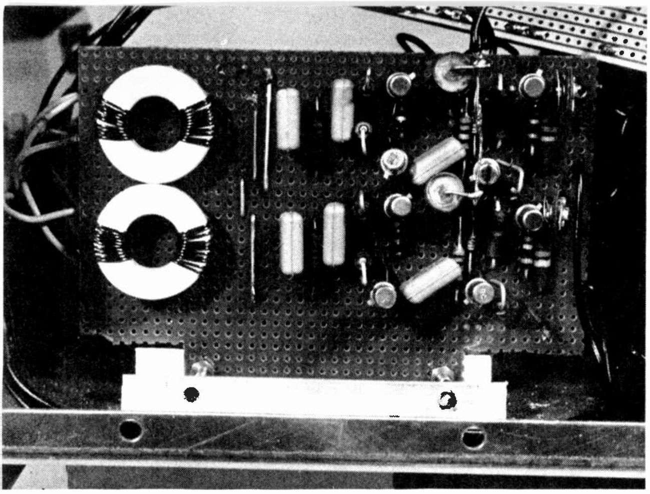
Switch
*S1 Double pole, on/off toggle switch

Lamp
*LP1 Neon indicator with ballast resistor for 250V a.c. mains

Fuse
*FS1 5 amp cartridge fuse and fuseholder

Miscellaneous
*Veroboard 0·1in matrix 4¼in × 2¼in
*Component tag board for C1, L1, L2

All components above mounted on Veroboard A (Fig. 8) except those shown (*) which are mounted on chassis or case (Fig. 11)



TRIGGER UNITS

In this system, eight trigger channels are shown, but readers have the option of making the system smaller or larger. Fig. 9a shows the layout of a single board which carries two complete trigger channels (with the exception of the thyristor or triac). It is possible to split the circuitry into the two separate elements at the dotted line if a smaller system is wanted.

Before starting to wire up the components ensure that all the strips are cut in the correct places and take particular care that all the copper is removed between the primary and secondary connections of the pulse transformer (T2). Note that both *pnp* and *npn* transistors are used on this board—both types specified are in TO-18 cans and it is easy to make an error by picking up the wrong device. There is quite a high packing density of components on this board so is it particularly important that all soldered joints are perfect and that there are no runs of solder. Remember that the transistor cans are connected to their collectors and should not be allowed to touch each other or any nearby wiring or components.

PULSE TRANSFORMERS

The pulse transformers (T2) are extremely simple to wind; it is worth making all these up at one time as an epoxy resin is used to hold the windings firm, and this will take some time to harden. Fig. 9b shows the winding details.

Ring cores were chosen owing to their low cost and high efficiency: some cores have a thick tough coating of insulating material which is adequate to give full protection. If during the course of winding this coating gets chipped or cracked (or if there is the slightest degree of doubt over the quality of the coating) at least two layers of good quality p.v.c. tape should be wound round the core before the windings are applied.

Adjacent turns of each winding should just touch but primary and secondary windings should be separated from each other by positioning them diametrically opposite. If any other form of ferrite core is used (see components list), ensure that the insulation between primary and secondary is adequate. Ferrite pot cores large enough to take the windings can be used, making sure that insulation is provided. The magnetic properties of the cores are not critically important, so any type will probably suit.

It should be noted that one end of C4 is left floating. On final assembly this capacitor on each channel is commoned to the output of the sync pulse generator. On no account should the zero line be connected to chassis, otherwise problems may be experienced when connecting to audio equipment.

SETTING UP

Each circuit on this board can be tested by connecting the output of T2 across the gate and cathode of a thyristor; the cathode is also connected in series with a 40W lamp and the mains supply, the other mains connection going to the thyristor anode. Points *11B* and *37U* should be connected to points *39A* and *39T* of the sync pulse generator board (this is the power supply output) and the flying lead of C4 taken to point *39P* of the sync board. VR1 should be set mid-way in its range and 15V d.c. applied to the boards and mains to the thyristor.

If all is well the lamp should light at medium intensity. By reducing VR1 to minimum resistance the lamp brightness should reach a maximum, showing that the dwell time of the monostable is being reduced. If the resistance of VR1 is increased the lamp brightness should fall to zero but, if the resistance is increased further, the lamp will suddenly start to fire again at medium intensity; this is due to the monostable "hanging on" into the next cycle.

To set VR1 correctly, slowly reduce its value from this latter condition until the lamp is off, then continue to reduce its value until the filament of the lamp can be seen just to glow. If an oscilloscope is handy this setting can be made more accurately by adjusting VR1 until the maximum dwell time of the monostable is 9ms.

CHECK VOLTAGE CONTROL

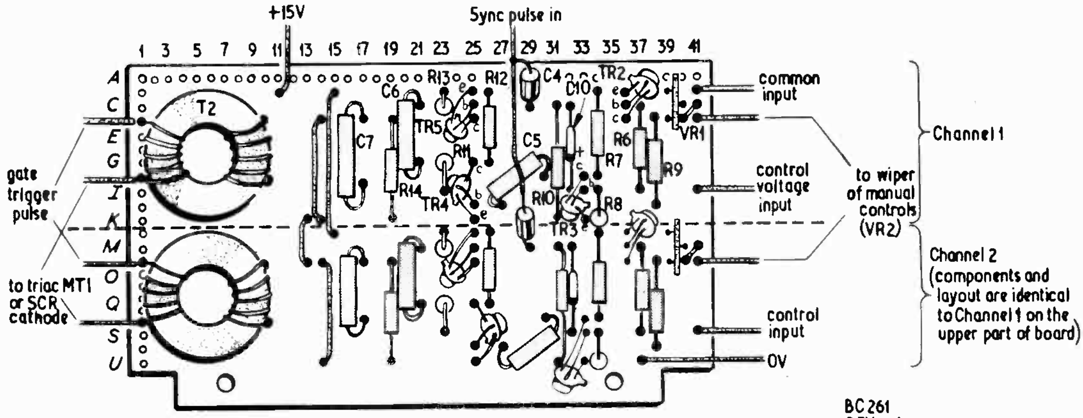
Having set VR1, now check that voltage control is working. This can be done simply by wiring a 10 kilohm potentiometer across a 1·5V cell. Connect the positive side of the cell to the +15V line and the wiper of the potentiometer to point *41I*. When the wiper of the pot is hard against the positive end, the light should be extinguished. On advancing it in a negative direction, nothing should happen initially but on about one-third of a rotation the light should start to brighten and should reach full brightness at two-thirds of a complete turn.

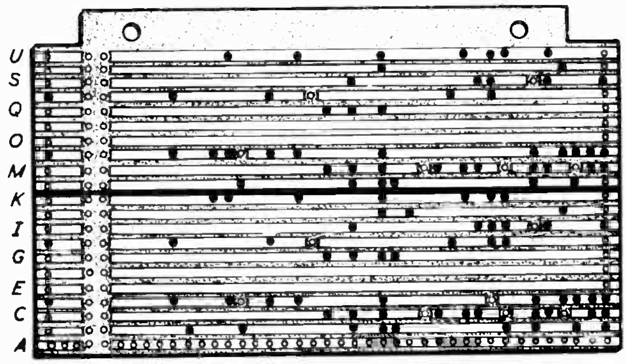
These tests should be carried out to all eight channels before further assembly is attempted. Any intermittent or erratic flickering of the lamp should be investigated as it is almost certainly caused by a dry joint.

ASSEMBLY OF THE THYRISTOR BOARDS

In the prototype the thyristors were small 1A devices which could be conveniently mounted on Veroboard. There are no real circuitry details for this assembly and no doubt readers will wish to use a variety of differing types of device, thus this description should be used mainly as a guide to a convenient layout. No heat sinks were used on the prototype, thus the current rating of the thyristors

LAMP CONTROLLER





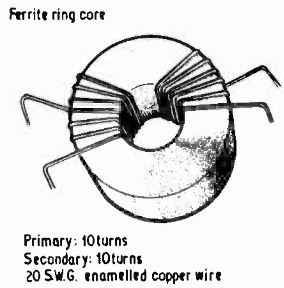


Fig. 9a. Layout of components on 0·1in matrix Veroboard for the trigger units of two control channels. The free end (top) of C4 on all channels are joined together and connected to the sync pulse generator. Do not connect the zero volts line to chassis

Fig. 9b. Winding details of the isolating transformers T2 on ferrite ring cores. Vinkor pot cores can be used if one large enough to accommodate windings is chosen. The core magnetic properties are not critical in this application. Primary 10 turns, secondary 10 turns, 20 s.w.g. enamelled copper wire

COMPONENTS . . .

PHASE CONTROL AND TRIGGER CIRCUIT

Eight of each of following except where stated

Resistors

R6	100kΩ		
R7	10kΩ	R11	10kΩ
R8	2·7kΩ	R12	5·6kΩ
R9	56kΩ	R13	56kΩ
R10	22kΩ	R14	1kΩ

All ±10%, $\frac{1}{4}$ watt carbon

Potentiometers

VR1 250kΩ linear skeleton preset
VR2 500kΩ linear control

Capacitors

C4 0·047μF polyester 125V
C5 0·1μF polyester 125V
C6 0·1μF polyester 125V
C7 0·1μF polyester 125V

Transformer

T2 20 s.w.g. enam. copper wire wound on ferrite ring cores or pot cores (see text)

Diode

D10 1N4148 or any small signal silicon type

Transistors

TR2 BC261 or any medium gain *pnp* silicon (e.g. 2N3702)
TR3 BSY95A
TR4 BSY95A
TR5 BC261 or any medium gain *pnp* silicon (e.g. 2N3702)

Thyristors or Triacs* (see text and Fig. 10)

Two of each of the above mounted on Veroboards (B to E) $4\frac{1}{4}$in × $2\frac{3}{4}$in 0·1in matrix (Fig. 9). Items shown (*) are mounted on Veroboards F and G (Fig. 10)

Other Items

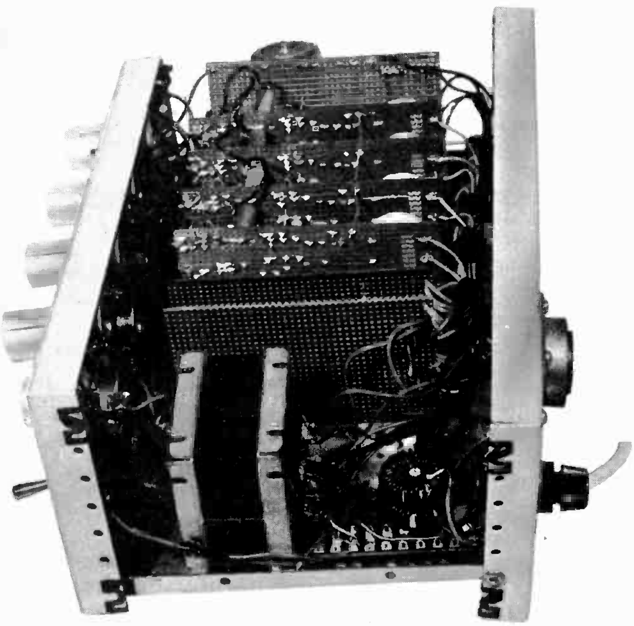
Case, Contil Mod-2 type C (West Hyde Developments)
Sockets, 5-pin DIN type (2 off)
Connector male 10 or 12 way rated at 250V 4A a.c. per pin, mounted on case. Female mate for light display

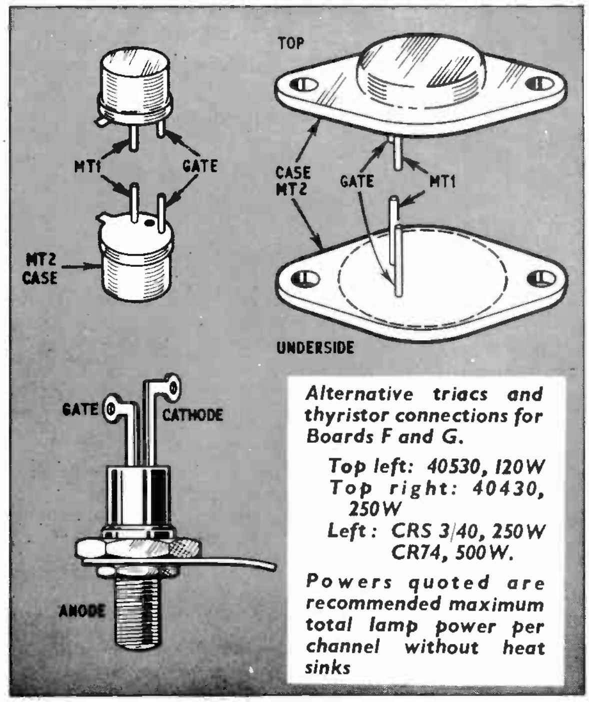
must take this into account, and should be considerably greater than the nominal operating current.

Only four connections are required to each device: two from the isolating transformer, one to the lamp channel and one as a return line to the mains. If we were not operating in the matrix mode (or did not require this facility) the polarity of the thyristors would not matter, but as explained previously, we shall need four devices with anodes commoned and taken to line and four whose cathodes are taken to neutral; these are mounted on separate boards and are shown in Figs. 10 and 11 as boards G and F.

Should higher power outputs be required it is recommended that the thyristors be mounted on heatsinks outside the main cabinet—if this is done it is only necessary to route the trigger pulse lines from the switching circuits. Care must be taken to ensure that full protection from accidental contact with the thyristors or trigger lines is provided.

If constructors abide by the layout of the prototype it is necessary to route the output from the thyristor boards to the lamps. This was effected



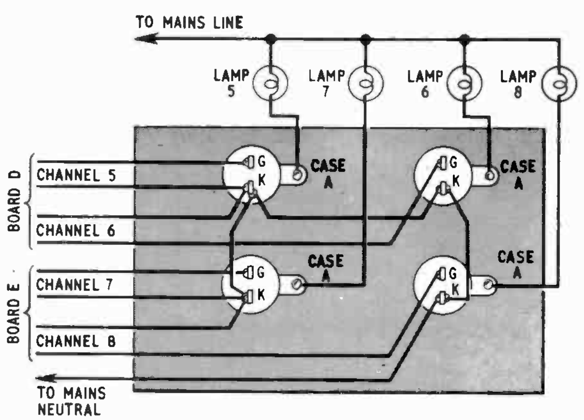


Alternative triacs and thyristor connections for Boards F and G.

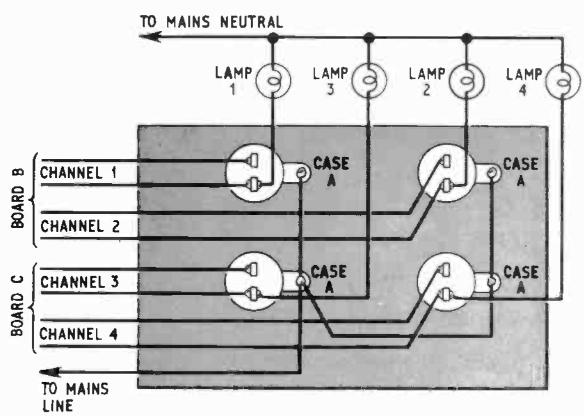
Top left: 40530, 120W
Top right: 40430, 250W
Left: CRS 3/40, 250W CR74, 500W.

Powers quoted are recommended maximum total lamp power per channel without heat sinks

Fig. 10. A guide to the layout of the thyristors on two boards. Those shown are the CRS3/40. Other types of thyristors or triacs may appear different—follow the outline guide for connections



(a) Board F—Common side of lamps 5, 6, 7, and 8 are connected to mains "line" for straight channel operation, but as in Fig. 7 if matrix operated. The cathodes of the thyristors (MT1 of triacs) are commoned and outputs to the individual lamp circuits are taken from the anodes of the thyristors (MT2 of triacs)



(b) Board G—Common sides of lamps 1, 2, 3, and 4 are connected to mains "neutral" for straight channel operation, but as in Fig. 7 if matrix operated. The anodes of the thyristors (MT2 of triacs) are commoned and outputs to the individual lamp circuits are taken from the cathodes of the thyristors (MT1 of triacs)

using a multi-pin plug and socket rated for mains operation and full load current. Ten pins are required: four connected to the cathodes on board G, four connected to the anodes on board F and common lines to mains neutral and line. If in-line operation of eight channels is required the external lighting circuits should be connected between mains neutral and the thyristor cathodes on board G and line and anodes on board F.

For matrix operation the circuit of Fig. 7 should be followed: the main matrix is connected between the respective thyristor anodes and cathodes, and the commoned ends of the holding current lamps to mains line and neutral.

Using this technique the two alternative methods of operating can be facilitated only by modifying the external lighting circuit and requires no internal modifications to the controller.

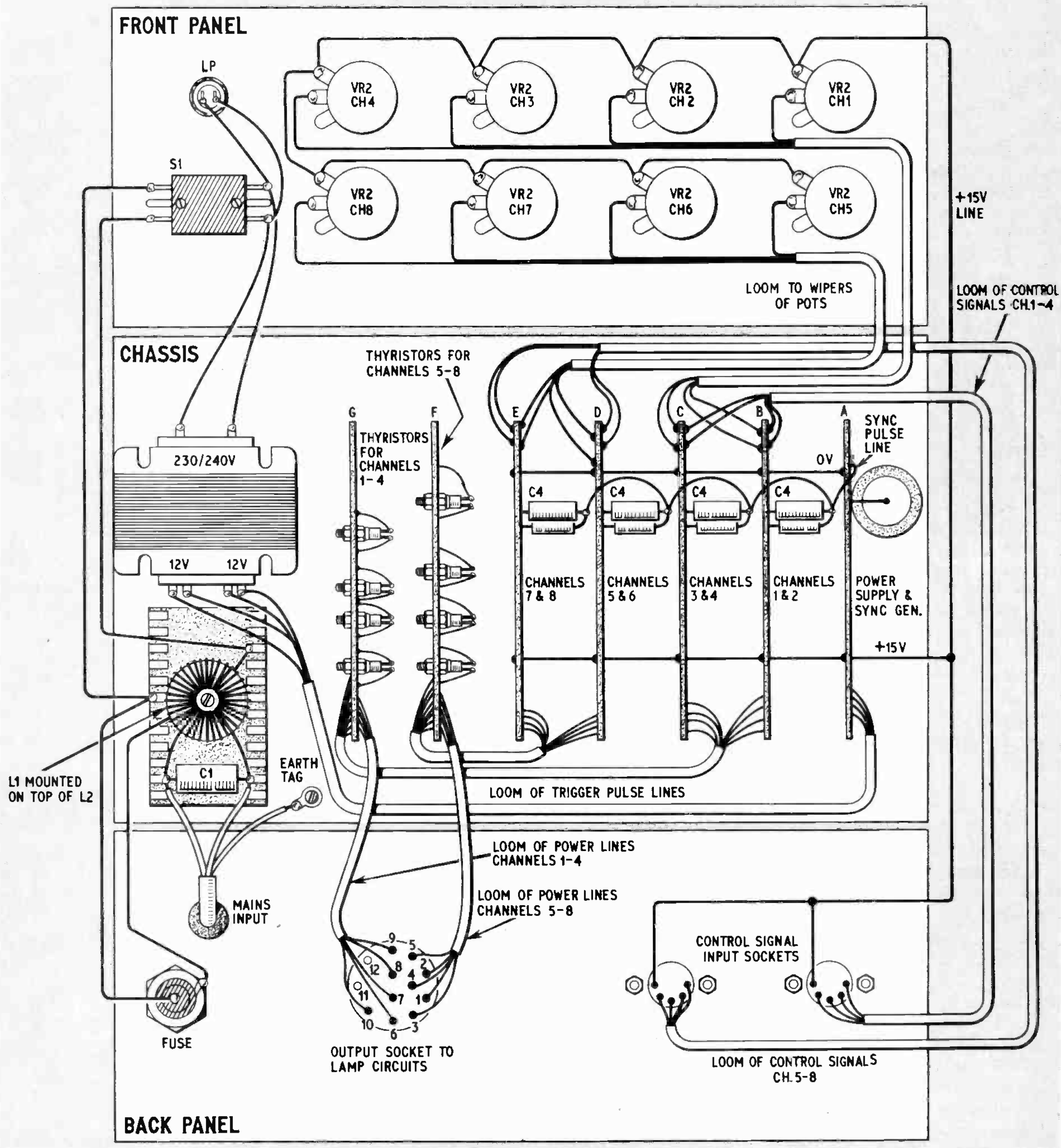


Fig. 11. Wiring looms for the boards mounted vertically on the chassis plate. Board identification is as follows: A—Power supply and sync pulse generator B—Channels 1 and 2 C—Channels 3 and 4 D—Channels 5 and 6 E—Channels 7 and 8 F—Thyristor (or triac) channels 5 to 8 G—Thyristor (or triac) channels 1 to 4

FINAL ASSEMBLY

Readers will, no doubt, have their own ideas for the best technique of carrying out the final assembly. The author mounted the individual boards on the sub-chassis of the Contil cabinet, using $\frac{3}{8}$in aluminium angle brackets. A tag board holds the suppression inductors and capacitor so that these can be connected into the mains leads as near the input to the cabinet as possible.

Inductors L1 and L2 are made by winding 40 turns of p.v.c. insulated connecting wire (of 5A rating) round ring cores of the same type as used for the isolating transformers, T2.

The eight manual controls are mounted on the front panel together with the mains switch and a neon. The rear panel carries two 5-pin DIN sockets (for control signal inputs), a panel mounted fuse holder (5A rating) and the multi-pin output socket. Once all the boards are in position, loop a pair of power supply lines to each board and back to the sync pulse board. Then parallel all the free ends of C4 (on each board) and take this to the output of the sync pulse generator.

One end of all the manual controls should be commoned and taken to the +15V rail and the individual wipers taken to their respective control channels. Keep this wiring as neat as possible and loom the wires together in bundles.

SEPARATE INPUTS

Separate input sockets were used for channels 1 to 4 and 5 to 8 so that completely separate control sources can be used simultaneously—this could be highly advantageous if it is desired to use matrix wiring of the lamps. Pin 1 on each input socket is commoned and taken to +15V, the remaining pins are connected to the respective control signal inputs (R6) on the individual channels. Once all these wires have been installed they should be neatly loomed together.

Pairs of wires should be taken from the output of each isolating transformer and connected between cathode and gate of each thyristor or triac. Finally, connections to mains neutral and line and outputs from the triacs or thyristors should be taken to the multi-pin output socket and the respective thyristor boards connected to mains line and neutral.

Care should be taken during this final wiring that some system of identifying individual channels is embodied—this will greatly simplify any trouble shooting that may occur at a later stage.

Before completely assembling the case it is worth giving the unit a final test and a trimming adjustment of VR1 made with VR2 set at maximum resistance. Be careful! Mains voltages are present on some boards.

The controller is now complete and will work as a manually controlled lamp dimmer. It is now necessary to start building input circuits which will provide various types of electronic control.

Note: On page 291 last month (ref. Fig. 6) the text stated that if y1 and x1 are triggered, lamp A will go on. This should read "lamp C."

Next month: The sound conversion unit with frequency band filters for the eight control channels.

NEWS BRIEFS

Machine-Tool Digital Readout System

After evaluation of several digital readout systems offered for machine tool operation, Elliott Machine Tools Limited have selected the Venture design, on the basis of versatility, simplicity, ruggedness, compact transducer and display design. Elliott Machine Tools Limited will offer its range of centre lathes, milling machines, and other machine tools equipped with Venture readout systems.

The digital readout in two co-ordinates is one of the Venture systems type MSI manufactured by Smiths Industries.

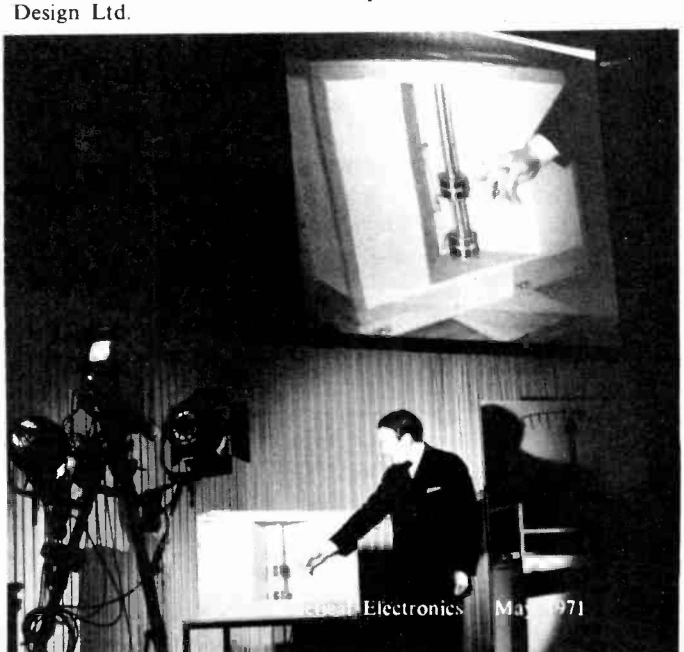
Automatic Flight Control

A digital automatic flight control system designed to increase reliability tenfold and result in a weight saving of 75 pounds is being developed for the F-106 all weather jet interceptor aircraft by Hughes Aircraft Company of California.

The digital automatic flight control system, which will be the first of its kind, will consist of one small solid-state electronics unit weighing 15 pounds that will replace eight valve units currently in use in the F-106. The unit will serve as an interface between the aircraft's control surfaces and a new solid-state digital computer built by Hughes and recently installed in the interceptors.

Picture Enlarger

Pictures from small T.V. cameras can be magnified up to 100,000 times for lecture-theatre audiences by the Swiss-made Eidophor electro-optical projector. It is shown below being used by Mr. Sebastian de Ferranti during the recent Faraday Lecture at Central Hall, Westminster, to illustrate fine detail in demonstrating the principle of magneto-electric generation during his lecture "Changes and the Future in Electrical Engineering". Made by Gretag AG in Switzerland, the Eidophor was lent for the series of lectures by Electronic Facilities Design Ltd.



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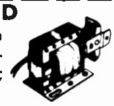

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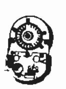

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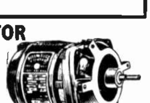

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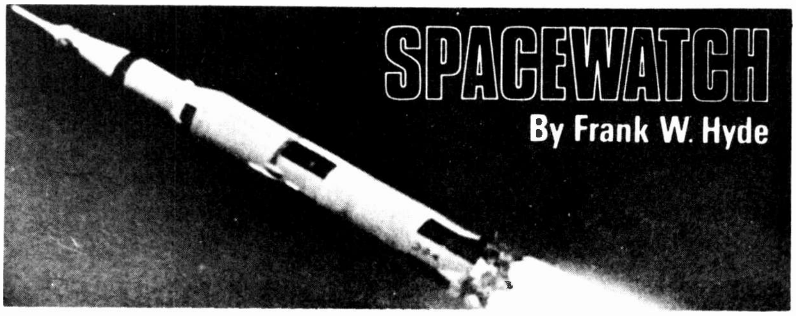


GYROSCOPE ALTERNATIVE

The Aerospace Division of Honeywell at Minneapolis have developed an alternative system to the traditional type of gyroscope with a spinning rotor for the sensing of angular displacements. The new system consists of a vibrating wire of berylium copper, stretched tightly between two magnetic fields. One of these drives the wire and the other generates the output signal.

To separate the two signals a second wire is set at right angles to the first. This is electrically earthed at the crossover point and the driving magnet is set with its poles in the same plane. The output magnet is set with its poles perpendicular to this plane.

The part of the tight wire which is in the drive field is caused to vibrate by an oscillator. This promotes sympathetic vibrations in the second half of the wire which is in the signal magnet field. Should there be any rotation along the longitudinal axis of the input side, "Coriolis forces" will appear as deflections of the wire which are proportional to the turning rate.

There are a number of advantages in this device, among them a short "warm up" time of only 100 milliseconds and a noise threshold of only 0·02 degrees per second in the output signal. For certain uses it has a possible lifetime of 75,000 hours.

CORIOLIS FORCE

The Coriolis force arises from the Earth's rotation and causes a horizontal force which is at right angles to the direction of the velocity of a body which may be clouds or, for example, a ship.

It has been suggested recently that these forces which are normally small can have an effect of some magnitude on large bodies such as the large oil tankers that are now coming into use. A nautical advisor to a Dutch firm, J. C. Annveld, has shown that the Coriolis force may be a source of danger which might lead to collisions between such vessels. It is possible that the *Torrey Canyon* disaster may have had this hazard to contend with.

In addition to the normal difficulties of manoeuvre, very large vessels contemplated for the future are expected to need to take the Coriolis force into account.

SPACE SHUTTLE PROGRAMME

Investigations into structures, aerodynamics and flight test instrumentation for the space shuttle programme is to be carried out by the British Aircraft Corporation.

It is in these fields that BAC are particularly adept and they have already been engaged in space contracts including a large contract for the *Intelstat IV* communications satellites. They are at the present completing the work on *UK-4* which is due for launch in 1971.

SECOND BRITISH SATELLITE

The second wholly British satellite to be launched by NASA will also carry a United States experiment in addition to those designed for Britain, so helping to reduce the cost of the launch. Due to be launched in 1973 it will be named *UK-5* until successfully in orbit when its name will change to *Ariel 5*.

Coming at a time when very great interest is being shown in X-ray astronomy, the decision of the Science Research Council that *UK-5* is to be devoted to this study will be a very welcome one. It will enable the special data, in detailed form that is so badly needed, to be obtained for a better understanding of the high energy sources that have been observed.

X-RAY EXPERIMENTS

There will be a number of separate experiments and the Mullard Space Sciences Laboratory will supply a proportional counter for the purpose of studying individual sources of X-rays in the 2–30keV band. Higher energy sources will be dealt with by Imperial College, London, who have designed a detector for the study of known sources up to 2MeV and also to search for X-ray emission from pulsars.

The University of Leicester group, who have already contributed so much in this field, are responsible for two detectors. One of these will scan the whole sky and the other will be designed to measure polarisation of the X-rays.

The Mullard group will also be responsible for another experiment at low energy levels from 0·3 to 30keV and for this several detectors will be used. In addition they will also be responsible for a special pointing detector which will have a photomultiplier to detect visible light.

The Goddard Spaceflight Centre will be adding an experiment to search for possible transient effects against the background X-radiation.

The satellite is a cylinder 37·75in in diameter and some 34in high. The sides will be almost entirely covered with solar cells to provide the necessary power. It has its own internal computer which will receive instructions from the ground. This means that most of the detectors on board can be pointed to specific sources as required, while the special detector mounted on one side will scan the whole sky as the satellite rotates in its search for new objects.

There is an interesting co-operative effort between Britain and America in the work of this satellite. Mount Palomar and Mount Wilson Observatories will carry out simultaneous optical measurements to correlate the X-ray observations.

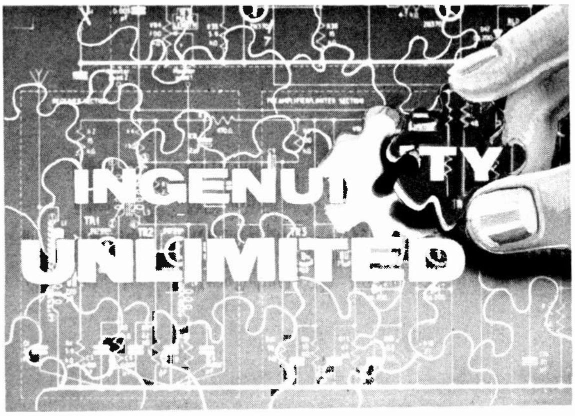
At the Hale Observatories astronomers are planning to have a set of plates ready by the time the satellite is in operation. These have already been obtained by using their 48in Schmidt telescope. The uniqueness of the Hale survey is that it covers most of the galactic plane within which X-ray sources have been observed already.

SHIP TO SHORE CONTACT via SATELLITE

A very successful experiment has been carried out by the Post Office from their radio station at Burnham-on-Sea, Somerset. This was to communicate via an application technology satellite, in this case *ATS-3*, with the container ship of Cunard-Brocklebank called the *Atlantic Causeway*.

Simple multi-element crossed yagi aerials were used to provide a wide capture angle. Techniques tried out were the Lincompex and Compandor systems of speech processing. Traffic that was successfully passed was teleprinter, speech, facsimile, data and selective calls. The frequencies used were 135·6 and 149·22Mhz. The power at the shore station was 250W.

The great advantage of this method of communication is that it avoids the changing ionospheric conditions which cause considerable difficulty with the conventional systems. It was found that transmission via satellite was only marginally affected.



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.

SIMPLE METRONOME/TUNING FORK

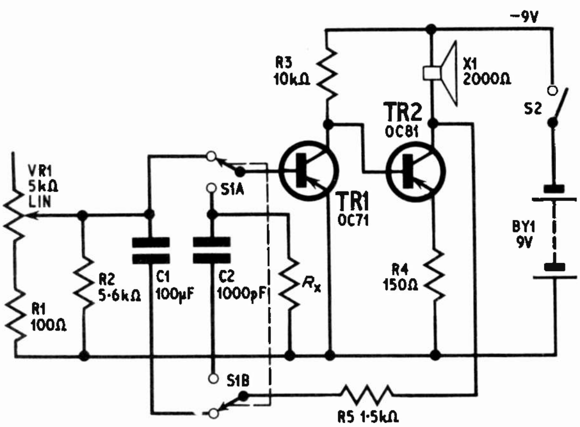


Fig. 1.

Readers with an interest in music may be interested in the circuit of a combined electronic metronome and tuning fork. The circuit, shown in Fig. 1, is an adaptation of a simple multivibrator circuit. A slide switch (S1) is used to change the circuit from the metronome to the tuning fork mode.

In order to give the metronome a loud "tick", a high gain output stage is used, the speaker (X1) being a balanced-armature type earpiece. The pitch of the tuning fork is governed by capacitor C2 and resistor R_x which, as a guide, is approximately 3·9 kilohms for a tone of A = 440Hz.

The device can easily be assembled in a small pocket-sized case and the layout of components is not critical.

Switched to the metronome mode, the control VR1 needs to be calibrated in beats per minute and the range of the metronome should be adequate: from about 30 to 240 beats per minute.

A. L. Dicks,
Wigston,
Leicester.

AUDIO CHOPPER OR EFFECTS UNIT

The circuit in Fig. 2 may be of interest to some of your readers. It was developed primarily to produce extra effects on "pop" records, but can also be used to give voice effects.

Transistors TR1, TR2 and associated components form an astable multivibrator; TR3 is a buffer to prevent the frequency from changing when the output is loaded.

Transistor TR4 is connected across the audio line and severely attenuates the signal when conducting. This transistor (TR4) function in a rather unusual mode, acting as an alternate high and low impedance across the audio line, and therefore, any attempt to use a collector resistor would result in a greatly amplified multi-vibrator "buzz" passing into the audio signal.

Potentiomcter VR3 controls the level of chopping, while C3 provides bass cut. Capacitors C1 and C2, together with potentiometers VR1 and VR2 control the frequency of the multivibrator. The capacitors C1 and C2 could be several different value capacitors arranged

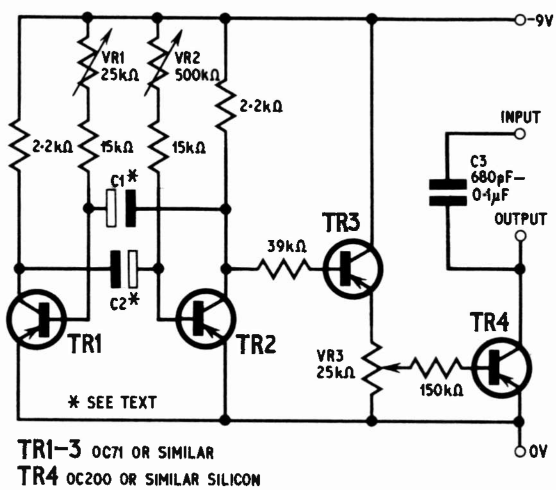


Fig. 2. Circuit diagram of the audio chopper or musical effects unit

so that they can be switched into the circuit depending on the required effect, i.e. 1·5μF, 0·47μF, 0·1μF or 0·02μF.

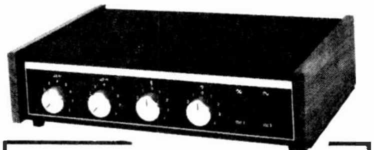
The input/output impedances were found to be approximately 2 kilohms.

With regard to sensitivity, a crystal record pick-up can be connected straight to the input, the output going to an amplifier or tape recorder.

However, a preamplifier must be used with a microphone, otherwise the multivibrator noise is excessive.

P. Tyrell,
Ilford,
Essex.

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



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Fully detailed 7-page construction manual and parts list free with kit or send 18p plus large S.A.E.

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

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

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-0-10, 20-0-20, 30-0-30V, at 2 amps full wave. Size 3inL × 3½inW × 3inD. Price **£1·75.** P. & P. 30p.
MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V. Sec. 9–0–9 at 500mA. **70p.** P. & P. 13p. Pri. 200/240V. Sec. 12–0–12 at 1 amp. **88p.** P. & P. 13p. Pri. 200/240V. Sec. 10–0–10 at 2 amp. **£1·38.** P. & P. 18p. Tapped Primary 200–220–240V. Sec. 21·5V at 500mA. **63p.** P. & P. 13p.
BATTERY CHARGER TRANSFORMERS. 200/240V. input. Nominal output for 6 or 12V. batteries 3 amps. Size approx. 3 × 2½ × 2½in. Brand New. Price **£1·05.** P. & P. 25p.

SPECIAL OFFER!!
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.

Our Price £8·40 Carr. 50p.

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

LOUDSPEAKER BARGAINS
3in 4 ohm **50p.** P. & P. 13p. 5in 3 ohm **80p,** P. & P. 15p. 7 × 4in 3 ohm **£1·05,** P. & P. 20p. 10 × 6in 3 or 15 ohm **£1·90,** P. & P. 30p. E.M.I. 8×5in 3 ohm with high flux magnet **£1·62,** P. & P. 20p. E.M.I. 13½ × 8in 3 ohm with high flux ceramic magnet **£2·10** (15 ohm **£2·25**). P. & P. 30p. E.M.I. 13×8in, 3 or 8 or 15 ohm with two inbuilt tweeters and crossover network **£4·20.** P. & P. 30p. E.M.I. 13"×8" twin cone (parastatic tweeter) 8 ohm **£2·25.** P. & P. 30p.
BRAND NEW. 12in 15w H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£5·50,** P. & P. 38p. Guitar models: 25w **£6·50.** 35w **£8·50.**
E.M.I. 3½in HEAVY DUTY TWEETERS. Powerful ceramic magnet. Available in 3, 8 or 15 ohm **98p** each. P. & P. 13p.
12in "RA" TWIN CONE LOUDSPEAKER
10 watts peak handling. 3 or 15 ohm, **£1·88.** P. & P. 30p.
35 OHM SPEAKERS. 3in **70p.** P. & P. 13p.

HI-FI STEREO HEADPHONES

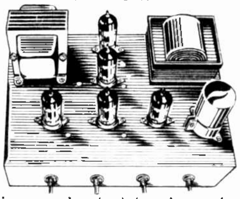
Adjustable headband with comfortable flexifoam earmuffs. Wired and fitted with standard stereo ¼in jack plug. Frequency response 30–15,000Hz. Matching impedance 8–16 ohms. PRICE **£2·95.** P. & P. 15p.

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 × 1¾ × ½in. Brand new — complete with instructions. Price **88p.** P. & P. 13p.

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

QUALITY RECORD PLAYER AMPLIFIER MK II
A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × 3 d. × 6 h. Ready built and tested. PRICE **£3·75.** P. & P. 30p. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE **£4·88.** P. & P. 38p.
DE LUXE QUALITY PORTABLE R/P CABINET MK II
Uncut motor board size 14½ × 12in., clearance 2 in. below, 5½in. above. Will take above amplifier and any B.S.R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18 × 15 × 8in. PRICE **£3·98.** P. & P. 48p.

10/14 WATT HI-FI AMPLIFIER KIT



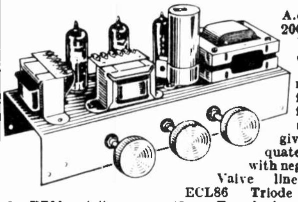
A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 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. 43p. Also available ready built and tested complete with std. input sockets, **£9·97.** P. & P. 43p.

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.

VERY POWERFUL COMPACT MOTOR
For 12v. D.C. operation. Off load consumption approx. 100mA. Totally enclosed. Quiet in operation with high starting torque. Overall size approx. 1⅞"L × 1¼" dia. Free shaft 3/32" dia. × ⅜"L. Ideal for Model Makers, etc. ONLY **38p** each. P. & P. 5p.
3 or more post free (A few 6v. versions also available).

HIGH GRADE COPPER LAMINATE BOARDS 8×6×1/16in. FIVE for **50p.** P. & P. 10p.

DE LUXE STEREO AMPLIFIER

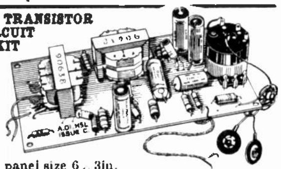


A.c. mains 200–240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2× ECL86 Triode Pentodes. 1×EZ80 as full wave rectifier. Two dual potentiometers are provided for bass and treble control, giving bass 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 300mV for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w × 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. Price **£8·92.** P. & P. 40p.

4-SPEED RECORD PLAYER BARGAINS
Mains models. All brand new in maker's packing.
LATEST B.S.R. C109/A21 4-SPEED AUTOCHANGER. With latest mono compatible cartridge **£6·97.** Carr. 33p. With stereo cartridge **£7·97.** Carr. 33p.
SUITABLE PLINTH UNIT FOR ABOVE with rigid plastic cover. **£5·75** complete. P. & P. 43p.
LATEST GARRARD MODELS. All types available 1025, 2025, SP25, 3000, AT60, etc. S.A.E. for Latest Prices!
PLINTH UNITS cut out for Garrard Models 1025, 2025, 2000, 3000, 3500, etc. With rigid transparent plastic cover. Special design enables above models to be used with cover in position. Also suitable for housing AT60 and SP25. OUR PRICE **£5·75** complete. P. & P. 43p.

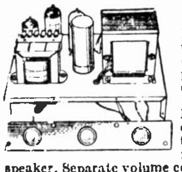
LATEST ACOS GP91/18C Mono Compatible Cartridge with t/o stylus for LP/EP/78. Universal mounting bracket. **£1·50.** P. & P. 8p.
ACOS HI-G Single sided mono cartridge for LP & EP. ONLY **50p.** Post Free.
SONOTONE 9TAHC COMPATIBLE STEREO CARTRIDGE T/O stylus. Diamond Stereo LP and Sapphire 78. ONLY **£2·50.** P. & P. 10p.
Also available fitted with twin Diamond T/O stylus for Stereo LP. ONLY **£3.** P. & P. 10p.
LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. **£1·63.** P. & P. 10p.
LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. **£1·50.** P. & P. 10p.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT
Type TA1



Peak output in excess of 1½ watts. All standard British components. Built on printed circuit panel size 6 × 3in. Generous size Driver and Output Transformers. Output transformer tapped for 3 ohm and 15 ohm speakers. Transistors (GET114 or 81 Mullard AC 128D and matched pair of AC128 o/p). 9 volt operation. Everything supplied, wire, battery clips, solder, etc. Comprehensive easy to follow instructions and circuit diagram **13p** (Free with Kit). All parts sold separately. **SPECIAL PRICE £2·48.** P. & P. 15p. Also ready built and tested, **£2·75.** P. & P. 15p.

3-VALVE AUDIO AMPLIFIER HA34 MK II



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in w. × 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4·75.** P. & P. 30p.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **£3·98.** P. & P. 30p.

HARVERSON'S SUPER MONO AMPLIFIER

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

OUR ROCK BOTTOM BARGAIN PRICE £2·75 P. & P. 30p

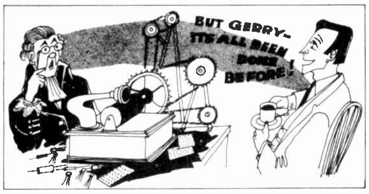
Open 9-5.30 Monday to Saturday
Early closing Wed. 1 p.m.
A few minutes from South Wimbledon Tube Station

HARVERSON SURPLUS CO. LTD.
170 HIGH ST., MERTON, LONDON, S.W.19 Tel. 01-540 3985
SEND STAMPED ADDRESSED ENVELOPE WITH ALL ENQUIRIES

(Please write clearly)
PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.

Gerry Brown . . .

ON THE FRINGE



COUNTERPOINT

Isn't it quaint how, just when you think you've thought of a really good idea, it turns out to be one that someone else thought of, and probably patented, years ago! Just such an idea occurred to me last week.

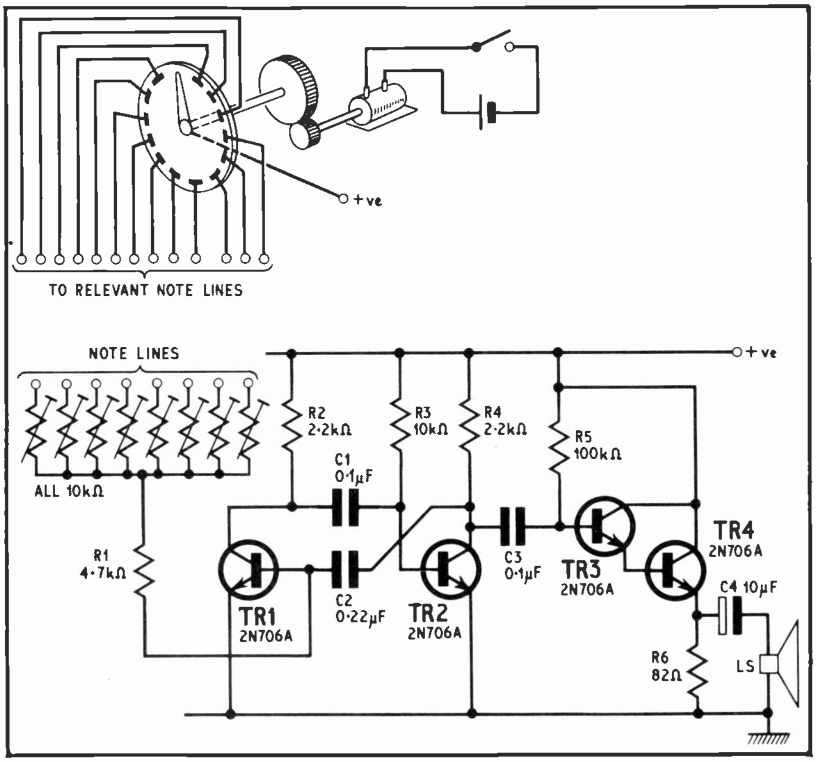
For a long time now I have idly considered the possibility of designing a transistorised version of the early Regency musical box. Initially, as you may imagine, this was intended to be a relatively uncomplicated affair; but, like "Topsy", I got carried away and the thing just grew, and grew! It now comprises something approaching a cross between an Emmett automatic soup maker and a knitting machine that had mistakenly been programmed to fabricate a barbed wire vest!

After all this hard work (which, incidentally, was rewarded by it returning a fairly good rendering of Annie Laurie) my visions of untold fortunes accruing from this fantastic invention were dashed to the ground. "Oi!", said my old mate John over coffee, "did you know that 'Doomwatch' thing that's growing all over your study has already been invented?" I could hardly believe him, but there it was Patent Specification No. 1,173,747 . . . A Device for Composing and Playing Musical Motifs.

Since I had such a lot of fun making one of these machines I thought it would be interesting to include the basic design in this column. The electronics and associated mechanical principles are shown in Fig. 1.

The motor drives a rotary switch, via the reduction gearing, which sequentially connects pre-arranged wires from the oscillator to the positive supply rail. In this way it is possible to play short tunes of one's choice merely by running the motor.

Naturally, the set-up can be more sophisticated than this and have auto-switch off facilities as well, but this can be left to personal preferences. Certainly the device would make a rather novel door-annunciator, in fact, a solid-state version using a shift-register technique for selecting the notes would lend itself ideally to a composer-player machine.—What do you think?



SHELL-OUT

Just imagine how much must be lost to egg producers in uncooked omelets ever year! I am referring of course, to the "eggstra" cost involved in time, effort, and the replacement of busted produce

caused by "butter-fingered", and frequently rough, packaging machinery.

Apparently the cost to the U.S.A. alone each year for cracked or broken eggs due to this cause exceeds something to the tune of $25 million. Not unnaturally, the U.S. Department of Agriculture has taken certain steps to reduce this high mortality rate and the result—the bringing into being of an electronic egg!

Having experimented with various materials for the "shell" of the gadget the research team finally settled on an acrylic plastic fashioned into the necessary shape, but hollowed out and having threaded halves so that the electronics embodied within could be serviced easily when required.

Incorporated inside the shell is a piezoelectric accelerometer coupled to a suitable amplifier which drives a telemetry transmitter so that the signals connected with the stresses undergone by the poor old crock can be monitored at a distance. A miniature mercury cell, also tucked away inside supplies all the power.

The electronic egg produces signals (as it goes through the routines connected with packaging) proportional to the degree of violence of its movement. To determine, in the case of a hen's egg, whether a crack or smash level has been exceeded requires the use of a pre-calibrated egg. The calibration, however, is a simple operation and it seems that such eggs have provided valuable data about critical areas in egg-handling machinery that could cause impacts severe enough to damage the cargo. Smashing!

TIME WARP

There was an error in the frequencies given for the two oscillators suggested for the long time-constant device outlined in the March issue. The frequencies should have been ten and six pulses per minute. Sorry about that.

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.

METAL LOCATOR

Due to a recent television programme on buried treasure hunting, we have received numerous enquiries for information on metal locators. We would like to point out that we have in the past published three designs for metal locators (January 1969, January 1970 and October 1970 issues), but these are, unfortunately, now completely out of print and unobtainable—surely a good reason to place a regular order with your newsagent, as we will certainly publish another design as soon as practicable.

For those readers who are interested in metal locators, **Heath (Gloucester) Ltd.,** have just introduced a metal locator, in kit form, to their range of electronic audio/visual kits. Known as the Heathkit G.D.48, it comprises all components necessary to make an extremely sensitive metal locator.

It is claimed to be able to detect small coins up to 6in (15cm) below ground and very large pieces of buried metal up to a maximum 6ft (1·8m). The locator can be used to search for souvenirs, find buried treasure and hunt for lost jewellery or coins on beaches. The locator can also be used to trace buried pipes and conduits or detect undersurface hazards on farmland.

Powered by a 9V battery with a life of approximately 80 hours, the metal locator employs the induction balance method of detection. This ensures that no sound is emitted from the amplifier until such time as a metal object enters the search field.

When a metal object is located the amplifier gives off a piercing note, the intensity of this being somewhat relative to the proximity and size of the buried metal.

The locator is simple to operate, costs £32·80 and weighs 4lb, including battery. No specialised knowledge of electronics is needed to assemble the kit which takes approximately 6-8 hours to build and a step-by-step manual in pictorial form is supplied for this purpose.

A Post Office licence is required for use in the U.K. and an application form is included with the kit.

Full particulars of the G.D.48 Metal Locator is available from Heath (Gloucester) Ltd., Bristol Road, Gloucester.

Heathkit Model GD-48 metal locator from Heath (Gloucester) Ltd

PUBLIC ADDRESS AMPLIFIERS

Seen for the first time at the *Sound '71* exhibition were the TA756 and TA757 professional P.A. Amplifiers from **Goldring Manufacturing Co. (GB) Ltd.**

The TA756 has an output of 30 watts, whilst the TA757 has an output of 60 watts. Both amplifiers have three microphone inputs plus one auxiliary input.

The amplifiers are fitted with 30 ohm plug-in internal transformers, but these can be changed for 200, 600 or 50 kilohm inputs. The outputs are 4, 8, and 16 ohms, and power supplies of 70 and 100V via a strip panel or octal plug are available.

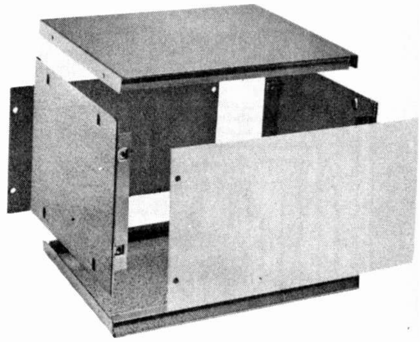
Each microphone channel has a switched bass-cut filter, and other facilities include a remote control relay precedent switch.

Full technical information on the amplifiers and other public address equipment is obtainable from Goldring Manufacturing Co. (GB) Ltd., 10 Bayford Street, Hackney, London, E.8. 35E.

EQUIPMENT CASES

Instrument cases, type 1 and 2, finished in hammer blue with a contrasting grey front panel are the latest product from **Radiospares Ltd.** Available through dealers, the cases are supplied in flat-packed form complete with feet and assembly instructions.

The two types available are, type 1 which measures: width 10in (254mm), depth 7¾in (197mm) and height 6¼in (159mm). Type 2 measures: width 16in (406mm), depth 7¾in (197mm) and height 6¼in (159mm).



Radiospares instrument case

BATTERIES

Seven new zinc carbon battery types are now being marketed by **Mallory Batteries** for general electrical and electronic apparatus.

The zinc carbon range covers all the standard types in common use at the moment, i.e. M1602 (PP6), M1603 (PP9), M1604 (PP3), M1605 (PP7), M13R (SP2), M14R (SP11) and M15R (H7). The numbers in brackets represent Ever Ready type numbers.

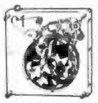
Details of nearest stockists and prices can be obtained from Mallory Batteries Ltd., Gatwick Road, Crawley, Sussex.

Range of zinc carbon batteries now being marketed by Mallory Batteries

LOW COST ELECTRONIC & SCIENTIFIC EQUIPMENT & COMPONENTS

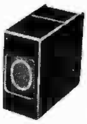
MOTORS

CONTINUOUS TAPE CASSETTE



Suitable for sleep-learning, teaching programmes, programming machine tools, telephone answering, etc. Complete with replay/record head and separate erase head; ¼in tape single track. Speed 3¾in per sec. Length of tape 88ft, but will hold three times this amount, 230V 50Hz supply. £4·50. Post free.

DIGITAL INDICATORS KGM TYPE M3



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

SINGLE SPEED TAPE DECK

¼in single track on 7in spools. 1⅞in per sec. 3 motors. Capstan 240V, others 130V. Series operated. Facility for remote control operation. Record/replay heads with separate erase head. Ex equipment. Less spools. Bargain price: Deck only no plinth, £5·95. P. & P. 75p. Buy now while stock exists.

KEYNECTOR

Connects anything electrical in seconds without plugs or sockets. No more worries about dangerous live wires. Now you can make electrical connections safely, in seconds with the revolutionary new Keynector. Cuts out plugs, sockets and saves time. A hundred different uses in the home, and a must for the do-it-yourself enthusiast. Only £2·33 plus P. & P. 25p. Or send for a leaflet.

GRAMPIAN AMPLIFIERS

Type 385B. 50W mains powered. 200 ohm O/P. Audio Power Amplifiers. Only a few available. Selling at well below list price: £15·50 each. Carriage £2.

TELEPHONE DIALS

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

LOW TORQUE HYSTERESIS MOTOR MA23

Extremely quiet running motor with high starting torque. Has many uses such as chart drives, discotheque colour wheels, etc. 1/20 r.p.m., 1/12 r.p.m., 1¼ r.p.m. 120V 50Hz, 1/12, ¼, 1/18, 1/24, 1/240 r.p.m. 1/20, 1/60, ⅓, 1/16, 1/15, 1 r.p.m., 20 r.p.m. £1·50 post free.

SYNCHRONOUS MOTORS

200/250V 50Hz. New condition, ex-equipment. 8.7 1 r.p.h. and 1 r.p.m. Self starting, complete with gearing shaft ¼in dia., ¾in long. £1·50.

ELECTRIC CLOCK MOTOR

NEW 200–250V, 50Hz, 2W. Synchronous induction motor. 2 revs. per hour. O/P shaft, ⅛in dia. × ⅜in long. Clockwise rotation. Three-holed mounting at 120° on 2in PCD. Price £1 post free.

GOOD QUALITY INSTRUMENTS TAKEN IN PART EXCHANGE OR PURCHASED FOR CASH !

BRAND NEW CAPACITOR REVERSIBLE SINGLE PHASE PARVALUX MOTORS

230/250V, 50Hz, 2,800 r.p.m.; 1/30 h.p. cont. rated; $\frac{5}{16}$ dia. shaft; 3¼in long foot mounting; wt. 6lb. £5·75. Post free.

E.H.T. GENERATOR. BRAND NEW D.C. CONVERTER MULLARD TYPE 1049

Input 12V d.c., 0·3A. Output 1,800V (min.) at 1mA, 2,500V (min.) on no load. Full spec. and circuit provided. Encapsulated module. L. 5in, W. 2½ in, H. 1⅞in. £5·50. Post free.

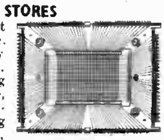
DELAY LINE LEXOR MDN 2484D

Miniature resin encapsulated module. Total delay 50msec to 10msec. Tapped at 10% intervals. Impedance 75 ohms to 10 kΩ. 30V wkg. Attenuation 0·5 dB/msec. 2¼in × ¾in × ⅜in. £1·50. Post free.

BATTERY OPERATED TRANSISTOR TESTER

Battery powered for checking leakage current and gain of P.N.P. transistors, meter and audio indication. Siemens Ediswan Type R2285. W. 7¼in, H. 4½in, D. 2in. £5·50. Post free.

MEMORY CORE STORES



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

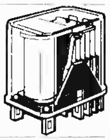
NEW ENICRON SHADED POLE MOTORS

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

NEW FRACTIONAL H.P. CAPACITOR MAINS MOTORS

230V, 50Hz, 0·65A, 1/20 h.p., 2,850 r.p.m. Cont. rated. Shaft $\frac{5}{16}$in, dia. × ¾in long. Circular clamp mounting. £3·50. Post free.

GENERAL PURPOSE RELAY



TMC Type GPR 300. Coil 700 ohm 12V. 4 × 1A changeover contacts. Plug in base. Price 5 for £1·75. Post free.

NEW MICROSWITCHES—HONEYWELL

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

RESET TIMERS — ACRO TIMER BY HAYDON

Synchronous motor driven timer providing manual adjusted delay. Delay time is set on graduated dial. Press button closes contact and drives motor which drives an arm until it actuates the load switch. The cam then returns to initial position for repeat action. Various ranges available. 230V 50Hz. Load contacts 15A 230V. £5.

WIDE RANGE OF PRECISION MULTI-TURN POTENTIOMETERS IN STOCK

EXTENSION TELEPHONES

Complete with dial. Suitable for numerous applications. Two for £2·70. Post free. Telephones less bells. Two for £2. Post free.

MEMORY PLANES

Ferrite core memory planes with wired Ferrite cores. Used for building your own computer or as an interesting exhibit in the demonstration of a computer. Mounted on plastic material, frame 5 × 8in. Consisting of matrices 40 × 25 × 4 cores each one individually addressable and divided into 2 halves with independent sense and inhibit wires. £6·50. P. & P. 15p.

LINEAR THYRISTOR CONTROLLED LIGHT DIMMER—BRAND NEW

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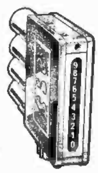

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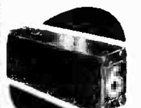

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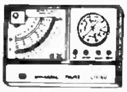

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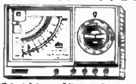

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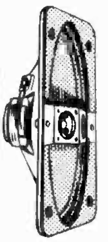

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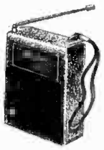

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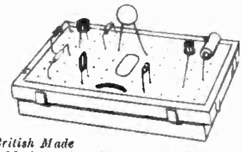

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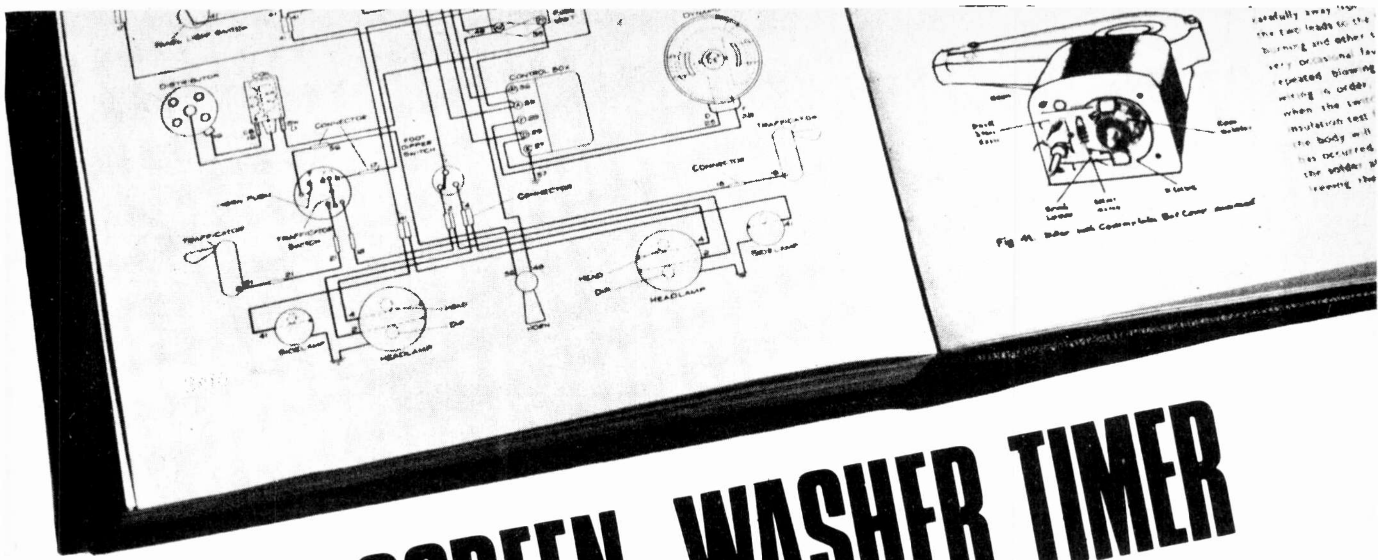


WINDSCREEN WASHER TIMER

By P. HANCOCK B.Sc.

THE MAIN advantage of fitting an electric windscreen washer to a car is that a continuous jet of water is available as opposed to the intermittent jet from a manual pump. However, in practice, much of the advantage is lost since modern driving conditions do not leave a hand or foot free for more than an instant or two. A means for delivering a jet of selected duration at a momentary touch of the button, is desirable.

A "remnant" relay could be used to give a timed action but these are relatively expensive and, in any case, are non-adjustable. A resistance capacitance circuit suggests itself as a means of establishing the necessary time constant.

The standard washer pump circuit is shown in Fig. 1, and Fig. 2 shows a basic timing circuit which would work, but in order to achieve the necessary time constant would require much too large a capacitor; typically 16,000µF for a ten second hold using a 600 ohm relay.

FUNDAMENTAL IDEAS

The basic circuit of Fig. 2 functions in the following manner. When S1 is pressed for a moment, RLA1 contacts connect to the supply and allow current from the battery to charge C1 via the relay coil. At the same time, the pump motor is switched on by the second set of contacts RLA2. The relay continues to hold itself latched until capacitor C1 is sufficiently charged to cause the charging current to fall below the value necessary to hold the relay on. Contacts RLA1 then change back to the original state, shorting out C1 ready for the next cycle. The resistor R1 is necessary to prevent too great a surge of current through the relay contact points. Requiring such a large capacitor, the physical circuit is bulky and costly; we need to increase the effective impedance of the relay.

A useful increase of impedance can be obtained using a single transistor arranged in an "emitter-follower" type circuit. With most general purpose

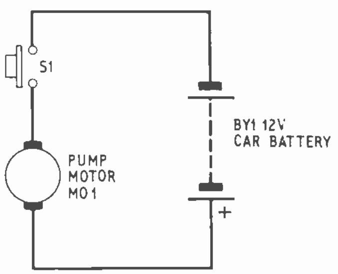


Fig. 1. Basic circuit diagram of an electric washer system

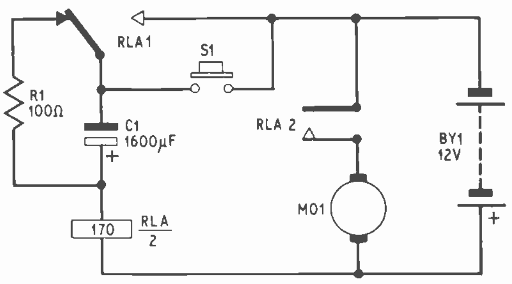
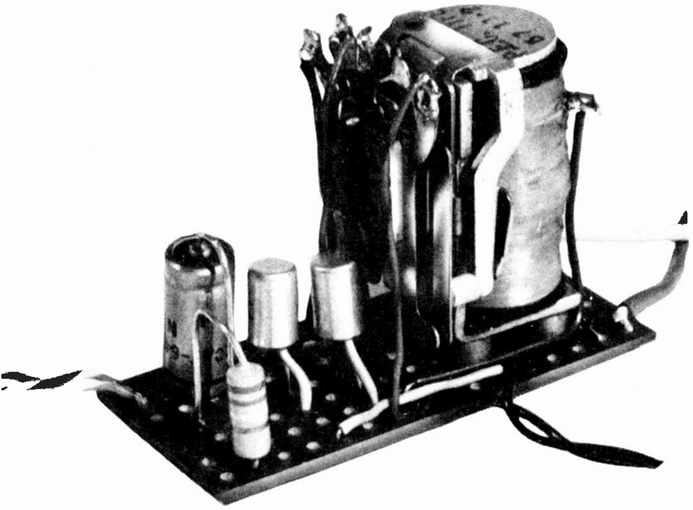
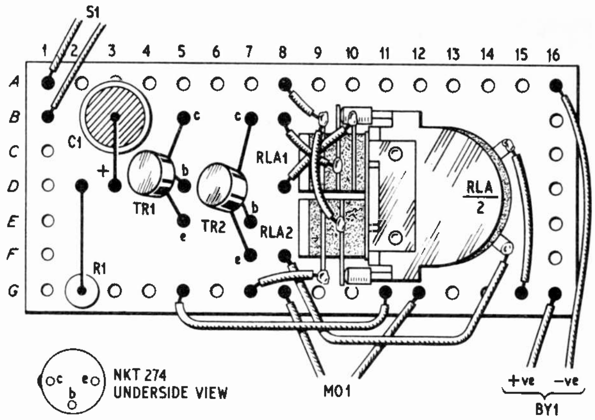


Fig. 2. Basic timing circuit





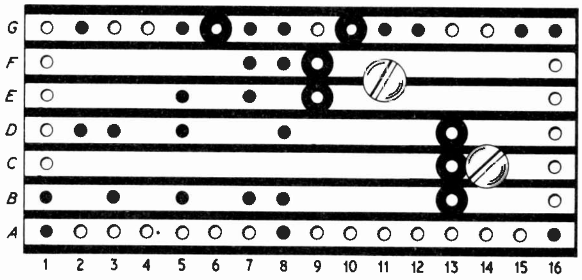


Fig. 4. Layout and wiring of the timer on Veroboard

transistors, the input impedance can be raised by a factor of at least 30. However, a capacitor of 500μF is still needed.

FINAL CIRCUIT

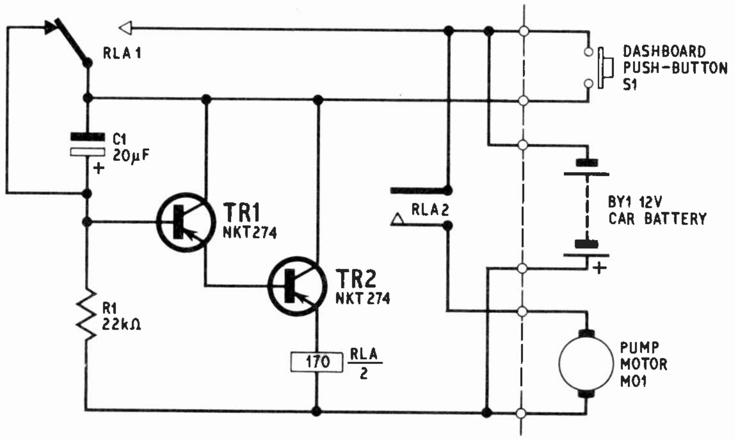
A second transistor in a similar configuration will again raise the impedance by a similar figure, making the necessary capacitor (for a ten second "dwell" time) about 16μF. We can now control the resistance of the time-constant circuit by putting a variable or a selected fixed resistor R1 in parallel with the input (see Fig. 3). Because of variations in components, especially cheap "reject" transistors, it may be necessary to experiment with values for R1 and C1. It was found in practice that a three second jet is adequate and using the transistors indicated, R1 is 22 kilohms and C1 20μF; these values provide a good starting point. Resistor R1 could be changed to a 500 kilohm potentiometer, which, set at maximum, would probably empty the bottle in a single continuous shot.

CONSTRUCTION

The prototype was built on Veroboard and mounted in a plastic photographic slide box under the dash board. It has proved completely reliable in service over six months.

The layout on Veroboard is shown in Fig. 4, this is not at all critical. The relay specified is a miniature 170 ohm, 6 to 12V type, the contacts of which are rated at 2 amp. Any relay having a coil resistance of 150 ohms or more, with one set of changeover contacts and one pair of "normally-open" contacts, rated at 2 amp, will do, so long as it will operate on 12 volts. If the relay is mounted on the Veroboard as in the prototype, rather than separately, some

Fig. 3. Circuit diagram of the windscreen washer timer



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2N1306	33p
2N1307	33p
2N1308	36p
2N1309	36p
2N1613	23p
2N1711	26p
2N1893	54p
2N2147	95p
2N2218	34p
2N2218A	43p
2N2219	38p
2N2219A	53p
2N2270	62p
2N2369A	19p
2N2483	35p
2N2484	42p
2N2646	54p
2N2904A	42p
2N2905	44p
2N2905A	47p
2N2924	20p
2N2925	22p
2N2926	11p
2N3053	27p
2N3055	75p
2N3702	13p
2N3703	13p
2N3704	13p
2N3705	13p
2N3706	13p
2N3707	13p
2N3708	13p
2N3709	13p
2N3710	13p
2N3711	13p
2N3819	35p
2N3904	35p
2N3906	35p
2N4058	20p
2N4059	20p
2N4060	20p
2N4061	20p
2N4062	20p
2N4124	18p
2N4126	27p
2N4284	15p
2N4286	15p
2N4289	15p
2N4291	15p
2N4292	15p
AC107	46p
AC126	20p
AC127	20p
AC128	20p
AC153K	25p
AC176	27p
ACY20	20p
ACY22	16p
AD140	50p
AD142	50p
AD149	60p
AD161	40p
AD162	40p

AF114	30p
AF115	30p
AF117	28p
AF124	30p
AF127	28p
AF139	48p
AF239	49p
ASY26	27p
ASY28	27p
BC107	14p
BC108	12p
BC109	14p
BC125	15p
BC126	22p
BC147	15p
BC148	14p
BC149	15p
BC153	19p
BC154	28p
BC157	19p
BC158	17p
BC159	18p
BC167	13p
BC168	11p
BC169	13p
BC177	17p
BC178	15p
BC179	17p
BC182L	13p
BC183L	11p
BC184L	13p
BC212L	25p
BC213L	25p
BC214L	25p
BCY70	19p
BCY71	33p
BCY72	15p
BF115	23p
BF167	27p
BF173	31p
BF194	17p
BF195	18p
BFX29	31p
BFX84	25p
BFX85	34p
BFX87	29p
BFX88	26p
BFY50	23p
BFY51	20p
BFY52	23p
BSX20	16p
C407	17p
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MPS6534	30p
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NKT212	25p
NKT214	23p
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COMPONENTS . . .

Resistor
R1 22kΩ $\frac{1}{4}$W, $\pm$10% carbon (or variable—see text)

Capacitor
C1 20μF elect. 25V

Transistors
TR1, 2 NKT274 *or* equivalent (2 off)

Relay
RLA 12V 170Ω d.p.d.t. contacts rated at 2 amp (STC midget open type available from Henry's Radio Ltd)

Miscellaneous
Veroboard 2$\frac{5}{8}$in $\times$ 1$\frac{1}{8}$in $\times$ 0·15in matrix—or larger size to accommodate various relays. Connecting wire. Plastics box for case.

care must be taken to isolate the relay mounting screws from the copper strips. The completed unit can be mounted in the box by means of nuts, bolts and spacers or glued in using Araldite. The power supply can be derived from any convenient live line, e.g. from the ignition switch, and a chassis connection. Be absolutely certain to connect up with the correct polarity.

Note that no harm comes of holding the button down continuously; the relay merely drops out momentarily at the end of each completed cycle.

The two transistors do not have to be the same, but TR2 should be able to withstand a collector current of at least 100mA.

TESTING

To test the completed unit before installation in the car the supply should be connected to the leads indicated and the leads for the load (MO1) connected across a 12V bulb. The leads that are to be connected to S1 can then be momentarily touched together. This should cause the bulb to light and remain on for a few seconds. The dwell time can be adjusted to suit various requirements by varying R1 and C1 or as mentioned earlier, R1 may be replaced with a variable resistor to provide variable dwell times.

POSSIBLE APPLICATIONS

The unit can be used to time almost any operation of the car's electrical system over a limited period. The relay contacts must be able to switch the required current and it should be noted that the repeat time accuracy of the unit will not be exceptionally high.

If a relay with more than two sets of contacts is used, more than one operation can be actioned simultaneously, e.g. washers and wipers together for a set period. Other possible uses of the timer are: sounding the horn—in an alarm system; reversing light timer—to prevent it being left on; head light timer—to light the garage doors after parking the car; interior light timer—to keep the interior light on for a few seconds after closing the car door thus giving light for finding seat belts and controls.

Readers will probably find many other uses for this unit. ★

BOOK REVIEWS

F. M. RADIO SERVICING HANDBOOK (2nd edition)

By Gordon J. King
Published by Newnes-Butterworths
206 pages, 10in $\times$ 6$\frac{1}{4}$in. Price £3·00

THE reliability of f.m. radio tuners and receivers is such that the amount of servicing or fault finding necessary on such modern equipment is minimal, particularly on those using semiconductors or integrated circuits. But when anything does go wrong it is essential to know what makes it tick if the serviceman is to restore it to full functional capabilities.

In particular, stereophony demands an understanding of some unusual radio propagation methods, and techniques for decoding to produce the optimum audio end-product.

It is not surprising therefore that actual servicing methods do not commence in this book until page 165. The preceding eight chapters, however, could have made up an excellent book on their own, being a fairly comprehensive down-to-earth description of the various principles involved in both valve and semiconductor f.m. tuners and stereo decoders.

The remaining chapters on servicing give a guide to analysis of breakdown symptoms with possible cures. Probably the most common faults are in the ageing of valves and capacitors which result in the tuned circuits drifting off frequency; a great deal is written on tuning procedures and the recommendations must be taken seriously to get the best results.

The final chapter explains the teminology used in specifications.

Overall this book is very well written, being largely new material that did not appear in the first edition. Some readers may even find it an improvement on the more general aspect found in "Radio and Audio Servicing Handbook" by the same author, and reviewed in our February issue.

M.A.C.

SEMICONDUCTORS — BASIC THEORY AND DEVICES

By I. J. Kampel
Published by Newnes-Butterworths
264 pages, 8$\frac{3}{4}$in $\times$ 5$\frac{1}{2}$in
Price £2·50

WITH a title such as this, a mere 260 pages obviously imposes constraints upon its author. This accounts, one presumes, for the somewhat terse style of writing. In the main this makes for a most readable work, which provides a good general introduction to the properties of semiconductors and to specific devices employed in everyday electronics. But it does inevitably lead to certain generalisations and some superficial skating over deep and complexing matters. Although aimed at "readers with little knowledge of physical science who require an introduction to semiconducting devices and the theory associated with them", at times the book appears to make certain assumptions about the reader's familiarity with physics: for example, on page 5 a bald statement "Pauli's principle states that the electrons in an atom must fill up the shells in order from the centre." That is the first and last we hear of Pauli and his principle. Maybe just a minor irritant. But, more seriously, on page 108 the author states that "the human being is particularly adept at sensing electromagnetic radiation in the region of 10^6 metres *with the ear*" (my italics). This confusion between e/m and sound compressional waves is by no means uncommon, but in the case of the author of a text book it is a bad and unexpected lapse.

Despite some shortcomings, this book has real worth, and its overall comprehensiveness will be attractive to those seeking to get to grips with solid state for the first time. The first ten chapters deal with the basic theory of semiconduction, from an outline of atomic structure through to *p*-type and *n*-type materials in contact, and so to the generic devices the diode and transistor, and how they are applied as active elements in circuits. After two chapters dealing with the somewhat abstruse subjects of Quantum Theory and Relativity, there are three devoted to photoelectric effects and semiconductors operating in the visible and infra-red regions respectively. Field effect semiconductors and switching devices are covered (but no mention of the triac), and then follow summary accounts of numerous other specialised solid state devices, including some advanced types not yet in common use. The manufacturing techniques for both discrete devices and integrated circuits are described with sectional views of typical devices. Strangely, the discussion on i.c.s is limited to linear devices.

F.E.B.

20 SOLID STATE PROJECTS FOR THE CAR AND GARAGE

By R. M. Marston
Published by The Butterworth Group
115 pages, 8½in × 5½in. Price £1·80

WHY OH WHY, must blurb writers make such amazing claims for the authors of books? I have been in trouble before because an introductory "sales" piece was so overwhelming that it was, in my opinion, a distortion of the facts, and now it has happened again. Most people read the cover blurb to get a quick synopsis of a book before buying, and so it is with me. The trouble is that when fantastic claims are made for a book or an author it is very annoying and can result in a bad book review. I hope I have learned to ignore such bumptious blurbs and try to give a fair appraisal of the book. However, publishers please do not print such things as; "R. M. Marston is probably five of the ten best-known electronics technical authors in the U.K. today." If you want to tell us how good he is, why not publish the pseudonyms and let the readers judge for themselves.

To get to the book itself, after the grouse the good points. All the projects would prove useful to most car owners, although I doubt if anyone would consider building them all. Circuit function is adequately described on all the circuits and this should help the novice building the simple circuits. The book is generally well written and the diagrams are good and easy to follow.

At a price of £1·80 the cost per project works out at 9p—even I can do it in my head with decimals—admittedly some of the designs are worth more than this figure, but I would have expected them all to contain full constructional details and, in some cases, more information on wiring the devices to the car. The range of projects covered is great, from a surpressed-zero voltmeter (three components) right up to the complexities of a capacitor discharge ignition system.

It would be good to see the book better laid out so that the projects are arranged in some formal order—say relating to complexity—rather than in a random fashion. The ignition system, which was first published in *Wireless World* some time ago, has been placed first but will probably provide the most problems for the constructor both in layout and wiring, for which no diagrams are given, and in fault finding.

Not all projects are illustrated with photographs and those that are, show mainly the circuit boards and are generally of poor quality. Veroboard layouts are given for more than half the projects and these will enable most people to build them. M.K.

POINTS ARISING

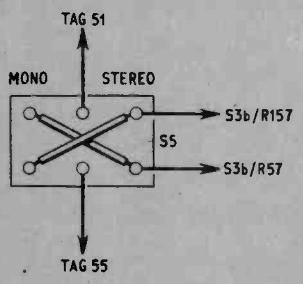
P.E. GEMINI AMPLIFIER *(November 70 to March 71)*

Some constructors have reported difficulty with h.f. oscillation when setting up the amplifier as described in December 1970 issue. The trouble appears to be caused by the additional impedance of the meter together with feedback from meter leads to the open circuit input. This can be prevented by temporarily shorting the inputs whilst adjusting VR2 and VR102, i.e. link tags 1 to 2 and 3 to 4 on the main amplifier board.

Note that metal foil capacitors *must* be used for C17, C117, C25 and C125, although it is preferable to use metal foil types in the other positions indicated; electrolytic types may be substituted.

Components list p. 118: R69 and R169 should be 47kΩ. Switch S2, 2 pole, 5 way should be S3 and switch S5 is a d.p.d.t. toggle or slide. Fig. 34, p. 120, tag 102 has not been shown on either diagram; its position is indicated on Fig. 35. Fig. 3, p. 863 (November 1970) the voltage at R9 and R10 junction should be 26·2V as given in the check chart, not as shown on the diagram.

We regret that the wiring of S5 was omitted, it is shown below:



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ACY17	0·15	2G303	0·13
AF239	0·37	2N711	0·50
AF186	0·50	2N1302-3	0·20
AF139	0·37	2N1304-5	0·25
BC154	0·25	2N1306-7	0·30
BC171 = BC107	0·13	2N1308-9	0·35
BC172 = BC108	0·13	2N3819FET	0·45
BF194	0·15		
BF274	0·15	**Power Transistors**	
BFY50	0·20	OC20	0·50
BSY25	0·57	OC23	0·30
BSY26	0·13	OC25	0·25
BSY27	0·13	OC26	0·25
BSY28	0·13	OC28	0·30
BSY29	0·13	OC35	0·25
BSY95A	0·15	OC36	0·37
OC41	0·13	AD149	0·30
OC44	0·13	AUY10	1·25
OC45	0·13	2S034	0·25
OC71	0·13	2N3055	0·63
OC72	0·13		
OC73	0·17	**Diodes**	
OC81	0·13	AAY42	0·10
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OC83	0·20	OA79	0·09
OC139	0·13	OA81	0·09
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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.

What about us!

Sir—May I make a strong plea to professional electronic components manufacturers to be a little more tolerant to amateurs, and at the same time suggest that we, the amateurs, take note of the specific problems that sometimes prevent the larger companies aiding us with the supply of specialised components.

Generally speaking we are able to obtain most day to day components through retail outlets and specialist companies advertising in your magazine. However, many of the projects that we might like to embark on require components of a highly specialised nature and it is only possible to obtain these directly from the manufacturers or their distributors.

Certain companies have attempted to satisfy this demand by setting up special divisions to deal specifically with the amateur but none seem to have been highly successful ventures—perhaps because the prices of components in question tend to be higher than average and that there are not sufficient of us to make the business worthwhile.

Professional distributors usually refuse to supply individuals because they are afraid that it will be the thin end of the wedge, but the thin end of what edge? Whenever I have challenged distributors to explain their fear it usually turns out that their impression is that individuals do not understand the usual conditions of business sales and present their orders in an un-intelligible way. Some have said that the "dribs and drabs" of business they would get involved in would be uneconomic.

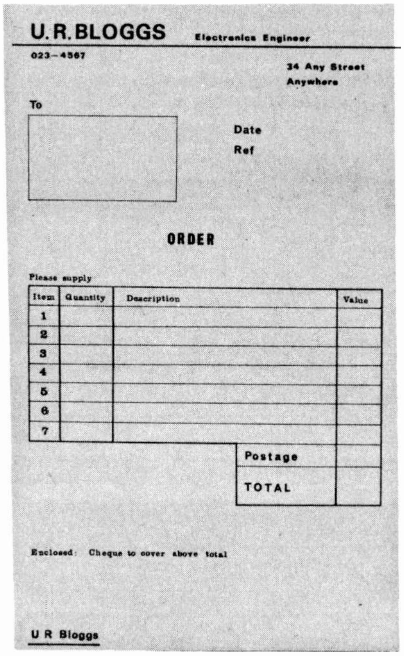
While I agree with the first two points I strongly disagree with the latter. The basis on which distributors operate is to provide a fast supply of small to medium quantities of components to user industries i.e., they take the business which is too small to be economic to the main factory. Most distributors are prepared to supply industrial concerns with remarkably low value orders—typically as low in value as £2. Admittedly this is padded out by large orders but nevertheless the organisation must be tooled up to handle the small business as well. I would say that most projects that this magazine deals with involve the use of many times this value of components.

My feeling is that the first two points mentioned are the ones which frighten the distributors, e.g. sending off orders lower than the minimum order value that most companies now have, or telephoning repeatedly, chasing orders, which have only just been sent off, or even sending back goods after ordering the wrong devices in error; and perhaps the worst offender is the illegible order enclosing money for goods which obviously cannot be dispatched.

May I suggest that you approach such distributors on behalf of the amateur asking whether they would in future be prepared to supply components against a formalised order form which really enthusiastic constructors can easily get printed for not much more than a pound or two (I enclose a simple example). Also that minimum order values are recognised.

If these conditions were laid down I seen no reason why the amateur should not receive exactly the same service as the professional and at the same time the distributors would find a none too small outlet for components.

M. J. Hughes,
Biggin Hill,
Kent.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U R Bloggs

Desirable scheme!

Sir—About a year ago we formed a buying group with about 15 other dealers in the London area which we provisionally call "Group One." Its primary object was to buy components at the best prices in reasonable quantities. There are several secondary aims such as exchange of excess stock and exchange of information.

To some extent this has been forced on us because we wished to buy certain items that wholesalers don't wish to handle and the manufacturers will only sell in quantities that are beyond the pocket of *one* dealer to buy. But I would like to stress the fact that this is not aimed at distributors or wholesalers (I for one, have always believed that they do a useful job and earn their money) in fact any small wholesaler or manufacturer would be welcome to join. I feel sure you will agree that this is a desirable scheme, as ultimately it means we can offer your readers a greater range of goods at the lowest prices.

Initially we were going to limit the Group to about 20 dealers (not an account of any closed shop principle but because we thought (quite wrongly) that we could not handle the administration of a larger number). Now we would like to offer membership to any bona fide trader in the U.K. and I would be very grateful if you could make this generally known through the courtesy of your columns. At the moment there is no entrance fee or subscription. If anyone is interested please write to me at the following address.

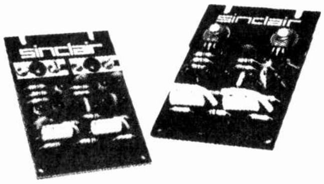
A. Sproxton,
Home Radio Ltd.,
234–240 London Road,
Mitcham, Surrey.

This magazine will give encouragement or support to any idea or scheme that seems mutually beneficial to all parties concerned. But our especial aim will always be to further the aspirations of the genuine enthusiast, which regrettably are often held in check through want of desired components.

See this month's editorial comment.

Sinclair Project 60

Z.30 & Z.50 power amplifiers



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SPECIFICATIONS ***(Z50 units are interchangeable with Z.30s in all applications).***
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Z.30 15 watts R.M.S. into 8 ohms using 35 volts: 20 watts R.M.S. into 3 ohms using 30 volts.
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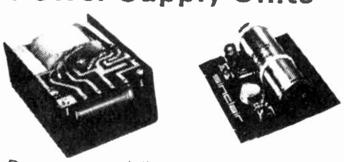


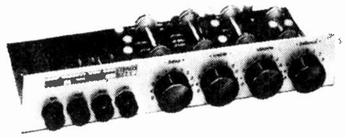
Designed specially for use with the Project 60 system of your choice.
Illustration shows PZ.5 to left and PZ.8 (for use with Z.50s) to the right. Use PZ.5 for normal Z.30 assemblies and PZ.6 where a stablised supply is essential.

PZ-5 *30 volts unstabilised* **£4.98**
PZ-6 *35 volts stabilised* **£7.98**
PZ-8 *45 volts stabilised (less mains transformer)* **£7.98**
PZ-8 *mains transformer* **£5.98**

Guarantee

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

Stereo 60 pre-amp/control unit



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

SPECIFICATIONS

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

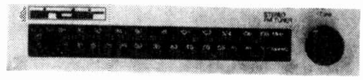
Built, tested and guaranteed. **£9.98**

Active Filter Unit

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

Built, tested and guaranteed **£5.98**

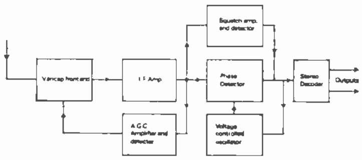
Stereo FM Tuner



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

SPECIFICATIONS:

Number of transistors: 16 plus 20 in I.C.
Tuning range: 87.5 to 108 MHz
Capture ratio: 1.5dB
Sensitivity: 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 B.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 ______	Name ______
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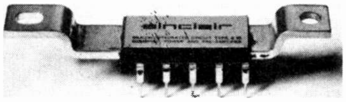
for which I enclose cash/cheque/money order.	

Sinclair IC10/Q16/Micromatic

IC10



The world's most advanced high fidelity amplifier

This is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself is a chip of silicon only a twentieth of an inch square by one hundredth of an inch thick, having 5 watts RMS output (10 watts peak). It contains 13 transistors (including two power types), 2 diodes, 1 zener diode and 18 resistors, and is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins. This exciting device is more rugged and has considerable performance advantages, including complete freedom from thermal runaway and a very low level of distortion. The IC10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of such components as tone and volume controls and a battery or mains power supply. It may also be used in other applications including car radios, electronic organs, servo amplifiers (it is dc coupled throughout) etc.

Circuit Description

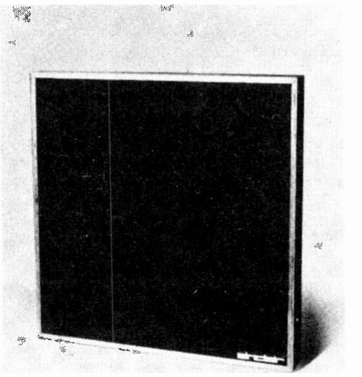
The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. Class AB output is used with closely controlled quiescent current which is independent of temperature. There is generous negative feedback round both sections and the amplifier is completely free from crossover distortion at all supply voltages, making battery operation eminently satisfactory.

Each IC10 is sold with a comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include oscillators, etc. The pre-amp section can be used as an RF or IF. amplifier without any additional transistors.

Specifications:

Output: 10 watts peak, 5 watts RMS continuous.
Frequency response: 5Hz to 100kHz 1 ± dB.
Total harmonic distortion: Less than 1% at full output.
Load impedance: 3 to 15 ohms.
Power gain: 110 dB (100,000,000,000 times) total
Supply voltage: 8 to 18 volts. (A Sinclair power unit, PZ.7 is available for mains operation).
Size: 1 x 0.4 x 0.2 in. plus heat sink and tags.
Sensitivity 5 mV.
Input impedance: Adjustable externally up to 2.5 Mohms.
Price (with manual) **59/6** (£2.97½) post free.

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.

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 TMS.
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 a 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 **£8.19.6.** (£8.97½).

Micromatic

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 and 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 ($1\frac{4}{5} \times 1\frac{3}{10} \times \frac{1}{2}$ 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 Hz).
Earpiece: Magnetic type.
On/off switching: By inserting and withdrawing earpiece plug.
Kit in pack with earpiece, case, instructions and solder **49/6** (£2.47½).
Ready built, tested and guaranteed, with earpiece **59/6** (£2.97½).
Two Mallory Mercury batteries type RM675 required. From radio shops, chemists, etc.

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Tel: St. Ives (046 06) 4311

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PIV	1A TO-5 £p	3A TO-66 £p	7A TO-66 £p	10A £p	16A TO-48 £p	30A TO-48 £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	0·97	1·25	—
800	0·63	0·70	0·90	1·20	1·50	4·00

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PIV	300mA £p	750mA £p	1A £p	1·5A £p	3A £p	10A £p	30A £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 £p	6A TO-66 £p	10A TO-88 £p
100	0·50	0·63	1·00
200	0·70	0·90	1·25
400	0·90	1·00	1·60

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PHOTO TRANS.

OCP71 Type. **43p**

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

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Ideal for Organ Builders.

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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.

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HIGH POWER SILICON PLANAR TRANSISTORS. TO-3.
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VCE40 Ptot. 75W
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PRICE 30p EACH

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.

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T5	8	2G382T	OC82
T6	8	2G344A	OC44
T7	8	2G345A	OC45
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All **50p** each pack

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

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U19	25 Silicon NPN transistors like BC108	0·50
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U33	15 Plastic case 1 amp silicon rectifiers IN4000 series	0·50
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U37	30 Sil. alloy trans. SO-2 PNP, OC200 2S322	0·50
U38	20 Fast switching sil. trans. NPN, 400Mc/s 2N3011	0·50
U39	30 RF germ. PNP trans. 2N1303/5 TO-5	0·50
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Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked.

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Q33	3 Sil. NPN trans. 2N1711	0·50
Q34	7 Sil. NPN trans. 2N2369, 500MHZ	0·50
Q35	3 Sil. PNP TO-5 2 × 2N2904 & 1 × 2905	0·50
Q36	7 2N3646 TO-18 plastic 300MH2 NPN	0·50
Q37	3 2N3053 NPN sil. trans.	0·50
Q38	7 PNP trans. 4×2N3703, 3×2N3702	0·50
Q39	7 NPN trans. 4×2N3704, 3×2N3705	0·50
Q40	7 NPN amp. 4×2N3707, 2×3N3708.	0·50
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Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACEMENTS FOR:—OC25–28–29–30–35–36. NKT401–403–404–405–406–450–451–452–453. T13027–3028, 2N250A, 2N456A–457A–458A, 2N511–511 A & B. 2G220–222. ETC.
SPECIFICATION
VCBO 80V VCEO 50V IC 10A PT 30 WATTS HFE 30–170.

PRICE	1–24	25–99	100 up
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SPECIFICATION
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AD149	43p

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

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Each kit comprises seven items—Choke, 2 tube ends, starter, starter holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15–20W, **£1**. Kit B—30–40W, **£1**. Kit C—80W, **£1·20**. Kit E—65W, **£1·20**. Kit F for 8ft 125W tube **£1·75**. Kit MF1 is for 6in, 9in and 12in miniature tubes, **£1**. Kit MF2 for 21in 13W miniature tube, **£1**. Postage on Kits A and B 23p for one or two kits then 23p for each two kits ordered. Kits C, D and E 23p on first kit then 18p for each kit ordered. Kit F 33p then 23p for each kit ordered. Kit MF1 18p on first kit then 18p on each two kits ordered.

BLANKET SWITCH

Double pole with neon let into side so luminous in dark, ideal for dark room light or for use with waterproof element—new plastic case **30p** each. 3 heat model **40p**.

BLANKET SIMMERSTAT

Although looking like, and fitted as an ordinary blanket switch, this is in fact a device for switching on for varying time periods, thus giving a complete control from off to full heat. Although suitable for controlling the temperature of any other appliances using up to 1A. Listed at **£1·40** each we offer these while our stocks last at only **65p** each.

REED SWITCHES

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

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

Standard. 2in long × $\frac{3}{16}$in diameter. This will break currents of up to 1A, voltages up to 250 volts. Price **10p** each, **90p** per dozen.

Flat. Flat type, 2in long, just over $\frac{1}{16}$in 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 1 amp 200 volts. Price **30p** each. **£3** per dozen.

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

HIGH CAPACITY ELECTROLYTICS

Brand new, not ex-equipment.

100 mfd. 25V, **6p** each **60p** doz.
200 mfd. 25V, **8p** each **75p** doz.
250 mfd. 50V, **16p** each **£1·65** doz.
400 mfd. 40V, **22p** each **£2·30** doz.
500 mfd. 12V, **10p** each **£1·05** doz.
500 mfd. 25V, **18p** each **£1·80** doz.
500 mfd. 50V, **23p** each **£2·40** doz.
500 mfd. 350V, **43p** each **£4·50** doz.
1000 mfd. 12V, **15p** each **£1·50** doz.
1000 mfd. 18V, **17p** each **£1·70** doz.
1000 mfd. 64V, **37p** each **£4** doz.
2000 mfd. 25V, **34p** each **£3·95** doz.
5000 mfd. 12V, **24p** each **£2·40** doz.
10,000 mfd. 6V, **29p** each **£3** doz.
10,000 mfd. 15V, **43p** each **£4·50** doz.
15,000 mfd. 10V, **53p** each **£5** doz.
60,000 mfd. 8V, **£1·10** each **£10** doz.
70,000 mfd. 13V, **£2** each **£20** doz.

3 AMP 12V BATTERY CHARGER KIT—comprising 230/40 mains transformer with 3 amp secondary and 3 amp rectifier **£1·15** + 23p post.

12 VOLT 1½ AMP POWER PACK. This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 m/f/d/smoothing. Price **£1·40**.

SONOTONE STEREO CARTRIDGE. Turnover type, ref. No. 19 T1. This fits most British pick-ups and is a really excellent reproducer. Limited quantity, **£1**.

5 AMP 3-PIN SOCKETS. These are always good stock, you never know when you will need some. Famous make, brown bakelite, standard size, 12 for **65p** plus 23p post.

DITTO WITH SWITCH. 12 for **£1** plus 23p post.

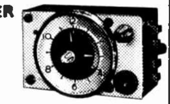
13 AMP SOCKETS, FLUSH MOUNTING. Bakelite, cream, less switch. 6 for **£1**.

BAKELITE PANELS, MANY THICKNESSES. We have just taken delivery of approximately 10 tons of bakelite in varying thicknesses from 2in. to a few thou. If you have a need for any of this then we would he glad to supply. The thickest is very heavy and could be used, for instance, as a bed for a motorised unit. Medium thickness is useful for front panels of instrument, etc., etc. Cut to your size price is **30p** per lb. plus **30p** cutting charge plus carriage.

2 AMP 3-PIN SWITCHED SOCKETS for surface mounting, brown bakelite. Made by famous maker. **13p** each or **£1·20** dozen.

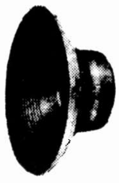
100 ASSORTED SILICON RECTIFIERS G.P. AND SWITCHING DIODES. Small and very small sizes. A real snip for experimenters, **65p** per 100.

20 AMP ELECTRICAL PROGRAMMER



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

HI-FI SPEAKERS (15, 30, 40 & 100W)

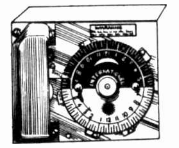


FULL FI 12 INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi load and Rhythm Guitar and public address. Flux Density 11,000 gauss—Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S. Cone Moulded fibre—Freq. response 30-10,000 c.p.s.—Specify 3 or 15 ohms—Mains resonance 60 c.p.s.—Chassis Diam. 12in.—12⅜in. over mounting lugs—Baffle hole 11 in. diam.—Mounting holes 4, holes—¼in. diam. on pitch circle 11½in. diam.—Overall height 5¼in. A £6 speaker offered for only **£4**. plus 37p p. & p. 12in. 40 watt **£7** carr. 43p. 15in. 25 watt **£8** carr. 53p. 18in. 100 watt **£19.50** carr. £1·50.

INTEGRATED CIRCUIT BARGAIN

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

THIS MONTH'S SNIP



ELECTRIC TIME SWITCH

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

DISTRIBUTION PANELS

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

BARGAIN OF THE YEAR

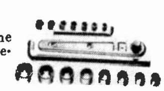
MICROSONIC KEYCHAIN RADIO

7 transistor Key chain Radio in very pretty case, size 2⅜ × 2⅛ × 1⅛in—complete with soft leather zipped bag. Specification:—Circuit: 7 transistor superheterodyne. Frequency range: 530 to 1,600 Kc/s. Sensitivity: 5 mv/m. Intermediate frequency: 465Kc/s or 455Kc/s. Power output: 40mW. Antenna: ferrite rod. Loudspeaker: Permanent magnet type. In transit from the East these sets suffered slight corrosion as the batteries were left in them but when this corrosion is cleared away they should work perfectly—offered without guarantee except that they are new. Price only **£1·25** plus 13p post and insurance, less batteries. 6 for **£7**, post free. Pair of rechargeable batteries and charger 85p.

4 AMP VARIAC CONTROLLERS

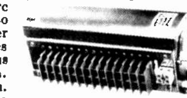
With this you can vary the voltage applied to your circuit from zero to 270 volts without generating undue heat. One obvious application therefore is to dim lighting. Ex equipment but little used—as good as new offered at approx. half price—**£5** plus 75p post and ins.

19-PIECE SOCKET SET



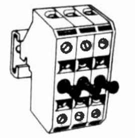
Complete with wall or bench rack. An ideal gift for the motorist. **80p** + 23p; post and insurance. Most useful sizes from ¼in to ¾in.

HONEYWELL PROGRAMMER



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

MAINS CONNECTOR



A quick way to connect equipment to the mains safely and firmly; disconnection by plugs prevents accidental switching on; has sockets which allow insertion of meter without disconnection; cable inlets firmly hold one hair wire on up to four 7,029 cables. **65p** each.

DRILL CONTROLLER

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

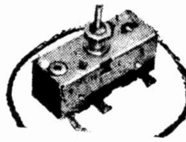
BALANCED ARMATURE UNIT

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

PROTECT VALUABLE DEVICES

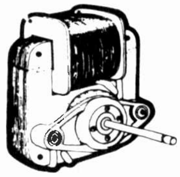
FROM THERMAL RUN-AWAY OR OVERHEATING: Thyristors, rectifiers, transistors, etc., which use heat-sinks can easily be protected. Simply make the contact thermostat part of the heat-sink. Motors and equipment generally, can also be adequately protected by having thermostats in strategic spots on the casing. Our contact thermostat has a calibrated dial for setting between 90deg. to 190deg.F. or with the dial removed range setting is between 80 to 800deg.F. Price **50p**.

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.

MAINS MOTOR



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

NEED A SPECIAL SWITCH?

Double Leaf Contact

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

MINIATURE WAFER SWITCHES

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

WATERPROOF HEATING ELEMENT

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

MICRO SWITCH

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

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

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NEW! roamer eight mk 1

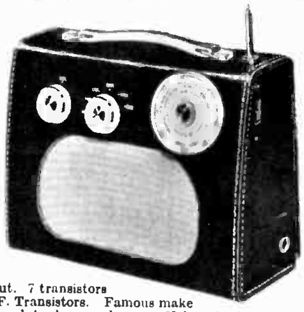
WITH VARIABLE TONE CONTROL

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

Total building costs £6·98

Post, packing and insurance 41p

Overseas P. & P. 90p



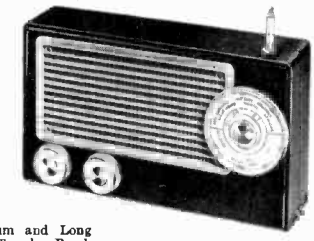
roamer seven mk IV

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

Total building costs £5·98

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

Post, packing and insurance 41p
Overseas P. & P. 90p



NEW! transeight

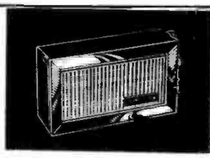
SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case in black with red grille and black knobs and dial with spun brass inserts. Size 9 × 5½ × 2½in. approx. Tunable on Medium and Long Waves, 3 Short Waves and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 8 improved type transistors plus 3 diodes. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans 25p (FREE with parts).

Total building costs £4·48

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

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



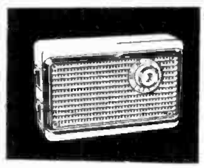
pocket five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER

Attractive black and gold case. Size 5½ × 1½ × 3½in. Tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Easy build plans and parts price list 8p (FREE with parts).
Earpiece with plug and switched socket for private listening, 30p extra.

Total building costs £2·23

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



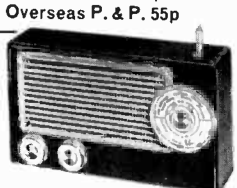
transona five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER

Attractive case with red speaker grille. Size 6½ × 4½in × 1½in. 7 stages—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker. Easy build plans and parts price list 8p (FREE with parts).
Earpiece with plug and switched socket for private listening, 30p extra.

Total building costs £2·38

Post, packing and insurance 22p
Overseas P. & P. 55p



IMPROVED MODEL ! roamer six

SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive black case with red grille and black knobs and dial with spun brass inserts. Size 9 × 5½ × 2½in. approx. Tunable on Medium and Long Waves, two Short Waves, Trawler Band plus an extra M.W. band for easier tuning of Luxembourg, etc. Sensitive ferrite rod aerial and latest telescopic aerial for Short Waves. Improved circuit. 8 stages—6 transistors and 2 diodes including Micro-Alloy R.F. Transistors, etc. Easy build plans and parts price list 10p (FREE with parts).
Earpiece with plug and switched socket for private listening, 30p extra.

Total building costs £3·98

Post, packing and insurance 26p
Overseas P. & P. 70p

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ROAMER EIGHT	☐	ROAMER SEVEN	☐
TRANSEIGHT	☐	POCKET FIVE	☐
TRANSONA FIVE	☐	ROAMER SIX	☐

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BRAND NEW FULLY GUARANTEED DEVICES

AC107	15p	AF115	17p	BC140	35p	BCY31	22p	BF272	80p	EC403	15p	ORP60	40p
AC113	20p	AF116	17p	BC141	35p	BCY32	25p	BF273	30p	GET880	27p	ORP61	40p
AC115	23p	AF117	17p	BC142	45p	BCY33	17p	BF274	30p	MAT100	15p	ST140	12p
AC125	17p	AF118	30p	BC143	40p	BCY34	20p	BF308	35p	MAT101	17p	ST141	17p
AC126	17p	AF124	21p	BC145	45p	BCY70	17p	BF309	37p	MAT120	15p	TIS43	40p
AC127	17p	AF125	20p	BC147	17p	BCY71	30p	BF316	75p	MAT121	17p	UT46	27p
AC128	17p	AF126	20p	BC148	12p	BCY72	15p	BFW10	55p	MPF102	43p	V405A	25p
AC141K	17p	AF127	20p	BC149	17p	BCZ11	20p	BFX29	27p	MPF105	43p	V410A	45p
AC142K	17p	AF139	33p	BC150	17p	BD121	85p	BFX84	20p	OC19	30p	2G301	19p
AC151	15p	AF178	50p	BC151	20p	BD123	85p	BFX85	27p	OC20	50p	2G302	19p
AC154	15p	AF179	50p	BC152	17p	BD124	75p	BFX86	22p	OC22	30p	2G303	19p
AC155	15p	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	13p	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	35p	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
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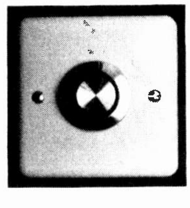

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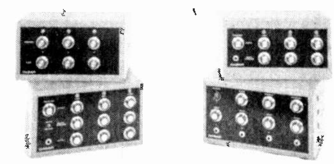

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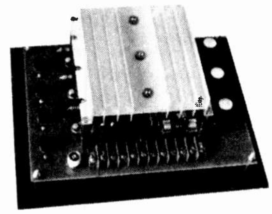

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