PRACTICAL ELECTRONICS

MARCH 1969

THREE SHILLINGS

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ELECTRONIC MIME MOBILE ANIMAL

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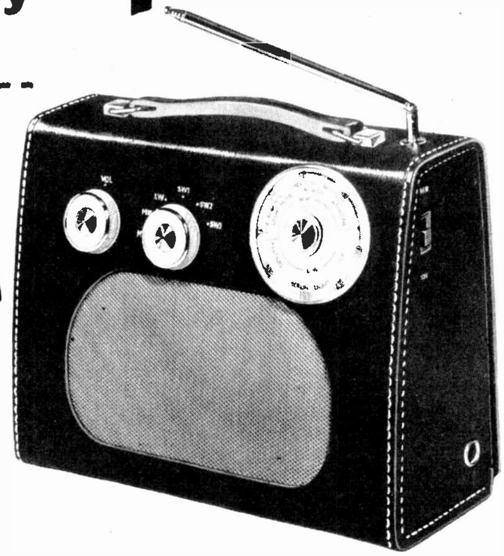


roamer seven mk iv

SEVEN WAVEBAND PORTABLE

SEVEN TUNABLE WAVEBANDS—

MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND.

Extra M.W. band for easier tuning of Luxembourg, etc. Built-in ferrite rod aerial for Medium and Long Waves. 5 Section 22in. chrome-plated telescopic aerial for Short Waves—can be angled and rotated for peak S.W. 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 for rich-tone volume. Air spaced ganged tuning condenser. Separate on/off switch, volume control, wave change switches and tuning control. Attractive case with carrying handle. Size 9 × 7 × 4in. approx. First-grade components. Easy to follow instructions and diagrams make the Roamer 7 a pleasure to build.

Total building costs

£5.19.6 P. & P. 7/6

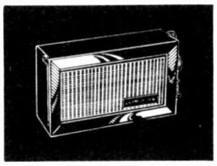
Personal Earpiece with switched socket for private listening 5/- extra.

Parts price list and easy build plans 3/- (Free with parts).

pocket five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND (to 50 metres approx.) PORTABLE WITH SPEAKER AND EARPIECE

Attractive black and gold case. Size 5¼ × 1¼ 3½in. Tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. All first grade components—7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker, also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list, 1/6 (FREE with parts).



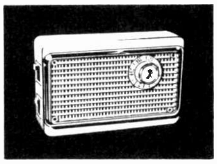
Total building costs

44/6 P. & P. 3/6

transona five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND (to 50 metres approx.) PORTABLE WITH SPEAKER AND EARPIECE

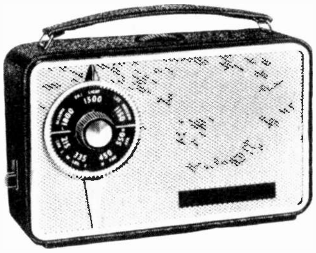
Attractive case with red speaker grille. Size 6¼ × 4½ × 1¼in. 7 stages—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker also Personal Earpiece with switched socket for private listening. All first grade components. Easy build plans and parts price list 1/6 (FREE with parts).



Total building costs

47/6 P. & P. 3/9

NEW LOOK melody six



8 stages—6 transistors and 2 diodes. Covers Medium and Long Waves. Top quality 3in. Loudspeaker for quality output and also with Personal Earpiece with switched socket for private listening. Two R.F. Stages for extra boost. High "Q". Ferrite Rod Aerial. Push-pull output. Handsome pocket size case with gilt fittings. Size 6¼ × 4 × 2in. Easy build plans and parts price list 2/- (FREE with parts).

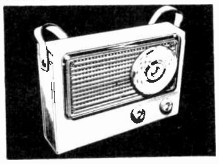
Total building costs

69/6 P. & P. 4/3

super seven

THREE WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case size 7¼ × 5¼ × 1¾in. with gilt fittings. The ideal radio for home, or outdoors. Covers Medium and Long Waves and Trawler Band. Special circuit incorporating 2 R.F. Stages, push pull output, ferrite rod aerial, 7 transistors and 2 diodes, 3in. speaker (will drive larger speaker) and all first grade components. Easy build plans and parts. Price list 2/- (FREE with parts). (Personal Earpiece with switched socket for private listening 5/- extra.)



Total building costs

69/6 P. & P. 4/6

roamer six

SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case with gilt fittings, size 7¼ × 5¼ × 1¾in. 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 telescopic aerial for Short waves. All top grade components. 8 stages—6 transistors and 2 diodes including Micro-Alloy R.F. Transistors, etc. (Carrying strap 1/6 extra.) Easy build plans and parts price list 2/- (FREE with parts). (Personal Earpiece with switch socket for private listening 5/- extra.)

Total building costs

79/6 P. & P. 4/6

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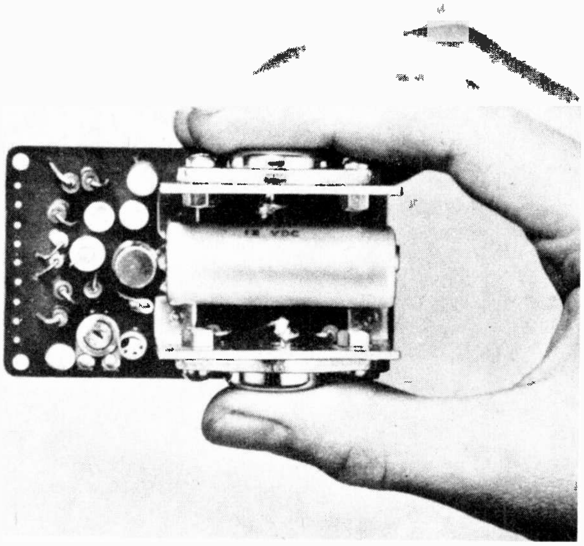
.... P.E. 3-69

SINCLAIR Z.12 12 WATT INTEGRATED HI-FI AMPLIFIER & PRE AMP

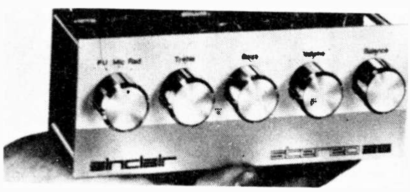


12 watts R.M.S. continuous sine wave output.

This is the recommended amplifier for those requiring greater power than that provided by the IC.10. This eight transistor amplifier is the most successful of its kind ever designed. It has an excellent power to size ratio and is easily adapted to a wide variety of applications. The Z.12 performs satisfactorily from a wide range of voltages and it can easily be run from car batteries. This true 12 watt amplifier comes to you ready built, tested and guaranteed together with useful manual of circuits and instructions for matching the Z.12 to your precise requirements. Two may be used for stereo, when the Sinclair Stereo 25 will be found the ideal control unit for use with it:

Size—3in x $1\frac{3}{4}$in x $1\frac{1}{4}$in. Class B Ultralinear Output: Frequency response from 15 to 50,000Hz $\pm$1dB: Output suitable for loudspeakers from 3 to 15 ohms impedance. Two 3 ohm speakers may be used in parallel: Input 2 mV into 2K ohms: Output 12 watts R.M.S. continuous sine wave (24 watts peak); 15 watts music power (30 watts peak) Power requirements 6—20V d.c. from battery or PZ.4 Mains Supply Unit. Ready built, tested and guaranteed.

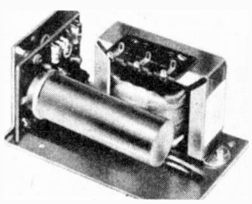
89/6



SINCLAIR STEREO 25

De Luxe Pre-amp and Control Unit for IC.10 or Z.12 Stereo assemblies. Switched inputs for P.U (equalised to R.I.A.A. curve from 50 to 20,000 Hz $\pm$1dB), Radio and auxiliary. Supplied ready built with very attractive solid brushed and polished aluminium front panel. Control knobs for Bass/Treble/Volume/Balance/Input are solid aluminium. Size—$6\frac{1}{2}$ x $2\frac{1}{2}$ x $2\frac{1}{2}$in plus knobs. Built, tested and guaranteed.

£9.19.6



SINCLAIR PZ4

STABILISED MAINS POWER SUPPLY UNIT

Heavy duty transistorised power supply unit to deliver 18V d.c. at 1.5A. Designed specially for use with two Z.12 or IC.10 Amplifiers together with Stereo 25. Built, tested and guaranteed.

99/6

sinclair

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SINCLAIR MICROMATIC

The world's smallest radio

This fantastic little British pocket receiver is available in kit form to build for yourself or ready built, tested and guaranteed. Its range and selectivity must be experienced to be believed; its power and quality everything you could want. The Micromatic tunes over the medium waveband and has A.G.C. to counteract fading from distant stations. Bandpass tuning makes reception of Radio 1 easier; in fact, you will find your Micromatic performing where other sets cannot be heard at all. The neat black case with aluminium front panel and tuning control give the Micromatic elegantly modern appearance.

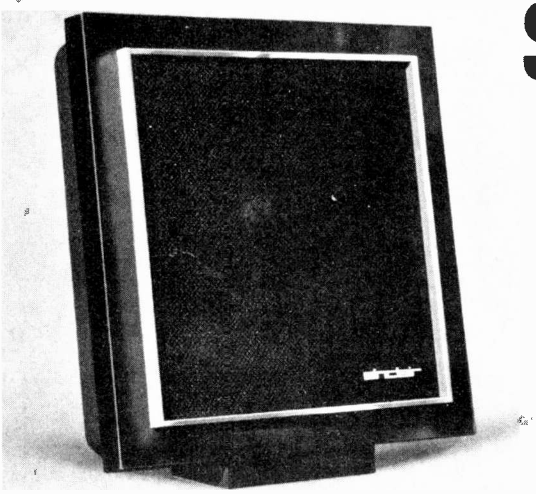
- High quality magnetic earpiece
- Choice of many stations
- Plays anywhere

Kit in fitted pack with earpiece, solder and instructions. **49/6**

Built, tested and guaranteed. **59/6**

Mallory Mercury Cells RM.675 (2 reqrd.) each 2/9

SINCLAIR Q.14



the most challenging loudspeaker design in years

It is more than a matter of saving money when you choose the Q.14. This is the loudspeaker that delights experts and critics alike for its find forward quality, its clarity and exceptional adaptability. Designed on original lines and from unusual materials, the Q.14 will easily carry up to 14 watts and has very smooth response from 60 to 16,000 Hz. Size—9¾in square x 4¾in deep, with matt black finish and solid aluminium bar embellishment. Input impedance—8 ohms.

The Q.14 costs about a quarter of what you might expect to pay for a good stereo speaker system. A pair used with IC.10s or Z.12s and the Stereo 25 will give you superb high fidelity to stand comparison with far costlier equipment.

Try the Q.14 in your own home without delay. If it does not delight you, send it back and your money including cost of postage will be refunded in full.

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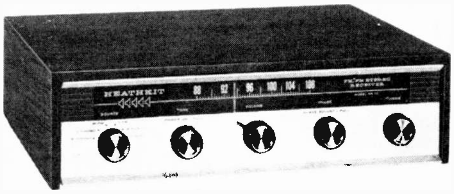
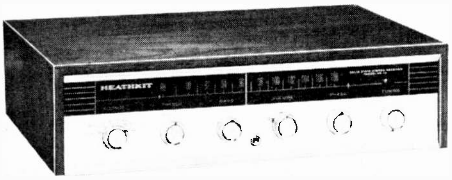


Low-cost FM Stereo Receiver, AR-17

Kit K/AR-17
£39.0.0
P.P. 10/6

28 transistor, 7 diode circuit, 14 watts music power, 10 watts r.m.s. from 25–35,000Hz @ ±1db. Automatic stereo indicator light. Adjustable phase control. Complete front panel controls. Flywheel tuning. Factory assembled and aligned FM front-end. Circuit board assembly. Compact 10¾″ deep × 3″ high × 12″ wide. Use free standing with Heathkit cabinet optional extra.

Cabinet walnut or teak finish **£3.10.0** extra

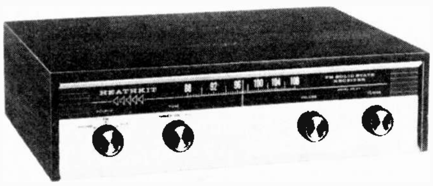


Quality FM Stereo Receiver, AR-14

Kit K/AR-14
£54.0.0
P.P. 13/6

31 transistor, 10 diode circuit can deliver ±1db, 15 to 50,000Hz at 10 watts per channel (20 watts total) 15 watts per channel 1HF music power (30 watts total). Wide-band FM/FM stereo tuner plus two preamps, two power amplifiers. Compact only 3⅞″ high × 15¼″ wide × 12″ deep. Install in a wall, free standing or in Heathkit cabinet optional extra. 210–240V 50Hz a.c.

Cabinet walnut or teak finish **£4.10.0** extra

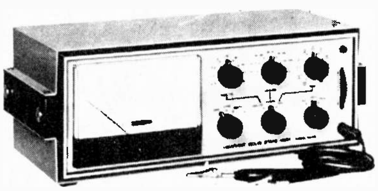


Low-cost FM Mono Receiver, AR-27

Kit K/AR-27
£22.10.0
P.P. 10/6

13 transistor, 6 diode circuit. 7 watts music power. ±1db, 25 to 60,000Hz at 6 watts. Input connectors for phono and aux. Complete front panel controls. Flywheel tuning, factory pre-aligned FM tuner. Circuit board assembly. Compact bookshelf size. Install in a wall, free standing or in cabinet optional extra. 210–240V 50Hz a.c. operation.

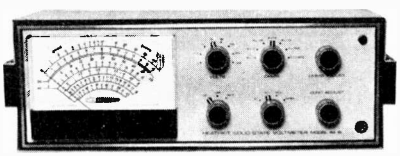
Cabinet walnut veneered **£3.10.0**



Solid-State Volt-ohm-Milliammeter, IM-25

Kit K/IM-25
£48.10.0
P.P. 10/6

9 a.c. and 9 d.c. ranges 150mV up to 1,500V f.s. 7 resistance ranges, 10 ohms centre scale with multipliers ×1, ×10, ×100, ×1k, ×10k, ×100k and ×1Meg. . . . measures from 1 ohm to 1,000Mohms. 11 current ranges from 15μA full scale to 1·5A full scale. 11Mohm input impedance d.c. 10Mohm input impedance a.c. 6″ 200μA meter. Internal battery power or 120/240V a.c. 50Hz supply. PCB construction.



Solid-State Volt-ohm Meter, IM-16

Kit K/IM-16
£28.8.0
P.P. 10/6

8 a.c. and 8 d.c. ranges 0–5V to 1,500V f.s. 7 ohmmeter ranges with 10 ohms centre scale with multipliers ×1, ×10, ×100, ×1k, ×10k, ×100k and ×1Meg. . . . 11Mohm input on d.c., 1Mohm on a.c. Internal battery power or 120/240V a.c. 50Hz supply.

Solid-State Low Voltage Power Supply, IP-27

Kit K/IP-27
£46.12.0
P.P. 10/6

0·5 to 50V d.c. with better than ±15 Millivolts regulation. Four current ranges 50mA; 150mA, 500mA, and 1·5 amperes. Adjustable current limiter: 30 to 100% all ranges. Panel meter for output voltage or current.

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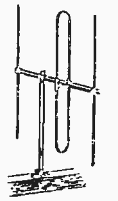

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K12TC—12in. 12 watt
Offers an exceptionally smooth and extended response, with very low level of distortion from the specially designed twin diaphragms.
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Impedance: 15-16 Ohm.
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Model 138: 13" x 8" EMI
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Brand new, p/p 6/6

● BARGAIN — Speakers, HI-Fi — The Baker Selhurst Guitar Group 25, 12in. round, 25 watt rating, 12,000 gauss, 15 ohms, response 30-10,000c/s, solid aluminium chassis, heavy duty cone. **Our price £5.9.6.**
Brand new, p/p 6/6

E.M.I. HI-FI SPEAKERS
SET 450: 13 x 8 with two built-in tweeters and cross-over unit. **Our Price 69/6.** 3 or 15 ohm, 10w, 40-13,000 Hz.
SET 850: 6½" bass plus 3½" tweeter and cross-over unit. 8 ohm, 10w, 65-20,000 Hz. 79/6.
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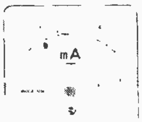


Type MR.52P. 2½in square fronts

50μA	59/6	100mA	37/6	300V a.c.	37/6
50-0-50μA	49/6	500mA	37/6	S Meter 1mA	39/6
100μA	49/6	1 amp.	37/6	VU Meter	59/6
100-0-100μA	45/-	5 amp.	37/6	1 amp. a.c.*	37/6
500μA	42/6	10V d.c.	37/6	5 amp. a.c.*	37/6
1mA	37/6	20V d.c.	37/6	10 amp. a.c.*	37/6
5mA	37/6	50V d.c.	37/6	20 amp. a.c.*	37/6
10mA	37/6	300V d.c.	37/6	30 amp. a.c.*	37/6
50mA	37/6	15V a.c.	37/6		

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

50μA	37/6	750mA	25/-
50-0-50μA	35/-	1 amp	25/-
100μA	35/-	2 amp	25/-
100-0-100μA	32/6	5 amp	25/-
200μA	32/6	3V d.c.	25/-
500μA	37/6	10V d.c.	25/-
500-0-500μA	25/-	20V d.c.	25/-
1mA	25/-	50V d.c.	25/-
1-0-1mA	25/-	100V d.c.	25/-
2mA	25/-	150V d.c.	25/-
5mA	25/-	300V d.c.	25/-
10mA	25/-	500V d.c.	25/-
20mA	25/-	750V d.c.	25/-
50mA	25/-	15V a.c.	25/-
100mA	25/-	50V a.c.	25/-
150mA	25/-	150V a.c.	25/-
200mA	25/-	300V a.c.	25/-
300mA	25/-	500V a.c.	25/-
500mA	25/-	S meter 1mA	29/6
		VU meter	39/6

Type MR.45P. 2in square fronts

50μA	42/6	10V d.c.	27/6
50-0-50μA	39/6	20V d.c.	27/6
100μA	39/6	50V d.c.	27/6
100-0-100μA	35/-	300V d.c.	27/6
500μA	29/6	15V a.c.	27/6
1mA	27/6	300V a.c.	27/6
5mA	27/6	S meter 1mA	35/-
10mA	27/6	VU meter	42/6
50mA	27/6	1 amp a.c.*	27/6
10mA	27/6	5 amp. a.c.*	27/6
500mA	27/6	10 amp. a.c.*	27/6
1 amp.	27/6	20 amp. a.c.*	27/6
5 amp.	27/6	30 amp. a.c.*	27/6

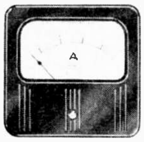
Type MR.85P. 4¼in × 4¼in fronts

50μA	69/6	15 amp.	49/6
50-0-50μA	59/6	30 amp.	49/6
100μA	59/6	20V d.c.	49/6
100-0-100μA	59/6	50V d.c.	49/6
200μA	55/-	150V d.c.	49/6
500μA	52/6	300V d.c.	49/6
500-0-500μA	49/6	150V a.c.	49/6
1mA	49/6	300V a.c.	49/6
1-0-1mA	49/6	S Meter 1mA	55/-
5mA	49/6	VU meter	69/6
10mA	49/6	1 amp. a.c.*	49/6
50mA	49/6	5 amp. a.c.*	49/6
100mA	49/6	10 amp. a.c.*	49/6
500mA	49/6	20 amp. a.c.*	49/6
1 amp.	49/6	30 amp. a.c.*	49/6
5 amp.	49/6		

Type MR.65P. 3½in × 3¼in fronts

50μA	65/-	50V d.c.	39/6
50-0-50μA	52/6	150V d.c.	39/6
100μA	52/6	300V d.c.	39/6
100-0-100μA	49/6	15V a.c.	39/6
500μA	45/-	50V a.c.	39/6
1mA	39/6	150V a.c.	39/6
5mA	39/6	300V a.c.	39/6
10mA	39/6	500V a.c.	39/6
50mA	39/6	S meter 1mA	45/-
100mA	39/6	VU meter	65/-
500mA	39/6	50mA a.c.*	39/6
1 amp.	39/6	100mA a.c.*	39/6
5 amp.	39/6	200mA a.c.*	39/6
10 amp.	39/6	500mA a.c.*	39/6
15 amp.	39/6	1 amp. a.c.*	39/6
20 amp.	39/6	5 amp. a.c.*	39/6
30 amp.	39/6	10 amp. a.c.*	39/6
50 amp.	39/6	20 amp. a.c.*	39/6
10V d.c.	39/6	30 amp. a.c.*	39/6
20V d.c.	39/6		

BAKELITE PANEL METERS

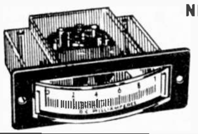


*Moving iron, all others moving coil.

Type MR.65. 3½in square fronts

25μA	67/6	500mA	32/6	30V a.c.*	32/6
50μA	45/-	1 amp.	32/6	50V a.c.*	32/6
50-0-50μA	42/6	5 amp.	32/6	150V a.c.*	32/6
100μA	42/6	15 amp.	32/6	300V a.c.*	32/6
100-0-100μA	42/6	30 amp.	32/6	1 amp. a.c.*	32/6
500μA	39/6	50 amp.	32/6	5 amp. a.c.*	32/6
1mA	32/6	5V d.c.	32/6	10 amp. a.c.*	32/6
1-0-1mA	32/6	10V d.c.	32/6	20 amp. a.c.*	32/6
5mA	32/6	20V d.c.	32/6	30 amp. a.c.*	32/6
10mA	32/6	50V d.c.	32/6	50 amp. a.c.*	32/6
50mA	32/6	150V d.c.	32/6	VU meter	59/6
100mA	32/6	300V d.c.	32/6		

NEW RANGE OF "SEW" EDGEWISE METERS



MODEL PE70. Dimensions 3 17/32 × 1 11/32 × 2¾ deep overall. Available as follows:

50 microamp	57/6	500 microamp	49/6
50–0–50 microamp	55/-	1 milliamp	45/-
100 microamp	55/-	300V a.c.	45/-
100-0-100 microamp	52/6	VU meter	62/6
200 microamp	52/6	Post extra	

ECHO HS-606 STEREO HEADPHONES

Wonderfully comfortable. Lightweight adjustable vinyl headband. 6ft. cable and stereo jack plug. 25–17,000 cps. 8 ohm imp. 67/6 P. & P. 2/6.

TRANSISTORISED TWO-WAY TELEPHONE INTERCOM

Operative over amazingly long distances. Separate call and press to talk buttons, 2-wire connection. 1000's of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets. £6.19.6. P. & P. 3/6.

AUTO TRANSFORMERS

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

150 W.	£1.12.6,	P. & P. 3/6
300 W.	£2.7.6,	P. & P. 3/6
500 W.	£3.10.0,	P. & P. 6/6
1,000 W.	£5.10.0,	P. & P. 7/6
1,500 W.	£6.10.0,	P. & P. 8/6
3,000 W.	£7.10.0,	P. & P. 12/6
7,500 W.	£15.10.0,	P. & P. 20/-

SINCLAIR EQUIPMENT

Z12 12 watt amplifier, 89/6
PZ4 Power Supply Unit 89/6
Stereo 25 Preamp., £9.19.6
Q14 Speakers, £7.19.6
Micromatic Radio Kit, 49/6. Built 59/6
ALL POST PAID

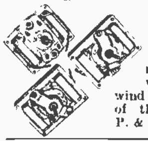
SPECIAL OFFER

Two Z12 Amps., PZ4 Power Supply, Stereo 25 Preamplifier, £22, or with two Q14 speakers, £37.

NEW SINCLAIR 2000 SYSTEM

35 watt Integrated Amplifier £29. Carr. 5/-
Self powered F.M. Tuner. £25. Carr. 5/-

GARRARD TAPE MOTORS

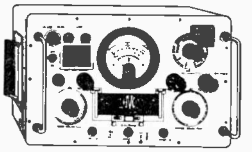


Brand new stock as used by famous manufacturer. 200/250V a.c. Capstan motor 15/-. Fast Forward 10/6, Fast Rewind 10/6. P & P. 3/-. Set of three motors 32/6. P. & P. 5/-.

FIELD TELEPHONES TYPE L

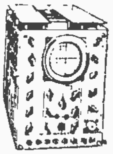
Generator ringing, metal cases. Operates from two 1·5v. batteries (not supplied). Excellent condition. £4.10.0 per pair. Carr. 10/-.

AVO CT.38 ELECTRONIC MULTIMETERS



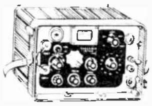
High quality 97 range instrument which measures a.c. and d.c. Voltage, Current, Resistance and Power output. Ranges d.c. volts 250mV–10,000V. (10megΩ–110megΩ input). D.c. current 10μA–25 amps. Ohms: 0–1,000megΩ. A.c. volt 100mV–250V (with RF measuring head up to 250Mc/s). A.c. current 10μA–25 amps. Power output 50 micro-watts–5 watts. Operation 0/110/200/250V. C. Supplied in perfect condition complete with circuit lead and RF probe £25. Carr. 15/-.

TYPE 13A DOUBLE BEAM OSCILLOSCOPES



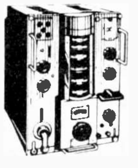
An excellent general purpose D/B oscilloscope. T.B. 2c/s–750 kc/s. Bandwidth 5·5 Mc/s. Sensitivity 33mV/CM. Operating voltage 0/110/200/250V a.c. Supplied in excellent working condition. £22.10.0. Or complete with all accessories, probe, leads, lid, etc. £25. Carriage 30/-.

AM/FM SIGNAL GENERATORS



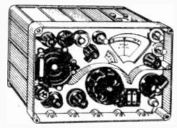
Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airmec. Frequency coverage 20–80Mc/s. AM/C.W./FM. Incorporates precision dial, level meter, precision attenuator 1μV-100mV. Operation from 12V d.c. or 0/110/200/250V a.c. Size 12 × 8½ × 9in. Supplied in brand new condition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

ADMIRALTY B.40 RECEIVERS



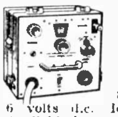
Just released by the Ministry. High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 650kc/s – 30Mc/s, I/F 500 kc/s. Incorporates 2 R.F. and 3 I.F. stages, band-pass filter, noise limiter, crystal controlled B.F.O., calibrator I/F, output, etc. Built-in speaker, output for phones. Operation 150/230V a.c. Size 19¼ × 13½ × 16in. Weight 114lb. Offered in good working condition, £22.10.0. Carr. 30/-. A few available Brand New £35, Carr. 30/-. With circuit diagrams. Also available B.41 L.F. version of above 15kc/s–700kc/s. £17.10.0 Carr. 30/-.

R209 MK. II COMMUNICATION RECEIVER



11 valve high grade communication receiver suitable for tropical use. 1·20 Mc/s on 4 bands. AM/CW/FM operation. Incorporates precision vernier driver, BFO. Aerial trimmer, internal speaker and 12 v. D.C. internal power supply. Supplied in excellent condition, fully tested and checked. £15. Carr. 20/-.

CLASS D WAVEMETERS

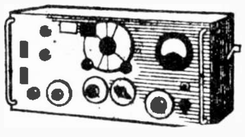


A crystal controlled heterodyne frequency meter covering 1·7–8Mc/s. Operation on 6 volts d.c. Ideal for amateur use. Available in good used condition £5.19.6. Carr. 7/6. Or brand new with accessories £7.19.6. Carr. 7/6.

TE-16A TRANSISTORISED SIGNAL GENERATOR

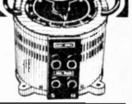
5 Ranges 400 KHZ–30 MHZ. An inexpensive instrument for the handyman. Operates on 9V battery. Wide, easy to read scale. 800 KHZ modulation. 5¼" × 3½". Complete with instructions and leads. £7.19.6. P. & P. 4/-.

MARCONI TEST EQUIPMENT



EX-MILITARY RECONDITIONED.
TF 144G STANDARD SIGNAL GENERATORS, 85kc/s–25 Mc/s, £25, carr. 30/-. TF.885. VIDEO OSCILLATOR. 0·5Mc/s, £45. Carr. 30/-. T.F. 195M. BEAT FREQUENCY OSCILLATOR 0–40kc/s, 200/250V a.c. £20, carr. 30/-. TF.142E. Distortion Factor Meter, £20, carr. 20/-. All above offered in excellent condition fully tested and checked. TF. 1100 VALVE VOLTMETER, Brand New, £50. T.F. 1267 TRANSMISSION TEST SET, Brand New, £75. TF.1371. Wide Band Millivolt Meter, £50.

Variable Voltage TRANSFORMERS



Brand new, guaranteed and carriage paid.
High quality construction. Input 230V 50-60 cycles.
Output full variable from 0-260V. Bulk quantities available.
1 amp.—£5.10.0; 2.5amp.—£6.15.0; 5 amp.—£9.15.0;
8 amp.—£14.10.0; 10 amp.—£18.10.0; 12 amp.—£21; 20 amp.—£37.

ADVANCE TEST EQUIPMENT

Brand new and boxed in original sealed cartons

VM76. VALVE VOLTMETER
R.F. measurements in excess of 100Mc/s and d.c. measurements up to 1,000V with accuracy of ±2%. D.c. range 300mV to 1kV. A.c. range 300mV to 300V RMS. Resistance 0.02–500MΩ. Price £72.

VM78. A.C. MILLIVOLT METER
Transistorised. 1mV to 300V. Frequency 1c/s to 1Mc/s. Price £55.

VM79. UHF MILLIVOLT METER
Transistorised. A.c. range 10mV to 3V. D.c. current range 0.01 μ/A to 0.3mA. Resistance 1 ohm to 10 megohms. £125.

H1B. AUDIO SIGNAL GENERATOR
15c/s to 50kc/s, sine or square wave. Price £30.

J1B. AUDIO SIGNAL GENERATOR
15c/s to 50kc/s. Price £30.

J22B. AUDIO SIGNAL GENERATOR
As per JIB except fitted with output meter. £35.

TT1S. TRANSISTOR TESTER
£37.10.0.

Carriage 10/- per item.

AMERICAN TAPE

First grade quality American tapes Brand new. Discount on quantities.

3in., 225ft. L.P. acetate	3/6
3¼in 600ft. T.P. mylar	10/-
5in. 600ft. std. plastic	8/6
5in. 900ft. L.P. acetate	10/-
5in. 1,200ft. D.P. mylar	15/-
5in. 1,800ft. T.P. mylar	32/6
5¾in. 1,200ft. L.P. acetate	12/6
5¾in. 1,200ft. L. P. mylar	16/-
5¾in. 1,800ft. D.P. mylar	22/6
5¾in. 2,400ft. T.P. mylar	39/6
7in. 1,200ft. std. acetate	12/6
7in. 1,800ft. L.P. acetate	15/-
7in. 1,800ft. L.P. mylar	20/-
7in. 2,400ft. D.P. mylar	25/-
7in. 3,600ft. T.P. mylar	45/-

Postage 2/-, Over £3 post paid.

TAPE CASSETTES

C60-60 mins. 10/3. C90-90 mins. 14/3.
Over £2 post paid.

G. W. SMITH & CO. (RADIO) LTD.
3-34 Lisle St., W.C.2
Also see oppos. page

MULTIMETERS *for EVERY purpose!*

LAFAYETTE DE-LUXE 100 KΩ/VOLT "LAB TESTER"

Giant 6½in. scale. Built-in meter protection. 0/·5/2·5/10/50/250/500/1,000V d.c. 0/3/10/50/250/500/1,000V a.c. 0/10/100μA/10/100/500 MA/2·5/10A. 0/1K/10K/100K/10M/10MΩ. —10 to 49·4dB **£18.18.0.** P. & P. 5/-.

LAFAYETTE 57 Range Super 50,000 O.P.V. Multimeter. D.c. Volts 125V-1000V. A.c. Volts 1.5V-1000V. D.c. Current 25μA-10 Amp. Ohms. 0-15 MegΩ. dB. —20 to +81dB. Overload Protection. **£12.10.0.** Carr. 3/6.

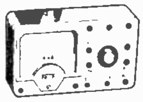
NEW MODEL 500.30,000 O.P.V. with overload protection. Mirror scale. 0/0·5/2·5/10/25/100/250/500/1,000V. d.c. 0/2·5/10/25/100/250/500/1,000V. a.c. 0/50μA/5/50/500mA. 12 amp. d.c. 0/60/K6. Meg./60megohm **£8.17.6.** Post paid.

MODEL TE-90 50,000 O.P.V. MIRROR SCALE OVERLOAD PROTECTION 0/3/12/60/300/600/1,200V d.c. 0/6/30/120/300/1,200V d.c. 0·03/6/60/600MA d.c. 16kΩ/160kΩ/1·6/16MΩ. —20 to +63dB. **£7.10.0.** P. & P. 3/-.

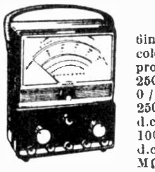
MODEL TE-12. 20,000 O.P.V. 0/0·6/30/120/600/1,200/3,000/6,000V. d.c. 1/6/30/120/600/1,200V. a.c. 0/60μA/6/60/600MA. 0/6K/600K/6meg./60. Megohm 50PF. 2 MFD **£5.19.6.** P. & P. 3/6.

MODEL TE 80. 20,000 O.P.V. 0/10/50/100/500/1,000V. a.c. 0/5/25/50/250/500/1,000V. d.c. 0-50μA. 5/50/500mA. 0/6K/60/K/600K/6 Meg. **£4.17.6.** P. & P. 3/-.

MODEL PT-34. 1,000 O.P.V.0/10/50/250/500/1,000V. a.c. and d.c. 0/1/100/500 mA. d.c. 0/100 KΩ **39/6.** P. & P. 1/6.

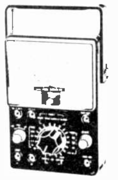


TE-900 20,000Ω VOLT GIANT MULTIMETER

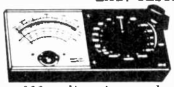


6in. full view meter. 2 colour scale, overload protection. 0/2·5/10/250/1,000/5,000V a.c. 0/25/12·5/10/50/250/1,000/5,000V d.c. 0/50μA/110/100/500mA 10A d.c. 20K/200K/20 MΩ. **£15.** P. & P. 5/-.

MODEL AS-100D. 100KΩ/VOLT 5in., mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1,200V. d.c. 0/6/30/120/300/600V. a.c. 0/10μA/6/60/300MA/12 Amp. 0/2K/200K/2M/200MΩ. —20 to +17dB. **£12.10.0.** P & P. 3/6.



PROFESSIONAL 20,000 O.P.V. LAB. TESTER



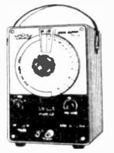
Automatic overload protection, mirror scale. Ranges: 1/10/50/250/500/1,000 volts, d.c. and a.c. 0-500μA, 10mA, 250mA. Current: 0/20K, 200K. 2 megohm. Decibels: —20 to +22dB, **£5.19.6.** P. & P. 2/6.

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/16megohm. **£5.10.0.** P. & P. 3/-.

MODEL TE-10A. 200kΩ Volt, 5/25/50/250/500/2,500 V. d.c. 10/50/100/500/1,000V. a.c. 0/50μA/2·5 mA./250 mA. d.c. 0/6K/6 megohm. —20 to +22dB. 10-0, 100 mfd. to 0·100-0·1 mfd. **69/6.** P. & P. 2/6.

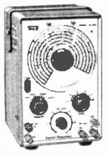
MODEL ZQM TRANSISTOR CHECKER It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec. A: 0·7-0·9967. B: 5-200. Ico: 0-50 microamps 0-5mA. Resistance for diode 200Ω-1MΩ. Supplied complete with instructions, battery and leads. **£5.19.6.** P.&P. 2/6.

TY75 AUDIO SIGNAL GENERATOR



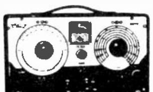
Sine Wave 20c/s to 200kc/s. Square Wave 20c/s to 30kc/s. High and low impedance output. Output variable up to 6 volts. 220/240 volts a.c. Size 210 × 150 × 120mm. Brand new with instructions. **£16.** Carr. 7/6.

TE-20D RF SIGNAL GENERATOR



Accurate wide range signal generator covering 120kc/s to 500Mc/s on 6 bands. Directly calibrated. Variable RF attenuator, audio output. Xtal socket for calibration. 220/240V a.c. Size 140 × 215 × 170mm. Brand new with instructions. **£15.** Carr. 7/6.

ARF-100 COMBINED AF-RF SIGNAL GENERATOR



AF. SINE WAVE 20 - 200,000c/s. Square wave 20—30,000 c/s. O/P. **HIGH IMP.** 21V P/P 600Ω 3·8V P/P. TF. 100kc/s-300 Mc/s. Variable R.F. attenuation int/ext. modulation. Incorporates dual purpose meter to monitor AF. output and % mod. on R.F. 220/240V a.c. **£30.0.0.** Carr. 7/6.

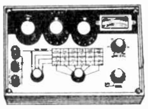
TE-65 VALVE VOLTMETER

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. **£17.10.0.** P. & P. 6/-. Additional Probes available: R.F. **35/-.** H.V. **42/6.**

AVOMETERS

Supplied in excellent condition, fully tested and checked. Complete with prods, leads and instructions. Model 7 **£13.10.0.** P. & P. 7/6.

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



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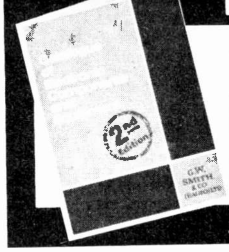

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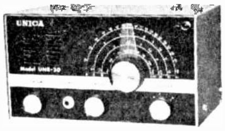

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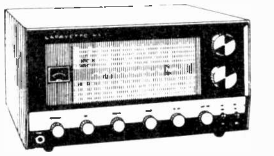

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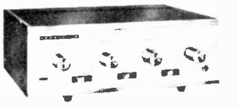

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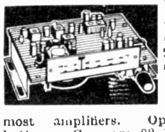

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VOL. 5 No. 3
March 1969

PRACTICAL ELECTRONICS

TECHNICALLY ECLIPSED

TECHNOLOGICALLY speaking, 1968 went out in a blaze of glory. From the comfort of our fireside chairs, we looked in on the greatest, most amazing live outside broadcast yet. The true measure of the *Apollo 8* achievement has still to register in many minds. But it is clear that electronic technology came through its severest test to date with flying colours. A virtual 100 per cent performance of the electronic systems has been reported. Considering over five million separate electronic parts were involved in the *Apollo 8* space project, this indeed speaks volumes for the order of reliability now attainable when operating under extraordinary arduous conditions.

Sad to say, man's triumphant progress in space contrasts greatly with his impotency in other areas of more direct concern to all. This was dramatically brought home to us in the first weeks of the New Year. Elation changed to downright depression when fog and icy conditions brought calamity to our motorways.

Before disaster returns next winter—on an even larger scale—action ought to be taken to apply some of *our own* native electronic expertise to this problem of driving under extreme weather conditions.

Surely it is by now recognised that modern high speed roads demand sophisticated electronic warning and guidance devices. These aids are just as vital here as the radar, navigation, and communication systems which are mandatory on ships and aircraft. The challenge of fog must somehow be met—whether through simple radars for cars or roadside installations that compute distances between vehicles and provide suitable warning.

Not as alluring or exciting as developing systems for space adventures—but since we are out of *that* race, we could well exert ourselves in winning this "road event".

The Minister of Technology should exhort, demand, and infuse some sense of urgency into the various Research Establishments that come under his sponsorship, as well as promote the required liaison with industry.

Those who appreciate the latent possibilities of electronics must be irritated and thoroughly impatient with the apparent lack of progress in this area. Heaven knows there are plenty of amateur inventors and experimenters of no mean talent who would welcome the chance to have some of the facilities enjoyed by the large staffs of highly qualified workers employed at these Government establishments.

How about some speedy results Mr Minister? After all, we taxpayers do foot the bill. And you can't dismiss this as mere moonshine.

F. E. Bennett—*Editor*

THIS MONTH

CONSTRUCTIONAL PROJECTS

SPECIAL SERIES

GENERAL FEATURES

NEWS AND COMMENT

Our April issue will be published on Friday, March 14

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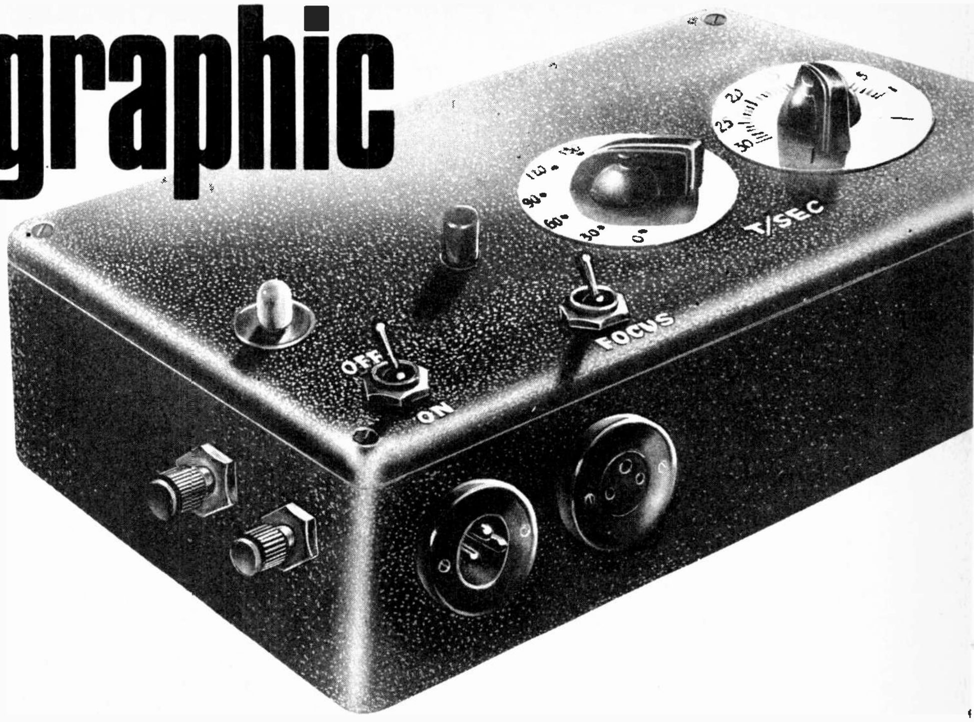
photographic timer



By A.GLOVER

THE small unit to be described in this article has been in use for some time as an enlarging timer. It is reliable, and gives consistent timing accuracy. The capacitor and resistor in the timing circuit are effectively isolated from the remainder of the circuitry, until the neon strikes, therefore the timer accuracy depends mainly upon these components.

Using a tantalum capacitor and high stability resistors a repeatable accuracy of better than five per cent on the full three minutes range is obtained, although this could be further improved by using a stabilised power supply instead of the one shown.

CIRCUIT DESCRIPTION

Fig. 1 shows the general circuit, which, with S1 on, functions as follows: when S3 is pressed the capacitor C1 is placed in series with R2 and the mains rectifier D1 causing this capacitor to be charged rapidly to about 250 volts.

On release of S3 the capacitor is connected across R3 and the relay coil, the relay operates closing contacts RLA2, so connecting the mains to the lamp via RLA1. At the same time, the timing capacitor C3 is disconnected from R11 by contacts RLA3. Capacitor C3 now commences to charge through VR1 and R4 (R6 to R10 being short circuited with S4 in position 1); this charging will continue until the neon strikes at around 75 volts.

When the neon strikes a current pulse is fed through R5 to the base of TR1, causing the transistor to be switched on and hence short circuit the relay coil. The relay de-energises and opens contacts RLA2, removing the mains from the unit.

Capacitor C2 is required to keep TR1 switched on for a longer period than it takes C1 to discharge; without it the relay would just click and leave the unit switched on. The purpose of diode D2 is to absorb the back e.m.f. from RLA which would otherwise appear across TR1 and damage it.

Resistor R4 is a current limiter and so should not be reduced below 1 kilohm. It also gives the minimum timing cycle; in this case approximately 0·1 second which corresponds to five cycles at mains frequency—hardly time for the bulb to reach full brilliance.

The contacts RLA1 are used to switch the external load (lamp); the relay contacts must be capable of carrying the load current and heavy duty contacts are recommended. In the original unit provision is made for switching the lamp on, prior to processing, to set up the focus; this switch (S2) is a normal toggle type capable of switching a current of 5A.

The relay used has a coil resistance of 570 ohms and a nominal operating voltage of 24V. The contacts are rated 5A at 250 volts a.c. Other types of low current relays could be used if the value of R3 is changed, the new value for R3 being given by:

$$R_3 = \frac{(250 - V_r)R_r}{V_r}$$

where V_r and R_r are the relay coil voltage and resistance respectively.

If the relay is rated at more than 24 volts, then a transistor with a higher collector rating will be required, an OC77 or NKT217 being suitable for relays of up to 48 volts.

CONSTRUCTIONAL DETAILS

Construction is quite straightforward and in no way critical as no signal voltages are involved. Most of the smaller components, including the relay, can be mounted on a piece of plain perforated s.r.b.p. using soldering pins. The size of the board used depends on the components, but a basic layout and wiring diagram is shown in Fig. 2. All wiring between the mains input and the load output connectors must be of reasonably substantial wire, capable of passing up to 5A.

Some difficulty may be experienced in obtaining a suitable polarised tantalum capacitor. The one used in

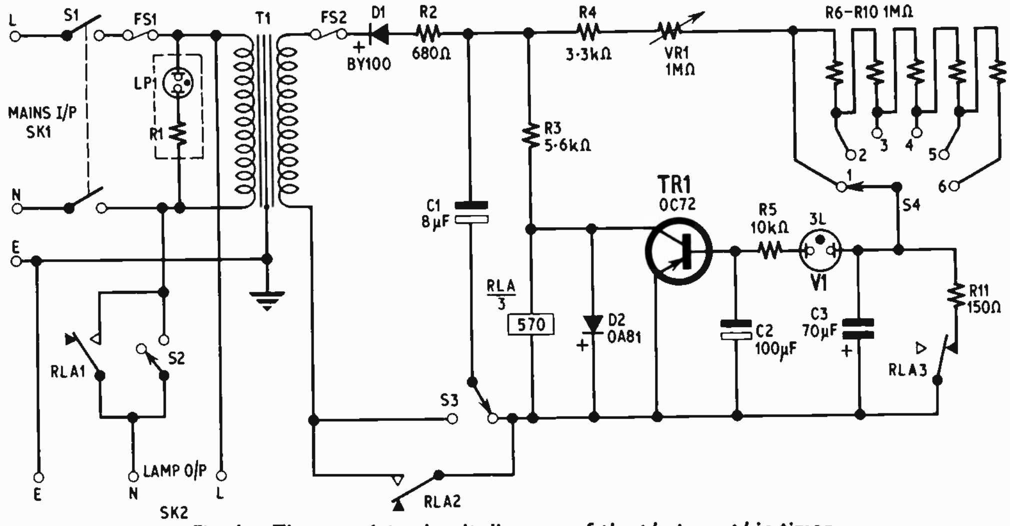


Fig. 1. The complete circuit diagram of the photographic timer

COMPONENTS . . .

Resistors
- R1 270kΩ (may be fitted in LP1)
- R2 680Ω
- R3 5·6kΩ 8W wirewound
- R4 3·3kΩ
- R5 10kΩ
- R6 1MΩ
- R7 1MΩ
- R8 1MΩ (see text)
- R9 1MΩ
- R10 1MΩ
- R11 150Ω

All ±10%, ½W carbon except where stated

Capacitors
- C1 8µF elect. 450V
- C2 100µF elect. 6V
- C3 70µF tantalum 75V (see text)

Semiconductors
- TR1 OC72 (see text)
- D1 BY100, 16MB16
- D2 OA81, WG51

Switches
- S1 Double-pole, on-off toggle (5A at 240V a.c.)
- S2 Single-pole, on-off toggle (5A at 240V a.c.)
- S3 Single-pole, changeover push button, press to change, release to restore
- S4 Two-pole, six-way wafer switch (only one pole used)

Miscellaneous
- T1 Mains transformer; secondary 240V at 100mA
- V1 2L, 70V neon
- LP1 Mains neon indicator (normally includes R1)
- VR1 1MΩ carbon potentiometer
- RLA 24V, 570Ω 3-pole changeover relay heavy duty contacts (see text)
- FS1 3A fuse and holder
- FS2 100mA fuse and holder
- SK1 Mains plug and socket, Bulgin type P340
- SK2 Mains plug and socket, Bulgin type P437

Die-cast metal box (see text) or other case
Two pointer knobs
Plain perforated s.r.b.p. board and soldering pins

the prototype was one of the Plessey "double-high-cap" range; these components are available through some retail suppliers. (List of suppliers will be available from Plessey Components Group, Chemical and Metallurgical Division, Wood Burcote Way, Towcester, Northamptonshire.)

The mains transformer, all switches, fuses, indicators, and potentiometer VR1 are mounted directly to the case which is earthed through the mains input socket. Resistors R6 to R10, which are wired around the wafer of switch S4, should not be mounted until the unit is calibrated, as described later.

A general layout and wiring diagram is given in Figs. 3 and 4; these diagrams show the components mounted in a die-cast metal box measuring 9in × 5in × 2½in but this size will depend on the size of the components used. The pre-wired board is mounted on pillars to prevent short circuits between the terminal pins and the case.

Components LP1, VR1, and all the switches are mounted on the front panel of the case and must be so arranged that they do not touch any components mounted inside the case (see Fig. 4). Leads between components on the front panel and components inside the case must be long enough to facilitate easy removal of the front panel. The input and output connectors used are made by Bulgin, the input connector being of the male type and the output of the female type.

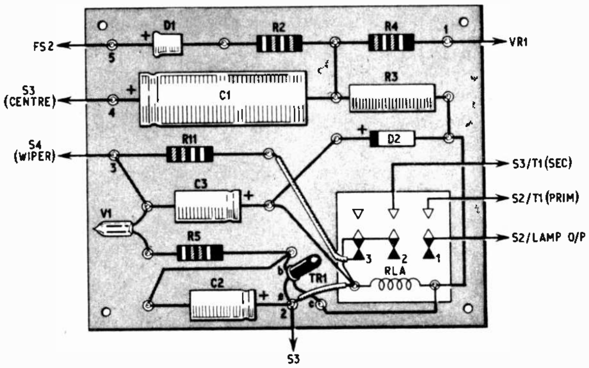


Fig. 2 Layout and wiring of the pre-wired board. All fly leads should be of plastic covered wire

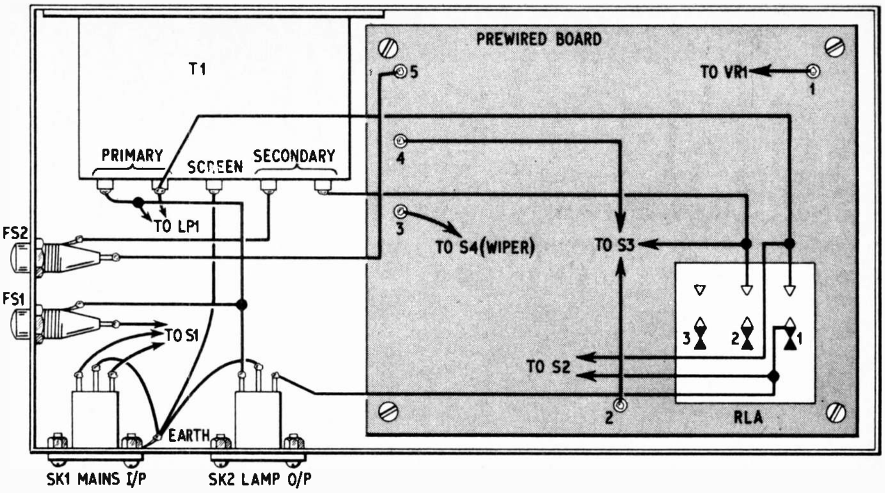


Fig. 3. Layout and wiring diagram of the components mounted inside the metal case. All connections are made with plastics covered wire.

ALTERNATIVE UNIT

It is possible to reduce the cost of this unit and ease construction by employing continuously variable timing. In this case resistors R6 to R10 and switch S4 should be omitted and VR1 connected directly to C3. The timing range, which will then be 30 seconds, could be increased by replacing VR1 with a higher resistance potentiometer, two megohms giving approximately one minute and five megohms approximately two and a half minutes.

Capacitor C3 could be replaced by a $100\mu F$ 100V electrolytic type; this would however reduce the accuracy of the unit on longer timings due to higher leakage current. It would also give different calibration scales.

CALIBRATING THE TIMER

Connect the lamp between the "lamp output" terminals, and connect up the mains supply. Set both timing controls to the lowest position, switch on and depress the start button—the lamp should switch on and off once quickly. Rotate the timing control (VR1) to the opposite end and repeat the procedure, timing the cycle with a stop watch or the second hand of any watch or clock. Time should be between 30 and 40 seconds for one cycle, if it is not then suspect the timing capacitor or VR1, i.e. time low—not enough capacitance, or VR1 is low in value, time high—too much capacitance or VR1 is high.

Place a piece of white card behind the control and, using a stop watch and pencil, calibrate the scale in seconds at five second intervals. Double check on the five and ten second marks, and space, at regular intervals, marks between each five second mark to represent each second. The scale can now be inked in or transferred to some other suitable dial material.

Set the timing switch (S4) to position 2, VR1 to 30 seconds, and connect R6 (1 megohm) temporarily in circuit. Check the timing and, if it is below one minute, connect a small value resistor in series with R5, thus adjusting the value to obtain an interval of exactly one minute. If above one minute the timing can be adjusted by adding a higher value resistor in parallel with R5, or alternatively selecting a suitable 1 megohm resistor to replace R6. Switch to higher ranges and repeat the above procedure to obtain the correct timing for each switch position, i.e. 30, 60, 90, 120 and 150 seconds (plus 30 seconds for each position with VR1 at maximum).

If the unit is used for photographic purposes do not fix it to the enlarger, as pressing the start button on the unit is liable to set up a small vibration in the enlarger column. This vibration will give an "out-of-focus" effect to the prints. ★

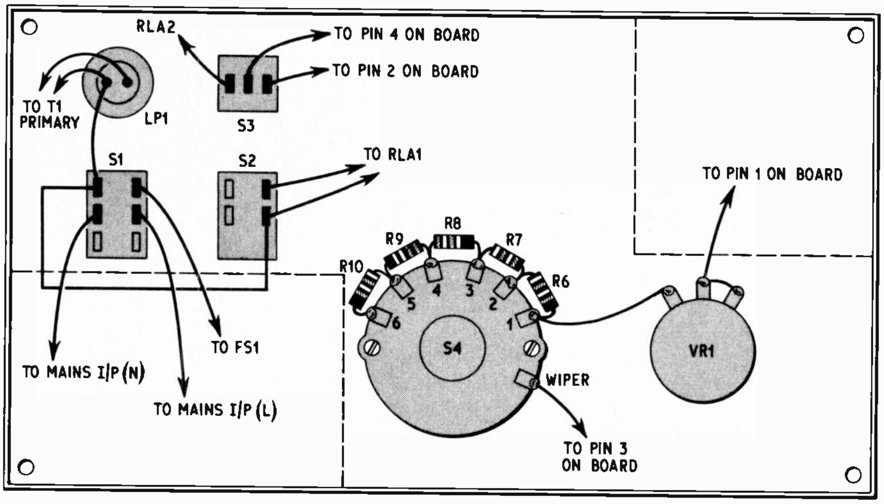


Fig. 4. Layout of components mounted on the front panel. The areas enclosed by the broken lines should be left clear to avoid shorting with the transformer and the relay

MODERN AUDIO CIRCUITS

By F. C. JUDD

SINCE the 1930's audio engineers have devoted a good deal of their knowledge and energy toward producing audio amplifiers with low distortion, low noise and a wide, flat frequency response. Negative feedback paved the way to improvement in frequency response and later, the introduction of low noise amplifier valves like the Mullard EF37, did much toward reducing noise and microphony in high gain pre-amplifier stages.

This trend continued for a time with improved low noise pentodes such as the Mullard EF86 and with special audio frequency triode valves like the ECC83 which were much favoured for tape recorder record and replay pre-amplifiers.

Most audio equipment manufacturers have now "gone over" to transistors, not without problems of course, but with reasonable success even in the realm of hi fi.

In this article a number of practical feedback amplifiers will be described. All of these are high performance audio designs and employ various Mullard *npn* silicon planar epitaxial transistors of the type BC107, BC108 and BC109.

IMPEDANCE TECHNIQUES

A technique now becoming common in transistor audio circuit design is the use of a high input impedance and low output impedance. This enables circuits like those given in this article, to be connected together since they each have the requisite high input and low output impedance for successful cascading. The supply voltage of 18V can be varied within limits of plus or minus 15 per cent without any appreciable change in performance, so that a stabilised voltage supply is not necessary.

A basic amplifier circuit is given in Fig. 1. This will provide voltage gains of 10, 20, 30 and 40dB dependent on the choice of circuit component values. Complete stabilisation is obtained by employing two d.c. feedback loops, one between the emitter of TR2 and the base of TR1 and the other between the collector of TR2 and the emitter of TR1.

The frequency response is uniform between 20 and 20,000Hz and the input and output impedances, although somewhat dependent on the overall gain and the amount of feedback, will be nominally low, from 60 to 700 ohms for the output and high, from 110 to 145 kilohms for the input. The actual input and output impedances together with circuit component values for amplifiers with a gain of 10, 20, 30 or 40dB are given in Table 1.

The distortion for this amplifier is below 0·1 per cent for output voltages up to 1 volt and below 1 per cent for output voltages up to 3 volts. The noise voltage referred to the input is less than 1 microvolt.

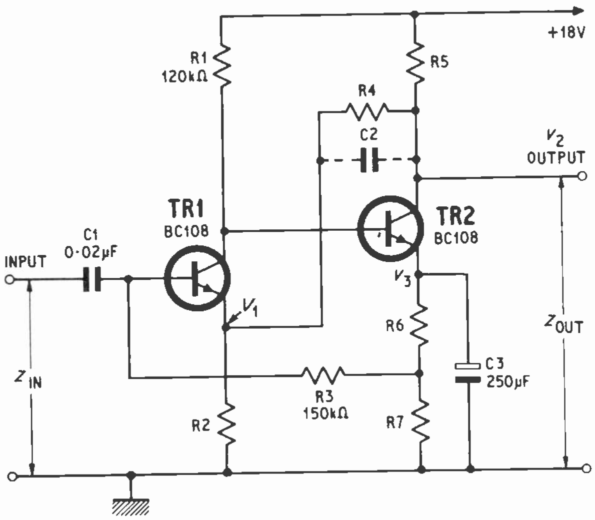


Fig. 1. Basic amplifier circuit

PRE-AMPLIFIERS WITH A SPECIAL FREQUENCY RESPONSE

With two feedback paths available as in Fig. 1 it is conceivable that one could be used for producing special frequency responses such as equalisation for gramophone record reproduction (RIAA) or for reproduction from a tape head (CCIR or NAB). For these applications the equalisation response is obtained by feedback from the collector of TR2 to the emitter of TR1 as in Fig. 2.

Table 1: COMPONENT VALUES AND VOLTAGE READINGS

Gain(dB)	10	20	30	40	Units
R2	4·7	1·5	1·5	1·0	kΩ
R4	12	15	56	180	kΩ
R5	1·8	2·2	2·2	2·2	kΩ
R6	470	560	330	680	Ω
R7	1200	470	270	220	Ω
C2	—	—	—	10	pF
V_1	3·4	0·97	0·4	0·15	V
V_2	10·8	9·3	9·3	9·7	V
V_3	5·6	3·55	2·3	3·4	V
Z_{in}	145	140	135	110	kΩ
Z_{out}	63	140	260	700	Ω

The component values given produce the necessary equalisation for record reproduction (RIAA) via modern low sensitivity magnetic pick-up cartridges as shown in Fig. 3.

The input sensitivity is approximately 3mV for a 60 to 100mV linear output. A twin channel stereo version of this circuit was constructed by the writer expressly for use with low sensitivity magnetic pick-ups and performed as follows:

Input Sensitivity	3mV at 1kHz for 75mV output
Input Impedance	56 kilohms
Output Impedance	10 kilohms
Distortion	Less than 0·2%
Equalisation	RIAA
Noise Level	Better than −60db

BUFFER AMPLIFIERS

The occasion often arises when one has to match a very high impedance device such as a crystal microphone to a comparatively low impedance input. The buffer amplifier circuit given in Fig. 4 has an input impedance of around 3·5 megohms to which a crystal microphone could be connected without loss of low frequency response.

The gain of the amplifier is unity and the output impedance is low. It could therefore be used with the pre-amplifier circuit in Fig. 5. TR1 operates in a common emitter arrangement with a large amount of feedback and with TR2 operating as an emitter follower. The frequency response is from 20 to 20,000Hz and distortion below 0·5 per cent with output voltages up to 2 volts.

VARIABLE GAIN PRE-AMPLIFIERS

The circuit given in Fig. 5 is derived from that given in Fig. 1 and permits a continuous variation in gain between 13 and 40dB. The gain is controlled by VR1 in the TR2 collector to TR1 emitter feedback circuit.

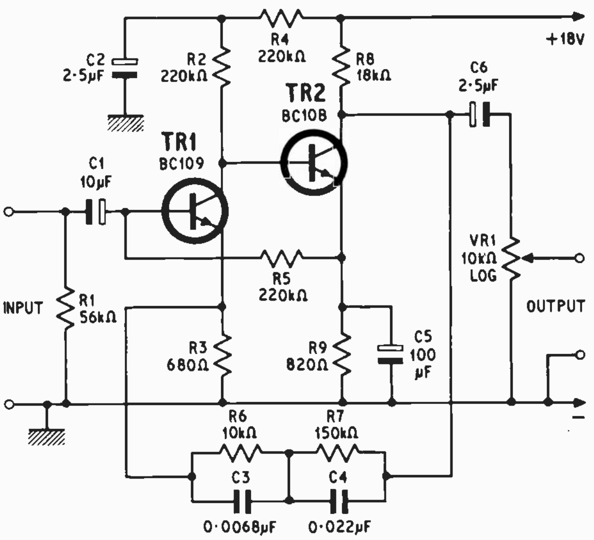


Fig. 2. Circuit for pre-amplifier with RIAA equalisation

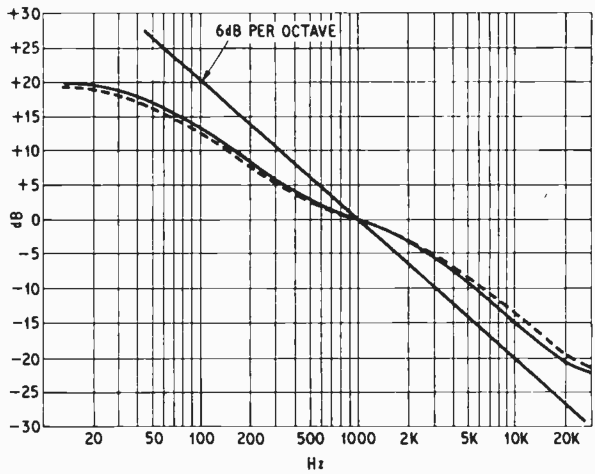


Fig. 3. Response of circuit given in Fig. 2. Dotted line is response for a duplicate of the amplifier, i.e. a second channel for stereo

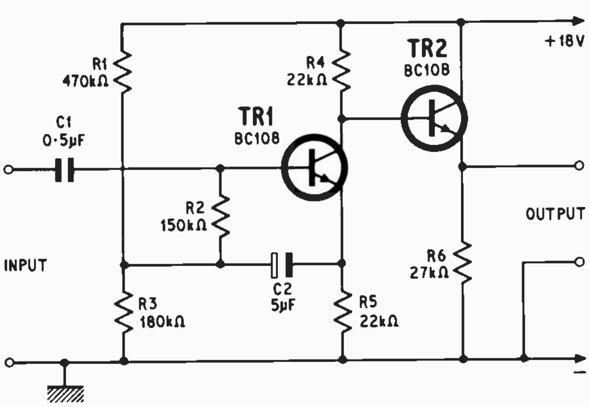


Fig. 4. Buffer amplifier with high impedance (3.6 megohms) input

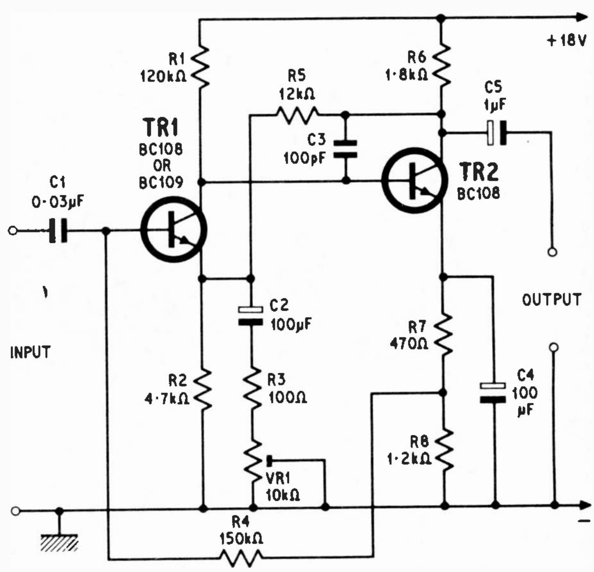


Fig. 5. Signal amplifier with variable gain

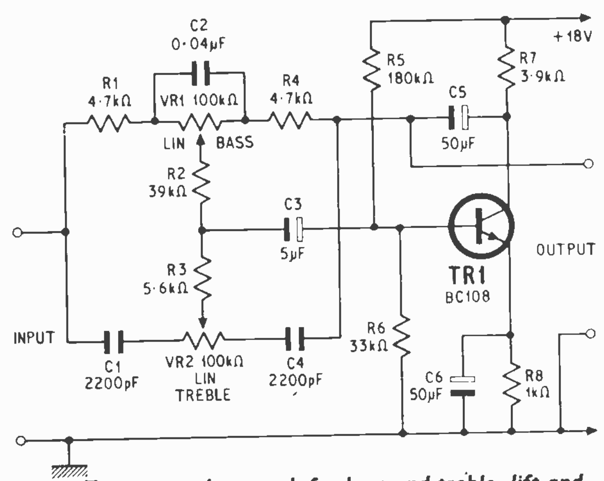


Fig. 6. Tone control network for bass and treble, lift and cut

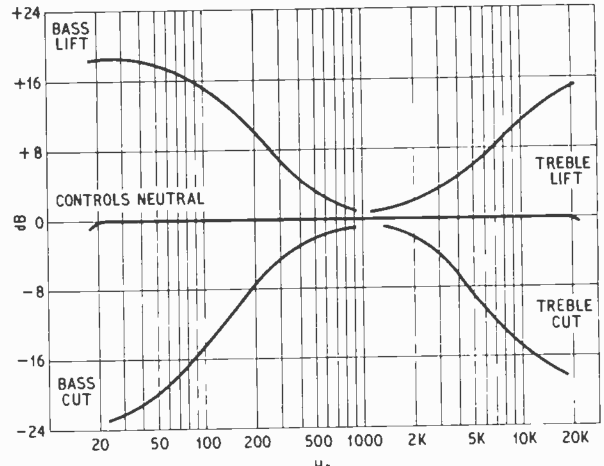


Fig. 7. Frequency response obtainable with the tone control circuit of Fig. 6

For the highest gain (40dB) and an output of 2 volts, the distortion is 0·75 per cent and for the lowest gain (13dB) is 0·1 per cent. Frequency response is from 20 to 20,000Hz within the limits of plus and minus 2dB. The input and output impedances are as follows: Z_{in} for a gain of 13dB = 145 kilohms and for 40dB = 120 kilohms. Z_{out} for a gain of 13dB = 47 ohms and for 40dB = 120 ohms.

A five channel microphone and high level signal mixer designed around this circuit will be described next month.

OTHER APPLICATIONS

The basic circuits given in this article lend themselves to numerous audio applications, some of which will be dealt with in later issues as working items of equipment. For example the buffer amplifier of Fig. 4 can be employed very successfully in an audio high pass/low pass filter with unity gain. The circuit of Fig. 2 can be extended to cover the usual requirements for a hi fi pre-amplifier with inputs for tape head, crystal or magnetic pick-up cartridges and radio tuner, etc.

Yet another application in hi fi pre-amplifier stages is the active tone control network shown in Fig. 6. This is quite different from the usual frequency dependent passive network and operates with a frequency dependent *feedback* network between the collector and base of the transistor.

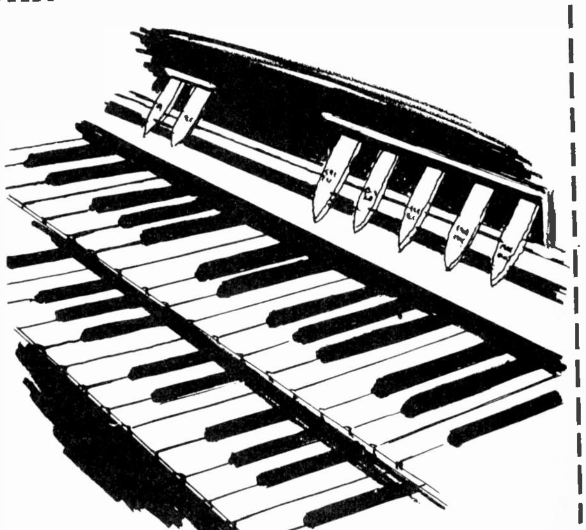
The gain through the amplifier is almost unity and the tone controls provide bass and treble lift and cut as shown in Fig. 7. For an input voltage not exceeding 250mV the total distortion is below 0·1 per cent. The input impedance is 40 kilohms and the output impedance 180 ohms.

ACKNOWLEDGEMENT

The writer would like to thank the applications staff of Mullard Limited for advice on the use of the Mullard transistors type BC107, BC108 and BC109 and for permission to quote from Mullard publications. ★

PRACTICAL ELECTRONICS ORGAN

—an invitation...



Very shortly we shall commence publication of a series of articles describing in full detail the construction of a two manual electronic organ. This instrument has been specially designed and built for Practical Electronics by Alan Douglas.

We believe this design is significantly in advance of any previously offered to the private constructor. But decide for yourself. The Practical Electronics Organ will be demonstrated at the next London meeting of the Electronic Organ Constructors Society, on Saturday, February 22, at St. David's Church Hall, Lough Road, London, N.7 (Two minutes' walk from Caledonian Road Station—Piccadilly Line).

The E.O.C.S. has extended a cordial invitation to P.E. readers to join their own members on this special occasion. The meeting commences at 2.30 p.m.

Further details concerning this forthcoming series will be given in our next issue.

First Manned Lunar Orbit Mission — A Triumph For Technology

by Frank W. Hyde

THE milestones of history cause widely different attitudes in community groups and perhaps it is not therefore surprising that in America complaints about the monitoring of the *Apollo* mission to the moon should have arisen.

The reactions of people to the mission have been as wide as they have been varied. To those who see it from the outside as it were and are responsive to the inevitable emotional reaction of an outstanding achievement, it must rank as one of the important moments of their time and be indelibly printed on their memories.

There have been others whose reaction takes a different direction, some to the point of deriding the whole concept of such projects. The superficial thinking which always surrounds such events indicates how blasé people at large have become after ten years of man in space. To those actively engaged in the projects the excitements of each step keeps alive an enthusiasm that is only tempered by a knowledge of what might be in the future.

MAGNITUDE OF THE ACHIEVEMENT

To engineers and scientists generally (there are some agin' it) the magnitude of the achievement and what is involved in the successful completion of such a mission, all marks a point in the history of technology where planned sequential events integrated with human endeavour shows man's capabilities of using his knowledge of his environment and the physical laws which govern it.

The most vital requirement for the *Apollo 8* mission was a perfect system of communication between the vehicle and the control centre at Houston, Texas. This was achieved without having to use the extensive "back up" systems that had been built into the spacecraft. It had been argued and indeed still is that this extensive use of "redundant" equipment reduces the payload to a considerable extent. While this undoubtedly is so there is perhaps a good reason to suffer this against the possible chance of failure however remote that may be.

COMPUTER PROGRAMME

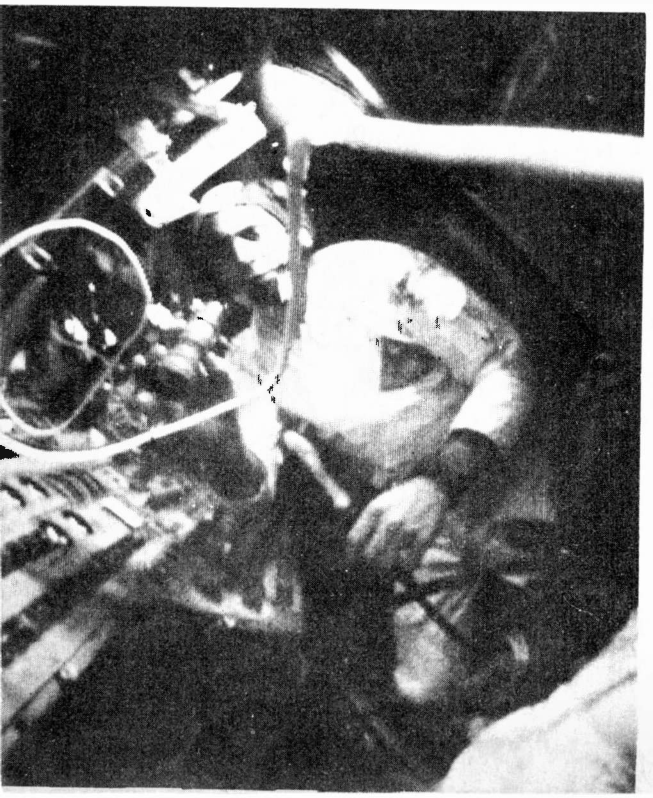
An example of this was the ability of the on-board computer to deal with the essential problems should the ground communication fail. This was called the Colossus programme and is summarised here:

> *launch monitoring; translunar injection monitoring; execute and monitor, mid-course correction manoeuvre, lunar orbit insertion manoeuvre; plan, target and monitor trans-earth injection manoeuvres; re-entry guidance; platform alignment with star sightings; navigation, star horizon sightings, lunar landmark sightings.*

The gains to be had from the mission itself were extensive and did in fact justify the decision to bring forward the programme of missions.

The flight trajectory, the critical points and manoeuvres necessary, and the television broadcasts have already been extensively written up, but these spectacular events are but a small part of the whole. It will take some weeks for all the data to be processed but

Astronaut William Anders checks the telephoto lens for the small television camera aboard the spacecraft some 130,000 miles from Earth on the way to the Moon



some comment can be made on the original programme. This can be summarised under the five following general headings.

NAVIGATION

Under navigation will come the lighting constraints. It is desirable that the lunar landing should be at a time when the lighting on the lunar surface is at a fairly low sun angle. This is required for the onboard computation of the navigational and guidance data to track accurately the targets on the horizons, stars or on the lunar surface. The second requirement is the evaluation of the back-up systems.

COMMUNICATIONS AT LUNAR DISTANCES

Under the heading of communications come all the systems of telemetry which concern the biological data, the interchange of information between ground control and spacecraft at voice levels, telemetry of environmental conditions outside and inside (other than biological) and television.

There are two aerial systems: an omni-directional aerial and the high-gain group of directional aerials. All systems communication is possible with the omni-directional aerial, except television. The high gain aerial system after adjustment operated quite satisfactorily. The blank period of course is the time when the vehicle is behind the moon, for line of sight facility is required for communication. The success of this has demonstrated the efficiency of the electronics involved. The frequencies chosen were in the "unified S-band" and the choice of this band has been entirely justified.

A significant and interesting thing about the television transmissions was the improvement of the standard of the picture when coming from the Madrid terminal via Eurovision as compared with the transmission from Houston via satellite channels.

There is another aspect of the communications dependent on line of sight and that is that in tracking earth orbiting satellites successive tracking stations are brought into operation to keep the satellite within the "beam". In the case of the moon it is far enough out to be in the beam for a longer period, but still the successive tracking is needed because the earth is rotating and compensation has to be made for this in order to keep in the beam.

THERMAL ENVIRONMENT

Temperatures and changes that take place as certain rolling manoeuvres are made to even up the direct effect of the sun's rays were monitored. A number of studies were also programmed to deal with radiation and its effect. One significant feature noticed was the different dosage received by each astronaut which seemed to have a relation to position in the spacecraft.

OPERATIONAL EXPERIENCE

Under the heading of operational experience come those manoeuvres and programming when within the moon's gravity, which will have a direct bearing on lunar landing techniques. Photography as well as direct viewing becomes important here since evaluation of surface features is vital. The stereoscopic mapping was obtained by shooting a series of pictures at an angle of some 20 degrees and the next orbit round a series of vertical shots.

During training the astronauts had made studies of earth sites which might be similar to those on the moon and also they had made an intense classroom study of geology to help in the evaluation. Five principal sites had been chosen for particular observation. The photography dealt with these by using stereo pairs in addition to the close time pairs mentioned above. This will give shots fore and aft and also side to side and will enable future teams to recognise sites as they come up and will of course be very valuable in training.

In addition to these special tasks on the orbiting part of the mission, the approach to the moon was extensively photographed. The importance of this to navigation for future missions is the ability to recognise the changed aspect of the moon when approaching it at several thousand miles per hour when all semblance to the moon as we see it has changed.

The television camera specially designed for these flights operates at 320 lines with a frame speed of ten per second. A telephoto lens was included but it seems that this had been designed for a much lower light level than was encountered and this made the pictures taken of the receding earth useless. Filters later helped this but it will be necessary to wait for the final details on this. There are only three terminals with the facilities to convert the direct television signals to the normal mode and the latest of these is at Madrid.

VERIFICATION

The last programme concerned with the verification of mission planning, computer programmes, and crew procedures has been amply rewarded for all systems worked well.

The power supply units, which incidentally provide the water for the astronauts as a by-product of the fuel cells, worked without trouble this time and the faults shown up on *Apollo 7* did not appear. It is perhaps of importance to remember that some minor modifications were made as a result of experience with *Apollo 7*.

INTO PERSPECTIVE

It may help to bring the magnitude of the *Apollo 8* achievement into perspective from two points of view.

For the first time man has been able to see his own habitat from the point that would be available to a visitor from space. A globe of blue and white which gives little clue, from the distance of the moon, as to its occupants or condition. No indication of whether or not it is inhabited for the cloud cover is extensive. For

Apollo 8's view of the large crater Goclenius (foreground) which is nearly 40 miles from rim to rim. An unusual feature is the rill that crosses the crater rim

the first time an environment that has bounded most direct experience has been left behind by three men who have entered and lived in an entirely different part of the planetary system. The psychological effect of this was evident when an astronaut spoke of "your earth" before correcting himself to "ours too, of course".

The other point of view is the compact and complete unit in which man was able to do this. A small, self-contained unit with not only the means to sustain life but also to send back the conditions of the function of the vehicle and its occupants. This involves the summit of many and varied techniques from cryogenics to recycling units.

Some indication of the extent of the systems involved is given by the twenty or more different services provided for by the power supply which operates basically from fuel cells. The power supply is duplicated and if necessary the spacecraft could have run quite successfully on one unit only.

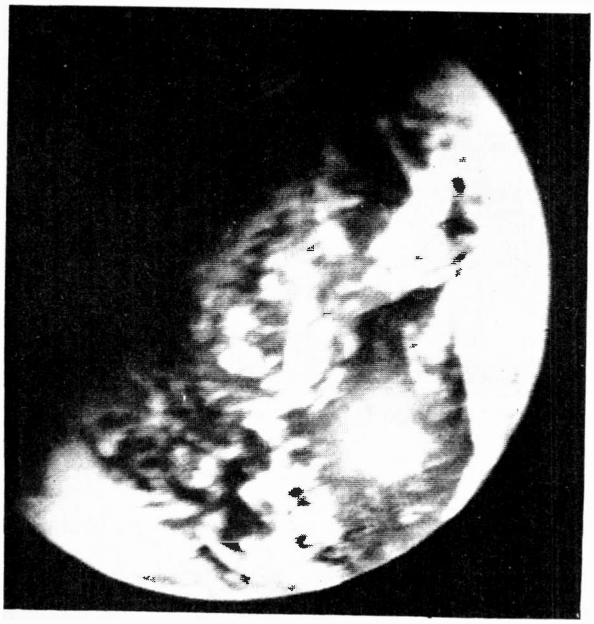
THE AMATEUR ASSISTS

Into this project comes also the amateur. Commander H. Hatfield at Sevenoaks was able to photograph the separation of the third stage rocket. This was a fortunate circumstance since this was one event that was not available to the launching site.

The second amateur connection is the matter of the possible erupting areas of the moon. Some 25 countries were co-operating in keeping a special watch for events during the *Apollo* flight.

Due largely to the activities of Miss Barbara Middlehurst, a world wide network of selected observers was alerted and an arrangement made for direct communication with a telephone at Houston in an attempt to give moment to moment details of observations. It was intended, if it were possible, to ask the crew of the spacecraft to photograph the area. The ground based observers were chosen because of their experience with the special observation of those areas of the moon that the spacecraft would be able to see. ★

View of the Earth, half covered with clouds, from Apollo 8. The photograph was taken when the spacecraft was half-way between the Moon and Earth



BOOK REVIEWS

THE PEGASUS BOOK OF RADIO EXPERIMENTS
By F. G. Rayer A.I.E.R.E., G3OGR
Published by Dobson Books Ltd.
214 pages, 7¾in × 5in. Price 16s

IN this moderately sized book the author covers many radio experiments from the simple crystal receiver through single valve and transistor radio circuits to audio and r.f. amplifiers and more complex receivers. There are 100 diagrams in this book and, although they are not always technically precise or, in a few cases, very clear, these illustrate the electronic principles, the method of construction of the various experimental units and the physical design of the electronic and mechanical components used.

The language used is not over-technical and abbreviations and symbols are explained as are the functions of each part of the circuits. Basic valve and transistor theory is covered and theoretical formulae given for calculations on the circuits. The book explains basic radio principles and lists numerous experiments that can be undertaken by the inexperienced in complete safety for a moderate outlay.

This is not a book for the radio amateur but one for those wishing to learn about simple radio theory and receiver construction. The author, who has written many books both on popular electronics and radio, has achieved a publication which is both informative and interesting and one which should help the newcomer along his first steps in this fascinating and rewarding technical hobby.

M.K.

ITV 1969
Published by the Independent Television Authority
236 pages, 9in × 7in. Price 10s 6d

THIS entirely revised seventh edition of the ITA handbook, besides continuing as an excellent reference on the structure and technical operation of Independent Television in the U.K., has a great deal of its contents devoted to the intended ITV colour service on 625 line u.h.f.

New maps show the estimated coverage for the first seven main u.h.f. stations. Details are also given of the first 26 main stations, expected to be in service before the end of 1971, and of the first 12 relay stations which are likely to be in service by the end of 1970.

To get best reception for these colour service areas choice and siting of aerial installations is important and in this context much useful advice is given.

G.M.H.

P.E. INDEX
An index for volume four (January 1968 to December 1968) is now available price 1s 6d inclusive of postage. Orders for the index should be addressed to the Post Sales Department, IPC Magazines Ltd., Tower House, Southampton Street, London, W.C.2

BINARY ADDER

By A. FORD

A simple educational aid for schools and hobbyists to teach the principles of binary arithmetic as used in modern electronic computing systems

THIS machine will add two binary numbers entirely by switching and display the answer on a bank of lamps. Before describing the machine it may be helpful to give a short explanation of the binary number system. The machine is designed to form a first introduction to computer ideas, and a knowledge of binary notation is essential for this.

PLACE VALUE SYSTEM

Our everyday number system, called the denary or decimal system, is made up of ten different symbols including nought, larger numbers being formed by placing these symbols in different columns. Counting from one, when we reach nine in the "units" column, we start again with a one in the "tens" column, the only function of the nought in 10 being to push the 1 into the next decimal increment column.

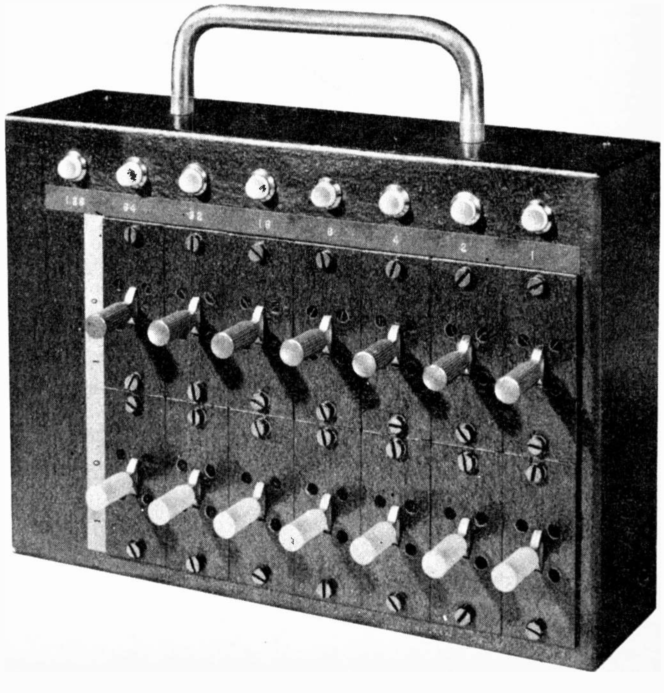
Every number can be analysed in this way; for example 216 means two hundreds, one ten, and six units. This makes our number system a "place value system", where the value of each figure symbol depends upon its position. To see the advantages of a place value number system, one has only to consider calculations in a different notation, the most common example being in Roman numerals. To add eighteen to three hundred and nineteen, using Roman numerals we get: CCCXIX + XVIII.

There is no logical way to set out the sum, and it is almost pointless to write it out at all. The most reliable method of adding would probably be to count in ones; this is what the Romans did, using an abacus. The above sum in denary notation would be arranged like this: 319 + and would be done column by column
18
starting at the right (units). It is important to see clearly the necessity for a place value system for fast calculations before going into binary notation.

ELECTRICAL OR ELECTRONIC SYSTEMS

When the idea of employing electrical or electronic calculating machines began to take shape, it was soon realised that the decimal system with its ten symbols presented some knotty problems. How, for instance, could the number seven be represented by the state of an electric current? One obvious answer is that it could be represented by a voltage of seven at a certain point, but this means that an accurate power source must be available to supply the circuitry with accurate analogues without varying more than a small fraction of one volt. Suppose that the place value system was kept, with different readout points standing for units, tens, hundreds and so on. This would be much better, but an error of a volt in say the thousands column obviously could not be tolerated.

A third method of representing numbers electrically would be by corresponding numbers of pulses, as is used on the telephone dial and uniselector. The disadvantages here is the relatively slow speed and the possibility of a dropped pulse, or an extra pulse introduced accidentally somewhere else in the circuit.



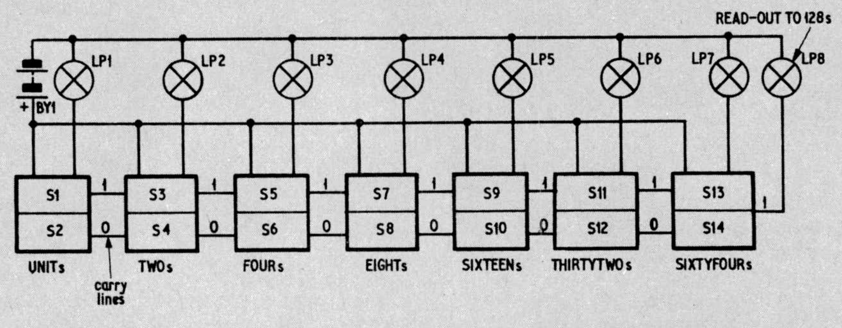


Fig. 1. Block diagram of binary adder with eight digit readout

The most reliable method of representing a number in an electric circuit is to make use of the on-off state of a circuit. In this case, OFF stands for nought and ON stands for one.

BINARY SYSTEM

It is here that the binary number system comes in and solves the problem. This can also work by place value, but has only two digits, one and nought, which can be represented electrically by ON and OFF. The system works in columns, but these are in multiples of two; units, twos, fours, eights, and so on.

Nine is the maximum number that can be shown in one column in the decimal system, and so one is the maximum for the binary system, after which carrying occurs. Study of the following table will make this clear.

Denary (decimal)		Binary
1	=	1
2	=	10
3	=	11
4	=	100
5	=	101
6	=	110
7	=	111
8	=	1000

It would appear to be nonsense to read binary numbers out as though they were decimals. The binary for eight is not "a thousand", it is read as one, nought, nought, nought. The system can be grasped easily if one remembers that the columns are units, twos, fours, eights, etc. Thus, the binary 110010 means one "two", one "sixteen", and one "thirty-two" (in denary terms fifty, since each column is added).

Changing from decimal to binary takes a little longer. To do this, factorise by two, showing at each step a remainder either of nought or one, until you are left with nought or one, for example take 20:

2 |20
2 |10 + 0 over
2 |5 + 0 over
2 |2 + 1 over
1 + 0 over

Then gather up the final figure and the remainders, and write them out from the bottom up, starting with the final figure, i.e. the binary 10100 = 16 + 0 + 4 + 0 + 0 = 20 (denary).
The next example is 56:

2 |56
2 |28 + 0 over
2 |14 + 0 over
2 |7 + 0 over
2 |3 + 1 over
1 + 1 over

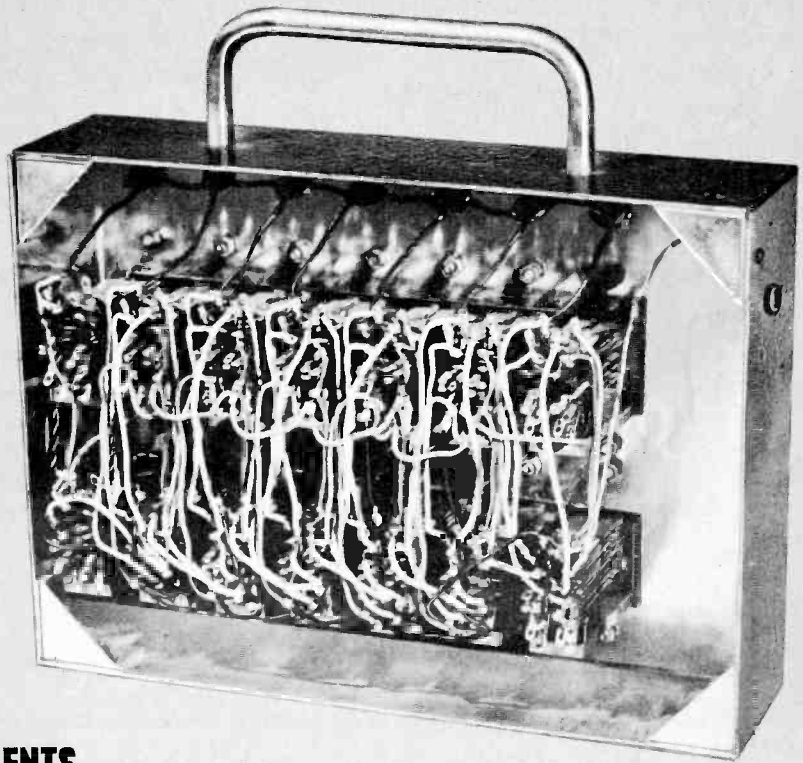
Therefore the binary number 111000 =
32 + 16 + 8 + 0 + 0 + 0 = 56.

Naturally, in a full-sized computer, these conversions are done automatically.

OPERATION

The following part of the article describes a switching device that is simple to build and operate for illustrating binary arithmetic. In computer terminology it consists of one half-adder and a number of full-adders. A half-adder deals with two quantities of either one or nought, and produces a result and a carrying figure. A full-adder deals with three quantities—the two numbers to be added and the "carry" from the previous column.

Each section of the circuit consists of two switches (Fig 1) and a "readout" lamp. To add two binary numbers the switches on each row are set to the number configurations (up for nought and down for one); the lights then give the added figure (off for nought and on for one). The machine adds two binary numbers of up to seven "bits" each (a binary digit is called a bit); units could be constructed to handle smaller or larger amounts since the intermediate switching circuits are identical.



COMPONENTS . . .

S1 to S14	4-pole, 2-way, keyswitch (14 off)
LP1 to LP8	Pilot lamp 6V, 100mA (8 off)
BY1	6V lantern battery
Chassis :	10in × 7in × $2\frac{1}{2}$in
Instrument handle 4in	

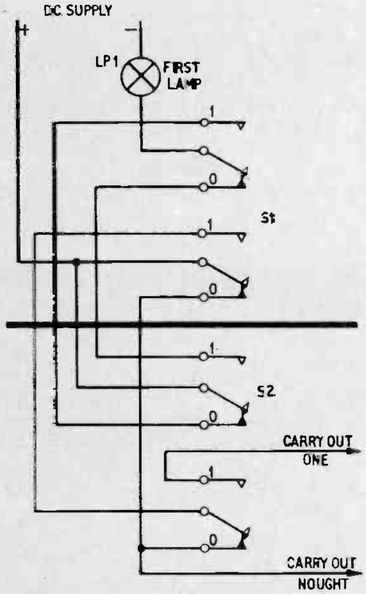


Fig. 2. The "units" column is a half-adder with carry "out" lines

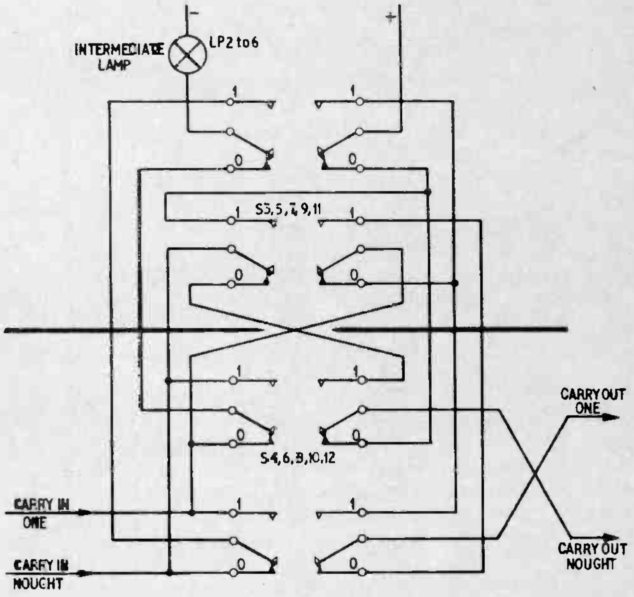


Fig. 3. Intermediate stages from the "twos" column to the penultimate stage are full adders with carry "in" and carry "out" lines

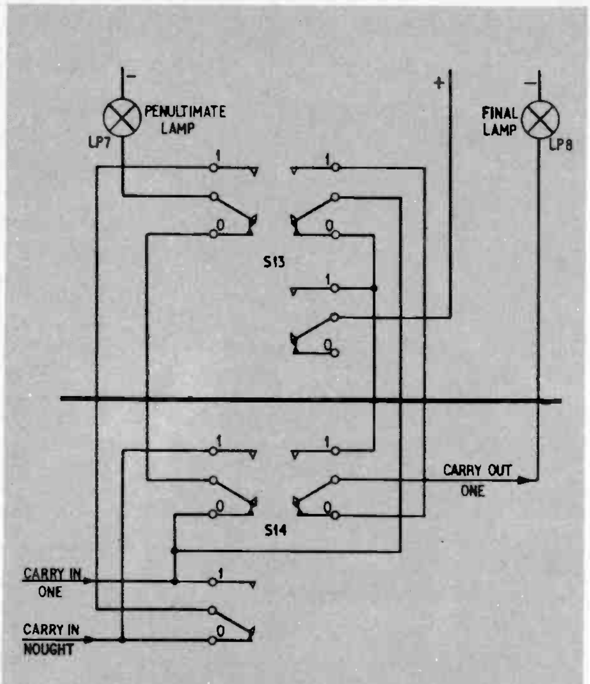


Fig. 4. The final stage displays the penultimate and final digits of the answer

CONSTRUCTION

The adder is built around a number of Post Office style key switches which are ideal for the purpose. These can be expensive items, but the constructor may be able to come across a cheap source on the surplus market. It is sometimes possible to strip them from certain ex-government units. Alternatively, fourteen rotary wafer switches, each switch being 6-pole 2-way, could be used; only four poles would be required on each water.

The lamps used are panel indicators rated at 6 volts 100 mA, but any type would do if they are all the same as the battery voltage. The unit was built into a 10in × 7in × 2½in chassis, stood on its side and fitted with an instrument handle. Two rows of rectangular holes were cut in the chassis to admit the keyswitches, a row of small holes for the lamps being the only other drilling required. A 6 volt lantern battery can be housed in the chassis and this provides the power for the lamp circuits. Drilling measurements are not given because these will depend on the type of switches and lamps used.

CIRCUIT WIRING

A block diagram is shown of the prototype (Fig. 1), and the circuit for each "column" shown in Figs. 2, 3, and 4. Any version of the adder must incorporate the circuits of the first bit (half-adder Fig. 2) and the last bit (Fig. 4). Any number of intermediate bits may be incorporated between these two, these being full-adders. To avoid confusion in the wiring, use several different colours, to identify certain parts of the circuitry. One wrong connection will certainly produce wrong answers. Finally, paint the chassis with at least two coats of plain or hammer finish paint or cellulose, and label the lamps and switches. ★

NEWS BRIEFS

Calling All Young Scientists

THE British Association for the Advancement of Science has now formed two sections specially for young members between the ages of 12 and 18. The new sections will be known as the British Association of Young Scientists or BAYS for short (covering the age group 15 to 18) and Junior BAYS (covering the age group of 12 to 15).

The aim is to stimulate, inform and give guidance to young "would-be" scientists, mostly schoolboys and schoolgirls, through films, lectures, meetings and exhibitions on all forms of research and developments in the fields of science.

As the BAYS organisation develops, it is hoped to provide opportunities to take part in national and international scientific activities, including science tours and other events in foreign countries.

Full details on how to become a member of BAYS can be obtained from the British Association for the Advancement of Science, 3, Sanctuary Buildings, 20, Great Smith Street, London, S.W.1.

Advanced Standard Converter

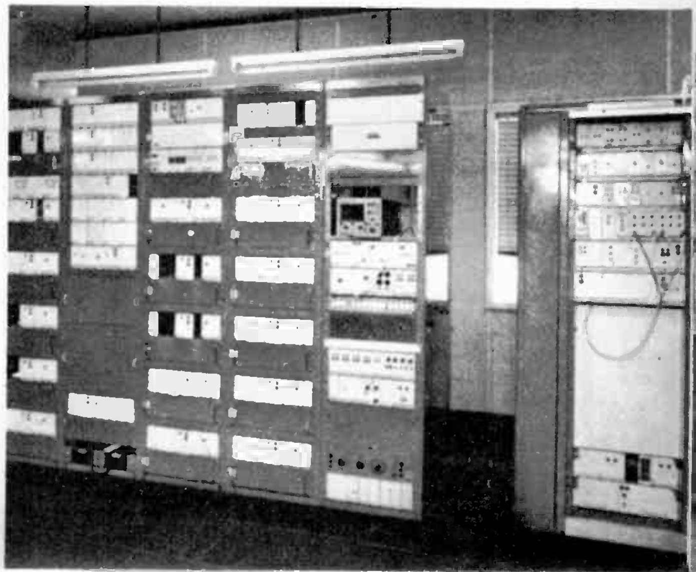
THE BBC has agreed with Rank Precision Industries Ltd. for the British firm to manufacture under licence and market abroad the BBC's new Advanced Field-store Television Standards Converter.

The exchange of television programmes between different systems is only possible by means of standard converters, because receivers are designed to operate only on the system or systems transmitted in the country where the sets are used.

The result of years of research and development work by the BBC is shown in the advanced field-store television standards converter which is a fully electronic device able to convert television signals on the American standard of 525 lines, 60 fields per second, with NTSC colour or monochrome, to the European 625 line, 50 fields per second standard, with colour on the PAL system.

During the Olympic Games in Mexico (12–26 October) the advanced converter was in use for a total of 170 hours of transmission via satellite relay across the Atlantic; 45 hours were live in colour for BBC 2. BBC 1 and ITV also showed pictures from Mexico in monochrome.

In the rest of Europe, eleven television services in nine countries took the converted programmes in colour. Twenty other television services in nineteen countries, including seven in Eastern Europe, took the programmes in monochrome.



UNLIMITED!

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.

SIMPLER FLIP FLOP GAME

THE *Flip Flop* game (December 1968) can be simplified and modified to provide a time delay. The following components can be removed or altered to provide the new version. (Fig. 1 shows the first stage modification only; the rest of the circuit remains as published.)

C1 to be 5μF elect. 12V
C2 to be 250μF elect. 12V in place of l.d.r. X1
Connect push button S1 and potentiometer VR1 2MΩ in parallel with the new C2.
Remove LP1, TR2, R4, R5, S1, C2 from original circuit on p. 898.

With the modified version the "heads" and "tails" lamps (LP2, LP3, page 898) start flashing when the new S1 is pressed. Within about 5 seconds the lamp flashing rate will slow down until only one of them remains lit.

When the new C2 is not charged, C1 discharges through it and TR1 emitter. Capacitor C2 charges at the same time until C1 can no longer supply a charge to C2. Consequently TR1 will set the flip flop to a static state with only one lamp conducting. When S1 is pressed again C2 is discharged immediately, C1 is charged and the circuit goes through the process again.

If a longer "spin" time is required the value of C2 should be increased. The setting of VR1 determines the pulse repetition frequency. The flashing speed of the lamps can be decreased by increasing the value of C1.

S. Whitehead,
Bradford,
Yorkshire.

SOUND EFFECTS ATTACK AND DECAY

HAVING read through the entire electronic music series in PRACTICAL ELECTRONICS, I noticed several complicated circuits for an attack and decay control.

The article in the April 1968 issue on Wind Effects gave me an idea for an extremely simple circuit, see Fig. 2.

Only one transistor is used, in exactly the same configuration as used by A. J. Bassett, but with two extra components. If instead of placing the transistor across the audio path, one places it in series with it, the device operates "in reverse" compared to the other use in the filter. The effect is very like an attack and decay circuit, but may require some experimentation to give the desired result.

This circuit is not prone to generating clicks because the capacitor absorbs them. The main advantage of this circuit is that there is no signal when S1 is not depressed, whereas there is a continuous noise with the others. The extra capacitors should be of several microfarads, values according to result required.

L. M. Newell,
Woodbridge,
Suffolk.

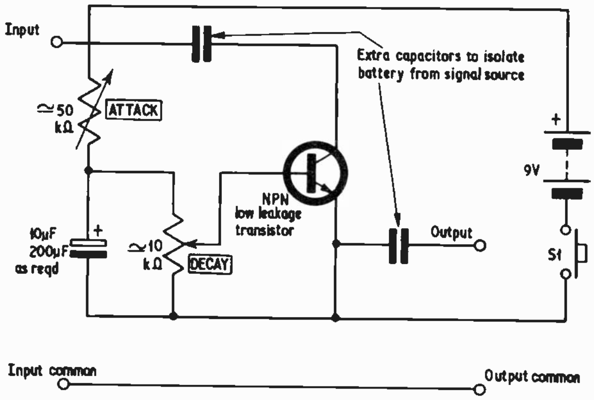


Fig. 2. Circuit diagram of the attack and decay unit

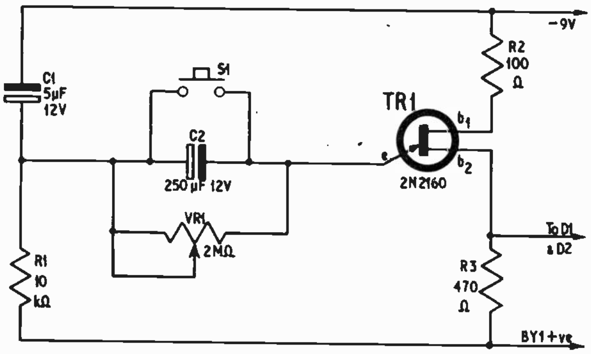


Fig. 1. The simple Flip Flop game with time delay

OPTICAL COMMUNICATION

The following circuit may be of interest to any of your readers who may be experimenting in optical communication.

As simplicity and low cost were important I decided to use an OC35 instead of a valve modulator. The resulting quality, although not quite up to hi fi standards, was reasonable. Speech is good and intelligible, even using a light bulb with its non-linear voltage/current characteristics.

The transmitter can be run from the low impedance loudspeaker output of any audio source, or a carbon microphone may be connected as shown in dotted lines, see Fig. 3. Potentiometer VR1 is set so as to bias the transistor with the bulb at just below full brightness. A little experimenting here will be necessary so as to prevent clipping of the waveform on high peaks.

The bulb used in the circuit is a 6V 0·06A m.e.s. type, and resistor R1 is 100 ohm ½ watt. This is included so that in the instance of the bulb filament short circuiting, the collector current will be 120mA thus not harming the transistor. The actual value of R1 will depend on the bulb used.

I found the receiver circuit to be most sensitive, even more so than an ORP12 and OC71 pre-amp. It was used to feed a small amplifier or a telephone receiver directly. The system worked well up to 60 feet with the amplifier and up to 100 feet with a telephone receiver.

Incidentally, mechanical feedback occurs very easily if the loudspeaker is on the same base as the OCP71 or the lens.

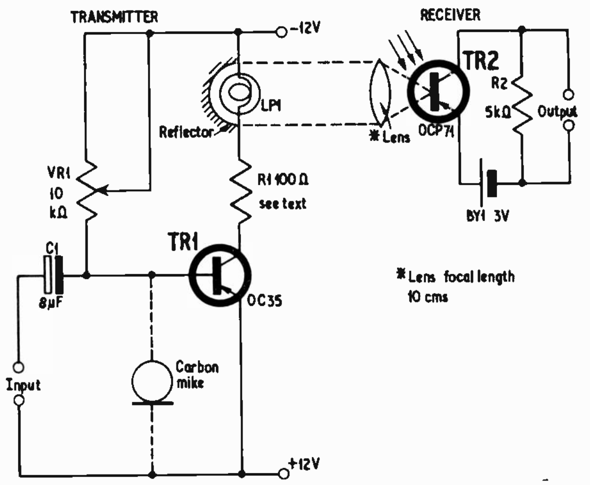


Fig. 3. Circuit diagram for optical communication system. The output should be fed into an amplifier with loudspeaker

G. J. Isley,
Leeds 15.

SIMPLE FROST WARNING DEVICE

In the November issue of Practical Electronics, Mr D. F. Moody describes a Frost Warning Device. Whilst not wishing to criticise any person's design, I feel that he is using "a sledgehammer to crack a nut." A thermistor is a pretty obvious choice for the sensitive element, but there is no need to go to the expense and complexity of a bridge circuit, and my circuit, Fig. 4, is vastly simpler and uses fewer components.

The thermistor X1 has a resistance at 0 degrees centigrade of 3·3 kilohms (nominal). Above this temperature its resistance is lower. Potentiometer VR1 is adjusted so that at 0 degrees TR1 is just switched off. Base current is then supplied to TR2 via R2 and the lamp lights. Below 0 degrees centigrade the resistance of the thermistor increases and TR1 is held even more securely off.

Above 0 degrees centigrade the potential at "A" rises, and base current is fed to TR1 which switches on. TR1 quickly saturates, TR2 is switched off, and the lamp goes out.

To prevent the operating temperature differing with the supply voltage, the thermistor is supplied by a semi-stable voltage source, using a 10V Zener diode, designed for use with a 12V car battery. By using a 4·7V Zener diode it will work with a 6V system.

The circuit has the following design considerations.

1. Output transistor will drive a bulb requiring up to 250mA, i.e. max. 3W (suggest 0·75 watt as adequate).
2. TR1 has high gain at low current so that TR2 is switched on and off rapidly.
3. D1 is 10V 400mW Zener diode. 10 per cent selection tolerance.
4. VR1 can be up to 1 kilohm but the higher its value the coarser the calibration.

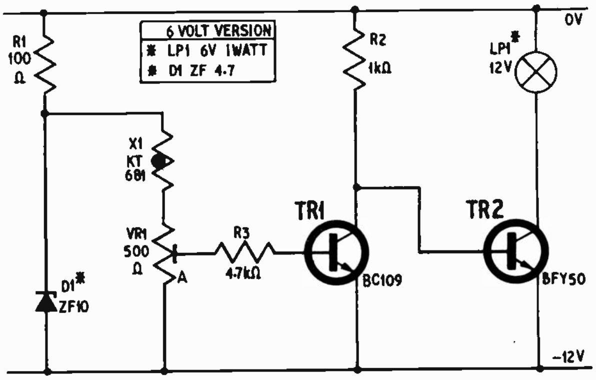


Fig. 4. A 12V car frost warning device. Alterations for a 6V version are shown in the inset box

G. N. Bartlett,
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Berks.

EMMA

THIS article deals with the construction and operation of an electronic "animal" (or robot) and is consistent with the subject matter given in the current P.E. series BIONICS. The design concept has been based largely on data relating to the habits of "real live" animals called *planaria*. These animals, which represent a species of flatworm, are commonly found lurking beneath small rocks and boulders in many of Britain's streams.

Whilst planaria demonstrate a crude form of learning, our synthetic version (which we have called EMMA) will exhibit only certain in-born or innate characteristics. This project should therefore be considered an open-ended affair, in that it can later form the basis for an even more sophisticated "animal". But, while keeping in mind such limitations, it must be emphasised that the model EMMA as described in detail in this article is a complete design and will provide a practical demonstration of this rather unusual application of electronics. In a more general sense, purely as a novelty, EMMA is likely to arouse interest amongst even those who have no electronic knowledge.

The electronic circuit boards, power supplies and the two electric motors which provide EMMA's muscle power are all mounted on a simple chassis. The constructional details for all these items, except the main circuit board, will be given next month in part two of this article. Final setting up and testing procedure will also be detailed in part two. In this opening article, we deal with the reflex circuits, which constitute the main circuit board (No. 1)—and the major portion of the electronics involved in EMMA.

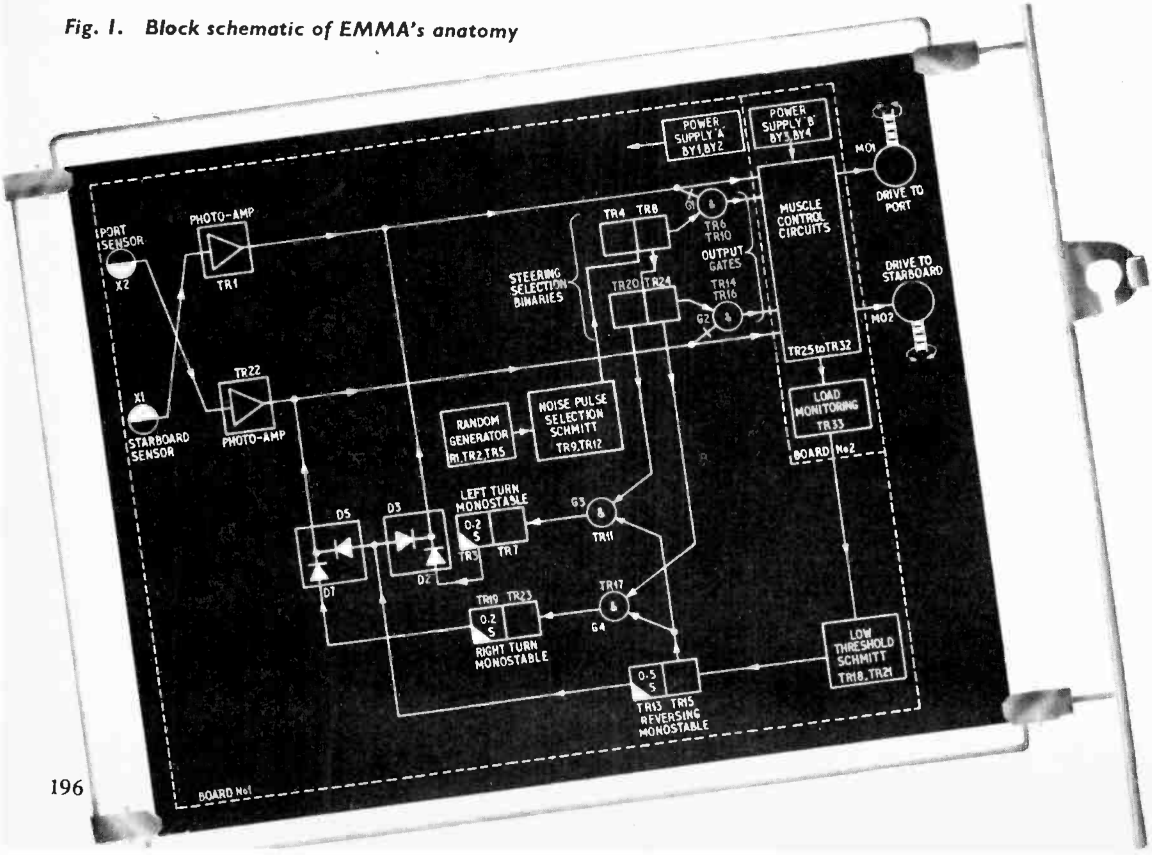
THE ANATOMY

An understanding of EMMA is best obtained by initially referring to Fig. 1 which is a block schematic of her anatomy. Like many real animals, particularly young ones, EMMA responds to stimuli in a rather negative fashion. By acting in such a way a fair degree of self preservation is thus afforded.

NORMAL FUNCTIONS

Under normal conditions the model will be capable of performing any one of four possible actions. These are

Fig. 1. Block schematic of EMMA's anatomy



ELECTRONIC MIME MOBILE ANIMAL

By G.C.BROWN
M.S.H.A.A. A.M.R.S.H.

determined quite randomly through a noise generator and drive selector. The responses available in this mode are as follows:

(a) Moving straight ahead—both motors driving forward.
(b) Moving forward to the right—one motor stopped (starboard) and the other (port) driving forward.
(c) Moving forward to the left—one motor stopped (port) and the other (starboard) driving forward.
(d) Stationary—both motors stopped.

The bracketed port and starboard refer to the respective physical locations on the "animal's" chassis, not to the direction of turn.

When the model is able to adopt this mode of operation its behaviour is very much like that displayed by a living animal finding itself in a strange environment. This design concept is intentional, since under these conditions a creature endowed with a learning faculty would gradually behave in a progressively less random way as it became familiar with its immediate environs. The normal functions are, however, overridden at times when EMMA interacts with photic and tactile (touch) stimuli.

REFLEX FUNCTIONS—PHOTO-SENSE

The sensing of light is bilateral; two quite separate channels exist—left and right. Each channel derives its input from a photo-sensor and, following suitable amplification, has direct control over the forward mode of operation of the opposite channel. Hence if a strong light stimulates one of the sensors the animal will make a reflex movement away from the source of illumination (i.e. the creature is negatively phototropic).

The photo-responses are thus:

(a) Reversing in a straight line away from frontal illumination—both motors running in reverse.
(b) Turning left and away from illumination on the right—one motor (starboard) driving forward and the other (port) driving in reverse.
(c) Turning right and away from illumination on the left—one motor (port) driving forward and the other (starboard) driving in reverse.

LOAD-SENSING

A form of tactile sense, reliant upon "muscle" loading, is built into the model and is an improvement on an earlier version which relied upon a sensitive "touch-boom" arrangement. This scheme was found to be somewhat unsatisfactory due to both the single-ended sensitivity of the boom and the awkwardness of its aspect.

The later concept incorporated in EMMA has quite a different basis of operation. Indeed the system adopted here, whilst retaining a good measure of sensitivity to tactile stimuli, additionally makes provision for monitoring loads. Currently the response to loads is set for some predetermined threshold, but because the model is capable of being modified *ad infinitum* there is no reason why the load-sensing system could not ultimately constitute one of the inputs to a learning network.

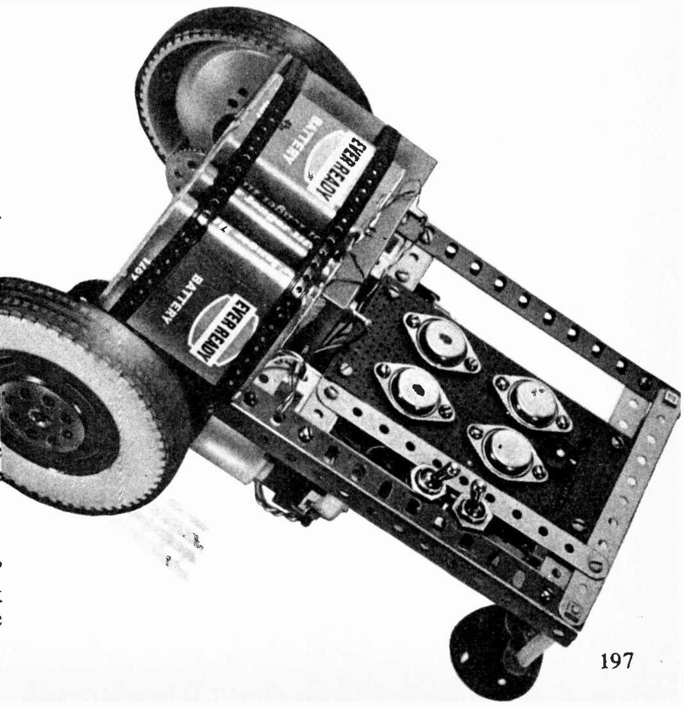
Load sensing then is achieved by monitoring the current drawn by the drive motors. If some pre-set level is exceeded, as for example when the model encounters an obstacle, a Schmitt threshold circuit will be caused to fire. The output from this circuit can then either be fed to a memory system or, as in the present application, to an avoidance circuit.

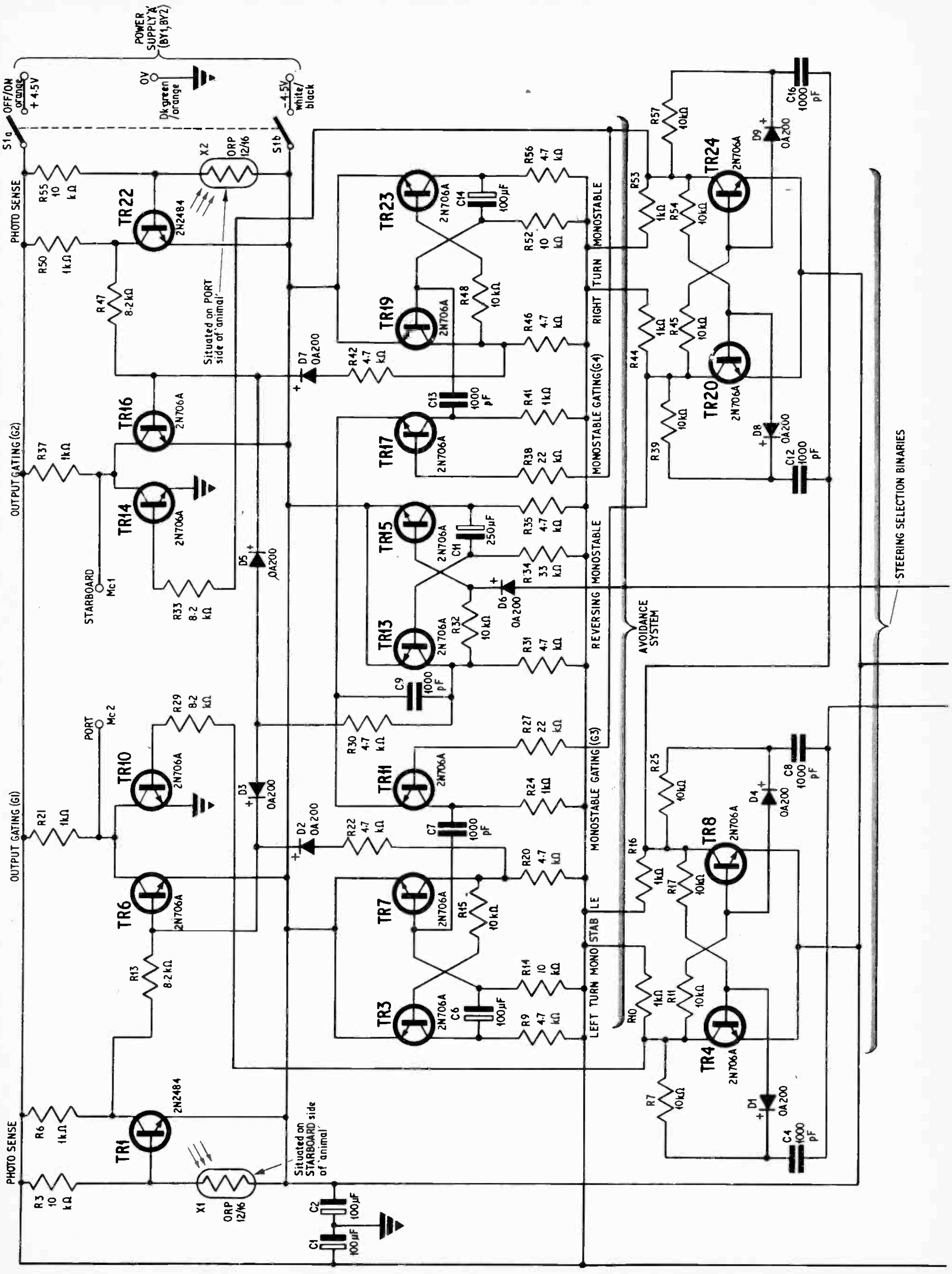
AVOIDANCE REACTION

During the time that the model is moving around it is likely to meet situations that it finds difficulty in extricating itself from; chair legs and so on representing a particular menace in this respect. In order to improve its chances (of survival!) in these tricky encounters, an avoidance system is employed which, following initial triggering by the load sensing circuit, causes the model to reverse away from the offending obstacle then quite randomly turn either left or right.

The randomness is derived from the noise generator. By making a turn in this rather unreliable way it can be demonstrated that EMMA stands a far more optimistic chance of moving out of trouble than would be the case if the turn was predictable.

As will be seen from the block diagram (Fig. 1), following the load threshold being exceeded the Schmitt circuit will fire the 0·5 second monostable causing the reversing procedure to be adopted. On return of this monostable to its stable condition the trailing edge of its pulse will appear at the inputs of gates G3 and G4 simultaneously.





POWER SUPPLY 'A' (BY1, BY2)
S1a OFF/ON orange +4.5V
0V Dk green /orange
-4.5V white/ black
S1b
PHOTO SENSE
R55 10 kΩ
R50 1kΩ
TR22 2N2484
X2 ORP 12/46
Situated on PORT side of 'animal'
R47 8.2kΩ
D7 OA200
R42 4.7 kΩ
OUTPUT GATING (G2)
R37 1kΩ
TR16 2N706A
TR14 2N706A
STARBOARD Mc1
R33 8.2 kΩ
D5 OA200
TR23 2N706A
C14 100μF
R56 4.7 kΩ
R52 10 kΩ
TR19 2N706A
R48 10kΩ
R46 4.7 kΩ
C13 1000 pF
R41 1kΩ
TR17 2N706A
R38 22 kΩ
TR15 2N706A
C11 250μF
R35 4.7 kΩ
R34 33 kΩ
D6 OA200
TR13 2N706A
R32 10 kΩ
R31 4.7 kΩ
C9 1000 pF
R30 4.7 kΩ
R27 22 kΩ
TR11 2N706A
R24 1kΩ
C7 1000 pF
R22 4.7 kΩ
R20 4.7 kΩ
TR7 2N706A
R15 10 kΩ
R14 10 kΩ
TR3 2N706A
C6 100μF
R9 4.7 kΩ
MONOSTABLE GATING (G4)
RIGHT TURN MONOSTABLE
REVERSING MONOSTABLE
MONOSTABLE GATING (G3)
LEFT TURN MONOSTABLE
AVOIDANCE SYSTEM
R53 1kΩ
R54 10kΩ
R57 10kΩ
TR24 2N706A
D9 OA200
C16 1000 pF
R44 1kΩ
R45 10kΩ
TR20 2N706A
R39 10kΩ
D8 OA200
C12 1000 pF
STEERING SELECTION BINARIES
R25 10kΩ
C8 1000 pF
D4 OA200
TR8 2N706A
R16 1kΩ
R17 10kΩ
R10 1kΩ
R11 10kΩ
TR4 2N706A
R7 10kΩ
D1 OA200
C4 1000 pF
OUTPUT GATING (G1)
R21 1kΩ
PORT Mc2
TR10 2N706A
R29 8.2 kΩ
D3 OA200
D2 OA200
TR6 2N706A
R13 8.2kΩ
TR1 2N2484
R6 1kΩ
R3 10 kΩ
X1 ORP 12/46
Situated on STARBOARD side of 'animal'
C2 100μF
C1 100μF

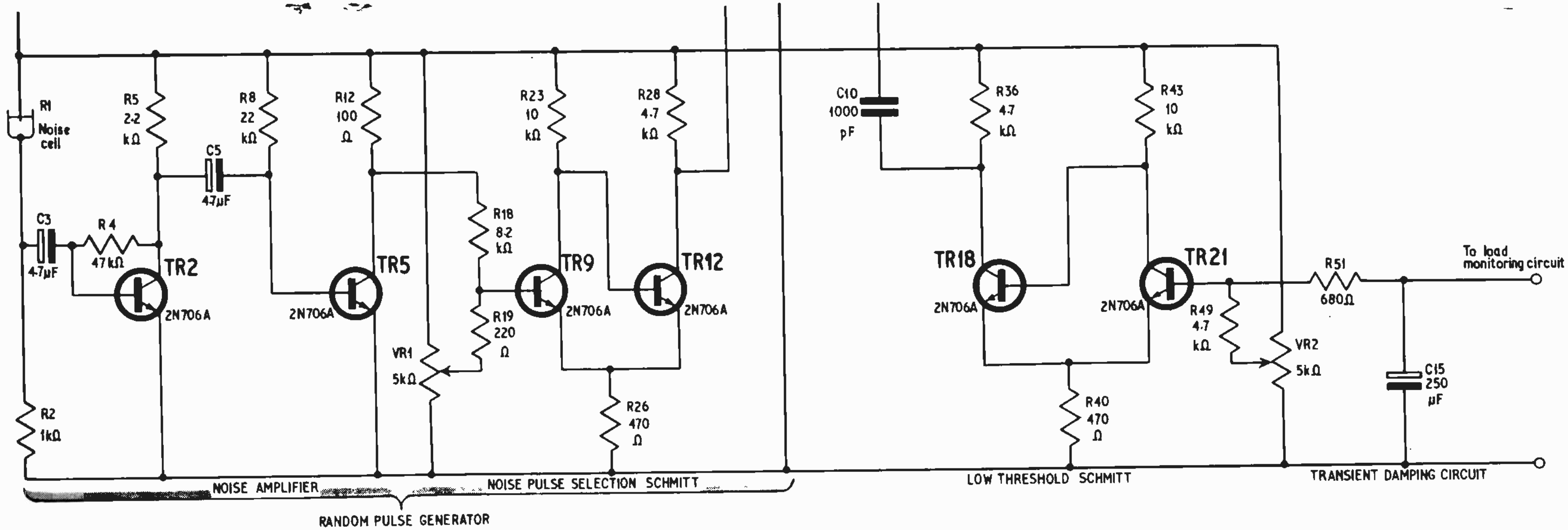


Fig. 2. Electronic mime mobile animal "EMMA" reflex circuits

COMPONENTS . . . REFLEX CIRCUITS

Resistors

R1 Electro-chemical cell (see text)

R2	1kΩ	R21	1kΩ	R40	470Ω
R3	10kΩ	R22	4·7kΩ	R41	1kΩ
R4	47kΩ	R23	10kΩ	R42	4·7kΩ
R5	2·2kΩ	R24	1kΩ	R43	10kΩ
R6	1kΩ	R25	10kΩ	R44	1kΩ
R7	10kΩ	R26	470Ω	R45	10kΩ
R8	22kΩ	R27	22kΩ	R46	4·7kΩ
R9	4·7kΩ	R28	4·7kΩ	R47	8·2kΩ
R10	1kΩ	R29	8·2kΩ	R48	10kΩ
R11	10kΩ	R30	4·7kΩ	R49	4·7kΩ
R12	100Ω	R31	4·7kΩ	R50	1kΩ
R13	8·2kΩ	R32	10kΩ	R51	680Ω
R14	10kΩ	R33	8·2kΩ	R52	10kΩ
R15	10kΩ	R34	33kΩ	R53	1kΩ
R16	1kΩ	R35	4·7kΩ	R54	10kΩ
R17	10kΩ	R36	4·7kΩ	R55	10kΩ
R18	8·2kΩ	R37	1kΩ	R56	4·7kΩ
R19	220Ω	R38	22kΩ	R57	10kΩ
R20	4·7kΩ	R39	10kΩ		

All (except R1) ±10%, $\frac{1}{8}$W carbon

Potentiometers

VR1, 2 5kΩ sub-miniature (Ardente) (2 off)

Capacitors

C1	100μF 15V elect.	C9	1,000pF ceramic
C2	100μF 15V elect.	C10	1,000pF ceramic
C3	4·7μF 15V elect.	C11	250μF 15V elect.
C4	1,000pF ceramic	C12	1,000pF ceramic
C5	4·7μF 15V elect.	C13	1,000pF ceramic
C6	100μF 15V elect.	C14	100μF 15V elect.
C7	1,000pF ceramic	C15	250μF 15V elect.
C8	1,000pF ceramic	C16	1,000pF ceramic

Transistors

TR1	2N2484	TR22	2N2484
TR2–21	2N706A (20 off)	TR23, 24	2N706A

Diodes

D1–9 OA200 (9 off)

Miscellaneous

S1 D.P.S.T. toggle switch
X1, 2 ORP12 *or* ORP16 (2 off)
Piece Veroboard 5in × 2½in (0·1in pitch)
Connecting wire: 22 s.w.g. plastic covered; 22 s.w.g. tinned copper. Silver wire, 18 or 20 s.w.g., 2·3in long; small quantity of silver nitrate (for R1)

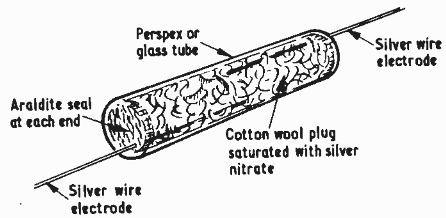


Fig. 3. Random pulse noise cell (R1)

If this input to the gates coincides with an enabling level from the random generator, one or other of the 0·2 second monostables will be fired. As a consequence although one motor will have begun driving forward, its opposite number will continue in the reverse direction for a further 0·2 seconds, resulting in the animal performing a turn. At the end of this period the avoidance reaction will be terminated, no further response being elicited unless the load threshold is again exceeded.

WORK AND REWARD

A further point of interest arising from this load-sensing/avoidance reaction system is that EMMA will tend to respond both to obstacles in its path and additionally display something of "annoyance" if direct loads (in the form of added weight—heavy books, etc.) are applied. The constructor will here see even more interesting possibilities—a creature able to determine loads need only be interconnected with a learning network to be in a position to receive payment in return for work. Thus if instead of attempting to shake-off an unwelcome load (e.g. when its battery is low) it accepted the task and was later rewarded (with a recharge), it would have learnt that to work was to survive—a not altogether unreasonable assumption! This more ambitious type of project will be a feature of the future article mentioned earlier.

TRANSIENT DAMPING AND LOAD THRESHOLD CIRCUITS

Because we have no wish to let our "animal" respond to transient loads (as for example would be caused by the initial stall currents when the motors turn on) it is necessary to include C15 (Fig. 2) to damp-out such effects. The response, as a result, is now more positive and only occurs when more continuous loads are applied.

The trigger circuit, shown in Fig. 2, comprising TR18 and TR21 has its threshold level set by VR2. Depending on the setting of this potentiometer the circuit can be made to fire for high or low load conditions. Prior to triggering, TR21 is cut off and TR18 is conducting; if the circuit fires, then TR18 collector will go positive. This transition is utilised in triggering the avoidance system as will be seen shortly.

OUTPUT GATING

The two output gates (G1 and G2 in Fig. 1) comprise TR6, TR10 and TR14, TR16. Whilst these gates are depicted in normal binary logic form in Fig. 1, they actually perform a ternary function (see Fig. 2). Their logic is such that the output function can be $+1$, 0, or -1 and is essential since EMMA is required to go forward, stop, and reverse. The gates are essentially of NAND/NOR format but differ in the respect that the transistors have their emitters returned to different potentials.

For example, with both TR6 and TR10 non-conducting their common collector point will be positive with respect to earth, corresponding to the forward condition in the port channel. If TR10 is made to conduct the collector point will drop to zero, corresponding to the stop condition. On the other hand if TR6 is caused to conduct the reversing condition will be initiated and override all else in the channel. At these times the common collector point will be negative with respect to earth. The gate for the starboard channel operates in an identical way.

RANDOM PULSE GENERATION

The requirement for a low-occurrence random pulse source in EMMA has given the author many a headache. Diodes and similar devices are of no real use in this application because the noise generated by them generally has a pulse rate which is inordinately high. An electro-chemical device finally proved to have the necessary characteristics. In an earlier project this took the form of a saline cell; although representing a practical proposition this needed frequently topping-up and could not unfortunately be sealed completely without the risk of high gas pressures developing.

A very much improved random pulse source is incorporated in EMMA and is depicted as R1 in Fig. 2. The device is a completely sealed electro-chemical cell and has a casing made either from glass or perspex tubing measuring approximately ½in × ¼in diameter.

Contained within and leaving the tube at either end are a pair of silver-wire electrodes making contact with a cotton-wool plug. This plug is barely saturated with about a one per cent solution of silver nitrate. The open ends of the tube are sealed off using an epoxy-resin such as Araldite. See Fig. 3.

Caution; silver nitrate is a particularly corrosive chemical and care should be exercised in keeping it clear from the skin and eyes.

When the completed cell (R1) is subjected to quite low applied voltages, metallic ions are taken out of the solution and form silver threads which rapidly grow from the negative to positive electrodes (these threads are extremely fine and can only be seen with difficulty). The threads are supported by and grow through the cotton-wool plug; however, upon reaching the opposite electrode a thread will just make contact (causing a sudden reduction in the voltage drop across the cell) and then be disrupted by the increased current.

Following each break-down a new thread will begin and the process repeats. As the growth processes and disruptions are quite unpredictable so the changes in voltage across the cell occur randomly.

The output noise pulses from the cell have varying amplitudes and hence, following suitable amplification (TR2 and TR5), can be applied to the Schmitt threshold circuit which, once set by VR1, provides selection of only the higher amplitude pulses. In this way it is possible to obtain randomly distributed pulses having very low occurrence rates. The output derived from the collector of TR12 in the Schmitt circuit is taken to the steering selection binaries.

STEERING SELECTION SYSTEM

The pulses derived from the randomising circuit are fed direct to a conventional two stage binary counter controlling the forward and stop functions of the model (Fig. 2). Feeds to the output gating circuits are taken via resistors from the collectors of TR4 and TR24, and with both these transistors in the conducting state (collectors negative) forward drive will be selected.

The first random pulse to appear at the counter will result in both stages of the counter turning over and as a consequence TR4 and TR24 collectors will go positive causing the animal to stop. However, the next two pulses to arrive will result in the animal performing right and left turns. Forward drive will be resumed as a result of the fourth pulse; the cycle will then repeat.

As it is impossible to predict when each pulse will occur, the times between the various forward modes are thus random. Operation of the circuit although sequential does not always appear so in practice. This is because the pulses sometimes have a bunched

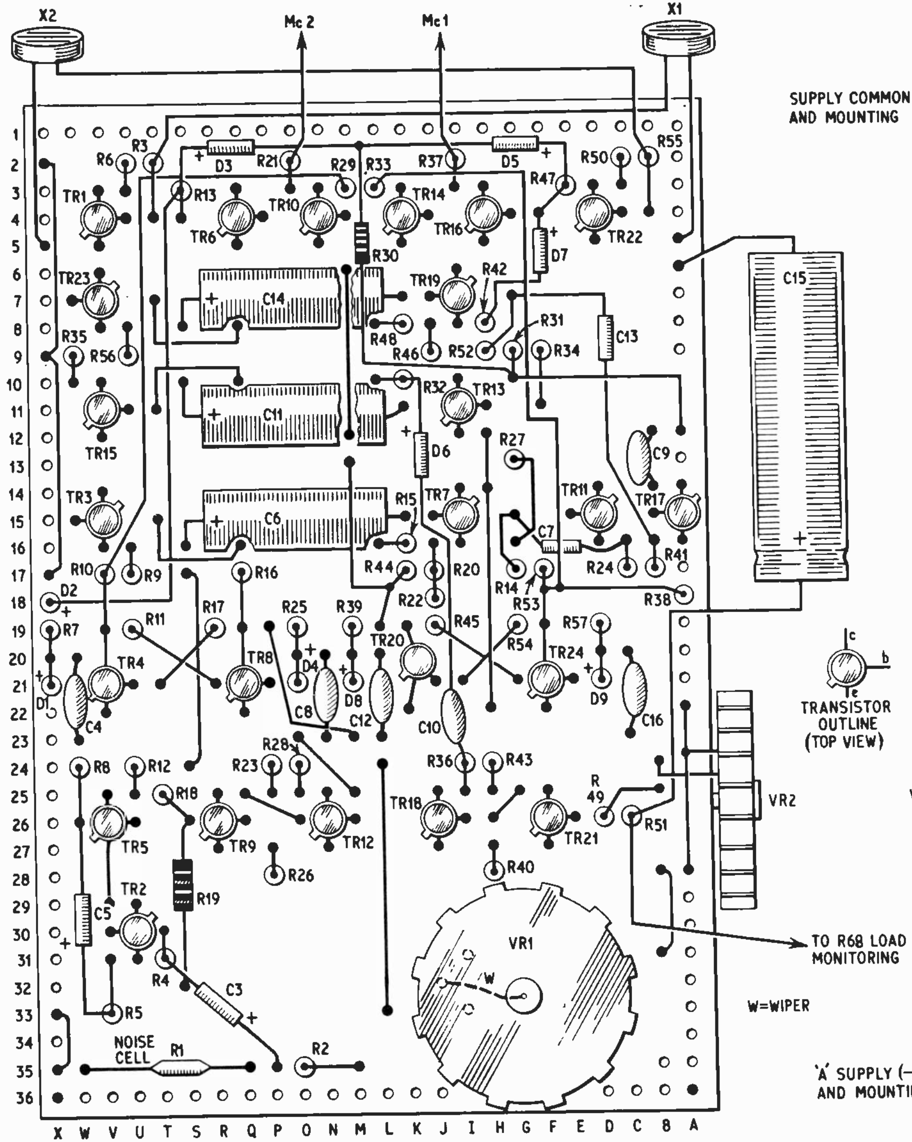


Fig. 4a. Layout of components on the reflex functions circuit board

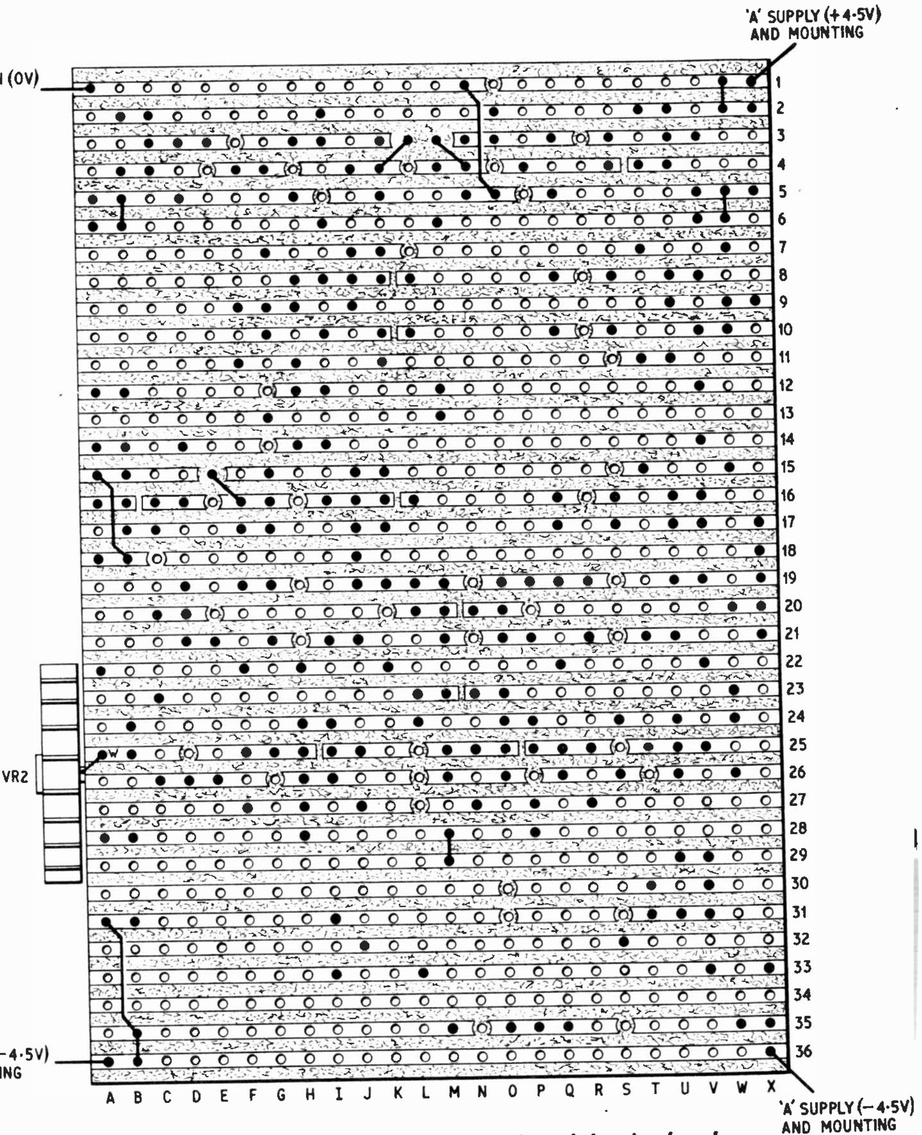
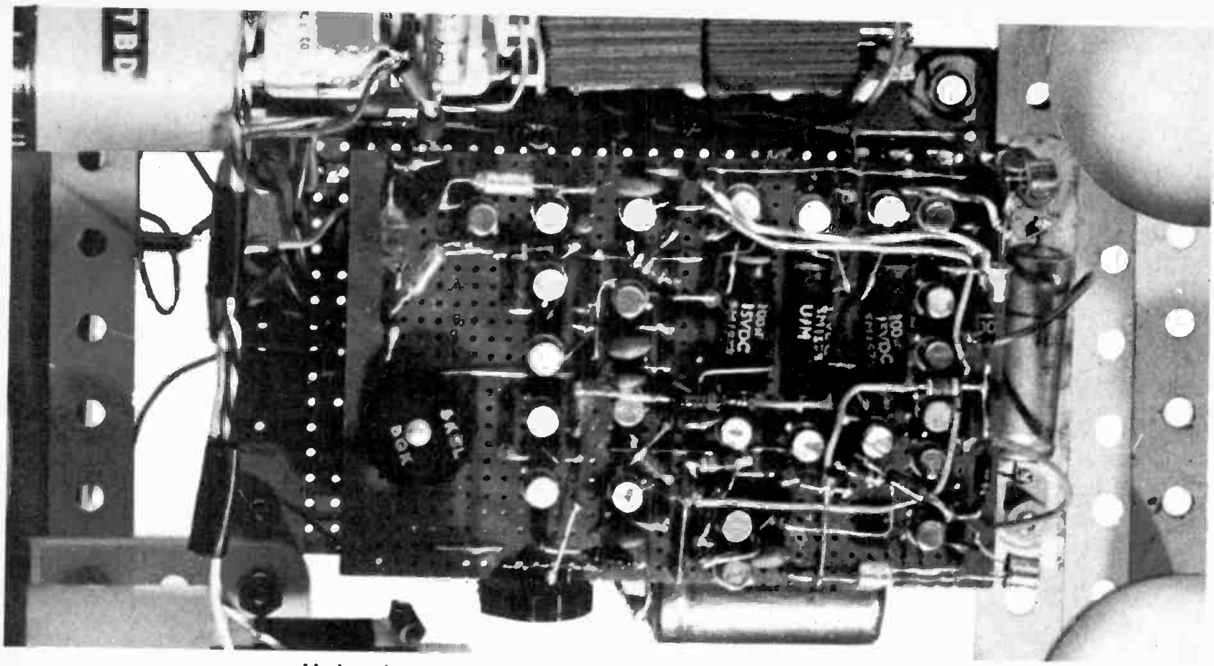


Fig. 4b. Underside of reflex function board showing breaks in copper strips. All link wires to be plastics sleeved



Underside view of EMMA showing the reflex functions board

characteristic and hence the counter may well be completely cycled several times without its effects being observed.

Additional outputs are taken from the last stage of the counter at the collectors of TR20 and TR24 and control the gating in the avoidance system.

AVOIDANCE SYSTEM

The avoidance system comprises the three monostables and random gating arrangement discussed earlier and shown in Fig. 2. Whenever a load is sensed which exceeds the set threshold level, the associated Schmitt TR18, TR21 will fire causing a positive pulse to appear at the base of TR15 in the reversing monostable. The monostable will therefore switch to its quasi-stable state and the positive level now appearing at the collector of TR13 will turn both TR6 and TR16 on, resulting in EMMA reversing.

Following a short period (about 0·5 seconds) the reversing monostable will return to its stable condition. In so doing, a negative pulse fed from TR13 collector will momentarily pull-down the emitters of gating transistors TR11 and TR17. Now at any particular time one of these transistors will be able to conduct because they are both under the control of the last stage in the steering selection system.

Thus, assuming TR17 base happens to be at a positive potential just when its emitter is taken negative, then TR19 will turn off and the right-turn monostable will fire. Therefore, although TR6 will have returned to normal, TR16 will maintain reverse drive in the starboard channel causing the turning mode to be to the right. Turning left after reversing will result from triggering of the left-turn monostable via TR11.

By employing the random output from the steering selection system to route pulses to one or other "turn" monostables, the avoidance reaction will hence in part also be random and therefore give a better chance of negotiating obstacles.

PHOTO-SENSORS

The animal relies for its photo-sense upon two CDS cells, X1, X2 (these can either be ORP12 or ORP16 types). Each cell is connected between the base of its associated photo amplifier and the negative rail. These cells must be mounted so that they face away from the circuit board in a direction which is parallel to the edge of the board.

In the un-illuminated condition of the cells, both TR1 and TR22 collectors will be at a negative potential. If, for example, X2 (physically located on the port side) is illuminated then TR22 collector will go positive, thereby turning TR16 on; as a consequence the starboard motor will drive in reverse causing the model to turn away. Similarly if X1 only is stimulated then the port motor will reverse.

Stimulation of both photo sensors results in the model backing away until it is out of the influence of the light source. Generally this backing-away mode will be terminated by a short turn in one or other directions due to slight differences in channel sensitivities; the process is thus unlikely to be uselessly repeated.

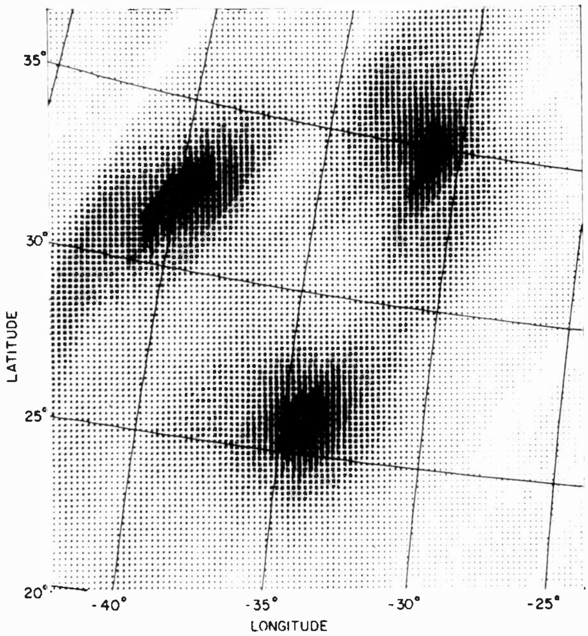
CONSTRUCTION OF THE CIRCUIT BOARD

Figs. 4a and 4b show the layout and wiring details of the main circuit board. This board contains all the electronic circuits which provide the reflex functions.

The Veroboard used only requires drilling for the randomising circuit potentiometer as shown in Fig. 4, all other components are mounted by means of their own leads. The breaks in the copper strips shown should be made before the components are fitted and care should be taken to ensure that the complete width of the strip has been cut.

It is advisable to mount the transistors and diodes after all the other components to avoid overheating when soldering.

Details of the motor control circuit board, power supplies and all mechanical construction and mounting of the various parts will be fully detailed next month.



MAP OF VENUS

SPACEWATCH

By Frank W. Hyde

LUNAR GRAVITY

Perturbations of the orbits of lunar orbitor vehicles have shown that there are areas on the moon where the gravity is increased. These areas also coincide with what have become known as "hot spots". Visual observations have shown changes of colour and infra-red observations during eclipses have confirmed this. The areas are mainly confined to the maria. The particular areas of greater gravity are situated in the maria and consistent with the presence of dense material. One suggestion put forward to explain this anomaly is the possibility of large meteoric missiles falling on the surface of the moon and penetrating to a considerable depth below the surface.

This hypothesis requires certain special circumstances to exist if it is to be tenable. One is that the size of meteoric bodies would need to be of the order of 100km in size and another that there was a swarm of such bodies at least five in number to account for the conditions that exist. There is considerable difficulty in finding the latter event possible. There are no bodies in the asteroid belt large enough to fit this condition.

The other possibility is that the interior of the moon is still hot and that where faults have occurred in the surface gases can emerge giving rise to visual changes on the surface. There is in fact just such an area in the Mare Humorum.

MASCONS

The mass concentrations or "mascons" as the areas of higher gravity have been called may be another hazard to lunarnauts. If the concentration of the higher gravity field is in an area of the size of the objects suggested earlier, it could be that the lunarnaut would have a hard time crossing the area or should he be on a "pogo" stick his leaps might be severely restricted.

The "pogo" stick reminiscent of the sprung stick of 40 years ago is a device developed for travelling over surfaces such as the moon. Jets are controllable enabling the user to make leaps of some 100 feet or so and have a height of 25 feet at the top of the trajectory.

PULSARS

It may be that Pulsars after all are farther away than was at first thought. An attempt to check the distances of these newest exciting objects has been made at Jodrell Bank by a team led by Dr J. E. B. Ponsonby. The first estimates of distance were made based on knowledge of the density of electrons in space and dispersion of radio pulses.

There are certain limitations in time which govern the smallest size of a radiating body. The limitation is that the radio pulse emitted cannot be shorter than the time it would take light to travel across the body. As an illustration the sun may be used to demonstrate this. If the radiation from the sun were to suddenly cease it would take about two seconds for it to become dark all over.

The first estimates of distance were based on this fact plus the clue from ionised interstellar gas where there are free electrons. In these conditions the higher frequencies have a higher velocity than the lower frequencies.

The original estimates were based on a density of one electron to a volume of 10 cubic centimetres. On this basis the distance of CP 0328 (Cambridge pulsar at R.A. 03 hours 28 minutes) was 268 parsecs (one parsec equals 3·26 light years). Since our galaxy has a diameter of about 30,000 parsecs the pulsars are near neighbours.

However in the case of CP 0328 measurements at Jodrell bank of the absorption spectrum of the radiation which is caused by the neutral hydrogen that lies between the earth and the pulsar extends this distance considerably.

The hydrogen is rotating with the galaxy at a velocity which is dependent upon the distance of the gas from the galactic centre. There will therefore be a Doppler shift in the spectrum. The amount of this shift would be related to the distance of the pulsar. It appears that the figure for this should be increased to something of the order of 25,000 light years—in other words well out to the edge of the galaxy. This also means that the energy is that much more intense and that the size will be greater.

VEIL OF VENUS LIFTED

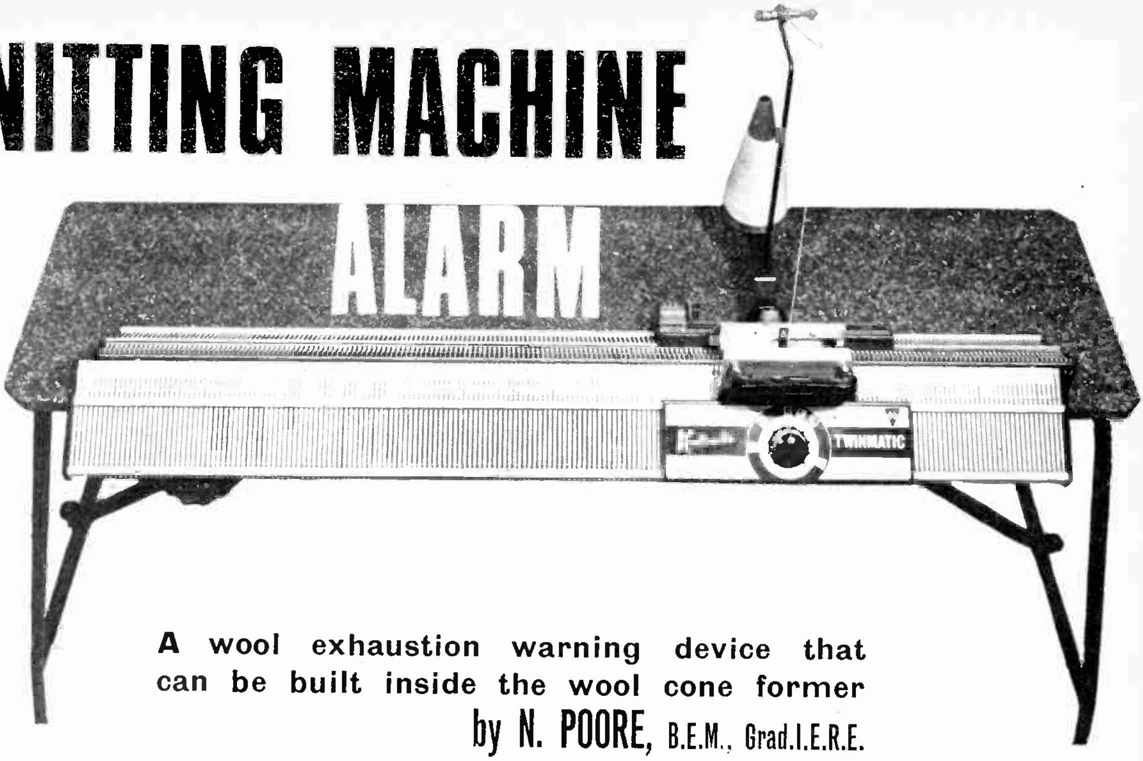
Mention was made previously in *Spacewatch* of the possibility of checking the claims of visual observers that there were markings darker than the normal surface appearance. The first radar contacts were made some ten years ago. Since that time improvements in instruments and techniques have made it possible to draw pictures of the Venusian surface.

Three particular groups have been concentrating on this work in America. They are at Cornell University, Massachusetts Institute of Technology and the Jet Propulsion Laboratory. An extensive area of the northwest face has been mapped. The extent of the triangular area is of the order of 160,000 square miles. Three irregular and somewhat rugged sectors appear on this map, *see photo*.

These features could be chains of mountains or extensive fields of boulders. It is known that these are permanent because they have appeared in all the tests. The first time was in 1962 rather faint, then in 1964, 1966 and 1967 strong. That they are part of the surface seems to be certain since they rotate with the planet.

The power required for this work is very high. The latest pictures obtained used a beam with a power of 100kW. After a 4½ minute journey a few millionths of a watt is returned. The measurements are made when the planet is closest to the earth. This is about 26,000,000 miles and occurs for a few months in every 18 months; the next period is in April. The 210ft Goldstone dish is to be used then with a power of 450kW and will no doubt provide even finer detail.

KNITTING MACHINE ALARM



A wool exhaustion warning device that can be built inside the wool cone former

by N. POORE, B.E.M., Grad.I.E.R.E.

MODERN home knitting-machines are capable of high speed operation and with speed comes a high rate of wool consumption. Many machines use a cone-former, upon which is wound an ounce of wool and this can be transferred to knitting in about seventy-five seconds. With this kind of work the machine-operator is aware that the wool is likely to run out and the cone is watched for this to happen.

However, when needle manipulation is required to produce patterned knitting, the process is much slower and the wool can become inadvertently completely exhausted. This invariably results in dropped stitches and in severe cases the removal of all knitting from the machine. The latter case can be painful because the knitting is sometimes tensioned with heavy weights which usually manage to land on the operator's feet, with the knitting.

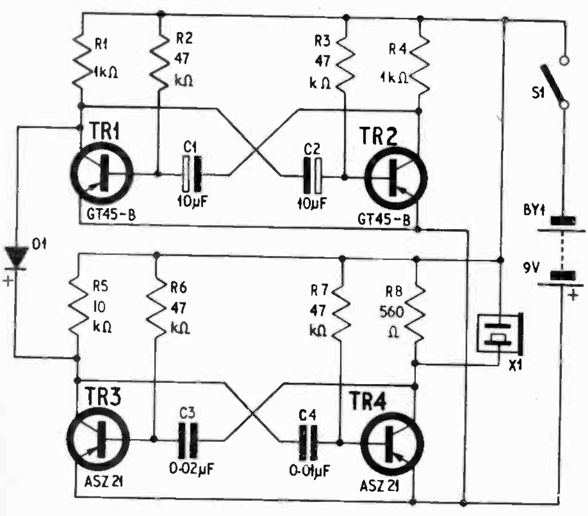


Fig. 1. Circuit diagram of the knitting machine wool exhaustion warning device

BUILT INSIDE CONE FORMER

To provide an indication of impending disaster, a warning device was designed, built inside the cone to give the operator as much warning as necessary for the type of work in progress. The device has the advantage that it can be built from odd junk-box pieces and apart from small resistors and capacitors the average constructor will need to spend little.

CIRCUIT OPERATION

The circuit is shown in Fig. 1. TR1 and TR2 are coupled to form a low frequency astable multivibrator, which has a quasistable time of $0{\cdot}7\ C_1R_2$ and a cycle period of $1{\cdot}4\ C_1R_2$. With the values used, the period becomes 0·66 seconds and the repetition rate 1·5 per second.

TR3 and TR4 are coupled to form a higher frequency circuit with unsymmetrical half cycles. The time period for one repetition is $0{\cdot}7\ (R_6C_3 + R_7C_4)$ seconds.

With the values used this approximates to one millisecond which provides a repetition rate of 1,000 per second.

A "personal" crystal earphone is coupled to the collector of TR4. The semiconductor diode D1, joined between TR1 and TR3 collectors, effectively "squeggs" the audio oscillation from the earphone X1 by fixing the collector potential of TR3 at a static level whenever TR1 collector potential is less negative than that of TR3. The effect of the diode has not been taken into account in estimating timing, and for ordinary purposes it can be ignored. Switch S1 applies power from a 9 volt battery BY1 to the circuit.

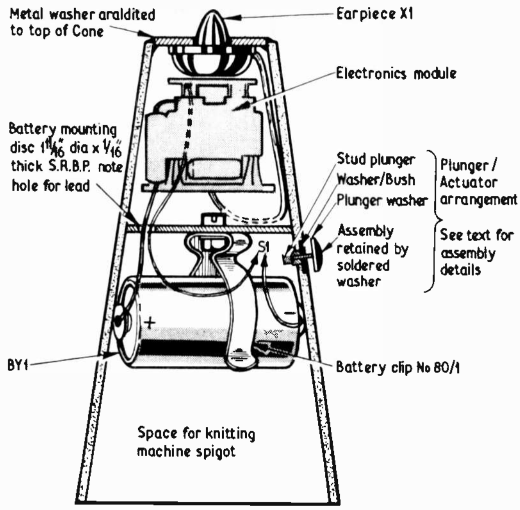


Fig. 2. Sectional view of the cone with the electronics installed

Circuit values have been purposely chosen for stability, coupled with audio requirements. In a normal domestic situation, a sudden, loud warning note would not be welcomed and components have been chosen to provide the sedate, interrupted note required by the writer. These circuit values allow for the use of a variety of odd transistors which may be available from discarded projects. The writer used those which are specified in the components list.

MECHANICAL CONSTRUCTION

The top of the empty cone is removed and neatly replaced by a washer 1¼in in diameter. The earpiece is fixed into the washer central hole. Both of these operations are carried out with adhesive. Fig. 2 shows an elevation view of the cone. Exact measurements will obviously vary with available components.

BUILDING THE CIRCUIT

Veroboard is used to form the circuit assembly. To fit into the conical space a frustum-shaped module is built, with components supported between circular pieces of Veroboard. The top disc is ⅞in in diameter and the lower disc 1⅜in diameter. Fig. 3 shows the two pieces of Veroboard and Fig. 4 the complete assembly. If four "leg" components are assembled first, this provides a stable base for inserting the other parts.

The actuator switch S1 is made from a pair of spring contacts as shown in Fig. 5 and attached to the cone wall with a countersunk screw. The prototype used a pair of contacts from a discarded washing machine relay.

Another hole through the cone wall is lined with a brass bush to provide ingress for the shaft of a plunger, one end of which is soldered to the relay spring so that when the shaft is pushed in the contacts open. The length of shaft is carefully adjusted by filing so that the cap soldered to the end outside the cone is as near to the cone as possible, consistent with efficient operation. The cap used was a copper washer, covered with solder and shaped to provide a non-slip surface for wool.

Most wool cones are made of a "compressed paper" material and this does not take wholesale perforation for fixing screws. Two 6B.A. fork ends are used as indicated in Fig. 4 for securing the electronic unit. When splayed out to an overall diameter greater than that at the fixing position, the sharp ends of the forks dig into the cone and provide a stable anchor.

An s.r.b.p. disc carrying a spring clip is used as a battery mount and wires to the battery positive and switch are brought through a small hole in the disc. The mount is accurately cut to be a tight push fit in the cone.

COMPONENTS . . .

Resistors
R1, R4 1kΩ (2 off)
R2, R3, R6, R7 47kΩ (4 off)
R5 10kΩ
R8 560Ω
All 10%, ⅛ watt carbon

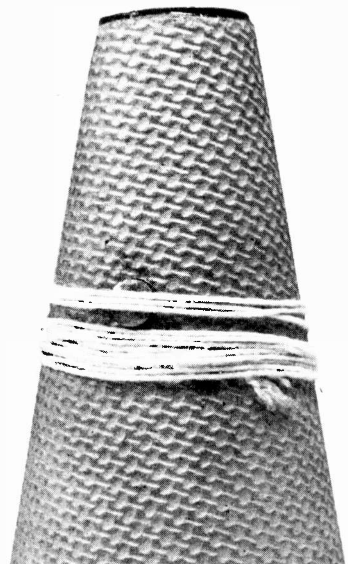
Capacitors
C1, C2 10μF elect. 12V (2 off)
C3 0·02μF plastic
C4 0·01μF plastic

Transistors
TR1 GT45-B *or* NKT126
TR2 GT45-B *or* NKT126
TR3 ASZ21
TR4 ASZ21

Diode
D1 15920 or similar small silicon type

Battery
BY1 9V (PP4 or equivalent)

Miscellaneous
S1 Actuator switch (see text)
X1 Crystal earpiece
Battery clip and connectors, printed wiring board, contacts, etc.



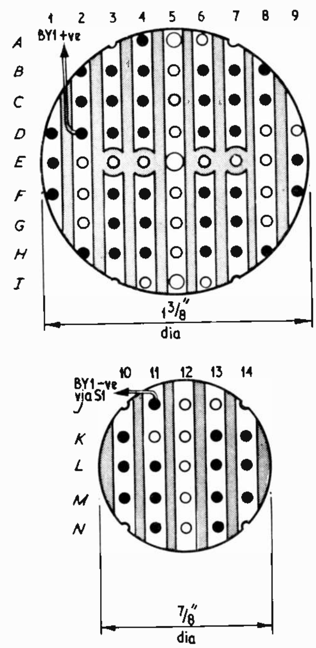


Fig. 3. The two circular pieces of Veroboard used for the electronic assembly

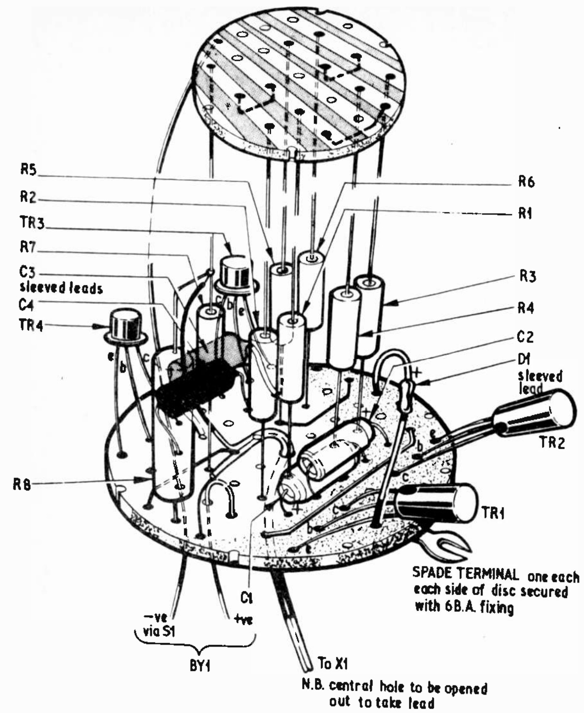


Fig. 4. The assembly and wiring of circuit components on the two printed wiring board discs

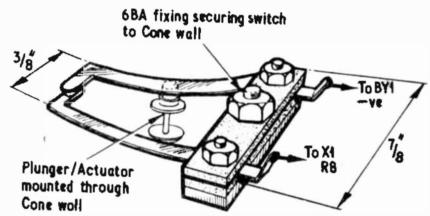


Fig. 5. A suitable actuator switch (S1) made from a pair of spring contacts

SEQUENCE OF ASSEMBLY

The earpiece is glued to the top of the cone as described and connected with about nine inches of flex to the electronics module. The module, with "tails" ready for connection to the battery and S1, is then pushed into the cone until the two forks grip the interior. This is followed by the pair of switch contacts—one being wired to the negative lead of module and the other provided with a tail ready for connection to the battery.

The remaining two wires should be posted through the holes in the battery disc, and the connecting clips attached. The battery disc (less battery) is now pushed home and positioned so that the battery will clear S1. On connecting the battery the unit is ready for use.

USING THE DEVICE

Wool is wound on the cone by starting just below the switch with about 30 turns, trapping the free end. The 31st turn (say) is passed with others over the switch actuator and the rest of the wool wound on.

When not covered with wool the device is switched off by depressing the plunger with a rubber band. ★

BOAT SHOW

At this year's International Boat Show the numbers of larger craft displayed had increased although the total number of boats on show was fewer than the previous year. As the demand for larger family boats rises so the demand for associated electronic equipment is also increasing and one manufacturer claimed that he was still receiving orders from contacts made at the previous Boat Show.

Electronic equipment used in small craft is mainly concerned with navigation but many other items such as wind speed and direction indicators and emergency radio equipment which can be carried in life rafts was also displayed. It is noteable that the Olympic Gold medal winners Lt. Rodney Pattison R.N., and Iain Macdonald-Smith were aided to their resounding victory by an electronic wind indicator carried in the bows of their Flying Dutchman dingy.

NEW INSTRUMENTS

The indicator used by Pattison and Smith was manufactured by Brookes and Gatehouse Ltd. These manufacturers market a comprehensive range of electronic aids for the small craft owner and have this year introduced a solid state computer which is extremely compact and which can be used in conjunction with other equipments from the same manufacturer to plot course deviations as small as 20 yards.

Precision Electronic Terminations (EMI) Ltd., who have been marketing a limited range of navigational aids for the last three years, have introduced a range of "Electra" modular navigational instruments for the weekend yachtsman. Instruments which are now available cover boat speed, distance, depth, apparent wind direction and wind speed; more instruments are expected to follow.

INEXPENSIVE RADAR

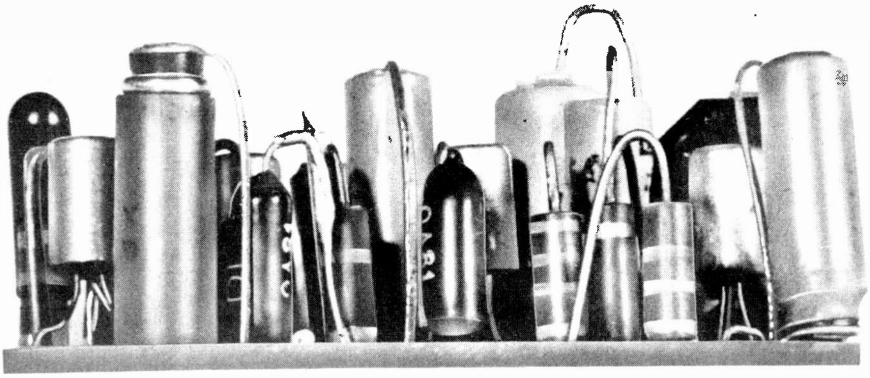
Radar sets costing less than £1,000 installed, were again displayed and the Decca 101 system appeared on most of the larger craft in the show. Few radar aerials are available in enclosures—although these have many advantages such as weatherproofing and no wind resistance on the aerial enabling smaller motors to be used. Two reasons for external aerials were given by manufacturers; many boat owners do not like the added wind resistance of an aerial enclosure and owners prefer to see the aerial revolving—"It lets others know you have radar"—keeping up with the Joneses!

EQUIPMENT DISPLAYS

Various interesting displays of working equipment were used to attract customers and, unintentionally, small children with sticky fingers and ice lollies. Taped sales talk was provided on the Ferrograph stand to advertise their graphic echo sounder, one of the smaller units displayed which uses dry recording paper. On another stand a marine receiver, made by S.P. Radio, was displayed working whilst being sprayed with water, although this receiver was removed from the stand at intervals during the show!

Electronic equipment for use at sea is not cheap but the quality of most of the equipment on display was excellent. Such equipment is built to high standards of reliability and most units are waterproof to some degree.

Electronics is playing a bigger and bigger part in weekend boating, not only in navigational aids but in the very necessary and useful distress signal equipment which is inexpensive when one considers its life saving ability.



SOUND OPERATED SWITCH

Although this unit is described as a "sound" operated switch, it can, in fact, be operated by any audio frequency signal that is connected to its input.

Basically, the unit consists of an amplifier section followed by a rectifier, which converts the amplified input signal to d.c.; the d.c. is then used to trigger an electronic switch, which in turn feeds the output load, a 6 volt 40mA bulb.

Normally, the bulb is off but is switched on when an audio signal of sufficient amplitude is connected to the input of the unit; if required, the mode of operation of the unit can be modified so that the bulb is normally on but is triggered off when the audio signal is applied.

A relay can be substituted for the lamp load, allowing external circuitry to be switched.

CIRCUIT DESCRIPTION

The full circuit diagram of the sound operated switch is shown in Fig. 1. A five transistor circuit is employed with the input connected, via C1, to the base of TR1, which acts as a common emitter amplifier.

Negative feedback is applied over this first stage by variable decoupling of the emitter load, VR1, thus providing an effective volume or sensitivity control.

The output of TR1 is coupled, via C3, to the base of TR2, which is also connected as a common emitter amplifier. The output of TR2 is fed, via C5, to the rectifier circuit, D1 and D2. C6 acts as a smoothing circuit in conjunction with the input impedance of TR3; the rectified voltage is negative in polarity.

SCHMITT TRIGGER

TR3 and TR4 are wired as a Schmitt trigger which is a two state circuit where either TR3 is hard on and TR4 off, or TR4 is hard on and TR3 is off; the state of the circuit can be changed by applying a suitable trigger potential to TR3 base.

In the circuit shown, TR3 is normally off and TR4 hard on, this state of the circuit being ensured by the choice of component values of R8 and R9, the base-bias network for TR3.

When the input signal is connected to the unit the rectified negative voltage is also fed to the base of TR3, changing its base-bias; when the bias is raised to a sufficient level, the Schmitt will trigger and the circuit will change its state very rapidly with TR3 switching hard on and TR4 off. The collector of TR4, which is normally at near zero potential, will jump to near full negative rail potential.

TR5 is wired as an emitter follower with its base direct coupled to the collector of TR4; thus, as TR4 switches off, TR5 switches hard on, illuminating the 6 volt 40mA bulb, LP1.

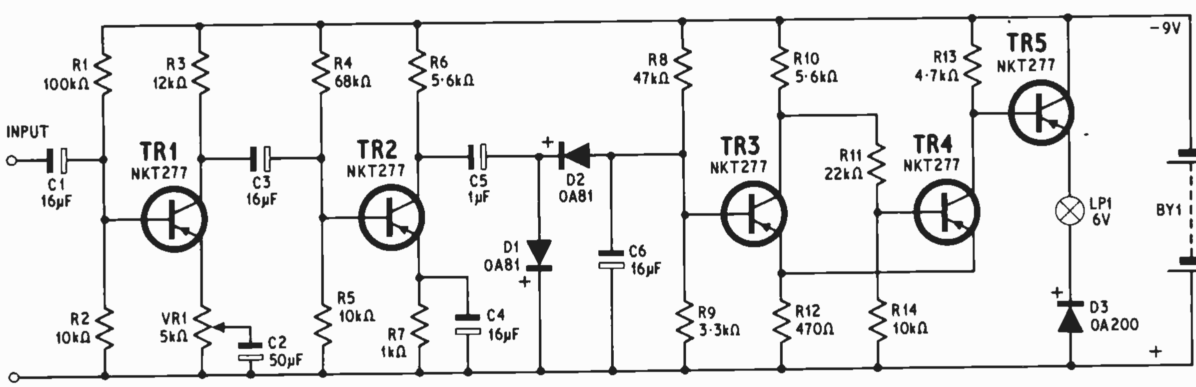


Fig. 1. Circuit diagram of the sound operated switch

PURPOSE OF DIODE

If diode D3 was omitted from the circuit it would be found that, although TR5 base and TR4 collector are at *near* zero volts, sufficient negative bias would still be available to cause TR5 to conduct quite heavily (almost 30mA). Including D3 in the circuit effectively raises the emitter potential of TR5, reducing the negative bias condition and reducing the emitter current to nearly 2mA with the Schmitt trigger off.

When the input signal falls to a sufficiently low level, the rectified d.c. decreases to a value at which the Schmitt can no longer be held on; the Schmitt then triggers very rapidly back to the off condition and the sequence of operations of the circuit is complete.

CONSTRUCTION

Start construction by cutting the Veroboard panel to size and breaking the copper strips, as indicated in Fig. 2.

COMPONENTS . . .

Resistors

R1	100kΩ	R6	5·6kΩ	R11	22kΩ
R2	10kΩ	R7	1kΩ	R12	470Ω
R3	12kΩ	R8	47kΩ	R13	4·7kΩ
R4	68kΩ	R9	3·3kΩ	R14	10kΩ
R5	10kΩ	R10	5·6kΩ		

All 10%; ¼ watt carbon

Potentiometer
VR1 5kΩ preset skeleton miniature

Capacitors
C1, C3, C4, C6 16μF elect. 15V
C2 50μF elect. 15V
C5 1μF elect. 15V

Transistors
TR1, 2, 3, 4, 5 NKT277 *or* NKT274 (Newmarket) (5 off)

Diodes
D1, 2 NKT249A30 (Newmarket) (2 off) *or* OA81 (Mullard)
D3 OA200 (Mullard)

Lamp
LP1 6 volt 40mA (or relay, see text)

Battery
BY1 9 volts, type PP7 *or* PP9

Miscellaneous
Veroboard, battery connectors, p.v.c. covered wire

As the first stage of assembly, wire up C1, R1, R2, R3, TR1, VR1 and C2 as shown in Fig 3. Double check the wiring and carry out a simple functional check to ensure that this section of the circuit is operating correctly. Next, wire up the second amplifier and rectifier stages.

If a voltmeter is available, connect it across C6 on its 10 volt d.c. range, apply a signal to the input of the unit and check that the circuit is functioning correctly by observing the reading on the voltmeter.

Now wire up the Schmitt trigger circuit and check that it operates by monitoring the voltage at TR4 collector.

With the Schmitt circuit off, TR4 collector will be almost 0·8 volts; with the Schmitt circuit on, TR4 collector will be around 8 volts.

Finally, wire up the rest of the circuit, comprising TR5, D3, and LP1, and check the operation of the complete unit.

VARIATIONS

In the circuit shown in Fig. 1, LP1 is normally off but is switched on when an input signal of sufficient amplitude is applied; if it is required that LP1 should be normally on instead, but switch off when the input signal is applied, modify the circuit by breaking the connection between TR5 base and TR4 collector, and re-connect TR5 base to TR3 collector.

If required, LP1 can be replaced by a 6 volt relay of resistance greater than 12 ohms; if a relay with a resistance of greater than about 100 ohms is used, D3 can be omitted from the circuit.

An input signal of about 8mV is required to trigger the unit; if it is driven from a speaker and matching transformer, quite loud noise levels are required for triggering. For low level triggering with a sound source such as a soft voice several yards away, one or both of two modifications can be made to the circuit:

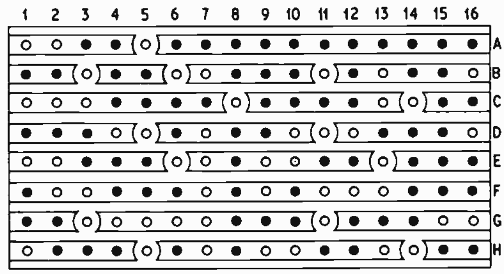


Fig. 2. Underside of board showing breaks in copper strips

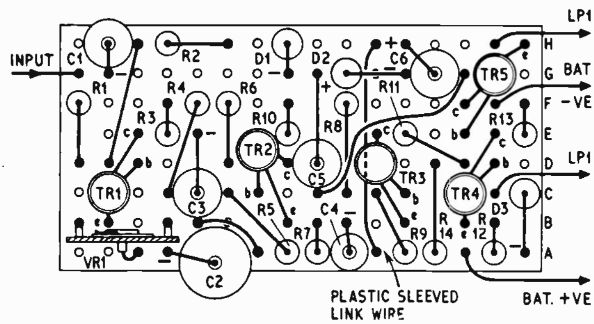


Fig. 3. Layout of components on board and connection details to other components

(a) Replace R9 with a 10 kilohm preset skeleton potentiometer, connecting one of the fixed arms to the slider; now short out the input to the unit and adjust the 10 kilohm potentiometer to the point at which the Schmitt circuit is just short of triggering; now connect an input signal and check that the Schmitt triggers at the required low level and resets itself when the input signal is removed.

(b) Add another amplifier stage to the unit, in front of the input connection, the additional stage being identical with the TR2 stage; if instability occurs, insert a decoupling network, comprising a 470 ohm resistor and 16μF capacitor, in the negative supply line between the new stage and the TR1 stage.

If either of these modifications are made, it will be necessary to increase the size of the Veroboard panel to accommodate the new components.

USING THE UNIT

To operate the unit directly by sound, connect a loudspeaker or microphone to the input via a matching transformer (the input impedance of the unit is in the order of a couple of thousand ohms, depending on the setting of VR1) and adjust VR1 for the required sensitivity; fairly high noise levels are required to trigger the unit.

The unit is primarily intended to be used in conjunction with other electronic equipment, such as amplifiers, transmitters, receivers, etc. and in this context the unit should be coupled into the other equipment at a point where sufficient drive is available to operate the switch; if the unit is to be used in conjunction with valve equipment, replace C1 with an adequately rated component; it may be necessary to include a limiting resistor in series with the input to prevent damage by overdriving.

APPLICATIONS

With a relay load the unit may be used as a baby alarm by remotely switching off the sound of a radio or television receiver when the child cries.

Two applications which should prove useful to the amateur radio fraternity are:

(a) as a voice command switch, the unit can be made to turn off the transmitter when not speaking, so providing considerable economies in carrier power radiation. This should appeal particularly to those owners of mobile equipment.

(b) as an indicator to provide a warning when a signal comes through on a preset channel of a communications receiver.

Since the switch can be made to trigger above an abitrary level of input signal, it can act as an overload cut-out if built into a composite piece of equipment.

PARTY NOVELTY

Finally, for those who like party tricks, the unit can be set up with the lamp LP1 mounted in front of a small concealed speaker, the lamp can then be illuminated by blowing on it (blowing on the speaker in fact).

Alternatively, if the connection between TR5 base and TR4 collector is broken and TR5 base connected to TR3 collector, a normally switched on lamp can be blown out. ★

POINTS ARISING

VARI WINDSCREEN WIPER (*October 1968*)

Following the author's notes on the Vari Windscreen Wiper (*Points Arising*, January 1969) some readers have noted that they are able to achieve satisfactory results when bench tested, but difficulties arise when fitted in the car. The following contributions may be of help to other readers:

Rapid Recovery Voltage

With reference to *Points Arising* in the January issue, the explanation may be correct in some cases, but I feel the fault is more likely to be due to the rapid recovery voltage of the electrical system causing the thyristor to switch on again.

The only remedy is to delay the rapid recovery of the voltage. One very effective way is to connect a capacitor across the thyristor (anode to cathode) thus giving a parallel path to produce the required delay (microseconds). The value could be from 1μF upwards.

I have built two of these devices with the modification which have been highly successful, then modified two others for friends who have had trouble with theirs. I used 25–50μF.

On those that I built, I removed the 560 ohm resistor R5, which does not appear to have any practical use; the devices have not suffered any as a result.—F.M., Sale, Cheshire.

Fire Risk

I feel obliged to advise you that there is a very serious fire risk on a modern vehicle if this system is employed together with *permanent magnet field* wiper motor. The user should be aware of the danger of pulsing the wiper or switch, since this switch effectively shorts out the motor armature, to produce the dynamic braking principle involved to stall the armature during "parking". However, the published circuit (October 1968) may be used to pulse a changeover relay which would have to be wired to replace the existing wiper switch.

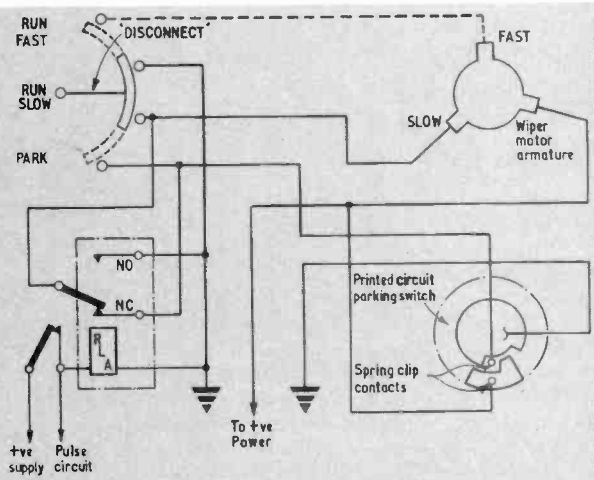


Fig. 1. Modified circuit for the Vari Windscreen wiper

To do this, disconnect the existing switch from the dash panel and transfer the wiring to the relay contacts as shown in Fig. 1. Then connect the new control relay coil either via the on-off switch for normal running, or via the pulse circuitry for delay wiping.—A.C.N.W., Ford Motor Co.

Capacitor Across Brushes

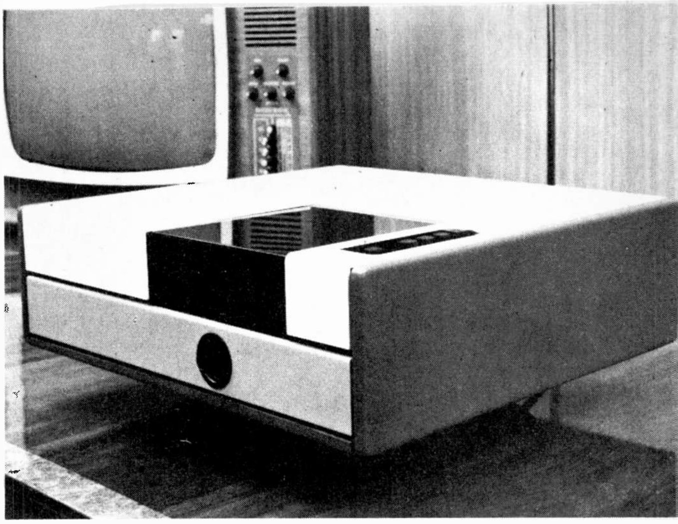
A friend of mine who had similar trouble suggested a capacitor across the brushes of the motor which cured the trouble of continuous action. However after being switched on for some time the action quickens up so that the slowest speed is only about three seconds between wipes. I tried a higher value potentiometer than 100 kilohms which gave a longer first delay, but again after running for some time quickens up to about the same previous three—second speed.—C.G.W., London, S.W.12.

Readers may also like to note that we have other ideas on windscreen wiper delay and hope to be able to publish details in the near future.—Ed.

METAL LOCATOR (*January 1969*)

We regret that a pagination error occurred in this article making continuity incorrect. The material on pages 18 and 19 should be transposed with the material on pages 20 and 21.

ELECTRONIC VIDEO RECORDING



using a flying spot scanner on specially prepared film

A LITTLE more than a year ago the first public announcement was made of a novel concept in audio visual recording. The idea was developed by Dr. Goldmark at the CBS Laboratories, Stanford, California, using specially prepared non-commercial film.

The system has now been released under patent protection rights by a partnership known as EVR, who will sell manufacturing and marketing rights by licence to genuinely interested and suitably equipped commercial concerns.

PLAYBACK ON F.M. TELEVISION

Special film records are prepared by copying 8 or 16mm masters and 1 or 2in video tape recordings at the Ilford Ltd. plant, Basildon. They are then loaded into a special cassette which, when inserted on the EVR (electronic video recording and reproduction) teleplayer spindle, will be automatically unloaded.

The playback film is threaded and automatically fitted to the take-up spool inside the teleplayer machine at the press of a button.

The teleplayer, which is connected to the aerial socket of a normal 625-line television receiver

The picture image on the film is converted to a frequency modulated video carrier of 175MHz suitable for injecting direct in the aerial socket of a 625-line standard domestic television receiver, while the sound track from a magnetic stripe on the film is suitably converted to a modulated television sound carrier frequency.

ELECTRON BEAM SCANNING

On the film originating side, the recording is made in the production laboratories at Basildon with an electron beam recorder. In this device a beam of electrons carrying the picture information bombards a special type of photographic film which is in a vacuum.

There is no purely optical system and there are no phosphor powders to cause a grainy effect on the film. Certain photographic emulsions are very sensitive to the high energy contained in the electron beam. The beam has a sharpness of definition beyond that obtainable with the very finest grain of film.

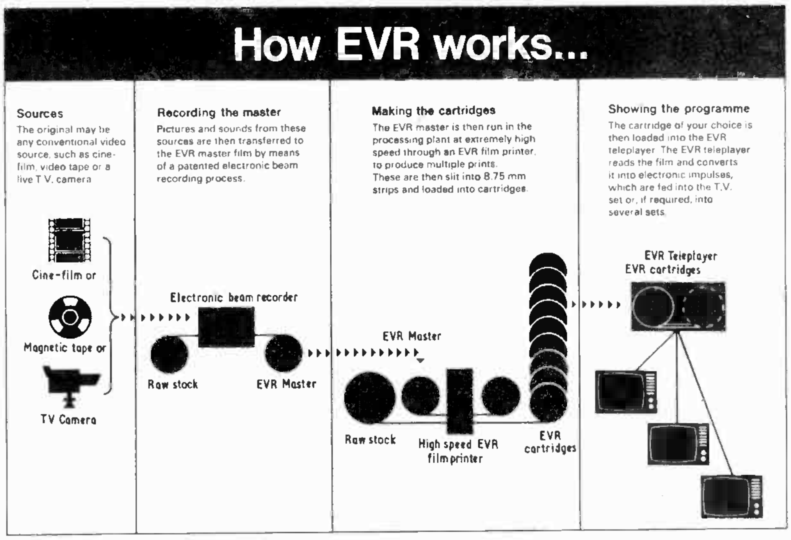
The electron beam sensitises the film to obtain a good-quality picture only about one tenth the size of the image on a 16mm film, and less than half the size of the image on an 8mm film. This ability to pack a lot of picture information in a small space without loss of quality is the essence of the system.

Two half-hour programmes in black and white or a single half-hour programme in colour can be recorded on a single spool of film of smaller dimensions than a conventional spool. Special signals are also recorded on the film whilst in the vacuum to serve as a basis for generating a modulated carrier in synchronism with the programme material.

The film has no sprocket holes, is contained in a sealed unit protected from dust, is completely automatic in threading and therefore is not subject to the wear and deterioration which is associated with conventional optical films with sprocket drive.

THE TELEPLAYER

The cathode ray tube used in the flying spot scanner is a long-life device which can be expected to deteriorate very slowly and be free from the sudden failure characteristic of normal projection lamps. Moreover, the life of the tube is prolonged by an automatic brilliance control circuit.



The teleplayer is about eighteen inches square and about seven inches high. It is completely automatic. It has facilities for normal playing, fast forward, fast reverse and for examining any selected single frame by manual drive in the vicinity of the selected part.

The output of the teleplayer goes by co-axial cable to any 625-line television set and can be plugged into either the aerial socket or a spare channel on the receiver. It in no way interferes with normal broadcast television reception and the receiver can be used for this or for EVR by the usual channel selection control.

On completion of playback, the film can be automatically rewound and loaded back into the cartridge; the cover is replaced making the complete film ready for immediate storage.

Whilst being of modest physical size the teleplayer uses semiconductors throughout to convert the recorded image and sound track simultaneously to f.m. signals, which are fully compatible with existing 625-line standards.

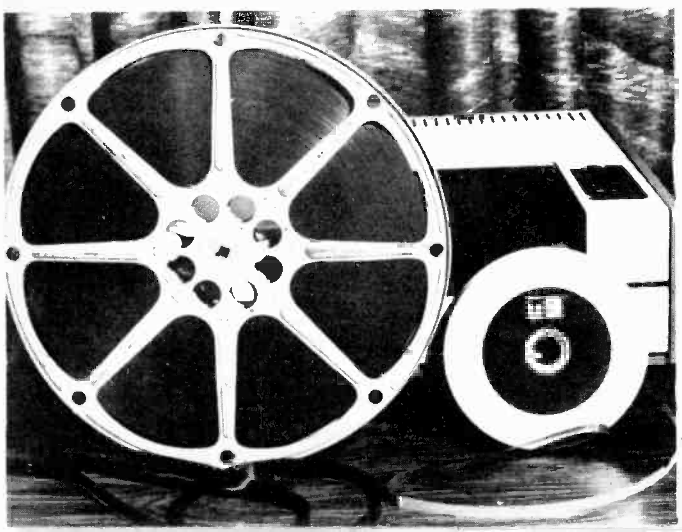
PRODUCTION AND APPLICATIONS

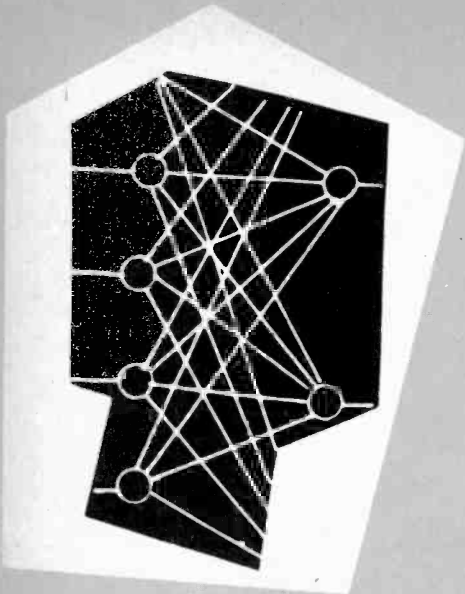
The first manufacturing licence has been granted to the Rank Organisation and the initial production run from Rank Bush Murphy is expected to be ready for field trials later this year.

Although it is possible to use the system for domestic purposes, it is primarily intended to assist in industrial training and educational establishments throughout the world. The basic price of a single teleplayer is estimated to be in the region of £200, while pre-recorded films could be made available on hire or by purchase, although the latter could in some cases be uneconomical to pursue.

A colour version of the teleplayer is expected to be demonstrated by EVR early next year, in which the luminance signal will be recorded on one track and the chrominance signal on the other. The EVR partnership was formed in 1967 by the Columbia Broadcasting System Inc. of America, Imperial Chemical Industries, and CIBA of Switzerland. ★

Comparison of 16mm film with an EVR telecartridge. The 16mm film on the left plays for 52 minutes. The cartridge on the right plays for one hour. A length of film from the cartridge shown has been unwound to illustrate the size of the film. Normally the film remains within the cartridge, except when it is being played. Take-up and rewind are automatic. On the right is the teleplayer being operated





BIONICS

BY G.C.BROWN
M.S.H.A.A., A.M.R.S.H.

5

NEURAL NETWORKS

To date an incredible quantity of information has been amassed concerning the operation of the *neuron*, or nerve cell. Theories and models too have appeared by the hundred showing ways in which networks of these neurons might be connected so as to produce certain intelligent functions. Indeed there are such a choice of theories, many of them perfectly feasible, that often rather than clarifying the situation, make the problem of finding the key to the working of the brain even more remote.

As it is, neurons are such tiny entities that an electron microscope is required to resolve their inner construction—an even bigger problem manifests itself when we try to picture the interconnections between say the "ten thousand million odd" in the human brain. An assessment of the number of interconnections becomes downright astronomical when we realise that there may very easily be something in the order of 5×10^4 individual contacts on *each* neuron.

THE HUMAN BRAIN

The various areas of the human brain and the primary functions associated with them have been largely mapped since the first World War; this last, in particular, appears to have been an ideal time for examining cortical topology—albeit rather unethically. However, the business of assigning "which bits appear to do what" seems to be more of a surgical operation than anything else, and as *our* brains are so complex anyway, neurologists have looked for some of the answers to the problem of "how" in the more simple forms of life.

We shall later inspect some of the less complex arrangements of neurons used in "property detectors" found in some of the simpler animals. In the meantime we shall take a look at the component that makes such things possible—the neuron.

It is fortunate for the animal kingdom that nature bestowed the neuron upon nearly all its members. Without networks of such neurons few living things, other than plants, would be able to regulate their external and internal environments and so survive. Functionally, a large proportion of neurons serve to receive and transmit information by way of electrical impulses to and from the various parts of an organism. These sensory and motor neurons, as they are called, are not the only type. In the brain of the vertebrates, for example, other neurons exist which co-ordinate the bodily activities, and so prevent chaotic or disorganised functioning

LIKE A MONOSTABLE

Electrically, individual neurons seem to operate in a way somewhat like the monostable circuit. When suitably triggered, the neuron fires a pulse of relatively constant amplitude lasting about 1 millisecond; it then goes through a short refractory period before it is able to accept triggering again. Increases in trigger amplitude cause the neuron to fire more frequently, while with relatively constant levels it "settles down" or accommodates to the input.

As has been previously discussed, there are several kinds of neurons—however, they all have a number of features in common with one another. Fig. 5.1 gives a general idea of the type found in the vertebrate brain. As can be seen from the illustration, each neuron comprises a soma or cell body from which several processes find their origin. These are the axons and dendrites. The axon is an output termination which feeds information from the neuron to other cells; while the dendrites (tree-like extensions) act as inputs connecting the neuron with axons from surrounding cells.

SYNAPSES

The point at which a dendrite meets an axon is called a synapse; this term was "coined" by Sir Charles Sherrington in about 1897 from the Greek word, meaning "to clasp". The synapse consists of a bulb adjoining the axon, and separates the latter from the receiving dendrite.

Not so long ago the neuron was considered to operate essentially in a binary fashion; to wit, it was

The design and construction of electronic "animals" or machines with artificial intelligence

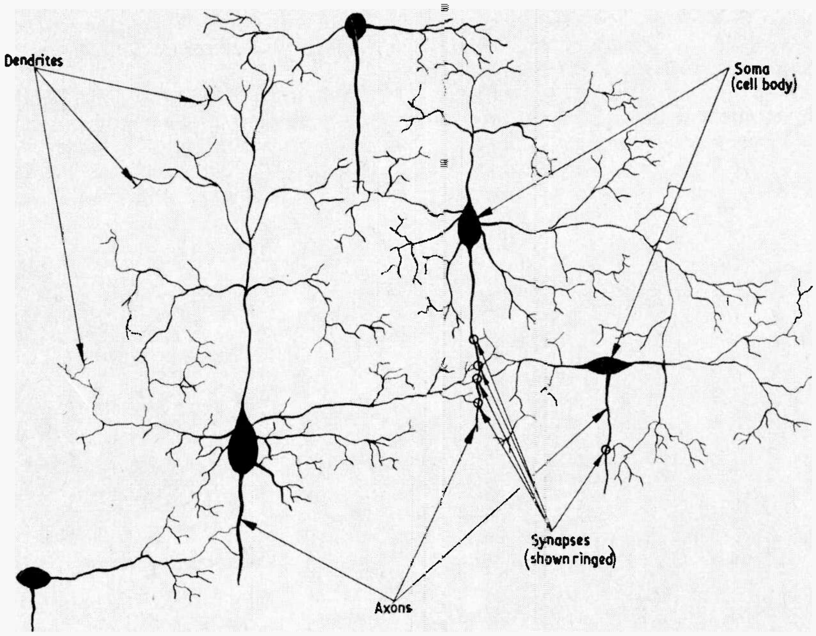


Fig. 5.1. Diagrammatical representation of a neural network which constitutes the basic component of the brain in vertebrates

either "off" or "on"—"firing" or "not firing". This view has changed in recent years, and "all or nothing firing" now appears limited to the axon alone. The electrical characteristics observed in dendrites appear markedly at variance with those seen in the axon, and this seems almost certainly due to the presence of the synaptic contacts.

Synapses are most easily conceived of as "weights" applied to each neuron cell which either allow it to fire easily, or only after some overall input threshold level has been exceeded. Looking at the neuron as a whole, complete with synapses adjoining axons from neighbouring cells, it might be thought of as a rather complex gate with a firing mode (as discussed previously) not unlike that of a monostable circuit. Fig. 5.2 shows a very much simplified schematic of the properties displayed by so-called "formal" neurons. Notice that the synapses although weighting a neuron may be either excitatory or inhibitory.

There is evidence that the synapses in addition to having varying controls over a neuron, can themselves vary over a period and so change the threshold. This seemingly gives rise to the effect that a neuron's ease of firing can be influenced by past events (previous inputs); tantamount surely to a memory.

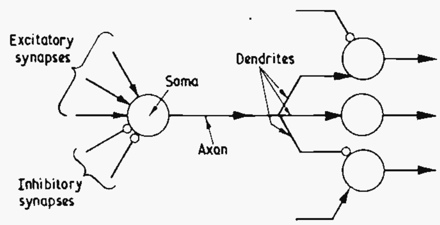
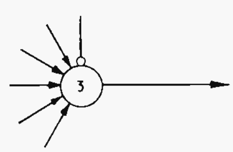


Fig. 5.2. Simplified schematic of the properties displayed by "formal" neurons

Fig. 5.3. Majority logic gate. If three or more inputs are active, the "neuron" will fire (this would also depend upon the weight of the inhibitory connection)



THRESHOLD AND MAJORITY LOGIC

In order to embrace both the digital-like axon function and analogue properties associated with the inputs to neurons, some convenient forms of logic have been evolved. These are threshold and majority logic. This latter type of logic, incidentally, is in the course of being applied to computer design because it carries a fair degree of redundancy, thus improving reliability of the equipment.

Majority logic is rather like a more versatile kind of normal logic: Fig. 5.3 gives the general idea. One could think of this example as having much the same properties as a three-input AND gate; except that there are *five* inputs, only three (and any three) of which need be stimulated together to provide an output.

Fig. 5.4 shows a threshold logic gate. This is like a combination of analogue and digital principles.

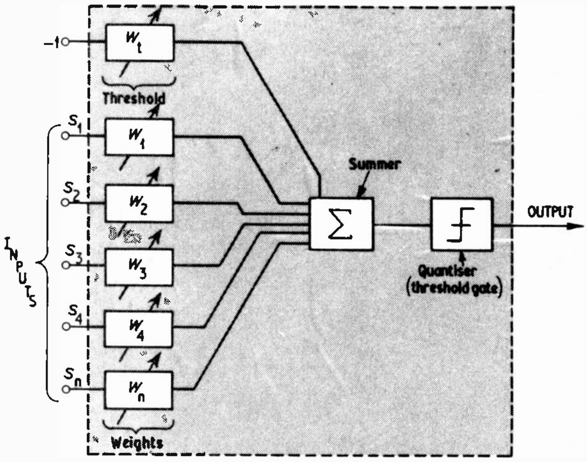


Fig. 5.4. Threshold logic gate

Remember that these examples are not actual neurons, but only hypothetical models which partly *mimic* a neurons action.

The threshold gate in Fig. 5.4 has binary inputs S_1, $S_2, S_3, S_4, \ldots S_n$; these for convenience are treated as having values of either $+1$ or -1 rather than the normal "0" or "1", and are supplied (following suitable weighting W_1, W_2, W_3, W_4, . . . W_n) to the summation unit. An additional threshold weight is applied to the summation device so that there may be a definite reference level. If this level is exceeded, the quantiser will produce an output of 1, otherwise it will remain at zero.

Whether an output from the gate occurs or not depends upon the level of the weighted sum of the inputs being equal to, or greater than, the threshold. This can be expressed mathematically as

$$\text{output} = +1 \text{ if} \sum_{n=1}^{n} W_n . S_n \geqslant W_t$$

or,

$$\text{output} = -1 \text{ if} \sum_{n=1}^{n} W_n . S_n < W_t$$

where W_t is the threshold weight.

Many of these threshold logic units (T.L.U's) have been dubbed "neural nets", because some of their characteristics are similar to those found in real neural systems. In fact the threshold device in Fig. 5.4 is capable of being "trained" to recognise certain inputs. This is accomplished by adapting the weights W_n until the quantities W_nS_n, compared with the threshold, result in an output of "1" at the quantiser. This process is then repeated with a number of variations in input to establish that the device gives the correct response only for particular inputs.

MOTOR-DRIVEN POTENTIOMETER

We suggested earlier that synaptic strengths often varied with the number of times a neuron had been triggered. As an electrical analogy this "semi-permanent memory" might be thought of as a motor-driven potentiometer, Fig. 5.5. With inappropriate responses the gain would be reduced, and conversely attenuation reduced for the correct response; it might be called a "punishment" and "reward" system.

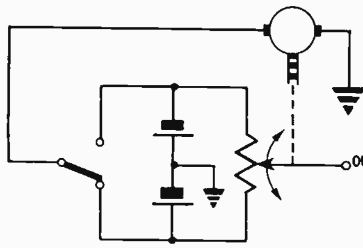


Fig. 5.5. An electrical analogy of a long-term memory

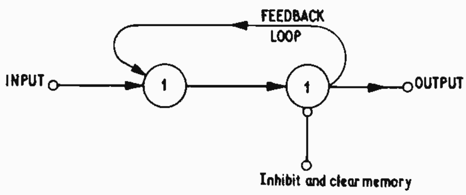


Fig. 5.6 Short-term memory

In a biological neuron, synaptic strengths seem to be varied chemically rather than electrically; the overall behaviour of a complete network of neurons would of course depend upon both this (the training) and the way in which the neurons are interconnected. (Whilst on the subject of chemistry, the reader may well be interested to know that we shortly anticipate examining some artificial memory devices using electro-chemical principles. Techniques, which the author uses, for constructing some of these devices will also be given.)

Although there is a considerable weight of evidence to suggest that we may now be "on the brink" of knowing the nature of memory storage, the question is still very moot as to just how many biological methods there could be for achieving this end; also, *which* of these happen to be relevant for a particular set of circumstances. We have already seen that variable synaptic weights may constitute a type of long-term storage device, but then is a similar principle involved in short-term memory? Certainly short-term memory can be demonstrated.

SHORT-TERM MEMORY

It has been conjectured that short-term memory may exist in the form of reverberatory feedback loops around neurons, so that once a group of such neurons have been activated they would continue firing one another until such time as they were inhibited. At that time, their output might either be modified, or destroyed (assuming it was no longer applicable), or alternatively transferred to a long-term memory in the event that a particular response proved fruitful. The former may also be true for long-term memory, where a certain long standing response to a contingency suddenly became inappropriate.

In Fig. 5.6, we see a formal representation of how this short-term memory could operate. An input at the first neuron will cause it to fire, resulting in the second being triggered and producing an output. The output pulse will also be fed back to the first neuron, resulting in it being re-triggered, and so on. After initial triggering, the system would hence produce an output indefinitely unless an input appeared at the inhibit connection to the second neuron.

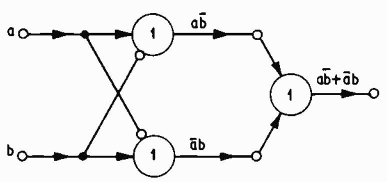


Fig. 5.7. Exclusive OR *function*

FEEDBACK LOOPS

Feedback loops of this kind do apparently exist biologically. If the reader inspects the two neurons on the extreme right of Fig. 5.1 it can be seen that synaptic connections exist between the processes radiating from both cells, forming a reverberatory loop. Not so long ago, an experiment was performed involving this type of feedback in the motor neurons of a frog's leg section. However, the feedback loop was deliberately introduced to establish whether reverberation could be induced artificially. This in fact proved to be true, for the muscle (conneeted with the neurons) continued twitching until the source of energy, maintaining its operation, was finally depleted.

OTHER LOGICAL FUNCTIONS

Up to now we have discussed some of the adaptive properties of neurons and neural networks. Neural networks also seem to perform many of the logical operations with which we are all familiar. The AND function we have already seen connected with majority logic; however such functions as "inclusive" and "exclusive" OR and NOT, are additionally evident biologically. Fig. 5.7 illustrates how the exclusive OR function is achieved in a neural system.

We shall see later on just how important these logical operations can be in several of the property detectors found in nature. In the meantime, another occurrence which must at times appear in neural nets should be examined. This is the possibility of malfunction. Although somewhat paradoxical, there is every likelihood that say a few intermittently operating neurons in a network may well be to a considerable advantage in certain situations. A hypothetical example of this will be discussed shortly, but first a look at an animal which seemingly has no memory.

ANIMALS WITHOUT MEMORY

In some of the most simple animals (protozoa) there is an indication that certain types of memory exist; this though may only be applicable to some of an organism's more major roles. Almost certainly, no real memory exists (that can be observed) in the amoeba. Surprisingly enough though, this single celled microscopic organism manages to perform in quite remarkable ways.

For example, an amoeba can sense tactile stimuli; it will screw up into a ball if given a good poke with a small glass rod. The amoeba also moves away from lesser tactile stimuli, bright light, and toxic chemicals. It additionally displays selective behaviour when on to the trail of food; for if the victim happens to be a quick mover, the amoeba will throw out its psuedopods (false feet) wide so as not to irritate or disturb the prey whilst engulfing it.

Conversely, the technique changes to clasping the food organism very closely for relatively inert objects. Quite a vocabulary of actions from a microscope blob of jelly-like protoplasm that apparently has no memory!

The truly incredible point that emerges from the example of the amoeba is that with no memory as such, *it manages to survive at all!* The whole virtue of a memory is, that with it, an animal is capable of remembering a particular event that has occurred within its environment and use the knowledge to advantage in the future. It thus learns from past experience. The amoeba seems unable to accomplish this, yet gets along quite well.

RANDOM MALFUNCTIONING

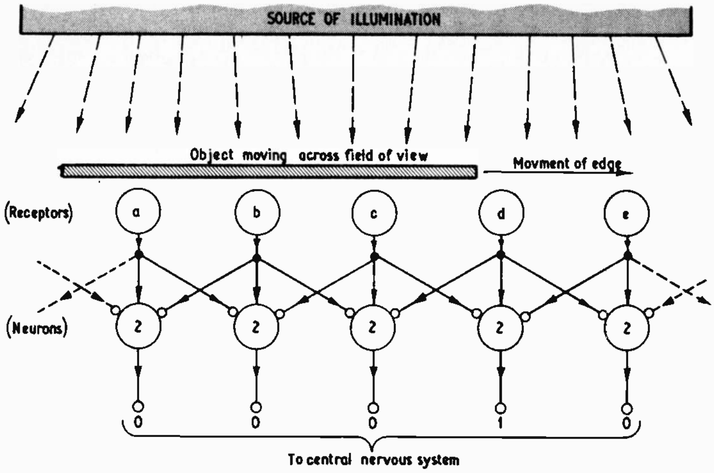
Suppose we designed an artificial device based on the amoeba; i.e. no memory, but some rudimentary sensory apparatus and the ability to move. One could imagine, that without the "animal" having some ability to keep a record of past events there would come a time when it found itself in serious difficulties. An example of this might be if the device elicited a response of say, a right turn, when confronted with bright lighting. Sooner or later it would make this response, and run headlong down a blind alley or into a brick wall.

Without a memory the "animal" would, to coin a phrase, be sunk! Nevertheless, even with no memory, it is possible to give the device a greater chance of survival. Let us suppose that instead of arranging to have the animal always turn right, we deliberately introduce some random malfunctioning. This might be a noisy (intermittent) component somewhere in its muscle control circuits. The modified "animal", we will assume, now occasionally turns (say) left, rather than making the "correct" response.

It will be clear that despite having an unreliable component within its framework, our "animal" now has a distinctly improved situation. This time, when it meets a bright light, it may well turn left instead of right and so avoid the previous contingency. Certainly it is better fitted for its environment than an animal without this defect, and would as a result exist for a longer time. (The reader will remember that this very notion of randomness was built in to the breadboard model of a few articles ago for the same reason.)

MORE COMPLEX ORGANISMS

Amoeba of course is an extremely simple animal. However, as we progress up the evolutionary ladder so we find that the more complex organisms utilise more and more specialised sensory equipment. We began to



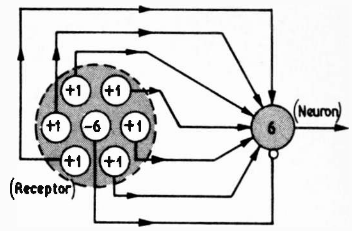


Fig. 5.9. Frog's "bug" detector

Fig. 5.8 (left). Image edge detector

notice for example that not only do some of these animals react to say the presence or absence of light, but also respond to changes in level of illumination and contrast between shadow and light in their field of view. For instance a large shadow might cause an organism to retreat, whereas a small one may elicit curiosity.

Yet higher up the ladder we come across even more sophisticated sensory apparatus—particularly that involved with sight and hearing. In addition to the sensory organs of which we are relatively familiar, there also exist a number which are not so immediately obvious. These receptors are naturally just as (sometimes more) important than those which go to make up the five senses, for they monitor the internal conditions of the animal.

The internal receptors may be found in muscles where they detect stretch and contraction; there are other sensory devices which detect the movement of joints. Still more pass on information about body temperature, posture, blood pressure, and pain stimuli. All these detectors vary in their construction according to the kind of sensory function they have to perform.

PROPERTY DETECTORS

Earlier we promised looking at some of the less complex property detectors; some of these will now be discussed both in the light of present knowledge, and hypothetically in relation to artificial counterparts.

A considerable proportion of the experimental work carried out with biological sensory systems up till now has been concerned with visual receptors. In this direction there is consequently a whole wealth of data available from which one may make comparisons, and postulate ways for synthesising some of the less complex examples. Indeed, it is from this very concept that the application of bionics springs.

Many of the more lowly marine animals, particularly the molluscs, and crustacea, have nervous systems which are extremely simple compared with the vertebrates. In fact some of their neural networks comprise only a handful of quite sizeable neurons—it is thus possible, in some cases at least, to be in a position to assign definite functions to these systems with a reasonable degree of accuracy.

COMPOUND EYE

One such case which has lent itself well to the study of visual systems has been the simple compound eye of the horseshoe crab *Limulus*. In such eyes there are a number of quite separate receptor cells, each having its own lens system and sensory cells from which run axonal fibres to the central nervous system.

The eye of the *Limulus* revealed some particularly interesting mechanisms, one of which (lateral inhibition) may well have exposed an important principle underlying certain functions in mammalian visual systems too. This particular mechanism makes itself evident when just a few of its visual receptors (ommatidia) are stimulated.

It seems that in addition to the receptor nerve fibres leading to the central nervous system, there also exist a plexus of further fibres from the same receptors communicating with their neighbours. These lateral interconnections make synaptic contacts at adjacent cells and appear to be mutually inhibitive. Thus by stimulating a group of receptors this lateral inhibition seems to promote contrast at the boundaries of an image—a type of edge or corner detector in fact.

IMAGE EDGE DETECTOR

Take a look at Fig. 5.8. Here we have part of a group of formal neurons and receptors which together show, in simplified form, how this property detection for edges seems to operate. Imagine that the receptors, *a* through to *e*, are illuminated. In this condition, each receptor will be generating an output which will place an inhibitory input on the neuron of its adjacent cell. Now each neuron requires *two* inhibitory inputs to ensure non-firing, so with all receptors stimulated (and assuming binary operation of the neurons) the neurons would return an output of zero. Come to think of it, we would additionally see zero output if none of the receptors were illuminated!

From inspecting the illustration, the reader will already have grasped what will occur if having illuminated the receptors we decided to move an object across the immediate field of view.

Assuming receptors *a*, *b*, and *c* are shaded from the light source, and *d* and *e* are exposed, an interesting phenomena takes place. The first three outputs will produce a "0", because although their neurons are disinhibited no inputs are present. The fifth output will also give a "0", for the opposite reason that despite having its receptor illuminated the neuron has *two* inhibitory inputs. The fourth output however will return a "1", due to it being illuminated and having insufficient inhibition to turn it off; i.e. only *one* inhibit from receptor *e*.

Thus, if an image moves in front of the receptors (from one side of the field to the other), the associated

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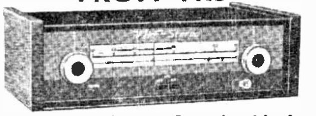

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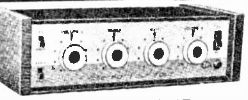

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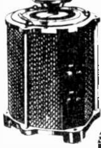

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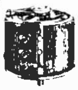

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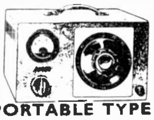

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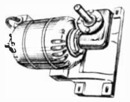
INDUSTRIAL KIT. Flash rate 1-80 f.p.s. Ideally suitable for schools, laboratories, etc. Incorporates double wound transformer which isolates both tube and timing circuit from mains. Stabilized timing circuit and high power tube. **£8/8/0** plus 6/- P. & P.

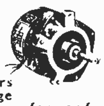
6½" POLISHED REFLECTOR.
Ideally suited for above Strobe kits. Price 8/6 post paid.
Regret not sold separately.

PARVALUX TYPE SD19 230/250 VOLTS A.C. REVERSIBLE GEARED MOTOR.



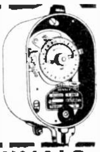
30 r.p.m. 40lb. ins. Position of drive spindle adjustable to 3 different angles. Mounted on substantial cast aluminium base. Ex-equipment. Tested and in first class running order. A really powerful motor offered at a fraction of makers' price. **6 GNS.** P. & P. 10/-.

BODINE TYPE N.C. I GEARED MOTOR.



(Type 1) 71 r.p.m. Torque 10lb. inch. Reversible. 1/70th h.p., 50 cycle, ·38 amp.
(Type 2) 28 r.p.m. Torque 20lb. inch. Reversible. 1/80th h.p., 50 cycle, ·28 amp.
The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115v. A.C. Supplied complete with transformer for **230/240v. A.C. input.** Price, either type **£2. 17. 6** plus 6/6 P. & P., or less transformer **£2. 2. 6** plus 4/6 P. & P.

200/250v AC HORSTMANN 20A TIME SWITCH

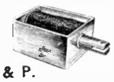


2 on/off every 24 hours at any pre-set time. Fitted in metal case. 36 hr. spring reserve. Used but fully tested. Fraction of makers' price. **£3.19.6** plus 4/6 P. & P. Available with solar dial on request.

INSULATED TERMINALS

Available in red, white, yellow, black, blue and green. New **17/-** per doz. **2/-.** P. & P.

230/240V. A.C. SOLENOID



Heavy duty type, approx. 3 lbs. pull. Price: **17/6** plus 2/6 P. & P.

12/24V. D.C. SOLENOID

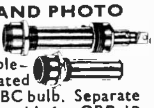
Approx. 8 oz. push. Price **8/6** plus 1/6 P. & P.

LIGHT SENSITIVE SWITCH

Kit of parts, including ORP12 Cadmium Sulphide Photocell, Relay, Transistor and Circuit, etc., 6-12 volt D.C. op. price **25/-** plus 2/6 P. & P. ORP 12 including circuit, **10/6** each, plus 1/- P. & P.

A.C. MAINS MODEL Incorporates Mains Transformer, Rectifier and special relay with 3, 5 amp mains c/o contacts. Price inc. circuit **47/6** plus 2/6 P. & P.

LIGHT SOURCE AND PHOTO CELL MOUNTING



Precision engineered light source with focusible lens assembly and ventilated lamp housing, to take MBC bulb. Separate photo cell mounting assembly for ORP. 12 or similar cell. Both units are single hole fixing. Price per pair **£2.15.0.** P. & P. 3/6.

UNISELECTOR SWITCHES
NEW

4 Bank 25 Way 24 v. D.C. operation **£5.17.6** plus 2/6 P. & P.
8 Bank 25 Way 24 v. D.C. operation **£7.12.6** plus 4/6 P. & P.

MINIATURE UNISELECTOR SWITCH

Ex-Equipment
3 banks of 11 positions plus homing bank. 40 ohm coil. 24-36 v. D.C. operation. Tested. **22/6,** plus 2/6 P. & P.

COPPER LAMINATE. Printed Circuit Board. Size 15½" × 5¼" 3/9 each. 3 for 10/-. Post paid.

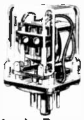
RELAYS

Bulk purchase enables us to offer the following new **SIEMENS, PLESSEY,** etc. miniature plug in relays complete with base, at a fraction of makers' price.

Coil Ω	Working Voltage	Contacts	Price
280	6 - 12	2 c/o	14/6
280	9 - 18	4 c/o	15/6
700	12 - 24	2 c/o	12/6
700	16 - 24	4 c/o	15/6
700	16 - 24	4M 2B	12/6
1250	20 - 40	2 c/o H.D.	12/6
2500	30 - 50	2 c/o H.D.	12/6
5800	50 - 70	4 c/o	10/-
9000	40 - 70	2 c/o	10/-

H.D. Heavy Duty. POST PAID

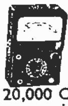
SEALED RELAY



230 VOLT AC COIL
Two c/o
5 amp contacts.
Plug-in I.O. Base.
Price **14/6.** incl. base. Post Paid.

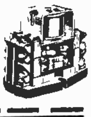
3 c/o Amp. CONTACTS **17/6** Incl. Base. Post Paid.

SANWA MULTI RANGE METERS



New Model U50D Multi tester, 20,000 OPV, mirror scaled with overload protection. Ranges—d.c. volts: 100mV, 0·5 v. 5 v., 250 v., 1,000 v.; a.c. volts: 2·5 v., 10 v., 50 v., 250 v., 1,000 v.; D.C. current: 5 μA, 0·5 MA, 5 MA, 50 MA, 250 MA. Complete with battery and test probe. **£7/5/0** post paid. Three other models available from stock. Descriptive leaflet on request.

A.C. CONTACTOR



2 make + 2 break (or, 2 c/o.). 15 amp. contacts. 230/240V. A.C. operation. Brand new. Price **22/6** plus 1/6 P. & P.

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All Mail Orders—Also Callers—Ample Parking Space
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SHOWROOM NOW OPEN CLOSED SATURDAY

Personal callers only
9 LITTLE NEWPORT ST.
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neurons will progressively show "ones" at their outputs as the approaching edge meets a receptor. This type of property detector, therefore, not only displays the ability to see edges and sharpen up contrast, but has the merit that it can pass on information about rate and direction of movement as well!

The *Limulus* is not, of course, the only animal whose visual system makes use of mutual inhibition—in fact it is fast becoming clear that without this property, true recognition, be it visual, auditory or whatever, would be virtually impossible.

FROG BUG DETECTOR

Not so long ago, some other workers in the bionics field localised a rather interesting form of inhibiton present in the eye of the common frog. The system that incorporated this form of inhibition they called, for lack of a better phrase, the frog's "bug detector". It will be apparent from Fig. 5.9 that a group of such devices besides giving the frog an indication of the "bugginess" of the environment, would also serve to warn the animal if a predator came into view. Small shadows across the frog's field of view would tend to mean food, and large shadows could imply, "hop it, someone's after you!"

Of course, Fig. 5.9 is but a simplification of the real thing—however, it does work! Assuming the receptors are all equally illuminated, then the effects of the six exciter receptors will be *just* cancelled by the -6 output from the inhibitor. The neuron would therefore return a vote of nil. Now if, whilst the receptors remained illuminated, the image of some object in the field of view happened *only* to cover the central inhibitor an output would immediately appear at the neuron. Such a condition might, to the frog, be indicative of a fly or some other tasty morsel in the immediate vicinity.

We could imagine other connections from the receptors in the "bug detector" which might pass on information only if a shadow covered *all* the receptors. Such data could constitute a warning that danger was imminent.

IMPORTANCE OF INHIBITION PROPERTY

Inhibition certainly seems to be one of the important fundamental characteristics of nervous systems; at times it would almost appear more significant than the property of excitation.

Research concerning the implications of inhibition in sensory mechanisms is currently being conducted in many universities and laboratories. In fact, so vast could be the outcome stemming from work in this field, that the United States Air Force recently granted a contract to a research foundation to "drum up" as much biological literature as possible in order to get ideas! The response they received was incredible, for it resulted in something like five hundred references on the subject, and in the region of one hundred and fifty odd papers and volumes connected with biological "transducers" alone!

In the article appearing next month we shall forge ahead with discussions about more of these property detectors. Also describe how some of them might be implemented in our "mobile breadboard", which incidentally the constructors amongst you must have felt the author had completely forgotten about!

A topic emerging from all these discussions about nerve nets and property detectors, will also be in evidence next month: that of pattern recognition.

To be continued

NEWS BRIEFS

Television Guidance System for Martel

AN ORDER worth several million pounds sterling has been placed with The Marconi Company by the Ministry of Technology, for television guidance systems for the first production batch of Anglo-French MARTEL guided missiles.

The heart of this very advanced missile system is a small sensitive television camera, carried in the nose of the missile, which provides a high quality picture from which any type of target can be positively identified.

This "missile-eye-view" is transmitted back to the launching aircraft, where the observer is able to follow the missile flight on a television monitor.

A joystick control in the cockpit enables him to adjust the field of view of the camera, over a command radio link. Control signals are then generated within the missile itself to align the flight path with the axis of the television camera, once the target has been identified.

The launching aircraft need never come within visual or radar range of the target, and can be safely on their way back to base while the missile is guided to its target.

Inventions and New Products Exhibition

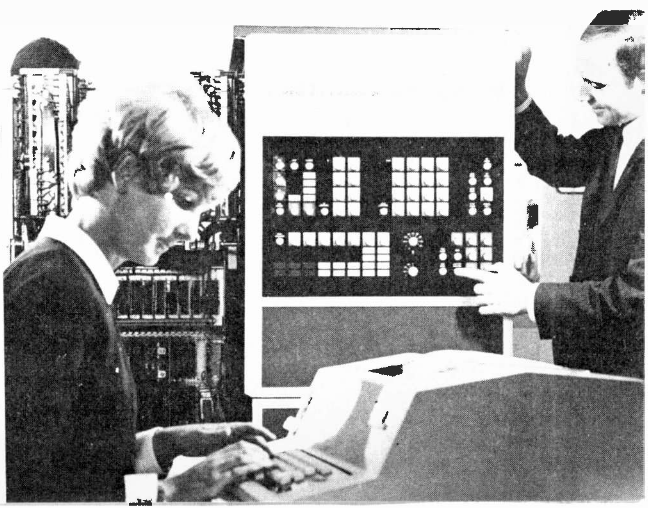
AN exhibition of inventions and new products covering a wide range of items was held at the New Horticultural Hall, Westminster, during January. Among the various electronic devices on display was a motor vehicle immobiliser, which cuts out the engine of the vehicle by blocking the air intake when the driver leaves his seat, and ensures that the engine cannot be restarted without the use of a special key.

A versatile low cost computer the Micro-16 made by Digico Ltd. was on display. This computer can be desk mounted, works as a real time machine with interrupt facilities and has a 4,000 word store with teletype input and output. The complete computer is priced at £4,100.

Other inventions included a kinetic abstract image display which produces a continually changing colour display and a pressure variable resistor which uses plastic foam impregnated with carbon as the resistive element.

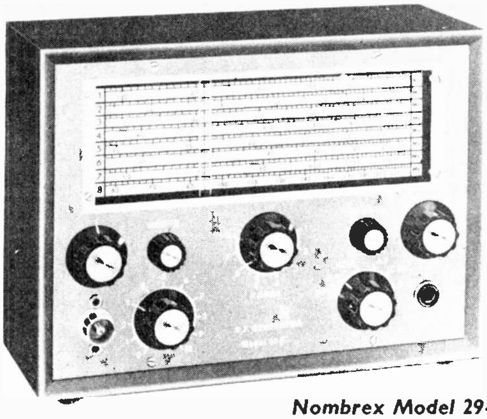
New Computers

TWO NEW computers have recently been introduced by Siemens; they are the 4004/16 and the 4004/25. The third generation Siemens computers using integrated monolithic circuits and featuring cycle times in the nanosecond range have so far proved to be reliable and efficient. The photograph shows the central processor 4004/26 of the Siemens computer system 4004.



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.

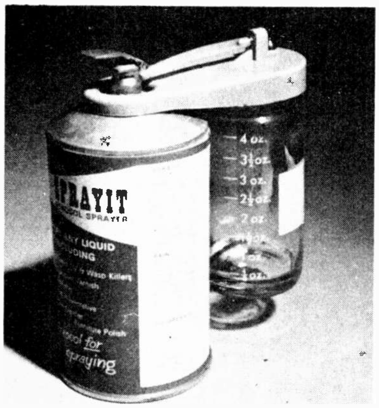


Nombrex Model 29-S signal generator

R.F. SIGNAL GENERATORS

The new range of **Nombrex** r.f. signal generators, models 29-S and 29-X, are ideal for the amateur constructor, service engineers and technical training colleges.

The main feature of the 29-S model is a frequency range of 150kHz to 220MHz in eight overlapping bands on separate scales with an accuracy said to be better than 2 per cent. There is a front panel electronic scale calibration control. The modulation frequency is adjustable from 400 to 1,000Hz and modulation depth is fully adjustable from 0 to 100 per cent.



"Sprayit" aerosol from David Hewson

The average r.f. output is 100mV on all ranges and the output impedance is 600 ohms, constant at all attenuation settings.

The 29-X model incorporates all the features of the standard model and also incorporates an integral crystal oscillator module.

The crystal oscillator provides harmonic calibration check points on all ranges to an accuracy of $\pm 0{\cdot}02$ per cent using the front panel calibration control. The marker signal level, adjustable by the attenuator, is available separately at the r.f. output socket for use with external equipment.

Both models are housed in a steel stove enamelled medium grey case and the rectangular tuning scale measures $5\frac{1}{4}$in $\times$ $2\frac{1}{4}$in. The generators are all solid state and are powered by standard 9 volt batteries. The retail prices are: model 29-S £20; model 29-X £27.

MISTER BASSMAN

A musical accompaniment instrument recently released by **D.E.W. Ltd.**, Ringwood Road, Ferndown, Dorset, should arouse the interest of our musically minded readers. Called "Mister Bassman" it is believed, by the manufacturers, to be the only self-contained bass accompaniment pedal unit on the market.

The unit has a thirteen note foot change arrangement giving an organ tone for vamping, or a string bass effect with decay on each note sounded. The unit is battery powered and can be used with almost any amplifier.

The Dewtron Mister Bassman costs £25 and is finished in hammer blue, with heavy chromed keys.

AEROSOL SPRAY

An item that should have many useful applications is the "Sprayit" Aerosol marketed by **David Hewson Ltd.**, 195, Sparrows House, Bushey Heath, Herts. The "Sprayit" costs 22s 6d and consists of a propellant aerosol spray, a glass jar with graduated volume markings on the side and plastics down tubes.

It is claimed that one ounce of propellant will spray up to two fluid ounces of any liquid from the jar. In some cases it is not necessary to pour liquid into the jar, but simply insert the down tube in the existing bottle or can.

The spray can be used to give a hammer finish to metal work; sealing, painting or varnishing woodwork; applying fluids when etching printed circuits; and used for cleaning switches, contacts and any delicate electronic equipment.

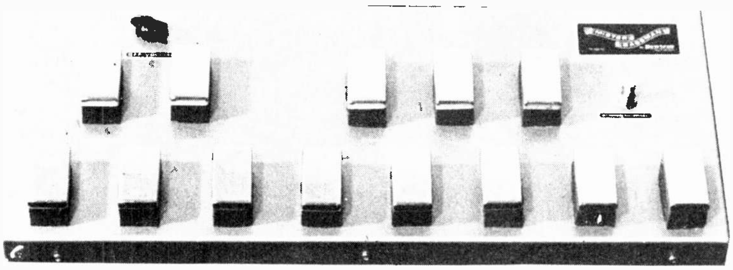
LITERATURE

The second edition of the catalogue of electronic components and equipment is now available from **G. W. Smith & Co. (Radio) Ltd.**, 34 Lisle Street, London, W.C.2.

Many new items are listed and the catalogue contains five 2s-in-the-£1 discount coupons enabling the cost of the catalogues to be recovered on subsequent orders.

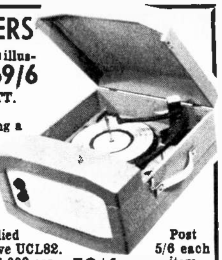
Because of increased postal and labour costs a minimum postal charge of 3s is made by G. W. Smith's on all parcels sent by post. The cost of carriage on larger items is indicated separately throughout the catalogue.

Readers looking for technical information are recommended to consult a technical library where most librarians are often helpful in finding the necessary data required. This often leads the reader to obtaining a copy of the book or perhaps leaves him in some doubt as to whether it really helps to solve his problem. A comprehensive stock of technical books on several subjects is often available through some local dealers, but if in difficulty, we would suggest readers obtain a copy of the new technical book catalogue from the **Modern Book Co.**, 19–21 Praed Street, London, W.2. Their "Catalogue of Radio Television and Electronics Books" (price 2s) contains 68 pages of probably the most comprehensive list of technical books in town.



"Mister Bassman" pedal accompaniment unit marketed by D.E.W. Ltd.

DE LUXE PLAYERS



PORTABLE CABINET As illustrated. To fit standard player or autochanger. **69/6**
RCS AMPLIFIER 3 WATT.
Ready made and tested. This is a 2-stage unit using a triode pentode condenser coupled valve, giving 3 watts output into a 3 ohm loudspeaker. Tone and volume controls mounted on chassis with knobs. Supplied with loudspeaker and valve UCL82. Frequency response 50-12,000 cps. Sensitivity 200mV. **59/6** Post 5/6 each item

SINGLE PLAYERS MONO		AUTOCHANGERS MONO	
BSR GU7.		BSR Superslim	£6.19.6
9v. Battery model	£4.19.6	GarrardAT60 Mk. II	£12.19.6
EMI Junior Mains	£2.19.6	BSR Transcription	
Garrard SRP22 ...	£6.19.6	UA70 Stereo/Mono	£12.19.6

All fitted LP/78 stylii and mono pickup crystal complete. Stereo/mono pickups 20/- extra except UA70.

GARRARD TEAKWOOD BASE WB.1. Ready cut out for mounting 1000, 2000, 3000, SP25, AT60. **65/-**

GARRARD PERSPEX COVER SPC.1 for WB.1 **65/-**

DE LUXE STEREO GRAM CHASSIS V.H.F. MW, SW 19-50m. SW 60-180m. Magic eye, push buttons. 6 valve plus rect. Size 15 × 7½ 6in. high. **£19.19**

PICK-UP ARM Complete with ACOS LP-78 GP67 and Stylii 29/6; XTAL GP67 17/6; Stereo Ceramic 35/-.

CRYSTAL MIKE INSERTS

1½ × ⅞in. 6/6; ACOS 1⅞ ⅞in. 8/6. BM3, 1" dia. 9/6
MOVING COIL MIKE with Remote Control Switch 19/6

PORTABLE TRANSISTOR AMPLIFIER PLUS DYNAMIC MICROPHONE

A self-contained fully portable mini p.a. system. Many uses — ideal for Parties, or as a Baby Alarm, Intercom, Telephone or Record Player, Amplifier, etc. Attractive rexine covered cabinet, size 12 × 9 4in., with powerful 7 × 4in. speaker and four transistor one watt power amplifier plus ultra sensitive microphone. Uses PP9 battery. Brand new in Makers' carton with full makers' guarantee. World famous make. Only **90/-** Post Free

WEYRAD P50 — TRANSISTOR COILS

RA2W 6 in. Ferrite Aerial with car aerial coil	12/6	Spare Cores	6d.
Osc. P50/1AC	5/4	Driver Trans. LFDT4 ..	9/6
I.F. P50/2CC 470 kc/s ..	5/7	Printed Circuit, PCA1 ..	9/6
3rd I.F. P50/3CC	6/-	J.B. Tuning Gang	10/6
		Weyrad Booklet	2/-

Telescopic Chrome Aerials 6in. extends to 23in. 5/-.
Ferrite Rods 8 × ⅜in. 4/-. 6 × ¼in. 5/-.

VOLUME CONTROLS

Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 3/-. D.P. 5/-. STEREO L/S 10/6, D.P. 14/6. 5K. S.P. Edge type, 5/-.

80Ohm Coax 8d. yd.

SEMI-AIR SPACED 40 yd. 20/-; 60 yd. 30/-.
FRINGE LOW LOSS Ideal 625 lines **1/6** yd.

VEROBOARD 0·15 MATRIX
2½ × 5in. 3/8. 2½ × 3¾in. 3/2. 3¾ × 3¾in. 3/8. 3¾ × 5in. 5/2.
EDGE CONNECTORS 16 way 5/-; 24 way 7/6.
PINS 36 per packet 3/4. FACE CUTTERS 7/6.
S.R.B.P. Board 0·15 MATRIX 2½in. wide 6d. per 1in., 3¾in. wide 9d. per 1in.; 5in. wide 1/- per 1in. (up to 17in.).
S.R.B.P. undrilled 1/16in. Board 10 8in. 3/-.

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in. sides, 7×4in., 5/6; 9×7in., 6/6; 11 3in., 6/6; 11 7in. 7/6; 13×9in., 9/6; 14×11in., 12/6; 15×14in., 15/-.
ALUMINIUM PANELS 18 s.w.g. 12 × 12in. 6/6; 14 9in. 5/6; 12×8in. 4/6; 10 × 7in. 3/6; 8×6in. 2/6; 6 × 4in., 1/6.

Q MAX CHASSIS CUTTER

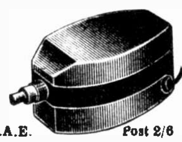
Complete: a die, a punch, an Allen screw and key
½in. 16/- ⅝in. 17/6 1⅛in. 19/6 1¼in. 24/- 2 3/32in. 44/3
¾in. 16/- 1in. 19/6 1⅜in. 20/6 1½in. 29/- 2½in. 57/3
⅞in. 16/9 1 1/16in. 19/6 1⅝in. 21/6 2in. 39/- 1in. sq. 36/6

'SONOCOLOR' CINE RECORDING TAPE

5" reel, 900' with LP strobe markings. also cine light deflector-mirror for synchronisation. 14/- each.
UNIVERSAL TAPE CASSETTES C60. OUR PRICE 14/-.

Tape Spools 2/6. Tape Splicer 5/-. Leader Tape 4/6.
Reuter Tape Heads for Collaro models 2 track 21/- pair.

"THE INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETISER



200/250 v. A.C. Leaflet S.A.E. Post 2/6 **35/-**

BARGAIN STEREO/MONO SYSTEM

Attractive Slimline PLAYER CABINET with B.S.R. UA25 Deck, 4 + 4 AMPLIFIER and TWO matched LOUDSPEAKERS. Carr. 10/6 **£19.19.6**
(Only 4 pairs of wires to join).

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2/350V ..	2/3	100/25V ..	2/-	8/600V ..	9/6
4/350V ..	2/3	250/25V ..	2/6	16/600V ..	12/6
8/450V ..	2/3	500/25V ..	4/-	16+16/500V	7/6
16/450V ..	3/-	8+8/450V	3/6	32+32/250V	3/6
32/450V ..	3/9	8+16/450V	3/9	50+50/350V	7/-
25/25V ..	1/9	16+16/450V	4/3	60+100/350V	11/6
50/50V ..	2/-	32+32/350V	4/6	3000/30V	8/6

SUB-MIN. ELECTROLYTICS. 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 250mF 15V 2/-; 500, 1000mF 12V 3/6; 2000mF 25V 7/-.
CERAMIC. 500V 1pF to 0.01mF, 9d. Discs 1/-.
PAPER 350V-0·1 9d, 0·5 2/6; 1mF 3/-; 2mF 150V 3/-.
500V-0·001 to 0·05 9d; 0·1 1/-; 0·25 1/6; 0·5 3/-.
1,000V-0·001, 0·0022, 0·0047, 0·01, 0·02, 1/6; 0·047, 0·1, 2/6.
SILVER MICA. Close tolerance 1%. 5-500pF 1/-; 560-2,200pF 2/-; 2,700-5,600pF 3/6; 6,800pF-0·01, mfd 6/-; each
TWIN GANG. "0-0" 208pF+176pF, 10/6; 365pF, miniature 10/-; 500pF standard with trimmers, 9/6; 500pF midget less trimmers, 7/6; 500pF slow motion, standard 9/-; small 3-gang 500pF 18/9. Single "0" 365pF 7/6. Twin 10/-.
SHORT WAVE. Single 10pF, 25pF, 50pF, 75pF, 100pF, 160pF, 200pF, 10/6 each. Can be ganged. Couplers 9d each.
TUNING. Solid dielectric. 100pF, 300pF, 500pF, 7/- each.
TRIMMERS. Compression 30, 50, 70pF, 1/-; 100pF, 150pF, 1/3; 250pF, 1/6; 600pF, 750pF, 1/9; 1000pF, 2/6.

250V RECTIFIERS. Selenium ½ wave 100mA 5/-; BY100 10/-.
CONTACT COOLED ½ wave 60mA 7/6; 85mA 9/6.
Full wave Bridge 75mA 10/-; 150mA 19/6; TV rects. 10/-.
NEON PANEL INDICATORS 250v. AC/DC 3/6.
RESISTORS. Preferred values, 10 ohms to 10 meg.
¼ w., ½ w., 1 w., 20% 3d.; 1½ w. 8d.; 2 w. 1/-; ½ w. 10% 6d.
HIGH STABILITY. ½ w. 1% 10 ohms to 10 meg., 2/-.
Ditto 5%. Preferred values 10 ohms to 22 meg., 9d.
5 watt } 0.5 to 8.2 ohm 3 w. { 2/-
10 watt } WIRE-WOUND RESISTORS { 2/-
15 watt } 10 ohms to 6,800 ohms { 2/-
10K, 15K, 20K, 25K, 68K, 10W. 3/-
FULL WAVE BRIDGE CHARGER RECTIFIERS:
6 or 12v. outputs. 1½ amp. 8/9; 2a., 11/3; 4a., 17/6.
CHARGER TRANSFORMERS. P. & P. 5/-. Input 200/250v. for 6 or 12v., 1½ amps., 17/6; 2 amps., 21/-; 4 amps., 30/-.

WIRE-WOUND 3-WATT POTS.	WIRE-WOUND 4-WATT
T.V. Type. Values 10 ohms to 30 K., Carbon 30 K to 2 meg. **4/6**	STANDARD SIZE POTS. LONG SPINDLE 50 OHMS to 100 K. **7/6**

VALVE HOLDERS, 9d.; CERAMIC 1/-; CANS 1/-.

NEW MULLARD TRANSISTORS 6/- each

OC71, OC72, OC81, OC44, OC45, OC171, OC170, AF117.
REPANCO TRANSISTOR TRANSFORMERS.
TT45. Push Pull Drive, 9:1 CT, 6/-. TT46 Output, CT8:1 6/-.
TT49. Interstage, 20:1, 6/-; TT52 Output 3 ohms, 4·5:1, 6/-.
TT23/4 PAIR 10W. Amp. Transformers and circuit 45/-.

TRANSISTOR MAINS POWER PACKS. FULL WAVE
9 volt 500mA. Size 4½ × 2½ × 2in. Metal case. Crackle finish. Output terminals. On/off switch. **49/6**
Half Wave 9 volt 50mA. Size 2½ × 1¼in. Snap terminals 32/6
9 volt 500mA. TRANSFORMER ONLY. 2½ × 1¾ × 1¾in. 10/6

MAINS TRANSFORMERS

Post 5/- each

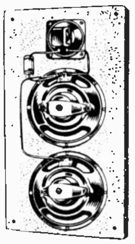
250-0-250 50 mA. 6.3 v. 2 amps, centre tapped	19/6
250-0-250 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a, or 5 v. 2 a.	30/-
350-0-350 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a, or 5 v. 2 a.	35/-
300-0-300 v. 120 mA., 6.3 v. 4 a. C.T.; 6.3 v. 2 a.	45/-
MINIATURE 200 v. 20 mA., 6.3 v. 1 a. 2½ × 2 × 1⅝in.	12/6
MIDGET 220 v. 45 mA., 6.3 v. 2 a. 2¾ × 2⅓ × 2in. ..	17/6
HEATER TRANS. 6.3 v. 1½ a., 8/6; 6.3 v. 4 a.	12/6
Ditto tapped sec. 1.4 v., 2, 3, 4, 5, 6.3 v. 1½ amp. ..	12/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a.	30/-
1 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60,	35/-
3 amp., 0-12 v. and 0-18 v.	19/6

AUTO TRANSFORMERS 0-115-230 v. Input/Output, 60w. 18/6; 150w. 30/-; 500w. 92/6; 1000w. 175/-.

COAXIAL PLUG 1/3, PANEL SOCKETS 1/3. LINE 2/-.
OUTLET BOXES. SURFACE OR FLUSH 4/6.
BALANCED TWIN FEEDERS 1/- yd. 80 ohms or 300 ohms.
JACK SOCKET Std. open-circuit 2/6, closed circuit 4/6; Chrome Lead Socket 7/6. Phono Plugs 1/-. Phono Socket 1/-.
JACK PLUGS Std. Chrome 3/-; 3·5mm Chrome 2/6. DIN SOCKETS Chassis 3-pin 1/6; 5-pin 2/-. DIN SOCKETS Lead 3-pin 3/6; 5-pin 5/-. DIN PLUGS 3-pin 3/6; 5-pin 5/-.
WAVE-CHANGE SWITCHES WITH LONG SPINDLES.
2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way 4/6 each.
1 p. 12-way, or 4 p. 2-way, or 4 p. 3-way, 4/6 each.
Wavechange "MAKITS" 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. 1 wafer 12/-, 2 wafer 17/-. 3 wafer 22/-
Additional wafers 5/- each up to 12 max.
TOGGLE SWITCHES, sp. 2/6; sp. dt. 3/6; dp. 3/6; dp. dt. 4/6

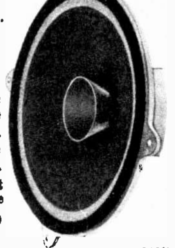
MINI-MODULE LOUDSPEAKER KIT

10 WATT 55/- CARR. 5/-



Triple speaker system combining on ready cut baffle. ½ in. chipboard 15 in. × 8½ in. Separate Bass, Middle and Treble loudspeakers and crossover condenser. The heavy duty 5 in. Bass Woofer unit has a low resonance cone. The Mid-Range unit is specially designed to add drive to the middle register and the tweeter recreates the top end of the musical spectrum. Total response 20-15,000 cps. Full instructions for 3 or 8 ohm. Teak veneered bookshelf enclosure £5.10.0 extra.

BAKER 12in. DE-LUXE MK II LOUDSPEAKER



Suitable for any Hi-Fi System. Provides truly rich sound recreating the musical spectrum virtually flat from 25-16,000cps. Latest double cone with special "Ferroba" ceramic magnet. Flux density 14,000 gauss. Bass resonance 32-38cps. 15 watts British rating. Voice coils available 3 or 8 or 15 ohms.
£9 Post Free

48-page Enclosure Manual 5/9 post paid.
LOUDSPEAKER CABINET WADDING 18in wide, 2/6ft

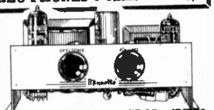
BAKER " GROUP SOUND " SPEAKERS—POST FREE
'Group 25' 12in 25 watt **6gns.** 'Group 35' 12in 35 watt **8½gns.** 'Group 50' 15in 50 watt **18gns.**
ALL MODELS "BAKER SPEAKERS" IN STOCK

Super Cone Tweeter 2½in square, 3-17kc/s. 10W 17/6.
Quality Horn Tweeters 2-18kc/s, 10W 29/6. Crossover 16/6.
LOUDSPEAKERS P.M. 3 OHMS. 2½in, 3in, 4in, 5in, 7 × 4in 15/6 each; 8in 27/6; 6½in 22/6; 10in 37/6; 8 × 5in, 21/-; 12in. Double cone 3 or 15 ohm 35/-; 10 × 6in, 30/-.
E.M.I. Double Cone 13½ × 8in, 3 or 15 ohm models, 45/- or with twin tweeters, X/over and H/D magnet 79/6.
SPECIAL OFFER! 8 ohm, 2½in; 6 × 4in; 80 ohm. 2½in, 2¾in; **15/6** EACH TYPE 25 ohm, 6 × 4in; 35 ohm, 3in; 15 ohm, 10 × 2½in., 7 × 4in.
5 in. WOOFER. 8 watts max. 30-10,000 cps. 8 or 15 ohm. 39/6.
OUTPUT TRANS. EL84 etc. 4/6; MIKE TRANS. 50:1 3/9.
SPEAKER FRET VARIOUS TYGAN SAMPLES. Send S.A.E.

ALL PURPOSE HEADPHONES

H.R. HEADPHONES 2000 ohms General Purpose	19/6
H.R. HEADPHONES 2000 ohms Super Sensitive..	35/-
LOW RESISTANCE HEADPHONES 3-5 ohms....	35/-
DE LUXE PADDED STEREO PHONES 8 ohms ..	79/6

MINETTE AMPLIFIER



A.c. Mains Transformer. Chassis size 7 × 3½ × 4in high. Valves ECL82, EZ80. 12 month guarantee. Quality output 3 ohm. With engraved fascia, valves, knobs, volume and tone controls, wired and tested. Post 5/6 **69/6**

ALL EAGLE PRODUCTS

SUPPLIED AT LOWEST PRICES

BARGAIN AM TUNER. Medium Wave. Transistor Superhet. Ferrite aerial. 9 volt. **79/6**

BARGAIN DE LUXE TAPE SPLICER Cuts, trims, joins for editing and repairs. With 3 blades. **17/6**

BARGAIN 4 CHANNEL TRANSISTOR MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt. **59/6**

BARGAIN FM TUNER 88-108 Mc/s Six Transistor. Ready built. Printed Circuit. Calibrated slide dial tuning. Size 6 × 4 × 2½in. 9 volt. **£6.19.6**

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume control. 9v. **69/6**

45-PAGE EAGLE CATALOGUE 5/- Post Free

★ RADIO BOOKS ★ (Postage 9d.)

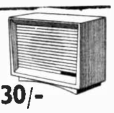
Practical Transistor Receivers	5/-
Practical Stereo Handbook..................	3/6
Supersensitive Transistor Pocket Radio	3/6
High Fidelity Speaker Enclosures and Plans........	5/-
Radio Valve Guide, Books 1, 2, 3, or 4 ea. 5/- No. 5 ea.	6/-
Practical Radio Inside Out..................	4/6
Shortwave Transistor Receivers..................	5/-
Transistor Communication Sets	6/-
Modern Transistor Circuits for Beginners	7/6
Sub-Miniature Transistor Receivers	5/-
Wireless World Radio Valve Data..................	9/6
At a glance valve equivalents..................	6/-
Valves, Transistors, Diodes equivalents manual	10/6
How to receive Foreign T.V. programmes on your set by simple modifications	5/-

SANGAMO 3 inch SCALE METERS 45/-

Various calibrations/movements, 500 Microamp; 1 Milliamp; 50-0-50 Microamp, etc. S.A.E. for list.

POCKET MOVING COIL MULTIMETER. 0-1,000 A.C./D.C. ohms 0 to 100k, etc. **49/6**
SUPERIOR MOVING COIL MULTIMETER 0-2-500v. D.C. 20,000 ohms per volt, 0-1,000v. A.C. Ohms 0 to 6 meg. 50 Microamps (Full list Meters S.A.E.) **99/6**

BRAND NEW QUALITY EXTENSION LOUDSPEAKER



Black plastic cabinet, 20ft. lead and adaptors. For any radio, intercom, tape recorder, etc. 3 to 15 ohm. PRICE **30/-**
Size: 7½" × 5½" × 3". Post 2/6

Minimum Post and Packing 2/6. **RETURN OF POST DESPATCH. CALLERS WELCOME—CUSTOMERS FREE CAR PARK.** *C.O.D. orders £1 min. 5/- extra. Full List 1/-.*

RADIO COMPONENT SPECIALISTS 337 WHITEHORSE ROAD, WEST CROYDON

Written guarantee with every purchase. *(Export: Send remittance and extra postage, no C.O.D.) Buses 133, 68 pass door. S.R. Stn. Selhurst.* **Tel. 01-684-1665**

ELECTRONORAMA

Small Ship Submarine Detector

A NEW British sonar equipment, the MS26, developed by the Plessey Marine Systems Division, has been demonstrated to representatives from selected overseas navies under sea-going operational conditions. This followed the charter of H.M.S. *Dee* (renamed MV *Robert Clive*) by Plessey from the Royal Navy for trials and demonstrations of this new equipment.

Developed as a derivative from a very successful Admiralty designed equipment, the sonar equipment is aimed at small to medium sized ships, for detection primarily of submarines. It is operated by a single man and can detect under best conditions up to 7,500 yds range. The practical average expected performance is up to 5,000 yds range.

This equipment has been designed specifically as a primary sonar on small patrol boats, but can be usefully employed in a secondary category on large warships.

Three Miles Under The Sea

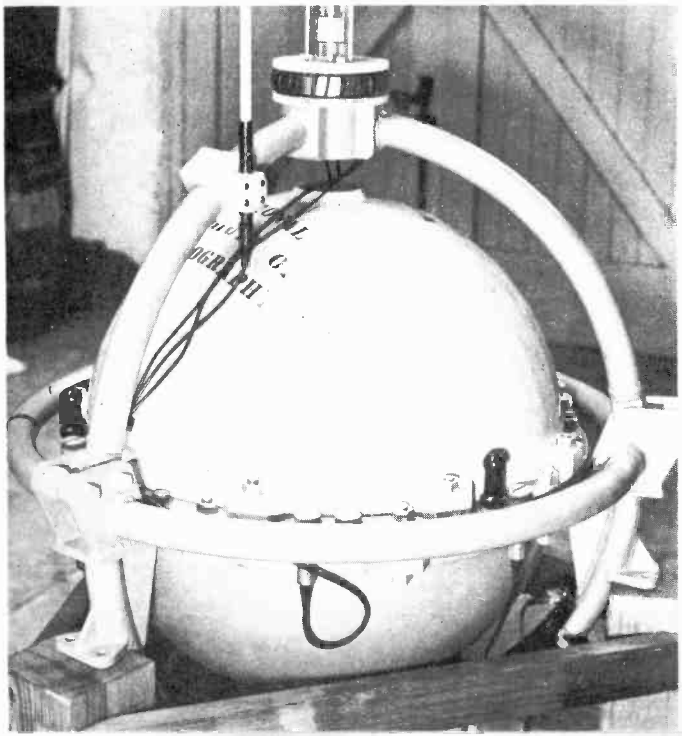
THE National Institute of Oceanography has been using Mallory batteries to power scientific recording equipment at depths in the North-East Atlantic of up to 2,640 fathoms.

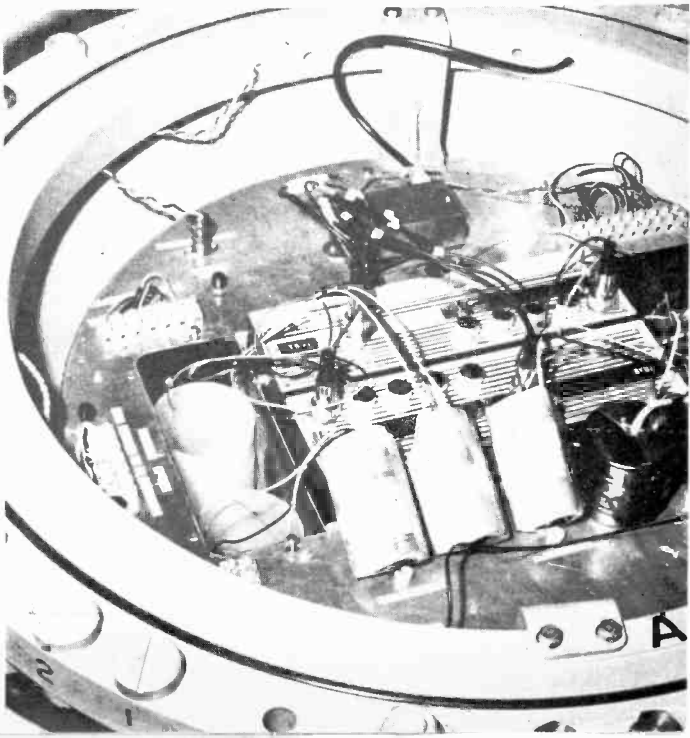
Geophysicists on the RRS *Discovery*, Britain's largest Oceanographic Research Vessel, used equipment which sinks to the ocean bed inside a ballasted sphere. The reverberations of explosive charges detonated 200 feet under the surface are picked up by a hydrophone, and the signals recorded inside the sphere on tape recorders.

Coded acoustic signals release the ballast and the positions of the spheres are tracked acoustically as they float upwards. Once on the surface the researchers find them by radio signals and flashing beacons attached to the spheres.

As a result of these experiments the scientists were able to record seismic refraction signals from the sea bed, and to obtain geological data.

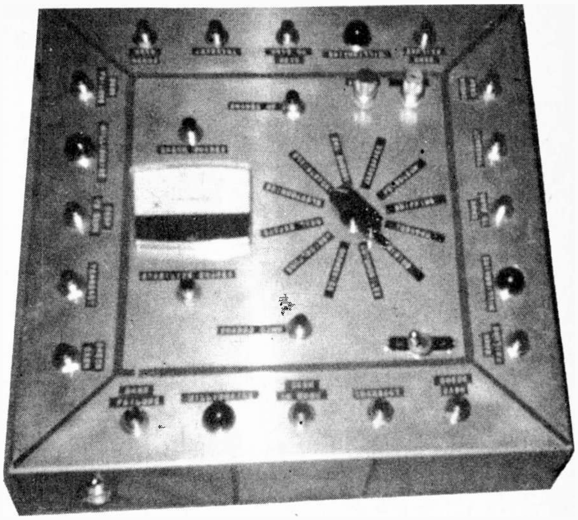
The photographs show (below left) the ocean-bottom spheres used in the Atlantic, and the interior (below right)—the seismic recording equipment and the Mallory 6·75V Duracell batteries which power it.





Readout—

A SELECTION FROM OUR POSTBAG



Mr Ken Greenberg's version of our Stockmarket

More on trial and error

Sir—I have just read with interest your leader in the December 1968 issue of PRACTICAL ELECTRONICS.

While Prof. Farvis is no doubt correct in frowning upon the undisciplined approach to circuit design as applied to complex systems required to operate over wide ranges of ambient conditions and in accordance with strict specifications, he is surely overlooking the merits of the semi-empirical method as applied to simple "one-off" circuits which are usually required in a hurry and when little essential design data is at hand.

I have always found that the most productive way of teaching electronics at an introductory level is to deal with the *minimum* amount of theory necessary to produce formulae which can be directly applied to simple circuit design to say a first approximation. Students are then encouraged to translate the formulae into component values and actually make up and check the resulting circuits on the bench.

The associated practical work has always been a headache with this approach—it is always tempting to take the easy way out in the laboratory and present students with pre-designed circuits for examination. However, since investing in some of the S-Dec "breadboards" advertised in your pages, I have found the problems have largely evaporated and that students are now able to cover much more ground. They have no need to fight their way through the soldered "birds-nests" mentioned in your paragraphs. To give examples, I have found it relatively simple and beneficial to let students actually work through the circuits discussed by A. Foord in his recent series on *Feedback Amplifiers*, and the *Feedback Pair* described by P. Williams in the December '68 issue of P.E. They have all the while to calculate their own component values.

I think many more of your readers would be able to follow through articles such as these were the S-Dec method presented to them and layouts suggested in the same way as you provide layouts for Veroboard in many articles.

B. Pounder,
Dept. Physics,
Dundee College of Technology,
Dundee.

Amplifier rating

Sir—The recently introduced Trade Description Act would seem to cover the accuracy of the figure used to express the output power of audio amplifiers, and therefore needs consideration by everyone associated with the marketing of all types of amplifiers. Whilst the vast majority of equipment is sensibly rated, exceptions do occur, particularly in items offered in the musical/entertainment field.

This Association has long campaigned for the universal adoption of continuous, sine wave, rating of Public Address amplifiers with considerable success.

Readers in any doubt as to the correct method of expressing the rated and maximum output power of an audio amplifier are referred to BS 3860 : 65 published by the British Standards Institute.

Further, those involved in the marketing of amplifiers in this country can obtain guidance and advice from the Information Service of the Association of Public Address Engineers.

H. G. Warren,
Technical Information Officer,
Association of Public Address Engineers,
394 Northolt Road,
South Harrow,
Harrow,
Middlesex.

Can anyone help?

Sir—I recently purchased a AVO CT.38 valve volt meter, but was unable to get a copy of the instruction manual from the manufacturers.

I wonder if it is possible that one of your readers may have a copy which I could purchase or borrow.

S. Tan,
17 Lophook Crescent,
London, S.E.23.

American stockmarket

Sir—Enclosed is a photograph of the *Electronic Stockmarket* game I built from the article in your December 1968 issue.

The game is constructed on a 12in × 12in × 3in aluminium chassis. Using all new American components, the game cost me about $45.00 (19 British pounds). I know it sounds incredible, but that's how high the cost of living here is these days.

The game works perfectly as described in the article. On my game I located the shares and tax presets on top of the chassis for easier access. I also fitted two four-contact sockets to the chassis for the future addition of two more players' positions (outboard on separate little chassis). I will be able to simply plug-in the extra positions.

I have only one suggestion that I feel might improve the game or at least make it more real. I think there should be a button that would allow each player to check his bank balance (charge on bank capacitor). Knowing your bank balance would certainly result in making more sensible transactions. What do you think of this idea?

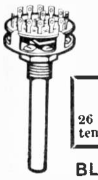
In any case, I enjoyed building the game and playing it is fun. Very few construction articles as interesting and simple as this appear in American electronics magazines. I subscribe to them all and they all tend to come up with expensive and complicated gadgets most of the time. Very few "games" articles appear.

Ken Greenberg,
Chicago,
U.S.A.

DRY JOINT TESTER

The most reliable way of testing for a dry joint is to measure the resistance between the component lead and the printed circuit board. Our kit for doing this comprises a large scale (3in.) moving coil meter, a variable resistance for adjusting zero setting, and a wiring diagram with instructions. The only additional items you will need are a battery, some wire, a pair of test rods. Price **19/6**, postage and insurance 2/6.

MINIATURE WAFER SWITCHES



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 **3/6** each. **36/-** dozen, your assortment.

WATERPROOF HEATING ELEMENT

26 yards length 70W. Self-regulating temperature control. **10/-** post free.

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. **5/6** each. 3 heat model **7/6**.

INDICATOR LAMP

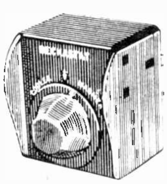
Panel mounting, consists of neon lamp in red plastic lens with resistor in leads for mains operation **2/6** each, **24/-** doz.

12V BLOWER

Heavy duty motor with centrifugal blower coupled to one end. Ideal for car heater. **12/6**, plus 4/6 post.

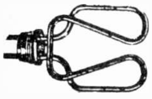
PP3 ELIMINATOR. Play your pocket radio from the mains! save £s. Complete component kit comprises 4 rectifiers—mains dropper resistances, smoothing condenser and instructions, only **6/6** plus 1/- post.

BECKASTAT



This is an instant thermostat, simply plug your appliance into it and its lead into wall plug. Adjustable setting for normal air temperatures. 13 A loading. Will save its cost in a season. **19/6**. Postage and ins. 2/9.

KETTLE ELEMENT



230/240V 1500 watt. Made by Best for kettles with $\frac{5}{16}$ in. dia. hole including: Best, Besco, Chalfont, Davidson, Dimplex, Grafton, Hawkins, Jurymaid, Mirroware, Monogram, Pifco, Revo, Towen, Swan. Normally 32/6. Our price **15/-** plus 2/6 post.

QUICK CUPPA

Mini Immersion Heater, 350w. 200/240v. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. **19/6**, post and insurance 1/6. 12v. car model also available.

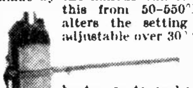
MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6V, 9V, 12V for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only **16/6**, plus 3/6 postage.

THERMOSTATS

Type "A" 15 amp. for controlling room heaters, greenhouses, airing cupboard. Has spindle for pointer knobs. Quickly adjustable from 30–80°F. **9/6** plus 1/- post. Suitable box for wall mounting, **5/-**. P. & P. 1/-.

Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50–550°F. Internal screw alters the setting so this could be adjustable over 30° to 1,000°F. Suitable for controlling furnace, oven kiln immersion heater or to make flame-start or fire alarm **8/6** plus 2/6 post and insurance.



Type "D". We call this the Ice-stat as it cuts in and out at around freezing point, 2/3 amps. Has many uses one of which would be to keep the 10ft. pipes from freezing, if a length of our blanket wire (16 yds. 10/-) is wound round the pipes. **7/6**. P. & P. 1/-.

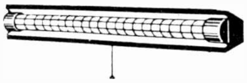
Type "E". This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperature. **7/6**, plus 1/- post.

Type "F". Glass encased for controlling the temp. of liquid—particularly those in glass tanks, vats or sinks—thermostat is held (half submerged) by rubber sucker or wire clip—ideal for fish tanks—developers and chemical baths of all types. Adjustable over range 50° to 150°F. Price **18/-**, plus 2/- post and insurance.

ELECTRIC CLOCK WITH 25 AMP. SWITCH

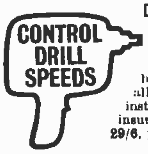
Made by Smith's these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—new and unused only **39/6**, less than the value of the clock alone—post and insurance 2/9.

INFRA-RED HEATERS

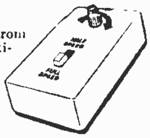


Make up one of these latest type heaters. Ideal for bathroom, etc. They are simple to make from our easy-to-follow instructions—uses silica enclosed elements designed for the correct infra-red wavelength (3 microns). Price for 750 watts element, all parts, metal casing as illustrated, **19/6**, plus 4/6 post and insurance. Pull switch 3/- extra.

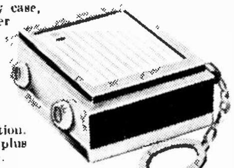
DRILL CONTROLLER



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. **19/6** plus 2/6 post and insurance. Or available made up **29/6**, plus 2/6 post.



REPAIRABLE RADIOS



7 transistor Key chain Radio in very pretty case, size $2\frac{3}{4} \times 2\frac{1}{4} \times 1\frac{1}{2}$in.—complete with soft leather zipped bag. Specification:—Circuit: 7 transistor superheterodyne. Frequency range: 530 to 1600 Kc/s. Sensitivity: 5 mv/m. Intermediate frequency: 465 Kc/s, or 455 Kc/s. Power output: 40mW. Antenna: ferrite rod. Loudspeaker: Permanent magnet type

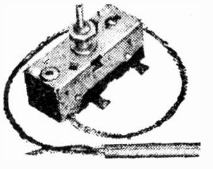
These radios are complete but require attention. Circuit diagram is not available. **17/6** each plus 2/9 post and insurance. 4 radios **£3** post free.

THIS MONTH'S SNIP

DEAC RECHARGEABLE BATTERIES

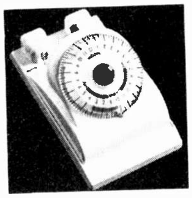
6V, 500mA/hr. size $2\frac{1}{4}$in. $1\frac{1}{2}$in. dia. Really powerful, will deliver 1 amp for $\frac{1}{2}$ hour. Regular price 65/-—our price **29/6**. New and unused.

THERMOSTAT WITH PROBE



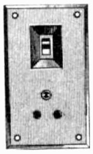
This has a sensor attached to a 15A switch by a 14in. length of flexible capillary tubing—control range is 20°F to 150°F so it is suitable to control soil heating and liquid heating especially when in buckets or portable vessels as the sensor can be raised out and lowered into the vessel. This thermostat 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 **12/6** each. Postage and insurance 2/9.

ELECTRIC CLOCK WITH 3A SWITCH



Electric Clock with 3 amp switch made by Smiths for Dreamland. These are mains driven and frequency controlled so are extremely accurate. The dial enables "switch-on" time to be accurately set. Swith off is 3 hours later or by manual control. Intended for switching electric blankets this needs only one setting for the season. Suitable also to control tape recorder, radio and lamp etc. up to 600W. In neat plastic case with mains lead and two outlet plugs. New and unused, **39/6**, post and insurance 3/6.

5A, 3 PIN SWITCHED SOCKETS



An excellent opportunity to make that bench dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Hicraft) bakelite flush mounting shuttered 5A switch sockets for only **10/-** plus 3/6 post and insurance. (20 boxes post free).

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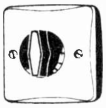

Will dim incandescent lighting up to 600 watts from full brilliance to out. Fitted on M.K. flush plate, same size and fixing as standard wall switch so may be fitted in place of this, or mount on surface. Price complete in heavy plastic box with control knob **£3.19.6.**

2¼kW FAN HEATER

Three position switching to suit changes in the weather. Switch up for full heater ($2\frac{1}{4}$ kW), switch down for half heat ($1\frac{1}{8}$kW), switch central blows cold for summer cooling—adjustable thermostat acts as auto control and safety cut-out. Complete kit **£3.15.0.** Post and ins. 7/6.

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Famous war-time "cat's eye" used for seeing in the dark. This is an infra-red image converter cell with a silver caesium screen which lights up (like a cathode ray tube) when the electrons released by the infra-red strike it. A golden opportunity for some interesting experiments. **7/6** each, post 2/6. Data will be supplied with cells, if requested.

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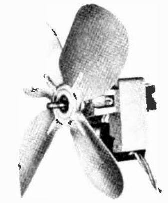

Small but very powerful mains motor with $6\frac{1}{4}$in. blades. Ideal for cooling equipment or as extractor. Silent but very efficient. **17/6**, post 4/6. Mounts from back or front with 4BA screws.

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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—15–20 w. **19/6**. Kit B—30–40 w. **19/6**. Kit C—80 w. **19/6**. Kit E—65 w. **19/6**. Kit MF1 is for 6in., 9in. and 12in. miniature tubes, **19/6**. Postage on Kits A and B 4/6 for one or two kits then 4/6 for each two kits ordered. Kits C, D and E 4/6 on first kit then 3/6 for each kit ordered. Kit MF1 3/6 on first kit then 3/6 on each two kits ordered.

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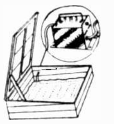
for portable, car radio or transmitter. Chrome Plated—six sections, extends from $7\frac{1}{4}$ to 47in. Hole in bottom for 6BA screw. **7/6**.

Be first this year! SEED AND PLANT RAISING



Soil heating wire and transformer. Suitable for standard size garden frame. Post and ins. 3/6. **19/6**

BLANKET SIMMERSTAT

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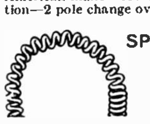

as fitted to telephones, 4 core **2/6** each, 3 core **2/-** each.

When postage is not stated then orders over £3 are post free. Below £3 add 2/9. Semi-conductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

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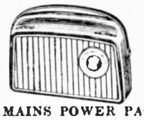
Also 102/3 Tamworth Road, Croydon

THE DORSET (600mW Output)



7-transistor fully tunable M.W.–L.W. superhet portable—with baby alarm facility. Set of parts. The latest modulised and pre-alignment techniques make this simple to build. Sizes: 12" × 8" × 3".

MAINS POWER PACK KIT: 9/6 extra.

Price £5.5.0 plus 7/6 p. & p. Circuit 2/6 FREE WITH PARTS.

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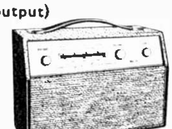

7-transistor fully tunable M.W.–L.W. portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board back printed for foolproof construction.

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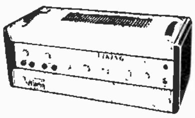

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Price 27 gns. plus 20/- p. & p.

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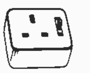
Size 3½ × 2½ × 1⅛in. Meter size 2½ × 1⅞in. Sensitivity 1000 O.P.V. on both A.C. and D.C. volts. 0–15, 0–150, 0–1000 D.C. current 0–150mA. Resistance 0–100kΩ. Complete with test prods, battery and full instructions, 42/6. P. & P. 3/6. FREE GIFT for limited period only. 30 watt Electric Soldering Iron value 15/- to every purchaser of the Pocket Multi-Meter.



OUR PRICE 12 for 30/- Postage 4/6 extra

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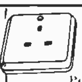

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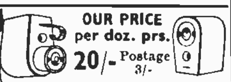
W. & D. 13 amp flush sockets in green.



OUR PRICE per doz. prs. 20/- Postage 3/-

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THE CLASSIC

Controls: Selector switch. Tape speed equalisation switch (3¾ and 7½ i.p.s.). Volume. Treble. Bass. 2 position scratch filter and 2 position rumble filter.

Specification: Sensitivities for 10 watt output at 1KHz. *Tape head:* 3mV (at 3¾ i.p.s.). *Mag. P.U.:* 2mV. *Cer. P.U.:* 80mV. *Radio:* 100mV. *Aux.:* 100mV. *Tape/Rec. output:* 100mV. Equalisation for each input is correct to within ± 2dB (R.I.A.A.) from 20Hz to 20KHz. *Tone control range:* Bass ± 13dB at 60Hz. Treble ± 14dB at 15KHz. *Total distortion:* (for 10 watt output) <1·5%. *Signal noise:* <—60dB. A.C. mains 200–250v. Size 12½" long, 4¾" deep, 2¾" high. Teak finished case. **Price 8 gns.** p. & p. 7/6.

The RELIANT 10W SOLID-STATE HIGH QUALITY AMPLIFIER

Specifications: *Output:* 10 watts R.M.S. *Output impedance:* 3 to 4 ohms. *Inputs:* 1. Xtal mic 10mV; 2. Gram/radio 250mV. *Tone controls:* Treble control range ± 12dB at 10KHz: Bass control range ± 13dB at 100Hz. *Frequency response* (with tone controls central): Minus 3dB points are 20Hz and 40KHz. *Signal to noise ratio:* better than —60dB. *Transistors:* 4 silicon Planar type and 3 Germanium type. *Mains input:* 220–250V a.c. *Size of chassis:* 10" × 3¾" × 2". A.C. Mains, 200–250V. For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Separate base and treble lift control. Two inputs with control for gram. and mike. Built and tested. 8" × 5" speaker to suit: Price 14/6 plus 1/6 p. & p. Crystal mike to suit: 12/6 plus 1/6 p. & p.

PRICE £5.5.0 plus 5/- p. & p.

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Integrated High Fidelity Transistor Stereo Amplifier

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ELECTROLYTIC CAPACITORS (Mullard). —10% to +50%.

Subminiature (all values in μF)

4V	8	32	64	125	250	400
6·4V	6·4	25	50	100	200	320
10V	4	16	32	64	125	200
16V	2·5	10	20	40	80	125
25V	1·6	6·4	12·5	25	50	80
40V	1	4	8	16	32	50
64V	0·64	2·5	5	10	20	32
Price	1/6	1/3	1/2	1/-	1/1	1/2

Small (all values in μF)

4V	800	1,250	2,000	3,200
6·4V	640	1,000	1,600	2,500
10V	400	640	1,000	1,600
16V	250	400	640	1,000
25V	160	250	400	640
40V	100	160	250	400
64V	64	100	160	250
Price	1/6	2/-	2/6	3/-

POLYESTER CAPACITORS (Mullard)

Tubular, 10%, 160V: 0·01, 0·015, 0·022μF, **7d.** 0·033, 0·047μF, **8d.** 0·068, 0·1μF, **9d.** 0·15μF, **11d.** 0·22μF, **1/-.** 0·33μF, **1/3.** 0·47μF, **1/6.** 0·68μF, **2/3.** 1μF, **2/8.**
400V: 1,000, 1,500, 2,200, 3,300, 4,700pF, **6d.** 6,800pF, 0·01, 0·015, 0·022μF, **7d.** 0·033μF, **8d.** 0·047μF, **9d.** 0·068, 0·1μF, **11d.** 0·15μF, **1/2.** 0·22μF, **1/6.** 0·33μF, **2/3.** 0·47μF, **2/8.**

Modular, metallised, P.C. mounting, 20%, 250V: 0·01, 0·015, 0·022μF, **7d.** 0·033, 0·047μF, **8d.** 0·068, 0·1μF, **9d.** 0·15μF, **11d.** 0·22μF, **1/-.** 0·33μF, **1/5.** 0·47μF, **1/8.** 0·68μF, **2/3.** 1μF, **2/9.**

POLYSTYRENE CAPACITORS: 5%, 160V (unencapsulated): 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820pF, **5d.** 1,000, 1,500, 2,200pF, **6d.** 3,300, 4,700, 5,600pF, **7d.** 6,800, 8,200, 10,000pF, **8d.** 15,000, 22,000pF, **9d.**
1%, 100V (encapsulated): 100, 120, 150, 180, 220, 270, 330, 390, 470, 500, 560, 680, 820pF, **1/-.** 1,000, 1,200, 1,500, 1,800, 2,200, 2,700, 3,300, 3,900pF, **1/3.** 4,700, 5,000, 5,600, 6,800, 8,200, 10,000, 12,000, 15,000pF, **1/6.** 18,000, 22,000, 27,000, 33,000, 39,000pF, **1/9.** 0·047, 5,000, 0·056μF, **2/-.** 0·068, 0·082, 0·1μF, **2/3.** 0·12μF, **2/9.** 0·15, 0·18μF, **3/-.** 0·22μF, **4/-.** 0·27, 0·33μF, **5/-.** 0·39μF, **5/9.** 0·47, 0·5μF, **6/3.**

JACK PLUGS (Screened): Heavily chromed, ¼in Standard: **2/9** each. Side-entry: 3/3 each.
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JACK SOCKETS (¼in Plug): With chrome insert, 2/9 each. Available with: Break/Break, Make/Break, Break/Make, Make/Make contacts.

POTENTIOMETERS (Carbon): Long life, low noise, ¼W at 70°C. ±20% ≦ ½M, ±30% > ½M. Body dia., ⅞in. Spindle, 1in × ¼in. 2/3 each. Linear: 100, 250, 500 ohms, etc., per decade to 10M. Logarithmic: 5k, 10k, 25k, etc., per decade to 5M.

SKELETON PRE-SET POTENTIOMETERS (Carbon): Linear: 100, 250, 500 ohms, etc., per decade to 5M.
Miniature: 0·3W at 70°C. ±20% ≦ ½M, ±30% > ½M. Horizontal (0·7in × 0·4in P.C.M.) or Vertical (0·4in × 0·2in P.C.M.) mounting, 1/- each.
Submin. 0·1W at 70°C. ±20% ≦ 1M, ±30% > 1M. Horizontal (0·4in × 0·2in P.C.M.) or Vertical (0·2in × 0·1in P.C.M.) mounting, **10d** each.

RESISTORS (Carbon film), very low noise. Range: 5%, 4·7Ω to 1MΩ (E24 Series); 10%, 10Ω to 10MΩ (E12 Series).
¼W (10%), 1½d, 100 off per value 12/-. ⅛W (5%), 2d, 100 off per value 13/9. ½W (10%), 2d, 100 off per value 13/9. ½W (5%), 2½d, 100 off per value 15/6.

SEMICONDUCTORS: OA5, OA81, 1/9. OC44, OC45, OC71, OC81, OC81D, OC82D, 2/-. OC70, OC72, 2/3. AC107, OC75, OC170, OC171, 2/6. AF115, AF116, AF117, ACY19, ACY21, 3/3. OC140, 4/3. OC200, 5/-. OC139, 5/3. OC25, 7/-. OC35, 8/-. OC23, OC28, 8/3.

SILICON RECTIFIERS (0·5A): 170 P.I.V., 2/9. 400 P.I.V., 3/-. 800 P.I.V., 3/3. 1,250 P.I.V., 3/9. 1,500 P.I.V., 4/-. (0.75A): 200 P.I.V., 1/6. 400 P.I.V., 2/-. 800 P.I.V., 3/3. (6A): 200 P.I.V., 3/-. 400 P.I.V., 4/-. 600 P.I.V., 5/-. 800 P.I.V., 6/-. THYRISTORS (5A): 100 P.I.V., 8/-. 200 P.I.V., 10/-. 400 P.I.V., 15/-.

SWITCHES (Chrome finish, Silver contacts): 3A 250V, 6A 125V.. Push Buttons: Push-on or Push-off 5/-. Toggle Switches: SP/ST, 3/6. SP/DT, 3/9. SP/DT (with centre position) 4/-. DP/ST, 4/6. DP/DT, 5/-.

PRINTED CIRCUIT BOARD (Vero).
0·15in Matrix: 3¾in × 2½in, 3/3. 5in × 2½in, 3/11. 3¾in × 3¾in, 3/11. 5in × 3¾in, 5/6.
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RECORDING TAPE (Finest quality MYLAR—almost unbreakable).
Standard Play: 5in, 600ft, **7/6.** 5¾in, 850ft, **10/6.** 7in, 1,200ft, **12/6.**
Long Play: 3in, 225ft, **4/-.** 5in, 900ft, **10/6.** 5¾in, 1,200ft, **13/-.** 7in, 1,800ft, **18/-.** 9d. P. & P. per reel.

Send S.A.E. for January, 1969 Catalogue

Readout— A SELECTION FROM OUR POSTBAG

continued

Bionics bug?

Sir—After reading your article in PRACTICAL ELECTRONICS, I came across a few points which interested me. The reason is that my hobby is electronics and I am just coming up to my "O" levels, of which one is chemistry.

The article in question is the one on *Bionics*, a subject which, besides my having done conditioned reflexes in Biology, interests me. Two things interest me, the first is the saline cell and the second is the proposed control of the motor by a current sensing device, this facilitating a tactile response.

In the saline cell two things happen which may result in the breakdown of the device. First I will relate the reactions involved.

This is a simple electrolysing process. The reactions involved are as follows:

In dilute NaCl solution:

$$NaCl \rightarrow Na^+ + Cl^-$$
$$2H_2O \rightleftharpoons H_3O^+ + OH^-$$

At the cathode

Na^+ and H_3O^+ are attracted. The H_3O^+ decomposes into H_2O and H_2, the H_2 being given off.

Cl^- and OH^- are attracted. The Cl^- turns into Cl_2 which will attack the metal electrode. One way of combating this is to use a carbon anode. But this may not happen, for the Cl atoms may combine with the OH^- atoms, and produce HCl, which would also attack the metal. In concentrated NaCl solution:

The reactions are the same for the diluted solution except for the fact that Cl_2 atoms will be given off and NaOH solution will be produced.

As for the proposed facilitation of tactile response by motor load measuring, an unwanted response would be caused by a gradient imposing greater loads on the motor.

The saline cell also develops a voltage of about 0·7 volts, and "destroys" itself if left in circuit. It also decomposes if left after use.

Michael Gee,
Waltham Forest,
London, E.17.

The comments relating to the saline-cell are largely correct, although in the main not strictly relevant in the context of the article. It will be remembered that the Bionics series is essentially experimental and as a consequence no switching, either to control supplies or disconnect the noise cell, has been embodied. The primary object of suggesting such a cell was to provide a means for generating random noise spikes, which it does quite efficiently.

The design of the cell was obviously left very "open-ended" and, indeed, no particular data for electrode materials was given. However, Mr Gee's suggestion for fabricating the positive electrode from a carbon rod is very valid because the $2Cl^-$ *ions upon conversion to* Cl_2 *would without doubt attack a metal electrode. Nevertheless, I feel that he could be a little inaccurate when he says that the* Cl^- *and* OH^- *may combine to produce HCl. Water, by itself, is an extremely weak electrolyte and although it would require less energy to discharge* OH^- *than* Cl^- *there are naturally more chloride ions present. Because of this (and unless we added some alkali) there would be far fewer hydroxyl (OH) ions available at the electrode and the chloride ions would be discharged. Any hydroxyl ions that are present would probably react with the chlorine to produce chloride ions, oxychlorate ions, and water thus:*

$$Cl_2 + 2OH^- \longrightarrow Cl^- + OCl^- + H_2O$$

Under most circumstances (except for fused NaCl) the sodium ions (Na^+) *which migrate to the negative electrode will react with the* H_2O *to produce sodium hydroxide, i.e.*

$$2Na^+ + 2H_2O \longrightarrow 2NaOH + H_2$$

(Present as the equilibrium $H_2O \rightleftharpoons H^+ + OH^-$. H^+*, as Mr Gee implies, does not exist in aqueous solution due to its polarising power and so combines with water to create a hydroxonium ion thus:* $H^+ + H_2O \rightarrow H_3O^+$*)*

Mr Gee states that the cell would decompose after use. Certainly this is possible if left in-circuit for a long while, but in the disconnected state there appear to be no likely chemical reactions that would support this view. However, a point worth noting is that the conventional primary and secondary cells, like the saline device, all have only a limited lifetime and require replacement from time to time. Descriptions about another device which has an incredible long lifetime, and is based on a different principle, appears in EMMA, see page 196 of this issue.

To conclude, Mr Gee's comments must be answered concerning the proposed tactile sensing arrangement based on motor current monitoring. Hypothetically it is true that such a scheme could permit certain reactions when travelling uphill, but then this is admitting of a little over-presumptuousness on his part! In some situations the "animal" might well be acting more prudently by "objecting" to steep gradients, although the system proposed employs a threshold mechanism which permits it to be selective in its response to loads. Indeed, it is this very ability which, in a later article, will demonstrate a method whereby an electrode animal can learn to "work" in return for reward (payment).—G.C.B.

Back numbers wanted for electronics course

Sir—I am trying to include a course in Electronics into my Science Syllabus and would like to ask if you would include in "Readout" an appeal for back copies.

G. M. Bartram
(Head of Science Dept.),
Teeside Education Committee,
Nunthorpe County Modern School,
Middlesbrough.

Any offers of help from readers would be gratefully considered by Mr Bartram at the above address.—Ed.

Solid state echo

Sir—I have recently become acquainted with your magazine, and find it to be of exceptional quality. Your projects alone make it a very worthwhile investment as I have just found out by completing your Electronic Door Chimes, which I might add are most satisfactory.

However, the reason I am writing to you, is to ask if you can help me in any way.

I am most keen to build a solid state echo chamber, to use in conjunction with a stereo amplifier and transcription deck but just don't seem to be able to get hold of a suitable circuit. I have had only limited experience with solid state electronics as I work mainly with heavy electrical machinery and therefore would have no idea as to how to design the project in question.

Any help at all will be most gratefully received, and I can assure you this is one customer you will not lose.

G. G. Arscott,
Hemswell,
Lincoln.

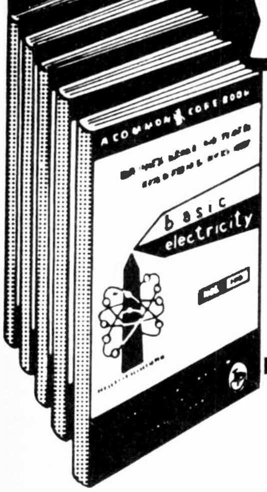
We have "on the stocks" a Spring Line Reverberation Unit; this may be just what you need, so keep looking out during the next few months.

Scope tube

Sir—Having decided to finish the construction of an oscilloscope described in your magazine by P. Cairns, I am finding great difficulty in obtaining a tube 3BP1, 3EP1 or 3GP1.

I wonder if any of your readers would sell me one of these tubes, preferably with the associate mumetal screen.

R. D. Cornforth,
83 Davyhulme Road East,
Stretford,
Manchester, M32 ODH.



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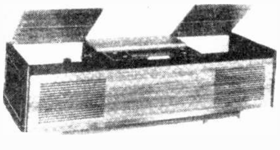

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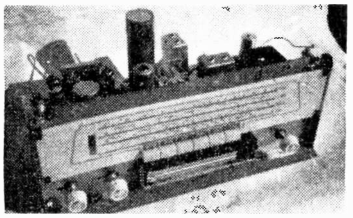

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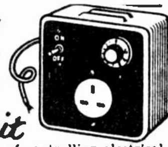

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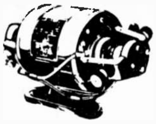

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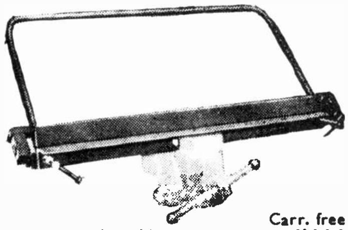

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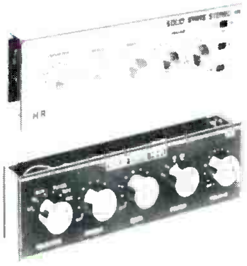

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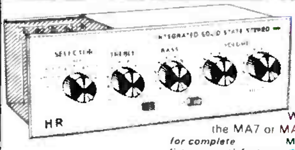

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Illustrated leaflets 12 and 14 FREE on request. Demonstrations Daily at our 309 Edgware Rd. Branch.

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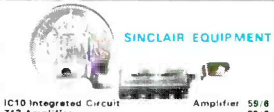

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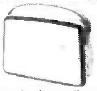

New printed circuit design with full power output. Fully tunable on both mw/lw bands. 7 transistors plus diode, push-pull circuit. Fitted 5 inch speaker, large ferrite aerial and Mullard transistors. Easy to build with terrific results. All local and Continental stations.

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Send for Brochure 1

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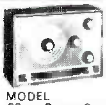

MODEL		PRICE £	s.	d.	Leaflet No.
22	Power Supply	14	0	0	22
30	Audio Generator	19	10	0	24
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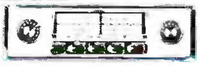
33	Inductance Bridge	20	0	0	29

Send for descriptive illustrated Brochure.

QUALITY CAR RADIOS



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Ask for Leaflet 2

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P.P. 22/6 either model

Kit comprises: Deck, Amplifier, Cabinet and speaker, with MICROPHONE 7 in 1 200 ft. tape, spare spool.

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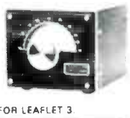
ASK FOR BROCHURE 6

VHF FM SUPERHET TUNER MKII

5 MULLARD TRANSISTORS & 4 DIODES · 300 Kc/s BANDWIDTH · PRINTED CIRCUIT CONSTRUCTION · HIGH FIDELITY REPRODUCTION MONO AND STEREO



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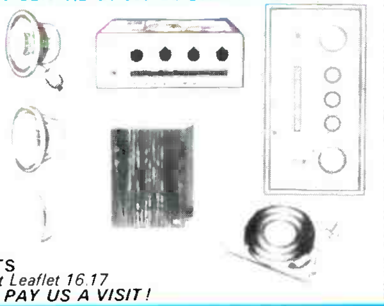

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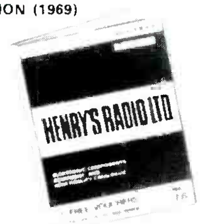

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