PRACTICAL
ELECTRONICS
DECEMBER 1972 20p


Solder a friendship! Give Antex this Christmas
Model X25
*
220-240 Volts or 100-120 Volts
The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live". Tested at 1500v. A.C. This 25 watt iron with its truly remarkable heat-capacity will easily "out-solder" any conventionally-made 40 and 60 watt soldering irons, due to its unique construction advantages. Fitted long-life iron-coated bit 1/8". 2 other bits available 3/32" and 3/16" Totally enclosed element in ceramic and steel shaft Bits do not "freeze" and can easily be removed PRICE: £1.75 (rec. retail) Suitable for production work and as a general purpose iron
Model CCN
*
220 volts or 240 volts
The 15 watt miniature model CCN also has negligible leakage. Test voltage 4000v. A.C. Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32" 4 other bits available, 1/8" 3/16" 1/4" and 1/16" PRICE: £1.80 (rec. retail) OR Fitted with triple-coated, (iron, nickel and Chromium) bit 1/8" £1.95 (rec. retail)
Model CN
*
Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 1/16" to 3/16". Voltages 240, 220, 110, 50 or 24
PRICE £1·70 (rec. retail)
Model SK.1 Kit
contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.
PRICE £2·75 (rec. retail)
Model MES Kit
Battery–operated 12v. 25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet with booklet "How to Solder". PRICE £1·95 (rec.retail) *
precision soldering kit
Model SK.2 Kit
contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, and "How to Solder" booklet.
PRICE £2·40 (rec.retail)
*
the DESIGN CENTRE
ANTEX
From radio or electrical dealers, car accessory shops or, in case of difficulty direct from:– ANTEX LIMITED FREEPOST (no stamp required) PLYMOUTH, PL1 1BR Tel. 0752 67377
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STANDARD and CUSTOM-BUILT AUDIO and ELECTRONIC EQUIPMENT NEW and SECONDHAND MUSICAL INSTRUMENTS. MAIN DISTRIBUTORS FOR A.K.G. HIGH QUALITY MICROPHONES

SA25-SA35-SA100

LOW-PRICED AUDIO MODULES FOR DOMESTIC and COMMERCIAL USE

THESE THREE MODULES HAVE ENJOYED UNPARALLELED SUCCESS DURING THE FIRST FEW MONTHS' OF THEIR BEING MADE AVAILABLE TO THE GENERAL PUBLIC. WE ARE PLEASED TO ANNOUNCE THAT WE CAN NOW OFFER FAST DISPATCH ON MOST OF OUR ADVERTISED ITEMS, INCLUDING THESE THREE MODULES.

SA25 £2·95 carr. free
25 WATTS R.M.S. 7 transistors, 7 diodes

SA35 £4·45 carr. free
35 WATTS R.M.S. 7 transistors, 7 diodes

SA100 £10·90 carr. free
100 WATTS R.M.S. 11 transistors, 6 diodes

ALL THREE MODULES HAVE OPEN AND SHORT CIRCUIT PROTECTION, AND THE SA100 IS PROOF AGAINST OVER-DISSIPATION AND FAULTY INDUCTIVE LOADS.

ONLY ADVANCED DESIGN TECHNIQUES MAKE THESE EXTRAORDINARILY LOW PRICES POSSIBLE.

BRIEF SPEC. FOR ALL THREE MODULES

Freq. response	15–40,000Hz ± 1dB
Distortion	0·2% at 1kHz
Loads	4 to 16 ohms
Quiescent current	15mA
Noise	Better than −75dB
Supply voltage	25–45V, SA25/35 40–70V, SA100
Size	4½in × 4in × 1in (SA100) 4in × 3in × 1in (SA25, SA35)

Circuits, connecting instructions and application data are supplied free with all modules.

POWER SUPPLIES FOR THE SA25/35 and SA100 AUDIO MODULES

PS45	Stabilised module for 2 SA25's or two SA35's, £35·0, carr. free
MT45	Transformer for above, heavy duty, £2·85, carr. 20p
MT30	Transformer for unstabilised supply complete with rectifier diodes mounted, £3·50, carr. 20p
PU70	Unstabilised supply for one or two SA100, £7·75, carr. 40p
PS70	Stabilised supply module for one or two SA100'8, £4·90, carr. free
MT70	Transformer for PS70, £4·90, carr. 40p

ALL MODULES ARE BUILT ON GLASS FIBRE P.C. BOARD

OTHER SAXON PRODUCTS . . .

120 WATT HEAVY DUTY MODULE

£13·90+20p carr. or with supply **£18·95**+40p carr.

Featuring a rugged class A driver stage, this module will run from all our mixers etc., and most other makes of mixer. It delivers 120W into an eight ohm load and employs 4 TO3 can (115W) output transistors.

SPECIFICATION

Power output	120W into 8 ohms
Freq. response	20–20,000Hz ± 2dB
Input sensitivity	200mV into 10K
Construction	Fibreglass board
Size	8in × 4in × 4in (5in with supply)

Low distortion parallel push-pull output stage.

NEW: 160 Watt version+supply **£27·90**

SINGLE CHANNEL SOUND/LIGHT CONVERTER

This compact and reliable unit operates from amplifiers with outputs from 5–100W. Does not impose a heavy load on the amplifier, or, if connected in the wrong polarity, cause any damage, as with some units.

Operation is simplicity itself and the unit is fully fused. The unit is supplied to function from bass notes but may easily be converted to respond only to treble or mid-range notes by the addition of components costing less than 5p.

£8·90 carr. free

THREE CHANNEL SOUND TO LIGHT UNIT

Handling the total of 3,000W (3kW) this unit is unique for its price in that not only bass middle and treble but also master controls are provided. Two amplifier sockets eliminate the need for split leads, etc. Supplied in tough white steel case with a blue stelevtite hooded cover. Fully guaranteed.

£19·75 carr. 30p

£15·80 carr. 30p

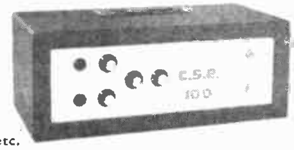
SAXON STEREO CONTROL UNIT

MONO VERSION **£6·50**, carr. 20p
(As illustrated below. S.A.E. details. 9V operation)
OUTPUTS UP TO 1V RMS

Two decks, and full headphone monitoring. The unit is mains operated and measures 17½in × 3in × 4in deep and is finished with a smart white on black facia. The controls are: Left/Right deck fader, volume, bass, treble, headphone selector and volume, microphone volume, bass, treble, mains on/off. **THIS IS A MUST FOR THE HOME BUILT HIGH QUALITY DISCOTHEQUE AND IS COMPARABLE TO UNITS AT OVER TWICE THE PRICE.**

COMPLETE AMPLIFIERS

THE CS 100. £34·90 carr. free



This versatile unit is now available in a black vynide case and so represents even better value than ever, delivering speech and music powers of up to 100W R.M.S. and continuous signal outputs of 70W.
Two individually controlled inputs with wide range bass and treble controls. Ideal for small groups, D.J's, etc.

The SAXON 100. £48·50, carr. free.

With an R.M.S. output of 120W speech and music, 100W continuous power, four individually controlled F.E.T. input stages and wide range bass and treble controls, this amplifier has established itself as a unit offering quality and reliability at low cost.

LOUDSPEAKERS British made bargains ! ! !

12in 25W 8/15 ohms £5·95, carr. 30p. 15in 50W 8/15 ohm, £14·50, carr. 50p.
12in 40W 15,000 gauss magnet system 8/15 ohm, £11·50, carr. 40p.

A.K.G. MICROPHONES suitable for disco, group or general P.A. use
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BSR LATEST SUPERSLIM STEREO & MONO

Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200 250v. Size 13¼ 11¼in. Above motor board 3¼in. below motor board 2¼in.

with STEREO and MONO XTAL **£8·75** Post 25p.

MONO-COMPATIBLE Plays all records **£7·75** Post 25p.

RCS DE-LUXE 3 WATT AMPLIFIER. Ready made, tested. Printed circuit. 3 watts output. Tone and volume controls. Complete with output valve and rectifier, two knobs, and high performance loudspeaker. Double wound fully isolated mains transformer. A.C. mains 200/250V. Response 50-12,000 cps. Sensitivity 300mV. **£4** Post 25p

GARRARD AUTOCHANGERS with Sonotone Cartridges. Stereo Diamond and Mono Sapphire. Model 1025 £10. Model 3500 Stereo and Mono Autochanger £14. Post 25p.

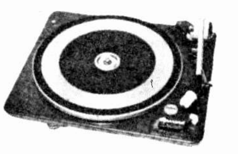
BSR JUNIOR SINGLE PLAYER

Heavy duty 4-speed motor with separate pick-up arm fitted LP/78 turnover mono cartridge **£4·50**

HI-FI PICK UP CARTRIDGES. Diamond LP Stereo, Stereo Mono 9TA £2 50; GP94 £2·50; GP93 £2. Sapphire Mono GP91 £1·50; Powerpoint LP 78 60p.

GARRARD DECCADEC SP25 DISCO DECK

Single play Stereo
Mono Deram transcription head and arm.
Four speeds
10½in. turntable.
Anti-rumble filter.
Bias compensation
Laboratory motor.



SPECIAL PRICE **£18·50** Post 25p

METAL PLINTH AND PLASTIC COVER

Cut out for most Garrard or B.S.R. Most will play with cover in position Latest Design. Covered in black leatherette Antimagnetic 12¼ · 14¼ · 7¼in. high. **£4·50** Post 35p

ALSO AVAILABLE IN SOLID NATURAL MAHOGANY WAX POLISHED FINISH—AT SAME PRICE

COAXIAL PLUG 6p, PANEL SOCKETS 6p. LINE 18p. OUTLET BOXES, SURFACE OR FLUSH 25p.
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VALVE HOLDERS, 5p; CERAMIC 8p; CANS 5p.

SPECIAL OFFER! SMITH'S CLOCKWORK 15 AMP TIME SWITCH

Single pole two-way. Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights, etc. Variable knob. Turn on or off at full or intermediate settings. Two types available 0 to 60 minutes or 0 to 6 hours. Fully insulated. Makers last list price £4 50. Brand new and fully guaranteed.
OUR PRICE **£1·50** P. & P 15p or £3 pair Post Free. (Please state type when ordering)

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RADIO BOOKS (Post 3p)

Handbook of transistor equivalents	40p
Radio valve guide, Book 1, 2, 3, 4, 5 (each)	30p
Master colour code folder	15p
Boys' book of crystal sets and simple circuits	18p
Universal gram motor speed indicator	8p
High fidelity loudspeaker enclosures	40p
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R.C.S. STABILISED POWER PACK KITS

All parts and instructions with Zener Diode, Printed Circuit, Bridge Rectifiers and Double Wound Mains Transformer input 200/240V a.c. Output voltages available 6 or 9 or 12 or 15 or 18 or 20V d.c. at 100mA or less PLEASE STATE VOLTAGE REQUIRED. Details S.A.E. Size 3½ 1½ 1¼in. **£2** Post Free

R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER BRITISH MADE

Ideal for Mike, Tape, P.U., Guitar, etc. Can be used with Battery 9-12v. or H.T. line 200-300v. D.C. operation. Size 1½" · 1½" ½". Response 25 c.p.s. to 25 Kc/s, 26 db gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A.E. **90p** Post 10p

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2 350V	14p	250/25V	14p	50+50 350V	35p
4 350V	14p	500/25V	20p	60+100/350V	58p
8 450V	14p	1000 25V	35p	32+32 250V	18p
16/450V	15p	1000 50V	47p	32+32/450V	33p
32 450V	20p	8+8 450V	18p	350+50 325V	50p
25 25V	10p	8+16/450V	20p	32+32+32/350V	43p
50/50V	10p	16+16 450V	25p		
100/25V	10p	32+32/350V	25p	100+50+50 350V	48p

LOW VOLTAGE ELECTROLYTICS.
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 10p.
500mF 12V 15p; 25V 20p; 50V 30p.
1000mF 12V 17p; 25V 35p; 50V 47p; 100V 70p.
2000mF 6V 25p; 25V 42p; 50V 57p.
2500mF 50V 62p; 3000mF 25V 47p; 50V 65p.
5000mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 50V 95p.

CERAMIC, 1pF to 0 01mF, 4p. Silver Mica 2 to 5000pF, 4p.
PAPER 350V-0 1 4p, 0·5 13p; 1mF 15p; 2mF 150V 15p. 500V-0·001 to 0 05 4p; 0 1 5p; 0 25 8p; 0 47 25p.
SILVER MICA. Close tolerance 1%, 2 2-500pF 8p; 560-2,200pF 10p; 2,700-5,600pF 20p; 6,800pF-0 01, mfd 30p each.
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SHORT WAVE SINGLE. 10pF, 30p, 25pF, 55p, 50pF, 55p.

SHORT WAVE SINGLE GANG. Precision Silver Plated Gangable Tuning Condensers. Values up to 100pF. **50p** each
Section Couplers supplied FREE with two or more gangs.

NEON PANEL INDICATORS 250V AC/DC Amber 20p.
RESISTORS. ¼ w., ½ w., 1 w., 20%, 1p; 2 w. 5p. 10Ω to 10M.
HIGH STABILITY. ½ w. 2%, 10 ohms to 1 meg., 10p. Ditto 5%. Preferred values 10 ohms to 10 meg., 4p.
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MAINS TRANSFORMERS

All post 25p each

250-0-250 80 mA. 6.3 v. 4 amp.	£1·50
250-0-250 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a. or 5 v. 2 a.	£2.50
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300-0-300 v. 120 mA., 6.3 v. 4 a. C.T.; 6.3 v. 2 a.	£3·25
MINIATURE 200 v. 20 mA., 6.3 v. 1 a. 2½ × 2¼ × 2in.	75p
MIDGET 220 v. 45 mA., 6.3 v. 2 a. 2¾ × 2¼ × 2in.	90p
MINI-MAINS 20v. 100mA. 1½ · 1¼ · 1¼in.	50p
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Ditto tapped sec. 1.4 v., 2, 3, 4, 5, 6.3 v. 1½ amp.	95p

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1 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60.	£2·25
2 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60.	£3·25
5 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£8 75
3 amp. 5, 8 and 13V	£1·00
5 amp. 5, 8 and 13V	£1·20
3 amp. 3, 5, 8, 10, 13 and 5-0-5V	£1·30
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Primary 0-110 240v. Secondary 0 240v. 3 amps. 720 watts. Insulated terminals. Varnish impregnated. Fully enclosed in steel case with fixing feet. Famous make. (Value £19) OUR PRICE **£10** Carr. 50p
Can be used as 800 watt auto transformers 240-110V.

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RA2W Ferrite Aerial	72p	Spare Cores	3p
Osc. P50 1AC	33p	Driver Trans. LFDT4	58p
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Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 15p. D.P. 25p. STEREO L/S 55p. D.P. 75p. Edge 5K. S.P. Transistor 25p.

80ohm Coax 4p yd.
BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd. £1 40; 60 yd. £2.
FRINGE LOW LOSS Ideal 625 and colour **10p** yd

1¼inch DIAMETER WAVECHANGE SWITCHES. 25p. 2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way 25p each. 1 p.1 2-way, or 4 p. 2-way, or 4 p. 3-way 25p
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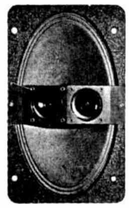
E.M.I. 13½ × 8in. SPEAKER SALE!

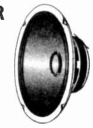


With twin tweeters. And crossover. 10 watt. State 3 or 8 or 15 ohm. As illustrated. **£4·25** Post 25p

With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45-60 cps. Flux 10,000 gauss. State 3 or 8 or 15 ohm. **£2·25** Post 25p

TEAK CABINET 16 10 · 9in. **£5** Post 25p

GOODMANS 6½in. HI-FI WOOFER



8 ohm. 10 watt. Large ceramic magnet. Special Cambric cone surround. Frequency response 30-12,000 cps. Ideal P.A. Columns. Hi-Fi Enclosure Systems, etc. **£4**

ELAC CONE TWEETER

The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 cps to 18,000 cps. Size 3½ × 3½ × 2in. deep. Rating 10 watt. 3 ohm or 15 ohm models. **£1·90** Post 10p

GOODMANS 8 in WOOFER

8 ohm 12 watt. Deep cone. Heavy ceramic magnet. Bass resonance 35 cps. Frequency response 30-8,000 cps. **£4·50**

SPECIAL OFFER: 80 ohm, 2¾in. 2½in. 35 ohm, 2in.; 3 in. 25 ohm, 2½in. dia.; 3in. dia.; 6 · 4in; 15 ohm, 3½in. dia. 6 4in; 7 · 4in; 8 · 5in. 3 ohm, 2½in, 2¾in, 3½in, 5in dia. **£1** EACH TYPE
LOUDSPEAKERS P.M. 3 OHMS. 7 4in. £1·25; 6½in. £1·50; 8×5in. £1·60; 8×2½in. £1·50; 8in. £1 75; 10×6in. £1·90.
RICHARD ALLAN TWIN CONE LOUDSPEAKERS 8in. diameter 4 watt; 10in. diameter 5 watt; 12 in. diameter 6 watt, 3 or 8 or 15 ohm models £2·20 each. Post 15p.
SPEAKER COVERING MATERIALS. Samples Large S.A.E. Horn Tweeters 2-16Kc/s, 10W 8 ohm or 15 ohm £1 95. De Luxe Horn Tweeters 2-18 Kc/s, 15W, 15 ohm £3. TWO-WAY 3,000 c.p.s. CROSSOVERS 3 or 8 or 15 ohm 95p.

TWO-WAY CROSSOVER NETWORK 3,000 c/s

With variable tweeter attenuator giving accurate high/low frequency balance. Mounted on panel 5¼in. × 4in. with control knob, tweeter and woofer leads and input terminals. Suitable for 3 to 8 ohm impedance. **£1·90** Post 10p

VALVE OUTPUT TRANS. 25p. MIKE TRANS. 50:1 25p.
5 WATT MULTI RATIO, 3, 8 and 15 ohms 80p.
PUSH-PULL VALVE OUTPUT TRANSFORMERS.
50 watt £9·50 100 watt £12·50

STEREO/MONO HEADPHONES

Model 6000 with new type slider volume controls. Stereo/Mono switch. 8 ohms. £10.
High Quality with tweeters and volume controls. 8 ohm. £7.
Budget Model. 8 ohm. £3·25.
Stereo Stethoscope 8 ohm £1·98.
HEADPHONE JUNCTION BOX with switch £1·75.
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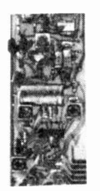
EAR PIECES. Crystal 25p.
Magnetic 8 ohms. 13p.
Magnetic 250 ohms. 23p.
ACOS 1000 ohms. 53p.

BRITISH MADE STEREO MULTIPLEX DECODER



Brand New. 7 transistors plus integrated circuit. Fibre glass printed circuit board. Size 2¾ × 6¾ × ¾in. Pre-aligned. Complete with stereo beacon indicator. 12V d.c. operation. 400mV output for 100μV input. Full instructions for any FM Tuner. Some technical experience essential. **£6·50**
DIPOLE LOFT AERIAL £1·50.
CABLE 4p yard.

WHARFEDALE SUPER 10" HI-FI LOUDSPEAKER OUR PRICE

15 watt. 4 to 8 ohms. Response 20 c s to 12 Kc s. Bass resonance 42 cps. Massive 4" Ceramic Magnet. Deep fabric cone surround. Cast alloy frame. Weight 5 lbs. (Value £10·50) **£5·50**

THE FAMOUS WHARFEDALE SOUND!

HI-FI STOCKISTS. RETURN OF POST DESPATCH. MINIMUM POST AND PACKING 15p.

RADIO COMPONENT

Illustrated Colour Brochure, Radio Books & Component Lists 10p. Written guarantee.

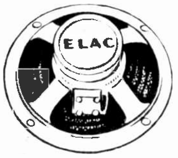
E.M.I. WOOFER AND TWEETER KIT

£5·75 THE PAIR Post 25p. (Available separately. Woofer £4·25; Tweeter £1·90).

Comprising a fine example of a Woofer 10½ × 6½in. with a massive Ceramic Magnet, 44oz, Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter 3½in. square has a special lightweight paper cone and magnet flux 10,000 lines. Crossover condenser and full instructions supplied.

Impedance Standard 8 ohms
Maximum power 12 watts
Useful Response 35 to 18,000 cps
Bass Resonance 45 cps

SUITABLE ENCLOSURE 20 x 13 x 9in. MODERN DESIGN. TEAK WOOD FINISH **£9** Post 25p



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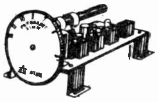

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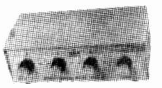

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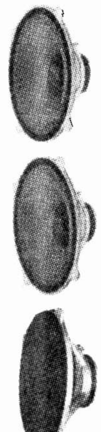

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[illegible]in. Round	83p	1[illegible]in. Round	98p	Key "C" for above	12p
[illegible]in. Round	83p	1 $\frac{3}{16}$in. Round	£1·05	2[illegible]in. Round	£4.10
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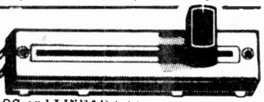

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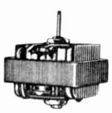

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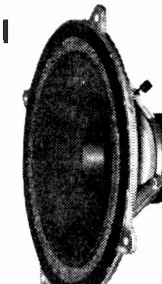

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Flux Density 14,000gauss
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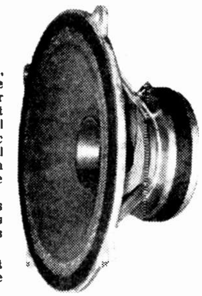

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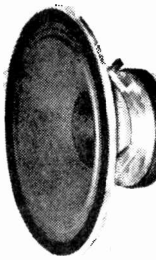

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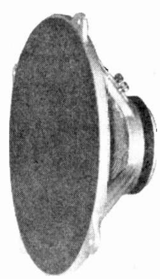

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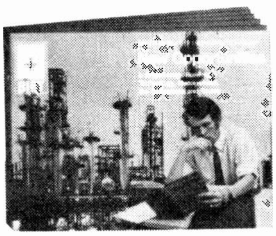

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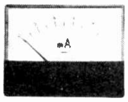

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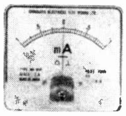

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100-0-100µA	£3·30	1A	£3·10
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500µA	£3·20	15A	£3·10
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100-0-100µA	£2·75	15V a.c.	£2·30
500µA	£2·55	300V a.c.	£2·30
1mA	£2·20	S Meter 1mA	£2·30
5mA	£2·20	VU Meter	£3·50
10mA	£2·20	1A a.c.*	£2·20
50mA	£2·20	5A a.c.*	£2·20
100mA	£2·20	10A a.c.*	£2·20
500mA	£2·20	20A a.c.*	£2·20
1A	£2·20	30A a.c.*	£2·20
5A	£2·20		
10V d.c.	£2·20		

Type MR.65P. 3½in × 3¼in fronts.

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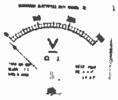
100µA	£3·00	150V d.c.	£2·40
100-0-100µA	£2.90	300V d.c.	£2·40
200µA	£2·90	15V a.c.	£2·55
500µA	£2·65	50V a.c.	£2·55
500-0-500µA	£2·40	150V a.c.	£2·55
1mA	£2·40	300V a.c.	£2·55
5mA	£2·40	500V a.c.	£2·55
10mA	£2·40	S Meter 1mA	£2·60
50mA	£2·40	VU meter	£3·70
100mA	£2·40	50mA a.c.*	£2·40
500mA	£2·40	100mA a.c.*	£2·40
1A	£2·40	200mA a.c.*	£2·40
5A	£2·40	500mA a.c.*	£2·40
10A	£2·40	1A a.c.*	£2·40
15A	£2·40	5A a.c.*	£2·40
20A	£2·40	10A a.c.*	£2·40
30A	£2·55	20A a.c.*	£2·40
50A	£2·75	30A a.c.*	£2·40
5V d.c.	£2·40		
10V d.c.	£2·40		

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



50µA	£2·30	200mA	£1·75
50-0-50µA	£2·10	300mA	£1·75
100µA	£2·10	500mA	£1·75
100-0-100µA	£1·95	750mA	£1·75
200µA	£1·95	1A	£1·75
500µA	£1·80	2A	£1·75
500-0-500µA	£1·75	5A	£1·75
1mA	£1·75	10A	£1·75
1-0-1mA	£1·75	3V d.c.	£1·75
2mA	£1·75	10V d.c.	£1·75
5mA	£1·75	15V d.c.	£1·75
10mA	£1·75	20V d.c.	£1·75
20mA	£1·75	50V d.c.	£1·75
50mA	£1·75	100V d.c.	£1·75
100mA	£1·75	150V d.c.	£1·75
150mA	£1·75	300V d.c.	£1·75
		500V d.c.	£1·75
		750V d.c.	£1·75
		15V a.c.	£1·85
		50V a.c.	£1·85
		150V a.c.	£1·85
		300V a.c.	£1·85
		500V a.c.	£1·85
		S Meter 1mA	£1·85
		VU meter	£2·30

Type MR.45P. 2in square fronts.

50µA	£2·50	10V d.c.	£1·85
50-0-50µA	£2·30	20V d.c.	£1·85
100µA	£2·30	50V d.c.	£1·85
100-0-100µA	£2·05	300V d.c.	£1·85
200µA	£2·05	15V a.c.	£2·00
500µA	£1·95	300V a.c.	£2·00
500-0-500µA	£1·85	S Meter 1mA	£2·05
1mA	£1·85	VU Meter	£2·50
5mA	£1·85	1A a.c.*	£1·85
10mA	£1·85	5A a.c.*	£1·85
50mA	£1·85	10A a.c.*	£1·85
100mA	£1·85	20A a.c.*	£1·85
500mA	£1·85	30A a.c.*	£1·85
1A	£1·85		
5A	£1·85		

"SEW" BAKELITE PANEL METERS

Type MR.65 3½in square fronts.

25µA	£3·85	1A	£2·15
50µA	£3·00	5A	£2·15
50-0-50µA	£2·60	15A	£2·15
100µA	£2·60	30A	£2·15
100-0-100µA	£2·50	50A	£2·15
500µA	£2·45	5V d.c.	£2·15
500-0-500µA	£2·15	10V d.c.	£2·15
1mA	£2·15	20V d.c.	£2·15
1-0-1mA	£2·15	50V d.c.	£2·15
5mA	£2·15	150V d.c.	£2·15
10mA	£2·15	300V d.c.	£2·15
50mA	£2·15	50mV d.c.	£2·40
100mA	£2·15	100mV d.c.	£2·40
500mA	£2·15	30V a.c.*	£2·20
		50V a.c.*	£2·20
		150V a.c.*	£2·20
		300V a.c.*	£2·20
		500mA a.c.*	£2·15
		1A a.c.*	£2·15
		5A a.c.*	£2·15
		10A a.c.*	£2·15
		20A a.c.*	£2·15
		30A a.c.*	£2·15
		50A a.c.*	£2·15
		VU meter	£3·40

*** MOVING IRON — ALL OTHERS MOVING COIL**
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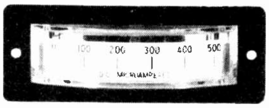
"SEW" EDUCATIONAL METERS

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

50µA	£5·50	20V d.c.	£4·85
100µA	£5·10	50V d.c.	£4·85
1mA	£4·85	300V d.c.	£4·85
50-0-50µA	£5·10	Dual range	
1-0-1mA	£4·85	500mA/5A d.c.	£5·10
1A d.c.	£4·85	5V/50V d.c.	£5·10
5A d.c.	£4·85		
10V d.c.	£4·85		

EDGEWISE METERS



PE.70 3 17/32in · 1 15/32in · 2¼in deep.

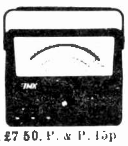
50µA	£3·40	500µA	£3·05
50-0-50µA	£3·30	1mA	£2·70
100µA	£3·30	300V a.c.	£2·70
100-0-100µA	£3·20	VU meter	£3·75
200µA	£3·20		

MULTIMETERS for EVERY purpose!

ROUND SCALE TYPE PENCIL TESTER MODEL TS.68

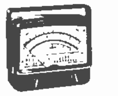
Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V AC and DC at 2,000 o.p.v. Resistance 0–20K ohms. ONLY **£1·97**. P. & P. 13p.

SKYWOOD SW-500



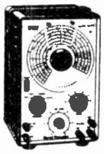
50 K Ω/Volt. Mirror scale DC Volts 0.6/3/12/30/300/600. AC Volts 3/30/300/600. DC Current 20uA/6/60/600mA. Resistance 10K/100 K/1Meg/10 Meg. Decibels −20 to +57dB. **£7 50.** P. & P. 15p

TMK LAB TESTER.



100,000 O.P.V. 6½in scale buzzer short circuit check. Sensitivity: 100,000 OPV d.c. 5/Volt a.c. D.c. volts: 0·5, 2·5, 10, 50, 250, 1,000V. A.c volts: 3, 10, 50, 250, 500, 1,000V. D.c. current: 10, 100µA, 10, 100, 500mA, 2·5, 10A, Resistance: 1K, 10K, 100K, 10 meg, 100 meg. Decibels: −10 to +49dB. Plastic case with carrying handle. size 7½in × 6⅞in × 3¼in. **£18·90.** P. & P. 25p.

TE-20D RF SIGNAL GENERATOR

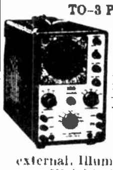


Accurate wide range signal generator covering 120Kc/s 500Mc/s on 6 bands. Directly calibrated Variable R.F. attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions. **£15.** Carr. 37½p. Size 140 × 215 × 170 mm.

TMK MODEL TW-50K

TMK MODEL TW-50K 46 ranges, mirror scale, 50K/Vol. D.C. 5K/Volt A.C. D.C.: Volts ·125, ·25, 1·25, 2·5, 5, 10, 25, 50, 125, 500, 1000V, A.C. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1000V, D.C. Current: 25, 50µA, 2·5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance: 10K, 100K, 1 MEG, 10 MEGΩ. Decibels: −20 to +81·5db. £8·50. P. & P. 17½p.

TO-3 PORTABLE OSCILLOSCOPE

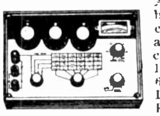


3in tube. Y amp. Sensitivity 0·1V p-p/CM. Bandwidth 1·5 cps-1·5MHz. Input imp. 2megΩ 25pF X amp. sensitivity 0·9V -800KHz. Input imp. 2 megΩ 20 pF. Time base, 5 ranges 10cps-300KHz. Synchronisation. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½lb 220/240V a.c. Supplied brand new with handbook. **£40.** Carr. 50p.

240° WIDE ANGLE 1mA METERS

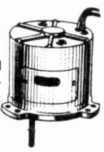
MW1·6 60mm square **£3·97½**. MW1·8 80mm square **£4·97½**. P. & P. extra.

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



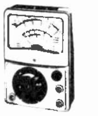
A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω-11·1 megΩ 6 Ranges ± 1%. L.1 µH - 111 HENRYS 6 Ranges −2%. C. 10pF - 1110mFd. 6 Ranges ± 2%. TURNS RATIO 1:1/1000-1:11100. 6 Ranges ± 1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100µA. Meter indication. Attractive 2 tone metal case. Size 7⅜ × 5 × 2in. **£20.** P. & P. 25p.

230/240V SMITHS SYNCHRONOUS MOTORS



Built in gearbox. All brand new and boxed. 30RPH. CW; 2RPH CW; 20RPH CW; 2RPH ACW; 30RRH CW.
50p each. Post 12p

HIOKI MODEL 720X 20,000 O.P.V.



Overhead protection. 5/25/100/500/1000V DC. 10/50/250/1000V A.C. 50µA/250mA. 20K/2 meg ohm. −5 to +62db. **£4·97.** P. & P. 15p.

Model S-100TR MULTIMETER TRANSISTOR TESTER

100,000 o.p.v. MIRROR SCALE OVERLOAD PROTECTION

0/ 12/ 6/3 / 12 / 30 / 120 / 600 VDC. 0/6/30/120/600 VAC. 0/12/600µA/12/ 300MA / 12 AMP DC. 0/10K/1 MEG/ 100 MEG. −20 to +50 db. 0·01 - 2 MFD. Transistor tester measures Alpha, Beta and Ico. Complete with batteries, instructions and leads. **£13·50.** P. & P. 25p.

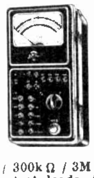
MODEL 500.

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

TE-16A Transistorised Signal Generator

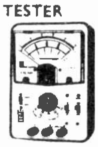
TE-16A Transistorised Signal Generator. 5 ranges 400 kHz–30 mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide, easy to read scale. 800 kHz modulation. 5¼ × 5¼ × 3½. Complete with instructions and leads. £7·97½. P. & P. 20p.

RUSSIAN 22 RANGE MULTIMETER



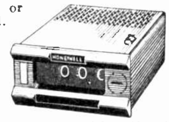
Model U437 10,000 o.p.v. A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2·5 / 10 / 50 / 250 / 500 / 1000V d.c., 2·5 / 10 / 50 / 250 / 500 / 1000V a.c. D.c. current 100 mA / 1 / 10 / 100mA/1A. Resistance 300 ohms / 3 / 30 / 300kΩ / 3MΩ. Complete with batteries, test leads, instructions and sturdy steel carrying case.
OUR PRICE £5·97. P. & P. 25p.

FTC-401 TRANSISTOR TESTER



Full capabilities for measuring A, B and ICO, *npn* or *pnp*. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads. **£7·50.** Post 20p.

HONEYWELL DIGITAL VOLTMETER VT. 100



Can be panel or bench mounted. Basic meter measures 1 volt d.c. but can be used to measure a wide range of a.c. and d.c. volt, current and ohms with optional plug-in cards.
Specification:—Accuracy: ± 0·2, ± 1 digit. Resolution: 1mV. No. of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999). Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100V d.c. Input: Fully floating (3 poles). Input power: 110-230V a.c. 50/60 cycles. Overall size: 5⅜in × 2 13/16in × 8 3/16in. AVAILABLE BRAND NEW AND FULLY GUARANTEED.
£35. Carr. 50p

G. W. SMITH & CO (RADIO) LTD.
Also see next two pages

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ALL DEVICES BRAND NEW AND FULLY GUARANTEED

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2G309	30p
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2G374	20p
2G381	22p
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2N697	15p
2N698	25p
2N699	30p
2N706	10p
2N706A	12p
2N708	15p
2N709	62p
2N718	25p
2N718A	30p
2N726	30p
2N727	30p
2N914	17p
2N916	17p
2N918	30p
2N929	22p
2N930	20p
2N987	40p
2N1090	22p
2N1091	22p
2N1131	25p
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2N1639	27p
2N1701	162p
2N1711	24p
2N1889	32p
2N1893	37p
2N2147	72p
2N2160	57p
2N2193	40p
2N2193A	42p
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2N3394	15p
2N3402	22p
2N3403	22p
2N3404	32p
2N3405	45p
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2N3564	17p
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2N5366	32p
2N5367	57p
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Type	Price
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2S103	25p
2S104	25p
2S301	50p
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2S303	60p
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2S502	35p
2S503	27p
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3N140	77p
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3N152	87p
40050	55p
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40412	50p
40467A	57p
40468A	35p
40528	72p
40600	57p
40603	50p
AC107	30p
AC126	20p
AC127	24p
AC128	20p
AC151	18p
AC152	22p
AC154	22p
AC176	20p
AC187	25p
AC188	25p
ACY17	27p
ACY18	24p
ACY19	24p
ACY20	20p
ACY21	20p
ACY22	10p
ACY28	17p
ACY39	47p
ACY40	20p
ACY41	15p
ACY44	25p
AD140	47p
AD149	47p
AD150	62p
AD161	35p
AD162	35p
AF109	45p
AF114	25p
AF115	25p
AF116	25p
AF117	20p
AF118	60p
AF121	30p
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AF125	19p
AF126	19p
AF127	16p
AF139	28p
AF178	42p
AF179	45p
AF180	50p
AF181	40p
AF186	39p
AF239	30p
AF279	47p
AF280	47p
AFZ11	32p
ASY26	25p
ASY27	30p
ASY28	24p
ASY29	27p
ASY50	25p
ASY51	32p
ASY54	25p
ASY67	45p
ASY86	32p
ASZ21	51p
AUY10	150p
BC107	10p
BC108	10p
BC109	10p
BC113	10p

Type	Price
BC114	15p
BC115	15p
BC116	15p
BC118	15p
BC119	30p
BC121	20p
BC122	20p
BC125	15p
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BCY59	22p
BCY60	97p
BCY70	15p
BCY71	20p
BCY72	15p
BCY78	30p
BCY79	30p
BCZ10	27p
BCZ11	40p
BD112	50p
BD116	112p
BD121	65p
BD123	80p
BD124	60p
BD131	75p
BD132	80p
BDY10	125p
BDY20	105p
BDY61	125p
BDY62	100p
BF115	25p
BF117	47p
BF152	28p
BF154	20p
BF158	16p
BF159	35p
BF163	35p
BF167	18p
BF170	33p
BF173	19p
BF177	30p
BF178	25p
BF179	30p
BF180	35p
BF181	32p
BF182	30p
BF184	20p
BF185	20p
BF194	15p
BF195	15p
BF196	15p
BF197	15p
BF198	15p
BF200	35p
BF224	14p
BF225	19p
BF237	22p
BF238	22p
BF244	23p
BFW61	47p
BFW87	25p
BFW88	22p
BFW89	20p

Type	Price
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BFW91	20p
BFX12	22p
BFX13	22p
BFX29	25p
BFX30	25p
BFX37	30p
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BFX85	30p
BFX86	25p
BFX87	25p
BFX88	20p
BFX89	62p
BFX93A	70p
BFY11	42p
BFY18	25p
BFY19	25p
BFY21	42p
BFY24	45p
BFY29	40p
BFY30	40p
BFY41	50p
BFY43	62p
BFY50	20p
BFY51	20p
BFY52	20p
BFY53	15p
BFY56A	57p
BFY76	42p
BFY77	57p
BFY90	65p
BSX19	17p
BSX20	15p
BSX21	20p
BSX26	45p
BSX27	47p
BSX28	10p
BSX60	82p
BSX61	62p
BSX76	15p
BSX77	20p
BSX78	25p
BSY24	15p
BSY25	15p
BSY26	17p
BSY27	15p
BSY28	17p
BSY29	17p
BSY32	25p
BSY36	25p
BSY37	25p
BSY38	20p
BSY39	22p
BSY43	50p
BSY51	32p
BSY52	32p
BSY53	37p
BSY54	40p
BSY56	90p
BSY79	45p
BSY90	57p
BSY95A	12p
C424	15p
C450	15p
GET102	30p
GET113	20p
GET114	20p
GET118	20p
GET120	25p
GET873	12p
GET880	30p
GET887	20p
GET889	22p
GET890	22p
GET896	22p
GET897	22p
GET898	22p
MAT100	22p
MAT101	25p
MAT120	25p
MAT121	25p
MJ400	107p
MJ420	80p
MJ421	80p
MJ430	102p
MJ440	95p
MJ480	97p
MJ481	125p
MJ490	100p
MJ491	137p
MJE340	50p
MJE370	80p
MJE371	80p
MJE520	60p
MJE521	70p
MPF102	42p
MPF103	35p
MPF104	37p
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NKT262	30p
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NKT271	20p
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NKT274	20p
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OC23	60p
OC24	60p
OC25	40p
OC26	25p
OC28	60p
OC29	60p
OC35	50p
OC36	60p
OC41	22p
OC42	25p
OC44	15p
OC45	12p
OC46	15p
OC70	15p
OC71	12p
OC72	12p
OC73	30p
OC74	30p
OC75	22p
OC76	22p
OC77	30p
OC78	20p
OC81	20p
OC81D	20p
OC82	25p
OC82D	15p
OC83	25p
OC84	25p
OC139	25p
OC140	32p
OC170	25p
OC171	30p
OC200	40p
OC201	60p
OC202	75p
OC203	40p
OC204	40p
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TI847	11p
TI848	12p
TI849	12p
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TI851	10p
TI852	11p
TI853	22p
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CA3042	109p
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FCH171	105p
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SN7423	51p
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SN7453	20p
SN7454	20p
SN7460	20p
SN7472	30p
SN7473	40p
SN7474	40p
SN7475	45p
SN7476	45p
SN7483	87p
SN7486	33p
SN7490	87p
SN7492	87p
SN7493	87p
SN7495	87p
SN7496	87p
SN74107	52p
SN74153	135p
SN74154	
SN74160	200p
	180p
SN74161	260p
SN74164	220p
SN74165	225p
SN74192	175p
SN74193	175p
TAA241	162p
TAA242	425p
TAA243	150p
TAA263	75p
TAA293	97p
TAA300	175p
TAA310	125p
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TAA435	147p
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50PIV 2A	45p	100PIV 4A	50p
100PIV 2A	50p	200PIV 4A	55p
200PIV 2A	55p	400PIV 4A	65p
400PIV 2A	60p	600PIV 4A	70p
		50PIV 6A	45p
		100PIV 6A	55p
		200PIV 6A	65p
		400PIV 6A	75p
		600PIV 6A	85p

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4003 200PIV	8p	10p	22p
4004 400PIV	8p	10p	25p
4005 600PIV	10p	12p	28p
4006 800PIV	12p	15p	27p
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50+ less 15% 100+ less 20%

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6AG7	40p
6AK5	35p
6AK6	60p
6AL5	20p
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6SJ7	40p
6SK7	40p
6SL7	35p
6SN7	35p
6SQ7	40p
6U4	65p
6V6G	25p
6V6GT	32p
6X4	35p
6X5G	30p
6X5GT	40p
10C2	50p
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30PL14	90p
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35W4	35p
35Z4	35p
35Z5	50p
50B5	50p
50C5	50p
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DAF91	30p
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DF91	22p
DF96	45p
DK91	40p
DK92	55p
DK96	50p
DL92	35p
DL94	48p
DL96	45p
DM70	40p
DY86	32p
DY87	33p
E88CC	100p
E180F	100p
EABC80	35p
EAF42	35p
EB91	20p
EBC41	55p
EBC81	30p
EBF80	40p
EBF83	40p
EBF89	32p
EBL21	60p
EC86	60p
EC88	60p
ECC40	65p
ECC84	30p
ECC85	40p
ECC88	40p
ECF80	35p
ECF82	35p
ECF86	65p
ECH21	57p
ECH35	100p
ECH42	75p
ECH81	30p
ECH83	45p
ECL80	45p
ECL82	35p
ECL83	70p
ECL86	40p
EF37A	120p
EF39	50p
EF40	50p
EF41	65p
EF42	70p
EF80	25p
EF85	35p
EF86	30p
EF89	28p
EF91	30p
EF92	35p
EF183	35p
EF184	35p
EH90	40p
EL34	50p
EL41	60p
EL42	65p
EL81	55p
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PCL83	65p
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PL83	45p
PL84	40p
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PY33	68p
PY80	40p
PY81	30p
PY82	35p
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PY88	40p
PY800	40p
PY801	50p
U25	80p
U26	80p
U50	40p
U52	35p
U191	75p
U281	40p
U282	40p
U301	40p
U801	180p
UABC80	40p
UAF42	55p
UBC41	50p
UBC81	40p
UBF80	40p
UBF89	35p
UCC84	49p
UCC85	40p
UCF80	55p
UCH21	60p
UCH42	70p
UCH81	40p
UCL82	35p
UCL83	60p
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UF80	35p
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AA129	10p	BAY38	15p	OA10	22p
AAZ13	10p	BY100	15p	OA47	8p
AAZ15	10p	BY103	22p	OA70	7p
BA100	15p	BY122	37p	OA73	10p
BA102	30p	BY124	15p	OA79	7p
BA110	25p	BY126	12p	OA81	8p
BA111	27p	BY127	15p	OA85	7p
BA112	70p	BY164	52p	OA90	7p
BA115	7p	BY210	35p	OA91	7p
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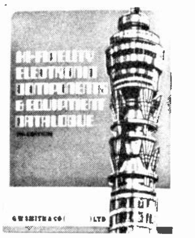

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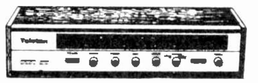
TELETON F.2000 AM/FM STEREO TUNER AMPLIFIER



Probably the most popular budget Tuner/Amp. and now offered at a ridiculous low price. 5 watts r.m.s. per channel. Tape/Cer phono inputs. AFC/Built-in MPX. **OUR PRICE £28·25.** Carr. 50p.

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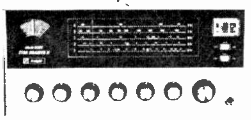

Solid state. Coverage on 5 bands 200–420 KHz and 0·55 to 30 MHz
Illuminated slide rule dial.
Bandspread. Aerial tuning. BFO. AVC. ANL. 'S' meter. AM/CW/SSB. Integrated speaker and phone socket. Operation 220, 240V AC or 12V DC. Size 325 × 266 × 150mm. Complete with instructions and circuit. **£30·00.** Carr. 50p.

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As used in world famous system. 5" dia. Impedance 4/8 ohms. High flux ceramic magnet. 20 watts rms Brand new. **£1·50.** Carr. 37p.

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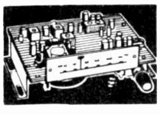

6 TRANSISTOR HIGH QUALITY TUNER, SIZE ONLY 6 × 4 × 2½in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88-108 MHz. Ready built ready for use. Fantastic value for money. **£6·37½.** P. & P. 12½p.
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Tape Head Cleaner **30p** each

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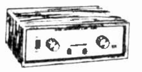

All silicon 10 transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. Inputs 5MU/100MU. Output 50mW. **£5·97.** P. & P. 15p.

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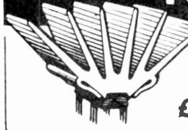
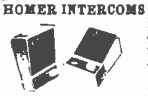


List Price £2·98
OUR PRICE
£1·80 P. & P. 10p.

HOMER INTERCOMS



Ideal for home, office, stores, factories, etc. Supplied complete with batteries, cable and free instructions.
2 Station **£2·97,** P. & P. 15p.
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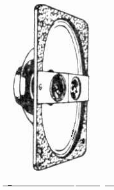

Model 350. 13" × 8" with single tweeter/crossover. 20–20,000Hz. 15 watt RMS. Available 8 or 15 ohms. **£7·25** each. P. & P. 37p.
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Sensitive, soft earpads, adjustable headband. Magnetic, impedance 2,600 ohms.
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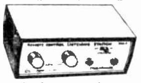
5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9¼" × 5" × 3". Inputs Mics: 3 × 3mV 50K; 2 × 3mV 600 ohms. Phono meg. 4mV 50K. Phono ceramic 100mV 1 meg. Output 520mV 100K. **£8·97.** P. & P. 20p.

1021 STEREO LISTENING STATION



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Extremely sturdy instrument for general electrical use. 667 o.p.v.
0/·3/1·5/7·5/30/60/150/300/600/900 VDC and 75mV.
0/·3/1·5/7·5/30/60/150/300 600/900 VAC.
0/300uA/1·5/6/15/60/150 600MA/1·5/6 AMP. D.C.
0/1·5/6/15/60/150/600MA/1·5/6 AMP. AC.
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Accuracy DC 1%, AC 1·5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. **£9·50** plus P. & P. 25p.

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Tests ICO and B, PNP/NPN. Operates from 9V battery. Complete with all instructions, etc.
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4 Bands covering 550KHz–30MHz B.F.O. Built in Speaker 220/240V a.c. Brand new with instructions. **£15·75.** Carr. 37½p.

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General coverage 150–400KHz, 550KHz–30MHz. FET front end, 2 mech. filters, product detector, variable B.F.O., noise limiter, S Meter, Bandspread. RF Gain. 15in × 9¾in × 8½in. 18lb. 220/240V a.c. or 12V d.c. Brand new with instructions **£50.** Carr. 50p.

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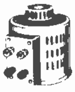

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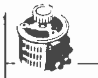

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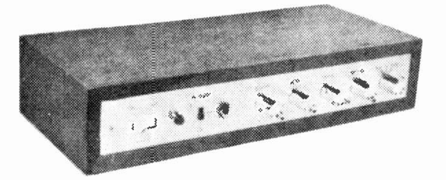

Complete Kit (inc Teak Case) **£28.50** P&P 45p

20 Watts per channel integrated stereo amplifier developed by engineers of 'Texas Instruments Ltd.' This designer approved kit, has a state-of-the-art specification, including distortion of only **0.09%** at **20 Watts** into **8 ohms** and a bandwidth of **5 – 35,000** at **–3db**. The semiconductor compliment of this superb kit includes no less than **6 integrated circuits**, 10 Silicon transistors, 4 rectifiers and 2 zeners. Controls include bass; treble; volume, balance, on/off; 'on' indicator, headphone sockets, scratch filter, rumble filter; inputs for magnetic phono; tuner, aux or tape, tape head etc; input, selector, mono/stereo switch. The construction of this kit was featured in 'Practical Wireless' May - Aug. 1972.

Veroboard

	Copperclad 0.1"	Copperclad 0.15"	Plain 0.15"
2½" x 1"	6p	6p	–
2½" x 3¾"	20p	16p (9)	10p
2½" x 5"	24p	21p (7)	12p
3¾" x 3¾"	24p	21p (8)	–
3¾" x 5"	27p	27p (10)	17p
17" x 2½"	67p	50p	37p
17" x 3¾"	90p	70p	52p
17" x 5"	–	–	75p

Spot-face Cutter 36p
Pin Insertion Tool 47p
Terminal Pins 18p per pack of 36

Aluminium Boxes

Including baseplate and screws

No.	L.	W.	D.	Price	p. & p.
(7)	2⅛"	x 5¼"	x 1½"	35p	8p
(8)	4"	x 4"	x 1½"	35p	8p
(9)	4"	x 2¾"	x 1½"	35p	8p
(10)	4"	x 5¼"	x 1½"	40p	8p
11	4"	x 2½"	x 2"	35p	8p
12	3"	x 2"	x 1"	32p	9p
13	6"	x 4"	x 2"	50p	10p
14	7"	x 5"	x 2½"	58p	12p
15	8"	x 6"	x 3"	75p	18p
16	10"	x 7"	x 3"	85p	20p

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½ watt 5% Carbon Film – low noise Hi-Stabs
All E24 values 1p. each plus p. & p. 7p. for up to 50 Resistors and a further 2p for each additional 50. Deduct 33 1/3% for 100 of one type or 25% for mixed orders over £1 in value.

1 watt	10% Carbon Composition	**3p. each**
2 watt	10% Carbon Composition	**6p. each**
2½ W	5% Wire wound	**9p. each**
5 W	Wire wound	**9p. each**
10 W	Wire wound	**10p. each**

plus p. & p. 7p. for up to 25 resistors plus 1p. for each additional 25.

Semiconductors

AC107	25p	AF239	30p	BF197	15p	2N1304	22p	AA120	9p
AC126	17p	BC107	10p	BU105	£2	2N1893	30p	AA129	9p
AC127	15p	BC108	10p	MPF102	40p	2N2926	10p	BA100	15p
AC128	15p	BC109	10p	MPF103	37p	2N3053	23p	BA154	13p
AC176	20p	BC147	10p	MPF104	37p	2N3055	49p	BA155	14p
AC187	25p	BC148	10p	MPF105	40p	2N3702	12p	BA156	15p
AC187K	25p	BC149	10p	MPF106	45p	2N3704	17p	OA47	10p
AC188	25p	BC157	12p	OC28	40p	2N3819	35p	OA79	9p
AC188K	25p	BC158	10p	OC35	40p	IN914)	6p	OA81	7p
AD140	40p	BC159	12p	OC44	15p	IN4148)		OA90	7p
AD149	40p	BC169	15p	OC45	15p	IN4001	6p	OA91	7p
AD161)	60p	BF180	25p	OC71	11p	IN4002	7p	OA200	10p
AD162)		BF181	30p	OC72	17p	IN4003	8p	OA202	10p
AF114	18p	BF184	25p	OC170	23p	IN4004	8p	SL403D	£1.50
AF115	18p	BF185	25p	OC171	30p	IN4005	10p	μA709C	45p
AF116	18p	BF194	15p	2N697	18p	IN4006	12p	μA710	45p
AF117	18p	BF195	15p	2N706	12p	IN4007	15p	μA741C	50p
AF139	28p	BF196	15p	2N708	15p	AA119	9p	μA723C	£1.05

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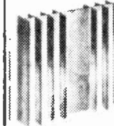
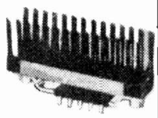
Heat Sinks

TO5
TO18
5p

TO66 14p
TO3 15p
Power Tab 13p



10D 50p



DIP10/2
for SL403D
15p

CHROMASONIC electronics

Capacitors

Mylar – 100V

1000pf	2p	0.04μF	3p
2000pf	2p	0.05μF	3p
5000pf	2p	0.068μF	4p
0.01μF	3p	0.1μF	4p
0.02μF	3p	0.2μF	5p

Polystyrene – 160V

10pf to 10,000pf all 3p. each in multiples of 10, 15, 22, 33, 47 & 68.

Mullard C280 - 250V

0.01μF	3p	0.22μF	5p
0.015μF	3p	0.33μF	6½p
0.022μF	3p	0.47μF	8p
0.033μF	3p	0.68μF	11p
0.047μF	3p	1μF	13p
0.068μF	3½p	1.5μF	20p
0.1μF	4p	2.2μF	24p
0.15μF	4p		

Mullard C281 - 400V

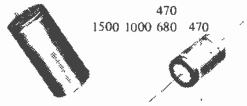
0.01μF	4½p	0.1μF	7p
0.015μF	4½p	0.15μF	8p
0.022μF	4½p	0.22μF	10p
0.033μF	5½p	0.33μF	14p
0.047μF	6p	0.47μF	15p
0.068μF	6p		

Mullard C426,015 & 016 all 6p each

Voltage			10	16	25	40	63
2.5	4	6.4	10	16	25	40	64
Capacity μF			22	15	10	6.8	1
			47	68	22	47	2.2
			100	150	47	100	4.7
			220		100		10
					150		
10	8	6.4	4	2.5	1.6	1	0.64
40	32	25	16	10	6.4	4	2.5
80	64	50	32	20	12.5	8	5
160	125	100	64	40	25	16	10
320	250	200	125	80	50	32	20
500	400	320	200	125	80	50	32

Mullard C437 & 017

2.5	4	6.4	10	16	25	40	64	
1000	800	640	400	250	160	100	64	8p
1600	1250	1000	640	400	250	160	100	10p
2500	2000	1600	1000	640	400	250	160	13p
4000	3200	2500	1600	1000	640	400	250	16p
			470		220			10p
					470			12p
			1500	1000	680	470		18p



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10	16	25	40	64	
2000	1250	800	500	320	33p
3200	2000	1250	800	500	40p
5000	3200	2000	1250	800	50p
10000	6400	4000	2500	1600	74p
16000	10000	6400	4000	2500	93p

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32μF	450V	20p
50μF	350V	20p

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8 + 16μF, 450 V.W	20p	32 + 32μF, 450 V.W	43p
16 + 16μF; 450 V.W	25p	50 + 50μF; 350 V.W	35p

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32 + 100 + 200 + 200μF, 300 V.W. £1.23
100 + 100 + 100 + 150 + 150μF; 320 V.W. £1.66
100 + 100 + 200 + 300μF, 275 V.W. £1.23
60+100+200μF, 300 V.W 93p
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10K	10 + 10K	log or lin
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50K	50 + 50K	
100K	100 + 100K	
30p	50p	

Knobs 10p.

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Vertical or Horizontal
0.1 watt 5p 0.25 watt 7p

100	1K	10K	100K	1M
250	2.5K	25K	250K	2.5M
500	5K	50K	500K	5M

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THE FABULOUSLY SUCCESSFUL VISCOUNT III AUDIO £52 complete

14 + 14 watts r.m.s. 40Hz to 40kHz ± 3dB. Total distortion at 10 watts at 1kHz — 0·1%.

This is real value for money! We have designed 2 systems and the heart of them all is the Viscount III amplifier. A unit of great eye appeal with teak finished cabinet. FET's (Field effect transistors) are incorporated on the input stages, just like top priced units. FET's give you more of the signal you want and almost none of the hiss you don't. Both units have output sockets for headphones and tape recorder. Filters and tone controls give a wide range of bass and treble adjustment.

For both systems we have chosen the famous Garrard SP25 Mk. III deck, with fitted magnetic cartridge, which comes complete with simulated teak plinth and tint acrylic cover.

The exclusive Duo loudspeaker systems are incomparable for quality within their price range. Large speakers in extremely substantial cabinets. There's a choice of the Duo II's for the smaller room or the big Duo III's for real bass response.

SPEAKERS

Duo Type II Size approx. 17in. × 10¾in. × 6¾in. Drive unit 13in. × 8in. with parasitic tweeter. Max power 10 watts, ohms. Simulated Teak cabinet.
£14 pair + £3 p & p.

Duo Type III Size approx. 23½in. × 11½in. × 9½in. Drive unit 13½in. × 8¼in. with H.F. speaker. Max power 20 watts at 3 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet.
£32 pair + £3 p & p.

SPECIFICATION R101

14 watts per channel into 3 to 4 ohms (suitable 3-15 ohms). Total distortion @ 10W @ 1kHz 0·1%. *P.U.1.* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2.* (for magnetic cartridges) 4mV @ 1kHz into 47K equalised within ± 1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power.) Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to −17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to −12dB @ 15kHz. Treble filter: 12dB per octave. *Signal-to-noise ratio*: (all controls at max) − P.U.1. and radio −65dB, P.U.2 −58dB. *Cross talk* better than −35dB on all inputs. *Overload characteristics* better than 26dB on all inputs. Size approx. 13¾in. × 9in. × 3¾in.
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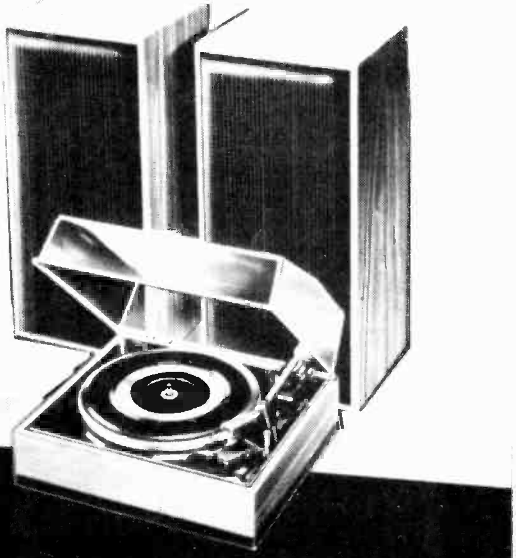
Viscount III R 101 amplifier	£22·00 + 90p p&p
2 × Duo Type II speakers	£14·00 + £2 p&p
Garrard SP25 Mk. III with MAG. cartridge plinth and cover	£23·00 + £1·50 p&p
Total	£59·00

Available complete for only £52 + £3·50 p & p

PRICES: SYSTEM 2

Viscount R 101 amplifier	£22·00 + 90p p&p
2 × Duo Type III speakers	£32·00 + £3 p&p
Garrard SP25 Mk. III with MAG. cartridge plinth and cover	£23·00 + £1·50 p&p
Total	£77·00

Available complete for £69 + £4 p & p



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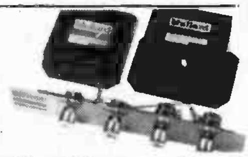

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The Tourist PB can be mounted in any standard size dash panel and it has an illuminated tuning scale for easy reading at night. Chassis size is: 7in wide, 2in. high and 4$\frac{13}{16}$in. deep (excluding front panel, etc.).

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★ Fully retractable lockable car aerial £1·25 post paid.

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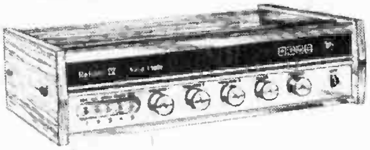

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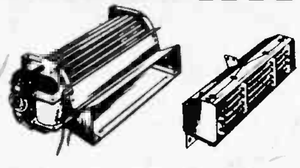

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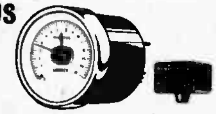

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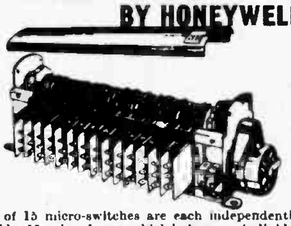

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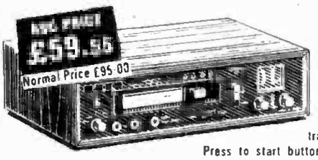
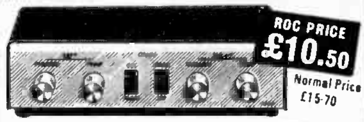


8-TRACK STEREO CARTRIDGE TAPE DECK MODEL RP-1000ST

The popular Lear-Jet type recording unit is the heart of the fantastic RP-1000ST, which has full record and playback facilities. Automatic track change with manual over-ride. Press to start button. Stereo headphone and Left and Right Mic sockets on front panel. Dual recording level meter, and Left and Right volume controls. Built-in pre-amp. Tape speed 3¾ ips (9·5 cms). Frequency response: playback 30-10,000 Hz; recording/playback 30-8,000 Hz. Line output: fully variable 0-500mV. The RP-1000ST incorporates all the features you'd expect on a top quality Cartridge Tape Deck. Size 16" wide, 4" high, 9" deep. Cabinet in walnut. Including connecting leads.

A-3000 36-WATT SOLID STATE STEREO AMPLIFIER

The A-3000 looks as good as it sounds! Giving you a big performance this superb audio amplifier has a full range of facilities on the front and rear panels. On the front – all the controls you're ever likely to need plus a headphone socket. On the rear – signal inputs, speaker outputs and a line fuse for circuit protection. Specifications: 18 watts rms per channel into 8 ohms. Frequency response 20-35,000 Hz (± 2db) Inputs Magnetic, Ceramic, Tuner, Tape, Aux, Tape Play. Size: 345mm × 300mm × 130mm.

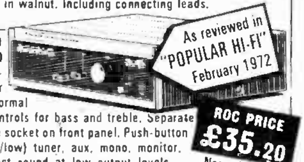


OLSON AM400 4-WATT STEREO AMPLIFIER

Here's marvellous value for someone just starting to set themselves up in audio! At only £10·50, you get a fine amplifier in a scratch resistant metal cabinet, with a smart brushed aluminium front panel. It incorporates separate tone and volume controls for each channel. Inputs are provided for turntable (ceramic cartridge), tuner and tape deck or recorder. Frequency response: 70-20,000 Hz ± 3dB. Output: 2 watts r.m.s. per channel into 8 ohms. Inputs: phono 80mV; tuner/aux 80mV. Size 8" wide, 2½" high, 4½" wide.

25-WATT 3-WAY CRYSLER 'LIVING AUDIO' SPEAKER CE-5b

This high quality speaker has its own built-in 3-way sound response switch, giving you the ideal frequency response for hi-fi, natural or mood music listening. Its beautiful, heavy, oiled walnut cabinet incorporates two separate speaker units an 8" woofer, and a 5" mid-range with 2" concentric tweeter. Power handling capacity: 25 watts r.m.s into 8 ohms. Overall frequency response: 35-20,000 Hz. Cabinet size: 10½" × 7½" × 8¾". Exactly right for matching the most modern decor.



REALISTIC 30 WATT STEREO AMPLIFIER MODEL SA-500

A superb hi-fi amplifier with all the features you've ever wanted – for under £46·00. Saving over £10·00 on the normal retail value. Up-to-the-minute slider controls for bass and treble. Separate volume and balance controls. Headphone socket on front panel. Push-button input controls – magnetic phono (high/low) tuner, aux, mono, monitor. Loudness push-button control for perfect sound at low output levels. Left and right push-button on/off switches for speakers. Noise filtering and tape monitoring facilities. Two auxiliary AC outlets. Frequency response 20-20,000 Hz ± 1 db at full power. 15 watts rms per channel. Walnut cabinet with satin aluminium trims. Inputs: phono 2·5mV and 5mV RIAA; tuner/aux 250mV. Hum and noise: phono – 50db; tuner/aux – 65db. How's that for a specification! Size 14¾" wide, 3½" high, 10½" deep.

OLSON RA-310 AM/FM/MPX STEREO TUNER

This ROC Tuner is especially designed to match the Olson AM-395 Stereo Amplifier. In price and value, as well as it's good looking design! But of course it's also ideal for use with any other amplifier. The RA-310 costs £10·00 less than the normal retail value, and yet it is a highly sophisticated unit, incorporating the latest solid state techniques. Operation is drift free for supreme station-holding capability. You can connect this Tuner to a stereo amplifier, to a tape deck or a tape recorder. And of course it covers all the stations in the AM and FM bands. FM: 87-108 MHz; AM: 525-1605 kHz. FM Sensitivites: FM, 3µV; AM, 250µV. Stereo separation 30dB at 1kHz, image rejection 60dB. Size: 11 1/16" wide, 4" high, 7½" deep.

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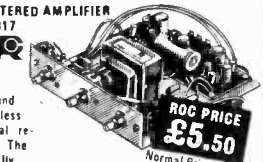
PALACE AM/FM/MPX STEREO TUNER AMPLIFIER SSA-16

This is one of the lowest priced stero tuner amplifiers on the market. It covers the full range of both AM and FM broadcast frequencies. And when you're switched to FM, an indicator lights up when a stereo signal is received – that's the time to switch to 'Stereo'! The SSA-16 has all the facilities you'd expect to find on tuners costing twice as much – separate volume, bass, treble, balance and tuning controls. Selector switch for tape, phono, AM, FM, stereo. Jack socket on front panel for stereo headphones. Frequency range: FM 88-108 MHz, AM 535-1605 kHz. Frequency response: 50-10,000 Hz ± 3dB. Power output: 4 watts total music power into two 8 ohm speakers. Size: 16" wide, 4½" high, 8" deep.

REALISTIC SA-100B 6-WATT STEREO AMPLIFIER

Here's fabulous, exciting value in miniature! This high quality stereo amplifier measures only 9" wide × 3" high × 5⅞" deep. And yet it has separate ganged volume, balance and tone controls. Plus speaker in/out, mono/stereo, phono/tuner and power on/off slide switches. The ends are oiled walnut, with matching enamelled metal top. The front panel is satin aluminium and walnut-brown enamel. Frequency response is 50 to 10,000 Hz ± 3dB. Output 3 watts r.m.s. per channel into 8 ohms. Inputs are 100mV for both phono and tuner.



ROC 7-WATT STEREO AMPLIFIER CHASSIS SK-317

This exclusive R O C Stereo Chassis is completely self-contained, and it costs £2·25 less than the normal retail value! The SK-317 is a really compact unit measuring only 5½" wide, 1¾" high and 6¾" deep. It contains its own mains power supply, and has a ganged volume control and separate treble controls for each channel. Specification: frequency response 40-17 000 Hz ± 3dB; output 3·5 watts music power per channel into 8 ohms; input, phono, 600mV; signal-to-noise ratio better than 45dB.

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When you want to listen to the radio all by yourself Then this will solve the problem. Separate volume and tuning controls with easy-to-use knobs Frequency range is 535 to 1605 kHz medium wave band Maximum output is 300 mW
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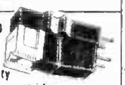

EAGLE LC.07 STEREO MOVING-MAGNET CARTRIDGE

Here's your opportunity to own a transcription cartridge for the price of a ceramic! Is specially designed to match top quality tone arms, and to get the very best from your hi-fi amplifier. 0·7 mil diamond stylus. Output: 7mV per channel. Frequency range: 20-21,000 Hz. Channel balance: +1dB. Channel separation: 28dB. Compliance: 12 × 10-6 cm/dyne.
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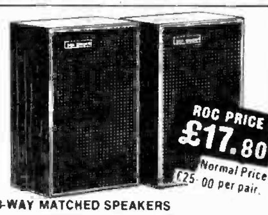
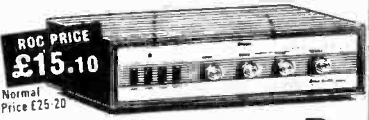


R.446 3-WAY MATCHED SPEAKERS

These will do justice to your amplifier – and to your pocket. At only £17·80 a pair, they are real value-for-money. Each cabinet is heavily lagged and teak finished. They handle 16 watts rms (8 watts rms each). Each loudspeaker contains a large dual cone base unit, plus a separate tweeter. Frequency range 40 to 19,000 Hz. Size 14in. high, 9in. wide, 6¼in. deep.



OLSON AM-372 16-WATT STEREO AMPLIFIER

Here's a really good amplifier at a really down-to-earth price – nearly £7 less than the normal retail value! Just look at what the AM-372 will do for you – reproduce signals from ceramic or crystal cartridges, AM and FM tuners, and tape recorders. And it gives you outputs for two sets of speakers, headphones and tape recorders. Frequency response is 30 to 20,000 Hz ± 3dB. Output 8 watts r.m.s. per channel music power into 8 ohm speakers. Phono input 200mV. Tuner input 200mV. Size: 12¼" wide, 3½" high, 7½" deep.

OLSON AM-395 40-WATT STEREO AMPLIFIER

An ideal unit for your new stereo separate system. It is more than £10·00 below the normal retail price! Making the AM-395 one of Britain's best hi-fi buys. It takes in signals from magnetic or ceramic pick-ups, tuners (see Olson RA-310) and tape decks. And it's got outputs for taping and for headphones. There are separate bass and treble controls, separate Left and Right channel volume controls. And a loudness switch for boosting the bass and treble notes when listening at low output levels. Frequency response: 20-20,000 Hz ± 3dB. Output: 20 watts r.m.s. per channel into 8 ohms. Inputs: magnetic phono 3·0mV RIAA, crystal phono 100mV, tape 160mV; tuner 160mV. Size 11 1/16" wide, 4" high, 7½" deep. The specification reads well – sounds even better!

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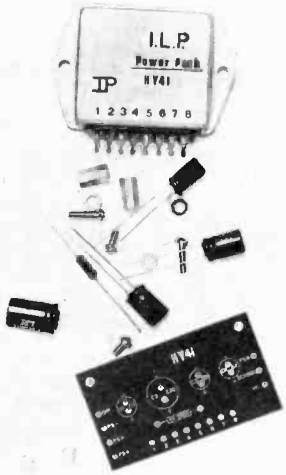


THE HY41

The HY41 supersedes the popular HY40 introduced by ILP last year. This highly improved module achieves true High Fidelity with a dramatic reduction in distortion (typically 0.05% at 1KHz into 8 ohms!) and is electronically and mechanically compatible with the HY40.

With this important improvement the HY41 retains all of the quality characteristics found in the earlier version and P.C. board, Resistor, Capacitors, Hardware Mountings and comprehensive manual are included in the basic kit. No further components are required to construct a complete power amplifier of extremely high performance sufficiently versatile to provide power not merely for Hi-Fi but also for public address systems and industry.

The free manual gives a full circuit diagram of the HY41 and its various applications including a complete stereo amplifier.

Like its predecessor the HY41 is based on conventional and proven circuit techniques developed over recent years.

OUTPUT POWER: British Rating 40 WATTS PEAK, 20 watts R.M.S. continuous.
LOAD IMPEDANCE: 4–16 ohms.
INPUT IMPEDANCE: 30K ohms at 1KHz.
VOLTAGE GAIN: 30db at 1KHz

TOTAL HARMONIC DISTORTION: less than 0.15% (typical 0.05%) at 1KHz.
FREQUENCY RESPONSE: 5Hz–50KHz ± 1db.
SUPPLY VOLTAGE: ± 22.5volts D.C.
SUPPLY CURRENT: 0.8 amps maximum.

PRICE: inc. comprehensive manual, P.C. board, five extra components and P. & P.:—
MONO: £4.90 **STEREO: £9.80**

UNIQUE HYBRID PRE-AMPLIFIER

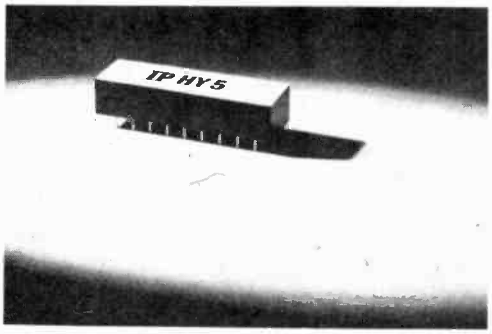
The HY5 has rapidly established a position in the WORLD as the sole hybrid pre-amplifier to contain all feedback and equalization networks within an integrated pre-amplifier circuit.

Supplied with the HY5 are two stabilizing capacitors and by the addition of volume, treble and bass potentiometers it is ready for use.

Internally the HY5 provides equalization for almost every conceivable input, the desired function is achieved by use of a multi-way switch or by direct interconnection.

Two distinctive features of the HY5 are its inbuilt stabilization circuit, allowing it to be run off any unregulated power supply from **16–25** Volts and a balance circuit which, when linked by a balance control to a second HY5, forms a complete stereo pre-amplifier.

Specifically and critically designed to meet exacting Hi-Fi standards, the HY5 combines extremely low noise with a high overload capability. When used in conjunction with the HY41 and PSU45 forms a completely intergrated system.



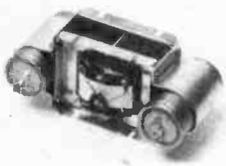
INPUTS
Magnetic Pick-up (within ±1db RIAA curve) 2mV. 47K Ω
Tape Replay (external components to suit head). 4mV. 47KΩ
Microphone (flat) 10mV. 47K Ω
Ceramic Pick-up (equalized and compensatable) 20–2000mV. variable.
Tuner (flat) 250mV. 100K Ω
Auxiliary 1 250mV. 47K Ω
Auxiliary 2 2–20mV. 100K Ω

OUTPUTS
Main Pre-amp output 500mV.
Direct tape output 120mV.

ACTIVE TONE CONTROLS (Bexendall)
Treble ± 12db.
Bass ± 12db.
INTERNAL STABILIZATION
Enables the HY5 to share an unregulated supply with the Power Amplifier.
SUPPLY VOLTAGE
16–25 volts

SUPPLY CURRENT
6mA approx.
OVERLOAD CAPABILITY
better than 26db on most sensitive input infinite on tuner and auxl.
OUTPUT NOISE VOLTAGE: 0.5mV.

PRICE: **MONO: £3.60** **STEREO: £7.20**



POWER SUPPLY PSU45

The versatile P.S.U.45 is designed to supply your HY41's +HY5's in stereo or mono format.

Specification

Input: 200–240 Volts.
Output: ± 22.5 Volts at 2 amps.
Overall Dimensions: L. 7"; D. 3.8"; H. 3.1"

PRICE: **£4.50 inc. P. & P.**

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VOL. 8 No. 12
December 1972

PRACTICAL ELECTRONICS

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FIFTY YEARS OF BROADCASTING

ANNIVERSARIES are always useful when they provide excuse to pause and look back over some really significant period. The pause is fully justified on the occasion of the BBC's 50th birthday. There is no question that these 50 years of broadcasting in the U.K. have had tremendous and lasting effect upon the individual and upon society as a whole. The history of broadcasting is also the history of the emergence of electronics, although the precise origins of both are indefinable or controversial, and go back certainly far beyond a half century.

In November 1922 the British Broadcasting Company was formed by a group of leading wireless manufacturers, at the behest of the G.P.O. This action followed years of agitation by various individuals and groups in this country. One of the most active pressure groups was the Wireless Society of London (later the Radio Society of Great Britain) representing the large number of amateur constructors and experimenters the new medium of wireless communication had already attracted. At the time, broadcasting was already in full swing in the United States where more than 300 registered stations were operating; in Europe regular broadcasts had been made from The Hague since 1920; while in this country irregular transmissions had been made throughout this period by the Marconi Company.

In 1926 the BBC was reconstituted as a public corporation by Royal Charter, fully committed to the public service concept by its indomitable chief executive J. Reith (later Lord Reith). High-minded principles and the uncompromising way in which they were applied produced a powerful, influential monopolistic organisation which has always been the centre of much controversy. The BBC during the past 50 years has been held up as an example of public service at its best, by some; while it has been condemned as an autocratic body out of touch with (or indifferent to) contemporary public opinion, by others. Political attitudes aside, all objective observers must acknowledge and pay respect to the integrity of purpose and high standards insisted upon and maintained consistently throughout these 50 years by the BBC, in both programme and engineering matters.

continued on page 1044

THIS MONTH

CONSTRUCTIONAL PROJECTS

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Our January issue will be published on Friday, December 8

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RALLY DRIVING GAME

By D. R. Daines

A game using a simple operational amplifier to simulate some of the characteristics of a car rally.

THE average car-race game suffers from two major drawbacks: all the cars taking part usually have identical characteristics and there is little or no room for skill. Here in a simple and inexpensive unit both drawbacks are overcome.

Not only are five different cars offered for use, with differing road-holding, braking and acceleration characteristics, but skill in manipulating brake and throttle is hard to come by. Players must use this skill in order to drift round corners at the maximum speed permissable without skidding off. Obviously, the winner will be the player who can acquire this skill the quickest.

The whole unit is completely self-contained and can be built for about £3, using spare materials for the case.

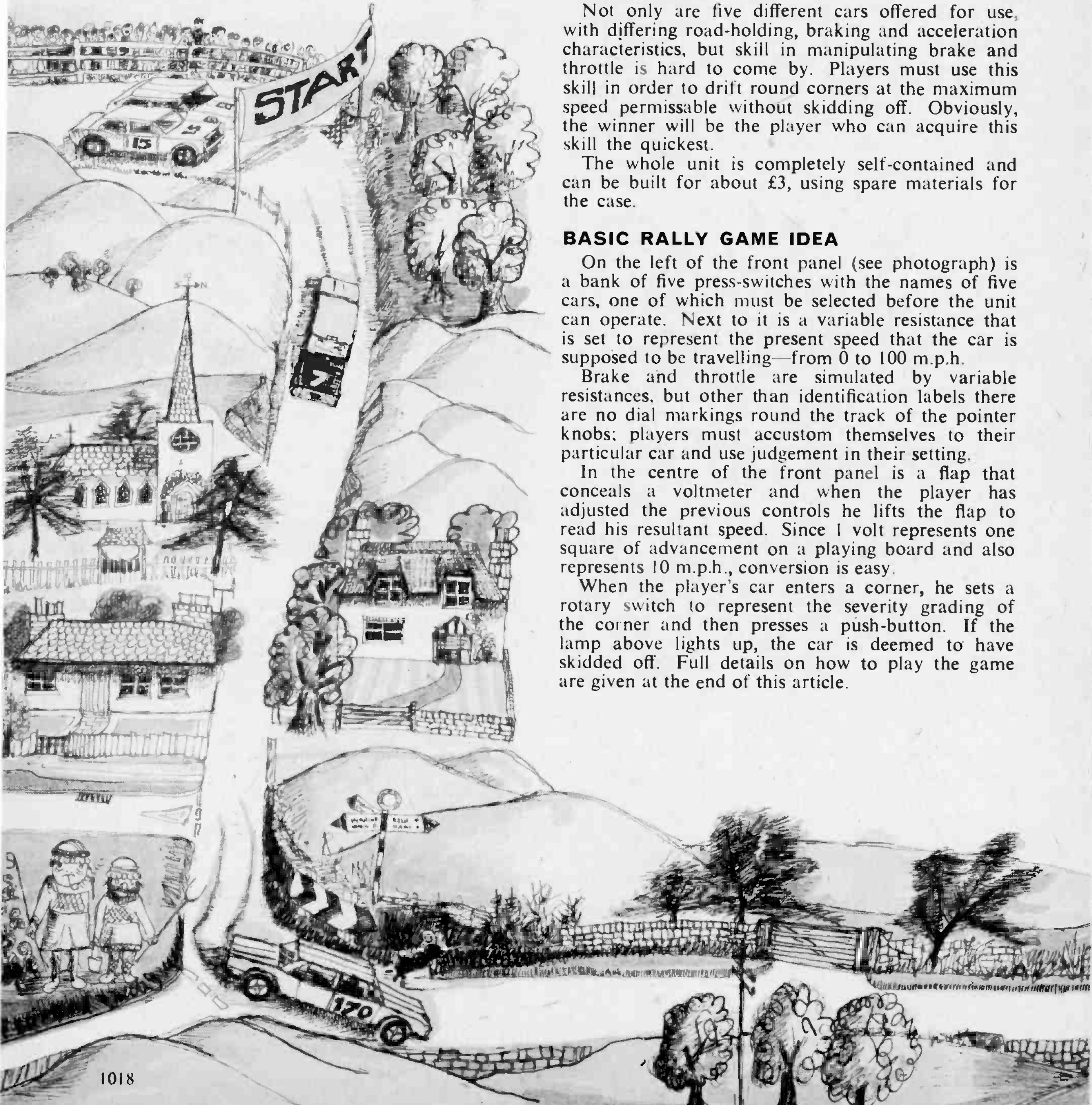
BASIC RALLY GAME IDEA

On the left of the front panel (see photograph) is a bank of five press-switches with the names of five cars, one of which must be selected before the unit can operate. Next to it is a variable resistance that is set to represent the present speed that the car is supposed to be travelling—from 0 to 100 m.p.h.

Brake and throttle are simulated by variable resistances, but other than identification labels there are no dial markings round the track of the pointer knobs; players must accustom themselves to their particular car and use judgement in their setting.

In the centre of the front panel is a flap that conceals a voltmeter and when the player has adjusted the previous controls he lifts the flap to read his resultant speed. Since 1 volt represents one square of advancement on a playing board and also represents 10 m.p.h., conversion is easy.

When the player's car enters a corner, he sets a rotary switch to represent the severity grading of the corner and then presses a push-button. If the lamp above lights up, the car is deemed to have skidded off. Full details on how to play the game are given at the end of this article.



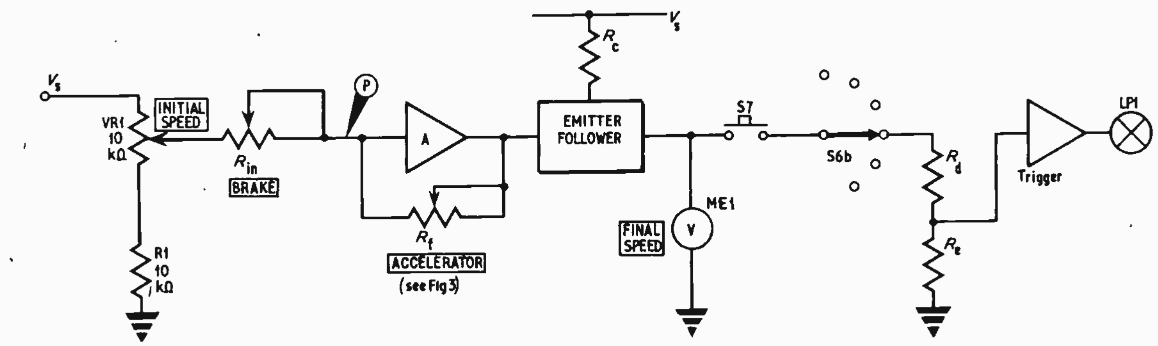


Fig. 1. Simplified circuit showing principle of operation

SIMULATION CIRCUIT

Fig. 1 shows a simplified schematic diagram of the whole unit. A 12V positive supply is presented to VR1, the SPEED control, which is arranged in a simple voltage divider system. Since R1 is equal to VR1, the minimum voltage output is half the supply, i.e. 6 volts.

The resistor is used because if VR1 was returned directly to earth, the input of the amplifier would also be earth and the output to the meter would be nil. Hence when starting off from rest the cars would achieve a speed of nothing; racing their engines without letting the clutch out, so to speak.

The next unit is a very interesting one that is really the heart of the system. It is a direct current amplifier with considerable negative feedback. Since it is direct current that is being amplified, capacitance coupling is out of the question and recourse must be made to direct coupling. The circuit used is a direct coupled d.c. amplifier which has a large input impedance, a very large gain, and considerable negative feedback, otherwise termed an operational amplifier.

OPERATIONAL AMPLIFIER

Let us assume that the gain of the amplifier is 10,000 and that the voltage out is 10 volts. This would mean that the voltage at point "P" in Fig. 1 is 10 ÷ 10,000 = 0·001 volt and considerable current is flowing back through R_f to maintain this very low figure—virtually at earth potential. It follows that increasing the value of R_f will reduce this current, raise the voltage at point "P" and raise the output voltage.

Table 1: VALUES OF INPUT VOLTAGE TO ACHIEVE 10V OUTPUT (where possible)

R_{in}	R_f= 3·3k Ω	R_f= 4·7k Ω	R_f= 6·8k Ω	R_f= 8·3k Ω
68k Ω	11·0V	8·5V	6·5V	5·75V
83k Ω	9·0V max	9·9V	7·5V	6·6V
97k Ω	5·4Vmax	11·5V	8·6V	7·6V
118k Ω	1·0V max	6·8V max	10·6V	9·3V

R_{in} has the opposite effect; raising this value will lower the voltage at point "P" and hence the output voltage. The analogy to accelerator and brake is obvious; R_f becomes the accelerator and R_{in} becomes the brake. See Table 1.

Of course R_{in} and R_f have upper and lower limits. The upper limits are no problem, but by adjusting the lower limits we may readily obtain different responses to the variable resistors. These are set to the individual car characteristics. (See Table 2 and Fig. 2). It will be seen from Fig. 2 that there is a choice of fixed resistors of differing values. Which one is chosen depends upon which switch is pressed. Then there is a small fixed resistor common to all and finally VR2, which is the brake. The total resistance equals R_{in}.

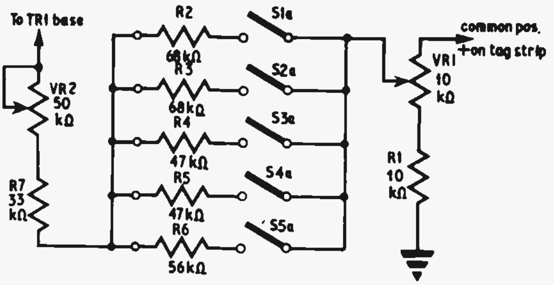
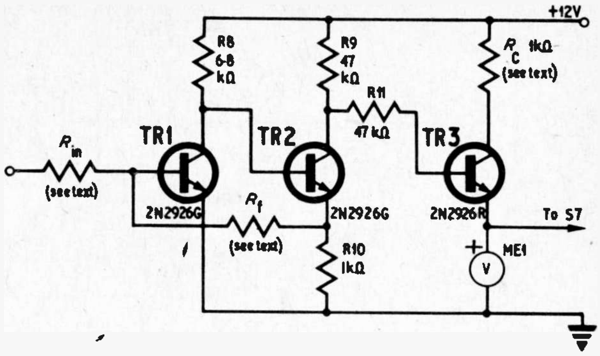


Fig. 2. Breaking is simulated by R2 to R6 switched in the brake position R_{in}



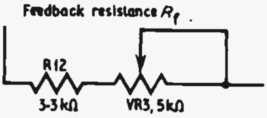


Fig. 3. The basic operational amplifier with the practical feedback resistance R_f

Table 2: RESISTOR BIAS VALUES

CAR (switch no.)	R_{in} (brake)	R_f (acce-lerated)	R_c (max. speed)	R_e (road holding)
1	68k	2·2k	4·7k	6·8k
2	68k	3·3k	Nil	5·6k
3	47k	4·7k	4·7k	5·6k
4	47k	3·3k	2·2k	8·2k
5	56k	2·7k	Nil	Nil
VR	50k	5k	—	—

Fig. 3 shows the operational amplifier and its associated low output-impedance stage. The circuit is surprisingly simple; TR1 and TR2 form the amplifier. Since they are direct coupled as a super-alpha pair, their individual current gains are multiplied. Notice particularly from where the feedback is taken. At this point (TR2 emitter) the voltage rise is out of phase with the base of TR1 and hence negative feedback.

In the prototype, the car-selection switches were only two-pole (see components list), so another selection of fixed minimum values were not provided for the feedback. However, from experimental work that has been done on the prototype, and for those readers who might prefer to use three- or four-pole switches, values have been given in Table 2. Not much can be gained in this way, however, and those who wish to incorporate only two-pole switches can be happy in the knowledge that the system works well.

An emitter-follower TR3 provides a low-impedance output that will not load the previous stages. The meter is arranged so that the resistance of the meter coil provides the emitter resistance. Normally, the collector is returned to the positive rail directly, but the insertion of resistor R_c in the collector lead will reduce the maximum output voltage. This is a useful facility for those who would like to limit the maximum speed of different cars; values are given in Table 2.

ROAD-HOLDING

From the meter, the current goes to a push-button (S7 in Fig. 1) which is included for three reasons. Firstly, there will be many game moves in which a corner is not encountered; secondly, illumination of the lamp would give players a valuable clue as to the position of the meter; and finally, current consumption is very low at 6mA, but jumps to over ten times that figure when the button is depressed and the lamp lights.

The corner selection switch S6 selects, in the first position, the battery on/off, while each of the other five positions selects a voltage-divider such as is shown as R_d and R_e. All resistors in R_d are connected together and fed to the Schmitt trigger, while those in R_e are selected by the car press switches. Thus the actual voltage division that takes place depends upon the severity of the corner and the car selected. See Fig. 4.

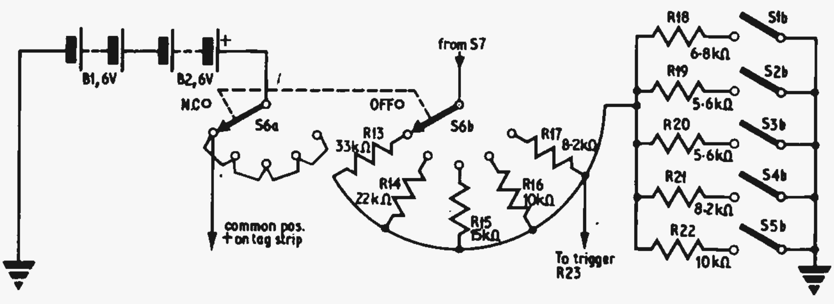


Fig. 4. Switching for road holding ability

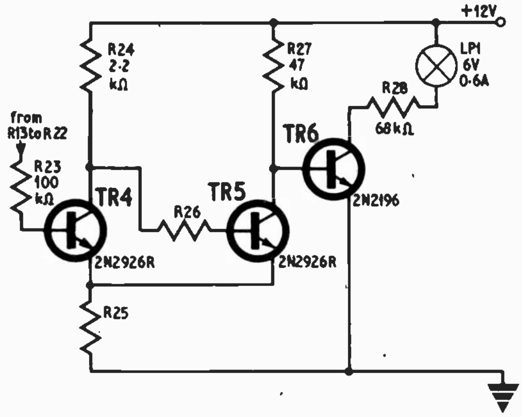


Fig. 5. Switch trigger and lamp driver

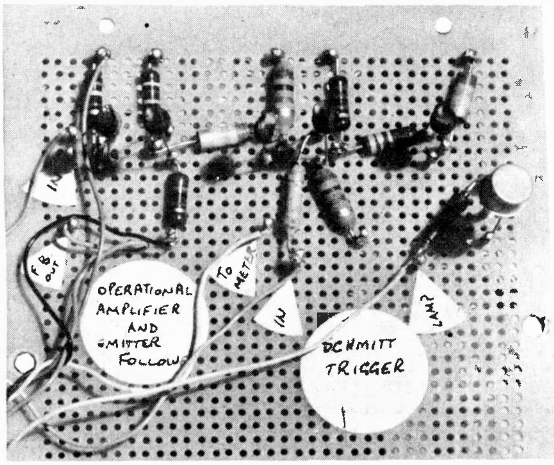
SCHMITT TRIGGER

Transistors TR4 and TR5 in Fig. 5 form a Schmitt trigger that will trigger the output of TR5 when the incoming voltage rises to 1·5 volts. When TR5 turns on, TR6 switches off, hence nearly 6V appears across the lamp, making it glow. The resistor in series with the lamp is a current limiter.

CONSTRUCTION

The constructor should start by obtaining his bank of press switches. There are many types available and many suitable as far as the circuitry is concerned. The panel may then be cut and drilled to suit, following the dimensions given in Fig. 6. The hole for the meter may require adjustment as well as extra fixing holes.

The hole in the top right-hand corner is to view the lamp. This was just drilled and countersunk, but readers may prefer to use a coloured plastics lens.



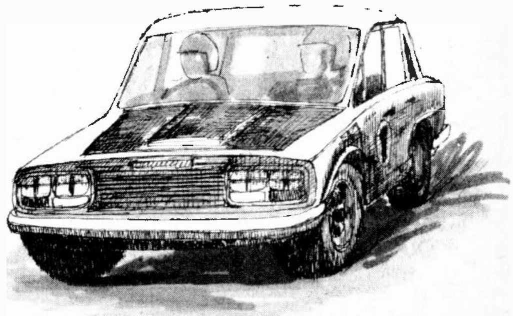
Rally driver circuit board

Before the panel can be painted, the meter-cover flap must be made. (Fig. 7). The two small brackets were made from thin (24 s.w.g.) tinplate, while the flap was made from thicker (18 s.w.g.) aluminium; as was the panel. A small $\frac{1}{8}$in × $\frac{1}{8}$in lug was left on each of the two top corners to fit in the $\frac{5}{32}$in holes in the brackets. This provides a very simple hinge for the flap. Notice that the flap has a 30 degree bend across it so that it lies flat on the face of the meter. When complete, glue a strip of felt on the underside in order to prevent scratches on the cover glass.

When the flap has been fitted—the meter having just been offered in position—the panel can be painted and put to one side while the case is made.

Make the bottom of the case next, ensuring that it is the same length as the panel (Fig. 8). Cut this from $\frac{3}{8}$in ply for rigidity, then cut two ends from $\frac{1}{4}$in ply to the dimensions given; glue and pin them over the ends of the base. Cut the top also from a sheet of $\frac{1}{4}$in ply. Make sure that it is exactly the length of the base plus the two ends, then glue and pin it on top of the ends.

Glue and pin $\frac{1}{2}$in square fillets inside the front to take the panel, and on the base to hold the batteries. When the glue has set, smooth all surfaces and prepare for paint or polish. Fit rubber mushroom feet to the base.



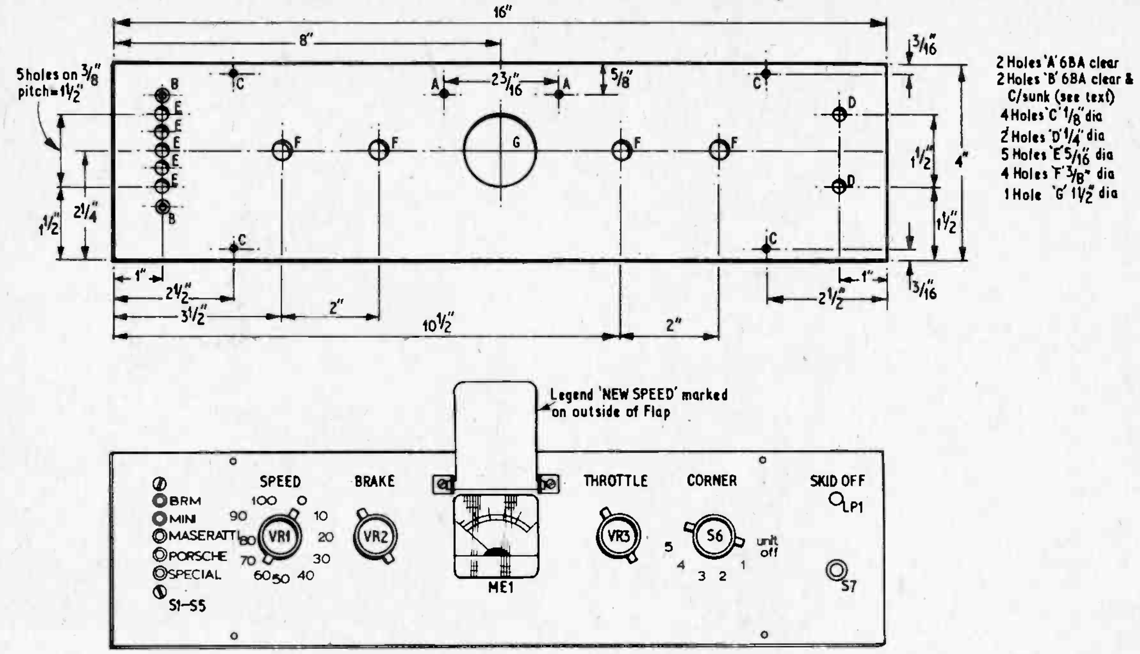
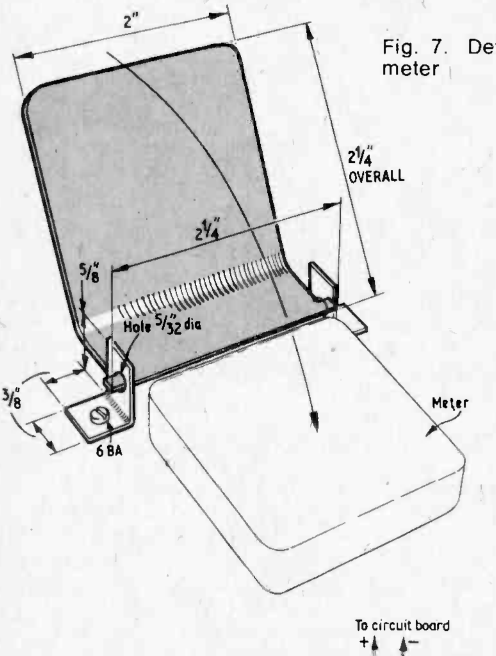


Fig. 6. Front panel drilling details and label layout

Fig. 7. Details of the brackets and flap for the meter



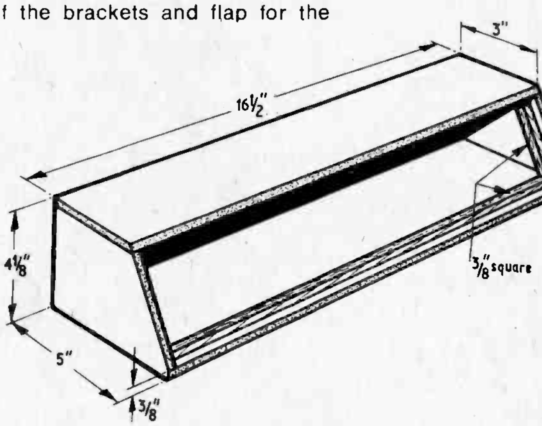


Fig. 8. Dimensions of case construction

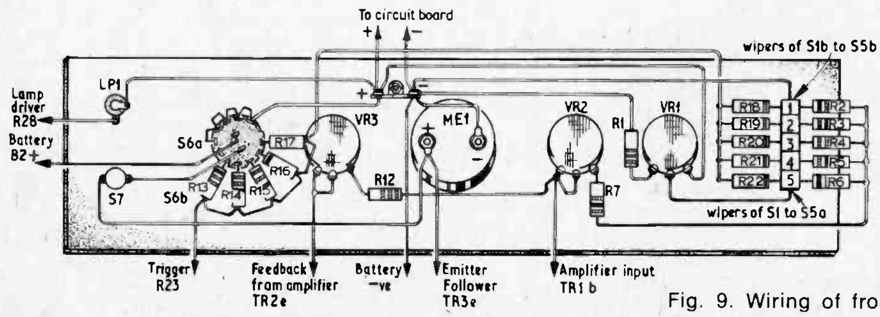


Fig. 9. Wiring of front panel components

WIRING

All the switches, potentiometers and the meter can now be mounted on the panel and the wiring as shown in Fig. 9 undertaken. Seven wires lead off to the circuit board; leave these at least 4in long. To save confusion, it is best if these wires are colour-coded. The battery clips are joined so as to connect the two 6V batteries in series; the negative wire is taken to the tag strip, and the positive to one central tag of S6.

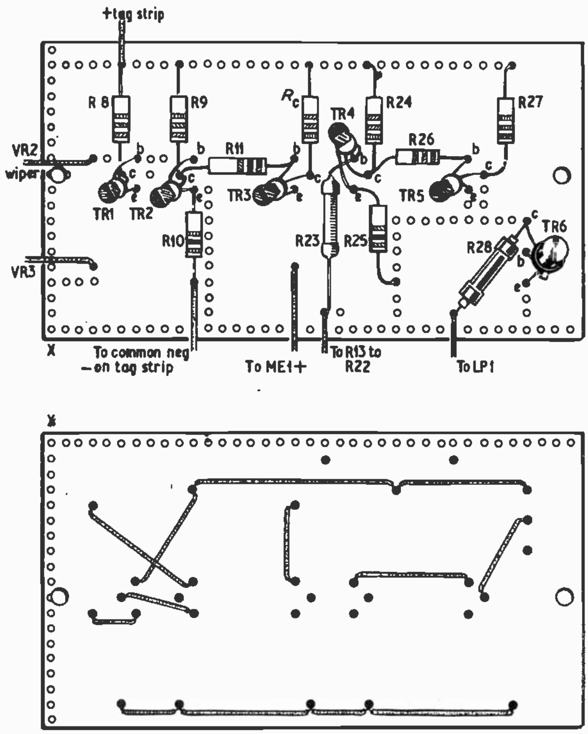
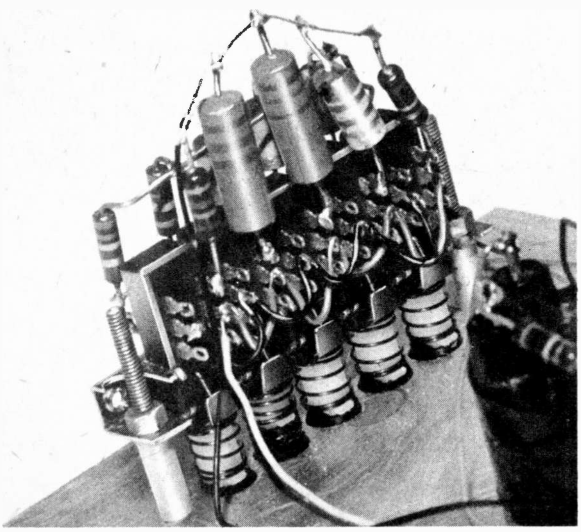


Fig. 10. Layout of components on s.r.b.p. circuit board and underside wiring



Wiring of switches S1-S5

CIRCUIT BOARD

It will be seen from the photographs that there is ample room inside the case and that a small circuit board will hold all the active components. The components are arranged in two distinct sections, sharing a common 12 volt supply line and a common earth. A suggested wiring layout is shown in Fig. 10.

Solder all the wires to appropriate points on the circuit board before putting it all into the case. Check all wiring against the circuits before connecting the batteries and testing. If for any reason the operational amplifier is not functioning as it should, adjustment of resistors in R_{in}' or R_f or both may solve the difficulty.

When all is satisfactory it can be assembled in the case. The circuit board sits on top of the bottom front strip and on a similar strip at the back, while the batteries are held by similar wood strips glued to the case. The panel is fastened to the fillets by four ½in chrome-plated screws. Finally, a back of hardboard may be pinned into place, its edges chamfered and smoothed.

COMPONENTS . . .

Resistors

R1	10k Ω	R11	47k Ω	R21	8·2k Ω
R2	68k Ω	R12	3·3k Ω	R22	10k Ω
R3	68k Ω	R13	33k Ω	R23	100k Ω
R4	47k Ω	R14	22k Ω	R24	2·2k Ω
R5	47k Ω	R15	15k Ω	R25	1k Ω
R6	56k Ω	R16	10k Ω	R26	33k Ω
R7	33k Ω	R17	8·2k Ω	R27	47k Ω
R8	6·8k Ω	R18	6·8k Ω	R28	68 Ω
R9	47k Ω	R19	5·6k Ω	R_c	See text and Table 2
R10	1k Ω	R20	5·6k Ω		

All ±10% ¼ watt carbon

Potentiometers

VR1 10k Ω linear carbon
VR2 50k Ω log. carbon
VR3 5k Ω linear carbon

Transistors

TR1, TR2 2N2926G
TR2, TR3, TR4, TR5 2N2926R *or* O
TR6 2N2196

Meter

ME1 Voltmeter 10V f.s.d. type MRA38 or similar

Lamp

LP1 6V 0·06A m.e.s. with holder.

Switches

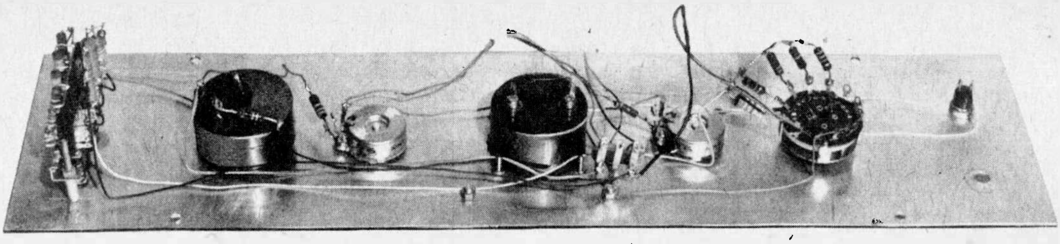
S1 to S5 Push button 2 or 4 pole changeovers on common frame with reset, or separate toggle switches
S6 2-pole, 6-way rotary wafer switch
S7 Single-pole, push button on/off

Batteries

B1, B2 6V each style PP1 (2 off)

Miscellaneous

Battery connectors (2 pairs)
Aluminium panel 16in × 4in
Plywood ¼in for case and ½in square section strip
Component wiring board or printed circuit board approx. 4·5in × 4in or less
Glue, pins, knobs



Components mounted on rear of rally driver front panel

GAME PREPARATION

A large sheet of card is obtained (the larger the better) and a road route marked out on it containing plenty of junctions, bends and corners of differing severity. Hazards, landmarks, buildings and other obstacles can be incorporated to choice. It is worth marking lanes into spaces or car-lengths. Mark a starting/finishing line, and grade each corner and hazard.

PLAY

Toy cars are placed in each lane at the starting line. Players may toss a coin for choice of lane. The last player to place his car has the privilege of moving off first. Each player specifies which type of car he is using and of course must stick to it throughout the game. A note is made of all choices. There is no limit to the number taking part, and any number of players may specify the same type of car.

In his turn, each player adjusts VR1 to his present speed, presses the switch for his type of car, then adjusts brake and/or throttle to his satisfaction. He lifts the flap and reads the voltmeter to the nearest whole division. Once he has lifted the flap he cannot readjust the controls until his next turn; he must lower the flap again afterwards. The player then moves his car the number of car lengths equal to the meter reading up to a maximum of ten lengths.

If during the course of this move he encounters a corner, he sets S6 to the numbered grading of that corner, from 1 to 5, with "1" being a slight bend and "5" the inside track of a hairpin. He then presses the button and if the lamp lights he spins off the track and misses the next turn. The turn after that he restarts from where he spun off.

LANE DISCIPLINE

Only one car is allowed in a square at a time. Changing lanes is permissible, provided that in the lane into which he wishes to move or cross, there is no car nearer than four lengths behind; that is, there must be three clear lengths.

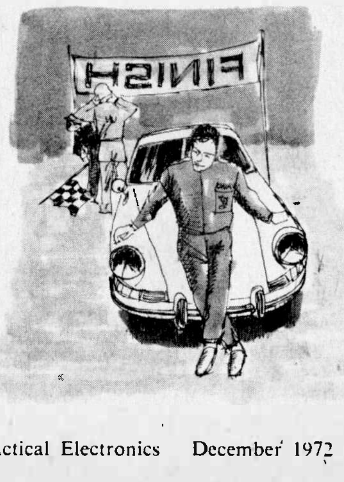
Cars wishing to overtake another may therefore be boxed in by a third and in these circumstances he must match his speed with the slower car in front. Failure to do so—that is, if his move would ordinarily take him beyond the car in front—means that he again must spin off the track and miss a turn.

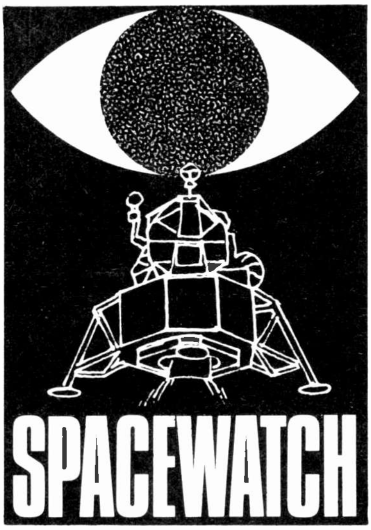
Of course, players may use this technique deliberately to force a car behind off the road, and there will be many cases where a player over-compensates or grossly mishandles the brake, bringing his car to a halt in the path of another. Unless the one behind can overtake without hindering a third, or unless he too can halt, then he must spin off and miss a turn.

CONCLUSION

Constructors preparing a track may have as many bends as they wish, but at least one good straight should be included—particularly if the top speed of some cars is limited in the manner described. Hazards such as chicanes and islands could also be introduced and constructors should bear in mind that the inside lane on a bend may have fewer car-lengths in it, but rate a higher corner-severity.

Much of the success of the game and the enjoyment derived is in the road layout, and it will probably be worthwhile to collaborate on this with someone who has had real rally driving experience.★





BY FRANK W. HYDE

SOVIET SPACE PROBES

Some additional information has now become available from Russia which relates to the *Mars-2* and *Mars-3* space probes. Some of the work done by *Mars-3* has already been reported here. The additional information was obtained with infra-red radiometers operating in the 8 to 40 micrometre band.

The system of measurement was such that the tracks of the probes went from the southern hemisphere to the northern hemisphere of Mars, going through the seasons and all parts of the day. The temperature of the surface of Mars was plotted through these periods and showed that the variation was from −13°C to −93°C.

From this data a clue can be obtained as to the structure of the surface, and the climate can be assessed. The low temperatures at night seem to indicate that the surface cools quickly after sunset. If this is the case then it points to the heat conductivity of the surface as being low and consistent with dust or dry sand in a comparatively rarefied atmosphere.

Generally speaking, there was a difference between the dark areas or seas, and the light areas or continents. The seas were warmer by some 10°C and this is no doubt due to lower reflective power in these areas. This is true of one special area, a dark region known as *Cerberus*, which lies north of the Cimmerian sea. It is likely that the higher heat conductivity is due to rocks projecting from the surface.

In February when the probe *Mars 3* was in the region of the northern ice cap the infra-red radiometer recorded a temperature of −110°C. Such a reading indicates that the polar cap consists mostly of solid carbon dioxide. This cap remains all through the year. There is also indication of some water-ice. The southern ice cap disappears in summer.

DRY MARS

The Soviet scientists have said that it is possible that the north polar cap contains more carbon dioxide and water than in the whole of the Martian atmosphere. The actual precipitation of water on Mars is about 0·02 of that of the earth's atmosphere. Mars, therefore, is much drier than earth based experiments and measurements indicated.

The dust storms on Mars still remain a mystery. Measurements have shown that the particles of dust are about one micrometre in size. These would settle very slowly, thus these dust clouds often endure for up to three months. One thing that has been noted with these clouds is that an increase in wavelength of observation can make them more transparent to the scanning photometer. Some particles are found to be as much as ten micrometres in size but these settle very quickly.

It is interesting to note that the two spacecraft from the Soviet Union have relied on astrophysical instruments for their observations whereas the United States have relied mostly on television. Such combination of observations should yield a much more positive accumulation of data for comparison.

So far the information from the various probes since 1965 has led to comparisons of earlier measurements. For example, in 1969 *Mariner* probes 6 and 7 recorded atomic hydrogen levels substantially higher than those recorded by *Mars-2* and *Mars-3*. The possible explanation is that either there is now a smaller amount of water vapour present, or that the temperature has fallen.

Finally, the presence of a shock wave due to the solar wind interacting with the upper levels of the Martian atmosphere, was detected.

GALAXY THAT EXPANDS FASTER THAN LIGHT

Radio telescopes at California and Massachusetts, working as an interferometer with 100 million wavelengths as a base line, and enabling changes of 0·001 second of arc to be detected, were focused on the source 3C 120, a quasar.

Astronomers D. B. Shaffer, M. H. Cohen, David Jauncey and K. Kellerman were examining the fine structure of this source and when they compared the present results with some made about eight months before, they observed considerable structural changes in the source. The movements observed, when reduced to a measurement of velocity, indicates that the "blobs" of matter were moving apart at two to three times the speed of light.

There have been previous records in two quasar explosions which indicated speeds faster than light. However, the uniqueness of this new result lies in the fact that whereas the two previous events were quasars with a high red shift, about which some astronomers now have doubts, the results from 3C 120 are from a source of quite low red shift. In this case there is no longer the criticism that the apparent high speed is because the distance from the earth is much less than supposed. The distance of 3C 120 is not in question. The situation has thrown the whole problem into a turmoil again.

CRUST OF THE MOON

The artificial production of seismic events on the moon by crashing spent stages and lunar module ascent stages plus one authentic meteorite of about six feet in diameter, have now provided a great deal of data from the seismic observatories on the moon. Altogether there have been about six artificial impacts and these have enabled the reflections from the various layers of the moon to be measured.

There is a sharp increase in velocity from 0·1km per second at the surface to 5km per second at a depth of 10 kilometres. These figures are consistent with the structure of the moon soil and fragmented rock. As the depth increases the velocity would be expected to increase due to the compacting of the rocks. At a depth of about 25km there is a sudden increase in velocity to 6·8km per second and this continues down to a depth of 65km. Down to 25km the structure is consistent with basalt but from there on to the 65km level there must be some other type of rock. At this level also there is another change in velocity which rises to 9km per second. The geologists working on the projects maintain that this indicates a major structural boundary which may be the junction of the crust and the mantle.

The meteoritic impact revealed that the upper mantle velocity was similar to that of the earth with a velocity of 8·2km per second. If this is so, the moon may have a mantle similar to earth.

The measurements also suggest that there is a core at a depth of about 600km. This is the first direct evidence of a core. Having got so far, the last opportunity for direct observation comes in December with *Apollo 17*. At the moment it would seem that the crust of the moon is twice as thick as that of the earth.

Strictly

by K. Lenton-Smith

ELECTRONIC MUSIC (as distinct from amplified conventional instruments) is often thought to be a relatively modern subject. In one sense it is, if *Music Concrete* is implied. In its real sense, the roots go back nearly 150 years, the recent pace having accelerated through technological advances.

C. G. Page described his music production methods in 1837 in the American Journal of Science in an article entitled "The Production of Galvanic Music". In the following year, C. E. L. Delezenne published a paper describing how a contoured iron wheel, rotated in front of an electromagnet, could produce a musical signal.

Professor Thaddeus Cahill patented his Teleharmonium in 1897, consisting of 58 alternators. As amplification was then unheard of, each alternator produced a musical frequency which could be played directly into a telephone system: the sine wave outputs could be mixed to produce various tone colours—so pointing the way for those who were to lay down, some 40 years later, the basic principles behind many modern electronic musical instruments.

MUSIC CONCRETE

The BBC Radiophonic Workshop and Daphne Oram are names that will be familiar to those interested in Music Concrete.

To produce this kind of music a tape recorder with 12 interchangeable capstans is required: with this, any sound may be recorded to produce a chromatic scale, provided that the source frequency is fairly steady. Re-recording this tape at different tape speeds on another machine will provide super- and sub-octaves of the sound source: careful cutting and splicing of these tapes can be done to produce a musical composition containing brilliant arpeggios and other unusual effects. A drum, cymbal (a very complex sound) or even a tap dripping into a basin are typical of the sound sources used in this work.

Rhythmic sounds are normally produced by tape loops, perhaps using the basic source after its frequency has been taken down several octaves. After rhythm, melody, and special effects have been combined and reverberation added, the end result will either be fascinating or unpalatable—according to one's personal taste.

This type of work calls for several tape recorders and other special equipment, such as variable tone sources, re-iterators and reverberation devices. It is thus somewhat out of the amateur's field, except for the most rudimentary experimentation. The author admires the patience and skill of those prepared to make their music this way, but this type of work is not, of course, Strictly Instrumental.

EARLY INSTRUMENTS

No real progress was made until amplification became a reality. Then, many ingenious inventions followed, most of which are now merely interesting curios.

The Trautonium, developed by Dr Friedrich Trautwein of the Radio Research section at the Berlin Academy of Music, was demonstrated in Berlin in 1930 and created considerable public interest.

The circuitry was fairly simple—an amplified relaxation oscillator: later versions had some tonal variation and an improved fingerboard. It was the electronic equivalent of a one-string-fiddle, the charge-discharge characteristic of the neon tube being the same sawtooth as obtained by drawing a bow over a string.

Another early instrument was the Theremin, which employed the principle of heterodyning two r.f. oscillators to produce an audio beat-note. Frequency variation of one oscillator was achieved by hand capacitance, using a small antenna: the player thus had to "feel" for his pitch, much like a string player. Though rapid passages were impossible, it was effective as a legato, solo instrument: vibrato and glissando were easy to accomplish.

Martenot produced a similar instrument, using a fingerboard to alter capacitance in the inductively coupled circuit.

MONOPHONIC

It is easy to overlook the fact that a number of highly skilled musicians play monophonic instruments (brass and reeds, for example). Whereas the pianist or organist might be disinclined to consider a melody instrument, a monophonic device still has its uses.

The Hammond Solovox came on the scene about 30 years ago and was used by small bands as another solo voice. The fact that it soon had a number of imitators was proof of its success. The small, three-octave keyboard was designed to be fixed adjacent to the upper half of a piano keyboard, the master oscillator covering the entire 37 note range. Three divider stages followed and, with the master oscillator, their outputs were labelled, Soprano, Contralto, Tenor & Bass. Any one—or combination—of these could be switched to a common busbar feeding a series of five tone filters. With a knee-operated swell and controls for attack and vibrato, the Solovox was a useful instrument in any small "combo".

The monophonic instrument can only sound one note at a time (or its suboctaves), whereas the organ/electric piano is fully polyphonic. In looking at earlier instruments, the development of polyphonic instruments has been ignored on this occasion: this is because the youngest member of the monophonic family—the Synthesiser—is important to many of today's musicians and constructors. The last few paragraphs may thus have helped, in a way, to trace its ancestry.

THE SYNTHESISER

From the circuitry point of view, we have come a very long way from the Trautonium! The attraction of the modern synthesiser is, however, the same as it was over 40 years ago—an entirely new sound. Multiple recording can produce existing, and often weird results.

The complexity of voltage controlled oscillators, envelope and noise generators, modulators, etc. means that the polyphonic synthesiser is still a twinkle in the eye of its commercial father. I.C. manufacturers are going through the throes of over-capacity: it may well be that they will turn their attention to simplifying the production of a polyphonic synthesiser at some future date.

TAPE HEADS

We are gradually obtaining more information about the Truvox tape heads we have, we'are told that these have been wound in a very ingenious way so that winding may be coupled either in parallel or in series depending whether high or low impedance is required. We also have matching erase heads and now offer these in pairs. 1 record and 1 erase head. Price of the 2 track **45p** per pair. 4 track **75p** per pair. Pair mounted on plate **45p** extra.

I R.P.M. MOTOR

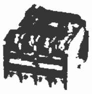
Made by the famous Smiths Company. 240V 50 cycle mains working. Ideal motor to drive clock mechanisms. Price **£1** each or 10 for **£9.**

DRILL CONTROLLER

NEW IKW MODEL

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£1·50** plus 13p post and insurance. Made up model also available. **£2·25** plus 13p P. & P.

MAINS OPERATED CONTACTOR



220/240V 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10 amps. Extremely well made by a German Electrical Company. Overall size 2¼in × 2in × 2in. **£1·50** each.

HIGH ACCURACY THERMOSTAT

Uses differential comparator I.C. with thermistors as probe. Designer claims temperature control to within 1/7th of a degree. Complete kit with power pack **£5·50.**

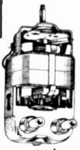
AUTO—ELECTRIC CAR AERIAL

with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. **£5·75** plus 25p post and insurance.

WATERPROOF HEATING ELEMENT

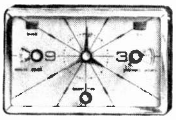
26 yards length 70W. Self-regulating temperature control. **50p** post free.

MULTI-SPEED MOTOR



Replacement in many well-known food mixers. Six speeds are available 500, 850 and 1,100 r.p.m. from either or both of the nylon sockets (where the beaters of the food mixer normally go) and 8,000, 12,000 & 15,000 r.p.m. (ideal polishing speeds) from the main drive shaft. This drive shaft is ¼in diameter and approximately 1in long. A further point about this motor is that being 230/240V a.c.-d.c. series wound its speed may be further controlled with the use of our Thyristor controller. This is a very powerful and useful motor size approx. 2in dia. × 5in long, mains 230/240V. Price **88p** plus 23p postage and insurance. 12 or more post free.

15A ELECTRICAL PROGRAMMER



Learn in your sleep: Have radio playing and kettle boiling as you awake—switch on lights to ward off intruders—have warm house to come home to. All these and many other things you can do if you invest in an electrical programmer. Clock by famous maker with 15A on/off switch. Switch on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price **£1·95** + 20p P. & P. or with glass front chrome bezel 75p extra.

0-8 AMMETER

2in square full vision for flush mounting. Moving iron instrument. Ideal for charger. Price **60p** each. 10 for **£5·40.**

NUMICATOR TUBES

For digital instruments, counters, timers, clocks, etc. Hi-vac. XN. 3. Price **£1·45** each. 10 for **£13.**

12-WAY SUB-MINIATURE MULTI-CORE CABLE

7·0076 copper cores each core P.V.C. insulated and of different colour. P.V.C. covered overall and approx. 3/16in thick. Price **20p** per yard.

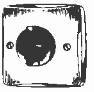
LIGHT CELL

Almost zero resistant in sunlight increases to 10K Ohms in dark or dull light, epoxy resin sealed. Size approx. 1in dia. by ¼in thick. Rated at 500MW, wire ended. **43p** with circuit. Also ORP 12 light cell **45p.**

MULLARD 4 + 4 UNILEX AMPLIFIER

We demonstrate these daily and almost always a sale results; it really is a cracking amplifier. Only Mullard with their know how could have made it possible at this low price. SPEC:—Mains operated. 4 watts music or speech per channel. Double wired power supply eliminates cross talk. Harmonic distortion less than 2%. Frequency response 50hz–16Khz. Input suitable for pick up tuner or microphone. 6 month guarantee. Only **£9·95p** + 30p postage and insurance.

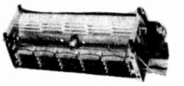
THYRISTOR LIGHT DIMMER



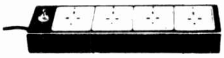
For any lamp up to 1kw. Mounted on switch plate to fit in place of standard switch. Virtually no radio interference. Price **£2·95**, plus 20p post and insurance.

TANGENTIAL HEATER UNITS

This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing **£15** and more. We have a few only. Comprises motor, impeller, 2kW element and 1kW element allowing switching 1, 2 and 3kW and with thermal safety cut-out. Can be fitted into any metal lined case or cabinet. Only need control switch. **£3·50.** 2kW Model as above except 2 kilowatts **£2·50.** Don't miss this. Control Switch **35p.** P. & P. 40p.



DISTRIBUTION PANELS



Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work. **£2·25** plus 23p P. & P.

THIS MONTH'S SNIP

BATTERY MOTORS. A bargain parcel of 7 motors for **£1.** Some not as large as a postage stamp and only ⅜in thick, largest is 1¼in × 1¼in dia. Some work off 1½V some as high as 18V. These motors are used in racing cars, power toys, etc. The largest is so powerful that it will drive a Mini drill, model lathe, or similar. This is a 4 pole motor, optimum working 16·5V but very powerful even as low as 4½V. Don't miss this wonderful snip.

TIMAC 24 hour 15 amp Clock Switch. Self-contained unit for flex connection to the mains. Clock switches 2 on/offs per 24 hours. Operates a 15 amp switch. All neatly made up in an ivory moulded case with outlet socket. The only snag is that the outlet socket is the continental type. Plugs for these can be brought in this country alternatively you could fit a connector strip in place of the outlet socket. Overall size of this unit is approx. 4" × 2¼" · 3" and the clock has a clear perspex cover which is easily removable for reprogramming. Ideal for blanket controller, etc. Price **£2·75** each.

STANDARD WAFER SWITCHES

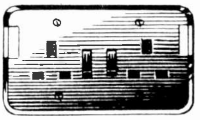
Standard size 1½in wafer—silver-plated 5-amp contact, standard ¼in spindle 2in long—with locking washer and nut.

No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole	40p	40p	40p	40p	40p	40p	40p	40p	40p
2 poles	40p	40p	40p	40p	40p	40p	40p	70p	70p
3 poles	40p	40p	40p	40p	70p	70p	70p	95p	95p
4 poles	40p	40p	40p	70p	70p	70p	70p	£1·20	£1·20
5 poles	40p	40p	70p	70p	95p	95p	95p	£1·45	£1·45
6 poles	40p	70p	70p	70p	95p	95p	95p	£1·70	£1·70
7 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£1·95	£1·95
8 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£2·20	£2·20
9 poles	70p	70p	95p	95p	£1·45	£1·45	£1·45	£2·45	£2·45
10 poles	70p	70p	95p	£1·20	£1·45	£1·45	£1·45	£2·70	£2·70
11 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£2·95	£2·95
12 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£3·20	£3·20

MULLARD AUDIO AMPLIFIER MODULE

Uses 4 transistors, and has an output of 500mW into 8 ohms speakers. Input suitable for crystal mic. or pick-up. 9V battery operated. Size 2in long × 1¼in wide × 1in high. SPECIAL SNIP PRICE **60p** each. 20 for **£5·40.**

13 AMP TWIN GANG SOCKETS

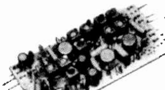


Offered at less than wholesale price your opportunity to replace those dangerous adaptors—brown bakelite flush mounting—standard fitting. Unswitched **20p** each, separately switched **30p** each. Separately switched and with neon on/off indicators **45p** each. Less 10% ten or more + 20p postage if order under £5.

INTEGRATED CIRCUIT BARGAIN

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

MULLARD I.F. MODULE



MULLARD AUDIO AMPLIFIERS. All in module form, each ready built complete with heat sinks and connection tags, data supplied.
Model 1153 500m watt power output **75p.**
Model 1172 750m watt power output **85p.**
Model EP9000 4 watt power output **£1·45p.**
10% discount if 10 or more ordered.

POCKET CIRCUIT TESTER

Test continuity of any low resistance circuit, house wiring, car electrics. Tests polarity of diodes and rectifiers. Also ideal size for conversion to signal injector (circuit supplied). **30p** or 2 for **50p** post paid.

AMPLIFIER IN CASE WITH SPEAKER

Marketed by British Relay under the name Luxistor. This is in a very neat looking cabinet and is ideal around the home or in the workshop for trouble shooting or for testing out a quick lash up. Size approx. 9½" × 6½" × 3½" deep. Input is via a matching transformer and volume control and amplifier may be powered by an internal 9v battery or an external 110v source. Speaker is an R-A eliptical 6" × 3½" 10,000 gauss. The amplifier proper is a Newmarket model ref. P.C.4. Price **£3·50** each, 10 for **£31·50.** Post and insurance 20p.

BAKELITE INSTRUMENT CASE

Size approx. 6½" × 3½" × 2" deep with brass inserts in four corners and bakelite panel. This is a very strong case suitable to house instruments and special rigs, etc. Price **45p** each.

TELEPHONES

Complete as illustrated. Save your legs, time and temper, simply by putting in some telephones. Ex-G.P.O., not new—but guaranteed in good condition and serviceable. Supplied with diagram and instructions showing how to connect. Price **75p each +50p** post or 2 for **£2** post paid. Also available separately, dials and handsets **50p** each + 20p post.

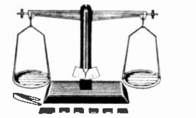
ROCKER SWITCH

13 amp self-fixing into an oblong hole, size approximately 1" × ⅝" **6p** each, 10 for **54p.**

SLIDE SWITCHES

Slide Switch. 2-pole changeover panel mounting by two 6B.A. screws. Size approx. 1in. × ⅜in. rated 250V lamp. **6p** each, 10 for **54p.** 100 for **£5·10.** 500 for **£24.** Ditto as above but for printed circuit **5p** each. 10 for **45p.** 100 for **£4·25.**
Sub Miniature Slide Switch. DPDT 19mm (¾in. approx.), between fixing centres. **13p** each or 10 for **£1·08.**

EDUCATIONAL KITS—all with pictorial instructions



THIS BALANCE KIT **FREE**

Eagle educational kits, Japanese made these are excellent value for money. We do not expect to be able to repeat this offer once stocks are sold. Brief description of each kit is given below and with 3 kits or more we give FREE an accurate 11 piece balance kit. Price of kits **40p** each post paid. Special price for all 8 kits **£3** with free balance kit.

KA2 Lens Kit. Eleven parts, including candle, one concave lens, one convex lens, stage and slit frame, etc. Watch light rays bend as they pass through different lenses.

KA3 Water Pump Kit. Thirteen parts. Top of pump is transparent so that operating parts may be observed. Small parts are brightly coloured to be seen easily while working. Three types of pump may be made: Lift pump. Force Pump and Force Pump with reservoir and nozzle.

KA4 Burner Kit. Eleven parts. Transparent covers allow the operation of buzzer to be seen. Illustrates and teaches how electromagnetism with an automatic switch results in an operating buzzer.

KA6 2-Pole Motor Kit. Twenty-four parts including enamel wire, armature and pole piece, etc. Motor operates from 1½ volt battery. Illustrates and teaches how electro-magnetism operates a motor.

SP Change over spring return 250v 1 amp **10p.**

KA7 Electro-Magnet Kit. Fifteen parts, includes compass. Makes two electro-magnets, one with one layer of wire and one with several layers of wire. Picks up tacks, nails and any small parts showing how magnetism works.

KA8 Current and Resistance Kit. Twenty-nine parts, including bench and light bulb. Conduct interesting and educational projects to learn the application of "OHMS LAW" and see the difference in current and resistance with different types and lengths of wire.

KA9 Bell Kit. Eight parts, including bell and push button switch. Build a complete electric bell and see how the hammer is triggered to make the bell ring.

KA10 Morse Key trigger and bell kit. 25 part kit easy to construct, simple to operate.

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

J. BULL (ELECTRICAL) LTD.

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Designing with Integrated circuits

BY A.FOORD

3 Basic Operational Amplifiers

AN operational amplifier is essentially a high gain direct coupled amplifier which makes use of positive or negative feedback to control its overall characteristics. Originally the term operational amplifier denoted a circuit which performed a mathematical operation (such as, summation, differentiation, integration) in analogue computing. However, their applications are now extended to cover many fields; instrumentation and measurements are but two examples.

The required overall response of an operational amplifier is usually obtained by connecting feedback components externally from the output terminal back to the inputs. A differential input allows a considerable flexibility in the feedback configuration and also allows a reduction in d.c. drift because of the close matching of the input characteristics.

GLOSSARY

OPERATIONAL AMPLIFIER A low frequency amplifier, often used to perform mathematical operations.

DIFFERENTIAL INPUT An input applied between two input terminals.

VIRTUAL EARTH Low impedance signal point.

OFFSET ERRORS Errors produced by voltage or current imbalance in the input stages.

COMMON MODE INPUT RANGE The maximum signal which can be applied simultaneously to both inputs.

BASIC FORM

The basic form of the operational amplifier feedback circuit, illustrated in Fig. 3.1, shows that the voltage at the virtual earth (or summing point) is very small and tends to zero for an infinitely large amplifier gain.

For this type of circuit where the output is fed back towards the input in such a way as to reduce it, the overall characteristics become almost independent of A (the gain of the amplifier without feedback). The assumptions in the formula are that e is zero, no current flows into the amplifier terminals, and that A is much greater than G (the overall gain with feedback).

Summation of currents at the virtual earth point must always be zero. The overall gain is given by:

$$G = \frac{V_o}{V_i} = -\frac{R_2}{R_1}$$

The minus sign indicates a phase inversion.

Amplifiers of this type have a considerable isolation between input and output and many variations are possible. The input impedance is equal to R_1. If R_1 equals R_2 the circuit gives unity gain where a sign change (inversion) is required.

INVERTING AMPLIFIER AND ADDER

If a separate resistor is used for each input, as in Fig. 3.2, then current summing occurs at the virtual earth, with excellent isolation between inputs. For the first input the gain is

$$G = -\frac{R_{FB}}{R_1}$$

Therefore

$$V_o = -\left\{\left(\frac{R_{FB}}{R_1}\right)V_1 + \left(\frac{R_{FB}}{R_2}\right)V_2 + \left(\frac{R_{FB}}{R_3}\right)V_3 + \dots\right\}$$

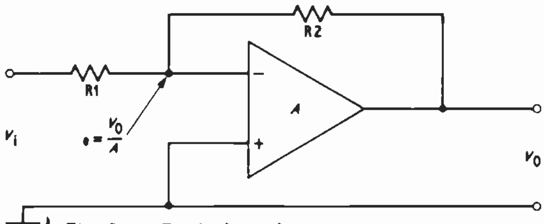

Fig. 3.1. Basic form for an operational amplifier

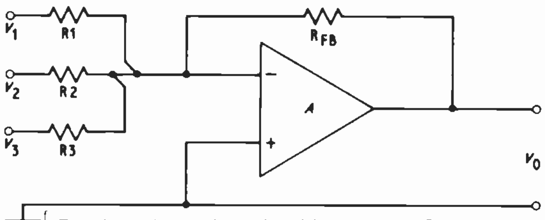

Fig. 3.2. Virtual earth addition amplifier

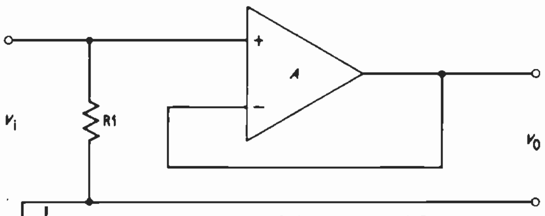

Fig. 3.3. Unity gain follower amplifier

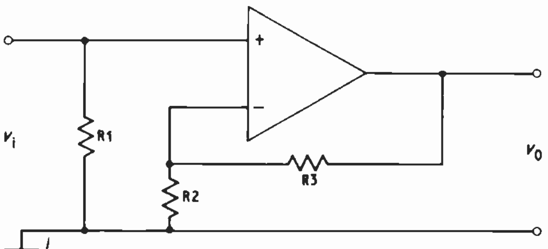

Fig. 3.4. Non-inverting amplifier with gain

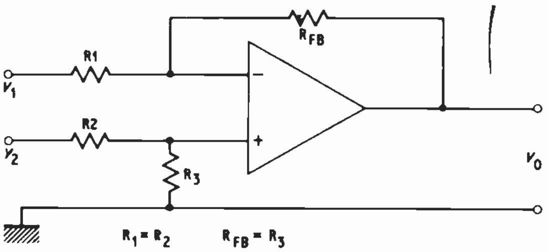

Fig. 3.5. Differential amplifier

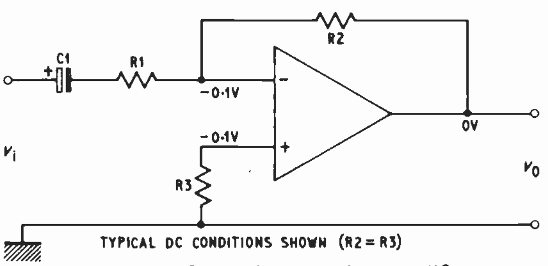

Fig. 3.6. AC coupled inverting amplifier

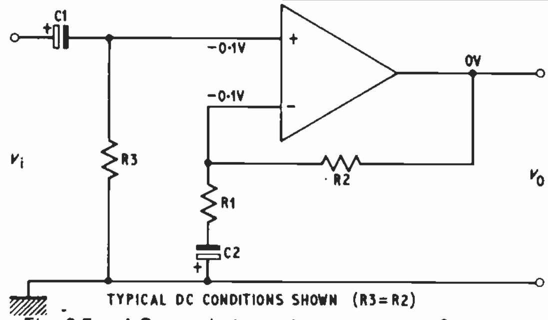

Fig. 3.7. AC coupled non-inverting amplifier

The amplifier input bias current in Figs. 3.6 and 3.7 provides the voltage drop across the resistors R2 and R3. Since this current is low, then low leakage capacitors are essential

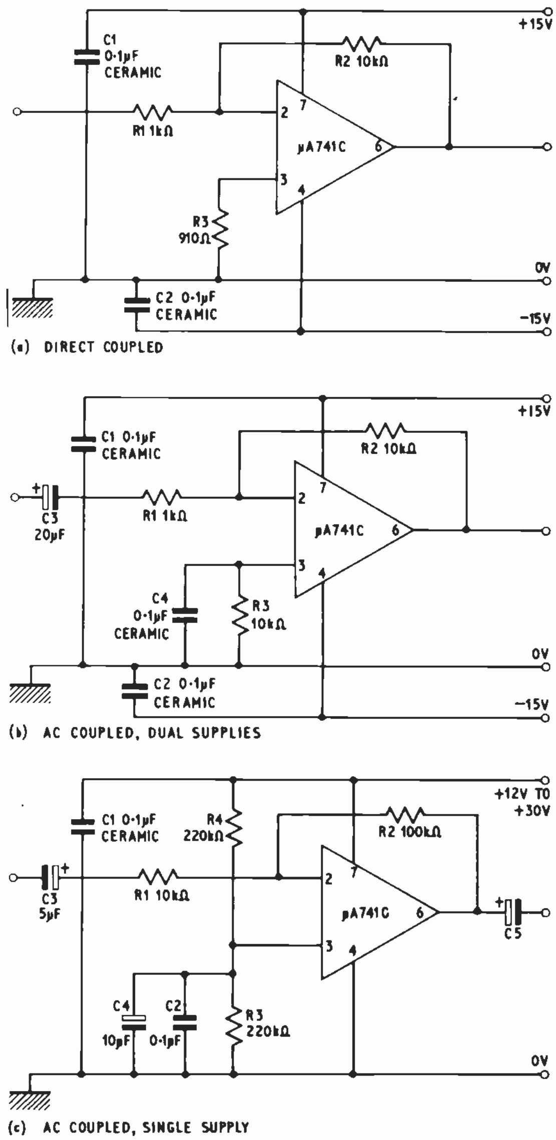

Fig. 3.8. Practical inverting amplifiers with ten times gain

NON-INVERTING AMPLIFIER

For a non-inverting amplifier the input is connected to the non-inverting terminal of the i.c., while negative feedback is applied as shown in the diagrams. Feedback is now effectively in series with the input signal and care must be taken to make sure that the common mode input range of the amplifier is not exceeded.

A unity gain follower is shown in Fig.3.3 where all the output voltage is fed back in series with the input. This gives a high input impedance, a low output impedance, and unity gain. The non-inverting amplifier with gain (Fig. 3.4) also has a reasonably high input impedance. The gain for this arrangement is

$$G = \frac{R_2 + R_3}{R_2} = 1 + \frac{R_3}{R_2}$$

DIFFERENTIAL AMPLIFIER

The amplifier in Fig. 3.5 uses both inputs to amplify the difference between two signals. The gain can be equal to, greater than, or less than unity.

$$V_O = \frac{R_{FB}}{R_1}(V_2 - V_1)$$

D.C. CONDITIONS

The amplifiers are designed to run from both positive and negative supplies with both input terminals and output terminal near earth potential (for a zero input signal) so that direct coupling can be used.

To maintain the correct d.c. conditions the amplifiers require a resistor from the output to the inverting input and a resistor from the non-inverting input to ground. Each input terminal should have the same d.c. source resistance to minimise the effects of input voltage and current offsets.

A.C. AMPLIFIERS

Although the amplifiers are basically designed for direct coupled use they are equally suitable for a.c. applications. In these cases d.c. blocking capacitors are used in the signal paths. When electrolytics are used, care must be taken with the d.c. biasing conditions since many circuits maintain little or no bias across the capacitors.

Low leakage tantalum capacitors are preferred, or two high grade electrolytics may be used back to back. This problem can sometimes be avoided by using a single supply rail.

For the inverting ampiifier circuit of Fig. 3.6 the input impedance is equal to R_1 and the low frequency bandwidth is determined by R1 and C1. For the non-inverting amplifier in Fig. 3.7 the input impedance is approximately equal to R_3.

PRACTICAL CIRCUITS

Some practical circuits for a.c. and d.c. use with a 741C integrated circuit (or equivalent) are shown in Figs. 3.8 and 3.9. The connections given are for the TO5 version. The ceramic decoupling capacitors should be connected as close to the integrated circuit as possible. The capacitors in the a.c. coupled circuits with dual supplies only have a small bias across them and should be tantalum types.

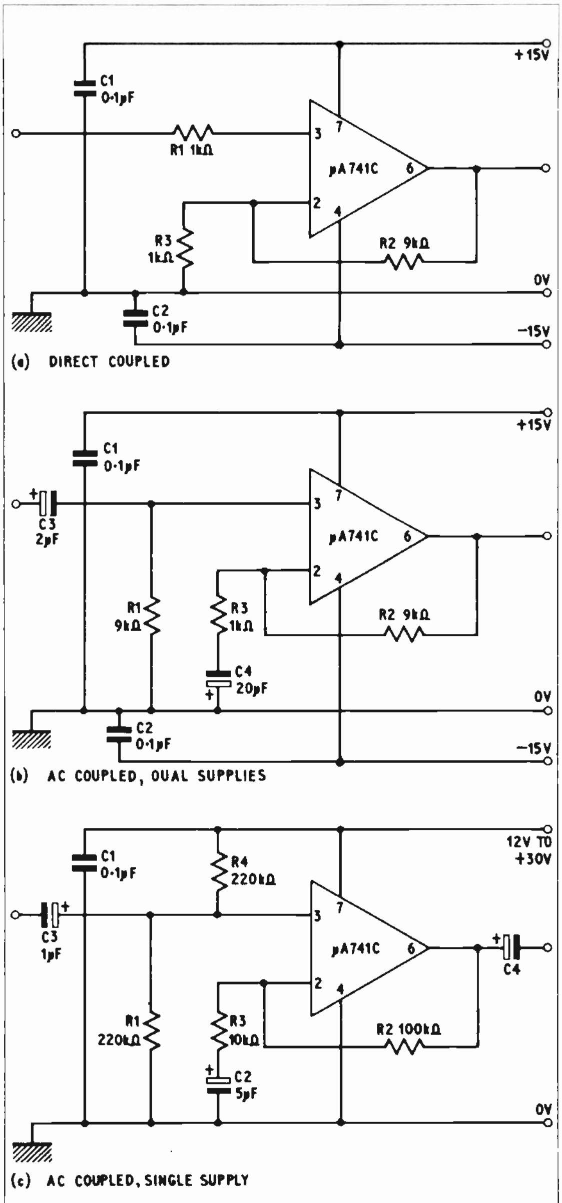

Fig. 3.9. Practical non-inverting amplifiers with ten times gain

Next month: Part 4 looks at one of the most useful i.c.s, the Schmitt trigger.

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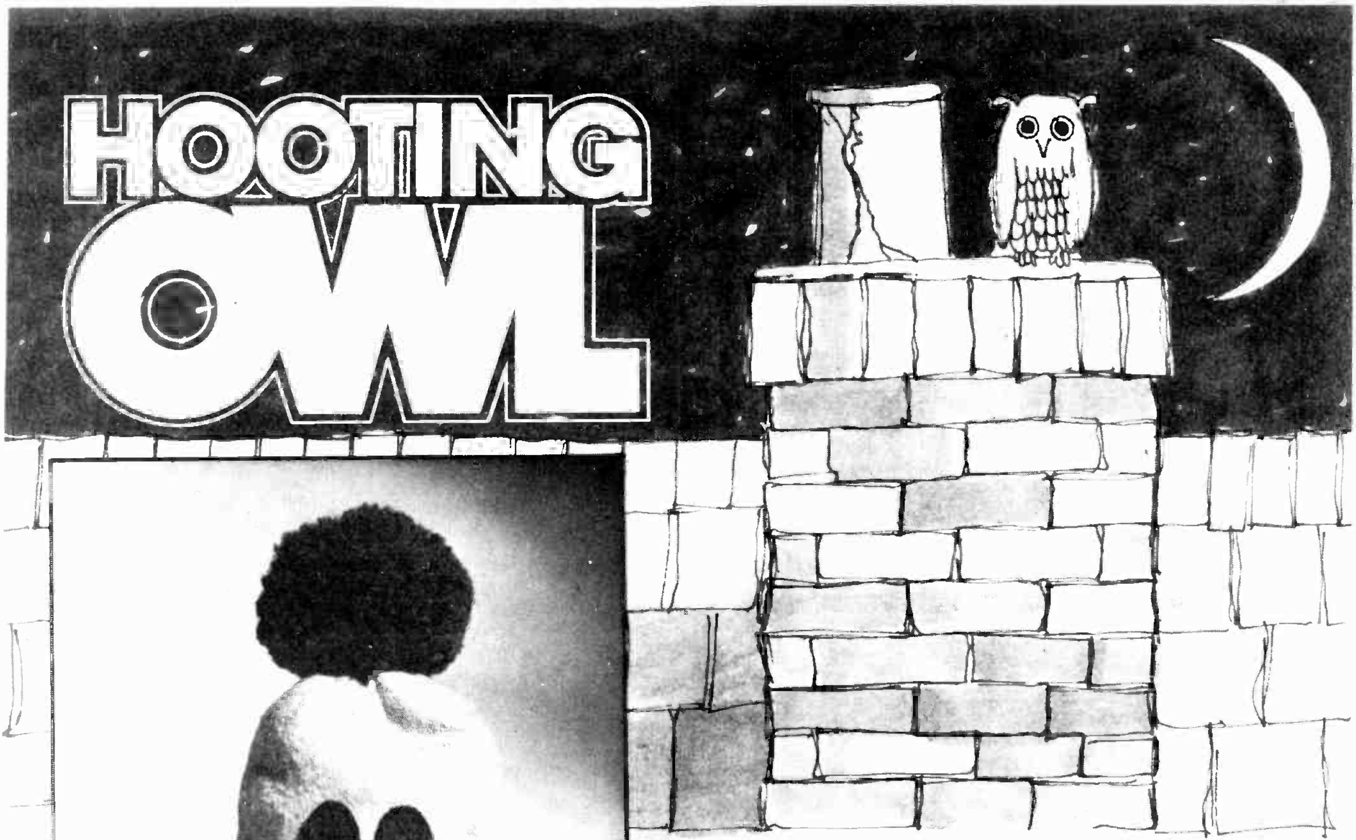
HOOTING OWL



By A. R. Cuff

Simple to build and capable of endless variations, this toy will provide hours of amusement for children and adults alike.

THIS project describes some simple circuits for producing sounds which somewhat resemble the cries of small animals. It should interest readers who are looking for something amusing, which is easily constructed, and can be used to intrigue their friends.

The "owl" described here is just one of a large number of possible variations of the basic design and makes an ideal present for children or the girl friend.

Because the idea is so versatile it can be made simple for beginners or rather more complex for advanced constructors; in fact this is a very good first project as there are no problems with tolerances or setting up, and only the cheapest components need be used.

The finished animal can be made extremely attractive if a little care is taken with the external detail.

THE SIMPLE MODEL

The basic element in all the units is the astable multivibrator which is used in various combinations to produce a wide variety of animal and bird sounds.

In the simplest design as shown in Fig. 1 a single note astable is turned on and off by a mercury switch. The mercury switch (for those who have not encountered them before) is a sealed tube containing mercury which is free to move about. Two contacts sealed into the glass form a switch which is only closed when the mercury covers both. Thus when this switch is used in the model animal it can be arranged so that the animal only emits a noise when tilted.

Also shown in Fig. 1 is a capacitively-coupled single-transistor amplifier to provide sufficient volume to operate a small 8 ohm speaker, and also to avoid excessive loading of the oscillator.

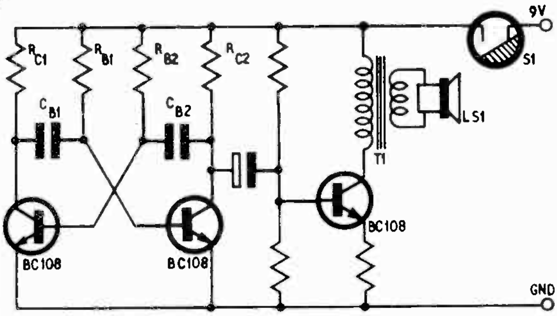


Fig. 1. With just a simple multivibrator and amplifier a toy animal can be built which emits a squeak each time it is lifted

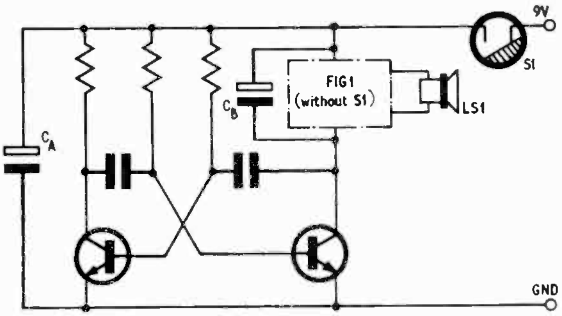


Fig. 2. With two multivibrators in cascade, a more complex sound is produced somewhat resembling the miaow of a cat

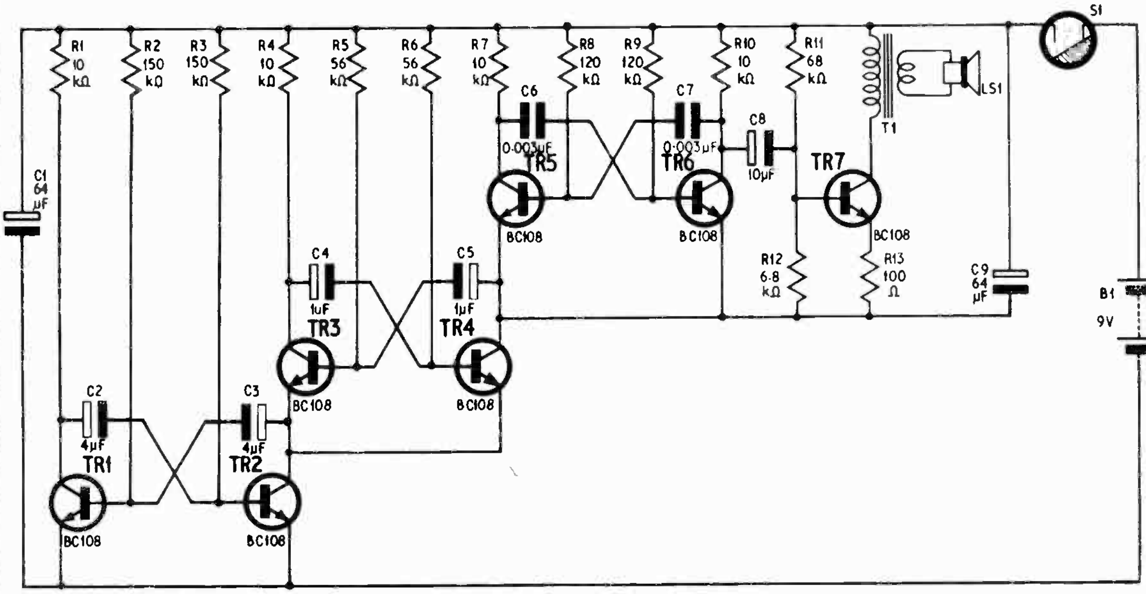


Fig. 3. With three multivibrators in cascade the owl sound can be produced. Variation of the base resistors or capacitors in any or all of the multivibrators will produce different sounds

Thus the creature remains silent until picked up when it mysteriously squeaks!

MULTIVIBRATOR DESIGN

In order to successfully design the astable of Fig. 1, two important points must be kept in mind. Firstly, that the frequency of the oscillation is given by the expression

$$f(\text{Hz}) = \frac{1}{0{\cdot}69(R_{B1} \times C_{B1} + R_{B2} \times C_{B2})}$$

so that the approximate frequency must be decided before construction is started (1kHz gives a pleasing tone).

Secondly, to ensure oscillation the value of the base resistors must be small enough to provide sufficient base current to cause saturation of their respective transistors.

This can be written as $R_B \leq h_{FE} \times R_C$ where h_{FE} is the current gain of the transistor.

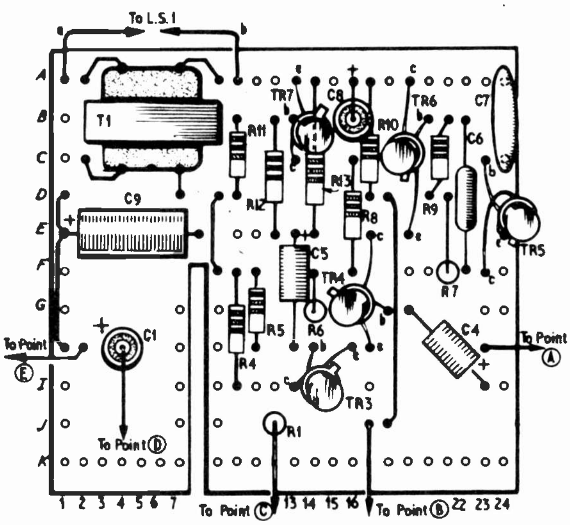
However, since most constructors will be unable to measure the current gain it is safer to ensure that the base resistors are not more than 10 to 15 times the value of the collector resistors, especially if unmarked transistors are to be used. Thus if R_C is 10 kilohms then R_B should not exceed 150 kilohms.

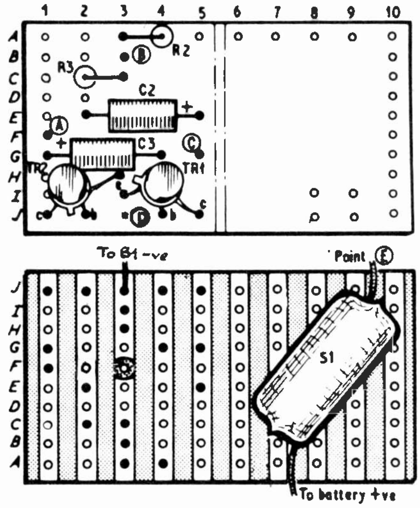
For the sake of simplicity the base resistors are made equal in this circuit.

ADDING SOPHISTICATION

The next step to improve the sound effect is to add a second astable as shown in Fig. 2.

In this version the entire circuit of Fig. 1 is used as the collector load for another, slower astable. The frequency at which this circuit oscillates can be varied from about 1Hz to approximately half the





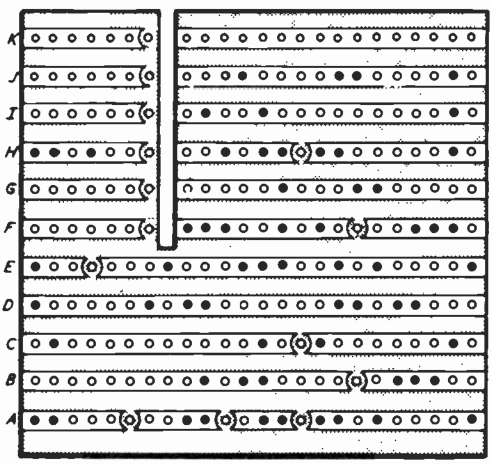


Fig. 4. Layout of the components on the Veroboard panels. (Standard Veroboard was not used in the prototype. Miss alternate tracks if this layout is followed.)

COMPONENTS . . .

Resistors

R1	10kΩ
R2, R3	150kΩ (2 off)
R4	10kΩ
R5, R6	56kΩ (2 off)
R7	10kΩ
R8, R9	120kΩ (2 off)
R10	10kΩ
R11	68kΩ
R12	6·8kΩ
R13	100Ω

All ¼W ± 10% carbon

Capacitors

C1	64μF 10V elect.
C2, C3	4μF 10V elect. (2 off)
C4, C5	1μF 10V elect. (2 off)
C6, C7	0·003μF (2 off)
C8	10μF 10V elect.
C9	64μF 10V elect.

Transistors

TR1–7 BC108 or similar (7 off)

Transformer

T1 Transistor audio output transformer (Eagle LT700 *or* similar)

Switch

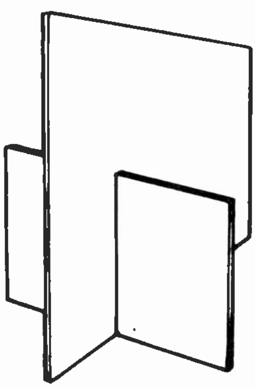
S1 Mercury switch

Miscellaneous

LS1 2¾in 8Ω speaker

B1 9V battery type PP3

0·1in matrix Veroboard, custard tin (or similar), felt or other suitable material for decoration



The boards are slotted together and glued to the lid

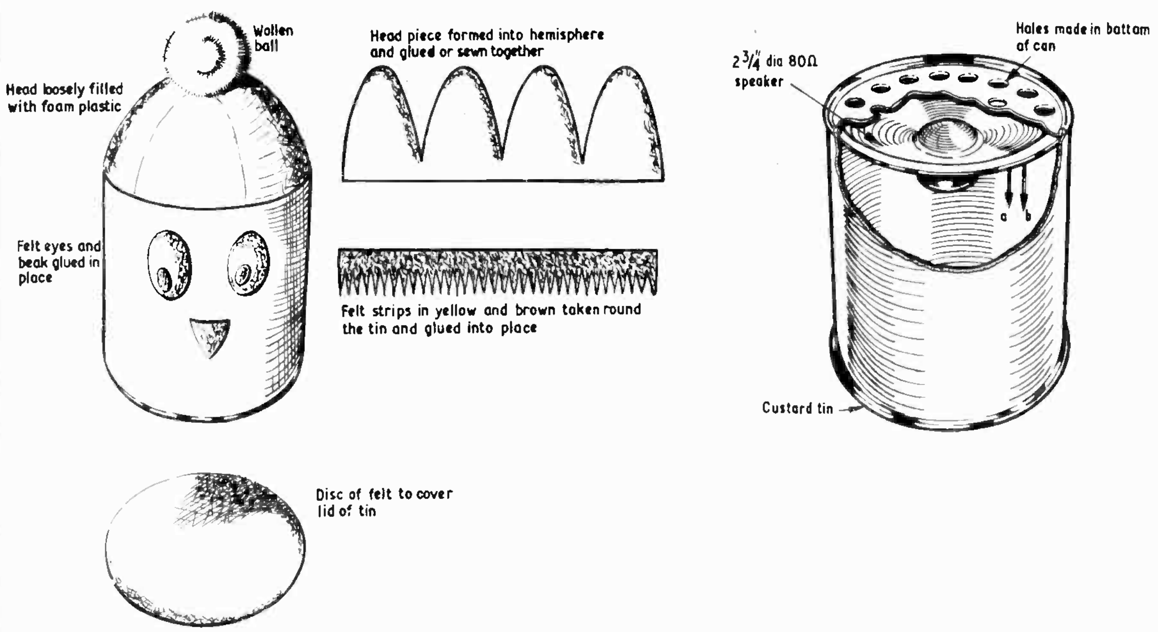
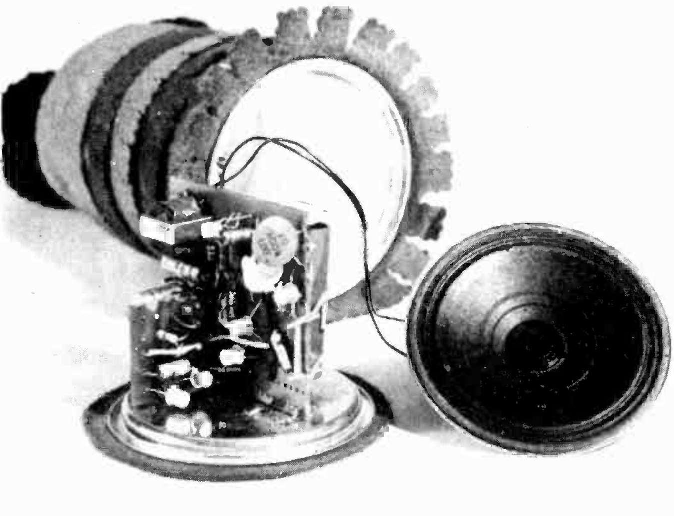


Fig. 5 Construction of the owl. Felt or similar material can be used to cover the tin. The pattern shown is only a suggestion and variations can no doubt be devised by the constructor

frequency of the first to provide some very interesting effects. At low frequencies the "squeak" is switched on and off and sounds something like a cat miaowing, at higher frequencies a warbling sound is produced.

In the prototype the addition of capacitors CA and CB of 100μF each was found to reduce the sharpness with which the circuit switched, and also enhanced the sound considerably. Of course the value of the capacitors is open to experiment.



HOOTING OWL CIRCUIT

By cascading astables as in Fig. 3, each time building on the existing circuit with a slower astable, very complex sounds can be made which are slow to repeat themselves exactly. (For more than three stages a higher battery voltage may be required.)

The circuit shown produces a sound somewhat like an owl, though other sounds can easily be made by changing the values of the capacitors in any or all of the astables.

A final point to remember when cascading stages is to ensure that each new stage can supply sufficient current to the existing stages. This means keeping the value of the base resistors as low as possible, in accordance with the desired frequency.

CONSTRUCTION

The scope for a suitable "carcass" is limitless, anything with sufficient space for the speaker and electronics will do. An ordinary 11oz size custard tin was found to be ideal for the owl.

First punch some holes in the metal end of the tin, and glue or solder the speaker in place (see Fig. 5). The circuitry is then built on Veroboard (Fig. 4) and soldered to the lid.

This method of construction allows sufficient room for the PP3 battery and the mercury switch as well as making access easy for battery replacement. The lid is just pushed home to seal the unit.

The outside of the tin can be disguised by using strips of coloured felt (see Fig. 5) and a very attractive finish can be obtained in a matter of an hour or so.

When completed the owl stands upright and is switched off for convenience. The mercury switch can be arranged to close at any desired angle to activate the device. ★

ELECTRONIC PIANO

Part 4

By A. J. Boothman B.Sc.

LAST month the construction of the basic pitch p.c.b. was described of which 13 are required. To test these and to compensate for possible variations in output from the logic circuits, it is desirable to make up a simple jig. Such a construction also facilitates choice of tuning capacitors for the Hartley oscillator.

PITCH BOARD TEST JIG

The jig consists simply of a one foot square piece of wood to the edge of which is screwed two terminal blocks; one three-way and the other two-way.

The first block (3-way) connects to V_s, earth, and the pre-amp output on the pitch board under test, whilst the second block (2-way) anchors two floating leads at supply voltage. Response to keying action is checked by touching one of the floating leads against a key input pin on the pitchboard, whilst the other lead can be used to check the sustain action. See Fig. 4.1.

In order to ease the handling of the pitch boards during initial alignment, and to minimise the possibility of damage due to careless short circuiting of supply leads, etc. it is recommended that the p.c.b. frame is first built prior to any alignment.

P.C.B. FRAME

Fig. 4.2 shows the method of construction of the frame. If the final mechanics of the piano are to fit together satisfactorily it is important that this is assembled with care to ensure squareness. To ease this problem it is suggested that screws alone are used at this stage and that the glueing process is left until later when the rest of the mechanics has been built.

WIRING THE FRAME BLOCKS

The rear connector blocks, which have been cut into groups of three, carry the positive rail (V_s), pitch output, and earth line. The pre-amplifier/ tremolo board is screwed onto the frame and panel, with the level tremolo depth and rate potentiometer spindles protruding from the frame side.

An eight-terminal connector is fixed to the bottom front bar at the right-hand side to provide the connections between the pre-amplifier board and other functions of the piano.

Red, blue and black wires for supply (V_s), pitch output and earth return are connected to each rear terminal block. From the last block this wiring is made to terminate at the pre-amplifier/tremolo board.

The black and blue terminations are shown as a screened lead on the pre-amplifier board layout shown earlier in Fig. 2.7, but this is not necessary provided that the leads between the last connector block and pre-amplifier board are kept as short as possible. The red and black leads are left long at the opposite end of the module in order to provide connections to the power supply.

The eight-terminal block takes leads shown in Fig. 2.7 as follows. The red and orange, that will finally connect to S3; the green, blue and red to S2; and the screened lead to the main amplifier.

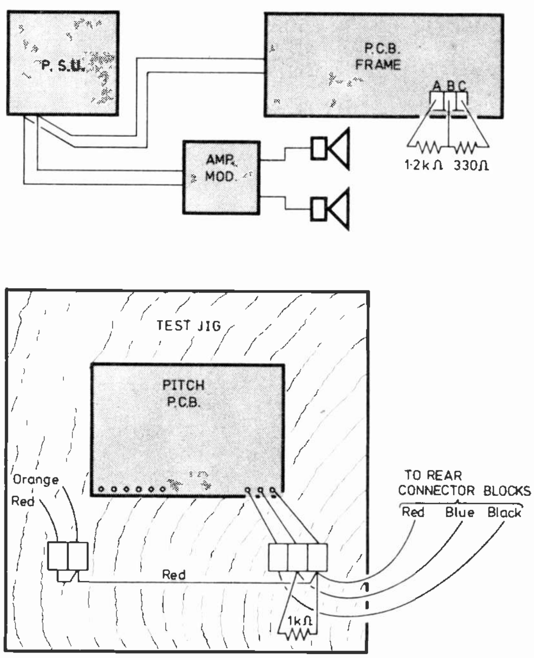


Fig. 4.1. Test set-up for individual pitch p.c.b.s

TEST SET UP

With the pitch p.c.b. module completed as above the initial setting up is almost ready to commence.

Fig. 4.1 shows the interconnection of the various units to give a test and initial setting up arrangement for the pitch boards. In order to make the system operational certain components have to be added during the test phase as follows.

Since the foot and keyboard level controls have not yet been constructed they must be simulated by soldering a short jumper between the VR3 red and yellow wiring pins on the pre-amplifier board (Fig. 2.7), and inserting two resistors in the terminal strips corresponding to S2 connections A-B and B-C. The resistor values should be 1·2kΩ and 330Ω respectively.

As we are to test one pitch board at a time, the output load condition will be very different to the final situation when all boards are connected up so a 1kΩ resistor is connected across the blue and black connections on the test jig terminal block.

From this point on the constructor could well be involved in a considerable amount of board removal and re-insertion, requiring repeated screwing and unscrewing on the connector strips. It is strongly recommended that a good screwdriver be purchased for this purpose, and further that it should be the correct length for easy operation from above the pitch p.c.b. module.

INITIAL SETTING UP

The purpose of the initial setting up procedure breaks down into the following:—

(a) Determine whether any catastrophic shorts are present on any of the assembled pitch boards. Also make sure correct fuses are inserted in FS1 and FS2 positions.

(b) Determine whether any mistakes have been made during board assembly, e.g. diodes connected the wrong way round.

(c) Correct for any large variations in logic output if necessary.

(d) Correct for any large variations in individual note outputs due to transistor gain spreads if necessary.

In order to approach the operation systematically, the key touch sensitivity is not involved at this stage

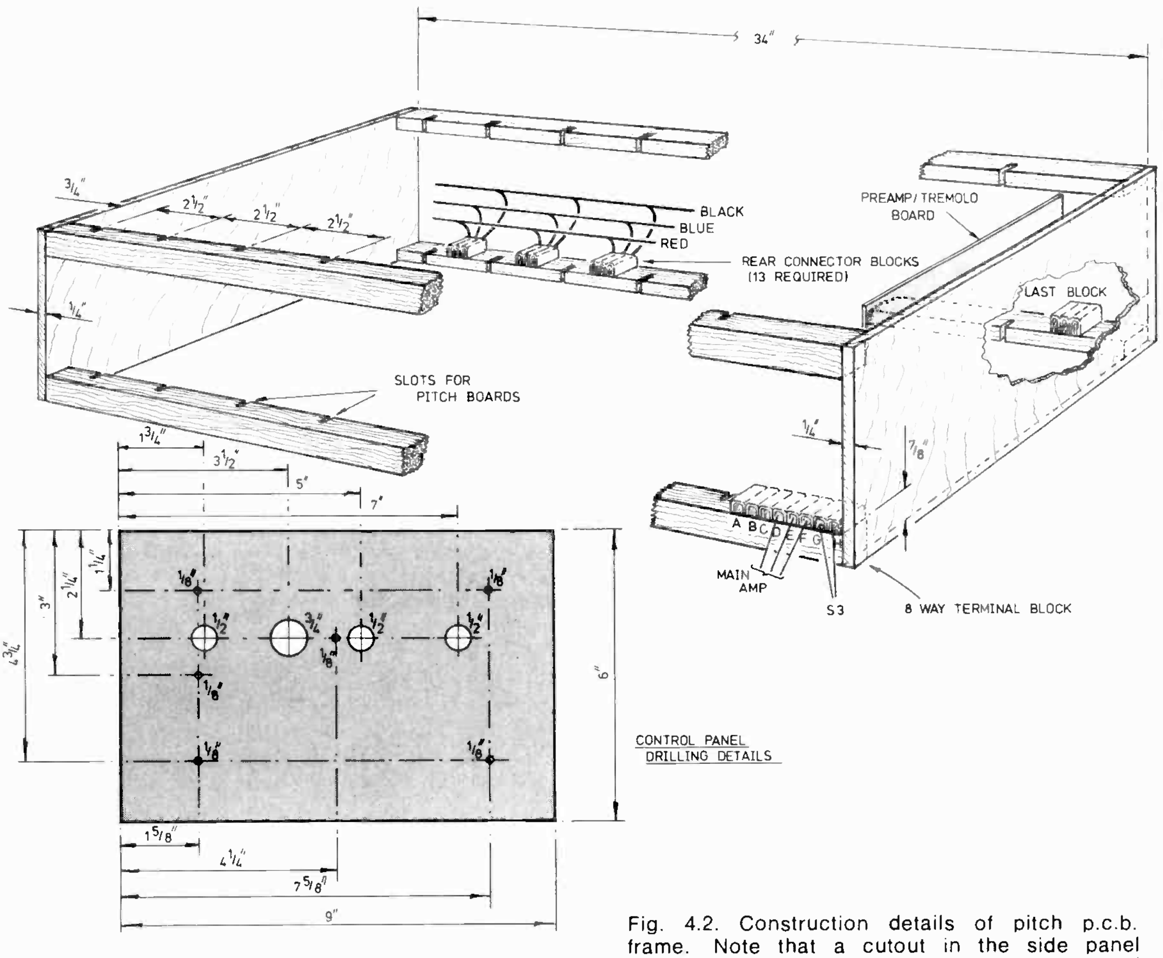
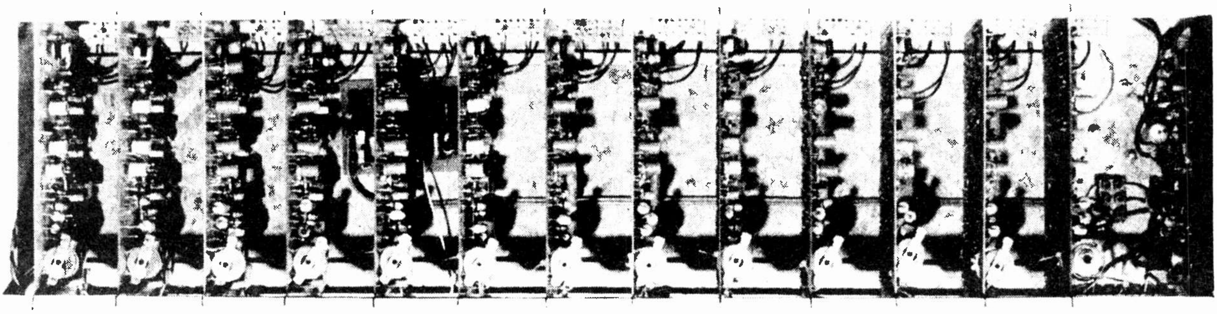


Fig. 4.2. Construction details of pitch p.c.b. frame. Note that a cutout in the side panel should be made to allow access to preamp/ tremolo controls



The thirteen pitch boards mounted in the wooden sub-frame

so that an acceptable balance is first achieved without the confusing element of touch variation.

TEST PROCEDURE

A board is first wired up to the test jig, with an 0·1μF or 0·2μF capacitor in position C48. On switching on the power, providing that everything is reasonably correct, a mixture of all the octaves of the note in question will be heard as a background noise.

Touching the test lead against any of the five key input terminals should cause the relevant note to trigger, and sustain in a fading manner for the period the test lead is held against the pin. Decay should be immediate on removal of the test lead, and it should be possible to simulate unkeyed sustain by connecting the second test lead to the sustain pin.

If, against the background noise, any particular note appears to be dominant, it may be desirable to reduce its level at this point. However some breakthrough will always occur, and the importance of this seems to diminish when the instrument is complete. It is therefore recommended that adjustments only be made if a note is extremely dominant, and the final decision as to the amount of time spent in this activity left until everything is built.

One point to remember here is that bass response is bound to be very low with the speakers mounted in this test arrangement with no cabinet resonance.

In order to adjust the breakthrough level on any particular note the value of R74 (or 75/76/77/78) is varied.

This is best carried out by soldering a second resistor across the 5·6kΩ original to reduce its composite value, and thus reduce the signal to the relevant mixer. Convenient values to be tried are 56kΩ, 27kΩ or 10kΩ.

Should any note require a higher output then a bridging resistor across R84 (85/86/87/88) can be used. When all the boards have been checked in this way they can be slotted into the pitch board module, and the 1kΩ resistor removed from the test jig. Tuning (and C48 selection) could be attempted at this point, but since this is done by ear it would be very difficult without the keyboard for easy interval reference.

TUNING CAPACITOR

Capacitor C48 in the oscillator circuit is composed of a number of capacitors connected in parallel and whose values are chosen to give the required pitch at the central position of adjustment on the tuning inductor. The range of capacitance required is approximately 0·1μF to 0·4μF, and the selection process is carried out using the board test jig described earlier. The table gives suggested capacitor values with which to make the composite capacitor C48, but since winding the inductors by hand can result in quite a spread in inductance values, the capacitor values given should only be considered as a rough guide.

Table 1: Approximate capacity values for tuning pitch p.c.b.s

Pitch	Frequency (Hz)	Tuning Capacitor (C48)	Added Capacity (μF)
F	700	0·33	—
F♯	740	0·22	0·057
G	784	0·22	0·022
A♭	830	0·22	—
A	880	0·1	0·1
B♭	932	0·1	0·069
B	988	0·1	0·047
C	1047	0·1	0·033
C♯	1109	0·1	0·015
D	1174	0·1	—
E♭	1245	0·047	0·043
E	1319	0·047	0·032
F	1397	0·047	0·022

PEDAL SOCKET BOARD

Figs. 4.3 and 4.4 show the circuits for the sustain and soft pedal sockets respectively. All components are mounted on the pedal socket p.c.b. The sustain voltage is dropped below V_s by Zener diode D34. This gives a sharper fall in voltage when a key is released with the sustain pedal depressed, such that rapid playing of a single note in the sustained mode produces a noticeable attack each time the note is pressed. Capacitor C51 prevents switching noise.

The soft pedal is simply a potentiometer, but R124 is connected on the p.c.b. as shown in order to present a similar load to the pre-amplifier when the soft pedal is disconnected. The piano can be played in this condition, and also with the sustain pedal unplugged. The jack socket is a stereo type in order to handle the three wires from the potentiometer.

In order to allow the pedals to be disconnected from the instrument and packed away whilst being carried, they are connected to the piano by two screened leads and jack plugs. Mating sockets are mounted on a printed circuit board which is screwed to the base inside the piano, with suitable holes drilled in the base board to allow the plugs to pass through. See Fig. 4.5.

When the pedal p.c.b. is later fixed to the base board, supply leads are taken from the pitch board frame, and the sustain output is connected to the nearest sustain point on the key frame assembly. The soft pedal socket is connected via screen leads to the pre-amplifier board. These are the green, yellow and red leads shown in Fig. 2.7 (part two), which should in fact be screened.

PEDAL SHELL DETAILS

The outer construction is common for both pedals, and consists of a shaped ¼in plywood box, with an extra ¼in strip at the front to act as a platform for the hinge. Fig. 4.6 shows the complete shell, including the ⅛in plywood flap.

The shell should be fixed together using a good grade of wood glue, and panel pins. The final assembly can be painted or covered in a fabric, with rubber foot and base pads.

SOFT PEDAL DETAIL

There are many ways in which the action could be constructed, and the author would expect many builders to choose to use an alternative method to that described here.

The important fundamental is that pressure should not be exerted on the potentiometer spindle against the body either in a rotational sense or at right

SUSTAIN PEDAL

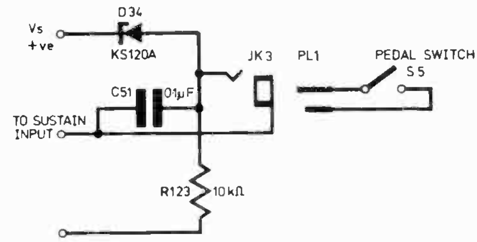


Fig. 4.3. Circuit diagram for the sustain pedal

SOFT PEDAL

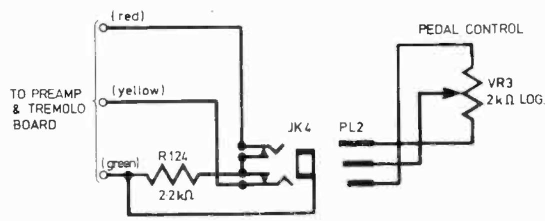


Fig. 4.4. Circuit diagram for the soft pedal

COMPONENTS . . .

Resistors
R123 10kΩ
R124 2·2kΩ
R125 3·9kΩ
All resistors ±5% ¼ watt

Capacitors
C51 0·1µF 125V

Switches
S5 Single pole microswitch
S6 Single pole, 5-way rotary switch

Diodes
D34 12V 400mW Zener diode
D35–D40 ZS170 (6 off)

Miscellaneous
JK3—Standard jack socket. JK4—Stereo jack socket. PL1—Standard jack plug. PL2—Stereo jack socket, knobs for keyboard control (4 off) (Bulgin)

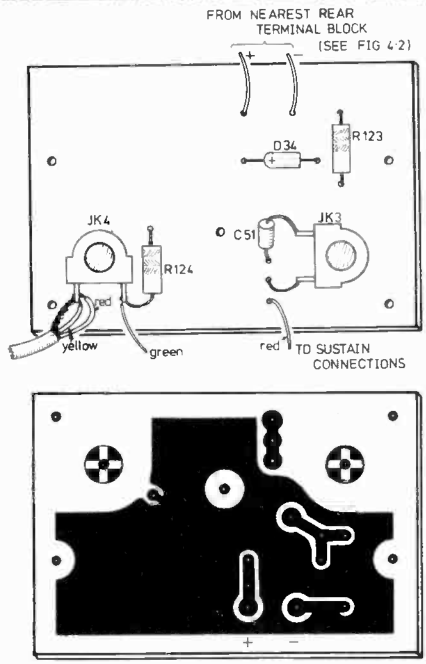


Fig. 4.5. Component layout and printed circuit details for pedal socket p.c.b.

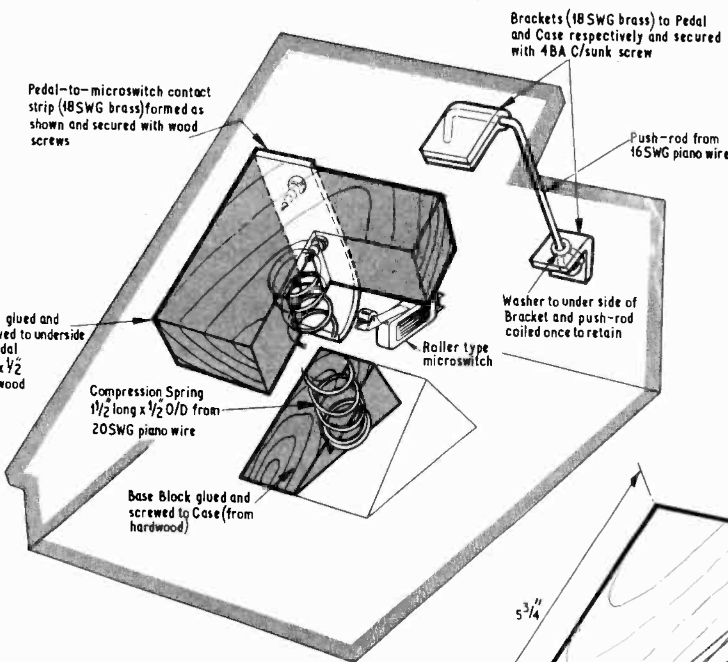


Fig. 4.8. Sustain pedal mechanics

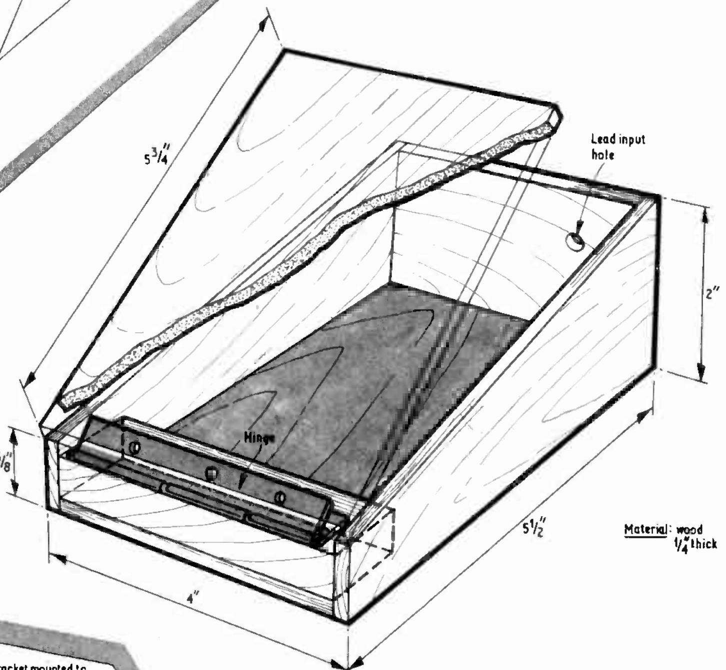


Fig. 4.6. Shell construction of soft and sustain pedals

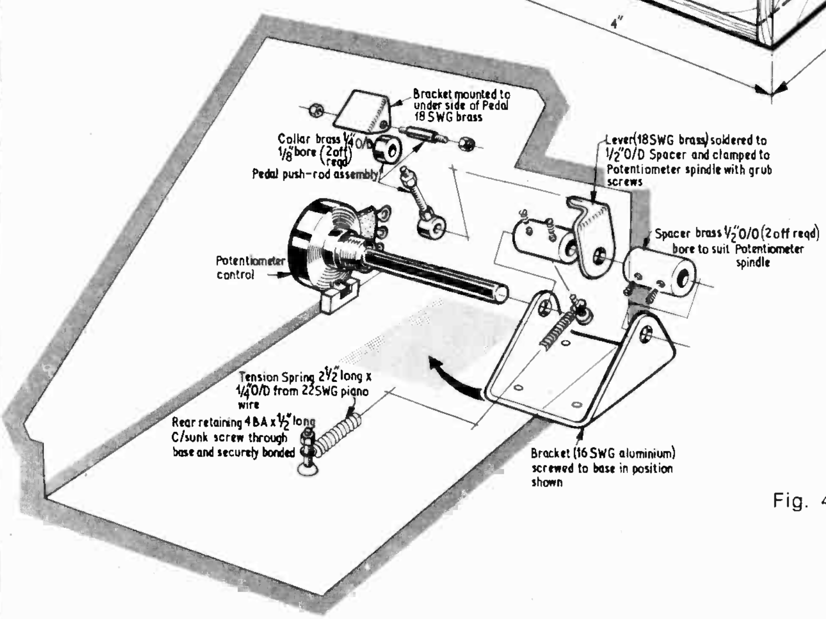


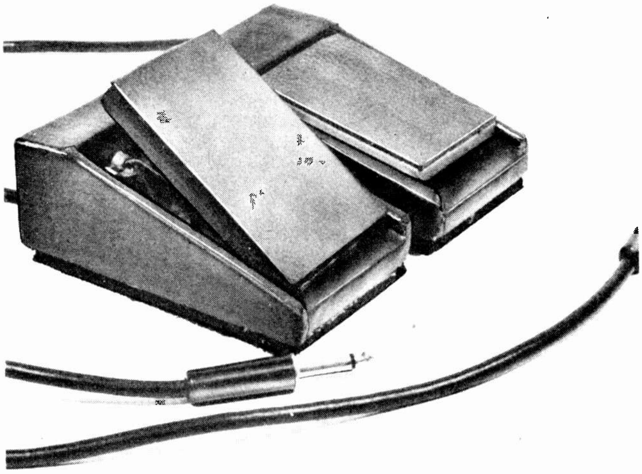
Fig. 4.7. Soft pedal mechanics

MATERIALS LIST FOR FOOT PEDALS

Shell Construction (Two Required)
5½in × 2in × ¼in plywood (2 off)
5½in × 3½in × ¼in plywood (base)
3½in × 1¾in × ¼in plywood (end plate)
3½in × ¾in × ¼in plywood (hinge platform)
5¾in × 4in × ⅛in plywood (top flap)
3in hinge

Soft Pedal Detail
2½in × ¼in dia. tension spring
3in × ⅛in dia. wire
3½in × 2¼in × 1/16in aluminium sheet
¼in brass spindle coupling
Screws, spacers, and cable cleats as required

Sustain Pedal Detail
1½in × ½in dia. compressing spring
3in × ⅛in dia. wire
1¾in × ½in × 1/16in aluminium sheet (switch actuator)
1¼in × ½in × 1/16in aluminium sheet (retaining bottom bracket for wire)
Screws, spacers, and cable cleats as required.



The two prototype foot pedals

angles to the axis. The action should therefore only be built around the spindle, without clamping the body, but it is obviously necessary to provide a stop with which to prevent the body rotating.

Fig. 4.7 shows a possible solution. Lateral movement is prevented by positioning the support in such a position that the potentiometer body rests up against the shell side, whilst a small piece of wooden channel fixed to the base prevents rotating movement of the body. If brass bushes can be obtained, instead of relying on ¼in holes in the aluminium, the action will be smoother.

The ¼in spindle coupler is slipped over the spindle and secured with one screw, which also acts as a stop in the pedal off position. A further screw, with suitable spacer gives a lever on which to mount one of the cable cleats which acts as a bearing for the bent wire. The second cleat is fixed to the flap, and can be removed when access to the mechanics is required after the initial build.

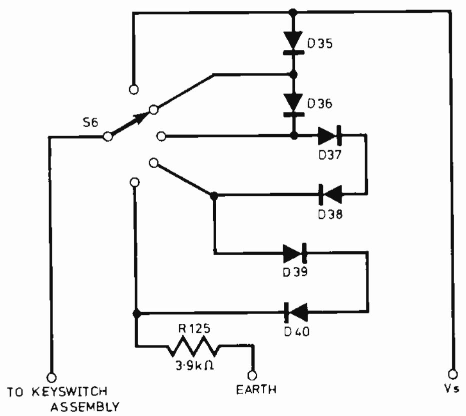


Fig. 4.9. Touch control circuit

SUSTAIN PEDAL

The same comments apply concerning alternative sustain pedal mechanics as for the soft pedal control. In the prototype the author used a commercial footswitch, but details of a suggested assembly are given in Fig. 4.8.

A ½in diameter compression spring provides the power to return the pedal after operation, and the upward travel is limited by a wire shaped to be captive in the top bearing (cable cleat), and retained within a slotted hole in the lower bracket. Access to the internal mechanics is again achieved by disconnecting the top bearing from the flap. The spring is seated within ½in diameter holes drilled in packing pieces which are attached to the flap and to the base.

Depending on the microswitch obtained a number of alternative configurations might be used.

TOUCH CONTROL

The touch control is mounted to the left of the keyboard, and gives preset selection of the maximum attack required at any particular time. The keyboard actuated touch sensitivity allows the player to reduce the attack below this maximum preset level by finger tip control.

The present variation in attack is achieved by controlling the voltage at the keyboard as seen in Fig. 4.9. Diodes D35–D40 give a range of attack voltages to suit the player. All diodes are mounted on the switch, which also has flying leads.

LEVEL CONTROL

This acts as a stepped potentiometer which allows rapid changes to be made in the playing volume. The resistors are mounted on the switch S2, as shown in Fig. 2.4. Normal playing position is position 2.

Next month: Keyboard, keyswitch assembly and cabinet details will be given.

FIFTY YEARS OF BROADCASTING

continued from page 1017

Two major technical developments, each to have profound effect upon the social habits of millions, are part of the exciting BBC story. They are television and recording.

A late entrant into the field of sound broadcasting, Britain was to become first in the field of television. The all-electronic high-definition system developed by E.M.I. was adopted by the BBC when it commenced a regular television service in 1936, thus antedating the start of television in the U.S. by three years. So public service broadcasting stole a march on commercially-run broadcasting. This pioneering achievement demonstrated very forcibly the strength of a combination formed of a free enterprise industrial concern and a national institution devoted to public service, when working together with a definite objective in view.

Recording has greatly influenced the pattern of broadcasting in recent times. In its earliest years the BBC made limited and cautious use of recorded sound (as distinct from commercial discs) although a Blattnerphone steel tape recording machine was installed at Savoy Hill as early as 1931. Apart from the imperfection of the techniques then available opposition to the use of recorded material was based on a strongly held view that actuality was the very essence of broadcasting. However romantic such a view may seem to blasé listeners of today, most listeners of the 20's and 30's agreed that the direct and immediate reception of events as they were happening was one of the unique enchantments of the new "wireless" entertainment.

Today's prodigious output of sound and television owes very much to the great advances made in the audio and video recording techniques, notably due to contributions by commercial firms in Germany and U.S. All those hours of broadcasting we have become accustomed to can only be sustained with the aid of a stock of "convenience programmes" stored on disc or tape. With the insistent demand by the public for more broadcasting the "live" element is diminishing and thus the character of broadcasting is changing. There is a danger that broadcasting organisations will become merely carriers of other peoples' canned wares. (The automated sound broadcasting station with built-in magazines of audio tapes is already available as a "packaged deal." How long before the television counterpart makes its debut?)

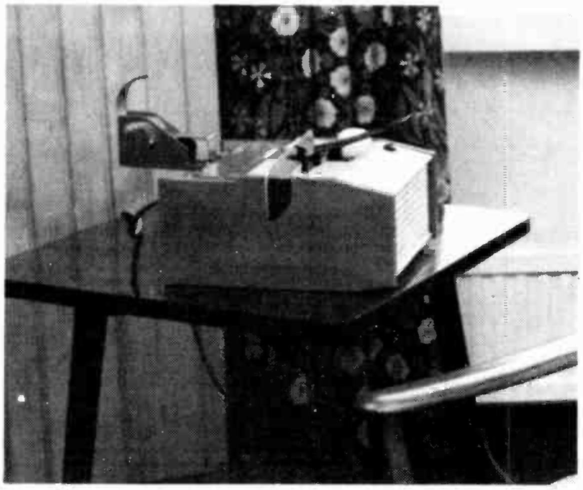
This tendency will be accelerated with the introduction of commercial local radio next year, and with the possible granting of a second television channel to IBA. There is every reason therefore to ensure we preserve in its existing form our first and most experienced national broadcasting organisation with its unrivalled artistic production facilities that complement a justly renowned technical organisation. And champions of public service broadcasting do need to be vigilant. In anticipation of the expiry of the BBC's Charter and the Television Act in 1976, the pattern broadcasting will follow in the future is already undergoing careful examination.

F.E.B.

NEWS BRIEFS

Talking Book Library for Handicapped

A NATIONAL library has been established to help the many disabled people who are unable to read books in the normal manner. It is a library of talking books covering a wide range of subjects, all on purpose-made tape-cartridges containing up to 13 hours of reading.



The National Library of Talking Books is a registered charity and following a successful pilot scheme it already has a readership of 500 disabled people. It is hoped that Local Authorities and organisations for the handicapped will co-operate so that the talking books and playback machines may be made freely available to those in need. Further inquiries should be made to the National Library of Talking Books for the Handicapped, 49 Great Cumberland Place, London W1H 7LH.

Novel Educational Aid

AN EDUCATIONAL aid with a wide range of applications has just been introduced by Palca and is being distributed by Dixons Technical. Known as the Wireless Headphones System it makes use of a long loop of flex which surrounds an area within which communication is to take place. Anyone inside the loop and equipped with the special headphones, which are, in effect, self-contained receiver amplifiers, will hear the signal fed into the loop.

The loop acts as an indication loop aerial and its size can be extended to the requirements of the user. For instance it could surround a factory floor so that orders can be given in a noisy environment, or it could be used in a classroom with small groups of desks connected to different sources so that a number of lessons can carry on in the same room. Because the headphones are self-contained the wearer has complete freedom of movement allowing the system to be used for such applications as relaying information to footballers while the players are in motion.

The headsets cost only £7·50 each and the loop connector an extra £2 so making this a worthwhile and economic proposition.

Further inquiries should be addressed to Audio Visual Division, Dixons Technical Ltd., 3 Soho Square, London W1V 5DE.

PATENTS REVIEW...

CHECKING ENGINE IGNITION

The conventional way of checking ignition advance and engine speed is to use stroboscopic illumination of a timing mark on an engine part, such as the flywheel, the stroboscope being triggered by the lead to a sparking plug.

In BP1 273 496 Snap-On Tools Corporation of Delaware, USA, suggests a more sophisticated approach.

Their system relies on a meter with a dial calibrated to show both engine and distributor advance in degrees and engine and distributor speed in r.p.m.

Instead of using a stroboscope to illuminate the timing mark, the mark is covered with a small strip of reflective tape and is illuminated by a sensing device housing a lamp and a photocell. During operation the lamp is energised continuously and the light from it picked up by the photocell only when reflected back from the reflective tape over the timing mark. This produces a series of voltage pulses and the patent describes circuitry for comparing this series if pulses with another series of pulses obtained from inductive coupling with a spark plug lead (ignition pulses).

Fig. 1 shows how the spark plug voltage pulses are fed, via amplifier transistor TR1, to a one-shot multivibrator (transistors TR2 and TR3). The pulses from the photocell XI are used to control the thyristor SCR1. A train of pulses triggered by the spark plug pulses are fed to the base of TR4, while another train of pulses triggered by the photocell are fed to the base of TR5. The meter ME1 measures the time interval relative to engine period between successive pulses of the two pulse trains and converts this time interval into a direct read-out of degrees of engine or distributor rotation.

As engine timing is automatically advanced with increasing engine speed, the time interval between successive pulses becomes longer relative to rotation time and produces a higher reading in degrees on the meter. By reading the ignition advance in degrees for a series of engine speeds and checking against those recommended by the manufacturer. the engine can be subjected to rigorous testing.

BP 1 273 496

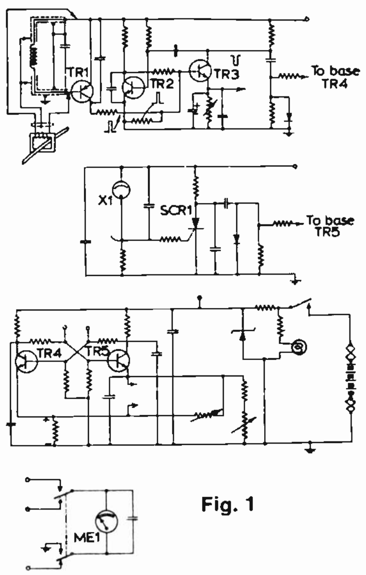


Fig. 1

WHEEL SPIN CORRECTION

Westinghouse Brake & Signal Co. Ltd., have patented (BP 1 277 474) some circuitry for use in testing devices for correcting spin or slide of a vehicle wheel.

These devices usually rely on deriving a rate of change of velocity signal depending upon the rate of change of the peripheral speed of the vehicle wheel. A modification circuit responds to a pre-selected value of this signal (indicative of the tendency of the wheel to spin or slide) and so modifies the braking forces.

A problem with such systems is that they are hard to check when stationary in a garage and the pre-selected signal values are hard to set. The Westinghouse invention attempts to tackle this problem.

The oscillator section of the patent is shown in Fig. 1. The unijunction transistor TR1 has b_1 base connected via R2 to the junction of R1 and Zener Diode D1. R1 and D1 are connected across a 30V supply and b_2 base is connected via R3 and the primary winding of T1 to the supply negative line.

The transformer T1 is part of a test device coupled through the secondary winding to a generator which produces a signal of which the frequency is proportional to the peripheral velocity of the vehicle wheel.

The emitter of TR1 is connected to the junction of diode D2 and capacitor C1, the other side of D2 being connected via R4 to one side of switch S1. Capacitor C2 bridges R4, D2, C1 and is itself bridged by a discharge resistor R5. An exactly similar arrangement of components is made between TR1 emitter and switch S2 with R7 acting as the discharge resistor.

As mentioned above, the secondary winding of T1 is connected to the wheel generator of a spin or slide detection apparatus, the generator providing signals for the detection apparatus and the latter responding to a predetermined rate of change of peripheral wheel speed to initiate modification of braking.

As a service check a mechanic operates switches S1 and S2 to produce oscillations and inject them into the secondary winding.

Closing S1 causes oscillation by alternate charging of capacitor C1 via D2 up to a point at which the transistor conducts and discharges C1 via the emitter and b_2 base of TR1 into the primary winding of T1. The frequency initially depends on supply voltage, and in release of S1 changes at a rate dependent upon the rate of change of voltage applied to the emitter electrode of TR1 via C2. This is in turn dependent upon the discharge rate of C2 via R5. R5 is chosen to give a rate of change after release of S1 which corresponds to the minimum rate of change of speed of the wheel.

BP 1 277 474

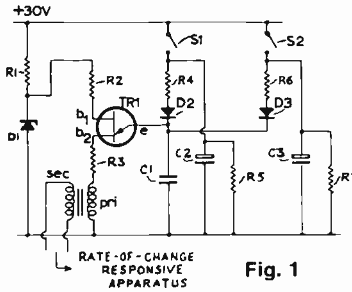


Fig. 1

Closure of S2 produces similar results but R7 is chosen such that the rate of change of frequency corresponds to a rate of wheel speed change to which the braking control is not required to respond.

Flipping switch S1 should trigger the modification circuit and flipping of S2 should not trigger the modification circuit. If the mechanic finds this is not the case, then adjustment of the sensing and braking equipment is called for.

Substitutes for VARACTOR DIODES

By B. Fistein

A REVERSE biased semiconductor diode has a high d.c. resistance. This is caused by the fact that the reverse voltage applied attracts current carriers (holes and electrons, in *p*- and *n*-type semiconductors respectively) away from the junction, leaving a region near the junction depleted of holes and electrons, called the "depletion layer". The greater the applied reverse voltage, the wider is the depletion layer.

Since the portions that are not depleted of carriers have a low ohmic resistance, a reverse-biased *pn* junction behaves as a capacitor in which the electrodes (i.e. the non-depleted regions) are separated by a thickness of dielectric (i.e. the depletion layer). The thickness of the dielectric, and hence the capacitance, can be varied by varying the reverse voltage applied.

The same principles apply to all semiconductor *pn* junctions and, in particular, *pn* junctions in transistors. Thus reverse biased junctions in transistors may be used as variable capacitors by varying the applied voltage.

Silicon transistors are particularly suitable for such use, as currents across their junctions when reverse biased are very small, resulting in a capacitance effect of very low leakage. Bias voltages that can be applied to vary the capacitance, range from a small fraction of a volt to a maximum which is the break-down (Zener) voltage of the junction.

The a.c. voltage applied to the variable capacitor, however, must be a small fraction of the bias voltage, otherwise detuning and the generation of harmonics will result.

TEST CIRCUIT

The circuit used for measuring the capacitance at different collector-base voltages is shown in Fig. 1. The inductance L1 is of known value. A reverse voltage is applied to the junction under test through the potentiometer VR1, and the resonant frequency of the circuit is determined by means of a grid-dip meter. A low impedance path for a.c. is provided by capacitor C1 to the potentiometer wiper.

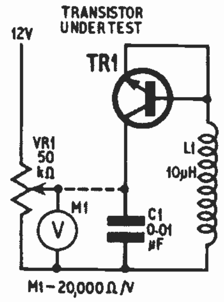
A number of transistors were tried. Plastic planar transistors appear to function best. Transistors encapsulated in TO5 or TO18 style metal cans had higher capacitances than plastic ones, although the ratio of maximum to minimum capacitance was much the same for both types.

Fig. 2 shows capacitances for applied voltages between 0·15 and 12 in transistors of three different types. There was some variation among transistors of the same type, but most transistors tested showed a ratio of maximum to minimum capacitance of about 5 : 1. The greatest change in capacitance occurred at low voltages.

Within the limitations mentioned these transistors functioned satisfactorally as tuning capacitors for frequencies up to 20 MHz or higher, and with reasonable care in the layout of circuits, the highest frequency tuned with a given inductance was generally a little more than twice the lowest.

RECEIVER APPLICATION

The possible uses of voltage dependent capacitors are many, and include tuning, automatic frequency control, generation of harmonics, and others. As an illustration of the use of a transistor as a tuning capacitor, one was used in a simple reflex receiver for the medium wave band.



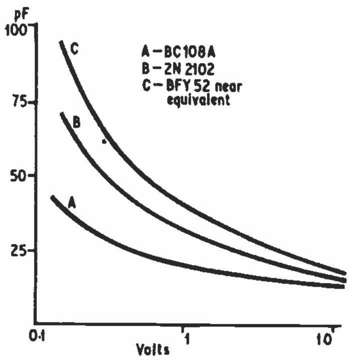


Fig. 1. (left). Circuit used to determine capacitance of a collector-base junction

Fig. 2. (right). The resultant voltage/capacitance characteristic of three sample transistors

The transistor used as a variable capacitor is TR1, in this case, type BC108. The variable voltage applied to it is obtained from the potentiometer VR1; as most of the change in capacitance occurs at low voltages, VR1 should be a logarithmic type. Since the capacitance (and hence the tuned frequency) depends on the applied voltage, the power supply to the receiver should be stabilised by means of a Zener diode.

The inductor L1 used for tuning consists of 200 turns of 36 s.w.g. enamelled wire, close-wound on a ferrite rod $\frac{3}{8}$in diameter and 3in long. The secondary winding L2 consists of eight turns wound over the "earthy" end of L1, and wound in the opposite sense. The regeneration capacitor, C2 consists of two short lengths of thin p.v.c. insulated wire twisted together.

TUNED CIRCUIT

Because of the small tuning capacitances and relatively high inductance used in tuning, C2 is connected to a tap on L1, 40 turns from the earthy end, rather than to the "live" end as usually done in receivers of this type.

Alternatively, C2 may consist of a short length of p.v.c. insulated wire; one end is connected to the collector of TR2, the other end is bent to fit snugly over L1 for one half turn. This half turn is moved along the length of L1 until optimum regeneration without oscillation is obtained over the whole tuning range, and is then fixed to L1 in that position.

With reasonable care in the lay-out of components associated with TR1 and TR2 the receiver will tune over the greater part of the medium wave band. VR1 may be placed where convenient, preferably well away from L1 to reduce detuning by hand capacitance while operating it. L3 should not be close to L1, and the axes of these inductances should be at right-angles to each other to avoid mutual coupling between them. Audio output is taken from C5 to high impedance headphones, or to an audio amplifier for loudspeaker operation. ★

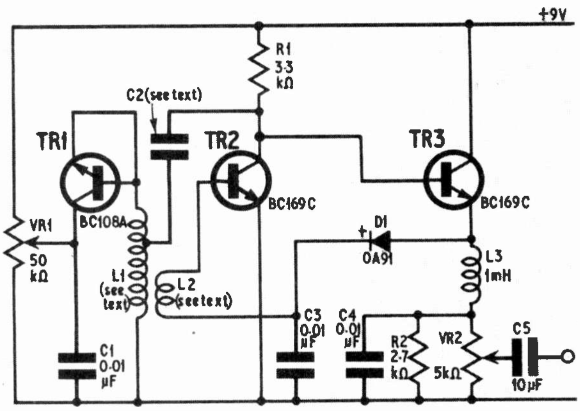


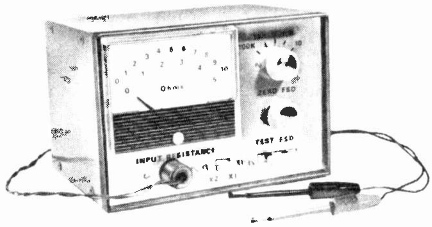
Fig. 3. An example of the practical application of the junction capacitance of a transistor. In this simple reflex receiver the "varactor" effect is achieved by feeding a preset voltage to the collector-base junction of TR1

NEXT MONTH....

A new area of interest, demonstrating how organic living systems and electronic systems can interact, is opened up with the publication next month of design and application data for a

Biological Amplifier

for detecting very low frequency signals produced by the brain.
In conjunction with various output stages, this amplifier can be safely employed for specific non-medical purposes: as an alphaphone to induce relaxation, with aural feedback between the brain and ear; or as a cardiophone where control of the heart rate is achieved by means of a visual feedback loop.



IC Linear Ohmmeter

Conventional ohmmeters have non-linear scales which, though providing large ohmic ranges, are difficult to interpolate and require special meter calibration. The I.C. linear ohmmeter gets round these difficulties using a cheap milliamp meter to provide three resistance ranges from 0-100kΩ.

PRACTICAL ELECTRONICS

January issue on sale December 8

Ensure your copy by ordering in advance from your newsagent.

ELECTRONORAMA

AIDS TO MOTORING SAFETY

The problems of traffic control and collision avoidance on the world's roads has long been a problem that many countries have been seeking to find a satisfactory solution. Two companies, in the U.K. and America, have been developing separate systems, both based on the principles of radar, to help combat the problems of safety on the roads. The great advantage of using radar is that it is able to penetrate fog.

At the moment these systems are still in the experimental stages but both RCA and Mullard, the developers, hold great hope for the future.

Radar "Cat's Eyes"

A traffic sensor has been devised at the Mullard Research Laboratories in Surrey, which could form part of a fully automatic system to control traffic, unaided by a human observer of traffic conditions.

One of the problems encountered with most radar traffic control systems has been that if more than one vehicle is in the beam it tends to confuse the equipment. But with the Mullard system the sensor device is very similar to the modern "cat's eyes" and is installed in the road in the centre of each lane. This way only the car passing directly over the sensor is detected.

The sensor device is a compact radar unit containing the transmitting aerial and receiving aerial and, as the cars passing overhead are detected, a second set of detectors activate circuits which measure the speeds of receding vehicles.

In a complete system, data derived from the radar "cat's eyes" installed in roads at strategic places would be routed to a central computer which would analyse the total traffic situation and control roadside warning lights and junction traffic lights accordingly.

Anti-collision radar

The RCA experimental auto radar system is designed to avoid rear-end collisions on the roads and help drivers to maintain reasonably safe distances between the car and the vehicle in front.

A feature of the system is its ability to eliminate false "targets" and "clutter". It is not "blinded" by

Tests being carried out on the RCA system. The radar units can be seen on the two cars, just above and below the licence plates

Artist's impression of how one of the traffic sensors, being developed by Mullard, would be installed in the road surface.

the radar signals of vehicles passing in either direction in adjacent lanes. The radar beam is narrow enough to avoid unwanted reflection when a car moves out into another lane to pass a car ahead. Consequently, the car can pass without a warning being sounded.

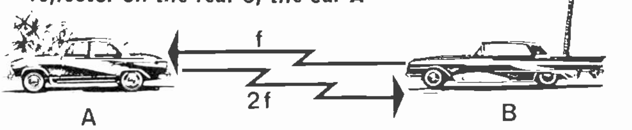
The compact radar, mounted on the front of a car, transmits a continuous 9GHz (X-band) signal which strikes the passive harmonic reflector on the obstacle ahead. This reflector re-radiates the second harmonic (18GHz) of the incident signal. The radar receiver is designed to accept only those radar echoes that are double the frequency of the transmitted signal.

The reflector is approximately the size of a number plate and can be affixed to the rear of any vehicle or to any sign designating a traffic hazard. By using this special reflector all vehicles and traffic hazard signs, no matter what size, provide the same reflected signal strength. Thus a small car or a "one-way-do-not-enter" sign will be picked up by the radar system as clearly as a large container lorry, and their radar echoes will not be swamped by the echoes of larger vehicles.

Eventually, it is hoped, an operational radar of this type might be integrated into a car so that it would automatically release the throttle and apply the brakes to keep distances between vehicles above a safe minimum. Furthermore, if special small reflectors were incorporated on the sides of motorways and on collision hazards such as bridges, the radar could automatically apply the brakes if the vehicle is approaching the hazards at an unsafe speed.

The RCA system still requires testing and refinement, but scientists believe that an operational system can be mass produced within five years.

Showing how the RCA system works. Radar on car B transmits a signal (f) which is reflected back at twice the frequency (2f) by a special reflector on the rear of the car A



Features MOTORWAY SAFETY and WEIGHING HAZARDOUS MOVING LOADS

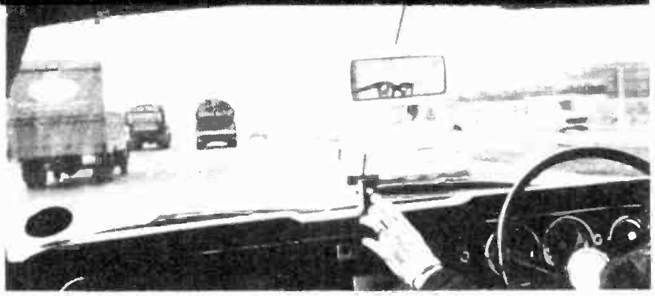
Automatic "Headway" Control

ONE example of automatic control in which brake and accelerator are operated as a result of obstacle detection, is being developed at the Lucas Group Research Centre near Birmingham.

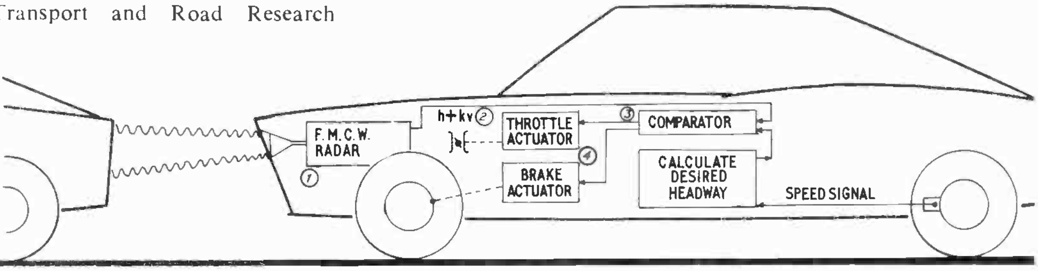
Intended primarily for use on motorways where lane discipline is essential, this investigation has as its objective, the automatic maintenance of "headway" or the distance between moving vehicles at varying speeds.

The equipment uses a 35GHz (8mm) continuous wave source, frequency modulated to give the required information on range and speed. The use of this high frequency enables both the transmitting and receiving "horns" to be compatible with automotive styling requirements while providing the narrow beam width required. An electronic computer carried on the vehicle makes calculations based on the reflected radar signals and relative velocity of the vehicle with respect to the leading vehicle. Brakes and throttle are then automatically adjusted to maintain a consistently "safe" distance.

The Government Department of the Environment are supporting the project with financial aid and facilities for testing at the Transport and Road Research Laboratory.



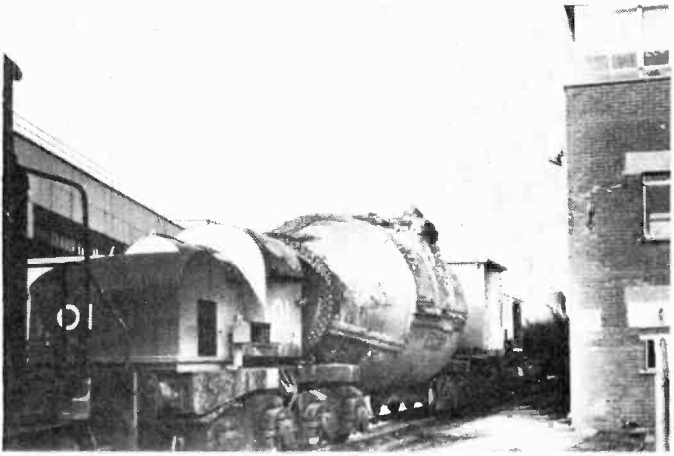
1. FMCW is frequency modulated continuous wave radar which measures "headway" and relative vehicle velocity
2. The relative velocity kv caused by Doppler shift is such that it enhances the effect of headway h
3. Headway is compared with desired headway, calculated from time vehicle speed to produce an actuating signal
4. The actuating signal adjusts vehicle speed by means of brake and throttle actuators, so that headway spacing of one second is maintained



Weighing-in-Motion Scheme for Heavy Loads

ONE of the problems encountered in heavy industry is the need to weigh large and sometimes hazardous loads on a continuously moving production line. Movement can influence erroneous measurements unless strict control of load vibrations is exercised. W. & T. Avery Ltd. the large weighing machine company have produced a "weighing-in-motion" system using a 27ft load-cell weighbridge linked to electronic sampling, recording, and data transmission instrumentation.

Four 500,000 pound capacity load cells are equipped with free-motion units to isolate them from shear forces and transmit analogue weight signals to a static digitiser in the weigh office. An analogue to digital converter interfaces these signals to the digital display and teleprinter.



High frequency vibrations are attenuated by the rigid design of the weighing structure and a filter in the instrumentation. A digital filter eliminates the effects of low frequency vibrations. By sampling the resultant output signals at various time intervals, the readout displays the loading in increments of 0·1 ton. If the load is moving over the weighbridge too fast, an "excess-speed" signal inhibits the system until reset.

This system has been installed at the British Steel Corporation's Port Talbot Works, where up to 600 tons of molten iron is weighed *en route* to the steelmaking plant. The load is hauled in huge ladles on a railway which passes over the weighbridge.

By R.W.COLES PART 6

ANSWER (A) AND Z REGISTERS

LAST month the construction of the ENTRY register was described together with the constant store and a fixed constant option. To follow this the logic and construction of the two registers which form the main part of the arithmetic section will be described, these being known as the ANSWER (A) register and the Z register.

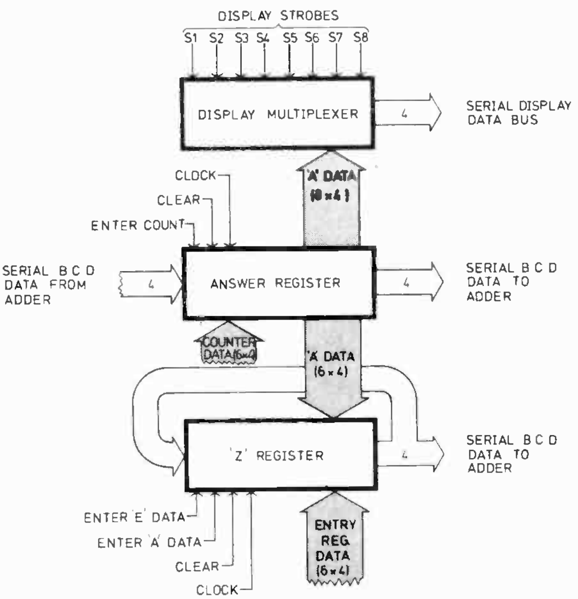


Fig. 6.1. Block diagram of the "A" and "Z" register sections of Digi-Cal

"A" AND "Z" REGISTERS

The A (ANSWER) and Z registers, together with the adder to be described next month, form the heart of the arithmetic unit of Digi-Cal. These registers are identical in capacity, being four (B.C.D.) digits "wide" and ten (decimal) digits "long". They differ in the type of input and output facilities which include both serial and parallel transfers.

Both are right-shift types, and are capable of shifting data at more than one million bits per second in the serial mode, when supplied with suitable clocking signals.

The A register has an associated display multiplexer which is used to send the answer data down the display bus under the control of the display strobes provided by the display board previously described in Part 3.

The multiplexer is identical in principle to the ENTRY register version, but is two (decimal) digits longer to allow display of a full eight digit answer. The most significant two digits are not displayed and are used to allow error detection and decimal point manipulation.

A block diagram of the A and Z register sections of Digi-Cal is given in Fig. 6.1 and this should be studied in conjunction with the overall system block diagram (Fig. 1.3) from the July edition, which did not include the display multiplexer.

REGISTER PARTITIONING

The division of the register circuitry to suit the constraints of a standard printed circuit system requires a good deal of thought to produce an arrangement which:

(a) uses a minimum of "wasted" i.c. positions, and thus the minimum number of separate boards;
(b) shares the number of input/output connections equally between boards so that one board does not demand more edge connector positions than are available on the standard board; and

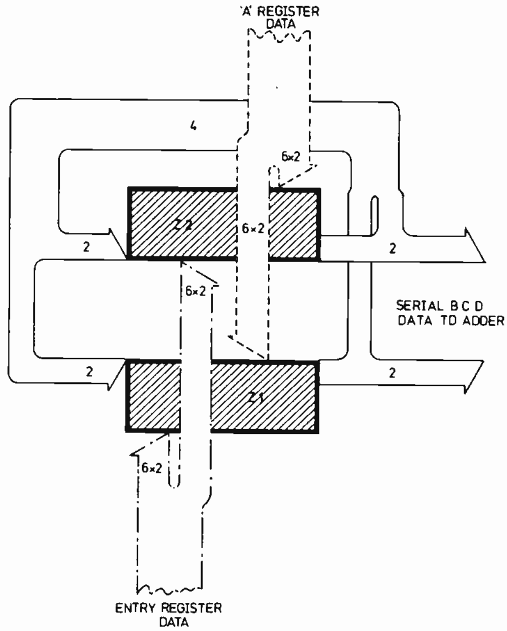


Fig. 6.2. The partitioning of the "Z" register is shown here, together with the inputs and outputs

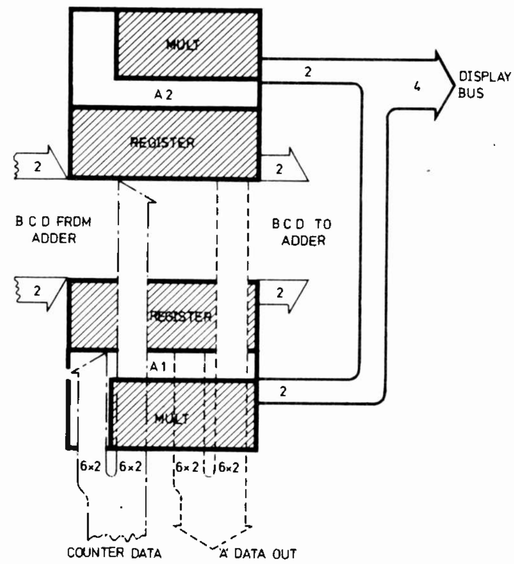


Fig. 6.3. The partitioning of the "A" register into the two halves known as the A1 and A2 registers is shown here

(c) gives a layout arrangement which permits the interchange of identical halves of the circuit and thus cuts down the number of different types of board required.

With the ENTRY register last month, the circuit was divided vertically into three boards each carrying a two digit long register of B.C.D. width, plus a separate multiplexer board.

The A and Z registers on the other hand are divided horizontally into two ten-digit long registers, each two digits wide, giving four boards in all. The A register multiplexer is also split in this way, and in this case is incorporated on the same boards as the register proper.

All this sounds a little complicated but is easier to understand with reference to Fig. 6.2 and Fig. 6.3.

"A" REGISTER

The A register is built on two DL109/44 cards, each of which houses eight TTL i.c.s, two resistors, and two decoupling capacitors.

Making a register ten digits long and four wide would require twenty SN7474 dual D-type flip-flops as used in the ENTRY register, and this number would take up a lot of room, as well as presenting a mammoth wiring-up problem.

Fortunately the TTL series of complex functions known as medium scale integration (M.S.I.) contains a number of ready-made shift register circuits, and it is one of these, the SN7496, which is employed in the A register circuit.

A diagram of the SN7496 is shown in Fig. 6.4, and as can be seen this i.c. consists of a complete five-bit serial shift register in a 16 pin D.I.L. package.

The register comes complete with gating to allow a five-bit parallel input transfer when the PRESET input is activated, and has a separate output from each stage to allow parallel output transfers.

The CLEAR input will set all the flip-flops to the logic "0" output state, and is used to erase the stored contents of the register.

By connecting two of these i.c.s in series a ten-digit register is formed, and by using four of these ten-digit sections, the required A register capacity is achieved, using eight SN7496 i.c.s (see Fig. 5.5).

OPERATION OF "A" REGISTER LOGIC

When an arithmetic programme is running, the data in the A register is shifted serially into the ADDER circuit, in synchronism with the data in the Z register which is either added to or subtracted from the A data.

The output of the ADDER forms the serial input of the A register, so that after a group of ten clock pulses, the A register contains the sum (or difference) of the original A and Z register contents.

If the arithmetic operation required is MULTIPLICATION, then the contents of the A register have to be duplicated in the Z register before the series of additions take place, and to facilitate this the parallel outputs of the A register are used to provide a single 24 bit transfer.

At the end of a DIVISION, the answer is represented by the state of the counter, and before this can be displayed it has to be transferred to the A register. This is also carried out in a single 24 bit transfer, this time using the parallel PRESET inputs of the SN7496s.

In each of these transfers the initiation is provided by a control pulse from the programme.

MULTIPLEXER

The multiplexer consists of a series of SN7401 open-collector gates, with their outputs "wired-OR" to give the required four-bit data-bus. It is formed in the same way as the ENTRY register multiplexer.

The eight strobes or "character call-up" lines are produced in a sequence starting at the most significant end of the register, each one activating a group of four gates to send a single B.C.D. group to the display.

In the case of this multiplexer, the data-bus is produced in two, two-bit halves as a consequence of the partitioning arrangement mentioned earlier. This division of the multiplexer into two physically separate sections means that the display strobes have to be connected to both board A1 and board A2.

"Z" REGISTER

Like the A register, the Z register is housed on two DL109/44 plug-in cards. This register is identical in size to the A register, being ten by four in format, but because of its different role in the arithmetic operations of the calculator, different integrated circuits are employed.

A glance at Fig. 6.1 shows that the Z register is required to accept parallel transfers from two sources, the A register and the ENTRY register. It is not required to provide parallel outputs, only serial outputs being needed to feed the ADDER.

These different input/output requirements preclude the use of SN7496 shift register elements, since these devices can only accept a single parallel input transfer without extensive external gating. Luckily, it is still possible to enjoy the advantages of M.S.I. in this circuit because another device which suits our needs, the SN7494, is available.

The SN7494 is a four-stage serial shift register element with provision for parallel loading from two separate sources, under the control of internal gating.

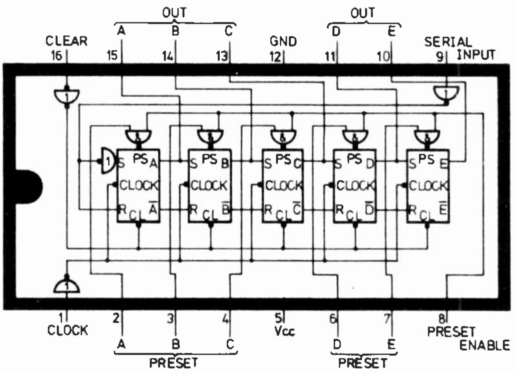


Fig. 6.4. The internal logic of the SN7496 integrated circuit

A logic diagram of this device is shown in Fig. 6.6 where is can be seen that the two sets of parallel inputs, 1A to 1D and 2A to 2D are presented to the PRESET inputs of the flip-flops via four AND-OR-INVERT gates, the appropriate set of input data being selected by the PRESET1 or PRESET2 control line.

Note that output connections are not provided from the A, B, and C flip-flops, which as previously stated, is quite satisfactory for this application.

REGISTER ASSEMBLY

Connecting two SN7494s in series gives a register eight digits long, which falls short of the requirement of ten digits. Therefore two more stages are added

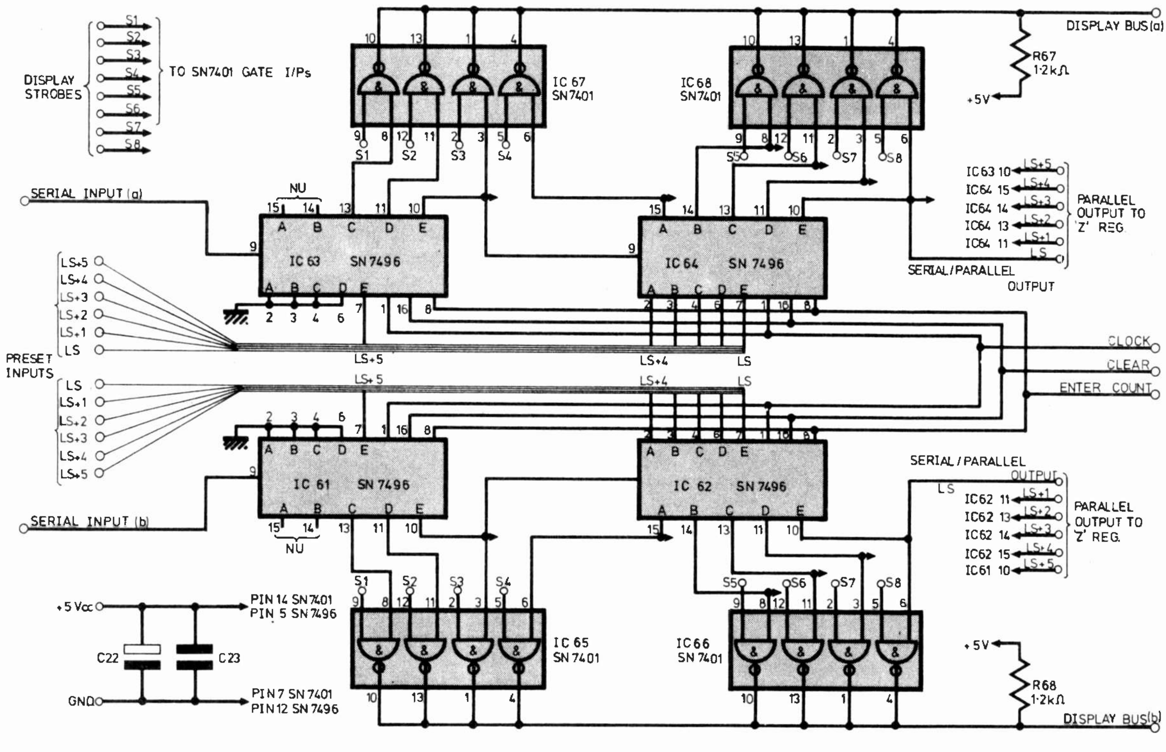


Fig. 6.5. The logic contained on the A1 register board. The A2 board is identical to this

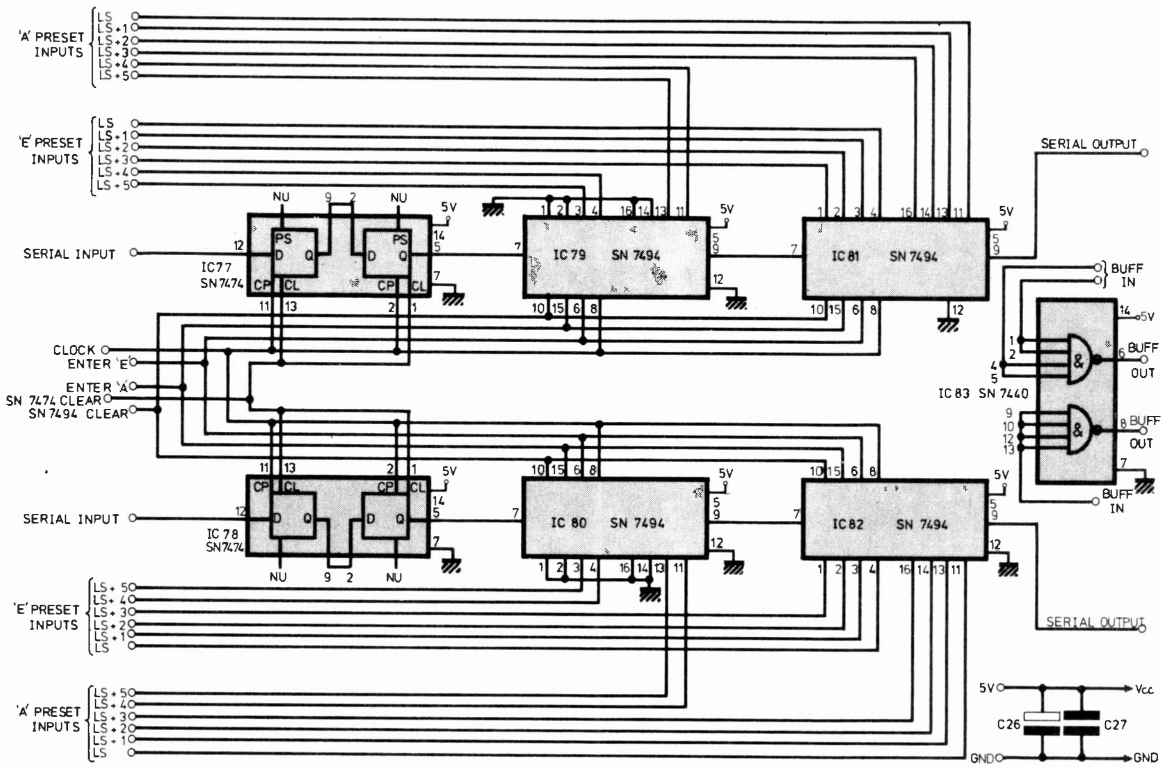


Fig. 6.7. The logic contained on the Z1 register board is shown here. The Z2 board is identical to this

in the form of an SN7474 dual D flip-flop. If these extra stages are placed at the "most-significant" end of the register, no extra input gating will be required since only the six "least-significant" stages are required to accept parallel input transfers. This is the approach adopted for the Z register and the resulting circuit is assembled from eight SN7494s and four SN7474s, giving the required total number of 40 flip-flops.

The circuit of one of the two identical Z register boards is shown in Fig. 6.7 where it can be seen that in addition to the shift register components, an SN7440 dual buffer gate is incorporated.

The connections to these gates are made external to the DL109 cards because these gates are used for different jobs on each of the two cards, and

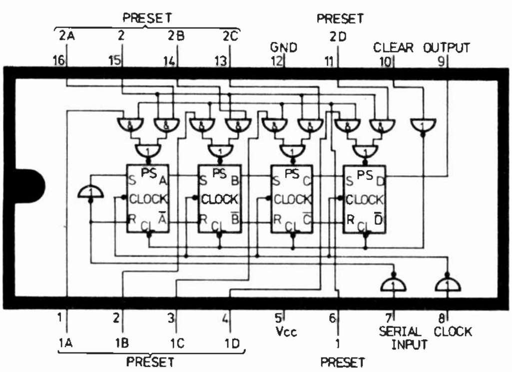


Fig. 6.6. The internal logic of the SN7494 integrated circuit

internal connection would prevent interchanging these when required.

One of the four buffer gates is used to invert the CLEAR Z signal from the programme to make it compatible with the CLEAR inputs of the SN7474 devices, which operate on *low* inputs, as opposed to the SN7494 CLEAR lines which operate on *high* inputs.

The remaining gates are used to buffer the Z register PRESET1 and PRESET2 lines, and in the OVERFLOW logic.

"Z" REGISTER OPERATION

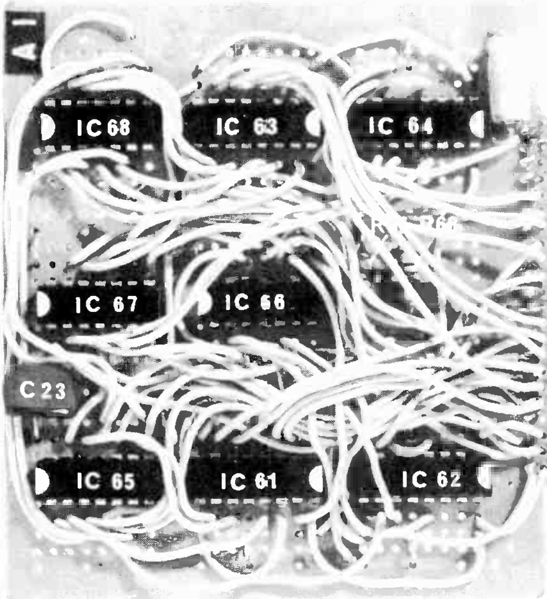
The most important operational aspect of the Z register is that it operates in a recirculating mode, which means that not only is its output fed to the ADDER, but also back to its own input, to give an endless loop.

This feature is important because it means that the register contents are not altered no matter how many bursts of ten clock-pulses are applied in the course of an arithmetic operation.

This facility is required in the MULTIPLY and DIVIDE programmes, where the contents of the Z register are continuously added to or subtracted from the contents of the A register until the result is produced.

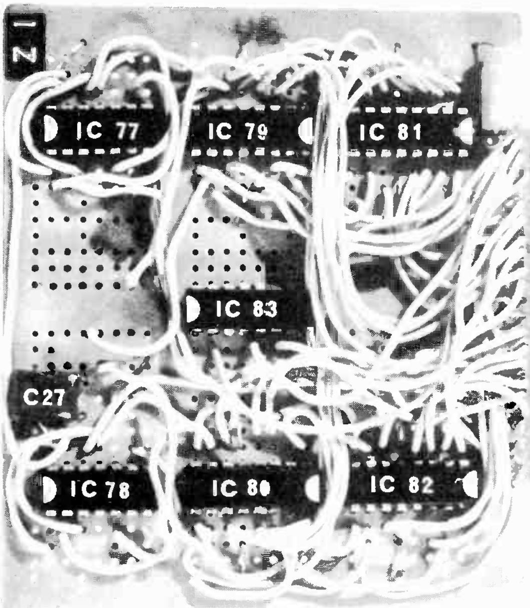
In these programmes the contents of the register can be used up to one million times in a single computation. Of course, this is not to say that the register contents are completely invariant, for when a particular set of data is finished with the register will be cleared by a CLEAR pulse from the programme, ready for new data to be entered in parallel from the ENTRY or A registers.

A AND Z BOARDS



Contact	Function	Function	Contact
1	Serial i/p (IC63)	LS + 5 o/p (IC63)	23
2	LS + 4 o/p (IC64)	LS + 5 o/p (IC61)	24
3	LS + 4 o/p (IC62)	spare	25
4	LS + 3 o/p (IC64)	spare	26
5	LS + 3 o/p (IC62)	LS + 5 i/p (IC63)	27
6	LS + 2 o/p (IC64)	LS + 5 i/p (IC61)	28
7	LS + 2 o/p (IC62)	LS + 4 i/p (IC64)	29
8	LS + 1 o/p (IC64)	LS + 4 i/p (IC62)	30
9	LS + 1 o/p (IC62)	LS + 3 i/p (IC64)	31
10	Serial o/p (IC64)	LS + 3 i/p (IC62)	32
11	Serial o/p (IC62)	GND	33
12	Disp. bus o/p (R67)	+5V	34
13	Disp. bus o/p (R68)	LS + 2 i/p (IC64)	35
14	8 Display strobes	LS + 2 i/p (IC62)	36
15	7 Display strobes	LS + 1 i/p (IC64)	37
16	6 Display strobes	LS + 1 i/p (IC62)	38
17	5 Display strobes	LS i/p (IC64)	39
18	4 Display strobes	LS i/p (IC62)	40
19	3 Display strobes	spare	41
20	2 Display strobes	CLOCK	42
21	1 Display strobes	PRESET	43
22	Serial i/p (IC61)	CLEAR	44

Fig. 6.8a. Layout of the i.c.s on the "A" register boards and function of the edge contacts, both boards being identical



Contact	Function	Function	Contact
1	E LS + 5 i/p (IC79)	Buffer o/p	23
2	E LS + 5 i/p (IC80)	Buffer i/p	24
3	E LS + 4 i/p (IC79)	Buffer i/p	25
4	E LS + 4 i/p (IC80)	spare	26
5	E LS + 3 i/p (IC81)	A LS + 5 i/p (IC79)	27
6	E LS + 3 i/p (IC82)	A LS + 5 i/p (IC80)	28
7	E LS + 2 i/p (IC81)	A LS + 4 i/p (IC79)	29
8	E LS + 2 i/p (IC82)	A LS + 4 i/p (IC80)	30
9	E LS + 1 i/p (IC81)	A LS + 3 i/p (IC81)	31
10	E LS + 1 i/p (IC82)	A LS + 3 i/p (IC82)	32
11	spare	GND	33
12	spare	+5V	34
13	E LS i/p (IC81)	A LS + 2 i/p (IC81)	35
14	E LS i/p (IC82)	A LS + 2 i/p (IC82)	36
15	Enter E	A LS + 1 i/p (IC81)	37
16	Enter A	A LS + 1 i/p (IC82)	38
17	Serial o/p (IC81)	A LS i/p (IC81)	39
18	Serial o/p (IC82)	A LS i/p (IC82)	40
19	Serial i/p (IC81)	spare	41
20	Serial i/p (IC82)	CLEAR (SN7474s)	42
21	CLOCK	Buffer i/p	43
22	CLEAR (SN7496s)	Buffer o/p	44

Fig. 6.8b. Layout of the i.c.s on the "Z" register boards and function of the edge contacts, both boards being identical

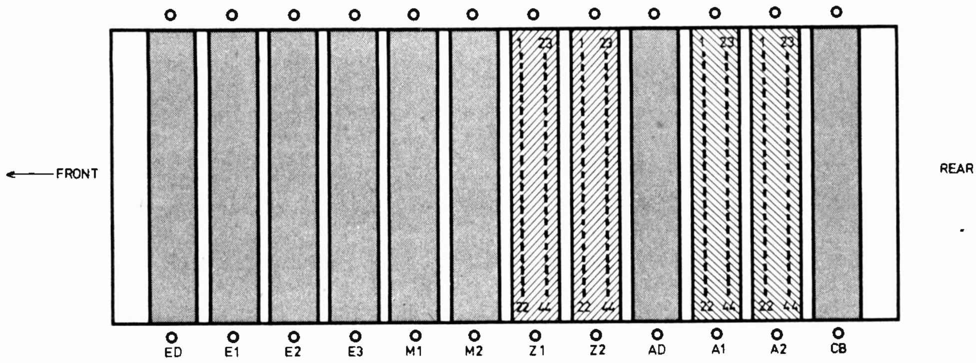


Fig. 6.9. Disposition of the edge connectors as seen from underneath the main chassis plate

CONSTRUCTION

The component layout arrangement for the A and Z register boards is shown in Fig. 6.8.

These boards have a good deal of wiring to the edge contacts due to the large number of parallel input/output wires required, and some care is required in laying this out so as not to produce very long wiring runs or large wiring concentrations.

The registers are required to perform serial shifts at high speed which means that the interconnections associated with this aspect of the circuit, i.e. everything except the parallel input/output wiring, should be kept as short as possible to reduce stray capacitance effects. With this in mind it is advisable to wire up the serial interconnections and clock lines before the rest of the wiring (which is not critical) is added.

Wiring is normally carried out on the component side of the DL109/44 boards, but it was found with the prototype that wiring congestion can be alleviated on the A1 and A2 boards by connecting the parallel output wiring to the edge contacts on the underside of the board.

EDGE CONNECTOR INTERCONNECTIONS

The edge connectors for these registers occupy the Z1, Z2, A1, and A2 positions on the chassis assembly (see Fig. 6.9), and are wired up in accordance with the wiring tables given. These tables (Fig. 6.10) are used by simply connecting the pin number required to the destination or destinations listed next to it in the table.

Each of these tables is complete, which means that a wire from the A register to the Z register will be listed in both the A *and* the Z register tables, so be sure to keep a record of wiring already carried out to prevent unnecessary duplication.

Again it is advisable to keep the wiring associated with serial transfers as direct as possible, and it is an idea to use a different coloured wire for these interconnections so that they may be easily identified later.

Where these serial data and clock lines exceed a few inches in length they should be routed as close to the chassis metal as possible to take advantage of its "ground-plane" properties. Interconnections to be treated with care are marked with an asterisk in Fig. 6.10.

Z1

E3/9	1	23	Z1/15, Z2/15
E3/10	2	24	enter E (prog)
E3/15	3	25	from E² logic
E3/16	4	26	not used
E2/9	5	27	A1/23
E2/10	6	28	A1/24
E2/15	7	29	A1/2
E2/16	8	30	A1/3
E1/9	9	31	A1/4
E1/10	10	32	A1/5
not used	11	33	GND
not used	12	34	+5V
E1/15	13	35	A1/6
E1/16	14	36	A1/7
Z1/23	15	37	A1/8
Z2/23	16	38	A1/9
*Z1/19	17	39	A1/10
*Z1/20	18	40	A1/11
*AD/19, Z1/17	19	41	not used
*AD/20, Z1/18	20	42	Z1/44
*CB/1	21	43	CB/13
CB/13	22	44	Z1/42, Z2/42

Z2

E3/7	1	23	Z1/16, Z2/16
E3/8	2	24	enter A (prog)
E3/13	3	25	not used
E3/14	4	26	not used
E2/7	5	27	A2/23
E2/8	6	28	A2/24
E2/13	7	29	A2/2
E2/14	8	30	A2/3
E1/7	9	31	A2/4
E1/8	10	32	A2/5
not used	11	33	GND
not used	12	34	+5V
E1/13	13	35	A2/6
E1/14	14	36	A2/7
Z1/23	15	37	A2/8
Z2/23	16	38	A2/9
*Z1/19	17	39	A2/10
*Z2/20	18	40	A2/11
*AD/17, Z2/17	19	41	not used
*AD/18, Z2/18	20	42	Z1/44
*CB/1	21	43	not used
CB/13	22	44	not used

A1

*AD/5	1	23	Z1/27
Z1/29	2	24	Z1/28
Z1/30	3	25	not used
Z1/31	4	26	not used
Z1/32	5	27	M2/25
Z1/35	6	28	M2/26
Z1/36	7	29	M2/29
Z1/37	8	30	M2/30
Z1/38	9	31	M2/35
*AD/9, Z1/39	10	32	M2/36
*AD/10, Z1/40	11	33	GND
To display data bus i/p B	12	34	+5V
To display data bus i/p A	13	35	M1/25
to display board strobe outputs 8	14	36	M1/26
to display board strobe outputs 7	15	37	M1/29
to display board strobe outputs 6	16	38	M1/30
to display board strobe outputs 5	17	39	M1/35
to display board strobe outputs 4	18	40	M1/36
to display board strobe outputs 3	19	41	not used
to display board strobe outputs 2	20	42	CB/18*
to display board strobe outputs 1	21	43	CB/16
*AD/6	22	44	CLEAR (prog)

A2

*AD/3	1	23	Z2/27
Z2/29	2	24	Z2/28
Z2/30	3	25	not used
Z2/31	4	26	not used
Z2/32	5	27	M2/25
Z2/35	6	28	M2/26
Z2/36	7	29	M2/29
Z2/37	8	30	M2/30
Z2/38	9	31	M2/35
*AD/7, Z2/39	10	32	M2/36
*AD/8, Z2/40	11	33	GND
To display data bus i/p D	12	34	+5V
To display data bus i/p C	13	35	M1/23
A1/14	14	36	M1/24
A1/15	15	37	M1/27
A1/16	16	38	M1/28
A1/17	17	39	M1/31
A1/18	18	40	M1/32
A1/19	19	41	not used
A1/20	20	42	CB/18*
A1/21	21	43	CB/16
*AD/4	22	44	CLEAR (prog)

Fig. 6.10. Interwiring details of the four edge connectors holding the "A" and "Z" register boards. The asterisks show connections which need special care

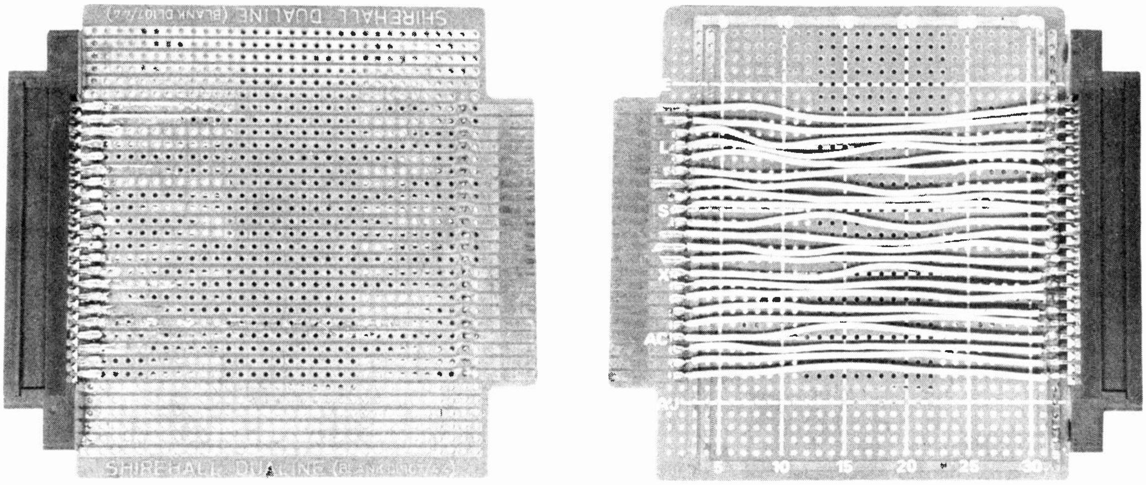


Fig. 6.11. Construction of a 44-way extension board which makes possible testing of boards in situ

TESTING

Testing these boards in an operational way is difficult at this stage and until the CLOCK board is constructed there is little that can be done except a check that the power supply lines are connected properly. For this reason it is essential that all wiring is double checked to remove wiring-up errors before proceeding.

EXTENSION BOARD

When the calculator nears completion and tests are possible in an operational situation, it will sometimes be required to measure a logic level, or inspect an interconnection while the logic boards are still connected in the circuit. As things stand this would prove difficult because of the close packing of the DL109 cards in their respective edge connectors.

To overcome this problem it is possible to construct an extension board which, when interposed between a particular board and its edge connector, has the effect of raising the board into a position where all its components and associated wiring are readily accessible, while still electrically connected to the rest of the circuit.

The layout for such an extension is shown in Fig. 6.11 where it can be seen that the component parts are simply an edge connector and a Shirehall DL107 board, together with some wiring.

The DL107 card is of the same physical size as a DL109, but instead of a printed wiring pattern to accept nine D.I.L. i.c.s, the DL107 has a Veroboard type of matrix, orginally intended for wiring up discrete components.

The construction of the extension consists of simply soldering the 22 ways of one half of the edge connector to the DL107 strips which terminate in gold plated edge contacts, then using single core wire to connect the other 22 edge connector tags to the corresponding DL107 edge contacts on the reverse side of the board.

COMPONENTS . . .

A1, A2 BOARDS

Resistors
R67–R70 1·2kΩ ¼W ±10% carbon

Capacitors
C22, C24 10μF 15V elect. (2 off)
C23, C25 0·047μF (2 off)

Integrated Circuits
IC61–64, IC69–72 SN7496 (8 off)
IC65–68, IC73–76 SN7401 (8 off)

Printed Circuit boards and sockets
Type DL109/44 boards (Shirehall) (2 off)
Type DPK165 edge connectors (Shirehall) (2 off)

Z1, Z2 BOARDS

Capacitors
C26, C28 10μF 15V elect. (2 off)
C27, C29 0·047μF (2 off)

Integrated Circuits
IC77, 78, 84, 85 SN7474 (4 off)
IC79–82, IC86–89 SN7494 (8 off)
IC83, IC90 SN7440 (2 off)

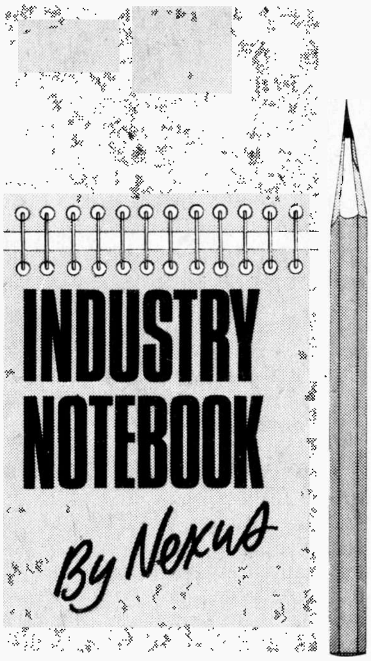
Printed Circuit Boards and Sockets
Type DL109/44 boards (Shirehall) (2 off)
Type DPK165 edge connectors (Shirehall) (2 off)

(In each case components are divided equally among the two boards which make up the A and Z registers)

The physical strength of the assembly can be improved by using a fillet of Araldite to join the edge connector and the DL107.

This simple servicing aid can come in very handy when testing any of the twelve Digi-Cal logic boards.

Next month: Clock Board.



COLD SHIVERS

Cold shivers ran up and down quite a lot of spines for a few brief moments when Dave Griffin, Motorola's director of marketing, Northern Europe, suggested there might be another slump in the semiconductor market in 1975. There was a sharp turndown in business in 1966/67 and the 1970/71 disaster is still painfully fresh in our memories. Is there a four-year cycle of slumps? Could be, says Griffin. Of course nobody really knows but Griffin's remarks got everybody crossing their fingers.

Griffin was speaking at a one-day seminar organised by component distributor Celdis Ltd. A hundred delegates turned up to hear the speakers in the Sculpture Gallery at Woburn Abbey. Their wives and girl friends were invited too, but they were hived off during the business sessions and enjoyed themselves watching wildlife in the Game Park and admiring the treasures in the Abbey itself.

But the sessions were by no means all gloom. Griffin came clean on Motorola forecasts which, among a great pile of statistics gave a U.K. semiconductor market worth £80 million by 1974. Big growth area was confirmed to be MOS devices which should reach £10 million worth of business in the same year. Big surprise is the market for germanium power devices which was expected to drop off very severely but which still has £4 million worth of business a year, even today.

This year, said Griffin, the U.K. market will have bought 40 million integrated circuits and 600 million discrete devices. Average selling prices have dropped since 1968. Then, the average price for a discrete device was 25 cents and for an integrated circuit 1·8 dollars. Today the averages are 20 cents and 1·2 dollars, respectively (dollar values are used universally in this type of comparison in the semiconductor industry).

TIME AND MOTION

The automotive industry as a major consumer of semiconductors will not really take off until 1975. But electronic watches are already starting to be a good growth area. Motorola has an electronic kit which is sold to watch manufacturers. It consists of a quartz crystal, a CMOS oscillator, divider and buffer circuit equivalent to 312 transistors in a 6-lead ceramic package, and a microminiature stepping motor which drives the hands. Total power consumption is a mere 5 microamps from a 1·5V silver oxide battery which lasts for over a year.

Motorola has greatly improved the yield of the CMOS package for watches by the use of ion implantation in which dopant material is "fired" at the target at enormous velocities but in a manner which can be deliberately controlled.

Another of the speakers, Kim Morrell of Mullard, forecast expansion of the U.K. electronics industry to £1,800 million by 1980 of which some £260 mililon would be in components of all types. My own belief is that his figure is on the low side and we should do much better than that.

The Vice-President of RCA Solid State Europe, Dr Joe Donahue, spoke on his company's solid commitment to European operations and to broadening the market base. The decision to set up in Europe was taken only three years ago. Now, says Donahue, RCA Solid State has almost 1,000 employees in Europe, well over 500 of them at the new semiconductor plant at Liege.

TOGETHERNESS

On the theme of togetherness, Donahue reminded his audience that RCA grew out of the old British-owned American Marconi Company. That was way back in 1919 when RCA was formed at the request of the American government to acquire the Marconi interests. It was the first time I ever heard RCA even admitting British ancestry publicly, let alone boasting about it!

To round up an interesting day, Peter Turner of Hewlett-Packard spoke of the dramatic growth of the optoelectronics market. Apart from obvious uses such as displays, Turner stressed that a huge growth area lay in electrically isolated couplers. H-P has a new fast one on the stocks promising a 20MHz bit rate with 2·5kV isolation, all in a small i.c. package. Overall optoelectronics sales in the U.K. could soar to £150 million per year by 1976 stated Turner.

So, on the whole, the news was good, especially for distributors who are currently handling some 20 per cent of all professional component supplies and are working hard to handle more.

CHATAWAY AT H-P

It was a great day for Dennis Taylor, managing director of Hewlett-Packard Ltd., when the Minister for Industrial Development, Mr Christopher Chataway, officially opened the 100,000sq ft extension to their South Queensferry plant. It more than doubles the area of the original unit built in 1966 and total employment at the plant has now risen to over 600.

Their total business in the U.K. is some £9 million and of total U.K. production 66 per cent is exported. Most famous of their instruments designed and built in the U.K. is the Microwave Link Analyser. To date over £4½ million worth have left the factory and 85 per cent went for export.

On the future, Taylor announced that they have just bought 33 acres of ground so we can expect further expansion although, chuckled Taylor, it will take a little time to expand into it. Hewlett-Packard has an R and D group of 50 people at South Queensferry and at least two completely new UK-designed instruments will be released by the end of the year.

RESETTLEMENT

An ex-editor in electronic publishing, T. Jeffrey Burton, and now a press relations consultant, has recently run a one-day seminar for RAF electronic technicians nearing the end of their service.

The idea was to give them a teach-in on the structure of the electronics industry and the job opportunities within it. Speakers include representatives of the electronics press, of the Society of Radio and Electronics Technicians (SERT), the Post Office and companies of the status of IBM and Exchange Telegraph.

Although the scientific and R and D ends of the business are not recruiting heavily at the moment, it seems that good technicians are hard to come by in the industry and are eagerly sought. The resettlement briefing, held at RAF Newton, near Nottingham, should help the boys in blue to ease themselves back into civvy street and do a good turn to the electronics industry as well.

INGENUITY 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 merits.

VISIBLE SPEED READOUT FOR A PROJECTOR

MANY home movie projectors rely for speed control on a rheostat which gives a film transport speed continuously variable from around 12 f.p.s. to around 25 f.p.s. This kind of control can have advantages over fixed (i.e. switched) controls, because many of the old silent films were shot at film speeds somewhere between 16 and 24 frames per second. Moreover, not all home movie cameras run at the same speed.

But anyone projecting films with a rheostat control will know that the snag with these controls is their unreliability as a positive guide to actual film speed. The same rheostat setting cannot be relied on to produce exactly the same speed on two occasions.

A few years ago I used a car tachometer or rev. counter to provide a direct visible readout of film speed.

Tachometers function by sensing the voltage pulses proportional to projector shaft speed; it is only necessary to produce low voltage pulses from the projector itself and feed them to an inductive load across which the tachometer is connected.

Experience shows that the most reliable source of pulses is from a make-and-break contact associated with the projector main drive shaft, but of course any positively driven shaft will do. All that is necessary is to attach a small spring metal strip (such as an old relay contact strip) to an insulating block which is secured (e.g. glued) to the projector chassis so that the spring strip presses against the shaft (Fig. 1).

A blob (or blobs—see later) of Araldite or other hard insulating material is painted on the shaft so that, as it revolves, the spring strip will alternately make with the metal shaft and break by contacting an insulating blob. By connecting leads between the spring strip and projector chassis (which will of course be electrically connected to the shaft) a make-and-break connection is easily achieved which can be used to produce low voltage pulses when in circuit with a low voltage source.

Tachometers or rev. counters come with two leads, one of which is red or marked "positive" for connection to the positive side of the supply.

The tachometer dial reading will not of course necessarily give a true r.p.m. reading for the projector shaft, but this is not important. By timing a film loop through the projector and marking the dial accordingly, points of reference for actual speeds of 16, 18 and 24 frames per second can be marked on the dial and the projector brought reliably to these speeds at any time in the future by operation of the rheostat.

By virtue of this arbitrary scaling, there is wide latitude of components, virtually any inductance or low voltage d.c. source that produces a healthy dial reading being acceptable. For guidance, 9 or 12 volts smoothed d.c. from a battery eliminator should be fed through the make-and-break contacts to the inductive load, for which the primary of a 5:1 transformer has proved ideal. To avoid radio or television interference, a 0·1 or 0·01μF capacitor should be connected across the contacts.

A. Hope,
London
N.W.3.

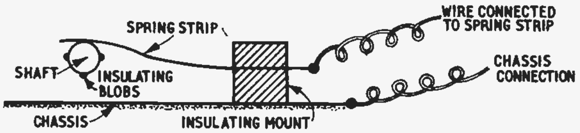


Fig. 1. Arrangement of the spring contact on the projector drive shaft. The insulating spots on the shaft can be any hard-setting glue

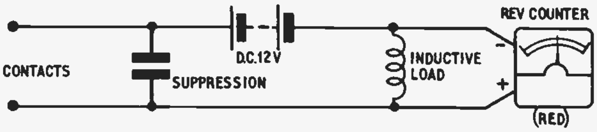


Fig. 2. Typical set-up for the visible speed control readout

LIGHT CONTROL

Recently I set about designing a system to enable me to remotely switch on and off two or more table lamps. I wished to be able to switch the lights on and off at any of three points regardless of the state of the switches at the other two.

This I decided could best be achieved by placing an electrically alterable bistable switch near the power point that fed the two lamps and running a twin flex lead from the bistable, connecting the three switches in parallel. Pushing on and releasing any switch would then change the bistable from on to off, or off to on depending on its history.

Since I had several suitable relays, and triacs are a little costly, I decided to use a relay to do the actual work of switching the lamps. The circuit I originally tried was the conventional type of bistable.

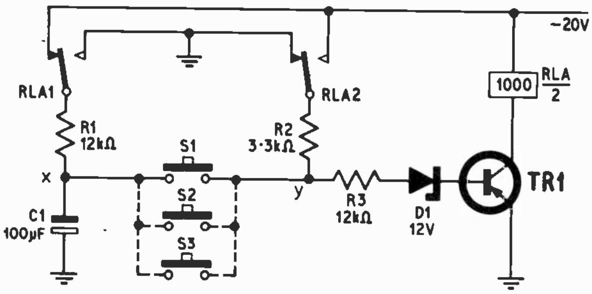


Fig. 1. Circuit diagram of the light control

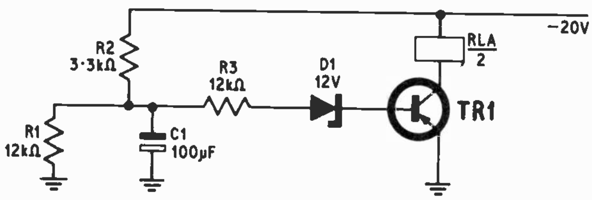


Fig. 2. Effective circuit when S1 is closed

Unfortunately, it had the disadvantage of requiring a fast edge to switch reliably, a faster edge than one could hope to regularly achieve with a mechanical switch. This meant, therefore, placing a monostable between the mechanical switch and the bistable. A rethink at this point produced the circuit shown in Fig. 1.

If TR1 is off and S1 is open, contacts RLA1 and RLA2 will be closed, point *y* will be at zero potential and capacitor C1 will charge to −20V through R1. If S1 is then closed, point *y* is reduced to the potential of point *x*, i.e. −20V. The Zener diode D1 then conducts, resistor R3 limiting the current, and TR1 switches on. The relay is energised and the relay switches over.

The circuit will now take the form shown in Fig. 2, points *x* and *y* at $\frac{12 \times 20}{(3{\cdot}3+12)}$ negative volts (approximately −16V), which is just sufficient to maintain TR1 conducting. When S1 is opened again, point *y* goes to −20V potential maintaining TR1 in conduction; capacitor C1 discharges through R1 to zero.

When S1 is pressed close, point *y* is reduced instantaneously to zero, TR1 switches off and the relay contacts revert back to their original state. Points *x* and *y* should now be at $\frac{3{\cdot}3 \times 20}{3{\cdot}3 + 12}$ negative volts (roughly −4V), insufficient to cause the Zener diode to conduct and TR1 remains off. When S1 is released (open) *y* goes to zero and *x* charges to −20V through resistor R1. The cycle may now be repeated.

Because of the delay in charging capacitor C1 the circuit will only change state when there is a minimum of two seconds delay between switching pulses, i.e. between S1 going off and coming on again. In certain circumstances this could be useful.

The delay could be reduced by reducing the values of R1 and R2 or C1. This is limited of course since C1 must not be allowed to charge or discharge through R2 in that instant when S1 is closed and the relay has not switched; in other words the minimum vales of C1, R1 and R2 are primarily limited by the inertia of the relay. It should also be remembered that lower values of R1 and R2 will require greater transient power pulses from the supply.

It was found that the bistable operated satisfactorily with up to about 50 ohms between S1 and point *x*. Line resistance to S1 is therefore not important.

The switch pulse duration may be any length from a few hundred milliseconds (sufficient to switch the relay) to infinity.

The power supply is not critical and a bell transformer driving an unregulated voltage doubler was found satisfactory. Using a G.P.O. 1,000 ohm relay the circuit uses approximately 20mA when switched on, and negligible current in the off state.

Any relay with double changeover contacts, other than very low coil resistance types, should work. The line voltage should be approximately the relay working voltage. The Zener diode should be 0·6 × line voltage. Additional heavy duty contacts would be required for switching the lamps.

An *npn* transistor may be used in the circuit if preferred. In this case the Zener must be reversed, and the supply and electrolytic polarities changed.

P. King,
Withington,
Manchester.

MODEL TRAIN CONTROL

THE circuit depicted in Fig. 1. was designed to automatically control the running of two trains through a single-line section, both trains always travelling in the same direction as each other.

Referring to Fig. 2, points A and B are set for the inner loop. Whilst train 2 is travelling round the single-line loop train 1 is held in isolating section *X*. Isolation of sections *X* and *Y* is controlled by the points blades at *B*. Track current is fed to either *X* or *Y* not both.

As train 2 passes position L, it interrupts a light beam focused on a light dependent resistor PCC1 (Fig. 1.) thereby triggering the desired sequence of switching operations. First point A changes to outer and then point B also changes to the outer track.

When point B is set for the outer section, current is fed to section *X*, train 1 starts up and proceeds around the single line section; the sense of points B will cause train 2 to halt in section *Y*.

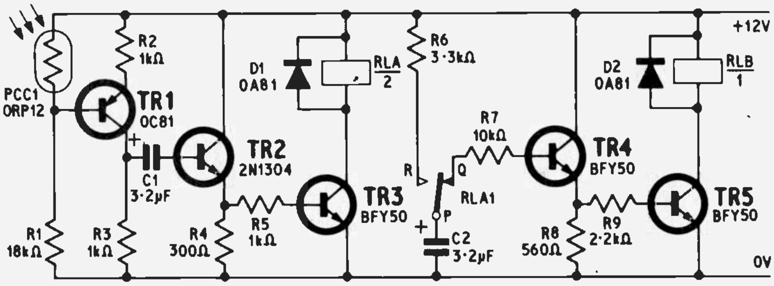


Fig. 1. Circuit diagram for the light operated model train controller. Note that C1 and C2 are electrolytics

As train 1 now passes position L it triggers off the same switching sequence as before, except this time the moving train is now on the outer loop and the points are therefore changed from outer to inner. By the time train 1 is halted in section *X* train 2 is on the move again, we are back at the beginning of the sequence of operations and the whole cycle repeats.

The points are actuated by point motors which consist of a 2-coil solenoid and an independently wired 2-way switch that changes synchronously with the points motor, see Fig. 3. Since for reliable operation these motors need a relatively high current, it was arranged to operate them in sequence. They also require a one-shot pulse to avoid overheating the coils.

The pulses are supplied by sets of contacts on the relays RLA2 and RLB1, which close in sequence. The cross-wiring of the 2-way switches on the points motors (Fig. 3) provides a flip-flop arrangement by which the closing of RLA2 causes point A to change to the sense determined by the setting of the switch S2 on the points motor M2. Similarly, when RLB1 closes, immediately on RLA2 dropping out, point B changes under control of the switch S1 on motor M1.

The circuit Fig. 1 comprises two relay buffer stages and a light-operated circuit for triggering. Interruption of the light beam at L causes TR1 to switch on because of the increased resistance of PCC1. Current from the collector of TR1 switches on TR2 and TR3, which in turn energises RLA.

Relay RLA, however, remains closed for a very short time until capacitor C1 has charged up and consequently switched off TR2 and TR3. Relays RLA and RLB are wired in a master-slave relationship, for while RLA is closed a secondary set of its contacts is being used to charge up capacitor C2, via R6 and the RLA1 contacts P and R. When RLA drops out contact P makes contact with contact Q (its normal state) and capacitor C2 discharges via R7 and TR4 base. This then switches on TR4 and TR5, but as before the pulse is momentary, until C2 has discharged sufficiently to reverse bias TR4.

After one cycle of operations has been completed, further triggering is not possible until after a delay (approximately 10sec) during which C1 discharges.

If desired, a variable resistor may be substituted for R2 to provide sensitivity control of the PCC1. The relays used were 12V types. The contacts on RLA2 need to be of the break-before-make type, but the contacts RLA2 and RLB1 need only be simple on-off types; normally off.

The light source used was an ordinary flashlight bulb masked to shine through a $\frac{1}{4}$in aperture into a 3in long cardboard tube housing PCC1 at the far end.

J. Duffill,
Southam.

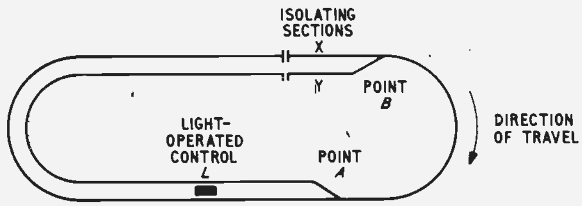


Fig. 2. Typical track layout

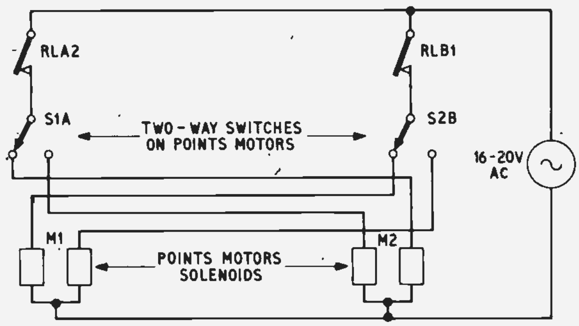


Fig. 3. Switch wiring arrangement

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D.I.L. I.C. sockets—14 pin, 20p; 16 pin, 20p
1N4001—50 P.I.V., 1·0A, 6p
1N4002—100 P.I.V., 1·0A, 7p
1N4003—200 P.I.V., 1·0A, 8p
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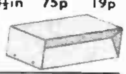
GB7 *	5¼in	2¼in	1½in	38p	15p
GB8 *	4in	4in	1½in	38p	15p
GB9 *	4in	2¼in	1½in	38p	13p
GB10*	5¼in	4in	1½in	44p	18p
GB11	4in	2½in	2in	38p	13p
GB12	3in	2in	1in	33p	13p
GB13	6in	4in	2in	52p	18p
GB14	7in	5in	2½in	63p	19p
GB15	8in	6in	3in	81p	26p
GB16	10in	7in	3in	92p	26p

* These sizes fit standard veroboards

EQUIPMENT CASES in plain aluminium with sloping front panel.

Type	H.	W.	D.	Price	p. & p.
SF1	2in	5¼in	2¼in	45p	12p
SF2	2in	7¼in	3½in	60p	16p
SF3	2in	9¼in	4¼in	75p	19p

Stove - enamelled silver-grey hammer finished, 25p extra.



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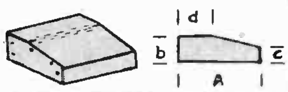

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2µF	450V	20p	1,000µF	50V	42p
4µF	350V	14p	2,000µF	25V	39p
8µF	450V	17p	2,000µF	50V	53p
16µF	450V	18p	2,500µF	25V	45p
25µF	25V	7p	2,500µF	50V	60p
25µF	50V	10p	3,000µF	25V	48p
32µF	450V	27p	5,000µF	25V	60p
50µF	50V	10p	5,000µF	50V	£1·10
100µF	25V	10p	8–8µF	450V	18p
100µF	50V	11p	8–16µF	450V	20p
250µF	25V	14p	16–16µF	450V	27p
250µF	50V	17p	16–32µF	450V	63p
500µF	25V	18p	32–32µF	450V	49p
500µF	50V	25p	50–50µF	350V	38p

MINIATURE ELECTROLYTICS

1µF	63V	6p	47µF	16V	7p
2·2µF	63V	6p	47µF	25V	6p
3·3µF	63V	6p	68µF	16V	6p
4·7µF	63V	6p	100µF	10V	6p
8µF	40V	7p	220µF	16V	7p
10µF	25V	6p	330µF	16V	11p
10µF	64V	7p	470µF	10V	11p
16µF	40V	7p	1,000µF	16V	19p
33µF	16V	6p	1,500µF	16V	23p

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3¾in × 3¾in	24p	25p
3¾in × 5in	27p	29p
17in × 2½in	75p	57p
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Edge connectors:
24 way, 0·1 (2½in)—34p
36 way, 0·1 (3¾in)—44p
16 way, 0·15 (2½in)—23p
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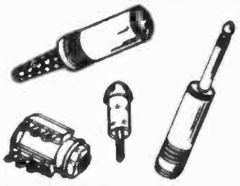
Co-axial	9p
D.I.N. 2 pin (speaker)	10p
D.I.N. 3 pin	13p
D.I.N. 4 pin	14p
D.I.N. 5 pin, 180°	13p
D.I.N. 5 pin, 240°	15p
D.I.N. 6 pin	15p
Jack, 2½mm unscreened	9p
Jack, 2½mm screened	10p
Jack, 3½mm unscreened	8p
Jack, 3½mm screened	12p
Jack, ¼in unscreened	12p
Jack, ¼in screened	20p
Jack, stereo, unscreened	20p
Jack, stereo, screened	35p
Phono, plastic top	5p
Phono, plated metal	12p
Wander, red or black	3p
Banana 4mm, red or black	6p



SOCKETS

Car aerial	8p
Co-axial, surface	8p
Co-axial, flush	9p
D.I.N. 2 pin (speaker)	10p
D.I.N. 3 pin	9p
D.I.N. 5 pin, 180°	9p
D.I.N. 5 pin, 240°	9p
Jack, 2½mm	10p
Jack, 3½mm	10p
Jack, ¼in unswitched	15p
Jack, ¼in switched	17p
Jack, stereo, switched	24p
Phono, single	5p
Phono, 2 on a strip	7p
Phono, 3 on a strip	9p
Phono, 4 on a strip	10p
Wander, single, red or black	5p
Wander, twin strip	7p
Banana 4mm red, or black	6p

LINE SOCKETS

Car aerial	14p
Co-axial	17p
D.I.N. 2 pin (speaker)	15p
D.I.N. 3 pin	16p
D.I.N. 5 pin, 180°	16p
D.I.N. 5 pin, 240°	16p
Jack, 3½mm	15p
Jack, ¼in screened	49p
Jack, stereo, screened	34p
Phono, plated metal	14p

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2·2pF	500V	S/M	7½p
3·3pF	500V	S/M	7½p
5pF	500V	S/M	7½p
10pF	125V	P.S.	5p
10pF	500V	S/M	7½p
15pF	125V	P.S.	5p
15pF	500V	Cer.	4p
18pF	500V	S/M	7½p
22pF	125V	P.S.	5p
22pF	500V	S/M	7½p
25pF	500V	S/M	7½p
27pF	500V	Cer.	4p
33pF	125V	P.S.	5p
33pF	500V	S/M	7½p
39pF	500V	S/M	7½p
47pF	125V	P.S.	5p
47pF	500V	Cer.	4p
50pF	500V	S/M	7½p
56pF	500V	S/M	7½p
68pF	125V	P.S.	5p
68pF	500V	S/M	7½p
75pF	500V	S/M	7½p
82pF	500V	S/M	7½p
100pF	125V	P.S.	5p
100pF	500V	S/M	7½p
100pF	500V	Cer.	5p
120pF	500V	S/M	7½p
150pF	125V	P.S.	5p
150pF	500V	S/M	7½p
150pF	500V	Cer.	5p
180pF	500V	S/M	7½p
200pF	500V	S/M	7½p
220pF	125V	P.S.	5p
220pF	500V	Cer.	5p
250pF	500V	S/M	8p
270pF	500V	Cer.	5p
300pF	500V	S/M	8p
330pF	125V	P.S.	5p
330pF	500V	S/M	8p
390pF	500V	S/M	8p
470pF	125V	P.S.	5p
470pF	750V	Disc	5p
500pF	500V	S/M	8p
560pF	500V	S/M	8p
680pF	125V	P.S.	6p
680pF	500V	S/M	8p
820pF	500V	S/M	8p
0·001µF	100V	Mylar	3p
0·001µF	125V	P.S.	6p
0·001µF	400V	Poly.	3p
0·001µF	500V	S/M	10p
0·001µF	500V	Cer.	5p
0·001µF	1,000V	MDC	6p
0·0015µF	400V	Poly.	3p
0·0015µF	500V	S/M	10p
0·0015µF	500V	Cer.	5p
0·0018µF	500V	S/M	10p
0·002µF	100V	Mylar	3p
0·002µF	500V	Cer.	5p
0·0022µF	125V	P.S.	6p
0·0022µF	500V	S/M	10p
0·0022µF	1,000V	MDC	6p
0·0027µF	500V	S/M	15p
0·003µF	500V	Cer.	5p
0·0033µF	125V	P.S.	6p
0·0033µF	500V	Poly.	6p
0·0033µF	1,000V	MDC	6p
0·0036µF	500V	S/M	15p
0·0047µF	125V	P.S.	9p
0·0047µF	500V	Poly.	6p
0·0047µF	500V	S/M	20p
0·0047µF	1,000V	MDC	6p
0·005µF	100V	Mylar	3p
0·005µF	500V	Cer.	5p
0·0068µF	125V	P.S.	10½p
0·0068µF	500V	S/M	30p
0·0068µF	500V	Poly.	6p
0·0082µF	125V	P.S.	10½p
0·0082µF	500V	S/M	30p
0·01µF	18V	Disc	4p
0·01µF	125V	P.S.	10½p
0·01µF	160V	Poly.	4p
0·01µF	250V	M.F.	3p
0·01µF	400V	Poly.	3p
0·01µF	500V	Cer.	5p
0·01µF	500V	S/M	30p
0·01µF	600V	MDC	7p
0·01µF	1,000V	MDC	9p
0·015µF	160V	Poly.	3p
0·015µF	400V	Poly.	3p
0·02µF	100V	Mylar	3p
0·022µF	18V	Disc	5p
0·022µF	250V	M.F.	3p
0·022µF	400V	Poly.	3p
0·022µF	600V	MDC	7½p
0·022µF	1,000V	MDC	10p
0·033µF	250V	M.F.	4p
0·033µF	400V	Poly.	4p
0·047µF	12V	Disc	6p
0·047µF	160V	Poly.	3p
0·047µF	250V	M.F.	3p
0·047µF	400V	Poly.	4p
0·047µF	600V	MDC	8p
0·047µF	1,000V	MDC	10p
0·1µF	30V	Disc	6p
0·1µF	250V	M.F.	4p
0·1µF	400V	Poly.	5p
0·1µF	600V	MDC	10p
0·1µF	1,000V	MDC	14p
0·15µF	250V	M.F.	5p
0·22µF	160V	Poly.	6p
0·22µF	250V	M.F.	5p
0·22µF	400V	Foil	10p
0·22µF	1,000V	MDC	15p
0·33µF	250V	M.F.	8p
0·47µF	250V	M.F.	8p
0·47µF	400V	Foil	15p
0·47µF	1,000V	MDC	25p
1·0µF	250V	M.F.	15p

Note:
S/M = silver mica 1% tol.
P.S. = polystyrene 2½% tol.
MDC—a.c. rating = 300V.
M.F. = Mullard min. foil.
Cer. = ceramic.

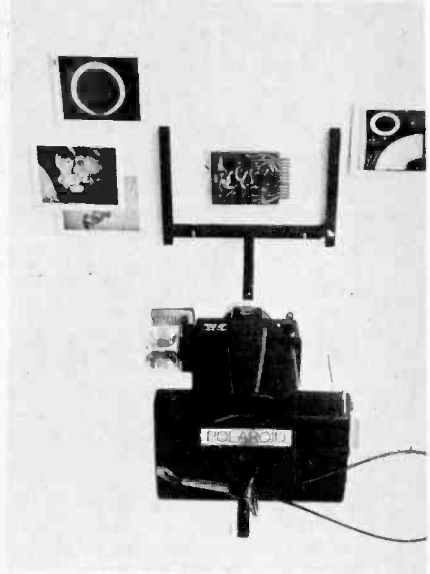
MAIL ORDERS: Some items have a post and packing charge shown against them. Where p. & p. is not shown the charge is 12p for any selection. When both classes of goods are ordered the charge is 12p plus any p. & p. charges shown. (Overseas extra.) Telephone 01-692 4412

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.

Two flash units from Honeywell

Adcola Products Soldering pack



Instant copying kit by Polaroid

SOLDERING PACK

Certainly an ideal kit to present as a gift to anyone, particularly at this time of the year. the new **Adcola Products** soldering kit contains all the essentials for simple soldering jobs. The kit contains an Invader soldering iron. a stand. solder wire. two spare soldering tips and an instruction card providing useful hints on successful soldering.

The soldering iron is thermally controlled to provide a constant heat level for ease of soldering. The standard soldering tip provided is $\frac{3}{16}$in diameter, but two replacement tips of $\frac{1}{8}$in and $\frac{1}{4}$in diameter are included to provide complete versatility for a 25W iron. The tips are merely inserted in the collar at the end of the iron to convert it from one task to another.

The stand provided with the kit features an integral sponge for cleaning excess solder from the tips and two holes to contain the spare tips. A spring holder is mounted on the base of the stand at an angle of about 45 degrees to take the iron when not in use.

The kit costs £3·99 and all the components are contained in a plastics tray featuring compartments for each component for safety in transit. The kit should be available from most d.i.y. shops, ironmongers or direct from Adcola Products Ltd., Adcola House, Gauden Road, London, S.W.4.

EMERGENCY LANTERN

With the forecast that power cuts are again probable this winter, it is wise to plan ahead for the eventuality and to have some form of emergency lighting handy.

A useful lamp is the "Safety Lantern" available from **Harris Marketing.** It is claimed to be virtually unbreakable, having a safe plastic dome which gives a 360 degree light and is powered by a 6V 996 battery.

It is particularly suitable around the home where there may be children or elderly people, for whom candles and other naked lights would be a danger, but it also makes a useful car, caravan or camping light.

Available direct from Harris Marketing, 16 Hillcroome Road, Sutton, Surrey, the lamp costs £1·85 plus 15p post and packing.

PHOTOGRAPHIC EQUIPMENT

Famous for their work in the computer field **Honeywell** have announced their entry into the photographic world with a range of electronic flash equipment, 35mm slide projectors and darkroom equipment.

Available in this country through **Photo-Science Ltd.** the range of equipment includes automatic flash units and slave flash units.

Also included in their range of products are four automatic self-focusing projectors with a special built-in preview screen. These models enable the projectionist to see each slide on a small screen before it is projected to the audience.

Two of the flash units represent Honeywell's latest technological advancements in this field, which they call "strobo-eye" remote sensing. The sensor device is completely separated from the flash so that the light can be controlled from the camera or wherever the photographer desires.

These two flash units are described by Honeywell as the only system that will give accurate automatic exposure control of on-camera, off-camera and wall- or ceiling-bounce flash lighting.

Further particulars of the complete range of Honeywell photographic equipment can be obtained from Photo-Science Ltd., Charfleet Road, Canvey Island, Essex.

INSTANT COPY KIT

An inexpensive instant copy kit and accessories, providing a complete photographic copying system, is being introduced by **Polariod (UK) Ltd.** Both the copy kit and accessory unit are designed for use with any of three Polaroid instant picture cameras.

Ideal for making copies from a master design of printed circuit patterns to any required size, the Polaroid 105-1 kit gives a $\frac{2}{3}$: 1 reduction. The kit consists of a copy stand, close-up lens in mount, blue filter (for colour film used with tungsten light), polarising filter (for flash only), Colorpack 80 camera and a carrying case.

The complete kit costs £38·95; without a camera the kit retails at £24.

The 106 Instant Copy Kit accessory unit, comprising a copy stand and close-up lens for 1 : 1 copies, will retail for £15·00.

EXTENSION LEADS

It has been brought to our attention that the price quoted for the Portapower cable reels mentioned in our September issue does not include the cost of cable.

We apologise for any inconvenience this may have caused.

Readout—
A SELECTION FROM OUR POSTBAG

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

Correct perspective

Sir—Mr Hickman (*Readout*, November issue) has raised the question of component cost in Australia, a point certainly omitted from the first *Report from Australia*. Detailed costings of parts were not quoted, as indeed many other aspects of home construction were omitted, due mainly to space considerations; it was intended only as an introduction.

However, since the subject has been raised, the question of component cost must be placed in the correct perspective. In Sydney and Melbourne, the BC108, if we are to use this device as an example, can be bought at the rate of 6 for \$2·00 (16p each) *including* sales (purchase) tax. The figures as quoted by Mr Hickman may be applicable to South Australia, but it is indeed a half-truth to suggest that his situation applies throughout Australia.

The cost of components generally must, in any case, be viewed against the background of higher salaries here. It has been stated that, for many professional occupations, salaries are very roughly 50 per cent higher than in the U.K.

I would agree with your correspondent's comments regarding Australian conditions, particularly those in respect of the somewhat over-glamorised publications for which Australia House is now famous.

Finally, Mr Hickman is under the illusion that I am Australian, and tend to avoid comparisons. I myself migrated from England some five years ago.

J. Waldie,
Tamarama, N.S.W.,
Australia.

The defender

Sir—I would like to come to the defence of your constructional features in general and R. W. Coles' "P.E. Digi-Cal" in particular.

I doubt whether I will ever build the Digi-Cal, but the detailed way in which its operation is explained by the author has added measurably to my understanding of the logic functions involved. If such features are to be excluded because of a cost disadvantage compared with custom built devices, we amateurs will be deprived of much needed design know-how.

I have to confess that I jumped the gun by buying the Minitrons before the total cost of parts was revealed. Doubtless they will come in handy one day—but it might be an idea if project-authors revealed the approximate cost of components at the outset and saved we impecunious constructors the embarrassment of having to abandon a project after buying a few of the items needed.

J. A. Burness,
Herts.

Valuable learning

Sir—I noticed a number of letters in the October issue of P.E. that objected to the Digi-Cal on monetary and aesthetic grounds. The question was raised, why should you publish an article outlining the construction of a calculator when the basic i.c. is now available.

I can certainly construct a very simple calculator around one of the many calculator integrated circuits that are now available, but this teaches me nothing new about digital electronics. Even though I may not want to build the Digi-Cal, I have certainly been able to follow along with the author and now I have a better understanding of how these devices work. Maybe I have also picked up some new ideas on how to do things such as keyboard multiplexing and readout demultiplexing. That is as valuable as learning the basic operations of a calculator.

Many electronic hobbyists here in the USA are all too ready to put together a kit that teaches them nothing and tests only their ability to follow directions. Most of the electronic publications here cater to these individuals and that is why I subscribe to P.E. Keep up the good work.

Jonathan T. Titus,
President,
Titus Labs,
Blacksburg, USA.

BACK NUMBERS WANTED

Anyone who can supply the undermentioned are asked to communicate directly with the reader.

We regret that back numbers of Practical Electronics can no longer be supplied. We will try to publish announcements of readers' requirements (without a guaranteed date) free of charge.

March–April 1971
Mr R. Brown, P.O. Box 926, Chingola, Zambia.

July 1969
Mr K. Farrance, Charity Cottage, High Rougham, Bury St Edmunds, Suffolk.

February 1971
Mr D. J. Hitchcock, 38 Deakin Street, Hampton 3188, Melbourne, Victoria, Australia.

December 1966
Mr M. Robson, 8 Withipoll Street, Ipswich, Suffolk.

February, March, May 1971
Mr T. J. Hsich, 39 Gold Jade Road, Kuching, Sarawak.

January 1968
Mr G. Hart, 41 Waterlow Road, London N19 5NJ.

August 1966
Mr R. A. Hume, 93 Sinclair Drive, Glasgow G42 9PU.

December 1970 to March 1971
Mr J. Jeffrey, 65 Sandmoor Road, Errington Park, New Marske, Redcar, Teesside.

May 1969 to March 1970
Mr L. W. Burton, 32 Castleton Farm, St Athan, Barry, Glamorgan.

April 1972
Mr M. P. Baker, 14 Cabell Road, Park Barn Estate, Guildford, Surrey.

September 1966, January, June, July, August 1967
Mr B. S. Stuck, 28 Chancelot Road, Abbey Wood, London SE2 0NB

July 1972
Mr P. J. Joyce, 21 Eggington Court, Loughborough University, Leicestershire.

December 1970 to March 1971
Mr A. Jones, Tyddyn Slaters, Pontrug, Caernarvon, North Wales.

November 1971 to March 1972
Mr C. Wright, 98 Swallow Road, Ipswich, Suffolk.

July 1969
Mr M. Armitage, Oakendean, 12 Shanter Way, Alloway, Ayrshire.

May to October, December 1969
Mr W. J. Miller, Dailard, 13 Adler Road, Glasgow S3.

November 1970 to March 1971
Mr J. Maplesden, 47 Oldford Crescent, Acklam, Middlesbrough, Teesside, TS5 7EH.

January–February 1971
Mr C. E. R. Flynn, A.P.C. Ltd., Dungeness Power Station, Romney Marsh, Kent.

May 1972
Mr N. Tawse, 25 Welland Road, Edith Weston, Oakham, Rutland, LE15 8JE.

May 1969 to February 1970
Mr S. P. Ganecki, 17 Belmont Close, Churchbridge, Cannock, Staffordshire.

November–December 1971
Mr H. D. Westwood, 12 Cairn Walk, Crumlin, Co. Antrim, N. Ireland.

June 1969
Mr J. E. Marshall, 4 Dellcott Close, Welwyn Garden City, Herts.

April–May 1971
Mr A. E. Thompson, 3 Uxbridge Court, Uxbridge Road, Kingston.

November 1971
Mr G. C. Street, 21 Linton Crescent, Hastings, Sussex.

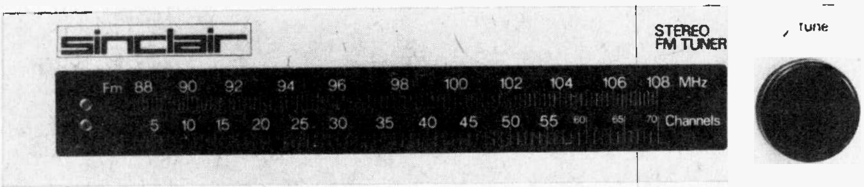
July 1970 to May 1971
Mr R. Konarek, 573 Daws Heath Road, Hadleigh, Benfleet, Essex.

May, June, July, Sept., Oct., Nov., Dec. 1969, January to April, August 1970
Mr J. Shapero, 64 Tixall Road, Birmingham, B28 0RS.

April–July 1971
Mr K. McKegney, 21 Queen Street, Chesterfield, Derbyshire, S40 4SF.
Up to Oct. 5.

Sinclair Project 60

Project 60 Stereo FM Tuner



Built and tested.
Post free.
£25

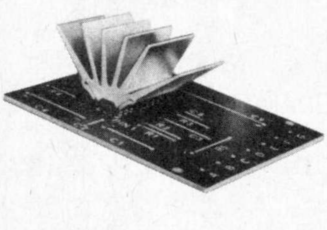
with phase lock-loop principle

Amongst the many advanced electronic features to be found in this remarkable stereo tuner, use of the phase lock loop principle ensures standards of audio quality better than from any other method of detection yet used. Varicap diode tuning, accurately formed printed circuit coils, an I.C. in the special stereo decoder section and switchable squelch circuit for silent tuning between stations contribute to the unsurpassed performance of this tuner, irrespective of price consideration. But the Project 60 FM Stereo Tuner is far from expensive – indeed, it offers fantastic value for money and will bring the thrill of stereo radio to many who previously may not have been able to afford it. The tuner may be used with any good system as well as Project 60, but if you use it with other Project 60 modules, you will find the matching front panels particularly impressive in appearance as well as function.

SPECIFICIATIONS

Number of transistors: 16 plus 20 in I.C.
Tuning range: 87·5 to 108MHz.
Sensitivity: 7μV for lock-in over full deviation.
Squelch level: typically 20 μV.
Signal to noise ratio: ±65dB.
Audio frequency response: 10Hz–15Khz (±1dB).
Total harmonic distortion: 0·15% for 30% modulation.
Stereo decoder operating level: 2μV.
Cross talk: 40dB.
Output voltage: 2×150mV R.M.S. max. (typically 2×50mV. stereo)
Operating voltage: 25–30V DC at 100mA.
Indicators: Stereo on: tuning.
Size: 93×40×207mm.

Super IC.12 Integrated circuit high fidelity amplifier



Having introduced Integrated Circuits to hi-fi constructors with the IC.10, the first time an IC had ever been made available for such purposes, we have followed it with an even more efficient version, the Super IC.12, a most exciting advance over our original unit. This needs very few external resistors and capacitors to make an astonishingly good high fidelity amplifier for use with pick-up, F.M. radio or small P.A. set up, etc. The free 40 page manual supplied, details many other applications which this remarkable IC. make possible. It is the equivalent of a 22 transistor circuit contained within a 16 lead DIL package, and the finned heat sink is sufficient for all requirements. The Super IC.12 is compatible with Project 60 modules which would be used with the Z.50 and Z.30 amplifiers. Complete with free manual and printed circuit board.

SPECIFICATIONS

Output power: 6 watts RMS continuous (12 watts peak). 6–8Ω. **Frequency Response:** 5Hz to 100KHz±1dB. **Total Harmonic Distortion:** Less than 1%. (Typical 0·1%) at all output powers and frequencies in the audio band (28V). **Load Impedance:** 3 to 15 ohms. **Input Impedance:** 250 Kohms nominal. **Power Gain:** 90dB (1,000,000,000 times) after feedback. **Supply Voltage:** 6 to 28V. **Quiescent current:** 8mA at 28V. **Size:** 22×45×28mm including pins and heat sink.

Manual available separately 15p post free.

With FREE printed circuit board and 40 page manual.
£2.98 Post free

Project 605

The easy way to buy and build Project 60

Project 605 is one pack containing: one PZ5, two Z30's, one Stereo 60 and one Masterlink. This new module contains all the input sockets and output components needed together with all necessary leads cut to length and fitted with neat little clips to plug straight on to the modules. Thus all soldering and hunting for the odd part is eliminated. You will be able to add further Project 60 modules as they become available adapted to the Project 605 method of connecting.

Complete Project 605 pack with comprehensive manual, post free £29.95

Everything you need to assemble a superb 30 watt high fidelity stereo amplifier without having to solder.

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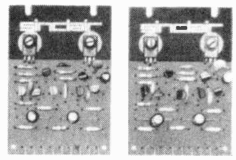
Sinclair Radionics Ltd, London Road, St. Ives, Huntingdonshire PE17 4HJ. Tel: St. Ives 64311

the world's most advanced high fidelity modules

Z.30 & Z.50 power amplifiers

Built, tested and guaranteed with circuits and instructions manual. **Z.30 £4.48** **Z.50 £5.48**

The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to provide unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at 15w (8Ω) and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and are intended for use principally with other units in the Project 60 range. Their performance and design are such, however, that Z.50s and Z.30 may be used in a far wider range of applications.

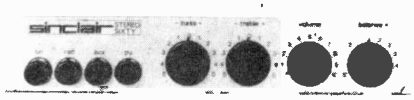


SPECIFICATIONS ***(Z.50 units are interchangeable with Z.30s in all applications).*** **— Power Outputs:**
Z.30 15 watts R.M.S. into 8 ohms using 35 volts : 20 watts R.M.S. into 3 ohms using 30 volts.
Z.50 40 watts R.M.S. into 3 ohms using 40 volts : 30 watts R.M.S. into 8 ohms using 50 volts.
Frequency response: 30 to 300,000Hz ± 1dB. **Distortion:** 0.02% into 8 ohms. **Signal to noise ratio:** better than 70dB unweighted. **Input sensitivity:** 250mV into 100 Kohms (for 15w into 8Ω). For speakers from 3 to 15 ohms impedance. **Size:** 14 x 80 x 57mm.

Stereo 60 Pre-amp/control unit

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

Designed specifically for use on Project 60 systems, the Stereo 60 is equally suitable for use with any high quality power amplifier. Since silicon epitaxial planar transistors are used throughout, a really high signal-to-noise ratio and excellent tracking between channels is achieved. Input selection is by means of press buttons, with accurate equalisation on all input channels. The Stereo 60 is particularly easy to mount.

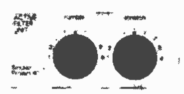


SPECIFICATIONS—Input sensitivities: Radio – up to 3mV. Mag. p.u. 3mV: correct to R.I.A.A. curve ±1dB: 20 to 25,000 Hz. Ceramic p.u. – up to 3mV: Aux – up to 3mV. **Output:** 250mV. **Signal to noise ratio:** better than 70dB. **Channel matching:** within 1dB. **Tone controls:** TREBLE +12 to —12dB at 10KHz: BASS +12 to —12dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.

A.F.U. High & Low Pass Filter Unit

Built, tested and guaranteed. **£5.98**

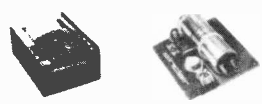
For use between Stereo 60 unit and two Z.30s or Z.50s. The unit is very easily mounted and is unique in that the cut-off frequencies are continuously variable. As attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. There are two filter sections – rumble (high pass) and scratch (low pass). H.F. cut-off (—3dB) variable from 28KHz to 5KHz. L.F. cut-off (—3dB) variable from 25Hz to 100Hz. Distortion at 1KHz (35V. supply) 0.02% at rated output. Operating voltage from 15 to 35V. Current 3mA. **Size:** 66 x 40 x 90mm.



Power Supply Units

Designed specifically for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ.6 or PZ.8 where a stabilised supply is essential.

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



Typical Project 60 applications

System	The Units to use	together with	Units cost
Simple battery record player	Z.30	Crystal P.U., 12V battery volume control, etc.	£4.48
Mains powered record player	Z.30, PZ.5	Crystal or ceramic P.U. volume control, etc.	£9.45
12W. RMS continuous sine wave stereo amp. for average needs	2 x Z.30s, Stereo 60; PZ.5	Crystal, ceramic or mag. P.U., F.M. Tuner, etc.	£23.90
25W. RMS continuous sine wave stereo amp. using low efficiency (high performance) speakers	2 x Z.30s, Stereo 60; PZ.6	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	£26.90
80W. (3 ohms) RMS continuous sine wave de luxe stereo amplifier. (60W. RMS into 8 ohms)	2 x Z.50s, Stereo 60; PZ.8, mains transformer	As above	£34.88
Indoor P.A.	Z.50, PZ.8, mains transformer	Mic., guitar, speakers, etc., controls	£19.43

F.M. Stereo Tuner **(£25)** & A.F.U. **(£5.98)** may be added as required.

Guarantee

If, within 3 months of purchasing any product direct from Sinclair Radionics Ltd., you are dissatisfied with it, your money will be refunded at once. Many Sinclair appointed Stockists also offer this same guarantee in co-operation with Sinclair Radionics Ltd.

Each Project 60 module is tested before leaving our factory and is guaranteed to work perfectly. Should any defect arise in normal use, we will service it at once and without any charge to you, if it is returned within two years from the date of purchase. Outside this period of guarantee a small charge (typically £1.00) will be made. No charge is made for postage by surface mail. Air Mail is charged at cost.

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I enclose cash/cheque/money order.

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Address ______________________ PE12 72

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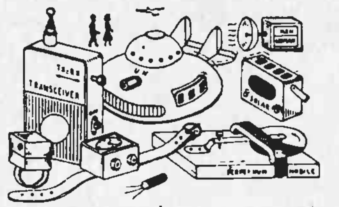

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L709C	DIL	0·33	0·31	0·27
L710C	TO5	0·47	0·42	0·37
L710C	DIL	0·45	0·40	0·35
L711C	TO5	0·49	0·44	0·39
L711C	DIL	0·45	0·40	0·35
L716	TO5	1·87	1·75	1·70
L723C	TO5	0·90	0·85	0·80
L739		1·95	—	—
L741C	TO5	0·40	0·38	0·34
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522	1·50
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SN7403	0·20	0·18	SN7426	0·32	0·28
SN7404	0·20	0·18	SN7427	0·48	0·42
SN7405	0·20	0·18	SN7428	0·50	0·41
SN7406	0·30	0·24	SN7430	0·20	0·18
SN7407	0·56	0·48	SN7432	0·48	0·42
SN7408	0·20	0·18	SN7433	0·71	0·62
SN7409	0·20	0·18	SN7437	0·52	0·45
SN7410	0·20	0·18	SN7438	0·52	0·45
SN7411	0·22	0·20	SN7439	0·52	0·45
SN7412	0·42	0·36	SN7440	0·20	0·18
SN7413	0·30	0·27	SN7441AN		
SN7416	0·45	0·40		0·75	0·72
SN7417	0·45	0·40	SN7442	0·79	0·68
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SN7452	0·20	0·18	SN74151	1·10	0·92
SN7453	0·20	0·18	SN74153	1·18	1·00
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SN7460	0·20	0·18	SN74155	1·55	1·35
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SN7472	0·30	0·25	SN74157	1·30	1·15
SN7473	0·40	0·34	SN74158	1·30	1·15
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SN7475	0·45	0·35	SN74161	2·60	2·50
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SN7480	0·75	0·70	SN74163	3·52	3·08
SN7481	1·25	1·07	SN74164	2·26	1·64
SN7482	0·87	0·61	SN74165	4·00	3·85
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SN7491	1·20	1·00	SN74178	1·80	1·55
SN7492	0·75	0·70	SN74179	1·80	1·55
SN7493	0·75	0·70	SN74180	1·37	1·20
SN7494	0·84	0·80	SN74181	6·50	6·15
SN7495	0·80	0·75	SN74182	1·48	1·34
SN7496	1·00	0·90	SN74190	1·95	1·75
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SN74100	2·20	2·05	SN74192	1·90	1·80
SN74104	1·52	1·33	SN74193	1·90	1·80
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SN74L04N	0·60	SN74L47N	2·15
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CA3004	2·26	1·86	CA3047	1·59	1·31
CA3005	1·50	1·24	CA3047A	2·92	2·41
CA3006	3·47	2·86	CA3048	2·34	1·93
CA3007	3·28	3·00	CA3049	1·96	1·62
CA3008	1·98	1·64	CA3050	2·28	1·88
CA3008A	3·24	2·67	CA4051	1·73	1·43
CA3010	0·56	0·47	CA4052	1·80	1·48
CA3010A	0·69	0·57	CA3053	0·52	0·43
CA3011	0·92	0·76	CA3054	1·19	0·98
CA3012	1·11	1·00	CA3058	3·32	2·74
CA3013	1·30	1·07	CA3059	1·84	1·52
CA3014	1·52	1·26	CA3060AD		
CA3015	1·40	1·15		3·47	2·86
CA3015A	1·82	1·50	CA3060BD		
CA3016	2·61	2·15		5·93	4·89
CA3016A	3·90	3·22	CA3060D	4·70	3·88
CA3018	0·88	0·72	CA3060E	2·74	2·26
CA3018A	1·19	0·98	CA3062	2·97	2·45
CA3019	0·94	0·78	CA3064	1·42	1·17
CA3020	1·55	1·28	CA3065	1·42	1·17
CA3020A	2·01	1·65	CA3066	2·61	2·15
CA3021	1·90	1·57	CA3067	2·72	2·24
CA3022	1·61	1·33	CA3068	3·01	2·48
CA3023	1·55	1·28	CA3070	2·15	1·78
CA3026	1·25	1·03	CA3071	2·01	1·65
CA3028A	0·88	0·72	CA3072	2·07	1·71
CA3028B	1·17	0·97	CA3075	1·46	1·21
CA3029	0·52	0·43	CA3076	1·67	1·38
CA3029A	0·63	0·52	CA3078AT	4·68	3·86
CA3030	1·08	0·89	CA3078T	2·80	2·31
CA3030A	1·64	1·35	CA3079	0·94	0·78
CA3033	2·92	2·41	CA3080	0·58	0·48
CA3033A	4·93	4·07	CA3080A	1·90	1·57
CA3035	1·22	1·09	CA3081	1·80	1·48
CA3035V1	1·52	1·26	CA3082	1·80	1·48
CA3036	0·72	0·64	CA3083	1·36	1·12
CA3037	1·68	1·39	CA3084	1·71	1·41
CA3037A	2·60	2·14	CA3085	0·94	0·78
CA3038	2·60	2·14	CA3085A	1·44	1·19
CA3038A	3·40	2·80	CA3085B	3·78	3·12
CA3039	1·00	0·91	CA3086	0·46	0·38
CA3040	2·95	2·43	CA3088E	1·70	1·51
CA3041	1·30	1·07	CA3089E	2·18	1·80
CA3042	1·30	1·07	CA3090Q	4·70	3·88
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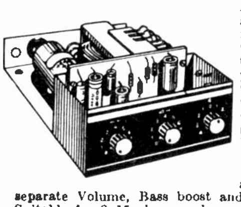
CA3044	1·42	1·17	CA3093E	1·36	1·12

SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13W r.m.s. into 8 ohm. Frequency response 12Hz—30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3in high × 6in wide × 7½in deep. A.C. 200/250V.

PRICE £10·50 P. & P. 25p.

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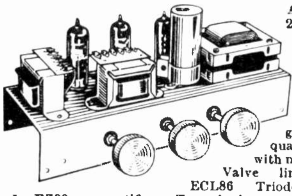

A.c. mains 200-240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble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

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200/240V A.C. input. Four switched fully smoothed D.C. outputs giving 6V and 7½V and 9V and 12V at 1 amp continuous (1½ amp intermittent).
Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case, overall size 6" × 3½" × 2½". Suitable for Transistor Radios, Tape Recorders, Amplifiers, etc., etc. Ready built and tested.

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

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12in "RA" TWIN CONE LOUDSPEAKER
10 watts peak handling. 3, 8 or 15 ohm, £2·20, P. & P. 30p.
35 ohm SPEAKERS 3". ONLY 63p. P. & P. 13p.

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Size 11½in × 14¾in × 1 3/16in deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz-20kHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only £5·75 each. P. & P. 25p.

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

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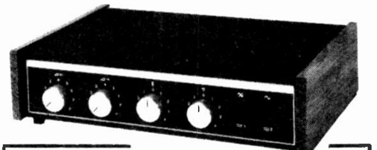
CENTRE ZERO MINIATURE MOVING COIL METER. 100μA for balance or tuning. Approx. size 1in × 1in × ¾in. Limited number 75p. P. & P 10p.

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



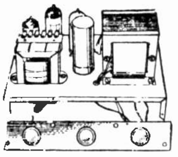
NEW FURTHER IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED FIBRE GLASS PRINTED CIRCUIT BOARD WITH COMPONENT IDENTIFICATION CLEARLY MARKED FOR EVEN EASIER CONSTRUCTION

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

PRICES AMPLIFIER KIT, **£10·50** P. & P. 15p.
(Magnetic input components 30p extra)
POWER PACK KIT, **£3** P. & P. 30p.
CABINET, **£3** P. & P 30p.

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

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



3-VALVE AUDIO AMPLIFIER HA34 MK II

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

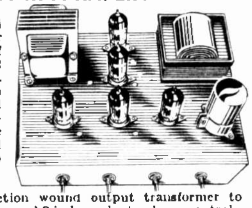
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £3·98. P. & P. 40p.

HARVERSON'S SUPER MONO AMPLIFIER

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

OUR ROCK BOTTOM BARGAIN PRICE **£2·75** P. & P. 35p

10/14 WATT HI-FI AMPLIFIER KIT



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

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THIS IS THE FIRST PAGE OF THE GREAT BI-PAK SECTION

BRAND NEW FULLY GUARANTEED DEVICES

AC107	0·20	AD162	0·38	BC148	0·10	BD137	0·45	BF188	0·40	OC19	0·35	2G371	0·16
AC113	0·20	AD161 &		BC149	0·12	BD138	0·50	BF194	0·12	OC20	0·63	2G371B	0·12
AC115	0·23	AD162 (MP)		BC150	0·18	BD139	0·55	BF195	0·12	OC22	0·38	2G373	0·17
AC117K	0·20		0·55	BC151	0·20	BD140	0·60	BF196	0·14	OC23	0·42	2G374	0·17
AC122	0·12	ADT140	0·50	BC152	0·17	BD155	0·80	BF197	0·14	OC24	0·56	2G377	0·30
AC125	0·17	AF114	0·24	BC153	0·28	BD175	0·60	BF200	0·45	OC25	0·38	2G378	0·16
AC126	0·17	AF115	0·24	BC154	0·30	BD176	0·60	BF222	0·95	OC26	0·25	2G381	0·16
AC127	0·17	AF116	0·24	BC157	0·18	BD177	0·65	BF257	0·45	OC28	0·50	2G382	0·16
AC128	0·17	AF117	0·24	BC158	0·12	BD178	0·65	BF258	0·60	OC29	0·50	2G401	0·30
AC132	0·14	AF118	0·35	BC159	0·12	BD179	0·70	BF259	0·85	OC35	0·42	2G414	0·30
AC134	0·14	AF124	0·30	BC160	0·45	BD180	0·70	BF262	0·55	OC36	0·50	2G417	0·25
AC137	0·14	AF125	0·25	BC161	0·50	BD185	0·65	BF263	0·55	OC41	0·20	2N388	0·35
AC141	0·14	AF126	0·28	BC167	0·12	BD186	0·65	BF270	0·35	OC42	0·24	2N388A	0·55
AC141K	0·17	AF127	0·28	BC168	0·12	BD187	0·70	BF271	0·30	OC44	0·15	2N404	0·20
AC142	0·14	AF139	0·30	BC169	0·12	BD188	0·70	BF272	0·80	OC45	0·12	2N404A	0·28
AC142K	0·17	AF178	0·50	BC170	0·12	BD189	0·75	BF273	0·35	OC70	0·10	2N524	0·42
AC151	0·15	AF179	0·50	BC171	0·14	BD190	0·75	BF274	0·35	OC71	0·10	2N527	0·49
AC154	0·20	AF180	0·50	BC172	0·14	BD195	0·85	BFW10	0·60	OC72	0·14	2N598	0·42
AC155	0·20	AF181	0·45	BC173	0·14	BD196	0·85	BFX29	0·27	OC74	0·14	2N599	0·45
AC156	0·20	AF186	0·45	BC174	0·14	BD197	0·90	BFX84	0·22	OC75	0·15	2N696	0·12
AC157	0·24	AF239	0·37	BC175	0·22	BD198	0·90	BFX85	0·30	OC76	0·15	2N697	0·13
AC165	0·20	AL102	0·65	BC177	0·19	BD199	0·95	BFX86	0·22	OC77	0·25	2N698	0·24
AC166	0·20	AL103	0·65	BC178	0·19	BD200	0·95	BFX87	0·24	OC81	0·15	2N699	0·35
AC167	0·20	ASY26	0·25	BC179	0·19	BD205	0·80	BFX88	0·22	OC81D	0·15	2N706	0·08
AC168	0·24	ASY27	0·30	BC180	0·24	BD206	0·80	BFY50	0·20	OC82	0·15	2N706A	0·09
AC169	0·14	ASY28	0·25	BC181	0·24	BD207	0·95	BFY51	0·20	OC82D	0·15	2N708	0·12
AC176	0·20	ASY29	0·25	BC182	0·10	BD208	0·95	BFY52	0·20	OC83	0·20	2N711	0·30
AC177	0·24	ASY50	0·25	BC182L	0·10	BDY20	1·00	BFY53	0·17	OC84	0·20	2N717	0·35
AC178	0·28	ASY51	0·25	BC183	0·10	BF115	0·24	BPX25	0·85	OC139	0·20	2N718	0·24
AC179	0·28	ASY52	0·25	BC183L	0·10	BF117	0·45	BSX19	0·15	OC140	0·20	2N718A	0·50
AC180	0·17	ASY54	0·25	BC184	0·12	BF118	0·70	BSX20	0·15	OC169	0·25	2N726	0·28
AC180K	0·20	ASY55	0·25	BC184L	0 12	BF119	0·70	BSY25	0·15	OC170	0·25	2N727	0·28
AC181	0·17	ASY56	0·25	BC186	0·28	BF121	0·45	BSY26	0·15	OC171	0·25	2N743	0·20
AC181K	0·20	ASY57	0·25	BC187	0·28	BF123	0·50	BSY27	0·15	OC200	0·25	2N744	0·20
AC187	0·22	ASY58	0·25	BC207	0·11	BF125	0·45	BSY28	0·15	OC201	0·28	2N914	0·14
AC187K	0·20	ASZ21	0·40	BC208	0·11	BF127	0·50	BSY29	0·15	OC202	0·28	2N918	0·30
AC188	0·22	BC107	0·09	BC209	0·12	BF152	0·55	BSY38	0·18	OC203	0·25	2N929	0·21
AC188K	0·20	BC108	0·09	BC212L	0·11	BF153	0·45	BSY39	0·18	OC204	0·25	2N930	0·21
ACY17	0·25	BC109	0·10	BC213L	0·11	BF154	0·45	BSY40	0·28	OC205	0·35	2N1131	0·20
ACY18	0·20	BC113	0·10	BC214L	0·14	BF155	0·70	BSY41	0·28	OC309	0·40	2N1132	0·22
ACY19	0·20	BC114	0·15	BC225	0·25	BF156	0·48	BSY95	0·12	P346A	0·20	2N1302	0·14
ACY20	0·20	BC115	0·15	BC226	0·35	BF157	0·55	BSY95A	0·12	P397	0·42	2N1303	0·14
ACY21	0·20	BC116	0·15	BCY30	0·24	BF158	0·55	Bu105	2·00	OCP71	0·43	2N1304	0·17
ACY22	0·16	BC117	0·15	BCY31	0·26	BF159	0·60	C111E	0·50	ORP12	0·43	2N1305	0·17
ACY27	0·18	BC118	0·10	BCY32	0·30	BF160	0·40	C400	0·30	ORP60	0·40	2N1306	0·21
ACY28	0·19	BC119	0·30	BCY33	0·22	BF162	0·40	C407	0·25	ORP61	0·40	2N1307	0·21
ACY29	0·35	BC120	0·80	BCY34	0·25	BF163	0·40	C424	0·20	ST140	0·12	2N1308	0·23
ACY30	0·28	BC125	0·12	BCY70	0·14	BF164	0·40	C425	0·50	ST141	0·17	2N1309	0·23
ACY31	0·28	BC126	0·18	BCY71	0·18	BF165	0·40	C426	0·35	TIS43	0·30	2N1613	0·20
ACY34	0·21	BC132	0·12	BCY72	0·14	BF167	0·22	C428	0·20	UT46	0·27	2N1711	0·20
ACY35	0·21	BC134	0·18	BCZ10	0·20	BF173	0·22	C441	0·30	2G301	0·09	2N1889	0·32
ACY36	0·28	BC135	0·12	BCZ11	0·25	BF176	0·35	C442	0·30	2G302	0·19	2N1890	0·45
ACY40	0·17	BC136	0·15	BCZ12	0·25	BF177	0·35	C444	0·35	2G303	0·19	2N1893	0·37
ACY41	0·18	BC137	0·15	BD121	0·60	BF178	0·30	C450	0·22	2G304	0·24	2N2147	0·72
ACY44	0·35	BC139	0·40	BD123	0·65	BF179	0·30	MAT100	0·19	2G306	0·40	2N2148	0·57
AD130	0·38	BC140	0·30	BD124	0·60	BF180	0·30	MAT101	0·20	2G308	0·35	2N2160	0·60
AD140	0·48	BC141	0·30	BD131	0·50	BF181	0·30	MAT120	0·19	2G309	0·35	2N2192	0·35
AD142	0·48	BC142	0·30	BD132	0·60	BF182	0·40	MAT121	0·20	2G339	0·20	2N2193	0·35
AD143	0·38	BC143	0·30	BD133	0·65	BF183	0·40	MPF102	0·42	2G339A	0·16	2N2194	0·35
AD149	0·50	BC145	0·45	BD135	0·40	BF184	0·25	MPF104	0·37	2G344	0·18	2N2217	0·22
AD161	0·33	BC147	0·10	BD136	0·40	BF185	0·30	MPF105	0·37	2G345	0·16	2N2218	0·20

2N2219	0·20	2N3054	0·46	2N4059	0·10
2N2220	0·22	2N3055	0·50	2N4060	0·12
2N2221	0·20	2N3391	0·14	2N4061	0·12
2N2222	0·20	2N3391A	0·16	2N4062	0·12
2N2368	0·17	2N3392	0·14	2N4284	0·17
2N2369	0·14	2N3393	0·14	2N4285	0·17
2N2369A	0·14	2N3394	0·14	2N4286	0·17
2N2411	0·24	2N3395	0·17	2N4287	0·17
2N2412	0·24	2N3402	0·21	2N4288	0·17
2N2646	0·47	2N3403	0·21	2N4289	0·17
2N2711	0·21	2N3404	0·28	2N4290	0·17
2N2712	0·21	2N3405	0·42	2N4291	0·17
2N2714	0·21	2N3414	0·15	2N4292	0·17
2N2904	0·17	2N3415	0·15	2N4293	0·17
2N2904A	0·21	2N3416	0·28	2N5172	0·12
2N2905	0·21	2N3417	0·28	2N5457	0·32
2N2905A	0·21	2N3525	0·75	2N5458	0·32
2N2906	0·15	2N3646	0·09	2N5459	0·40
2N2906A	0·18	2N3702	0·10	2S301	0·50
2N2907	0·20	2N3703	0·10	2S302A	0·42
2N2907A	0·22	2N3704	0·11	2S302	0·42
2N2923	0·14	2N3705	0·10	2S303	0·55
2N2924	0·14	2N3706	0·09	2S304	0·70
2N2925	0·14	2N3707	0·11	2S305	0·84
2N2926 (G)		2N3708	0·07	2S306	0·84
	0·12	2N3709	0·09	2S307	0·84
2N2926 (Y)		2N3710	0·09	2S321	0·56
	0·11	2N3711	0·09	2S322	0·42
2N2926 (O)		2N3819	0·28	2S322A	0·42
	0·10	2N3820	0·50	2S323	0·56
2N2926 (R)		2N3821	0·35	2S324	0·70
	0·10	2N3823	0·28	2S325	0·70
2N2926 (B)		2N3903	0·28	2S326	0·70
	0·10	2N3904	0·30	2S327	0·70
2N3010	0·70	2N3905	0·28	2S701	0·42
2N3011	0·14	2N3906	0·27	40361	0·40
2N3053	0·17	2N4058	0·12	40362	0·45

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AAZ13	0·10	BYZ10	0·35	OA81	0·07
BA100	0·10	BYZ11	0·30	OA85	0·09
BA116	0·21	BYZ12	0·30	OA90	0·06
BA126	0·22	BYZ13	0·25	OA91	0·06
BA148	0·14	BYZ16	0·40	OA95	0·07
BA154	0·12	BYZ17	0·35	OA200	0·06
BA155	0·14	BYZ18	0·35	OA202	0·07
BA156	0·13	BYZ19	0·28	SD10	0·05
BY100	0·15	CG62		SD19	0·05
BY101	0·12	(Eg) OA91		IN34	0·07
BY105	0·17		0·05	1N34A	0·07
BY114	0·12	CG651		1N914	0·06
BY126	0·14	(Eq) OA70-		1N916	0·06
BY127	0·15	OA79	0·06	IN414B	0·06
BY128	0·15	OA5	0·35	IS021	0·10
BY130	0·16	OA5SL	0·21	IS951	0·06

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C16	20	Assorted Tag Strips & Panels	0·50
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C19	3	Relays 6—24V Operating	0·50
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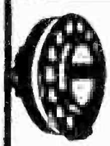

BRAND NEW POST OFFICE TYPE TELE-PHONE DIALS ONLY 75p each

THE NEW S.G.S. EA 1000 AUDIO AMP MODULE **Guarantee*

3 Watts R.M.S. ONLY £2·63 each

Modual Tested and Guaranteed. Qty. 1—9 £2·63; 10—25 £2·28 Price each. Larger quantities quoted on request. Full hook-up diagrams and complete technical data supplied free with each modual or available separately at 10p each.

SYSTEM 12 STEREO

Each Kit contains two Amplifier Modules, 3 watts RMS, two loudspeakers, 15 ohms, the pre-amplifier, transformer, power supply module, front panel and other accessories, as well as an illustrated stage-by-stage instruction booklet designed for the beginner.
Further details available on request.

ONLY £16·95 FREE P. & P.

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BI-PAK STILL LOWEST IN PRICE. FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURERS

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SN7403	0·15	0·14	0·12
SN7404	0·15	0·14	0·12
SN7405	0·15	0·14	0·12
SN7406	0·35	0·31	0·28
SN7407	0·35	0·31	0·28
SN7408	0·18	0·17	0·16
SN7409	0·18	0·17	0·16
SN7410	0·15	0·14	0·12
SN7411	0·25	0·24	0·23
SN7412	0·35	0·31	0·28
SN7413	0·29	0·26	0·24
SN7416	0·43	0·40	0·30
SN7417	0·43	0·40	0·38
SN7420	0·15	0·14	0·12
SN7422	0·50	0·48	0·45
SN7423	0·50	0·48	0·45
SN7425	0·50	0·48	0·45
SN7427	0·45	0·42	0·40
SN7428	0·70	0·65	0·60
SN7430	0·15	0·14	0·12
SN7432	0·45	0·42	0·40
SN7433	0·80	0·75	0·70
SN7437	0·64	0·62	0·60
SN7438	0·64	0·62	0·60
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SN7441	0·67	0·64	0·58
SN7442	0·67	0·64	0·58
SN7443	£1·30	£1·25	£1·20
SN7444	£1·30	£1·25	£1·20
SN7445	£1·80	£1·77	£1·75
SN7446	0·97	0·94	0·88
SN7447	£1·00	0·97	0·95
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SN7453	0·15	0·14	0·12
SN7454	0·15	0·14	0·12
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SN7470	0·29	0·26	0·24
SN7472	0·29	0·26	0·24
SN7473	0·37	0·35	0·32
SN7474	0·37	0·35	0·32
SN7475	0·45	0·43	0·42
SN7476	0·40	0·39	0·38
SN7480	0·67	0·64	0·58
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SN7482	0·87	0·86	0·85
SN7483	£1·10	£1·05	0·95
SN7484	£1·00	0·95	0·90
SN7485	£3·60	£3·50	£3·40
SN7486	0·32	0·31	0·30
SN7489	£5·50	£5·25	£5·00
SN7490	0·67	0·64	0·58
SN7491	£1·00	0·95	0·90
SN7492	0·67	0·64	0·58
SN7493	0·67	0·64	0·58
SN7494	0·77	0·74	0·60
SN7495	0·77	0·74	0·60
SN7496	0·87	0·84	0·78
SN74100	£1·65	£1·60	£1·55
SN74104	0·97	0·94	0·88
SN74105	0·97	0·94	0·88
SN74107	0·40	0·38	0·36
SN74110	0·55	0·53	0·50
SN74111	£1·25	£1·15	£1·10
SN74118	£1·00	0·95	0·90
SN74119	£1·35	£1·25	£1·10
SN74121	0·40	0·37	0·34
SN74122	£1·40	£1·30	£1·10
SN74123	£2·80	£2·70	£2·60
SN74141	0·67	0·64	0·53
SN74145	£1·50	£1·40	£1·30
SN74150	£3·00	£2·70	£2·50
SN74151	£1·00	0·95	0·90
SN74153	£1·20	£1·10	0·95
SN74154	£1·80	£1·70	£1·60
SN74155	£1·40	£1·30	£1·20
SN74156	£1·40	£1·30	£1·20
SN74157	£1·90	£1·80	£1·70
SN74160	£1·80	£1·70	£1·60
SN74161	£1·80	£1·70	£1·60
SN74162	£4·00	£3·75	£3·50
SN74163	£4·00	£3·75	£3·50
SN74164	£2·20	£2·15	£2·10
SN74165	£2·25	£2·20	£2·15
SN74166	£3·50	£3·25	£3·00
SN74174	£2·30	£2·20	£2·10
SN74175	£1·60	£1·50	£1·40
SN74176	£2·50	£2·40	£2·30
SN74177	£2·50	£2·40	£2·30
SN74180	£2·00	£1·60	£1·40
SN74181	£5·50	£5·00	£4·75
SN74182	£2·00	£1·80	£1·60
SN74184	£3·50	£3·25	£3·00
SN74190	£1·95	£1·90	£1·85
SN74191	£1·90	£1·85	£1·80
SN74192	£1·95	£1·90	£1·85
SN74193	£2·00	£1·80	£1·75
SN74194	£2·70	£2·60	£2·50
SN74195	£2·00	£1·90	£1·80
SN74196	£1·80	£1·70	£1·60
SN74197	£1·80	£1·70	£1·60
SN74198	£5·50	£5·00	£4·50
SN74199	£5·50	£5·00	£4·50

LINEAR I.C.'s—FULL SPEC.

Type No.	Price 1–24	25–99	100 up
BP201C—SL201C	68p	58p	45p
BP701C—SL701C	68p	50p	45p
BP702C—SL702C	68p	50p	45p
BP702—72702	53p	45p	40p
BP709—72709	36p	34p	30p
BP709P—μA709C	36p	34p	30p
BP710—72710	44p	42p	40p
BP711—μA711	45p	43p	40p
BP741—72741	75p	60p	50p
μA703C—μA703C	28p	26p	24p
TAA263—	70p	60p	55p
TAA293—	90p	75p	70p
TAA350	170p	158p	150p
S.G.S. EA1000 2·63			

ROCK BOTTOM PRICES
LOGIC DTL 930 Series I.C's

Type No.	Price 1–24	25–99	100 up
BP930	12p	11p	10p
BP932	13p	12p	11p
BP933	13p	12p	11p
BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
BP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9093	40p	38p	35p
BP9094	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

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

NUMERICAL INDICATOR TUBES

MODEL	CD66	GR116	3015F Minitron
Anode voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2·5	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41 or 141	BP41 or 141	BP47
PRICE EACH	£1·70	£1·55	£1·90

All indicators 0·9 + Decimal point. All side viewing. Full data for all types available on request.

RTL MICROLOGIC CIRCUITS

Epoxy TO-5 case	Price each 1–24	25–99	100 up
uL900 Buffer	35p	33p	27p
uL914 Dual 2i/p gate	35p	33p	27p
uL923 J-K flip-flop	50p	47p	45p

Data and Circuits Booklet for IC's Price 7p.

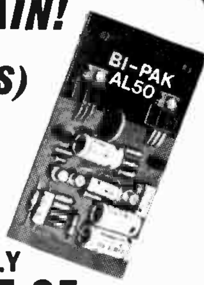
DUAL IN LINE SOCKETS.
14 & 16 Lead Sockets for use with

DUAL-IN-LINE I.C's. TWO Ranges PROFESSIONAL & NEW LOW COST.

PROF. TYPE No.	1–24	25–99	100up.
TSO 14 pin type	30p	27p	25p
TSO 16 ,, ,,	35p	32p	30p
LOW COST No.			
BPS 14	15p	13p	11p
BPS 16	16p	14p	12p

BI-PAK DO IT AGAIN!

50W pk 25w (RMS)



0·1% DISTORTION!
HI-FI AUDIO AMPLIFIER

THE AL50

★ Frequency Response 15Hz to 100,000—1dB.

★ Load—3, 4, 8 or 16 ohms.

★ Distortion—better than ·1% at 1KHz.

★ Signal to noise ratio 80dB.

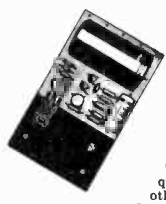
ONLY £3.25p each

★ Supply voltage 10–35 Volts.

★ Overall size 63mm × 105mm × 13mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and AL50 was conceived to fill the need for all your A.F. amplification needs.
FULLY BUILT — TESTED — GUARANTEED.

STABILISED POWER MODULE SPM80

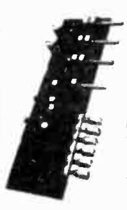


AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available, 10p **PRICE £2·95**

TRANSFORMER BMT80 £1·95 p. & p. 25p.

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.



SPECIFICATION

Frequency Response	20Hz – 20KHz ± 1dB
Harmonic Distortion	better than 0·1%
Inputs : 1. Tape Head	1·25 mV into 50K Ω
2. Radio, Tuner	35 mV into 50K Ω
3. Magnetic P.U.	1·5 mV into 50K Ω

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.

Bass Control	± 15dB at 20Hz
Treble Control	± 15dB at 20KHz
Filters : Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than – 65dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm × 82mm × 35mm

ONLY £11·95

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £23·00 FREE p. & p.

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KEMPSTON HARDWICK
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Catalogue which contains data sheets for most of the components listed will be sent free on request. 10p stamp appreciated.

OPEN ALL DAY SATURDAYS

RESISTORS
¼W Iskra high stability carbon film—very low noise—capless construction.
½W Mullard CR25 carbon film—very small body size 7·5 x 2·5mm.
2% ELECTROSIL TR5

Power watts	Tolerance	Range	Values available	Price 1–99	Price 100+
½	5%	4·7Ω–2·2MΩ	E24	1p	0·8p
½	10%	3·3MΩ–10MΩ	E12	1p	0·8p
¼	2%	10Ω–1MΩ	E24	3·5p	3p
¼	10%	1Ω– 3·9Ω	E12	1p	0·8p
½	5%	4·7Ω–1MΩ	E12	1p	0·8p
4	10%	1Ω–10Ω	E12	6p	5·5p

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

DEVELOPMENT PACK
0·5 watt 5% Iskra resistors 5 off each value 4·7Ω to 1MΩ.
E12 pack 325 resistors £2·40. E24 pack 650 resistors £4·70.

POTENTIOMETERS
Carbon track 5kΩ to 2MΩ, log or linear (log ¼W, lin ½W).
Single, **12p.** Dual gang (stereo), **40p.** Single D.P. switch **24p.**

SKELETON PRESET POTENTIOMETERS
Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, **5p** each. Miniature 0·25W, **6p** each.

TRANSISTORS

AC107	15p	BC108	10p	BFY51	22p	OCP71	40p	2N3703	12p
AC126	12p	BC109	10p	BFY52	22p	ORP12	50p	2N3704	13p
AC127	12p	BC147	10p	BSY 56	32p	2N2369	16p	2N3705	12p
AC128	12p	BC148	13p	OC26	45p	2N2646	60p	2N3706	11p
AC131	12p	BC149	13p	OC28	45p	2N2926R	9p	2N3707	12p
AC132	12p	BC157	13p	OC35	45p	2N2926O	9p	2N3708	10p
AD140	50p	BC158	13p	OC42	12p	2N2926V	9p	2N3709	11p
AD161	33p	BC159	13p	OC44	12p	2N2926G	10p	2N3710	11p
AD162	36p	BD131	75p	OC45	12p			2N3711	11p
AF114	20p	BD132	75p	OC70	12p	2N3054	58p	2N4062	12p
AF115	20p	BF179	32p	OC71	12p	2N3055	60p	ZTX302	15p
AF116	20p	BF181	25p	OC72	12p	2N3442	140p	ZTX500	16p
AF117	20p	BF194	15p	OC81	12p			ZTX503	16p
AF118	38p	BF195	15p						
BC107	10p	BFY50	22p	OC82D	12p	2N3702	13p	40362	58p

ZENER DIODES
400mW 5% 3·3V to 30V, **15p.**

LINEAR I.C.'s (D.I.L.)
709 **50p** 741, **50p**
710 **50p** 748, **50p**

DIL Socket 14 and 16 pin. **16p**

DIODES

RECTIFIER				SIGNAL	
BY127	1250V	1A	12p	OA85	7p
BZV10	800V	6A	25p	OA90	5p
BZY13	200V	6A	20p	OA91	5p
IN4001	50V	1A	7p	OA202	7p
IN4004	400V	1A	8p	IN4148	5p
IN4007	1000V	1A	12p	BA114	8p

BRUSHED ALUMINIUM PANELS
12in x 6in = **25p**; 12in x 2½in = **10p**; 9in x 2in = **7p.**

SLIDER POTENTIOMETERS
86mm x 9mm x 16mm, length of track 59mm
SINGLE 10kΩ, 25kΩ, 50kΩ, 100kΩ, log or lin **40p**
DUAL GANG 10kΩ + 10kΩ, etc, log or lin **60p**
Knob for above **12p**
FRONT PANEL **65p**
20 gauge panel 12in × 4in with slots cut for use with slider pots.
Grey or matt black finish, complete with fixings for 4 pots.

MULLARD POLYESTER CAPACITORS C296 SERIES
400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, **2½p.** 0·0068μF, 0·01μF, 0·015μF, 0·022μF, 0·033μF, **3p.** 0·047μF, 0·068μF, 0·1μF, **4p.** 0·15μF, **6p.** 0·22μF, **7½p.** 0·33μF, **11p.** 0·47μF, **13p.**
160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, **3p.** 0·1μF **3½p.** 0·15μF **4½p.** 0·22μF, **5p.** 0·33μF, **6p.** 0·47μF, **7½p.** 0·68μF, **11p.** 1·0μF, **13p.**

MULLARD POLYESTER CAPACITORS C280 SERIES
250V P.C. mounting: 0·01μF, 0·015μF, 0·022μF, **3p.** 0·033μF, 0·047μF, 0·068μF, **3½p.** 0·1μF, **4p.** 0·15μF, 0·22μF, **5p.** 0·33μF, **6½p.** 0·47μF, **8½p.** 0·68μF, **11p.** 1·0μF, **13p.** 1·5μF, **20p.** 2·2μF, **24p.**

MYLAR FILM CAPACITORS 100V
0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF, **2½p.** 0·04μF, 0·05μF, 0·068μF, 0·1μF, **3½p.**

CERAMIC DISC CAPACITORS
100pF to 10,000pF, **2p** each.

ELECTROLYTIC CAPACITORS—MULLARD C426 SERIES **6p each.**
(μF/V) 10/2·5, 40/2·5, 80/2·5, 160/2·5, 320/2·5, 500/2·5, 8/4, 32/4, 64/4, 125/4, 250/4, 400/4, 6·4/6·4, 25/6·4, 50/6·4, 100/6·4, 200/6·4, 320/6·4, 4/10, 16/10, 32/10, 64/10, 125/10, 200/10, 2·5/16, 10/16, 20/16, 40/16, 80/16, 125/16, 1·6/25, 6·4/25, 12·5/25, 25/25, 50/25, 80/25, 1/40, 4/40, 8/40, 16/40, 32/40, 50/40, 0·64/64, 2·5/64, 5/64, 10/64, 20/64, 32/64.

MULLARD C437 SERIES
100/40, 160/25, 250/16, 400/10, 640/6·4, 800/4, 1000/2·5, **9p.** 100/64, 160/40, 250/25, 400/16, 640/10, 1250/4, 1000/6·4, 1600/2·5, **12p.** 160/64, 250/40, 400/2·5, 640/16, 2000/4, 1000/10, 1600/6·4, 2500/2·5, **15p.** 250/64, 400/40, 640/25, 3200/4, 1000/16, 1600/10, 2500/6·4, 4000/2.5, **18p.**

ELECTROLYTIC CAPACITORS Miniature P.C. mounting **5p each.**
(μF/V): 10/12, 50/12, 100/12, 200/12, 5/25, 10/25, 25/25, 100/25.

VEROBOARD

	0·1	0·15
2½ × 3¾	22p	16p
2½ × 5	24p	24p
3¾ × 3¾	24p	24p
3¾ × 5	27p	27p
17 × 2½	75p	57½p
17 × 3¾	100p	78p
17 × 5 (plain)	—	82p
17 × 3¾ (plain)	—	60p
17 × 2½ (plain)	—	42p
2½ × 5 (plain)	—	12p
2½ × 3¾ (plain)	—	11p
Pin insertion tool	52p	52p
Spot face cutter	42p	42p
Pkt. 50 pins	20p	20p

JACK PLUGS AND SOCKETS

Standard screened	18p	2·5mm insulated	8p
Standard insulated	12p	3·5mm insulated	8p
Stereo screened	35p	3·5mm screened	13p
Standard socket	15p	2·5mm socket	8p
Stereo socket	18p	3·5mm socket	8p

D.I.N. PLUGS AND SOCKETS
2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p. Socket 8p.
4 way screened cable, **15p**/metre.
6 way screened cable **22p**/metre.

BATTERY ELIMINATOR **£1·50**
9V mains power supply. Same size as PP9 battery.

THERMISTORS
VA1055S **15p**; VA1066S **15p**; VA1077 **15p**; R53 **£1·35.**

COMPACT CASSETTES—IN PLASTIC LIBRARY BOX
C90 **65p** C120 **85p.**

LARGE (CAN) ELECTROLYTICS

1600μF	64V	74p	3200μF	16V	50p
2500μF	40V	74p	4500μF	16V	50p
2500μF	50V	58p	4500μF	25V	£1·68
2500μF	64V	80p	5000μF	50V	£1·10
2800μF	100V	£3·00			

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLT

0·01μF	10p	0·047μF	13p	0·22μF	20p
0·022μF	12p	0·1μF	13p	0·47μF	22p

POLYSTYRENE CAPACITORS 160V 2½%
10pF to 1,000pF E12 Series Values **4p each.**

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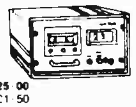

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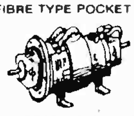

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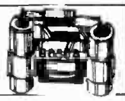
GEC 4 pole c/o 24V 670 ohm. GEC 2 pole on/off 24V 670 ohm. GEC 2 pole c/o 65V 5.000 ohm. STC 2 pole c/o 12V 170 ohm.
Price each 75p. P. & P. 10p.



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NKT450	30p	NKT16229	27p	NKT121	21p	NKT224	22p
NKT603	22p	NKT20329	29p	NKT124	28p	NKT227	25p
NKT613F	28p	NKT80111	65p	NKT125	38p	NKT237	29p
NKT674	30p	NKT80113	98p	NKT126	35p	NKT238	18p
NKT677	18p	NKT80125	80p	NKT127	23p	NKT249	29p
NKT713	27p	BC107	8p	NKT128	18p	NKT261	19p
NKT734	24p	BC108	8p	NKT129	22p	NKT270	18p
NKT736	30p	BCY70	13p	NKT135	24p	NKT271	16p
NKT773	23p	BFY51	17p	NKT137	30p	NKT272	15p
NKT0216	20p	BSY95A	10p	NKT142	48p	NKT273	18p
NKT3055	23p	2N697	13p	NKT143	48p	NKT274	16p
NKT6917	27p	2N706	8p	NKT212	23p	NKT275	21p
NKT10339	23p	2N914	15p	NKT213	23p	NKT278	18p
NKT10419	17p	2N918	28p	NKT214	21p	NKT301	70p
NKT10439	25p	2N930	22p	NKT215	19p	NKT302	85p
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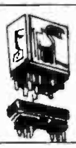

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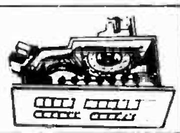
11301D	Single Pole C/O	18V d.c.	875 ohm	£0·40

UNISELECTOR SWITCHES



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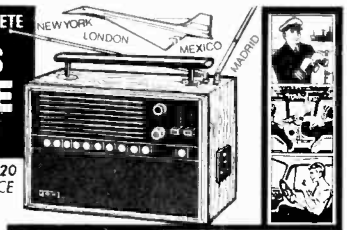

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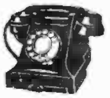

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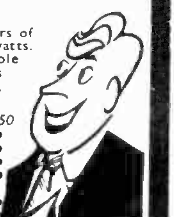

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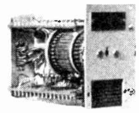

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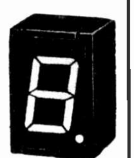

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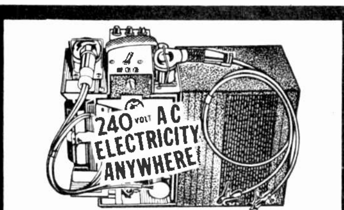

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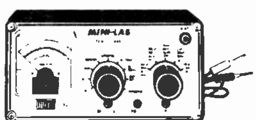

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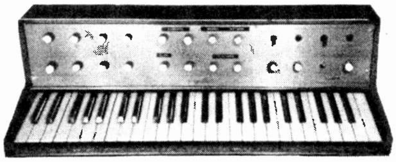

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