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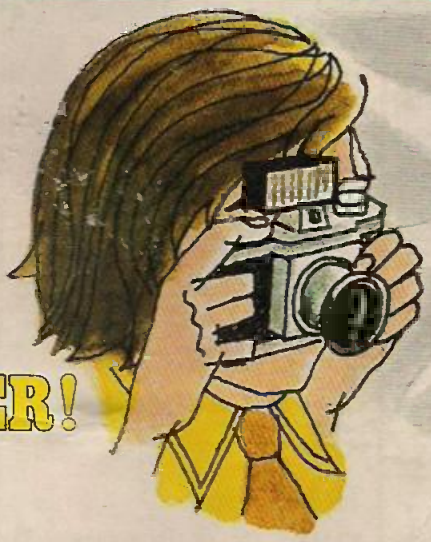

SLAVE FLASH

Easy-to-build unit allows a second flash gun to be automatically fired

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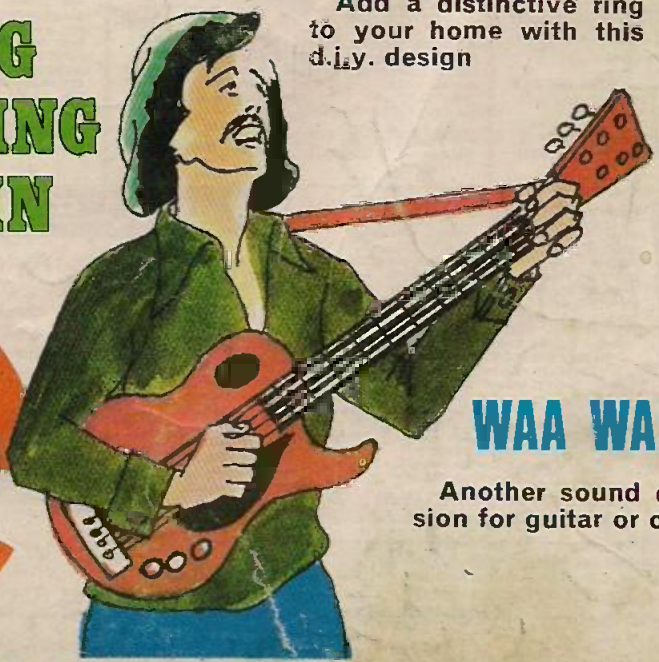
Add a distinctive ring to your home with this d.i.y. design



WAA WAA

Another sound dimension for guitar or organ

Build yourself a TRANSISTOR RADIO

WITH AFTER SALES SERVICE

ROAMER 10 WITH VHF INCLUDING AIRCRAFT

10 TRANSISTORS. 9 TUNABLE WAVEBANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER BAND. VHF AND LOCAL STATIONS ALSO AIRCRAFT BAND

Built in Ferrite Rod Aerial for MW/LW. Retractable, chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600mw Transistors. Car Aerial and Tape Record Sockets. 10 Transistors plus 3 Diodes. Fine tone moving coil speaker. Ganged Tuning Condenser with VHF section. Separate coil for Aircraft Band. Volume on/off. Wave Change and tone Control. Attractive Case in black with silver blocking. Size 9" × 7" × 4". Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts).

Total building cost

£9·35

P. P. & Ins. 52p

(Overseas P. & P. £1·05)

ROAMER EIGHT Mk I

NOW WITH VARIABLE TONE CONTROL

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mW transistors. Car aerial and Tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold-blocking. Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

Total building cost (Overseas P. & P. £1·05) **£7·68** P. P. & Ins. 47p.

ROAMER SEVEN MK IV

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for MW and LW. Retractable 4 section 24in. chrome plated telescopic aerial for SW. Socket for Car Aerial. Powerful push-pull output. 7 transistors and 2 diodes, fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning and wave change controls. Attractive case with carrying handle Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

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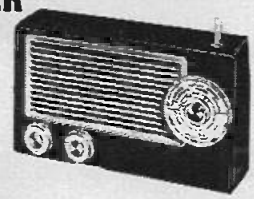
ROAMER SIX



6 Tunable Wavebands: MW, LW, SW1, SW2, SW3 Trawler band plus an extra Medium waveband for easier tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Plans and parts price list 25p (FREE with parts).

Total building costs (Overseas P. & P. £1·05) **£4·38** P. P. & Ins. 31p

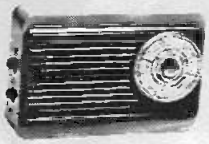
POCKET FIVE

3 Tunable Wavebands: MW, LW, Trawler Band with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5½ × 1½ × 2½in. Plans and parts price list 15p (FREE with parts).

Total building costs (Overseas P. & P. 65p) **£2·50** P. P. & Ins.24p

TRANSONA FIVE

5 TRANSISTORS AND 2 DIODES



3 Tunable Wavebands: MW, LW and Trawler Band. 7 stage—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6½ × 4½ × 1½in. Plans and parts price list 15p (FREE with parts).

Total building costs (Overseas P. & P. 65p) **£2·75** P. P. & Ins. 25p

TRANS EIGHT

8 TRANSISTORS and 3 DIODES

8 Tunable Wavebands: MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 3in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).

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ROAMER EIGHT	☐	TRANS EIGHT	☐
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Parts price list and plans for .....

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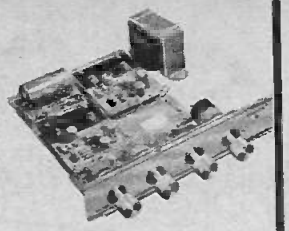
QUALITY STEREO AT BUDGET PRICES!

The STEREO 20



The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5·5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet.

Output power 20w peak
Freq. res. 25Hz-25kHz
Harmonic distortion typically 0·25% at 1 watt
Input 1 (Cer.) 300mV into 1M
Input 2(Aux.) 4mV into 30K
Bass control ±12dB at 60Hz
Treble con. ±14dB at 14 kHz

£13·48 free p. & p.

STABILISED POWER MODULE SPM80 £3·25

AP80 especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. Embodies latest circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, will provide outputs of up to 1·5 amps at 35 volts. Size: 63 mm x 105 mm x 20 mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available. 10p.

TRANSFORMER BMT80 **£2·15** p. & p. 27p.

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50W pk 25 (RMS)

0·1% DISTORTION

- Frequency Response 15Hz to 100,000—1dB.
- Load—3, 4, 8 or 16 ohms.
- Supply voltage 10–35 Volts.
- Distortion—better than 0·1% at 1kHz
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- Overall size 63 mm x 105 mm x 13 mm.

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STEREO PRE-AMPLIFIER TYPE PA100

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SPECIFICATION:

Frequency response	20Hz—20kHz ±1dB	Bass control	±15dB at 20Hz
Harmonic distortion	better than 0·1%	Treble control	±15dB at 20kHz
Inputs: 1. Tape head	1·25mV into 50kΩ	Filters: Rumble (high pass)	100Hz
2. Radio, Tuner	35mV into 50kΩ	Scratch (low pass)	8kHz
3. Magnetic P.U.	1·5mV into 50KΩ	Signal/noise ratio	better than +65dB
All input voltages are for an output of 250mV.		Input overload	+26dB
Tape and P.U. inputs equalised to RIAA curve within ±1dB from 20Hz to 20kHz.		Supply	+35 volts at 20mA
		Dimensions	292 x 82 x 35 mm.

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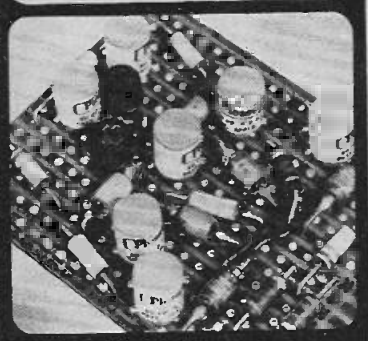

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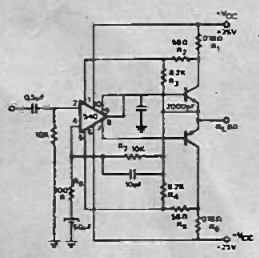
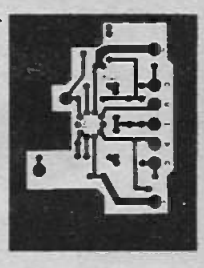
Device of the Month NE540L





35 Watt Amplifier
The Signetics 540 is a monolithic, class AB power audio amplifier designed specifically to drive a pair of complementary output transistors.

This device features: internal current limiting; low standby current; high output current capability; wide power bandwidth; low distortion – features which make this device ideal for use as an audio power amplifier.

Signetics power driver NE540L
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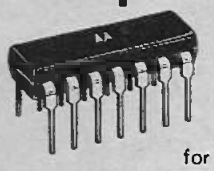

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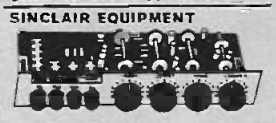

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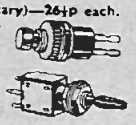

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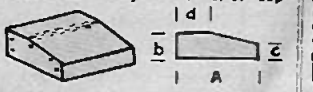
GB21	10	9	3½	2	3	£1·74	33p
GB22	12	9	3½	2	3	£1·89	33p



CAR-CASSETTE VOLTAGE STABILISERS

PU12 for Philips and similar cassette recorders. Gives 7½V stabilised output when connected to 12V + or— E car circuit. Fitted with 5 pin, 240° plug, £3·55 plus 16p P. & P.

PU126, as above, but for 6V recorders. Fitted with coaxial power connector, £3·55, plus 16p P. & P.

MAINS POWER SUPPLY

PP75 for Philips and similar cassette recorders. Input 240V a.c.; output 7½V d.c. Fitted with 5 pin, 240° plug, £2·15, plus 16p P. & P.

ALUMINIUM BOXES

with lids and screws

Type	L. in	W. in	D. in	Price	P. & P.
GB7*	5¼in	2¾in	1¼in	42p	16p
GB8*	4in	4in	1¼in	42p	16p
GB9*	4in	2¾in	1¼in	42p	14p
GB10*	5¼in	4in	1¼in	49p	19p
GB11	4in	2¼in	2in	42p	14p
GB12	3in	2in	1in	36p	15p
GB13	6in	4in	2in	57p	20p
GB14	7in	5in	2¼in	69p	21p
GB15	8in	6in	3in	89p	29p
GB16	10in	7in	3in	£1·00	29p

* These sizes fit standard veroboards

DYNAMIC MICROPHONE UD 130HL

This sensitive, quality microphone is uni-directional and is complete with mute switch and 20 feet of cable and plug. 100–12,000Hz. Dual impedance 600Ω and 50kΩ.

£6·60, plus 24p P. & P.

SPEAKERS

2½in 8Ω
2½in 8Ω
2½in 80Ω
All at 71p each.

TAPE ERASER

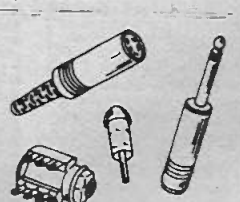
erases a whole reel of tape in seconds. 240V a.c. Full instructions. £2·20, plus 22p P. & P.

SCREENED CABLES

Single for mics, audio leads, etc. 5½p yd.
Twin, as above, common screen 10p yd.
Stereo, two cores, individually screened 11p yd.
Four core with common screen 23p yd.
Four core, individually screened 30p yd.
Coiled screened leads, 20 feet long £1·05 each.

PLUGS

Car aerial	15½p
Co-axial	10p
D.I.N. 2 pin (speaker)	11p
D.I.N. 3 pin	15p
D.I.N. 4 pin	15½p
D.I.N. 5 pin, 180°	14½p
D.I.N. 5 pin, 240°	16½p
D.I.N. 6 pin	16½p
Jack, 2½mm unscreened	10p
Jack, 2½mm screened	11p
Jack, 3½mm unscreened	9p
Jack, 3½mm screened	13p
Jack, ¼in unscreened	13p
Jack, ¼in screened	22p
Jack, stereo, unscreened	22p
Jack, stereo, screened	38p
Phono, plastic top	5½p
Phono, plated metal	13p
Wander, red or black	3½p
Banana 4mm, red or black	6½p



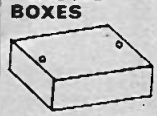
LINE SOCKETS

Car aerial	15½p
Co-axial	19p
D.I.N. 2 pin (speaker)	16½p
D.I.N. 3 pin	17½p
D.I.N. 5 pin, 180°	17½p
D.I.N. 5 pin, 240°	17½p
Jack, 3½mm	16½p
Jack, ¼in screened	34p
Jack, stereo, screened	37p
Phono, plated metal	15½p

SOCKETS

Car aerial	9p
Co-axial, surface	9p
Co-axial, flush	10p
D.I.N. 2 pin (speaker)	11p
D.I.N. 3 pin	10p
D.I.N. 5 pin, 180°	10p
D.I.N. 5 pin, 240°	10p
Jack, 2½mm	11p
Jack, 3½mm	11p
Jack, ¼in unswitched	16½p
Jack, ¼in switched	18½p
Jack, stereo, switched	26p
Phono, single	5½p
Phono, 2 on a strip	7½p
Phono, 3 on a strip	10p
Phono, 4 on a strip	11p
Wander, single, red or black	5½p
Wander, twin strip	7½p
Banana 4mm red, or black	6½p

PLASTIC BOXES



for constructional projects. White, with lid and screws.
BP1 4¼ins × 3ins × 1¾ins—37p.
BP2 6ins × 4ins × 2½ins—37p.

CATALOGUE

15p

POST FREE

TRANSFORMERS

all with 0-250 Volt primaries.

Miniature
MM6 6V, 500mA + 6V, 500mA.
MM12 12V, 250mA + 12V, 250mA.
MM20 20V, 150mA + 20V, 150mA.
£1·42, plus 14p P. & P.

L.T.
LT1 6·3V, 1·5V—82p, plus 20p P. & P.
LT2 6·3V, 3A—96p, plus 28p P. & P.
LT3 12V, 1·5A—96p, plus 28p P. & P.
LT4 12V, 3A—£1·45, plus 33p P. & P.
LT5 9-0-9V, 0·5A—83p, plus 23p P. & P.
LT6 12-0-12V, 1A—£1·04, plus 29p P. & P.

Multi-tapped
MT30/2 0-12-15-20-24-30V, 2A—£2·15, plus 33p P. & P.
MT60/1 0-5-20-30-40-60V, 1A—£2·31, plus 33p P. & P.
MT60/2 0-5-20-30-40-60V, 2A—£3·25, plus 37p P. & P.

Charger
CT/01 1A—£1·16, plus 28p P. & P.
CT/02 2A—£1·43, plus 33p P. & P.
CT/03 4A—£1·76, plus 33p P. & P.
Secondaries 0-5-11-17V.

Speaker Matching 3-8-16Ω
Example: 16Ω speaker to 8Ω amplifier. 8Ω amplifier to 3Ω speaker, etc. 99p, plus 22p P. & P.

MINIATURE ELECTROLYTICS

1·0μF	63V	7p	150μF	25V	8p
1·5μF	63V	7p	150μF	40V	13p
2·2μF	63V	7p	150μF	63V	15p
3·3μF	63V	7p	220μF	4V	7p
4·7μF	63V	7p	220μF	10V	7p
6·8μF	40V	7p	220μF	16V	8p
6·8μF	63V	7p	220μF	25V	13p
10μF	25V	7p	220μF	40V	15p
10μF	63V	7p	220μF	63V	22p
15μF	16V	7p	330μF	4V	7p
15μF	40V	7p	330μF	10V	8p
15μF	63V	7p	330μF	16V	13p
22μF	10V	7p	330μF	63V	26p
22μF	25V	7p	470μF	6·3V	8p
22μF	63V	7p	470μF	10V	13p
33μF	6·3V	7p	470μF	25V	15p
33μF	16V	7p	470μF	40V	22p
33μF	40V	7p	680μF	6·3V	13p
47μF	4V	7p	680μF	16V	15p
47μF	10V	7p	680μF	25V	22p
47μF	25V	7p	680μF	40V	26p
47μF	40V	7p	1000μF	4V	13p
47μF	63V	8p	1000μF	10V	15p
68μF	6·3V	7p	1000μF	16V	22p
68μF	16V	7p	1000μF	25V	26p
68μF	63V	13p	1500μF	6·3V	15p
100μF	4V	7p	1500μF	10V	22p
100μF	10V	7p	1500μF	16V	26p
100μF	25V	7p	2200μF	6·3V	22p
100μF	40V	8p	2200μF	10V	26p
100μF	63V	15p	3300μF	6·3V	26p
150μF	6·3V	7p	4700μF	4V	26p
150μF	16V	7p			

VEROBOARD

Size	0·1 Matrix	0·15 Matrix
2½in × 3¾in	25½p	18½p
2½in × 5in	28½p	28½p
3¾in × 3¾in	28½p	28½p
3¾in × 5in	32p	35p
17in × 2½in	87p	66p
17in × 3¾in	£1·18	94p

Spot face cutter—44p
Pins, either size, pack of 36—21p

Edge connectors:
24 way, 0·1—37½p
24 way, 0·15—37½p
36 way, 0·1—48½p
16 way, 0·15—23p

BONDED ACRYLIC FIBRE

B.A.F. wadding, 18in wide, 1in thick. The ideal lining for speaker enclosures, 33p per yard. P. & P. 1yd 14p; each extra yard 4p.

CONTROLS

Log. or Lin.
Single, less switch, 15p
Single, D.P. switch, 26p
Tandem, less switch, 44p
5kΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ.

BATTERY ELIMINATORS

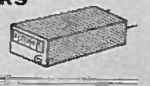
suitable for transistor radios and similar light current equipment. Input 240V a.c.
Output: PP6—6V d.c.; PP9—9V d.c.
Price £1·65, plus 15p P. & P.

RESISTOR BARGAIN PACK

of 100 ½W resistors. Tolerance 5% or better, E24 values. Good assortment; our selection, only 50p.

MAGNETIC COUNTERS

Brand new, neat; 48 volt, 5 digit counters. 66p.



CASSETTE MICROPHONE

Low impedance dynamic with remote control switch. Fitted 2½mm and 3½mm plugs. £2·34, plus 15p P. & P.

ELECTROLYTICS

1μF	450V	21p	1000μF	50V	46p
2μF	450V	22p	2000μF	25V	43p
4μF	350V	15½p	2000μF	50V	58p
8μF	450V	18½p	2500μF	25V	50p
16μF	450V	20p	2500μF	50V	66p
25μF	25V	7½p	3000μF	25V	53p
25μF	50V	11p	5000μF	25V	66p
32μF	450V	30p	5000μF	50V	£1·21
50μF	50V	11p	8–8μF	450V	20p
100μF	50V	12p	8–16μF	450V	22p
250μF	25V	15½p	16–16μF	450V	30p
250μF	50V	19p	16–32μF	450V	69p
500μF	25V	20p	32–32μF	450V	54p
500μF	50V	27½p	50–50μF	350V	42p
1000μF	25V	30p			

1 CHIP RADIO

Ferranti's latest device ZN414—gives results better than superhet. Supplied complete with technical notes and circuits. £1·35 each. 10 for £12.

Hi-Q TUNER COMPONENTS

For experimenting with the ZN414.

KIT NO. 1. Pleasey Miniature Tuning Condenser with built in LW switch and 3" ferrit slab and litz wound MW coil. 72p.

KIT NO. 2. Air spaced tuning condenser 6" ferrite rod litz wound MW and LW coils. 94p

KIT NO. 3. Air spaced TC with slow motion drive 8" ferrit rod. with litz wound LW and MW coils. £1·10.

KIT NO. 4. Permeability tuner with fast and slow motion drive and LW loading coils. 50p.

12 VOLT 1½ AMP POWER PACK

This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 m/f/d/ smoothing. Price £2·20 + p. & p. 20p.

Heavy Duty Mains Power Pack. Output voltage adjustable from 15–40V in steps—maximum load 2500W—that is from 6 amp at 40V to 15amp at 15V. This really is a high power heavy duty unit with dozens of workshop uses. Output voltage adjustment is very quick—simply interchange push on leads. Silicon rectifiers and smoothing by 3,000mF. Price £6·33 plus 65p post.

BALANCED ARMATURE UNIT

500 ohm, operates as speaker or microphone, so useful in intercom or similar circuits. 37p each.

MUSIC ON TAPE

A further buy enables us to offer these at an even lower price—namely 72p each or 5 for £2·50. Send S.A.E. for list of titles. We can't repeat when sold out.

FIRE ALARM BELL

Mains operated. Really loud ring 6" gong. Size approx. 12" × 6" × 4½". Suitable outside or inside. Heavy cast case with ¾" conduit entry. Made by A.F.A. Operates off 200/240V AC. £4·13 plus 60p.

MICRO SWITCH

6 amp changeover contacts, 11p each.

15 amp. On/Off 12p each. 15 amp. change over 15p each. ULTRA sensitive 5 amp. change over 30p each. 10% off if 10 of a type ordered.

FLEX CABLE SNIP

3 core heavy circular T.R.S. waterproof flex, ideal for running down the garden to pool or shed. 1·5mm cores (5 amp) 100 yard coils £4·78 plus carriage 75p up to 200 miles. £1—300 miles £1·50—500 miles.

20 WATT INVERTER

Smart and Brown—For van lighting or camping etc. Will light a 2ft. 20 watt standard fluorescent tube from a 12V car battery, current approx. 2A. Very well made unit using die cast chassis. Size 11½" × 2" × 1¼". Price £7·15 complete with lamp holders and tube clips.

BAKELITE INSTRUMENT CASE

Size approx. 6¼" × 3¼" × 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 54p each.

pax lid 11p extra.

QUICK CUPPA

Mini Immersion Heater. 350W. 200/240V. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. £1·25, post and insurance 20p. 12V car model also available. Same price. Jug heater also available £1·75 plus P. & P. 20p.

DOOR INTERCOM

Know who is calling and speak to them without leaving bed, or chair. Outfit comprises microphone with call push button, connectors and master inter-com. Simply plugs together. Originally sold at £10. Special snip price £3·85 plus 20p postage.

SPIT MOTOR

200-250V induction motor, driving a Carter gearbox with a 1½" output drive shaft running at 5 revs p.m. Intended for roasting chickens, also for driving models—windmills, coloured disc lighting effects, etc. £2·05 plus 20p post and ins.

10 AMP. DIMMER CONTROLLER. For the control of lighting on stage or in studio or for the control of portable equipment in workshops etc. This has two 13 amp. socket outlets. Each is controlled by a 5 amp. solid state regulator. The overall length is 17", width 3½" and depth 1½". In the end is fitted a master on/off switch indicator, inp and fuse. Price £ 8·25.

ZPM—MODULATION MOTOR

Could also be used to open ventilators, doors, valve, damper etc., particularly suitable for remote control. Made by Satchwell. Essentially a reversible geared motor fitted with internal limit switches to stop it at the end of its travel Size approx. 6" × 6" × 5½" and weighing approx. 10 lbs. This is extremely powerful and would lift a heavy door or open a long line of ventilators. To operate this motor you put the 50 cycle supply through a change over switch. For instance a thermostat with change-over contacts could automatically regulate the temperature in a growing house, chicken hatchery etc. An indicator on the motor graduated 0–10 shows the state of open or close. Also internally fitted is a veriable resistor, wires from this to a volt meter would give a remote indication of the open or close position. A very expensive motor if both direct from Satchwell, our price complete with step down Transformer is £18·15.

CENTRIFUGAL FAN

Mains operated turbo blower type. Pressed steel housing contains motor and aluminium impeller. Motor is 1/10th h.p. giving considerable air flow but virtually no noise. Approx. dimensions 10¼in. wide × 12¼in. dia. outlet into trunking 10½ × 4¼in. £6·50 plus £1 post and insurance.

FORTYLITE

Fluorescent lighting units with polyester choke and finished white enamel. 40 ins model, ideal kitchen, bedroom, hallway, porch, loft etc. With tube assembled ready to install, £2·20. post 40p.

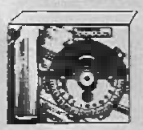
PROCESS TIME CONTROLLER

Made by Smiths. Motorised and mains driven in metal case with glass front and chrome surround. Covers a period of 18 hours. During this 18 hours the controlled device can be made to switch on for a period of 15 minutes to 3 hours. Probable cost from Smiths over £6. Special snip price £1·76 plus 20p post and insurance.

THIS MONTH'S SNIP

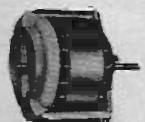
Solenoid Operated (so could be remote controlled) tape deck—comprises; motor driven heavy but balanced fly-wheel which forms capstan. Tape drive is operated by No. 1 solenoid, two more solenoids operate fast forward and fast reverse. Complete with tape spools record/playback head and erase head. Real Bargain at £6·60.

24-HOUR TIME SWITCH



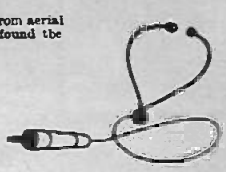
Made by Smiths, these are AC mains operated NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods for 24 hours, 5 amp changeover contacts will switch circuit on or off during these periods. £2·75, post and ins. 23p. Additional time contacts 50p pair.

PAPST MOTORS



Est. 1/40th h.p. Made for 110–120 volt working, but two of these work ideally together off our standard 240 volt mains. A really beautiful motor, extremely quiet running and reversible. £1·65 each. Postage one 23p, two 33p. 230v model £3·30.

RADIO STETHOSCOPE



Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV amplifier, anything — complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2·20—twin stethoset instead of earpiece 83p extra—post and ins. 20p.

MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied.

Model 1163 500m watt power output 83p.
Model 1172 750m watt power output 94p.
Model EP9000 4 watt power output £1·66.
KP9001 Stereo preamp £2

10% discount if 10 per type or more ordered.

1 HOUR MINUTE TIMER

Made by famous Smiths company, these have a large clear dial, size 4½in. × 3½in., which can be set in minutes up to 1 hour. After preset period the bell rings. Ideal for processing, a memory jogger or, by adding simple lever, would operate micro-switch. £1·25

DIGITAL COUNTER TIMER

Very stable and reliable crystal controlled circuit. Capable of work in excess of 15 MHz. Construction simplified by use of 15 integrated circuits. Complete kit with case £43·50 or construction data and price list 50p.

TIME SWITCH

Smiths mains driven clock with 15 amp switch, also notes showing how you can wake up with music playing, kettle boiling or come home to a warm house, warn off burglars keep pets warm, halve your heating bill, etc. £2·20.

PRESSURE SWITCH

Containing a 15 amp. change over switch operated by a diaphragm which in turn is operated by air pressure through a small metal tube. The operating pressure is adjustable but is set to operate in approx. 10 in. of water. These are quite low pressure devices and can in fact be operated simply by blowing into the inlet tube. Original use was for washing machines to turn off water when tub has reached correct level but no doubt has many other applications £1·38, each.

5 PUSH BUTTON SWITCH

Mains, suitable for audio or R.F. Each switch rated at 250v. 15 amps. 1st (black push button) closes 2 circuits, 2nd (white push button) operates one change-over, 3rd (white push button) operates one change-over, 4th (white push button) opens one circuit. Note: all depressed buttons remain down until cleared by the 5th (red button). Further note: It is a relatively easy job to alter the position of the tags thus making the switches suit your circuit. Fitted with 3 white, 1 red and 1 black button. 33p each or 10 for £2·97.

5A 3-PIN SWITCHED SOCKETS

An excellent opportunity to make that bench dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Hicraft) bakelite flush mounting shuttered switch sockets for only 55p plus 20p post and insurance. (20 boxes post free.)

CAR ELECTRIC PLUG

Fits in place of cigarette lighter Useful method of making a quick connection into the car electrical system. 42p each or 10 for £3·76.

EXIT SIGNS

One of our customers has pointed out how easily our box signs can be converted to exit signs. These are illuminated, having a 20W fluorescent lamp with associated control gear. The front is very thick, clear plastic. Directly on to this you can stick down the letters available at most stationers. There is room inside the box for a battery and low volt lamp in the case of power failure. Size of sign is 2ft. high × 14in. wide × 5in. deep. Solidly made from sheet steel and hammer finished in enamel. Price £3·85 plus 50p carriage per 200 miles.

SPRING COIL LEADS

As fitted to telephones, 4 core 17p each, 10 for £1·53. 3 core 11p each. 10 for £1.
6 core 20p each

LARGE PANEL MOUNTING MOVING COIL METERS

Size 5in. × 4in. Centre zero 200-0-200 micro amp. Made by Sangamo Weston. Regular price probably £8. Our price £3·85.

A.C. AMMETER

0-5 amps. flush mounting—moving iron. Ex equipment but guaranteed perfect £1·65.

CIRCUIT BOARDS

Heavy copper on 3/32 paxolin sheet, ideal for making power packs etc. as sheet is very strong and thick enough to allow copper to be cut away with hacksaw blade. 5in. × 5in. 9p each. 15in. × 5in. 28p.

PHOTO-MULTIPLIER TUBE

American RCA type no. 4555. The regular price is understood to be between £14 and £15 each. We offer these brand new and perfect for £4·50 each.

RESISTANCE WIRE

Kanthal, Nichrome etc. Approx. 2 tons of this coming in—many sizes and grades. If you are a user of this you can save yourself half the cost. Send now for our list. Sorry, not available on small size reels.

PP3 BATTERY CHARGER

Almost 3 times the life can be obtained from PP3 battery if you re-charge it from the mains —this ready to use charger with instructions only 65p.

SUB-MINIATURE MOVING COIL MICROPHONE

as used in behind the ear deaf aids

Acts also as earphone, size only ½in.× ½in.× ½in. Regular price probably £3 or more. Our price £1·10. Note these are ex equipment but if not in perfect working order they will be exchanged.

PROTECT VALUABLE DEVICES FROM THERMAL RUNAWAY OR OVER-HEATING

Thyristors, rectifiers, transistors, etc., which use heat-sinks can easily be protected. Simply make the contact thermostat part of the heat-sink. Motors and equipment generally, can also be adequately protected by having thermostats in strategic spots on the casing. Our contact thermostat has a calibrated dial for setting between 90deg. to 190deg.F. or with the dial removed range setting is between 80 to 800deg.F. Price 83p.

KITS FOR PREVIOUS PROJECTS

Unless otherwise stated, kits contain electronic parts only. The case and special items can be obtained locally. Also batteries are not included. Kits may be returned for refund if construction has not been started. We reserve the right to substitute components should deliveries be protracted so as to avoid undue delay.

If reprint of data is required add 10p

HOME SENTINEL
"Ward off the unwanted intruder"—No elaborate setting up or wiring required. Kit of parts £4·35.

"SNAP" INDICATOR
Press your button first and your opponent is blocked also suitable for Quiz games and reaction testing. Kit of parts £1·10

RECORD PLAYER
Good quality at a reasonable price—good enough for classical records and pop. Kit of parts £6·10.

WINDSCREEN WIPER CONTROL
Wet dirty road—Drizzle—Fog—Smeared screen—Scraping wipers—combat these with add-on wiper control. Kit of parts £2·50.

FUZZ BOX
Add weird and interesting effects to guitar playing with this solid state Fuzz box. Kit of parts £2·50.

PHOTOGRAPHIC COLOUR TEMPERATURE METER
Must for colour photographer get the colours right gives quick indication of filters necessary for correction in any light. Can be used with natural or Studio lighting. Kit of parts £3·58.

ASTRON M.W. RADIO
A simple M.W. reflex circuit receiver—easy to build. £3·30.

REMOTE TEMPERATURE COMPARATOR
Measures small temperature changes in liquids or gasses—fish tank, photographic solution—thermostatically controlled rooms etc. Kit £5·25.

RAIN WARNING ALARM
Keep your washing dry with this automatic alarm device Kit £2·20.

WAA WAA PEDAL
Add excitement and sound vibration to your music. Kit £3·50.

ELECTRO LAUGH
Laughter simulator also useful electronic alarm. Kits of part £2·20.

SOIL MOISTURE METER
Many plants are killed through over-watering—this meter measures soil moisture at root depth—probes can be left permanently beside the plant—indicator remotely housed could monitor several plants. Kit £3·90.

SIGNAL INJECTOR
A useful pocket instrument for fault finding radios and amplifiers. Kit £1·10.

BABY ALARM
Keep a check on the kids—this device will give you peace of mind as you watch T.V. Kit £4·40.

SIMPLE CALCULATOR
Teaching aid for multiplication—can be used for quick checks. Kit £3·10.

POWER SUPPLY UNIT
Just right for testing low voltage circuits—a simple stabilised supply providing 0-16 volts D.C. continuously variable. Kit £5·20.

METAL LOCATOR
A simple easy to construct self-contained metal locator giving a meter indication of buried metal. Kit £5·00.

AUDIO TONE GENERATOR
Makes electronic music—covers range from 50—2000 hz. Specifically designed for use with tape recorder. Kit £3·25.

LIGHT TO SOUND CONVERTER
Produces an audio tone—the frequency of which is dependent on the light level. Kit £2·15.

SHAVER INVERTER
Provides 240v 50hz from 12 volt car battery—gives approx 10 watts which is enough for most shavers. Kit £4·35.

ELECTRONOME
Electronic Metronome with pulse frequency continuously variable from 40—225 beats per minute. Kit £2·15.

THROUGH LENS LIGHT METER
A simple light meter for use with single lens reflex camera. Kit £4·35.

MEDIUM AND LONG WAVE RADIO TUNER
A simple radio tuner for use with almost any amplifier. Kit £3·25.

INFRA RED BURGLAR ALARM
Uses an invisible, reflected beam to detect intruders when beam is intercepted—a power output is switched on for up to one minute. Kit £4·35.

MULLARD UNILEX

This D.I.Y. Stereo Amplifier is still available complete at £7·00 for the four Mullard Modules, or Modules can be bought separately as follows: —4 watt amplifier module (2 required) Mullard Ref. No. E.P.9000—£1·80 each.
Pre amp module Mullard Ref. No. E.P.9001—£1·98 each.
Power module—Mullard Ref. No. E.P.9002—£2·53 each.
In addition and made to Mullard Specification we offer:—
Standard Control Unit with escutcheon and knobs—£3·30
Knobs—Set of 4—50p

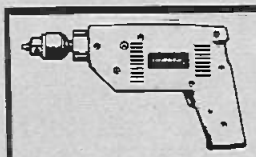
SPECIAL OFFER the complete Unilex with control panel at PRE VAT PRICE. **£10** post paid.

THYRISTOR LIGHT DIMMER

Domestic model for any lamp up to 250 watt. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price £2·95. Industrial model 5 amp module with control knob £3·80.

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. £2·50 plus 23p P. & I



PORTABLE ELECTRIC DRILL

Very superior quality made by a famous Dutch toolmaker. Model No. ABM 930. 300w—2 speed 2200/3000. With ¼" chuck and chuck key, also separate side handle and hammer facility for dealing with concrete, etc. An equivalent British made drill would cost £15·00. £10·90—similar model but without the hammer attachment £7·95. Have either model on approval for 7 days.

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.

CD CAR IGNITION

This system which has proved to be amazingly efficient. We offer kit of parts as P.W. Circuit £8·55 plus 20p p. & p. Deluxe model with prepared circuit board £7·95. When ordering please state whether for positive or negative systems.

CENTRIFUGAL BLOWER

Miniature mains driven blower centrifugal type blower unit by Woods. Powerful but specially built for quiet running—driven by cushioned induction motor with specially built low noise bearings. Overall size 4½" × 4½" × 4". When mounted by flange, air is blown into the equipment but to suck air out, mount it from centre using clamp. Ideal for cooling electrical equipment or fitting into a cooker hood, film drying cabinet or for removing flux smoke when soldering etc. etc. A real bargain at £2·05.

MORTSMAN 24 HOUR TIME SWITCH

With 6 position programmer. When fitted to hot water systems this could programme as follows:—

Programme	Hot Water	Central Heating
0	Off	Off
1	Twice daily	Off
2	All day	Off
3	Twice daily	Twice daily
4	All day	All day
5	Continuously	Continuously

Suitable of course, to programme other than central heating and hot water, for instance, programme upstairs and downstairs electric heating or heating and cooling or taped music and radio. In fact there is no limit to the versatility of this Programmer. Mains operated—Size 3" × 3" × 2" deep as illustrated but less case. Price £3·50 each.

GOOD COMPANION

We can now offer these again in i.c. version using Ferranti ZN414 and Mullard AF Modules 1172. Excellent tone wood cabinet. Cabinet size approx. 11in wide × 8in. high × 3in. deep. Complete assembly instructions £5·75 plus 25p post and ins.

MIGHTY MIDGET

Probably the tiniest possible radio, as described in Practical Wireless, January '73. All electronic parts £2·20 post paid.

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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. £1·65 plus 13p post and insurance. Made up model also available. £2·50 plus 13p post & p.

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Two units to power a cassette tape player or recorder one from the mains Price £2·50. Two from the car battery—price £1·40.

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A reaction testing game that can also be a quiz answering indicator. Kit £3·30.

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A humane mouse trap—catches them alive so that you can release them in the park. Kit £3·25.

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Prolongs life of soldering iron bit—prevents pitting. Kit £1·95.

ICE WARNING DEVICE
A device that can be set to indicate 'ice' conditions or similar temperature levels. Kit £1·55.

AUDIO COLOUR UNIT
Add a colour dimension to your audio equipment. This unit will modulate three lamps in accord with Bass—middle and treble notes of any music. Kit of parts £7·20.

U.H.F. T.V. AERIAL
A simple aerial for U.H.F. to reception on your band could improve your reception immensely. Kit £1·65.

DAMP LOCATOR
Easily carried in your pocket this little unit gives visible indication of damp. Kit £1·25.

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For D.I.Y. photographer £5·00.

EGG TIMER
Simple timer with audible warning. £4·15

NEON NOVELTY
Interesting modern ornamental device £1·65.

CONNECTING WIRE
500m. coils—7 stranded flex copper P.V.C. covered. Available in popular colours:—£2·20 per coil, plus 40p post.

8" x 5" P.M. SPEAKER
15 ohm—£1·50. This is a good quality speaker by a famous maker. High flux ideal for use with our Mullard 4 watt amplifier.

3 GANG TUNING CONDENSERS.
500pf each section ideal for transmitter or communications receivers. £1p.

16 TRACK TAPE HEAD
for ¼" or 1" tape. This is a brass encased tape head and measures approx. ½" x ½" x ½". Resistance is approx. 20-0-20 ohms. These heads are beautifully made but we have no technical data, also have only a limited quantity. Price £5·50 each or 10 for £50.

RECORD PLAYBACK HEADS (TRUVOX)

Individual prices of these are:—
2 track record playback heads 50p each.
4 track record playback heads 72p each.
Erase heads are also available separately—
2 track 17p—4 track 28p

AC CONDENSERS

In addition to the normal uses as motor starters, power factor correction etc. These make very good voltage droppers for working low voltage appliances from mains. The voltage working quoted is AC and condensers are usually suitable for working on DC at 2½ times the quoted AC voltage.

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2 mfd 440v 33p	6·25 mfd 250v 55p	12 mfd 250v 77p
3·4 mfd 440v 44p		15 mfd 250v 88p
3·5 mfd 250v 33p	8 mfd 250v 55p	20 mfd 275v 99p

TINIEST AUDIO UNIT

Although only the same size as an Oxo cube these are completely self contained and comprise microphone, 3 transistor amplifier with volume control and battery compartment and finally a dynamic earpiece. All in a plastic case. Made by Ardent (Sold, we believe at over £50 each). These are really hearing aids complete except for the ear tube but we are not selling these as hearing aids only for the micro midget parts they contain. Believed to be in perfect working order but not tested. Price £8·30 each.

MAINS MOTOR

Precision made—as used in record decks and tape recorders—ideal also for extractor fan, blower, heaters, etc. New and perfect. Snip at 65p. Postage 20p for first one then 10p for each one ordered.
1" stackmotor 94p.
1½" stackmotor £1·10.

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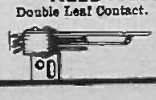
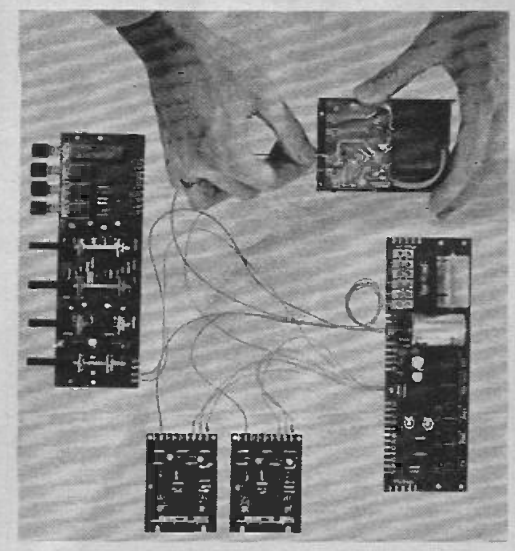


Double Leaf Contact. Very slight pressure closes both contacts. 8p each 10 for 60p. Plastic pushrod suitable for operating. 6p each. 10 for 54p.

Project 605 the new simple way to assemble Sinclair high fidelity modules



For several years now you have been able to assemble your own high fidelity system to world beating standards using Sinclair modules. We have progressively improved these technically but hitherto the method of assembly at your end has remained the same – there has been no alternative to a soldering iron. Now for those who prefer not to solder, there is an alternative – Project 605.

In one neat package you can now obtain the four basic Project 60 modules plus a fifth completely new one – Masterlink – which contains all the input sockets and output components you previously bought separately. Also in the Project 605 pack are all the inter-connecting leads, cut to length and fitted at each end with plugs which clip straight onto the modules, eliminating soldering completely. The pack contains everything you need to build a complete 30 watt stereo amplifier together with a clear well illustrated Instruction Book. All you have to do is to arrange your modules in the plinth or case of your choice and then clip them together – the work of a few minutes.

Your hi-fi system will, as we said, match the finest in the world and you can add to it at any time to increase power or extend the facilities. For example a superb stereo FM Tuner unit is obtainable for only £25. **PRICES DO NOT INCLUDE VAT**

Guarantee If within 3 months of purchasing Project 605 directly from us, you are dissatisfied with it, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air-mail charged at cost.

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Reg. No. 393594

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Inputs – Mag. P.U. – 3mV correct to R.I.A.A. curve 20–25,000 Hz ± 1dB. Ceramic pick-up – 50mV. Radio – 50 to 150mV. Aux. adjustable between 3mV. and 3V.
Signal to noise ratio – Better than 70dB.
Distortion – better than 0.2% under all conditions.
Controls – Press buttons for on-off, P.U., radio and aux. Treble +15 to –15 dB at 10 kHz. Bass +15 to –15 dB at 100 Hz. Volume. Stereo Balance.
Channel matching within 1dB.
Front panel – brushed aluminium with black knobs.

Project 605 comprises Stereo 60 pre-amp/control unit, two Z-30 power amplifiers, PZ-5 power supply unit, the unique new Masterlink, leads and instructions manual complete in one pack. Post free

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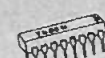


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	p	p	p		p	p	p		p	p	p
SN7400	0·20	0·18	0·16	SN7450	0·20	0·18	0·16	SN74145	1·50	1·40	1·30
SN7401	0·20	0·18	0·16	SN7451	0·20	0·18	0·16	SN74150	3·35	2·95	2·15
SN7402	0·20	0·18	0·16	SN7453	0·20	0·18	0·16	SN74151	1·10	0·95	0·90
SN7403	0·20	0·18	0·16	SN7454	0·20	0·18	0·16	SN74153	1·35	1·27	1·20
SN7404	0·20	0·18	0·16	SN7460	0·20	0·18	0·16	SN74154	2·00	1·75	1·55
SN7405	0·20	0·18	0·16	SN7470	0·30	0·27	0·25	SN74155	1·55	1·47	1·35
SN7406	0·30	0·27	0·25	SN7472	0·30	0·27	0·25	SN74156	1·55	1·47	1·35
SN7407	0·30	0·27	0·25	SN7473	0·40	0·37	0·35	SN74157	1·80	1·70	1·50
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SN7409	0·45	0·42	0·35	SN7475	0·55	0·52	0·50	SN74161	2·50	2·40	2·25
SN7410	0·20	0·18	0·16	SN7476	0·45	0·42	0·39	SN74162	3·40	3·25	2·70
SN7411	0·23	0·22	0·20	SN7480	0·80	0·75	0·67	SN74163	3·40	3·25	2·70
SN7412	0·42	0·40	0·35	SN7481	1·25	1·15	1·10	SN74164	2·75	2·30	2·10
SN7413	0·30	0·27	0·25	SN7482	0·87	0·80	0·70	SN74165	4·00	3·50	3·00
SN7416	0·30	0·27	0·25	SN7483	1·00	0·90	0·85	SN74166	4·00	3·50	3·00
SN7417	0·30	0·27	0·25	SN7484	0·90	0·85	0·80	SN74167	6·25	5·60	5·10
SN7420	0·20	0·18	0·16	SN7486	0·45	0·41	0·38	SN74170	4·10	3·55	2·05
SN7422	0·48	0·44	0·40	SN7490	0·75	0·70	0·65	SN74174	2·00	1·75	1·30
SN7423	0·48	0·44	0·40	SN7491AN	1·00	0·95	0·90	SN74175	1·35	1·27	1·15
SN7425	0·48	0·40	0·35	SN7492	0·75	0·70	0·65	SN74176	1·60	1·35	1·20
SN7427	0·42	0·39	0·35	SN7493	0·75	0·70	0·65	SN74177	1·60	1·35	1·20
SN7428	0·50	0·45	0·42	SN7494	0·80	0·75	0·70	SN74180	1·55	1·30	1·20
SN7430	0·20	0·18	0·16	SN7495	0·80	0·75	0·70	SN74181	7·00	6·00	5·50
SN7432	0·42	0·39	0·35	SN7496	1·00	0·97	0·95	SN74182	2·00	1·80	1·60
SN7433	0·70	0·61	0·44	SN7497	6·25	5·50	5·00	SN74184	2·40	2·00	1·80
SN7437	0·65	0·60	0·50	SN74100	2·50	2·30	2·00	SN74185A	2·40	2·00	1·80
SN7438	0·65	0·60	0·50	SN74104	1·45	1·35	1·20	SN74190	1·95	1·35	1·75
SN7440	0·20	0·18	0·16	SN74105	1·45	1·35	1·20	SN74191	1·95	1·85	1·75
SN7441AN	0·75	0·72	0·70	SN74107	0·50	0·45	0·40	SN74192	2·00	1·80	1·80
SN7442	0·75	0·72	0·70	SN74110	0·80	0·70	0·60	SN74193	2·00	1·80	1·80
SN7443	1·00	0·95	0·90	SN74118	1·00	0·95	0·90	SN74194	2·50	2·35	1·90
SN7445	2·00	1·75	1·60	SN74119	1·90	1·75	1·65	SN74195	1·85	1·70	1·60
SN7446	2·00	1·75	1·60	SN74121	0·60	0·55	0·50	SN74196	1·50	1·40	1·30
SN7447	1·75	1·60	1·45	SN74122	1·35	1·25	1·10	SN74197	1·50	1·40	1·30
SN7448	1·75	1·60	1·45	SN74123	2·70	2·55	2·47	SN74198	4·60	3·70	3·35
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20p each

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IN4002	100	7
IN4003	200	8
IN4004	400	8
IN4005	600	10
IN4006	800	12
IN4007	1000	15
1·5 amp miniature		
PL4001	50	8
PL4002	100	9
PL4003	200	10
PL4004	400	10
PL4005	600	12
PL4006	800	15
PL4007	1000	16

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SC35B	200	79p
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6 AMP RANGE (TO48)		
SC40A	100	85p
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SC40D	400	£1·00
SC40E	500	£1·20
10 AMP RANGE (TO48)		
SC45A	100	95p
SC45B	200	£1·00
SC45D	400	£1·25
SC45E	500	£1·45
15 AMP RANGE (TO48)		
SC50A	100	£1·25
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3 Amp T048


15 Amp T048

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BO5/10	100	25p
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B1/05	50	25p
B1/10	100	25p
B1/20	200	30p
B1/60	600	35p
ONE AMP (G.I.) TUBULAR		
W005	50	20p
W01	100	35p
W02	200	40p
W06	600	45p
TWO AMPS ½ H × ½ L × ⅜		
B2/05	50	35p
B2/100	100	40p
B2/200	200	45p
B2/600	600	50p
B2/1000	1000	60p
FOUR AMPS ½H × ½L × ⅜		
B4/100	100	60p
B4/200	200	65p
B4/400	400	70p
B4/800	600	75p
B4/800	800	£1·00
SIX AMPS ½H × ½L × ⅜		
B6/100	100	70p
B6/200	200	75p
B6/400	400	90p
B6/600	600	£1·00



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Type	Volts P.I.V.	Price 1-11
ONE AMP		
CRS1/05	50	25p
CRS1/10	100	30p
CRS1/20	200	30p
CRS1/40	400	35p
CRS1/60	600	45p
THREE AMP (TO48)		
CRS3/05	50	30p
CRS3/10	100	30p
CRS3/20	200	35p
CRS3/40	400	45p
CRS3/60	600	55p
FIVE AMP (TO66)		
CRS5/400	400	60p
SEVEN AMP (TO48)		
CRS7/100	100	60p
CRS7/200	200	65p
CRS7/400	400	70p
CRS7/600	600	95p
SIXTEEN AMP		
SCR 16/100	100	65p
SCR 16/200	200	70p
SCR 16/400	400	80p
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1 Amp T05


3 Amp T048

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Size	4½" x 4" x 1" (SA100) 4" x 3" x 1" (SA35/SA50)

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PU45	Unstabilized supply for 2 SA25/35	£4·90
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MT45	Transformer for above, heavy duty	£2·85 carr. 20p
MT30	Transformer for unstabilized supply complete with rectifier diodes mounted	£3·50 carr. 20p
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● Channel section modules, for building your own mixer. Gain—16 x (24dB). Tone controls—18dB swing. Carr. pd. £3·50 + V.A.T.

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Two decks, and full headphone monitoring. The unit is mains operated and measures 17½" x 3" x 4" 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.
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Freq. response	20-20,000 HZ ± 2dB		
Input sensitivity	200 mV into 10K		
Construction	Fibreglass board		
Size	8" x 4" x 4" (5" with supply)	Module & power supply (Carr. 40p)	**£18·95**
Low distortion parallel push-pull output stage.			

160 watt version with power supply (Carr. 50p) £27·90 **£27·50**

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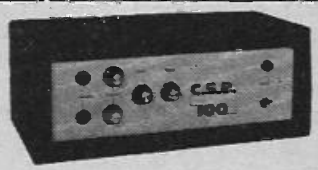
This versatile unit is now available in a black vynide case and so represents even better value than ever delivering speech and music powers of up to 100 watts RMS and continuous signal outputs of 70 watts. Two individually controlled inputs with wide range bass and treble controls.



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everyday electronics

PROJECTS..
THEORY....

TIME ON OUR HANDS

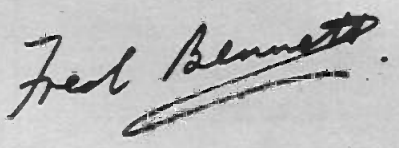
Time on our hands. That's the prospect—exciting or frightening, depending upon the individual—as the four-day working week becomes a reality. Already a number of industries have adopted a flexible method of working whereby the employee can choose the days and hours he works, so long as the requisite total of hours is worked within each week.

Make no mistake, a second industrial and social revolution is upon us. The signs have of course been around for years, but positive moves to reorganise working life have only just begun. The insurance industry and local government are noteworthy pace setters in this new fashion, and it seems to be happily accepted by the employees concerned.

The industrial revolution we are in the midst of owes very much to the progress and expansion of electronics. Business offices, no less than factory floors, are feeling the effect of electronics. Automated calculating and computing systems are contributing as significantly to this new industrial age as automated machine tools and conveyor belts.

But to come back to our opening remarks. We think it will be generally conceded that more free time is not a prospect greatly relished by some people. Sociological workers have been concerned with this very problem for a long time now. The general conclusion is that much more must be done to promote interest in leisure activities and the necessary facilities must be made available for all to pursue their chosen recreation. How one spends one's free time is a matter of personal preference. The kind of activities we can choose from are without number. They range widely in character and setting: from the overtly flamboyant and energetic to the quiet and reflective sedentary kind of occupation; from the great outdoors to the domestic scene.

Electronics has played a very vital role in creating the conditions that promise a transformation in the future pattern of our working life. Electronics can also play a very important and useful part in filling in some of the extra leisure hours that will shortly become the general rule. The study of electronics and the construction of simple electronic devices is an interesting and rewarding pastime, in itself. It must not be overlooked that this particular hobby can, furthermore, become a very useful supplementary activity to support and increase the enjoyment derived from many other, totally different, leisure activities.



Our September issue will be published on Friday, August 17

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..EASY TO CONSTRUCT
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VOL. 2 NO. 8 AUGUST 1973

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

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SLAVE FLASH

Enables a more realistic photograph to be obtained.

By C. Angell

Approximate cost of components including V.A.T.

£1·85 plus case

PHOTOGRAPHS taken using a single flash unit tend to have a rather "flat" appearance because they are usually devoid of shadows. A second flash unit, used with the master at the camera, can, when positioned correctly, give a feeling of depth and produce a more realistic photograph.

This article describes a unit which operates a second flash unit—or slave flash as it is known—without long trailing wires across the room. It has a maximum range of 60 feet and can be used for side or back lighting.

THE CIRCUIT

The complete circuit diagram of the Slave Flash unit is shown in Fig. 1. The components R1, D1, D2 and TR1 form a common "and" gate with only one input.

Resistor R1 provides the bias to turn on TR1 through D2; the latter and the base/emitter junction of TR1 form two diodes in series and this combination drops 1·2V (since silicon devices are used).

If D1 is connected to earth, there will be a voltage drop of 0·6V across it and the current through R1 will flow through D1, rather than D2 and the base emitter junction of TR1. Under these conditions TR1 will turn off, i.e., not conduct.

The l.d.r., PCC1, has a very high resistance under dark conditions and a very low resistance under bright conditions (typically in the order of 25 ohms for very bright sunlight) so when the master flash fires, and the light is incident on PCC1, its resistance value momentarily falls

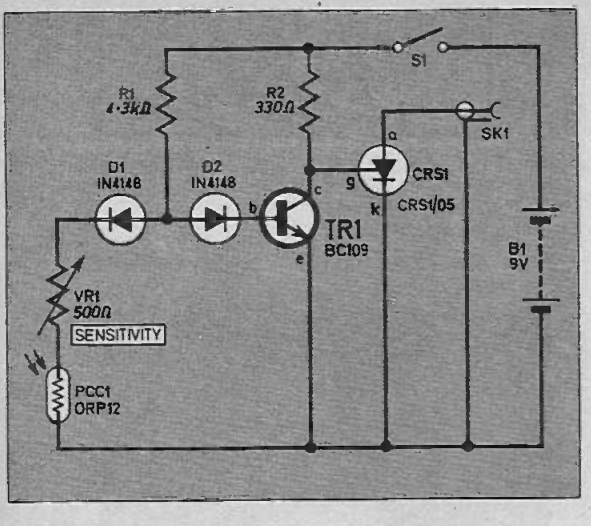


Fig. 1. The complete circuit diagram of the Slave Flash.

to a very low value.

Thus when the master flash operates, D1 is virtually shorted to earth at the moment of the flash and TR1 is turned off.

The diodes D1 and D2 ensure that turn off of TR1 is rapid.

The gate of the thyristor has to be positive with respect to the cathode, but while TR1 is on, the gate is virtually at earth potential so the thyristor remains switched off. When TR1 switches off, the gate of CSR1 receives a positive pulse since the collector end of R2 quickly rises to +9V and CSR1 is switched on and fires the Slave Flash. When CSR1 is switched on the gate current is limited to about 20mA by resistor R2.

CONSTRUCTION

The layout of the components on the Veroboard is shown in Fig. 2. The layout is not critical and can be changed if desired and may be built into any type of case required.

However, a case with a wide base or side is preferred so that the unit can stand up by itself. A transparent case can be used if desired, in which case PCC1 can be mounted inside the case on the Veroboard.

The prototype circuit was built on a piece of 0·15in. matrix Veroboard size 9 x 6 holes and as the circuit board is so small it seemed unnecessary to mount it.

If a metal case is used, the circuit board must be insulated and one way of doing this is to place the board in a small sealed plastic bag.

When a suitable case has been chosen, drill and make the cut-outs for VR1, PCC1, S1, the battery mounting clip and the grommet to take the screened cable, as indicated in Fig. 3, and attach these components to the case and lid.

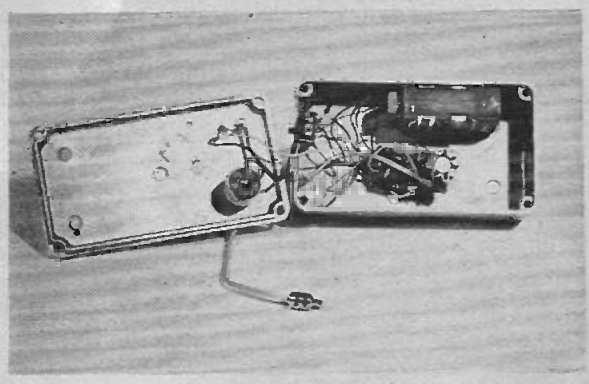
To mount the l.d.r., two small holes are drilled in the lid, 9mm apart (Fig. 3). These holes are filled with waterproof glue and the l.d.r. is immediately stuck to the case with its leads through the holes.

The screened cable used is a length of normal audio coaxial cable and the socket is an in-line type which can be bought from most large photographic shops.

Next solder the components on the Veroboard as shown in Fig. 2, remembering to use a heat-shunt on the leads of the diodes, transistor and thyristor. When satisfied that the components have been mounted correctly, wire up the board to the other components as depicted in Fig. 3.

The polarity of the flash gun must be determined, and the negative side of the flash should be connected to the negative on the circuit board, location *I2* via the screen of the cable.

Photograph of the completed Slave Flash unit ready for use.



Photograph of the completed unit with lid removed.

SLAVE FLASH

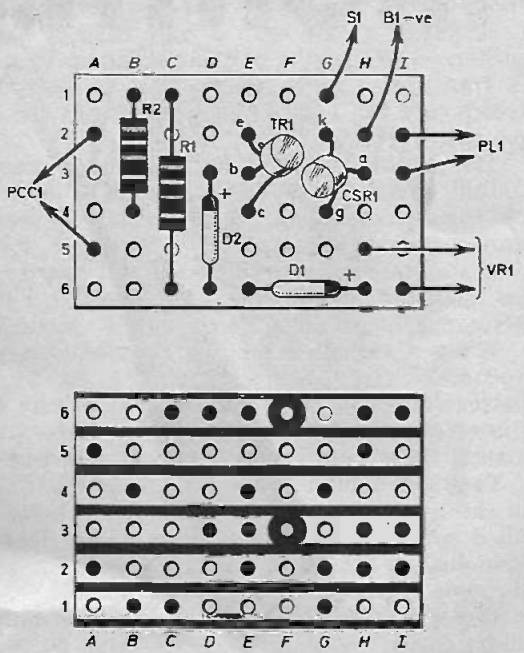
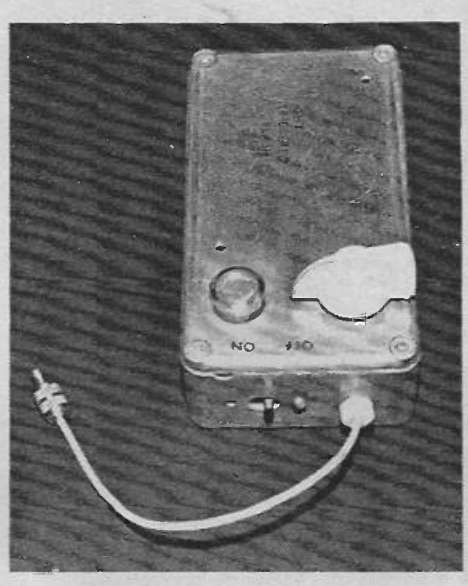


Fig. 2 (Above). The layout of the components on the Veroboard.



Photograph of the finished unit ready for plugging into the second flash.

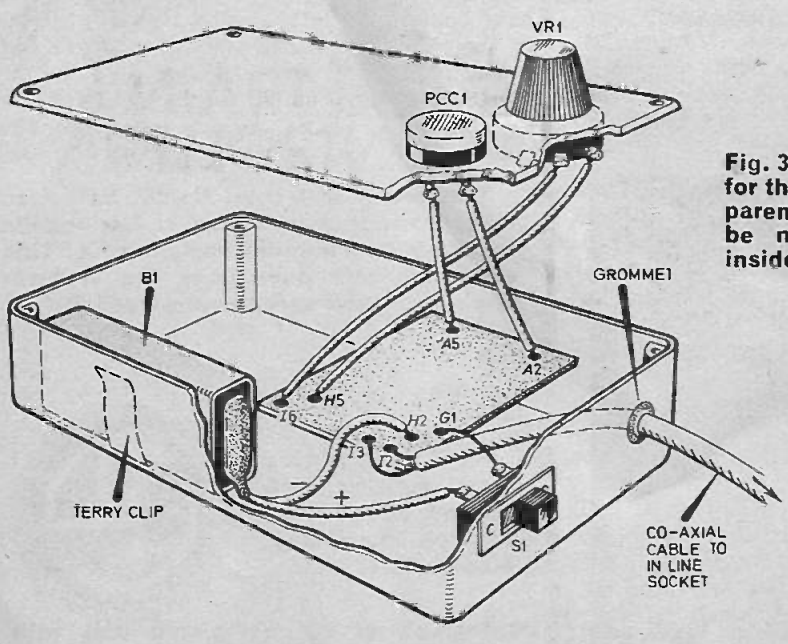


Fig. 3. The complete wiring details for the Slave Flash Unit. If a transparent case is used, PCC1 would be mounted on the Veroboard inside the case.

Components....

SEE SHOP TALK

Resistors
R1 4·3kΩ
R2 330Ω

Variable resistor
VR1 500Ω

Light Dependent Resistor
PCC1 ORP12

Semiconductors
TR1 BC109 silicon *npn*
D1 1N4148
D2 1N4148
CSR1 CSR1/05 or similar type

Miscellaneous
SK1 In-line socket (see text)
S1 On/off slide or toggle
B1 9V PP3
Veroboard: 0·15in. matrix 9 x 6 holes; battery clip; grommet; Terry clip; waterproof glue; suitable case; length of screened cable; knob.

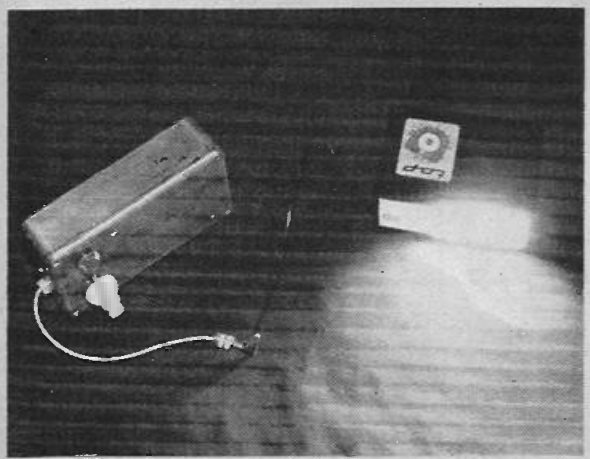
USING THE UNIT

The slave flash is plugged into the unit and positioned to provide light from the required angle. The l.d.r. is pointed towards where the camera will be, or towards a wall where light will be bounced from. The master flash is mounted on the camera and all the units are switched on.

The photograph is now taken in the normal way and the slave flash produces extra light from useful angles without long wires trailing over the room and getting in the picture.

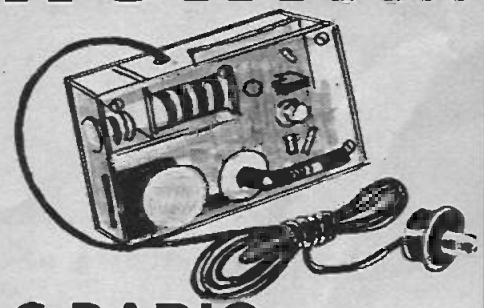
The unit can also be used out of doors for fill-in flash at a range of up to 60ft.

In bright sunlight VR1 will have to be adjusted so that the flash doesn't fire by itself. This of course will reduce its range. ▣



The Slave Flash unit in use.

NEXT MONTH..

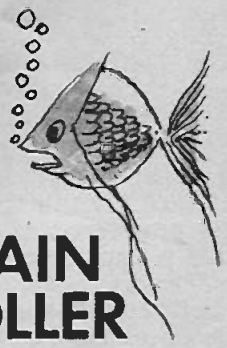


I.C. RADIO

A fantastic personal radio. Using a special integrated circuit this receiver is small in size, cheap and easy to build yet gives excellent results.

AQUARIUM THERMOSTAT

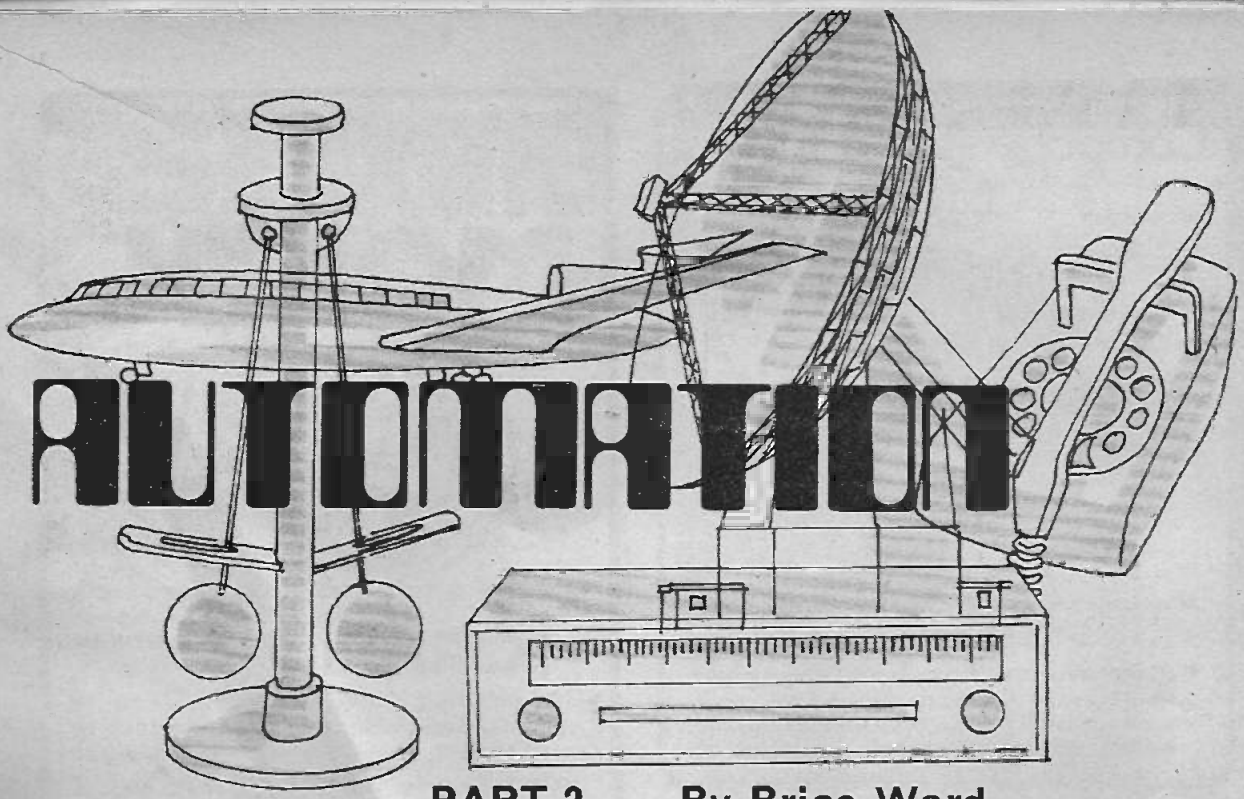
For all who keep tropical fish, a very sensitive electronic thermostat. Can also be used for many other applications requiring fine temperature control.



TRAIN CONTROLLER

The trouble with most electric train controls is the lack of torque at low speeds resulting in unnatural performance. This electronic unit overcomes the problem and makes slow speed control realistic.

See these and other exciting features in the September issue on sale Friday, August 17.



AUTOMATION

PART 2

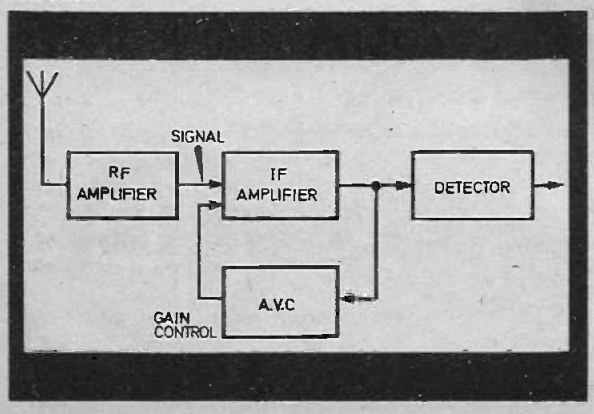
By Brice Ward

ONE of the early uses of electronic automation was in the control of receiver volume by controlling the gain of preceding stages. In Fig. 4 a radio frequency (r.f.) amplifier is followed by an intermediate frequency (i.f.) amplifier.

The output of the i.f. amplifier is applied to a detector and an automatic volume control (a.v.c.) circuit. If the signal level at the output of the i.f. amplifier decreases, the a.v.c. circuit increases the amplification of the i.f. circuit and the signal level at the output is brought back to the predetermined level required.

If the signal level at the output of the i.f. amplifier increases, the amplification is decreased. In this way the signal level is automatically controlled by feedback.

Fig. 4. Automatic gain control for a receiver circuit.

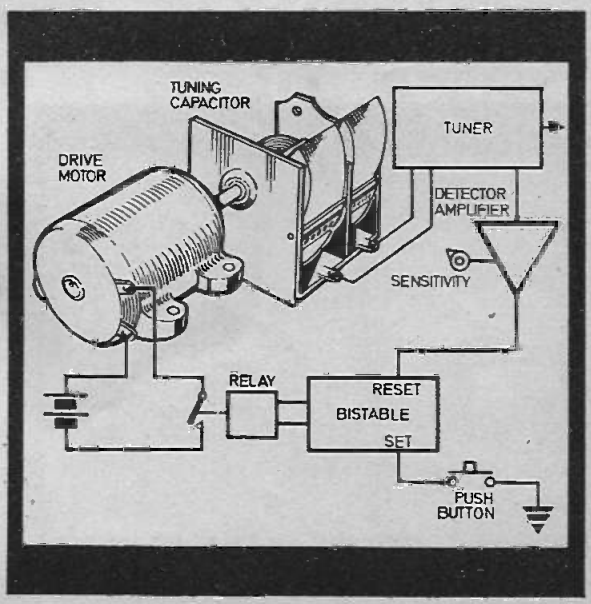


AUTOMATIC RADIO TUNING

In Fig. 5, a continuously rotating capacitor is driven by a d.c. motor. With a signal level above that set by the sensitivity control, the bistable is reset and the solenoid de-energized.

The pushbutton can be foot or hand operated and when pressed it will set the bistable. The solenoid is energized and the motor begins to turn the variable capacitor until the next

Fig. 5. Automatic radio tuning device.



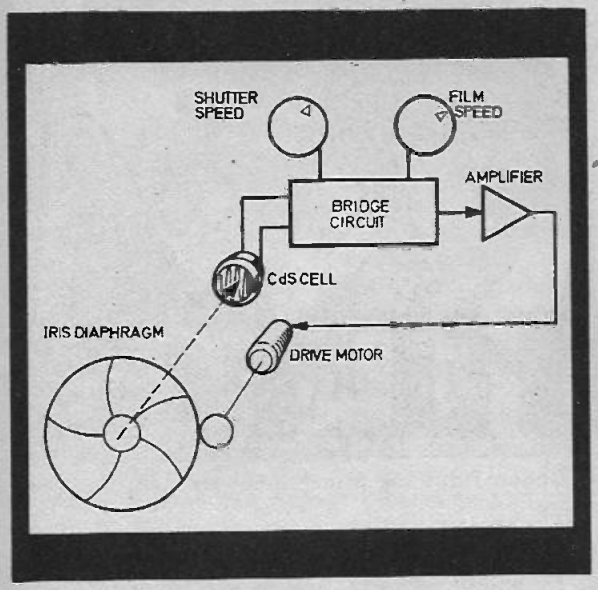


Fig. 6. Basic automatic iris control for a camera.

station, which has an output above the desired signal level, is reached. At that point the bistable is again reset, the solenoid de-energized and the motor stopped.

In this way, the entire band can be swept searching for the desired station.

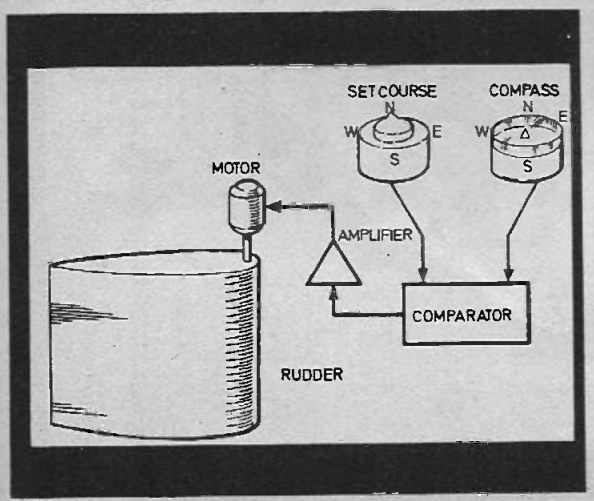
AUTOMATIC DIAPHRAGM CONTROL

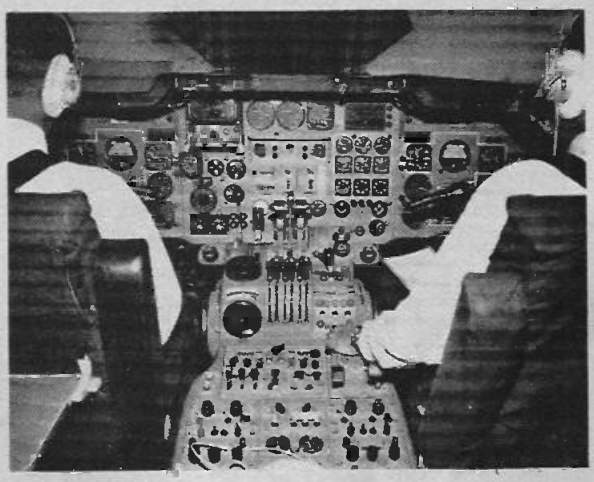
In modern cameras, the iris diaphragm can be automatically adjusted to the available light level. In Fig. 6, the shutter speed control and ASA speed control set the bridge sensitivity. With the camera directed at the scene to be photographed, a certain amount of light falls on the photocell.

If the amount of light is too great, the bridge circuit is unbalanced. The output is applied to an amplifier to drive a motor which reduces the diaphragm opening. The decrease in light level causes the bridge to balance and the motor stops.

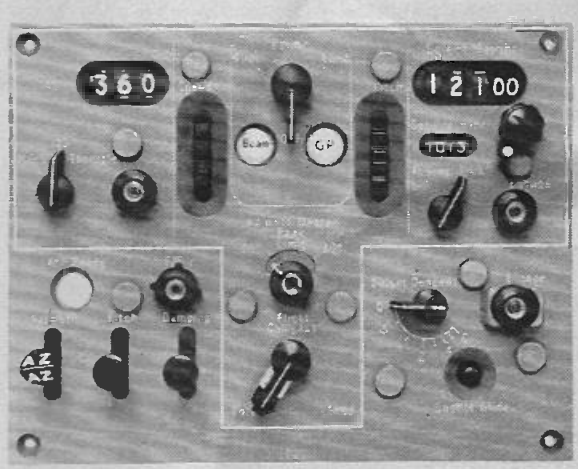
If the light level is too low, the "error signal" voltage polarity from the bridge is reversed and the motor opens the diaphragm to admit more light. Again, in this way the exposure of the film is automatically controlled in response to shutter speed, film speed and the amount of available light.

Fig. 7. Block diagram of a simple automatic pilot, control system.





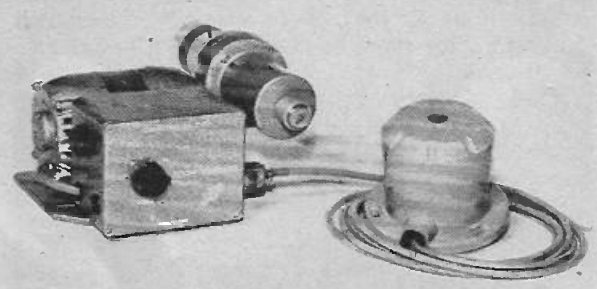
Photograph of a Trident cockpit showing the central controller of a Smiths Autolanding System (shown larger below). The system is in use in the photograph above.



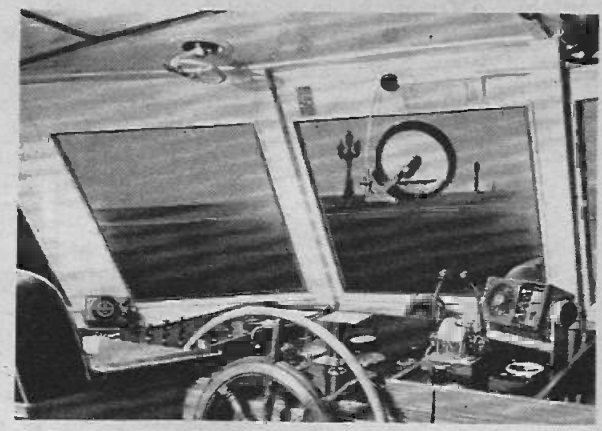
AUTOMATIC PILOT

An automatic pilot for either a boat or an aircraft depends on a magnetic compass or gyro compass. Since the compass will indicate the course of the boat or aircraft at any time, it is only necessary to compare the output of the compass with a device that allows a desired course to be set.

This device could be a potentiometer, synchro transmitter or a more sophisticated device. When the desired course is set, the comparator (Fig. 7) will detect the difference between the



A simple Space Age Electronics autopilot for small boats.



A Decca Pilot 250 fitted on board *M.Y. Cadabra.*

actual and the desired course and actuate the rudder to reduce the difference to zero. The motor would actually be more complex than shown in terms of gearing and auxiliary circuits or it could be a hydraulic system.

AIRCRAFT

In an aircraft it becomes necessary to control both the heading, the bank and the pitch. These signals are obtained from gyroscopes called the "directional gyro" and the "artificial horizon". There will be other instruments in the modern jet aircraft but these serve to illustrate the basic idea.

Control surfaces on the aircraft will be operated by hydraulic systems controlled by special servovalves in response to error signals obtained from the comparison of the gyros with the various attitude controls set by the pilot.

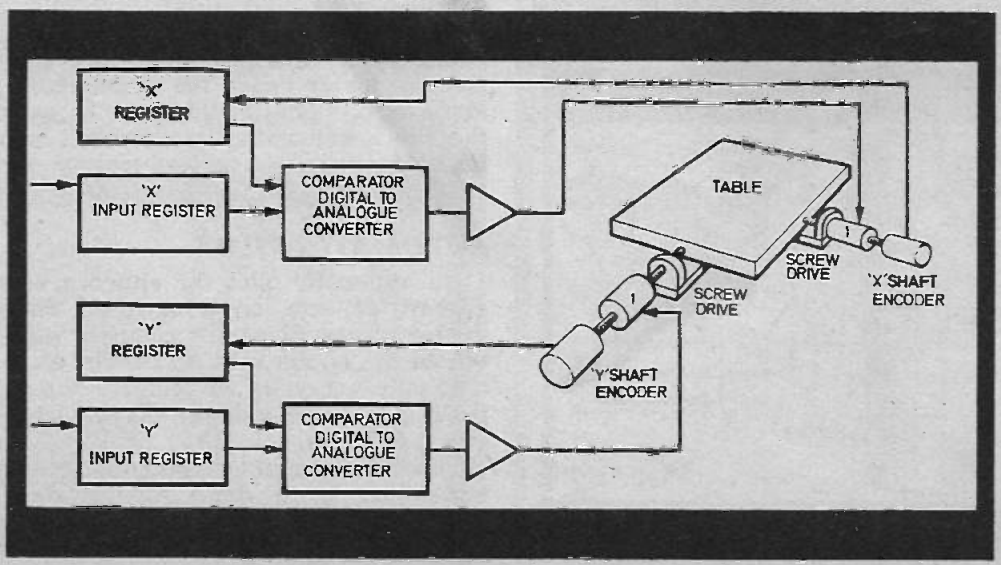
The current work to advance automatic landing systems that allow passenger aircraft to land at fogbound airports, makes use of even more complex control systems. Radio altimeters and airport radar are used in conjunction with the aircraft's "on-board" systems to make it possible to land without pilot intervention.

NUMERICAL CONTROL

Generally, numerical control refers to the various systems used for drilling, milling, and grinding metals to various shapes under the control of special computers or computer systems.

One part of such a system is shown in Fig. 8. In this case a table that would carry a workpiece is controlled in its position in two dimensions. Other necessary controls for a more complex system would include a third dimension, tool selection and tool speed control systems.

Fig. 8. Part of a numerical control system for two dimensional control.



The illustrated system is only one of a number of possible approaches to this operation. The "X" and "Y" registers obtain their input from the "X" and "Y" shaft encoders attached to the drive motors.

The table would normally be zeroed by setting both inputs to zero and allowing the table to stabilise. At this point the work-piece could be attached to the table and mechanical adjustments made.

Once the set-up is complete, the process would begin by entering information into the "X" and "Y" input registers. A continuous comparison is being made by the comparator circuitry between the contents of the input register and the contents of the "X" and "Y" register.

When the information is entered, the comparator detects the digital difference and converts it to an analogue voltage to drive the table positioning motor in a direction that will reduce the difference.

ACCURACY

The shaft encoders are constantly feeding digital information to the "X" and "Y" registers which causes the difference between the contents of the "X" input and "X" register to reach zero at which time the table is properly positioned.

In actual fact, the motors would be driving a set of reduction gears and the shaft encoder would be attached to a further reduction gear for best resolution in reading the table position. It is quite easy to obtain accuracies of 0·001 inch and, with some care in design, accuracies of better than 0·0001 inch can be obtained.

Modern digital plotters use systems similar to this to drive a pen but much additional circuitry is involved since the plotter must actually look ahead to determine when a curved section of line must be calculated with analogue techniques.

These plotters can move at rates of 70 inches per second on straight line segments—a velocity that could literally tear the pen apart if a curved line was attempted at top speed.

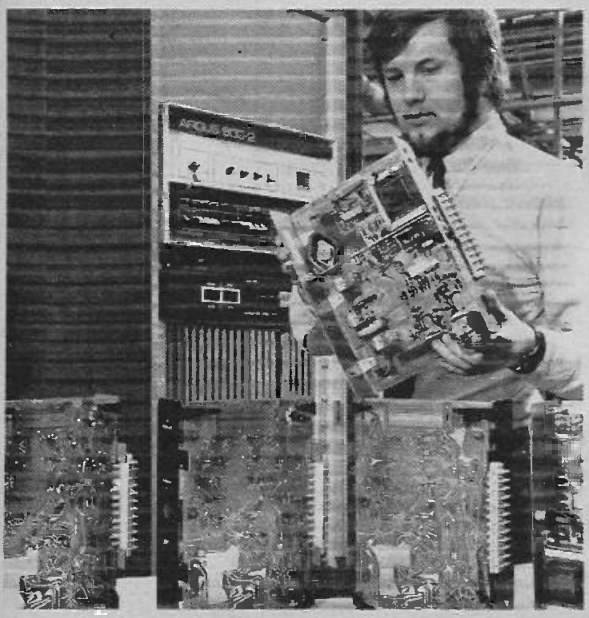
DRAFTING

In conjunction with computers, plotters can be used to draw schematic diagrams, make circuit board layouts and draw masks for integrated circuits. One of the most modern applications—one that anyone might have developed—is that of drawing graded patterns for use in the clothing industry. One size is laid out by hand and the material fed to the computer where all other sizes are computed from this initial one. The computer can also be used to control the cutting of the fabrics.

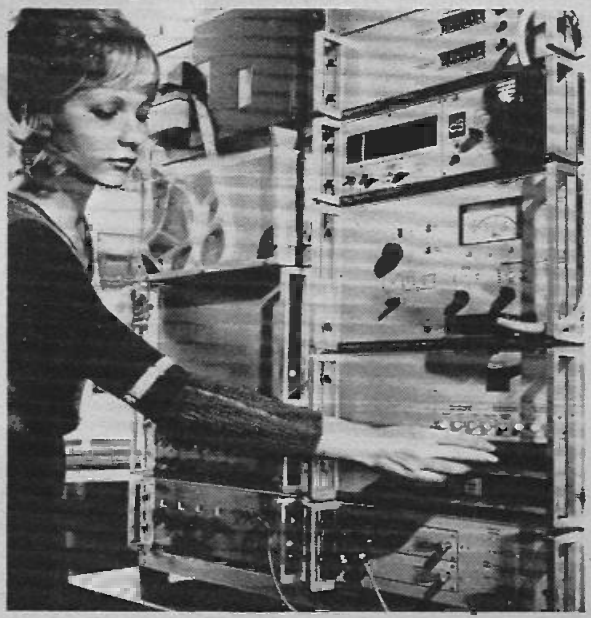
Did you ever stop to think how blazer badges for school uniforms and a thousand other uses are made? Believe it or not on giant 50 to 100 foot looms with hundreds of needles being controlled by Jacquard type punch cards. But efforts are already underway to automate both the design and layout—number of stitches, colour of thread and so forth—and the actual embroidery operation itself.

Automation, especially in the field of electronics, is an ever widening subject and almost everyday another process is automated. ▣

Spegel battery charge controllers in production being prepared for automatic test under control of a Ferranti Argus computer.



The Siemens Ltd., Pegamat automatic test system for general automatic measurement and testing.



Approximate cost of components including V.A.I.

£4.00 plus case

ELECTRONIC doorbell

An electronic unit providing an unusual sounding monitor.

by A. D. Huff.

The old-fashioned type brass door knocker was made redundant many years ago by the electric door bell, this too, however, has largely been superseded by the two tone door chime. Several electronic alternatives have also been designed and have found their way into the constructor's hall. These vary from amplified musical box mechanics to wailing sirens, not forgetting the latest two tone electronic horn.

All of these devices work quite well but all tend to suffer from the same fault, that is, the sound they emit, although loud and clear, is often harsh and unpleasant.

The design offered here, however, does not suffer from the above disorders, due to the fact that several vibrating tones are emitted at the same time, thus making it quite pleasant to listen to. The sound is difficult to describe in words but can be assumed to be that of several notes varying in frequency (pitch) with an overall tremolo effect.

Although the device is only low power output (typically 500mW) the resultant varying tone makes it quite distinct from any other general noise.

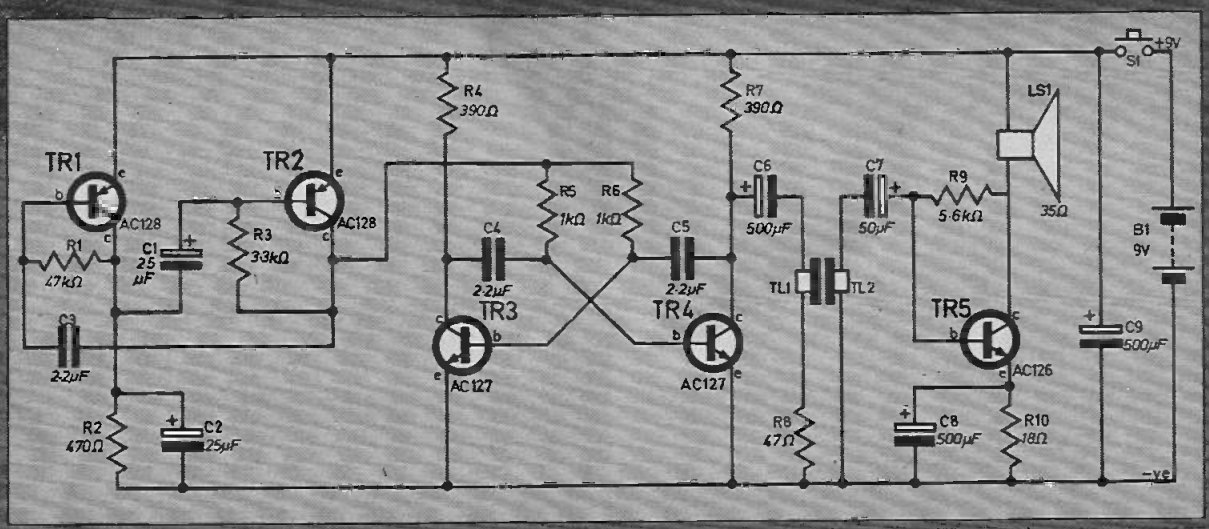
CIRCUIT DESCRIPTION

The basic circuit consists of two astable multivibrators, one being comprised of TR1 and TR2, and the other TR3 and TR4.

A basic knowledge of the operation of an astable multivibrator is all that is required to understand the circuit. Hence, the multivibrator comprised of TR3 and TR4 and the overall function of the unit will be explained.

The circuit of TR3 and TR4 has two states,

Fig 1. Circuit diagram of the Electronic Doorbell.



these are: with TR3 hard on and TR4 off (no collector current), and with TR3 off and TR4 on.

At the instant of switch on, current will flow in TR3 and TR4, but, due to variations in gain and component tolerances, one transistor will draw more current than its counterpart.

Let us assume TR3 draws more current than TR4. The voltage at TR3 collector therefore goes less positive, this voltage change is coupled to TR4, via C4, which tends to switch TR4 off. Positive feedback occurs via C5, and TR3 is turned fully on. Capacitor C5 now charges through R7 and TR3, and, as it becomes fully charged, tends to turn off TR3. Positive feedback takes place via C4 which tends to turn TR4 on. As soon as TR4 is turned on, C4 starts to charge and will eventually switch TR4 off. This see-saw action continues as long as the supply is connected.

Components....

SEE SHOP TALK

Resistors

R1	47kΩ
R2	470Ω
R3	3·3kΩ
R4	390Ω
R5	1kΩ
R6	1kΩ
R7	390Ω
R8	47Ω
R9	5·6kΩ
R10	18Ω

All ¼W ± 10% carbon

Capacitors

C1	25μF elect. 12V
C2	25μF elect. 12V
C3	2·2μF miniature foil
C4	2·2μF miniature foil
C5	2·2μF miniature foil
C6	500μF elect. 12V
C7	50μF elect. 12V
C8	500μF elect. 12V
C9	500μF elect. 12V

Transistors

TR1	AC128 germanium *pnp*
TR2	AC128 germanium *pnp*
TR3	AC127 germanium *npn*
TR4	AC127 germanium *npn*
TR5	AC126 germanium *pnp*

Miscellaneous

S1 Single pole push to make pushbutton (for door mounting).
B1 9V PP6 battery and connectors
TL1, TL2 G.P.O. telephone earpiece inserts (approx. 21 ohms impedance, 2 off)
LS1 35Ω loudspeaker approx. 5 x 2¾ inches.
Veroboard plain perforated 0·15 inch matrix 5 x 2½ inches, materials for cabinet (see text), 4BA fixings, Terry clips (2 off), small clip on heat sink for TR5, connecting wire.

CIRCUIT OPERATION

Transistors TR3 and TR4 as already stated form an astable multivibrator the frequency output of which has been centred around 400Hz. This frequency is the resultant of the time constant between R5, C4, R6, C5 plus the resistance of the collector emitter junction of TR2. Therefore if a current change can be made to flow through the emitter base junction of TR2, its collector current will change thus altering the time constant values and hence the output frequency of TR3 and TR4.

Since TR1 and TR2 also form a multivibrator, the base current of TR2 is constantly changing and therefore constantly changing the output frequency. The complex resultant frequencies of the two multivibrators are thus present across TL1.

Base bias for TR1 and TR2 is obtained via R1 and R3 respectively, the collector load of TR1 (R2) has been decoupled by C2 to remove any high frequency harmonics in this part of the circuit and also lower the working frequency of TR1 and TR2.

The varying output frequency of TR2 and TR3 appears, together with the output frequency of TR1 and TR2 (via R6, C5 and C6) across the transducer TL1. The coupling of the multivibrators to the audio amplifier is by two G.P.O. telephone earpiece inserts placed together as shown in Fig. 2, care must be taken to ensure that the three holes of each earphone align correctly.

The resistor R8 is included to account for any changes in resistance of TL1 which should be 21 ohms. There is no doubt that a matching transformer could be used in place of TL1 and TL2 but, however, all those tried produced a much more harsh output than the earphone coupling, also, the price of the two earphone inserts is cheaper than most matching transformers.

Transistor TR5 and its associated components follow normal audio amplifier practice and TR5 is biased into class A operation by R9 and LS1; R10 is included in the emitter leg to prevent thermal runaway, this is decoupled by C8 to prevent negative feedback occurring at low frequencies across R10.

The output volume could if required be increased by use of an output transformer but care must be taken to avoid distortion.

The component values are quite critical and should not be varied from the original. The current drawn by the monitor is about 140 milliamps which is quite small compared to that of conventional door chimes which are often in the order of amps. Hence quite a long life from a standard PP6 battery should be expected.

CABINET CONSTRUCTION

The original unit was built complete with loudspeaker and battery into a small wooden box made from 3-ply to the dimensions shown

ELECTRONIC doorbell

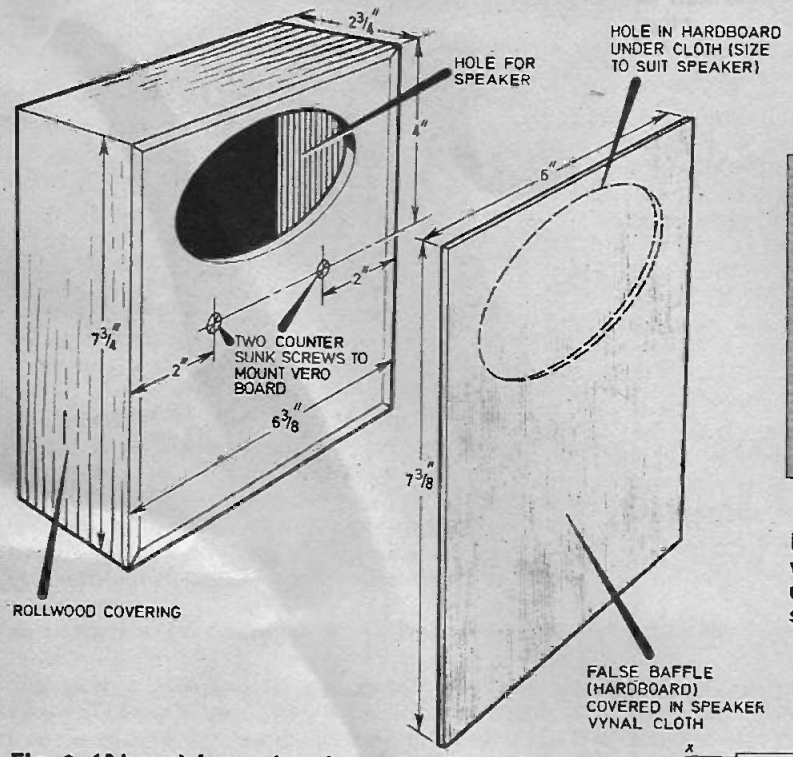


Fig. 3. (Above) Layout and construction of the basic case.

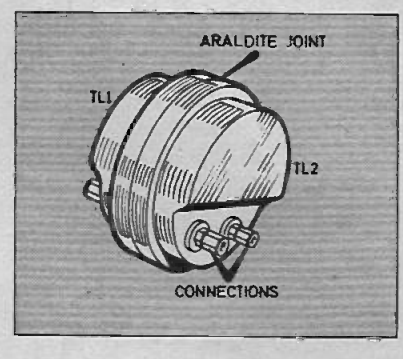
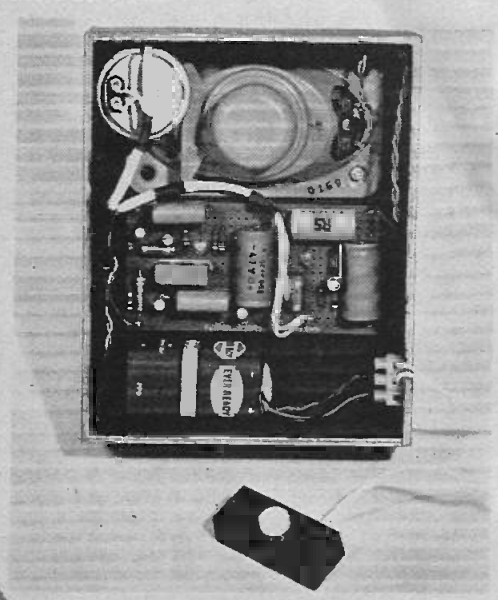


Fig. 2. Showing the way in which the two earpieces are used to couple the output stage.



Photograph of the complete unit.

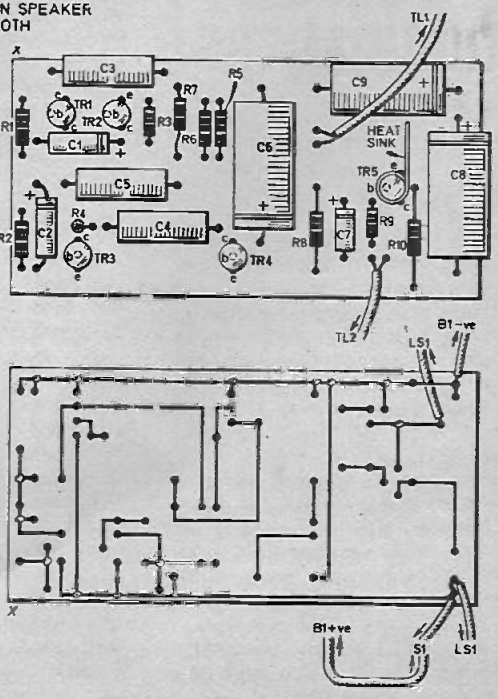


Fig. 4. Layout and wiring of the Veroboard.

in Fig. 3. Before covering, two countersunk $\frac{3}{4}$inch long 4BA bolts were set and lock-nutted into the front panel to hold the Veroboard and associated components. The cabinet was then covered in teak rollwood to give a professional finish, although Formica or vinyl covering would have served just as well.

At the front of the cabinet a false baffle is fitted, this is made from hardboard. The baffle is slightly smaller than the front and can be covered in vinyl speaker cloth and then glued to the main cabinet. The overall appearance is thus that of a miniature speaker cabinet.

CONSTRUCTION

Commence construction by wiring the positive and negative supply wires to each side of the Veroboard (Fig. 4). Resistors and capacitors should be first to be soldered in, and last of all, the transistors. The layout is not critical and may be modified if required. Care must be taken in correct wiring since direct coupling is used in the circuit and any faulty wiring could easily destroy one or more transistors.

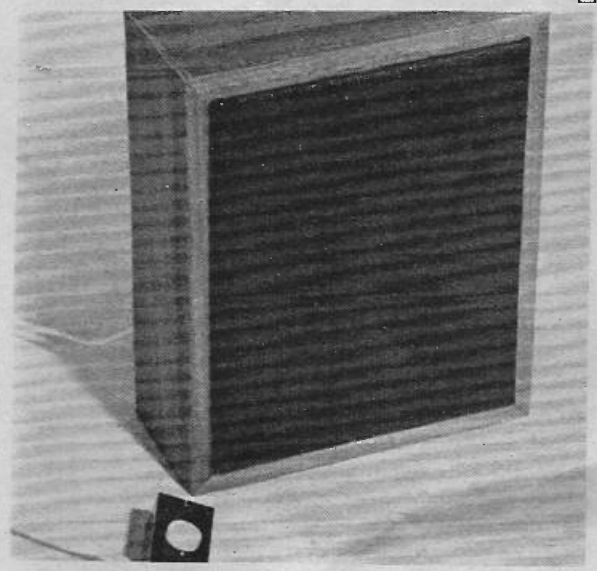
When the two earphones have been glued together they can be secured to the cabinet by a Terry clip or just glued to the cabinet. The battery is also held in place by a Terry clip.

The monitor has been well proven and should, if constructed correctly, function perfectly for years.

GENERAL USE

If the unit is to be used for a door monitor the heat sink on TR5 should be sufficient, however if continuous use, such as alarm, is required, this heat sink should be increased in size.

Several other interesting outputs can be obtained by increasing the value of C3 in stages, up to about 100μF, best results are found by experimentation. ▣



Ruminations

By Sensor

Blind Faith

Last week I met a radar engineer who is responsible for the maintenance of radar and electronic navigational equipment fitted on board fishing boats. In the area where he works, sea fogs are common at this time of the year and the fishermen are very dependent on the ship's radar in order to avoid collisions with other vessels or natural hazards. In fact, so much confidence have these seamen in their radar gear that they will continue to fish in conditions so bad that a ship only a cables length away cannot be seen!

It says much for the reliability of the equipment when men are prepared to place their lives at risk with complete faith in their electronic equipment. The engineer responsible for maintenance carries a heavy load and is aware of the reliance placed upon the equipment under his charge but nevertheless may feel a little anxious when the fog comes down.

Joining Up

Great things are happening off the coast of North East Scotland. The pipe line is now being laid to bring oil from a well 160 miles off shore to a landfall in Aberdeenshire. The pipe layers are kept "on track" over a previously surveyed route by the Decca Navigator system and, as the pipe is being laid simultaneously by two vessels, one from landward and one from seaward, the two ends will be joined together far out at sea. Although I have every confidence in the men and equipment involved I would, personally, feel much better if a very long flexible joint were available—just in case of difficulty.

There are other examples of the use of electronics in this kind of application. Modern tunnel boring techniques employ a laser beam to keep the excavators on the right road and there is no fear of missing the "other end".

Enormous, unwieldly looking machines are controlled and guided with precision by electronic systems and their users take for granted that the equipment will function accurately and reliably at all times. Of course, we all rely upon other sciences in a similar way and perhaps have the least confidence in those we know best.

Does the civil engineer avoid driving over box section girder bridges? Or does he cross gingerly with a prayer on his lips? Does the surgeon avoid the knife?

I think that most journalists are sceptical of what they read in the papers and a chef I knew was not at all keen to eat in a restaurant. I suppose that if everyone does his job properly everything will be fine. But a "long flexible joint" is well worth having.

SEMICONDUCTORS

THREE DIODES AND THE TRANSISTOR

J.B. DANCE M.Sc.

LAST month explained the various characteristics associated with silicon and germanium diodes; we shall now continue with various types of diode and introduce the transistor.

POINT CONTACT DIODES

A point contact diode consists of a springy wire (often tungsten) which touches a semiconductor crystal (normally *n*-type germanium). A small region of *p*-type germanium is formed beneath the tungsten wire by passing a suitable current through the device during manufacture.

The *pn* junction thus formed enables the diode to pass a current in one direction only. The point contact concentrates the electric field near to the surface of the germanium. The point contact diode is the modern equivalent of the old "cat's whisker" which was used as a detector in the early days of radio.

Point contact diodes have a low capacitance when reverse biased and are widely used as radiofrequency detectors and mixers. They have the disadvantage that their forward voltage tends to be higher than that of junction diodes at the same forward current.

It can be seen in Table 3.1 that the forward voltage of the point contact diodes is higher than that of silicon diodes, although one might expect it to be lower owing to the lower natural junction potential of germanium.

On the whole, point contact diodes are less robust than junction diodes, but this is not normally of great importance.

GOLD BONDED DIODES

Gold bonded diodes are point contact diodes in which the point contact is made of gold wire.

The electrical characteristics of gold bonded diodes are roughly intermediate between those of normal point contact diodes and those of germanium junction diodes. Their forward voltage is fairly low, whilst their junction capacitance is only a little greater than that of a normal junction diode.

JUNCTION DIODES

Germanium junction diodes have been largely replaced by silicon diodes. It can be seen from the table, however, that the type OA10 germanium junction diode has a low forward voltage. The type OA10 is now a maintenance type and therefore it may not be readily available.

ZENER DIODES

Zener diodes are silicon junction diodes which show a very sharp breakdown characteristic when reversed biased, see Fig. 3.1.

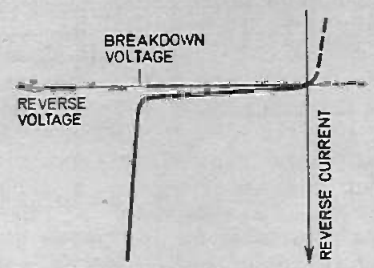


Fig. 3.1. Shows the sharp breakdown point for reverse biased silicon *pn* junction.

Table 3.1: Diode Parameters

Device	Maximum Reverse Voltage (V)	Maximum Forward Current (mA)	Typical V_F at I_F (V)	(mA)	Typical I_R at V_R (μA)	(V)	Construction
OA91	115	50	2·1	30	75	100	Germanium point contact
AA119	45	35	2·6	30	170	45	
OA47	30	250	0·54	30	10	30	Germanium gold bonded
IN994	8	20	1·0	10	30	6	
OA10	30	100	0·38	30	4	30	Germanium junction
OA200	50	80	1·15	30	0·02	50	Silicon junction
IN4148	75	200	1·0	10	0·025	20	Silicon high speed
IN4308	80	250	0·77	20	0·1	75	Silicon planar epitaxial
BY100	800	550	1·5	5000	10	1250	Silicon power

V_F–forward voltage; I_F–forward current; V_R–reverse voltage; I_R–reverse current.

The manufacturers can make diodes of a chosen breakdown voltage by a suitable choice of impurity levels on each side of the junction. The diodes can be used for voltage stabilisation.

You will come across two circuit symbols for the Zener diode—to distinguish them from other diodes, and these are shown in Fig. 3.2. The symbol type (a) will be found in English text books and journals whereas (b) will be found in American books and journals. The polarity marking at the end of the body i.e. the ring or dot, signifies the cathode.

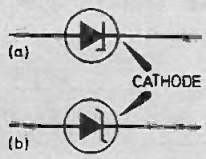


Fig. 3.2. Circuit symbols used for identifying the Zener diode.

STABILISATION

The simplest circuit in which a Zener diode can be used for voltage stabilisation is shown in Fig. 3.3.

The voltage across the Zener diode remains fairly constant as the current passing through it changes. If, therefore, the input voltage becomes somewhat larger, the Zener diode will pass an increased current so that the voltage drop across *R1* becomes greater and the stabilised output voltage remains almost unchanged.

If the output current increases, the current passing through the Zener diode will decrease by almost the same amount, leaving the output voltage almost unchanged.

The circuit must be designed so that some current always passes through the Zener diode, but the current must never exceed the amount which would cause more than the permissible amount of power to be generated in the diode.

These conditions must be satisfied no matter how the output current or input voltage may vary.

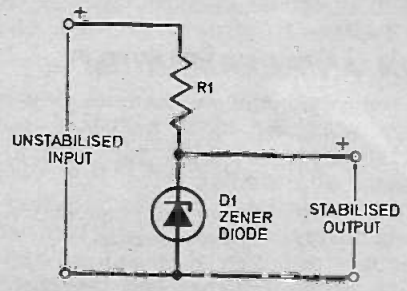


Fig. 3.3. A simple stabilised voltage supply.

More complicated circuits with a wider range of output currents can be designed using Zener diodes with transistors.

Diodes which pass a high reverse current at an applied voltage of less than about 5V depend on the true Zener effect.

ZENER BREAKDOWN

Zener breakdown occurs when the large electric field near the junction releases numerous charge carriers.

When reverse voltage breakdown occurs at about 7V or more, the avalanche effect is responsible. In this case electrons are accelerated across the junction to such a velocity that they produce further charge carriers when they collide with atoms. The newly formed charge carriers are in turn accelerated and form still more charge carriers. The process continues and produces complete breakdown.

Diodes employing this effect are usually called Zener diodes, although voltage regulator diodes would be a rather better term.

A typical series of voltage regulator diodes is the Mullard BZY88 series. These can provide stabilised outputs from 1·3 to 30V, depending on the particular diode chosen.

For example, the BZY88/C6V8 has a breakdown voltage of 6·8V, whilst the BZY88/C10 breaks down at 10V, the tolerances on these voltages being ±5 per cent. The maximum dissipation of this type is 400mW and the maximum current 250mA.

The diodes numbered 1N746 to 1N759 are a similar series of 400mW Zener diodes for the voltage range 3·3 to 10V. Larger Zener diodes are available for high currents and high power dissipation; some types should be mounted on a heat sink.

DIODES AS VARIABLE CAPACITORS

It has been shown earlier in this series that the thickness of the depletion region of a junction diode varies with the applied reverse voltage (and also with small forward voltages less than the natural junction potential).

The insulating depletion region of a junction diode can act as the dielectric of a capacitor, the capacitance value varying with the thickness of the dielectric.

Thus, the capacitance of a junction diode can be varied by altering the voltage applied to the device.

Reverse biased junction diodes are used as electrically controlled variable capacitors for tuning radio receivers, especially in the v.h.f. and u.h.f. regions.

OTHER TYPES

Many specialised types of diode are manufactured for use at high frequencies (such as

tunnel diodes, backward diodes, hot carrier diodes, Schottky barrier diodes, etc.). The principles of operation of such devices will not be covered, since they are beyond the scope of the present article.

SIMPLE DIODE TESTING

The amateur experimenter can easily test a *normal type* of diode using the simple circuit of Fig. 3.4.

When the diode is placed across the test prods in one direction, little current should pass, whilst in the other direction the diode should pass about 5mA.

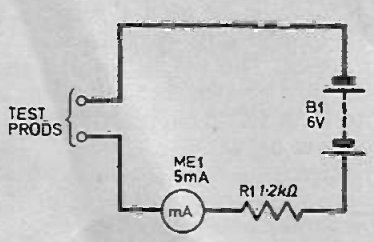


Fig. 3.4. A simple circuit for the testing of diodes.

Obviously many more tests would have to be carried out to check the full performance of a diode, but the purpose of the simple circuit of Fig. 3.4 is merely to provide a very rapid check that the diode is performing basically in the way that it should.

If the diode being tested is a Zener type, care should be taken to reduce the voltage of the battery to a value of less than the Zener voltage, or the diode will conduct in both directions. Even if this is not done, the circuit will not damage the diode, since the series resistor limits the current to 5mA.

The values suggested are convenient ones, but any other reasonable values could be used, for example, a 9V battery, a 0-10mA meter and a 1 kilohm resistor.

TRANSISTORS

The common transistor is somewhat more complicated than the semiconductor diode, since it involves the use of two junctions in a single crystal of the semiconductor material. Nevertheless the elementary theory we have so far developed can be used to explain its mode of action in very simple terms.

Transistors are extremely important devices because they can be used in circuits which enable a small current to control the amplitude of a much larger current; they can therefore be used as amplifiers.

POINT CONTACT TRANSISTORS

The point contact transistor was the first type of transistor to be produced in commercial quantities. In this device two pointed wire contacts (or "cat's whiskers") touch a piece of *p*-type or *n*-type germanium, the two points of contact being very close together.

The point contact transistor has not been in commercial production for many years and will not, therefore, be discussed further.

JUNCTION TRANSISTORS

Modern transistors can be divided into field effect transistors (which will be covered in a later article in this series) and the more common junction bipolar type to be discussed now.

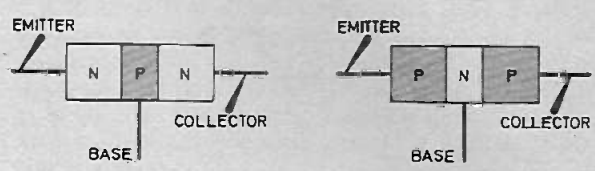


Fig. 3.5 Construction of *npn* and *pnp* transistors.

Ordinary junction transistors can be constructed in two distinct ways, as shown in Fig. 3.5. Both of these types of device consist essentially of a single crystal of the semiconductor material containing a sandwich of the one type of doped material between two layers with the opposite type of doping.

The two types of junction transistor are known as *npn* and *pnp* types for reasons which are obvious from Fig. 3.5.

The layer at the centre of the sandwich is known as the base, whilst the other two parts are known as the emitter and collector respectively. We shall see shortly that the emitter emits charge carriers (electrons or holes) and most of these charge carriers pass through the base region into the collector.

In almost all practical transistors, the construction of the two junctions is different. Thus the emitter and collector are not completely interchangeable, as might be expected from the symmetry of Fig. 3.5.

The base is always very thin, being perhaps 0·001cm in thickness in some types.

SILICON AND GERMANIUM

Some ten years ago germanium *pnp* transistors were used for most purposes, but now silicon transistors can be made with a better performance at a similar price.

Silicon *npn* transistors tend to be rather easier to manufacture than silicon *pnp* transistors of a similar performance thus silicon *npn* types tend to be rather cheaper and therefore more frequently used. For this reason the *npn* transistor will be considered first in detail.

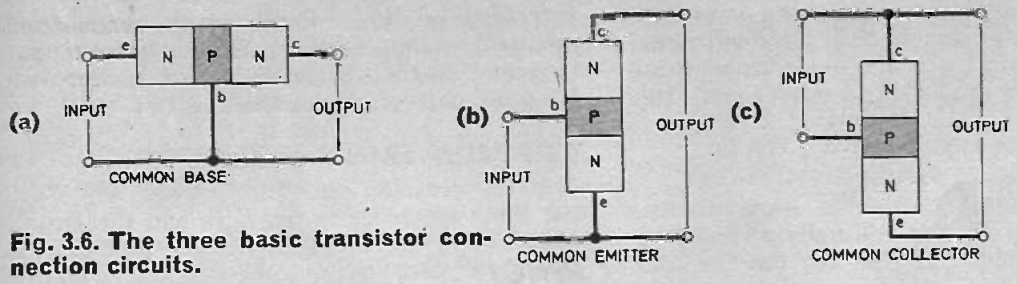


Fig. 3.6. The three basic transistor connection circuits.

THREE BASIC CIRCUITS

If an input circuit is connected to a transistor, two wires are used. A further two connections are required for the output. Thus a total of four connections must be made to the three leads from the transistor.

One of the transistor leads must therefore be common to both the input and output circuits. Any one of the three connections to the transistor may be chosen as the common one, but the performance of the circuit is very dependent on the choice made.

In the basic circuit of Fig. 3.6a, the base is common (**common base**) to both the input and output circuits. The most commonly employed basic circuit is the **common emitter** circuit of Fig. 3.6b, since this provides maximum overall amplification.

The **common collector** circuit of Fig. 3.6c is also known as the **emitter follower** and is used when a low output impedance or high input impedance is required.

It may be mentioned in passing that three similar methods of connection are used with thermionic valves, these being the common grid (or grounded grid), the common cathode (the most commonly used circuit) and the common anode (or the cathode follower).

BIASING

When a transistor is to be used as an amplifier, it is necessary that the emitter/base junction should be forward biased and the base/collector junction reverse biased, no matter which type of basic circuit is used.

In the *npn* transistor, this means that the base should be slightly positive with respect to the emitter and the collector appreciably positive with respect to the base, as shown in Fig 3.7.

The resistor R_e limits the current flowing in the forward biased emitter/base circuit to a reasonable value.

A depletion region is formed at the base/collector junction, since this is reverse biased. Majority carriers (holes in the *p*-type material and electrons in the *n*-type material) are repelled away from the junction.

Thus the reading of the milliammeter in Fig. 3.7 would be very small if the presence of the emitter/base junction did not affect the current flowing in the collector circuit.

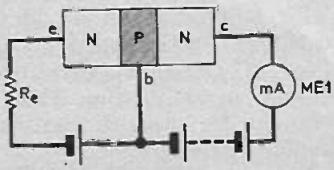


Fig. 3.7. Biasing of an *npn* transistor.

THE EMITTER BASE JUNCTION

The forward current flowing at the emitter/base junction consists of electrons passing from the emitter to the base and of holes passing in the reverse direction. Any of the electrons from the emitter which pass through the thin base region into the depletion region of the base/collector junction, will be quickly swept into the collector by the positive voltage applied to the latter.

A few of the electrons entering the base will combine with the holes present in the latter, thus giving rise to a current in the base connecting lead.

In a practical transistor, the base is lightly doped and contains few holes, therefore most of the electrons from the emitter will reach the collector before they have the opportunity to combine with a hole. Fewer electrons are lost by combination with holes in the base region if the base is very thin.

Electrons which pass from the emitter to the collector in Fig. 3.7 cause a collector current to be registered by the milliammeter. The fraction of the electrons from the emitter which reach the collector is almost constant. Therefore the collector current is almost proportional to the emitter current.

In the common base circuit of Fig. 3.6a, this means that the output current is almost proportional to the input current.

COMMON BASE CURRENT GAIN

In a typical transistor, about 98 per cent of the electrons leaving the emitter reach the collector. Thus one may say:

$$\text{current gain} = \frac{\text{output current}}{\text{input current}} = \frac{\text{collector current}}{\text{emitter current}} = 0{\cdot}98$$

In practice, we are usually more interested in the incremental current gain (or small signal current gain), since we are likely to be using the transistor for amplifying a small signal. This current gain is usually designated α or h_{FE} in the *common base* circuit and is given by:

$$\alpha = \frac{\text{a small change in output current}}{\text{corresponding change in input current}}$$

The value of α is also normally about 0·98.

One may wonder how one can use the common base circuit to amplify a signal, since the output current is slightly smaller than the input current. In order to answer this point, we must consider the circuit resistances involved and the behaviour of the collector circuit.

COLLECTOR CHARACTERISTICS

The collector characteristic of a transistor is of the general form shown in Fig. 3.8.

As the collector voltage is increased from zero, more electrons from the emitter will be attracted from the base across the depletion region into the collector, thus increasing the collector current.

When almost all of the electrons leaving the emitter reach the collector however, any further increase in the collector voltage will have little effect on the collector current. Thus the characteristic has a "knee" or bend at point *A* in Fig. 3.8.

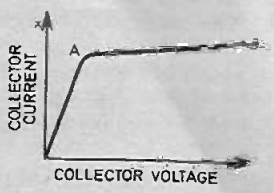


Fig. 3.8. Basic collector characteristics of a transistor.

The small increase in current with applied voltage above point *A* implies that the collector circuit resistance has a high value at applied voltages above this point. Typically, the value of the collector resistance is about one megohm above point *A*.

If a resistor is placed in series with such a high resistance circuit (that is, in series with the collector), it will produce a much smaller effect on the current flowing than a similar resistor placed in a low resistance circuit, such as the emitter circuit.

Although a small change in the input emitter current produces a collector current change at the output which is slightly smaller than the input current change, a much larger value of resistor may be used in the output circuit than in the input circuit. Even a small change in the collector current will produce quite a large voltage change across this resistor.

A transistor in the common base circuit can therefore provide voltage amplification (and also power amplification), although the output current changes are always rather smaller than the input current changes.

COMMON EMITTER CIRCUIT

In the common emitter circuit of Fig. 3.6b, the input electrode is the base and the output electrode is the collector. The current gain is therefore base current divided by collector current.

The transistor is biased as before. A forward current flows in the emitter base junction, this consisting mainly of electrons flowing from the emitter to the base (and hence, to the collector), since there are few holes in the lightly doped *p*-type base to flow in the other direction.

The few holes which do flow are replaced by a current flowing into the base through the external base lead.

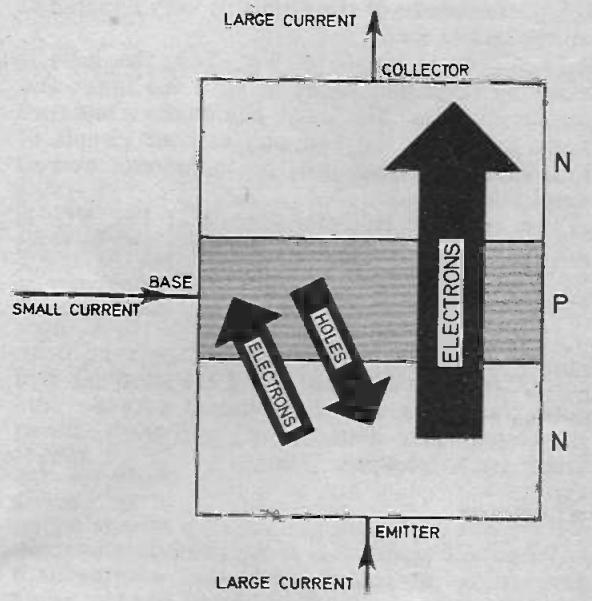


Fig. 3.9. Flow of charge carriers in the *npn* transistor.

Thus, as depicted in Fig. 3.9, a large electron current flows from the emitter to the collector via the base, whilst a much smaller current flows in the base lead.

Any increase in the base current being fed to the transistor will result in an increased flow of forward current in the emitter/base junction and the flow of collector current will be increased almost in proportion. Thus, the small base current can be used to control the much larger collector current.

Next month: Common emitter current gain and further discussion on transistors in circuits.

Batteries

Why do battery manufacturers choose such odd values for their voltages (i.e. $4\frac{1}{2}$ and 9 volts)? It would make calculations a lot simpler if they were to be 5 and 10 volts respectively!

We agree! Unfortunately the manufacturers have to pander to the whims of nature (or rather the Leclanché cell). The standard cell used in batteries has electrodes of zinc and carbon; these provide electrode potentials that give a difference of about 1·5V. Hence most common batteries have voltages which are an exact multiple of 1·5. Some special types of batteries (e.g. those based on the mercury cell) have a different range—based on multiples of about 1·2V.

Meter Output

My multimeter has a socket on it marked "output". As far as I can see there is nothing that can come out of it! I investigated inside and found a capacitor connected to this point but am none the wiser about what it is for.

It is quite likely that this is (paradoxically) another input to your meter and it is for measuring a.c. signals superimposed on a d.c. level—as one encounters in the output stages of amplifiers.

Try it across the loudspeaker connections of an amplifier having the meter switched to a low a.c. range. In the absence of an audio signal you should get no reading but as soon as there is sound to be heard in the speaker you should get a reading proportional to the volume. This facility is useful when tuning a superhet radio to maximum signal because the ear is not always as discerning to level changes as one would like it to be.

Radio Amplifier

I have an old radio which produces a very good tone but unfortunately only works well on very local stations. Is it possible to dispense with the radio part and just use the amplifier to make a simple record player? If so what sort of pick up should I use?

You can convert most radio sets to make a simple record player amplifier. Obviously the quality depends on the type of set you have but the conversion is quick and simple and if done properly does not prevent the set being used as a radio as well. The technique can be applied to valved or transistorised radios but **should not be carried out on a.c./d.c. mains sets** that do not have isolating transformers.

Locate the rear of the volume control—be careful that you select the right component if it is ganged with the mains on/off switch! Of the three connections to the potentiometer, ignore the centre one (the wiper). Of the other two, one will be connected to ground or chassis (it might have the screening of coaxial wire connected to it or have a piece of tinned copper wire running straight to the chassis of the radio). Leave that as it is but now —by a process of elimination turn to the third termination. This will have the signal wire coming from the radio detector.

Replace this wire with the centre core of a piece of screened lead running from your pick-up; the screen should be connected to the chassis of the radio. You might prefer to insert a switch so that you can change over from radio to "gram"; a single pole two way switch is suitable for this, and the pick up connections brought out to a socket on the radio's cabinet. You will probably need a reasonably high level signal from the cartridge and we suggest a crystal pick up would be best.

Radio Design

I would like to know if there is a formula which relates the number of turns on a ferrite rod used in a radio, to the frequency covered. Could you also tell me what frequencies coastal stations and trawlers/ships broadcast on.

Most of the services you mention can be heard in the 1·75 to 3·0 MHz band, or on approximately 170 to 100 metres.

Using a 6inch ferrite rod $\frac{3}{8}$inch in diameter, this band may be covered by a winding consisting of 35 turns of 24 s.w.g. enamelled wire, side by side, the winding beginning $\frac{1}{2}$inch from one end of the rod.

As the inductance and coverage depend largely on the position of the winding on the rod, the turns may be wound on stout paper or thin card, so that it can be slid on the rod to adjust coverage if necessary. The tuning capacitor for this range is 350 or 365pF maximum capacitance.

Moving the winding towards the end of the rod raises the frequency tuned. This adjustment will allow a 5 inch to 8 inch rod to be used.

Exact inductance calculations with ferrite rods or cores can only be made with reference to actual core material of particular manufacture, and by reference to the maker's figures for the material.

Earth

Why is it we hear that using an earth wire makes a piece of equipment safe. As I see it there is still just as good a chance of getting an electric shock from the mains going into, say, an electric fire.

Having an earth wire does not prevent one getting an electric shock if one was to touch the live mains lead under certain conditions. However, most pieces of electrical equipment have metal cases to protect you from such contact and there is always a faint chance that a live wire might come loose inside the box and touch the case, or possibly insulation on a transformer might break down. If either of these possibilities occur, the case will be live and there is no way of telling—until it is too late!

If, however, the case is well and truly connected to earth, the cur-

rent from the loose wire, inside, will go to ground preferentially down the earth wire—rather than through you—and at the same time there is a very good chance that the current will be so great that the fuse will blow—giving total protection. That is why you should always check why a fuse has blown before you replace it!

Transformer Action

Am I right to assume that a direct current flowing in the primary of a transformer gives a standing direct current in the output with any alternating current superimposed?

No, this is not true. It is possible to have a circuit when there is standing d.c. flowing through a transformer primary. This does not produce any induced voltage across the secondary because induction only takes place when there is a rate of change in current. If there is a.c. superimposed on the standing primary current only the a.c. variations will induce currents in the secondary circuits.

There is a side effect from the standing d.c. If it is too great it could saturate the magnetic characteristics of the iron core of the transformer and make transformer action less efficient; at the same time one has to watch that the input current rating of the transformer is not exceeded—the a.c. has to be added to the standing d.c.

Thyristors

You say that CSR's (thyristors) used in the *Audio Colour Unit* conduct only in one direction so the lamps do not receive the full sine wave. Does this mean there will be a flickering of the lamps? If so could triacs be substituted in the same circuit?

It is true you will notice a slight flickering of the lights because when using only half the a.c. cycle the power applied will be going from zero to peak only 50 times a second whereas normal mains goes from zero to peak 100 times a second—positive going and negative going alternatively. Strictly speaking the lamps run from the *Audio Colour Unit* are off for as long as they are on. The flicker is only slight and is not very noticeable. It is not possible to substitute triacs without circuit modification.

Thyristor Ratings

The thyristor CRS1/40 is exactly the same physical size as some types of transistors. The thyristor is capable of passing 1 amp at up to 400 volts (which I make to be 400 watts) whereas the transistors in the same size case have a maximum rating of only about 1 watt. They are both semiconductors so why is there such a vast difference?

The power dissipated in a device is obtained by multiplying the current flowing through the device by the voltage drop across it at that current. A thyristor—when it is in a correctly operating circuit—is always in one of two possible conditions, (a) non-conducting, or open circuit in which case virtually no current flows, (b) in full conduction when maximum current is flowing but the voltage drop across the device is very small—typically a volt or two.

Take the first case; the current is zero and the voltage across the thyristor might be the full 400V. Even so when you multiply 400 by zero the answer is zero so there is no dissipation in the device. In the second case say the maximum current flowing is 1 amp (as for the CRS1/40) and the voltage drop across the device is 1V; power dissipation is 1 watt.

You should be able to see now that although the thyristor might be operating a load that dissipates 400 watts there is only 1 watt dissipation within the thyristor—equivalent to the maximum rating of the transistors you mentioned. With a thyristor you can never have maximum current and peak voltage across it at the same time; however this is a possible condition that a transistor might meet when it is operating on the linear region of its characteristic.

Impedance

Is there any simple way of determining whether a loudspeaker is 3 ohms or 80 ohms?

Strictly speaking the 3 or 80 ohm is describing the loudspeaker's impedance at 400Hz. This impedance is made up of the coil's inductive reactance in series with its resistance to d.c. Usually, and especially for small loudspeakers, the inductive reactance is small and most of the value for impedance is contributed by the resistance.

As a rule of thumb you can measure the resistance on a low range ohm-meter and add about 20 per cent to get a rough idea of the impedance. The alternative method is rather complex and requires some more equipment.

Transistors

Do the direction of the arrows on *npn* and *pnp* transistors have any significance apart from being an arbitrary identification of the two types?

Yes! They point in the direction conventional current can flow through the transistor i.e. from positive towards negative.

DEMO CIRCUITS

9 By MIKE HUGHES

The Monostable

As promised earlier we shall now deal with another member of the family of multivibrators. This one is called the **monostable** or **one shot multivibrator**. Very often used in amateur applications its prime role in any circuit is to provide a timing or time delay function. For example, the circuit that we shall describe could form the basis for a simple photographic enlarger timer (automatically switching off the lamp at the end of a pre-determined time period).

Sometimes it is necessary to convert a very short electronic pulse (such as a "spike") into a clearly defined and time extended rectangular pulse—the monostable (perhaps preceded by a Schmitt trigger) is ideal for this.

The basic circuit is shown in Fig. 9.1. Notice the similarity between it and the bistable—described in a previous part. The main difference is that cross coupling in one direction is by means of a resistor (R2) but the other way the coupling is done by means of a capacitor (C1) and an associated resistor R3.

CIRCUIT OPERATION
STABLE STATE

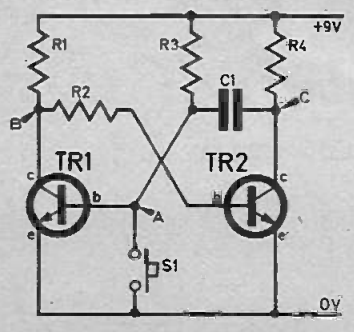
To understand how the circuit works we must make an initial assumption—that TR2 is switched off. This means that point *C* is at approximately 9V positive and that, given a reasonable period of time, C1 will discharge (assuming it had some charge on it in the first place) through the circuit of R3 and R4. This means that in the absence of any other effects, the junction of R3 with C1 would eventually reach a potential of 9V positive.

However there is something we have overlooked. The junction of R3 and C1 is connected to the base of TR1 at point *A* and we know that as soon as *A* reaches a potential of 600mV positive with respect to the emitter of TR1—assuming TR1 is a silicon device—base current will be drawn through R3 and the potential at *A* will be "clamped to a maximum positive value of 600mV.

The base current flowing in TR1 will cause it to be switched on and the potential at *B* will be—to all intents and purposes—zero. Thus no base current can be provided through R2 into TR2 so we can say TR2 is switched off—the assumption we made in the first place.

Discerning regular readers will see that we have a, now familiar, feedback loop. The fact that TR2 is off makes TR1 on and the latter in its turn ensures that TR2 stays off. Provided we introduce no other effects the circuit will stay in this condition indefinitely—so long as the supply is not interrupted. This is a "stable" state.

Fig. 9.1. Basic monostable circuit.



UNSTABLE STATE

We are now going to describe the effect produced by an action that occurs very quickly and while you read the description remember that although our arguing takes quite a long time the electronic operation that is occurring happens within a few microseconds.

We can upset the stable state of affairs by deliberately making TR1 turn off. This is easily accomplished by shorting point *A* to ground—thus diverting all TR1's base current. When TR1 turns off, point *B* tries to rise to 9V positive but in so doing base current starts to flow through R1 and R2 into the base of TR2 turning TR2 on. The potential at *C* falls rapidly towards zero.

The sudden change in charge on the plate of C1 connected to TR2's collector induces a change in potential on the other plate. The potential will change in the same sense (i.e. in a negative direction) and will be of approximately the same magnitude (9V). Here is a slight problem in our argument—we must

ensure that once we have shorted point *A* to ground to initiate the action we must immediately remove the short to allow the potential at point *A* to follow the change at *C*. This would not be possible manually but using electronic help—to be described in the practical circuit—this can be achieved quite easily.

Point *A* was initially 600mV positive, but when we get the sudden change in charge on C1, as described, the potential will swing by 9V in a negative direction to minus 8·4V. This action makes doubly sure that no base current flows in TR1—a sort of "overkill"—TR1 stays switched off. For those sitting with bated breath, that is the end of the high speed part of the circuit's operation. We can now sit back and at our leisure describe the rest of the operation.

Transistor TR1 will not stay switched off indefinitely because C1, which has a potential difference across it (0V at *C* and minus 8·4V at *A*), will slowly discharge through R3 and R4. As point *C* is well and truly held to ground by the action of TR2 the discharge of C1 will cause the potential at *A* to rise in a positive direction towards 9V positive. It will never, however, reach 9V because as soon as point *A* reaches 600mV positive TR1 will switch on and—as described previously—this makes TR2 turn off.

Point *C* is now able to rise to 9V positive and this sudden movement contributes to a surge of current from the other plate of the capacitor into the base of TR1 ensuring that TR1 is well and truly on. From the instant when we shorted point *A* to ground we have been describing the astable part of the circuit's operation.

TIME DELAY

There are two distinct phases in the opera-

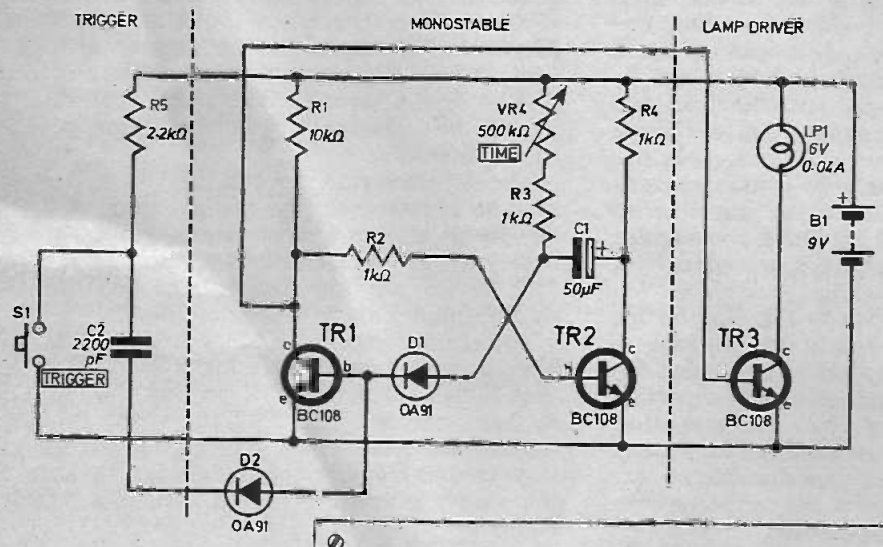


Fig. 9.2. Practical circuit used to demonstrate the monostable action.

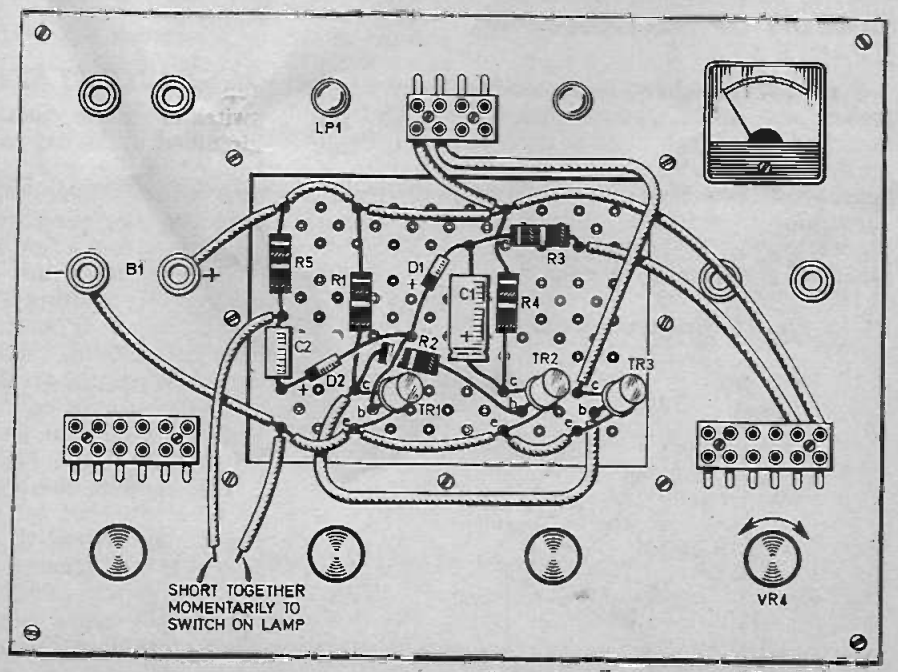


Fig. 9.3. The circuit of Fig. 9.2 wired up on the Demo Deck.

tion, one is stable and the other unstable hence the circuit's name—the monostable. It is the unstable part that gives us our timing factor—the time it takes C1 to discharge from minus 8·4V to plus 600mV. There is a simple formula for this:

Time (in seconds) $t = 0{\cdot}7 \times C1 \times R3$

where C and R are measured in farads and ohms respectively.

This formula is an approximation because it assumes that R3 is very large compared with R4.

COMPONENT VALUES

There are several, not so obvious, points to be made about the value of the various components in the circuit. We have already implied that R4 should be a low value compared with R3 otherwise the timing equation becomes modified; also the waveform at C will show a slow rise time as TR2 switches off. Resistor R3 must have a value that does not exceed a certain amount; the value being determined by the minimum base current into TR1 that will guarantee the latter switching hard on. This—in turn—is dependent on R1 not being too low a value. Resistor R2 is chosen so that when in series with R1 enough base current can be made to flow into TR2 when TR1 switches off.

Generally speaking once the values for resistors have been chosen—and these are usually set by considerations of the stage the monostable is to drive—the length of time of the unstable phase can be set by adjusting the value of C1 which, theoretically can be as large or as small as possible. Further adjustment of time can be effected by reducing the value of R3 below its maximum. The minimum value for the latter must be considered otherwise unlimited base current could flow in TR1.

PRACTICAL CIRCUIT

A practical circuit is shown in Fig. 9.2. The monostable portion is very similar to that already described; R3 has VR4 in series to adjust the length of time delay. In this case the maximum delay will be about 18 seconds (probably slightly higher because there is a good chance the 50μF of C1 will have a value on the high side due to tolerance). With VR4 set to minimum resistance the time will reduce to a fraction of a second.

Remember we used the term "overkill" describing the negative swing at TR1's base; this term was deliberately used because a reverse voltage of 8·4V between base and emitter of a BC108 exceeds the reverse rating of the junction so diode D1 is incorporated. This has no effect on the working of the circuit and only affords protection to TR1.

TRIGGERING

Triggering—and removal of the short—at TR1's base is effected by R5, C2, D2 and the switch. When the switch is closed (in the practical circuit, shown in Fig. 9.3, the two flying leads are shorted together) C2 charges through D2 and the base current into TR1 is momentarily diverted to provide this charge current. As soon as the potential at the junction of R3 and C1 goes negative D1 becomes reverse biased and the capacitor discharges through R3 and VR4 free from any other influences.

With this type of trigger it does not matter if the switch is kept closed—provided C2 is small compared with C1—the astable part of the cycle will still maintain the same delay, during which time TR1 will be off. We can indicate this effect by driving a lamp from the signal produced at TR1's collector.

Touch the leads together and the lamp will light and stay alight for the length of time set by C1 and VR4 in series with R3. Try substituting different values for C1; 500μF should give a time approaching 3 minutes. If LP1 was replaced by a relay with contacts capable of switching mains, you can see how valuable this circuit would be as an enlarger timer.

What do you know?

SEMICONDUCTORS

1 What two materials do you most associate with semiconductors?
2 A circuit is said to use a transistor in the common emitter mode, what does this mean?
3 There are two main types of transistors, what are they and how do you differentiate between them on a circuit diagram?
4 If a circuit calls for a BC109 type transistor and you only have 2N2926, OC71, AC127, 2N3819 types, which one could you substitute and expect the circuit to operate?

ANSWERS

1 Germanium and silicon, the basic substances in modern transistors and diodes.
2 Basically, it means that the emitter is common to both the input and output terminals of the transistor.
3 The two types are *dpd* and *npn*. They can be distinguished by two methods: the arrow on the emitter terminal points in towards the base in a *pnp* device and away from the base in an *npn* device; in an *npn* device the collector is more positive than the emitter whereas the emitter is more positive than the collector in a *pnp* type.
4 You could expect the circuit to work with the *npn* type 2N2926 transistor. The OC71 and the AC127 types are *pnp*; the 2N3819 is a f.e.t.

LOOKING back over the past months—in particular at those Shop Talks giving names of suppliers of the more difficult to get items—it is apparent that about three or four firms are mentioned quite often—try it.

Since these suppliers all sell catalogues (at reasonable prices considering the amount of information in them) it would seem that the easiest way to find components would be to get the catalogues and have a good look at what's on offer. There are of course some items that can only be obtained from special suppliers or single sources and this is what this page is for—to tell you where.

Slave Flash

One component used in the *Slave Flash* will not be available from your electronic component dealer — the in-line "camera socket"—this should be purchased from a photographic shop. Remember it is for connection to a flash gun and not a camera.

Two other items to note concerning components for this project are the photocell, ORP12—this exact type may not be available but the type number is well known and most alternatives will be suitable. The case used should be fairly wide so that it is able to stand up, enabling the photocell to "look" at the camera operated flash. The prototype uuit used a small diecast aluminium case, available from most suppliers, and this makes a tough case which is heavy enough not to be easily knocked over.

Waa Waa

The *Waa Waa* design published in this issue must be one of the simplest posible and it is one that works well. There are one or two points on the components used that are worth noting.

One of the sockets—the input—should be a Re-An Products type R26/1, this has an extra tag that is used to turn the unit on—the second socket can be the same type to make ordering easier if required. Re-An Products are at Burnham Road, Dartford, Kent.

The potentiometer used should be a carbon type of 1 kilohm, only a small portion of track at one end of this is used and wirewound types have proven noisy in this situation.

Lastly a couple of points on the mechanical parts; the linkages can be made from Meccano parts as shown in the photographs—this will help to simplify construction. The return spring is taken from a battery as stated in the text—if you cannot find anyone who uses these batteries you could try asking your local retailer if he has any dud or broken ones.

Electronic Doorbell

The magnetic earphone inserts (GPO type) used in the *Electronic Doorbell* are not available from all suppliers. If you cannot find a local supplier, Henry's Radio list them at 35p each. The 35 ohm loudspeaker may also cause some difficulty but should be available from the larger suppliers. A speaker of lower impedance should not be used—one of higher impedance will result in a lower volume.

The pushbutton used can be bought from most electrical shops or Woolworths.

New Products

Another low cost stereo system in kit form has been announced by Radio and TV Components. At £17·95 plus £1·50 for postage and packing this system must be one of the cheapest available. By using complete modules with tag connections the need for soldering has been eliminated, the cabinets are also easy to construct and only require glueing together.

Using two integrated circuits

The complete Stereo 21 unit as it looks when finished.

the output is 2·7 watts r.m.s. per channel, the amplifiers have separate volume controls and a tone control (treble lift and cut). Both headphone and tape output are provided, as is an auxiliary input socket.

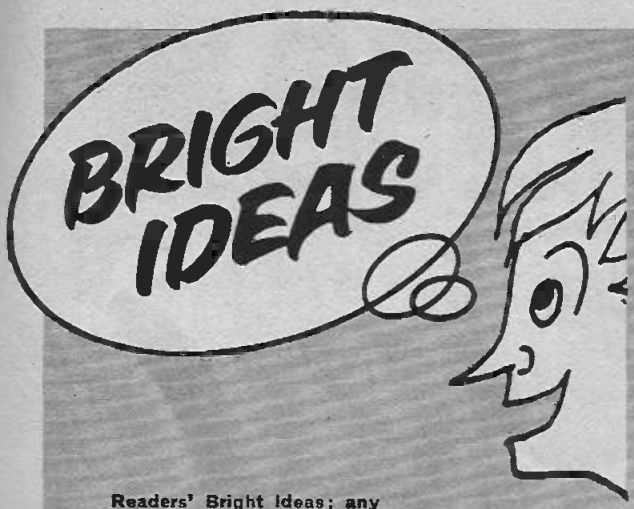
The Stereo 21 utilizes a BSR autochange deck housed, together with the amplifier, in a neat, Perspex topped, cabinet and two matching speaker cabinets each housing an 8 inch by 5 inch drive unit. Not claimed to be hi fi but for the price few could ask for better quality.

Also new this month is the Minos case, initially in only two sizes (100mm x 65mm and 130mm x 100mm, both 50mm deep). The cases are moulded in ABS (plastic) of high impact strength which provides a gloss finish of intense black.

The front panels are fixed by plated steel posidrive screws and are in white p.v.c. coated steel, or plain aluminium.

From West Hyde Developments Ltd., Ryefield Crescent, Northwood Hills, Northwood, NA6 1NN, Middlesex. Price for one offs 40p and 50p, postage and packing 7p and 8p respectively.

"I've shelved the idea of constructing a two-way intercom—she'd be able to nag me when she wasn't with me."



Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

This simple idea of mine will be found most useful to the experimental handyman. It consists of a two-amp connector strip which can be purchased at any electrical shop, and used as an assembly jig for any test circuit.

No soldering is necessary, and any component can be substituted at will. The strip can be used over and over again and its simplicity is an encouragement to any keen experimenter.

Mr. T. Doyle,
Croydon.

Not long ago I discovered an economical "test board" for the construction of "spur of the moment" circuits.

Glue a piece of one foot square hardboard onto a piece of chipboard of the same size. Next make a grid of 1in. squares on the hardboard, and then hammer large-headed ¾in. nails in each corner of the squares, leaving about a quarter of the nail protruding above the board. File the nail heads and apply solder to form a button on the top of the nail. You now have a test board that components can be applied to quickly and securely. If one of the nails is in the way then it is quickly removed with a pair of pliers. It can be replaced later.

R. Harris,
Petworth,
Sussex.

I do not know if fellow constructors have the same problem as I, but I find that when building a circuit from the magazine, the latter ends up on the bench and eventually gets covered with flux, hot solder burns and generally becomes very tatty. A good remedy I found was to glue a piece of flat ¼in. thick plate glass to four pieces of wood size 1in. x 1¼in. so making a small table with transparent top. The magazine (or book) can then be placed under this and work carried out on the top.

R. J. McLellan,
Birmingham.

As a lot of electronic projects are housed in aluminium cases, perhaps other readers would be interested in a method I have found of giving the cases a professional finish.

Place a piece of emery cloth or paper over a piece of wooden doweling and fix in the chuck of a power or hand drill so that the emery paper is held firm. If the drill is then operated and the covered dowel placed in contact with the aluminium case, circular impressions will be made. Overlapping of these circles will produce a very pleasing effect.

A thin layer of clear varnish over the surface will protect and keep the surface shiny.

P. Horton,
Stourbridge,
Worcs.

I have made a Demo Deck using a T-Dec and I overcame the difficulty of fastening this to the panel by the use of Velcro strips (obtainable from any haberdasher) glued on with rubber cement. This can also be used for firmly fixing other articles such as battery-holders. A push and it is fixed—a pull and it is free.

G. Edmunds,
South Africa.

Please Note: this column is intended for constructional ideas and ideas relating to electronic construction. It is not our intention to publish circuits of any description.

All items submitted should be original and not previously published. If similar ideas are submitted by two or more readers the first received will be published.

PLEASE TAKE NOTE

Some readers who have constructed the *Mini Organ* (June 1973) have only been able to obtain a clicking noise instead of the correct oscillation.

The "clicking" noise is caused by the unijunction oscillator working at the wrong frequency and is due to C3 being connected in parallel with C2 via the base/emitter junction of TR2. This did not show up on the prototype organ because the three unijunctions tried out were from the same source and thus, presumably, from the same production batch. Due to production spread of characteristics the saturation voltage across the junction of emitter and base I can vary, and this seems to be the cause of the trouble. The higher voltage of some of the junctions raises the emitter of TR1 to a higher voltage than that at the base of TR2, thus effectively paralleling C3 with C2.

The remedy for this is to remove C2 and C3, and to then replace C2 in the C3 position; i.e. C3 becomes 0·1 microfarad (it may be necessary to alter the value of this capacitor slightly to tune the organ to the right frequency.)

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H38	30	Short lead Transistors, NPN Silicon Planar types.	55p
H39	6	Integrated Circuits. 4 Gates BMC 962, 2 Flip Flops BMC 945	55p
H40	20	BFY50/2, 2N696, 2N1613 NPN Silicon uncoded TO-5	55p
H41	2	Sil Power transistors comp pair BD131/132	55p

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AC128	12p	AF127	20p	BF115	25p	OC42	12p	2N3705	12p
AC131	12p	AF139	32p	BF173	20p	OC44	12p	2N3706	11p
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AC176	12p	AF180	40p	BF178	32p	OC70	12p	2N3708	10p
AC187	22p	AF181	40p	BF179	32p	OC71	12p	2N3709	11p
AC188	32p	BC107	9p	BF180	32p	OC72	12p	2N3710	11p
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1·0μF	35V	10μF	25V	100μF	3V

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17 x 3½	100p	78p
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Draw the planned circuit onto a copper laminate board with the P.C. Pen, allow to dry, and immerse the board in the etchant. On removal the circuit remains in high relief.

DOWN TO EARTH

By GEORGE HYLTON

"The feedback bias arrangement (Fig. 1) used in some transistor amplifiers worries me. If the input signal swings positive as shown then the output must immediately go strongly negative. This will cancel the signal and also remove the operating voltage from the collector. How can the circuit work?"

Let's begin with a parable. A man dropped a penny into a wishing well. At once, fifty pennies shot up out of the well and landed at his feet. "That's not much use," he said, "my penny-worth of wishing has been more than cancelled out." He walked off, leaving the pennies on the ground. Along came another man. He picked up the pennies and dropped them into the well, one by one. Each time, fifty pence came back. When the man had collected all the money he could carry he went home. What has all this got to do with feedback bias circuits? More than you might think. The moral of this story is, don't worry if things move in an unexpected direction, so long as you can still profit.

In the feedback bias circuit of Fig. 1, there's no need to worry because the polarity of the signal gets reversed, so long as the signal gets amplified. It certainly does get reversed, since a positive-going input, as shown, brings about an instantaneous increase in collector current. This means that the 10 kilohm load resistor R2 drops more than the usual voltage, so the collector voltage falls below its steady-state value of 4·5V that we have assumed.

The collector swings to a less positive i.e. more negative voltage, without actually becoming negative. Does this matter?

If the voltage gain of the circuit is 200, and the input signal swings to a positive peak of 10mV, then the collector voltage must change by (200 x 10) mV = 2V.

This change of 2V reduces the collector voltage to 2·5V, but this is quite enough to keep the transistor working and all is well. The output coupling capacitor removes the steady component of the voltage at the collector and passes on the variation, in other words the output is 2V. Strictly we should have said *minus* 2V, since it is a negative swing with respect to "earth". By the same token, the voltage gain should strictly be stated as minus 200.

To my way of thinking, the person who raised the question has been trying very hard to get the feel of the circuit, maybe he hasn't quite succeeded, but he's not a thousand miles from it. For one thing, he's quite right about the removal of the operating voltage from the collector, because if you go on increasing the signal voltage the point will be reached at which the collector swings downwards by 4·5V, in which case all the standing voltage is wiped out and the transistor can't go on working.

What this means is that the amplifier overloads at this point. All amplifiers overload at some point, it's a natural limitation.

He says that the signal is cancelled, no doubt because when the collector swings negative this puts a polarity swing at the collector end of the feedback resistor R1 which appears to oppose the signal. In fact, it has the opposite effect.

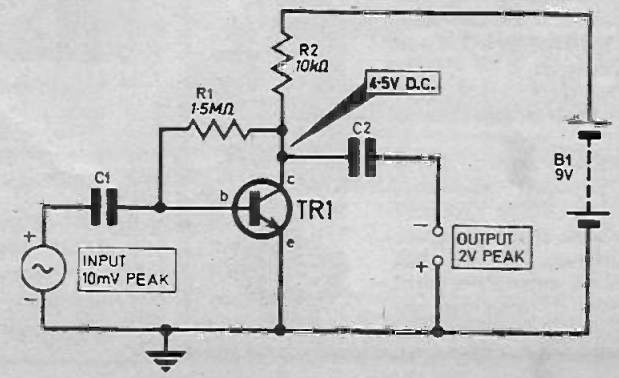
If you study the circuit carefully you see that the a.c. input and output voltages are "series-aiding". They both try to drive current through R1 in the *same* direction. The net signal voltage across R1 is 2010mV (2V+10mV), which drives just 201 times as much current through the resistor as would the signal itself.

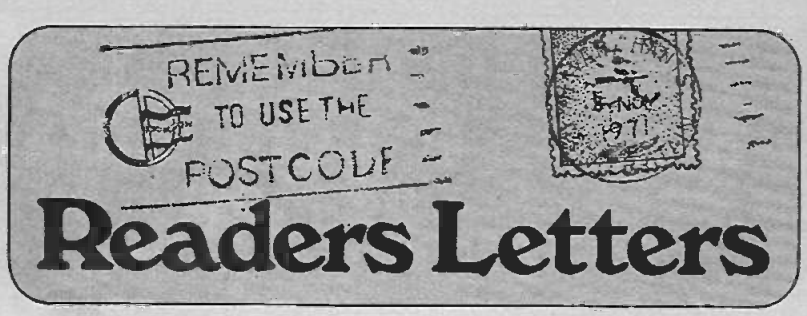
Way back in the early days of electronics, when we had only radio valves to perform the task of amplification, an American called Miller realised that this was the reason for getting an unexpectedly low input impedance. All the extra current has to come from somewhere. It turns out that it has to come, in the long run, from the signal source.

Looked at from the signal's point of view, R1 takes the same current as you would expect a resistance of only 1·5MΩ/201 (=7·5 kilohms) to take. The actual figures don't matter though, the important thing is that if you connect a resistance between collector and base then from the input signal's point of view that resistance is reduced by a factor of (A+1) where A is the voltage gain. This reduces the input impedance of the amplifier. Fortunately the input resistance is low anyway in the present circuit, so the overall effect is not to drastically reduce the input resistance to a small fraction of the expected value.

In a stage designed on the lines of Fig. 1, this "Miller feedback" effect reduces the input resistance (or impedance, if you like) to just *half* the expected value. This is a point to bear in mind when deciding on what size C1 must be to give the required low frequency response. It should be twice as big as you would expect.

Fig. 1. Feedback bias circuit.





Readers Letters

Test Gear

I have been taking EVERYDAY ELECTRONICS since last November and I find that the issues are very enlightening and just about as easy to understand as any subject as complex as electronics could be.

I am very interested in the test gear in the May '73 issue. As I intend buying a multimeter and an oscilloscope—cost is not the primary consideration. First the multimeter, I would need one suitable for checking components used in proportional radio equipment as used in model cars, boats and aeroplanes, these use miniature components and operate on the 27MHz Band. According to the adverts in EE, some have *overload protection* and an instruction leaflet and others don't mention this.

Generally I purchase an article first and then find out afterwards what I should have bought, so I would be glad of your advice. Obviously you can't mention any particular make but if you could quote the range I need to check miniature components it would be a great help. To check from 4·7 ohms to 100 kilohms, capacitors 4·7pF to 0·047μF.

Also, what specifications would the oscilloscope need to have to check for a 27MHz pulse of approximately 8 milliseconds duration. Where could I buy one at £25 as mentioned in the May E.E. article on *Workshop Components and Tools.*

R. Lockie
Bournemouth

The multimeter should be a 20,000 ohms per volt type and, for the resistance range required should really have three separate resistance ranges. It is not possible to check capacitors with a multimeter on its own and we suggest that you take no notice of capacitance ranges — these can hardly ever be used satisfactorily. There are many good meters available for about £8 and one with overload protection will prevent damage to the meter if you try to measure too large a current or voltage.

To get a 'scope that will display a waveform with a frequency of 27MHz will probably cost about £200. We suggest that your best bet will be to look around for a good secondhand 'scope with a frequency response up to about 8MHz—this should give some indication of operation at 27MHz although you will not be able to see the actual waveshape.

Keyboard Polishing

With respect to the *Mini Organ* design given in the June issue. I believe that the printed circuit keyboard must be polished with metal polish before being played because once the surface becomes tarnished the notes change, due to increased resistance of the copper oxide coating.

A roller tinned or silver plated keyboard would seem to be necessary if this tiresome task is to be avoided.

F. L. Ellis
Oxford

The keyboard will not require polishing very often—as you say only when it becomes tarnished—since it is quite small this task is simple.

Shock!

With reference to the *Night Light Switch* in the April 1973 issue of EVERYDAY ELECTRONICS, in the drawing on page 198 the "live" wire from the mains is connected to the "open" end of the fuseholder, and not to the tip.

In these circumstances an inquisitive child may unscrew the fuse and push one of his or her fingers into the fuseholder thus receiving a shock.

This may seem a small point to make, but if the fuseholder is wired-up the right way a person may be saved a nasty experience —which I have seen happen.

D. S. Franklin
High Wycombe

Courses

I thought it might be useful to let you know what courses for radio and electronic enthusiasts are to be offered at the Knaresborough Adult Education Centre during the academic year 1973-74. They are as follows:

Tuesday, beginning September 18, "Morse Code for Radio Amateurs."
Wednesday, beginning September 19, "Electronics Workshop."
Thursday, beginning September 20, "Radio Amateurs' Examination Course."

All these classes are from 7.30 to 9.30 p.m. at a fee of £1 per term. The courses have run for several years now, have been well attended and a stock of tools and test equipment has been built up.

J. B. Smith
Head of Centre
Knaresborough Centre
King James Road
Knaresborough
Yorkshire

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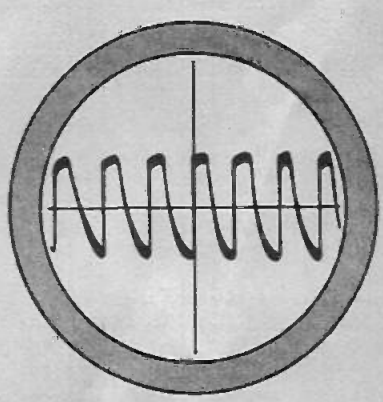

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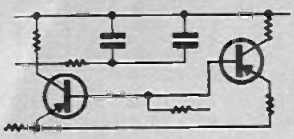

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2G302	0·15	2N3414	0·10	40303	0·61	BC137	0·15	BF121	0·25	BSY54	0·30
2G303	0·25	2N3415	0·10	40389	0·46	BC138	0·24	BF123	0·27	BSY56	0·79
2G306	0·30	2N3416	0·15	40394	0·56	BC140	0·34	BF125	0·25	BSY65	0·15
2G309	0·30	2N3417	0·21	40395	0·65	BC141	0·39	BF152	0·20	BST78	0·40
2G345B	0·25	2N3570	1·25	40406	0·44	BC142	0·24	BF153	0·23	BST79	0·40
2G371	0·15	2N3571	1·12	40407	0·53	BC143	0·21	BF154	0·16	BSY95A	0·09
2G374	0·15	2N3572	0·97	40409	0·52	BC145	0·21	BF159	0·27	C111	0·53
2S174	1·40	2N3702	0·11	40410	0·53	BC147	0·11	BF160	0·23	D40N3	0·55
2S404	0·43	2N3703	0·10	40411	2·00	BC148	0·10	BF161	0·42	GET111	0·45
2N456	0·75	2N3704	0·14	40414	3·55	BC149	0·13	BF163	0·20	GET114	0·20
2N456A	0·75	2N3705	0·10	40467A	0·69	BC152	0·18	BF166	0·35	GET115	0·50
2N457A	0·80	2N3706	0·09	40468A	0·44	BC154	0·16	BF167	0·21	GET119	0·35
2N491	3·25	2N3707	0·13	40600	0·69	BC157	0·14	BF173	0·24	GET535	0·20
2N696	0·15	2N3708	0·07	40601	0·67	BC158	0·13	BF177	0·29	GET536	0·20
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2N706	0·10	2N3712	0·95	40636	1·10	BC168B	0·13	BF181	0·32	TIP29A	0·49
2N706A	0·12	2N3713	1·08	40673	0·50	BC168C	0·11	BF182	0·40	TIP30A	0·58
2N708	0·18	2N3714	1·15	AC107	0·35	BC169B	0·13	BF183	0·40	TIP31A	0·62
2N709	0·38	2N3715	1·23	AC113	0·16	BC169C	0·13	BF184	0·17	TIP32A	0·74
2N711	0·30	2N3716	1·30	AC115	0·16	BC170	0·11	BF185	0·17	TIP33A	1·01
2N718	0·21	2N3773	3·00	AC117	0·20	BC171	0·18	BF194	0·14	TIP34A	1·51
2N718A	0·30	2N3779	3·15	AC121	0·13	BC172	0·11	BF195	0·17	TIP35A	2·90
2N720	0·50	2N3790	2·20	AC126	0·25	BC182	0·10	BF196	0·15	TIP36A	3·70
2N721	0·55	2N3794	2·06	AC127	0·25	BC182L	0·12	BF197	0·15	TIP41A	0·79
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2N916	0·17	2N3792	2·20	AC141K	0·30	BC183L	0·09	BF199	0·18	TIP2955	0·98
2N918	0·30	2N3794	0·10	AC142K	0·25	BC184	0·11	BF200	0·40	TIP3055	0·80
2N929	0·14	2N3819	0·37	AC151V	0·14	BC184L	0·11	BF224J	0·14	ME0401	0·18
2N930	0·14	2N3820	0·47	AC152V	0·17	BC186	0·25	BF225J	0·19	ME0402	0·20
2N1090	0·23	2N3823	0·97	AC153	0·22	BC187	0·25	BF237	0·22	ME0404	0·13
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2N1131	0·20	2N3825	0·23	AC154	0·20	BC208	0·11	BF244	0·16	ME0412	0·18
2N1132	0·20	2N3854	0·16	AC176	0·18	BC212K	0·10	BF245	0·33	ME0413	0·14
2N1302	0·16	2N3854A	0·16	AC187K	0·20	BC212L	0·16	BF246	0·43	ME1120	0·25
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2N2905	0·33	2N5245	0·43	AF211	0·55	BCZ11	0·50	BFY76	0·22	MPS112	0·40
2N2905A	0·35	2N5457	0·38	AL102	0·75	BD115	0·75	BFY77	0·24	MPS113	0·47
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2N2924	0·12	2N140	0·92	ASY50	0·20	BD131	0·40	BSX21	0·20	MPSA56	0·28
2N2925	0·15	3N141	0·81	ASY55	0·35	BD132	0·50	BSX26	0·49	MPSA65	0·25
2N2926		3N142	0·58	AU103	1·25	BD135	0·43	BSX27	0·34	MPSA66	0·28
Green	0·12	3N143	0·75	BC107	0·14	BD136	0·49	BSX28	0·25	MPSU01	0·44
Yellow	0·10	3N152	0·92	BC108	0·13	BD137	0·55	BSX29	0·47	MPSU05	0·48
Orange	0·10	3N153	0·81	BC109	0·14	BD138	0·68	BSX60	0·54	MPSU55	0·60
2N3053	0·31	3N154	0·84	BC113	0·13	BD139	0·71	BSX61	0·42	MPSU06	0·55
2N3054	0·60	3N158	1·17	BC114	0·12	BD140	0·83	BSX76	0·15	MPSU56	0·68
2N3054	0·60	3N187	1·55	BC115	0·15	BDY10	1·25	BSX77	0·20		
2N3055	0·80	3N200	2·49	BC116	0·15	BDY11	1·50	BSX78	0·25		
2N3390	0·20	3N201	1·05	BC116A	0·18	BDY17	1·50	BSW70	0·28		
2N3391	0·20	40050	0·78	BC117	0·21	BDY18	1·75	BSY24	0·20		
2N3391A	0·22	40251	0·81	BC118	0·11	BDY19	1·97	BSY25	0·15		
2N3392	0·13	40309	0·30	BC119	0·27	BDY20	1·05	BSY26	0·20		
2N3393	0·12	40310	0·50	BC121	0·23	BDY38	0·65	BSY27	0·15		
2N3394	0·17	40313	0·82	BC125	0·15	BDY60	0·90	BSY28	0·15		
2N3402	0·12	40316	0·50	BC126	0·20	BDY61	1·25	BSY38	0·20		
2N3403	0·19	40318	0·92	BC132	0·30	BDY62	1·00	BSY39	0·20		
2N3404	0·24	40360	0·46	BC134	0·11	BF115	0·23	BSY51	0·25		

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1S44	7p	AAZ17	10p	BY100	15p	OA47	8p
1S113	15p	BA100	15p	BY103	22p	OA70	7p
IS120	12p	BA102	25p	BY123	47½p	OA73	10p
IS121	14p	BA110	25p	BY124	15p	OA79	7p
IS130	8p	BA114	15p	BY126	15p	OA81	8p
IS131	10p	BA115	7p	BY127	17p	OA85	10p
IS132	12p	BA141	17p	BY161	57p	OA90	7p
IS920	7p	BA142	17p	BYX10	22p	OA91	7p
IS922	8p	BA144	12p	BYZ10	35p	OA95	7p
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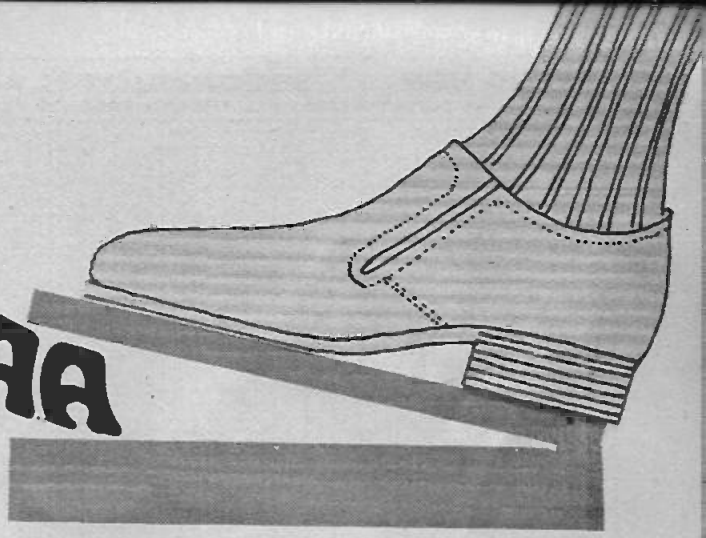
WAA WAA



A very simple unit designed with the "pop" group in mind

By B. W. Terrell B.Sc.

OF THE many special effects employed in the musical world, especially the world of "pop" music, the waa waa may be one of the most difficult to use, but when mastered, the waa waa can add a new and useful dimension to your music.

WHAT IS WAA-WAA?

For those who do not know what waa waa is, try saying nasally aloud and several times the words WAA WAA. The sound produced gives a good idea, with a little imagination, of the manipulation of the Waa Waa device to the output from an electric guitar, piano, organ or microphone.

Electronically, the waa waa sound is produced by means of a tuned amplifier (this amplifies only a selected band of frequencies) whose resonance peak can be varied smoothly between the bass and treble content of the signals from the musical instrument.

FILTER

The heart of a tuned amplifier is a filter network; consider the simple filter shown in Fig. 1. This is known as a "bridged-T" filter.

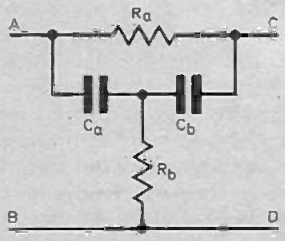


Fig. 1. A bridged-T filter used as the basis of the Waa Waa.

If an input signal containing a multitude of frequencies is applied across terminals *AB*, most of the signal will be transmitted with relatively little attenuation and will appear across *CD*. However, a narrow band will be attenuated drastically—the position of this band being dependant on the relative values of R_a C_a C_b and R_b. Thus for a particular band the attenuation of the circuit is very high. The position of this band and its overall shape is dependant on the relative values of the filter components.

This type of filter is sometimes called a notch filter, the reason for this is seen in Fig. 2 which shows the ratio of the output to the input as a function of frequency for one set of filter components.

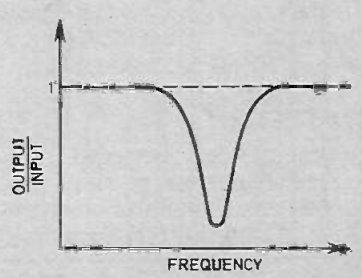


Fig. 2. Bridged-T filter characteristics.

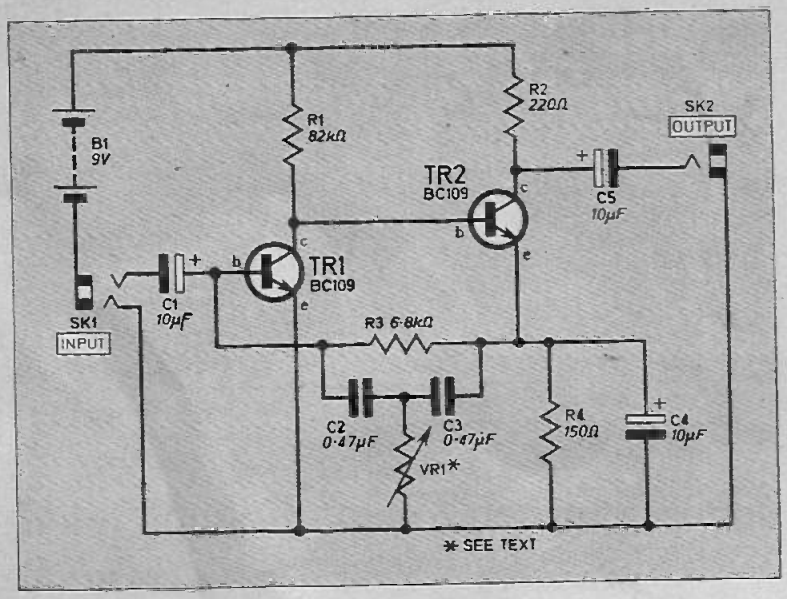


Fig. 3. The complete circuit diagram of the Waa Waa unit. Note that the unit is switched on by inserting the input Jack plug.

It was found experimentally that the notch position could be varied over a considerable range by varying only one component, namely R_b. Although the overall shape of the notch changes with the value of R_b, it was found to have no adverse effect on the performance for this particular application.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Waa Waa unit is shown in Fig. 3 and consists of a two-stage d.c. feedback pair amplifier, with a bridged-T filter built around the d.c. feedback resistor R3; the latter provides the base bias for TR1 from the emitter of TR2. The complete circuit forms a tuned amplifier whose resonant peak can be varied by the variable resistor VR1, and functions as follows.

Dependent on the setting of VR1, the filter network for a particular frequency is a high impedance path, at other frequencies it is a low impedance path for negative feedback.

Therefore, signals other than those near the narrow band (selected by VR1) are not amplified whilst the selected band is amplified and appears at the output.

By varying the value of VR1, the amplified band can be made to sweep smoothly from the bass end to the treble region of the frequency spectrum. By varying the value of VR1 up and down, the waa waa sound is produced.

VARIABLE RESISTOR

The pedal linkages were designed to be as simple and as inexpensive as possible while at the same time, the actual pedal movement was to be kept to a minimum for easy use and comfort.

The value of VR1 needs to vary from near zero ohms to about 150 ohms for the required effect. This is accomplished by means of a 1 kilohm potentiometer which gives the required range since the linkage causes a maximum rotation of about 45 degrees. It is essential to use a carbon track type potentiometer—a wirewound type will produce a noisy output.

COMPONENT BOARD

The Waa Waa circuit in the prototype was constructed on a piece of 0·15in. matrix Veroboard size 14 x 10 holes. The layout of the components on the board is shown in Fig. 4.

Make the cut-out on the reverse side of the board as shown and then drill the mounting hole. Next mount the components on the board in accordance with Fig. 4 leaving the transistors until last and remembering to use a heat shunt on the transistor leads when soldering. Do not connect the flying leads at this stage.

CASE AND LINKAGE

Details for constructing the case, pedal and linkages are shown in Figs. 5 and 6. The prototype case was constructed from $^1/_{16}$in. thick aluminium for the sloping base and base-plate and $^1/_2$in. thick chipboard for the pedal. The latter had rubber matting glued to the top to prevent the foot from sliding when in use.

The linkages in the prototype were made from Meccano parts but these parts are not essential as tin plate cut to the dimensions shown will do just as well.

The shorter linkage was made by soldering one half of a $^1/_4$in. diameter spindle coupler (cut with a hacksaw) as shown. The two linkages should be joined together by means of a copper or brass rivet, but this should not be made too tight as the joint must be free to move without binding or catching.

It is important that the case and linkage

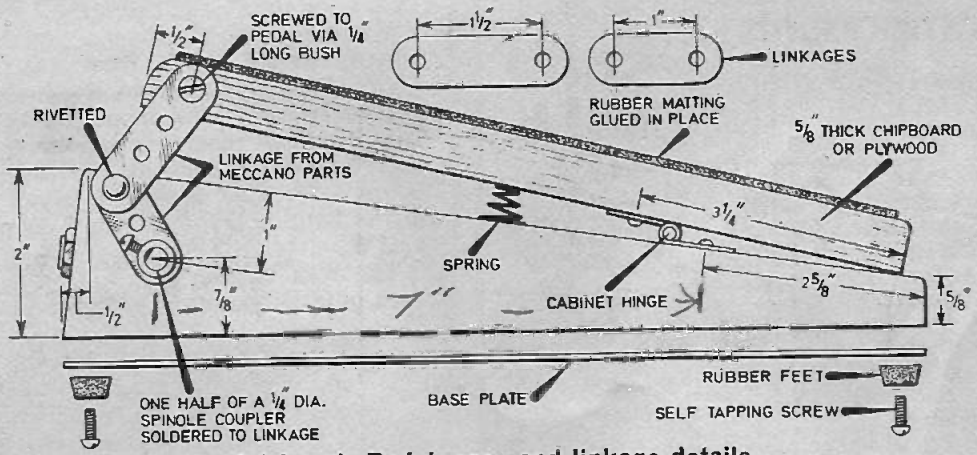


Fig. 5 (above). Pedal, case and linkage details.

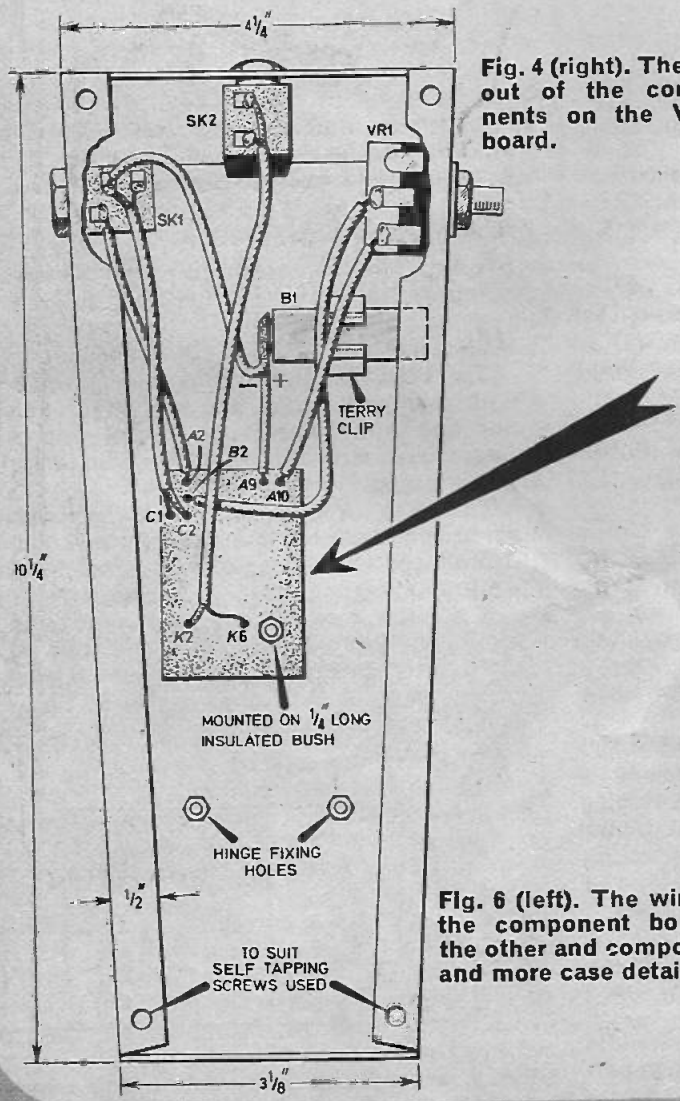
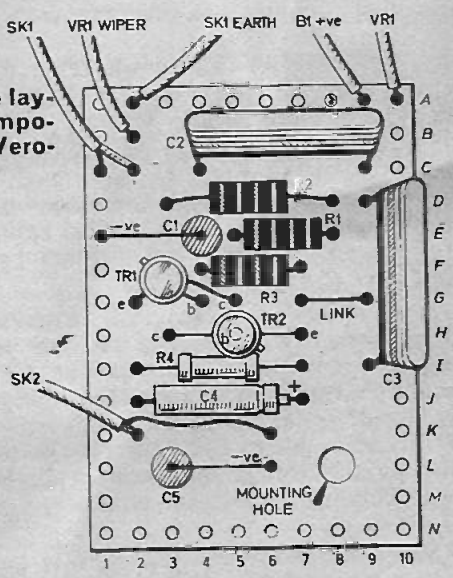


Fig. 4 (right). The layout of the components on the Veroboard.



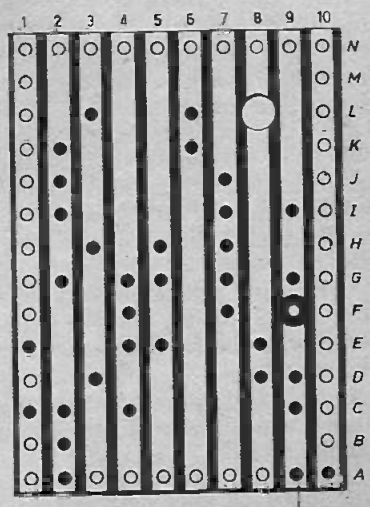


Fig. 6 (left). The wiring of the component board to the other and components, and more case details.

Components .... SEE SHOP TALK

Resistors
R1 82kΩ
R2 220Ω
R3 6·8kΩ
R4 150Ω
All ¼ watt ± 10% carbon

Potentiometer
VR1 1kΩ linear carbon

Capacitors
C1 10μF elect. 10V
C2 0·47μF
C3 0·47μF
C4 10μF elect. 10V
C5 10μF elect. 10V

Transistors
TR1 BC109 silicon *npn*
TR2 BC109 silicon *npn*

Miscellaneous
SK1 Jack socket with one break contact type R26/1
SK2 Jack socket standard type
B1 9V PP3
Veroboard: 0·15in. matrix 14 x 10 holes; battery clip; screened cable; ¼in. diameter spindle coupler; insulated spacer; ¼in. long bush for linkage; cabinet hinge; rubber matting; aluminium for case; chipboard or plywood for pedal; conical spring; 2BA and 4BA nuts, bolts and shakeproof washers.

dimensions be adhered to, otherwise the required resistance sweep range may not be obtained, resulting in a reduced waa waa sound or "dead" pedal movement.

It is advisable to make the case before drilling any of the component locating holes in case your bending is not that accurate.

ASSEMBLY

With the case and pedal finished and the holes drilled, fit the component board mounting bolt (2BA) in place and tighten down using a shakeproof washer, and then fix the battery clip in position again using a shakeproof washer. Screw the potentiometer VR1 and the Jack sockets in position and fully tighten.

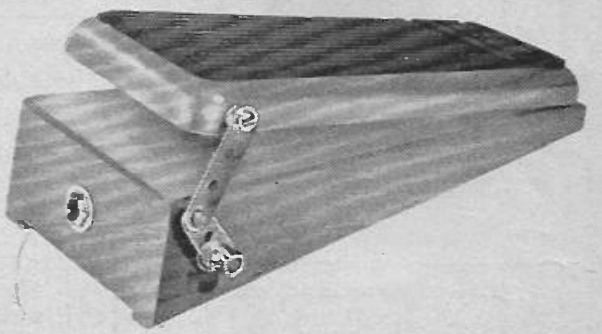
Screw the conical type spring and the cabinet hinge in the correct place on the underside of the pedal and then bolt the hinge to the sloping base by means of 4BA nuts, bolts and shakeproof washers. The prototype used the spring from the top of an old 996 battery; this type of spring was chosen because when compressed it is virtually flat.

Next lightly screw the complete linkage assembly to the side of the pedal (Fig. 5) via a ¼in. long bush.

Turn the shortened potentiometer spindle fully *clockwise* and with the pedal in its uppermost position, attach the coupler to the spindle and tighten fully. Tighten the other end of the linkage to the side of the pedal.

Wiring up of the board to the other components should now be carried out according to Fig. 6. When this is complete, secure the component board to the mounting bolt via a ¼in. long insulated spacer. It may be as well to stick some insulating tape on the casing below the board to prevent a possible short circuit. Plug in the battery, screw on the base plate and the unit is complete.

The Waa Waa is switched on by inserting a Jack plug in the input socket, SK1.



When the unit has been tested and found to work it can be dismantled and painted. It was found on the prototype that the spray on aerosol paints could easily be scratched off, so it was hand painted with a plastic enamel paint after being rubbed down and undercoated. This was found to give a very good and durable finish.

USE

The Waa Waa unit has been designed for use with standard guitar and amplifier equipment and has been satisfactorily tested with this arrangement. It should also be suitable for electronic organ.

The Waa Waa pedal should be interposed between instrument and amplifier and the effect is produced when the pedal is moved to and fro whilst playing.

If desired a switch can be incorporated in a small box located near the main unit so that the latter can be bypassed for normal play. The circuit diagram for this is shown in Fig. 7 and a double-pole double-throw switch should be used. ▣

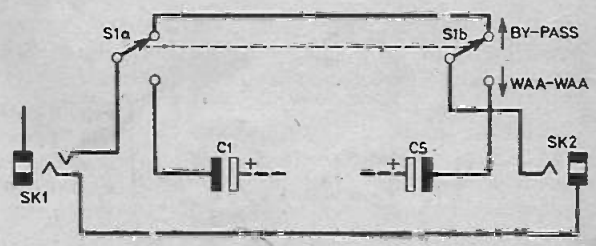


Fig. 7. Wiring details for connecting a by-pass switch.

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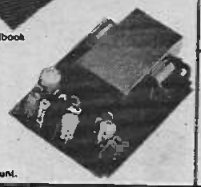

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·01µF	18v	5p	
·022µF	18v	5p	
·047µF	12v	5p	

ceramic plate

1000pf	10p
2200pf	10p

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0·1µF	30v	5p
0·22µF	6v	5p
0·47µF	3v	5p

30V

4700pf	10p
10,000pf	10p

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1·8pf	8·2pf	33pf 120pf
2·2pf	10pf	39pf 150pf
3·3pf	12pf	47pf 180pf
3·9pf	15pf	56pf 220pf
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5·6pf	22pf	82pf 330pf
6·8pf	27pf	100pf

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1000pf	2p	·01µF	3p	·068µF	4p
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		·05µF	3p		

polystyrene 160V
10pf to 10,000pf in multiples of 10, 15, 22, 33, 47 & 68. 3p each

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·01µF	3p	·068µF	3½p	·47µF	8p
·015µF	3p	·1µF	4p	·68µF	11p
·022µF	3p	·15µF	4p	1µF	13p
·033µF	3p	·22µF	5p	1·5µF	20p
·047µF	3p	·33µF	6½p	2·2µF	24p

metallised polyester 400V (C281)

·01µF	4½p	·047µF	6p	·22µF	10p
·015µF	4½p	·068µF	6p	·33µF	14p
·022µF	4½p	·1µF	7p	·47µF	15p
·033µF	5½p	·15µF	8p		

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2·2pf—820pf	7p	4·7nF—5600pf	19p
1nF—2·2nF	9p	6800pf—·01µF	29p
2·7nF—3·6nF	16p		

mixed dielectric 600V

·01µF	7p	·047µF	7p	·22µF	16p
·022µF	7p	·068µF	8p	·47µF	24p
·033µF	7p	·1µF	8p	1µF	33p

mixed dielectric 1000V

1000pf	6p	6800pf	9p	·1µF	12p
2200pf	6p	·01µF	9p	·22µF	22p
3300pf	6p	·022µF	9p	·47µF	30p
4700pf	6p	·047µF	12p		

Ceramic

12KV.d.c.	8KV.d.c.		Hi-K 750V.	
10pf	9p	200pf	9p	1000pf 5p
15pf	9p	220pf	9p	
22pf	9p	250pf	9p	2000pf 5p
68pf	9p	270pf	9p	3000pf 5p
82pf	9p	300pf	9p	5000pf 5p
100pf	9p	750V DISC		10,000pf 5p
120pf	9p	470pf	5p	feed-
140pf	9p	1000pf	5p	through
150pf	9p	5000pf	5p	
180pf	9p	10,000pf	5p	1000pf 6p

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TO5 TO18 5p
TO66 14p TO3 15p
Power Tab 13p

10D 50p
DIP10/2 for SL403D 15p

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

NEW LISTS

BOXES, CHASSIS, etc.	No. 7
TRANSISTORS, I.C.'s, etc.	(soon)

(postage 5p)

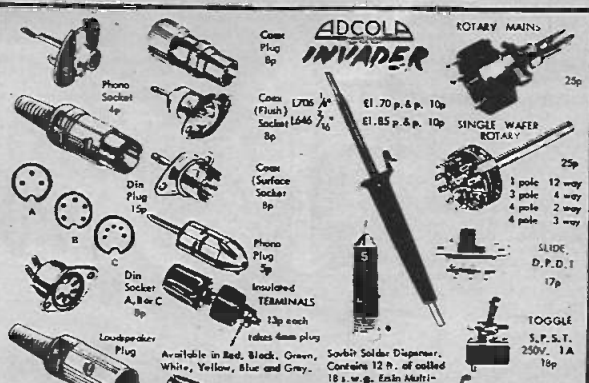
Aluminium Boxes

Including baseplate and screws

No.	L.	W.	D.	Price	p. & p.
(7)	2¾"	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

Transistors & Integrated Circuits

AC107	25p	BC147	10p	BF196	15p	OC81	19p	2N1304	22p	2N5172	15p
AC126	17p	BC148	10p	BF197	15p	OC140	29p	2N1711	25p	BZY88 ZENERS SERIES	10p ea.
AC127	15p	BC149	10p	BF272	53p	OC170	23p	2N1893	38p		
AC128	15p	BC157	12p	BFY50	24p	OC171	38p	2N2926	all 18p	LO05T1	£1.58
AC176	15p	BC158	10p	BFY51	21p	ZTX107	15p	2N3053	23p	LO36T1	£2.58
AC187	25p	BC159	12p	BRY39	36p	ZTX108	12p	2N3054	58p	LO37T1	£1.50
AC187K	25p	BC160	15p	BSX21	28p	ZTX109	15p	2N3055	49p	MC1303L	£1.75
AC188	25p	BC268	15p	BSY95A	14p	ZTX300	12p	2N3702	12p	MC1330	80p
AC188K	25p	BD115	67p	BU105/02	£1.75	ZTX301	15p	2N3703	12p	MC1350	75p
ACY20	28p	BD131	78p	M.JE340	67p	ZTX302	28p	2N3704	10p	MC1351	£1.88
AD140	48p	BD132	70p	MPF102	48p	ZTX303	28p	2N3705	10p	MC1352	£1.88
AD149	48p	BD131/2M.P.		MPF103	37p	ZTX304	25p	2N3706	10p	MFC4000B	48p
AD161 AD162	60p		149p	MPF104	37p	ZTX341	28p	2N3707	13p	MFC4010A	55p
AF114	18p	BF160	21p	MPF105	46p	ZTX500	15p	2N3708	12p	LM380	£1.45
AF115	18p	BF167	29p	MPF106	45p	ZTX501	15p	2N3709	12p	SL403D	£1.50
AF116	18p	BF173	26p	OC28	48p	ZTX502	26p	2N3710	12p	TAD100	£1.50
AF117	18p	BF180	25p	OC35	40p	ZTX503	17p	2N3711	12p	FILTER DISCS	£1.50
AF139	28p	BF181	30p	OC44	15p	ZTX504	50p	2N3819	35p		
BC107	10p	BF184	25p	OC45	15p	ZTX531	25p	2N3903	15p	µA709C	45p
BC108	10p	BF185	25p	OC71	11p	2N697	18p	2N3904	17p	µA710	45p
BC109	10p	BF194	15p	OC72	17p	2N706	12p	2N3905	21p	µA723C	£1.85
BC109	10p	BF195	15p	OC76	15p	2N708	15p	2N3906	12p	µA741C	58p



Mullard & Siemens Electrolytics

CAP µF	VOLTAGE 4	8.3	10	16	25	40	63
1	—	—	—	—	—	—	6p
1·5	—	—	—	—	—	—	6p
2·2	—	—	—	—	—	—	6p
3·3	—	—	—	—	—	—	6p
4·7	—	—	—	—	—	6p	6p
6·8	—	—	—	—	—	6p	6p
10	—	—	—	6p	—	6p	6p
15	—	—	6p	—	6p	6p	8p
22	—	6p	—	6p	—	8p	—
33	6p	—	8p	—	8p	—	—
47	8p	—	8p	8p	8p	8p	8p
68	—	8p	—	8p	—	—	10p
100	8p	—	8p	—	8p	8p	12p
150	—	8p	—	8p	8p	10p	12p
220	8p	—	8p	8p	10p	12p	18p
330	8p	—	8p	10p	—	—	21p
470	—	8p	10p	—	12p	18p	40p
680	—	10p	—	12p	18p	21p	—
1000	10p	—	12p	18p	21p	40p	60p
1500	—	12p	18p	21p	—	—	—
2200	—	18p	21p	40p	45p	86p	93p
3300	—	21p	—	—	60p	—	—
4700	21p	—	—	60p	75p	93p	—

CAP µF	VOLTAGE 16	25	40	64
500	—	—	33p	40p
1250	—	—	50p	—
1800	—	—	—	75p
2000	40p	50p	—	—
2500	—	—	75p	93p
3200	50p	—	—	—
4000	—	75p	93p	—
6400	75p	93p	—	—

Quantity Prices on application.

Hi-Volt Electrolytics

1; 2·4; 8nF	450V	14p	32µF	450V 20p
16µF	450V	15p	50µF	350V 20p
8 + 8pF; 450 W.V.		18p	32 + 32µF; 350 W.V.	25p
8 + 16µF; 450 V.W.		20p	32 ; 32µF; 450 V.W.	43p
16 + 16µF; 450 V.W.		25p	50 ; 50µF; 350 V.W.	35p

G.W.SMITH & CO (RADIO) LTD

TS60 POCKET MULTIMETER

High-precision at low-cost. Ranges: D.C. 15V, 150V, 1,000V (10,000 opv). A.C. 15V, 150V, 1000V (1,000 opv). D.C. Current 150mA. Resistance 100k ohms. £1·85. Post 15p.

AUDIOTRONIC MODEL ATM.1

Top value 1000 o.p.v. pocket multimeter. Ranges: 0/10/50/250/1000v. AC and DC DC Current 0·1mA/100mA. Resistance 0/150k ohms. Decibels −10 to +22dB. Size 90 × 60 × 28mm. Complete with test leads. £2·50. Post 15p.

LT601 MULTIMETER

New style 20,000 o.p.v. pocket multimeter. 5/25/50/250/500 / 2500 V. D.C. 10 / 50 / 100 / 500 / 1000V. A.C. 50μA / 250mA. 6K / 6 meg ohms. −20 to + 22 dB. £3·75. Post 20p.

MODEL TH-12

20,000 o.p.v. Overload protection. Slide switch selector 0 / ·25 / 2·5 / 10 / 50 / 250 / 1000V. D.C. 0 / 10 / 50 / 250 / 1000V. A.C. 0 / 50μA / 25 / 250mA. D.C. 0 / 3K / 30K / 300K / 3 meg − 20 to + 50db £4·97. Post 15p.

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. DC Current 100mA/1/10/100mA/1A. Resistance 300 ohms/3/30/300K/3m Ω. Complete with batteries, test leads, instructions and sturdy steel carrying case. OUR PRICE £5·97. P. & P. 25p

HIOKI MODEL 730X

30,000 O.P.V. Overload protection. 6/30/60/300/600/1200 VDC. 12/60/120/600/1200 VAC. 60μA/30 mA/300 mA. 2K/200K/2 megohm. −10 to +63db. £7·60. P. & P. 15p.

MODEL PL436

20k Ω/Volt D.C. 8k Ω/Volt AC. Mirror scale. ·6/3/12/30/120/600 V D.C. 3/30/120/600 V A.C. 50/600μA/60/600 mA. 10/100K/1 Meg/10 Meg Ω − 20 to +46db. £8·97. P. & P. 12p.

MODEL 500

30,000 O.P.V. with overload protection mirror scale 0/·5/2·5/10/25/100/250/500/1,000v. D.C. 0/2·5/10/25/100/250/500/1,000V. A.C. 0/50μA/5/50/500mA. 12 amp. D.C. 0/60/K/6 Meg/60 Meg Ω £9·95. Post paid. Leather Case £1·75

U4312 MULTIMETER

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. 0/300μA/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. 0/200 Ω/3K/30K Ω. Accuracy DC 1%. AC 1·5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. £9·50. P. & P. 25p.

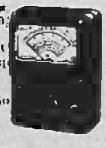
HIOKO MODEL 700X

100,000 O.P.V. Overload protection. Mirror scale. ·3/·6/1·2/1·5/3/6/12/30/60/120/300/600/1200V DC 1·5/3/6/12/30/60/150/300/600/1200 V. A.C. 15/30μA/3/6/30/60/150/300mA 6/12 AMP. DC. 2K/200K/2 Meg/20 Meg ohm −20 to +63dB. £13·50. P. & P. 20p

MODEL C-7080 EN

Giant 6" mirror scale 20,000 o.p.v. 0 / ·25 / 1 / 2·5 / 10 / 50 / 250 / 1000 / 5000V. D.C. 0 / 2·5 / 10 / 50 / 250 / 1000 / 5000V. A.C. 0 / 50μA / 1 / 10 / 100 / 500mA / 10 amp. D.C. 0 / 2K / 200K / 20 meg − 20 to + 50 dB. £13·95. Post 35p.

370 WTR MULTI-METER



Features A.C. current ranges 20,000 o.p.v. 0/·5/2·5/10/50/250/500 1000 V. D.C. 0/2·5/10/50/250/500/1000V A.C 0/50uA/1/10/100mA/1/10 Amp D.C. 0/100mA/1/10 Amp AC 0/5K/50K/500K/5 MEG/ 50 MEG. −20 +62db. £15. P. & P. 25p.

KAMODEN 72.200 MULTITESTER

High sensitivity tester. 200,000 o.p.v. Overload protection. Mirror scale. Ranges: 0 / ·06 / ·3 / 3 / 30 / 120 / 600 / 1200V. D.C. 0 / 3 / 12 / 60 / 300 / 11,200V. A.C. 0 / 6μA / 1·2mA / 120mA / 600mA / 12A. D.C. 0 / 12A. A.C. −20 to +63dB. 0 / 2K / 200K / 2 meg / 200 meg ohms. £16·95. Post 30p.

TMK LAB TESTER.

100,000 O.P.V. 6½in. Scale Buzzer Short Circuit Check. Sensitivity: 100,000 O.P.V. D.C. 5K/Volt A.C. D.C. Volts: ·5, 2·5, 10, 50, 250, 1,000 V. A.C. Volts: 3, 10, 25, 50, 250, 500, 1,000V. D.C. Current: 10, 100μA. 10, 100, 500mA, 2·5, 10 amp. Resistance: 1K, 10K, 100K, 10MEG, 100MEG Ω. Decibels: −10 to +49 db. Plastic Case with Carrying Handle. Size: 7½in. x 6½in. x 3½in. £18·95. P. & P. 25p.

Model S-100TR MULTIMETER/ TRANSISTOR TESTER

100,000 o.p.v. mirror scale/ overload protection. 0/·12/·6/3/12/30/120/600 V DC. 0/6/30/120/600. V AC. 0/12/600μA/12/300mA/12 AMP DC. 0/10 K/1 MEG/100MEG. −20 to +50db. 0·01−2 MFD. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. £13·50. P/P 25p.

KAMODEN HM.350 TRANSISTOR TESTER

High quality instrument to test Reverse Leak current and DC current. Amplification factor of NPN, PNP, transistors, diodes, SCR's etc. 4" × 4½" clear scale meter. Operates from internal batteries. Complete with instructions, leads and carrying handle. £12·50. Post 30p.

MODEL 449A IN CIRCUIT TRANSISTOR TESTER

Checks true A.C. beta in / out. Checks Icbo. Checks diode-in / out. Checks SCR, etc. Beta HI 10 − 500. LO 2 − 50. Icbo 0−5000μA. 220/240 V A.C. operation £17·50. Post 25p.

LB3 TRANSISTOR TESTER

Tests ICO and B. PNP / NPN. Operates from 9v battery. Complete with all instructions, etc. £8·95. P. & P. 20p.

MODEL U4311 SUB-STANDARD MULTI-RANGE VOLT AMMETER

Sensitivity 330 ohms/Volt AC and DC. Accuracy 5% D.C. 1% AC. Scale length 165mm. 0/300/750μA 1·5 / 3 / 7·5 / 15 / 30 / 75 / 150 / 300 / 750mA / 1·5 / 3 / 7·5AMP DC 0 / 3 / 7·5 / 15 / 30 / 75 / 150 / 300 / 750mA / 1·5 / 3 / 7·5 AMP AC 0 / 75 / 150 / 300 / 750mV / 1·5 / 3 / 7·5 / 15 / 30 / 75 / 150 / 300 / 750V DC 0/750mV / 1·5 / 3 / 7·5 / 15 / 30 / 75 / 150 / 300 / 750V AC. Automatic cut out. Supplied complete with test leads, manual and test certificates. £49·00. Post 50p.

TE-65 VALVE VOLTMETER

28 ranges. D.C. volts 1·5−1,500v. A.C. volts 1·5−1,500v. Resistance up to 1,000 megohms. 200/240v. A.C. operation. Complete with probe and instructions. £17·50. P. & P. 30p. Additional probes available: R.F. £2·12½; H.V. £2·50.

KAMODEN HM. 720B F.E.T. V.O.M.

Input impedance 10 meg ohms. Ranges: 0 / ·25 / 1 / 2·5 / 10 / 50/ 250 / 1000V. D.C 0 / 2·5 / 10 / 50 / 250 / 1000V. A.C. 0 / 25μA / 2·5 / 25 / 250 MA D.C. − 20 to + 62dB 0 / 5K / 50K / 500K / 5meg 500meg ohms. £14·95. Post 30p

TE−40 HIGH SENSITIVITY A.C. VOLTMETER

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

TMK MODEL 117 P.E.T. ELECTRONIC VOLTMETER

Battery operated. 11 meg input. 26 ranges. Large 4½" mirror scale. Size 5½" × 4½" × 2½". DC VOLTS 0·3−1200V AC VOLTS 3−300V RMS. 8−800V P-P. DC CURRENT ·12−12MA. Resistance up to 2000M ohm. Decibels −20 to + 51dB. Complete with leads/instructions. £17·50. P. & P. 20p.

MODEL L-55 FET V.O.M.

Input impedance 10 meg ohms. 0 / 3 / 1·2 / 6 / 30 / 120 / 600V. D.C. 0 / 3 / 12 / 60 / 120 / 600V. A.C. 0 / 120μA / 120mA D.C. 0 / 1K / 100K / 10 meg /100 meg ohms £15·97. Post 15p.

KAMODEN HMG-500 INSULATION RESISTANCE TESTER

Range 0−1000 Megohms, 500 Volt. Battery operated. Wide range clear meter 4½" × 4". Complete with de-luxe carrying case, batteries, instructions. £19·95. Post 30p.

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

Sine 18 × 200,000 Hz: Square 18 × 50,000 Hz Output max. + 10 dB. (10 K ohms) Operation internal batteries Attractive 2-tone case 7½" × 5" × 2". Price £17·50. Carr. 17½p.

CI-5 PULSE OSCILLOSCOPE

For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth 10MHz. Sensitivity at 100KHz VRMS/mm. ·1-25; HOR. AMP. Bandwidth 500KHz. Sensitivity at 100KHz, V RMS/mm. ·3-25; Preset triggered sweep 1-3,000usec.; free running 20-200,000Hz in nine ranges. Calibrator pips. 220 × 360 × 430mm. 115-230V. AC operation. £39·00. Carr. paid.

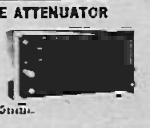
TO-3 PORTABLE OSCILLOSCOPE

3in. tube, Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps-1·5 MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9v. p-p/CM. Bandwidth 1·5cps-800kHz. Input imp. 2 meg Ω 20pF Time base. 5 ranges 10 cps 300 kHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½lb. 220/240V. A.C. Supplied brand new with handbook. £47·50. Carr. 50p.

RUSSIAN CI-16 DOUBLE BEAM OSCILLOSCOPE

5 mc/s Pass Band. Separate Y1 and Y2 amplifiers. Rectangular 5in. × 4in. C.R.T. Calibrated triggered sweep from ·2 u/sec. to 100 milli-sec. per cm. Free running time base 50 c/s-1 mc/s. Built-in time base calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manual £87. Carr. Paid.

MODEL AT201 DECADE ATTENUATOR



Frequency range 0−200 KHz. Attenuator 0−111db, 0-1db step. Impedance 600 ohms. Max. input power 30dbm. Size 180 × 90 × 55mm. £12·50. Post 37p.

ARF-300 AF/RF SIGNAL GENERATOR.

All transistorised, compact, fully portable. AF sine wave 18 Hz to 220 KHz. AF square wave 18 Hz to 100 KHz. Output sine / square 10v. P-P. RF 100 KHz to 200 MHz. Output 1v. maximum. Operation 220/240v. AC. Complete with instructions and leads. £29·85. Post 50p.

TE-20D RF SIGNAL GENERATOR

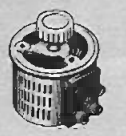
Accurate wide range signal generator covering 120 Kc/s 500 Mc/s on 6 bands. Directly calibrated Variable R.F. attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions £17·50. Carr. 37½p. Size 140 × 215 × 170 mm.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

Sine: 20cps to 200 kc/s on 4 bands. Square: 20cps to 30 kc/s. Output impedance 5,000 ohms. 200/250V. A.C. operation. Supplied brand new and guaranteed with instruction manual and leads. £17·50, Carr. 37½p.

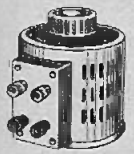
"YAMABISHI" VARIABLE VOLTAGE TRANSFORMERS

Excellent quality at low cost. All models—Input 230V. 50/60 c/s. Variable output 0–260V.



MODEL S-260
GENERAL PURPOSE BENCH MOUNTING

1 Amp ..	£7·00
2·5 Amp ..	£8·05
5 Amp ..	£11·75
8 Amp ..	£15·90
10 Amp ..	£22·50
12 Amp ..	£23·60
20 Amp ..	£49·00
25 Amp ..	£58·00
40 Amp ..	£82·50



MODEL S-260B
Panel Mounting.

1 Amp ..	£7·00
2·5 Amp ..	£8·05

Carriage and Packing Extra

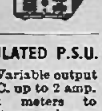
AUTO TRANSFORMERS

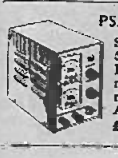
0/115/250V. Step up or step down. Fully shrouded.

80 W	£2·10	P. & P. 18p
150 W	£2·70	P. & P. 18p
300 W	£3·60	P. & P. 23p
500 W	£5·25	P. & P. 33p
1000 W	£7·50	P. & P. 38p
1500 W	£10·20	P. & P. 43p
2250 W	£17·25	P. & P. 50p
5000 W	£35·00	P. & P. £1

MCA. 220 AUTOMATIC VOLTAGE STABILISER

Input 88 125 VAC or 176. 250VAC. Output 120VAC or 240VAC. 200VA rating. £11·97. Carr. 50p.





PS.200 REGULATED P.S.U.

Solid state. Variable output 5–20 volt D.C. up to 2 amp. Independent meters to monitor voltage and current. Output 220/240 V. A.C. Size 7½" × 5½" × 3½". £19·95. P. & P. 25p.

PS.1000B REGULATED POWER SUPPLY

Solid state. Output 6, 9 or 12 volt DC up to 3 amps. Meter to monitor current. Input 220/240v AC. Size 4" × 3½" × 6½". £11·97. P. & P. 25p.

230V/240V SMITHS SYNCHRONOUS GEARED MOTORS

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

POWER RHEOSTATS

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

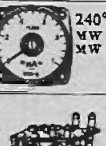
25 WATT. 10/25/50/100/250/500/1000/1500/2500 or 5000 ohms. 95p. P. & P. 10p.

50 WATT. 10/25/50/100/250/500/1000/2500 or 5000 ohms. £1·85. P. & P. 10p.

100 WATT. 1/5/10/25/50/100/250/500/1000 or 2500 ohms. £1·95. P. & P. 15p.

240° Wide Angle 1mA Meters

MW 1-6 60mm square £3·97
MW 1-8 80mm square £4·97
P. & P. extra



230 VOLT A.C. 50 CYCLES RELAYS

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

SEW CLEAR PLASTIC PANEL METERS

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1mA	£3·10	10 amp.	£3·10
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5mA	£2·90	300V. D.C.	£2·90
10mA	£2·90	15V. A.C.	£3·00
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100mA	£2·90	VU Meter	£3·15

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50–0–50μA	£3·05	20V. D.C. ..	£2·50
100μA	£3·00	50V. D.C. ..	£2·50
100–0–100μA	£2·95	300V. D.C.	£2·50
500μA	£2·65	15V. A.C. ..	£2·60
1mA	£2·50	300V. A.C. ..	£2·60
5mA	£2·50	8 Meter 1mA	£2·60
10mA	£2·50	VU Meter ..	£3·80
50mA	£2·50	1 amp. A.C. *	£2·50
100mA	£2·50	5 amp. A.C. *	£2·50
500mA	£2·50	10 amp. A.C. *	£2·50
1 amp	£2·50	20 amp. A.C. *	£2·50
5 amp	£2·50	30 amp. A.C. *	£2·60

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100μA	£3·15	50V. D.C. ..	£2·60
100–0–100μA	£3·10	150V. D.C.	£2·60
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100mA	£2·60	VU Meter ..	£3·70
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1 amp.	£2·60	100mA A.C. *	£2·60
5 amp.	£2·60	200mA A.C. *	£2·60
10 amp.	£2·60	500mA A.C. *	£2·60
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200μA	£2·25	1 amp.	£2·25
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500–0–500μA	£2·25	5 amp.	£2·25
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10mA	£2·25	20V. D.C. ..	£2·25
20mA	£2·25	50V. D.C. ..	£2·25
50mA	£2·25	100V. D.C.	£2·25
100mA	£2·25	150V. D.C.	£2·25
150mA	£2·25	300V. D.C.	£2·25
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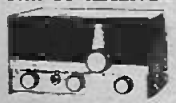

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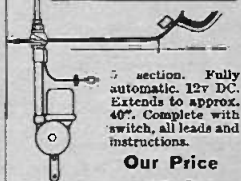

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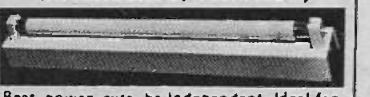

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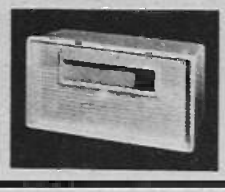

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4 VOLT		16 VOLT		40 VOLT	
47μF	6½p	15μF	6½p	47μF	6½p
100μF	6½p	33μF	6½p	100μF	9p
220μF	6½p	68μF	6½p	150μF	10p
330μF	6½p	150μF	8p	220μF	11p
1000μF	13p	220μF	9p	470μF	19p
4700μF	29p	680μF	17p	680μF	25p
		1000μF	17p	1000μF	25p
		1500μF	25p	2200μF	44p
		2000μF	43p		
6·3 VOLT					
33μF	6½p				
68μF	6½p				
150μF	6½p	**25 VOLT**			
470μF	11p	10μF	6½p		
680μF	13p	22μF	6½p		
1500μF	18p	47μF	6½p		
2200μF	18p	100μF	8p		
3300μF	26p	150μF	8p	**63 VOLT**	
		220μF	10p	1μF	6½p
		470μF	13p	2·2μF	6½p
		680μF	20p	4·7μF	6½p
10 VOLT		1000μF	22p	6·8μF	6½p
22μF	6½p	2200μF	39p	10μF	6½p
47μF	6½p	5000μF	68p	22μF	6½p
100μF	6½p			68μF	10p
220μF	8p			100μF	11p
330μF	10p			150μF	13p
470μF	10p	**40 VOLT**		220μF	19p
1000μF	11p	6·8μF	6½p	330μF	22p
1500μF	20p	15μF	6½p	470μF	26p
2200μF	24p	33μF	6½p	1000μF	44p

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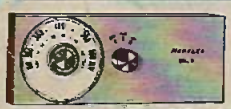

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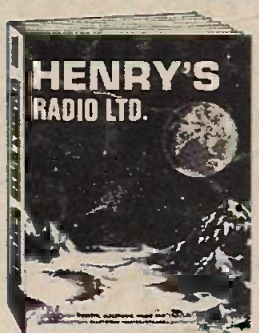

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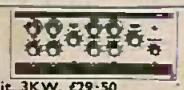

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