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everyday electronics

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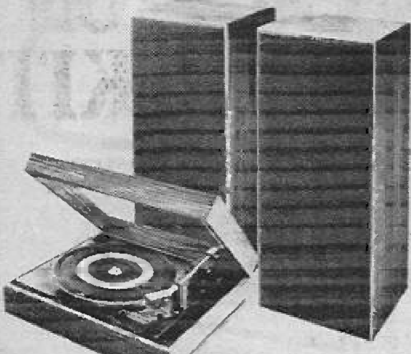
FREE! INSIDE
24 PAGE Dictionary of Electronic Terms

RTVC

COMPLETE* STEREO SYSTEM



£51·00

40 Watt Amplifier.
Viscount III – R102 now 20 watts per channel.
System I includes,
Viscount III amplifier – volume, bass, treble and balance controls, plus switches for mono/stereo on/off function and bass and treble filters. Plus headphone socket.
Specification
20 watts per channel into 8 ohms.
Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K. equalised within ± 1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to –17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble – 12dB to –12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max.) –58dB.
Crosstalk better than 35dB on all inputs. Overload characteristics better than 26dB on all inputs. Size approx. 13¾" × 9" × 3¾".
Garrard SP25 deck, with magnetic cartridge, de luxe plinth and hinged cover.
Two Duo Type II matched speakers – Enclosure size approx. 17½" × 10½" × 6" in simulated teak. Drive unit 13" × 8" with parasitic tweeter **Complete System £51.00**

£69·00

System II
Viscount III amplifier (As System I)
Garrard SP. 25 (As System I)
Two Duo Type IIIA matched speakers— Enclosure size approx. 31" × 13" × 11½". Finished in teak veneer. Drive units approx. 13½" × 8½" with 3½" HF speaker. Max. power 20 watts. 8 ohms. Freq. range 20Hz to 20kHz.

Complete System £69.00

PRICES: SYSTEM 1

Viscount III R 102 amplifier	£24·20 + £1 p & p
2 Duo Type II speakers	£14·00 + £2·20 p & p
Garrard SP25 with MAG. cartridge de luxe plinth and hinged cover	£21.00 + £1.75 p & p.
total	£59.20

Available complete for only £51.00 + £3·50 p. & p.

PRICES: SYSTEM 2

Viscount R 102 amplifier	£24·20 + £1 p & p
2 Duo Type III A speakers	£39·00 + £4.00 p & p
Garrard SP25 with MAG. cartridge de luxe plinth and hinged cover	£21.00 + £1.75 p & p.
total	£84.20

Available complete for only £69.00 + £4 p & p.

STEREO 21

QUALITY SOUND* FOR LESS THAN £19·00

Stereo 21 easy to assemble audio system kit, – no soldering required. Includes:—
BSR 3 speed deck, automatic, manual facilities together with ceramic cartridge.
Two 8" × 5" speakers with cabinets.
Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.
For the technically minded:—
Specifications:
Input sensitivity 600mV: Aux. input sensitivity 120mV: Power output 2.7 watts per channel: Output impedance 8–15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs – radio, tape, etc., and outputs for taping discs. **Overall Dimensions.** Speakers approx. 15½" × 8" × 4". Complete deck and cover in closed position approx. 15½" × 12" × 6". Complete only **£18.95 + £1.00 p & p**
Extras if required.
Optional Diamond Styli **£1.37**
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance. **£3.85.**

DISCO AMPLIFIER

Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties.
Outputs 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).
Inputs *5 Electrically Mixed Inputs. *3 Individual Mixing controls. *Separate bass and treble controls common to all 5 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling.

INPUT SENSITIVITIES

1) Crystal Mic or Guitar 9mV. 2) Moving coil Mic or Guitar 8mV. 3), 4), 5) Medium output equipment (Gram. Tuner, Monitor, Organ, etc.) – all 250mV sensitivity.
AC Mains 240V. operation.
Size approx. 12½ ins × 6 ins × 3½ ins
£13.50 + 60p. postage & packing.

8 TRACK CARTRIDGE PLAYER*

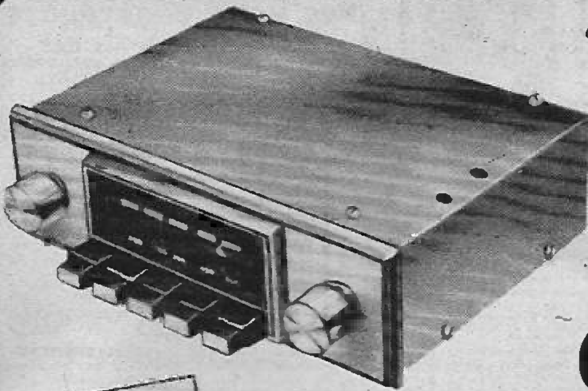
Elegant self selector push button player for use with your own stereo system. Compatible with Viscount III system, the Stereo 21 and the Unisound module.
Technical specification.
Mains input. 240V. Output sensitivity 125mV
Comparable unit sold elsewhere at £24·00 approx.
Yours for only £10.95 + 90p. p & p

BUILD YOUR OWN STEREO AMPLIFIER*

For the man who wants to design his own stereo —here's your chance to start, with Unisound— pre-amp. power amplifier and control panel. No soldering—just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum.
240V. AC only. **£7·64 + 55p. p & p**

PE TAPE LINK CONSTRUCTORS

A suitable 3 speed tape deck, less heads. Caters up to 5¾ ins. spools. 240V AC mains. Unused but store soiled hence no warranty. **£4.00 + £1.00 p & p**



Remember! one of the Top Ten Accessory Awards from Motor *magazine*

PUSH BUTTON* CAR RADIO KIT

BUILD YOUR OWN TOURIST PUSH BUTTON CAR RADIO

Technical specification:
1.) Output 2.5 watts R.M.S. into 8 ohms. For 12 volt operation on negative or positive earth.
2.) Integrated circuit output stage, pre built three stage IF Module.
Controls Volume, manual tuning and five push buttons for station selection, illuminated tuning scale covering full medium and long wave bands.
Size Chassis 7 ins. wide, 2 ins. high and 4 3/16 ins. deep approx.

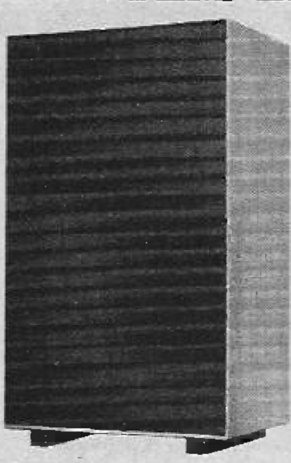
NOTE: The ability to solder on a printed circuitboard is necessary to complete this kit successfully. Circuit diagram and comprehensive instructions 55p free with kit.

Car Radio Kit
£6.60 + 55p. postage & packing.

Speaker including baffle and fixing strips
£1.65 + 23p. postage & packing.

Recommended Car Aerial - fully retractable and locking.
£1.35 post paid.

THE ULTIMATE COMPLETE SPEAKER SYSTEM EMI LE 315



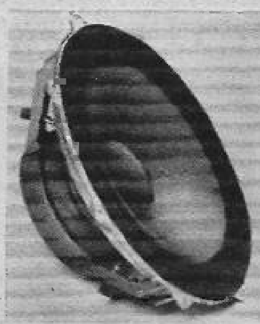
A professional standard five way speaker system with enclosure giving top quality performance.
Enclosure Dimensions
approx. (3 ft. × 2 ft. × 1 ft.).
Drive Units
Hand built – 15" diameter bass with 3" voice coil,
– two 5" diameter Mid Range units.
– two 3¼" HF. units,
plus matching crossover panel with two variable potentiometers for mid and high frequency adjustment.
Powder Handling
Continuous rating
35 W rms., Peak power rating 70 W.
Frequency Response
20 Hz 20,000 Hz.
Impedance 8 ohms.

Recommended retail selling price, £86·00.

Our price £45·00 + £3.50 postage & packing.

EMI SPEAKERS

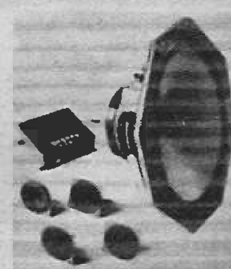
FANTASTIC REDUCTION



15" 14A/780. Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts RMS. and is treated to give a smooth frequency response. Resonance 30 Hz. flux density 360,000 Maxwells. Impedance at 1 kHz is 8 ohms. 3" voice coil.

Recommended retail price £40·80.

OUR PRICE £18·70 + £1·50 p & p



950 Kit – Five matched speakers and crossover unit for handling up to 45 watts, frequency response from 20 to 20,000 Hz.
Huge 19" × 14" (approx.) high efficiency Bass-Speaker with 16,500-gauss magnet built on a heavy diecast frame.
The four 10,000 gauss tweeters, each 3½" dia. approx., are fed by the crossover which critically adjusts signal for maximum fidelity. Impedance at 1 kHz is 8 ohms. Bass coil 2", others 0·5". Recommended list price £44·00.

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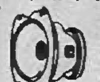
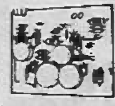
7" x 4" LOUDSPEAKER



A top quality speaker ideal where small size is important. Manufactured by E.M.I. for a well-known hi-fi set maker. Size: 7in. x 4in. Impedance: 8 ohms. Flux: 38,000. Max. Free range: 90Hz to 12kHz. Power handling: 5W. Unbeatable. Price: £1·60. Free postage on this item.

BARGAIN BOARDS



Components galore for the experimenter Ex computer boards with: Resistors, Capacitors and useful Transistors—at least 4 transistors per board.

5 BOARDS £1·00, P. & P. Free

CRESCENT P.300. DISCO CONTROL PACK.

A control unit which when connected to twin decks makes a disco of professional quality. We supply a smart front panel which incorporates controls, switch and input sockets. The control module, I.C. construction, incorporating, mixing, pre-amp and head-phone listening amplifier. The power pack enables this unit to work from the standard mains. • Inputs include Mic. Tape/Cassette and Twin Decks. • Controls include Mic. Tape, Each Deck and P.F.L. Full instructions are included with every Pack. MONO — £14 plus 20p PP. STEREO — £17 plus 20p PP. Send a S.A.E. for more information.

STEREO / MONO HEADPHONE VOLUME CONTROL BOX

Plug Stereo phones into this control box and you then incorporate a right and left hand volume control and a stereo/mono switch. Complete with stereo jack plug and 2 m cable.
A Bargain at £1. Plus 10p P. & P.

TWO WAY STEREO ADAPTOR

Stereo jack plug to two stereo line sockets complete with 110 mm of cable. For plugging two stereo inputs into one. A Bargain at 65p plus 5p P&P.

LOW VOLTAGE AMPLIFIER Few only at **£1·75** plus 13p P. & P.

5 transistor amplifier complete with volume control, is suitable for 9V d.c. and a.c. supplies. Will give about 1W at 8 ohm output.
With high IMP input this amplifier will work as a record player, baby alarm, etc., amplifier.

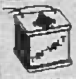
"CRESCENT" CATALOGUE

If you are a constructor you should own a copy.
Send 20p inc. Postage.

MINI LOUDSPEAKERS

2¼" (57mm) 40ohm — 50p each
2¼" (57mm) 80ohm — 50p each
Please include 5p. P. & P. up to 3 Mini-Loudspeakers

TRI-VOLT BATTERY ELIMINATOR



Enables you to work your transistor radio, amplifier, or cassette, etc. from A.C. mains through this compact eliminator. Just by moving a plug you can select the voltage you require — 6v, 7½v or 9 volts. This means all your transistor power pack applications can be handled by this one unit. Approx. size: 2¼" x 2¼" x 3½". OUR PRICE — £2·75p + 10p. P. & P. Same model suitably wired for the Philips Cassette — £3·00 + 10p. P. & P.

TRI-VOLT CAR CONVERTER

Enables you to work your Transistor Radio, Amplifier or Cassette etc. from the 12 volt car supply positive or neg. earth.
This converter supplies 6, 7½ or 9 volts and is transistor regulated. Approx. size 2½" × 3½" × 2"
Very easy to fit and a real money saving device for £2·50 + 10p. P. & P.

WAFER SWITCHES

1 pole 12 way
2 pole 2 way
2 pole 3 way
2 pole 4 way
2 pole 6 way
3 pole 4 way
4 pole 3 way
18p each. Please inc. 5p P. & P. Up to 3 switches.

"CRESCENT" 100 WATT R.M.S. ALL PURPOSE AMPLIFIER U. BUILD. IT

We supply the three modules for you to build this Disco-Group-P.A. amplifier into the cabinet of your choice.

★ **THE POWER AMP MODULE TP 100W**
170W. r.m.s. sq. wave 300W instantaneous peak into 8 ohm (60W into 16 ohm). £14·28, carr. 45p.

★ **THE PRE-AMP MODULE**
Four control pre-amp. Vol. Bass. Treble. Middle controls. Designed to drive most amplifiers using F.E.T. first stage. £3·96 carr. 25p.

★ **THE POWER SUPPLY MODULE PS100**
Is supplied complete with the mains transformer. £9·66, carr. 50p. Complete fixing instructions are supplied and no technical knowledge is required to connect the three ready wired modules. A fantastic bargain. If you purchase all three modules. £25, carr. 75p. Send S.A.E. for further details on this or our ready built amplifiers

200/250V MAINS RELAY

Heavy duty contacts. 2,500 Ω coil. All new and unused D.P.D.T. mains relays 50p + V.A.T. Carr. Free. Special quantity price: £40 per 100 relays.

"CRESCENT BEAT BRITE" SINGLE CHANNEL SOUND TO LIGHT UNIT

This fantastic little box approx. 4" × 3" × 2½" when connected to the output of a sound source from 1 to 100 watts produces a psychedelic light display of up to 1000 watts.
Complete with a sensitive level control the unit is fused and can not harm your amplifier.
A Bargain at £7·50 plus 10p P. & P.

MAINS TRANSFORMER

Fused Primary 240V. Secondary 220V @ 50mA. 6·3V @ 1A.
This transformer is made to a very high standard and is a small size: 2in × 2½in × 2½in. 63p plus 15p P. & P.

POTENTIOMETERS

All types 1" and less diameter.

SINGLES		DUAL	
5K	Log or	5K	
10K	Lin Less	10K	
25K	Switch	25K	Less
50K	12p ea.	50K	Switch
100K		100K	40p.
250K	Double	250K	each
500K	Pole	500K	
1M	Switch	1M	
2M	24p ea.	2M	

Up to 3 Pots. Please add 5p. P. & P.

MINIATURE RELAYS

Brand new range of British made Relays.
Size—1¼" × 1" × ¾"
All two changeovers with 250V. 1·5A contacts and suitable for fitting on ·1in Veroboard.

Type	Volts	Current	Ohms.
27/A	12v	17M/A	700 Ω
21/A	12v	28M/A	430 Ω
12/A	6v	33M/A	185 Ω

80p each.
Please include 5p P & P up to 3 Relays.

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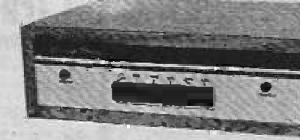
. . . . . until you tune in to stereo perfection with the 'varicap'



Approx. Size 8¾" x 2¾" x 6½"

Features include push button "Spot On" tuning, with up to 5 pre-set stations (no difficult tuning dial and drive cord). Easy "no problem" construction, requiring only a few simple setting up adjustments with a D.C. Voltmeter. Uses NEW pre-set modules for R.F. and I.F. circuits—no circuit alignment. High efficiency Integrated Circuit Phase Lock Loop Decoder for perfect stereo reception, with stereo lamp indicator. TOTAL KIT price only £28·50 including V.A.T. and postage. With Fibre Glass P.C. Board, neat slimline teak veneered cabinet with brushed aluminium front panels, push buttons etc.
All parts available separately.
IDEAL FOR USE WITH THE "TEXAN", "GEMINI" AND ANY GOOD QUALITY STEREO AMPLIFIER.
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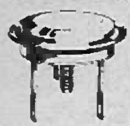

B79	4	IN4007 Sil. Rec. diodes. 1,000 PIV lamp plastic	55p
B81	10	Reed Switches, 1" long, ⅛" dia. High Speed P.O. type	55p
B99	200	Mixed Capacitors. Approx. quantity, counted by weight P & P 15p	55p
H4	250	Mixed Resistors. Approx. quantity counted by weight P & P 15p	55p
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Unmarked Untested Paks

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The 'TACHO BLOCK'. This encapsulated block will turn any 0-1mA meter into a linear and accurate rev. counter for any car with normal coil ignition system.

£1·10p each

Ex GPO Push Button Intercom Telephones

Exactly as internal telephone systems still in everyday use where automatic internal exchanges have not yet taken over. Available in 5, 10 or 15 ways. Complete with circuits and instructions. Necessary 24 pair cable 22p per yard. Price of each instrument is independant of the number of ways.

£2.75 p.p. 38½p PER INSTRUMENT

Cable can be sent by Parcel Post. Post and Packing per 50 yds. 73½p.
Extension Telephones. 71½p each. p.p 27½p. £1·37½ for 2. P.&P. 55p.
These phones are extensions and do not contain bells.

A Cross Hatch Generator £3·85 post paid

A complete kit of parts including Printed Circuit Board. A four position switch gives X-hatch, Dots, Vertical or Horizontal lines. Integrated Circuit design for easy construction and reliability. A project in the Sept. '72 edition of Television. Subject to Availability

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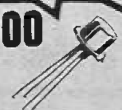
H65	4	40361 Type NPN Sil. transistors TO-5 can comp to H66	55p
H66	4	40362 Type PNP Sil. transistors TO-5 can comp to H65	55p

UNTESTED' UNMARKED

H67	10	3819N Channel FETs plastic case type	55p

Over 1,000,000 Transistors in stock



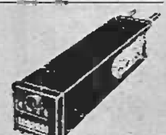
We hold a very large range of fully marked tested and guaranteed transistors, power transistors, diodes and rectifiers at very competitive prices. Please send for free catalogue.

Our very popular, 4p transistors

TYPE "A" PNP Silicon alloy, TO-5 can
TYPE "B" PNP Silicon, plastic encapsulation
TYPE "E" PNP Germanium AF or RF
TYPE "F" NPN Silicon plastic encapsulation
TYPE "G" NPN silicon similar ZTX 300 range
TYPE "H" PNP silicon similar ZTX 500 range

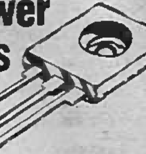
8 RELAYS FOR VARIOUS TYPES P & P 27½p **£1·10p**

High Speed Magnetic Counter



4 digit (non-reset)
24v or 48v (state which) 4 x 1 x 1in, 33p, p.p 5p.

Plastic Power Transistors



NOW IN TWO RANGES

These are 40W and 90W Silicon Plastic Power Transistors of the very latest design, available in NPN or PNP at the most shatteringly low prices of all time. We have been selling these successfully in quantity to all parts of the world and we are proud to offer them under our Tested and Guaranteed terms.

Range 1. VCE. Min 15. HFE Min 15.

	1–12	13–25	26–50
40 Watt	22p	20p	18p
90 Watt	26½p	24½p	22p

Range 2. VCE. Min. 40. HFE Min 40

	1–12	13–25	26–50
40 Watt	33p	31p	29p
90 Watt	38½p	36½p	33p

Complementary pairs matched for gain at 3 amps. 11p extra per pair. Please state NPN or PNP on order.

LM380 Audio I.C. as featured in Practical Wireless December issue complete with application data £1·10

INTEGRATED CIRCUITS

We stock a large range of I.Cs at very competitive prices (from 11p each). These are all listed in our FREE Catalogue. see coupon below.

METRICATION CHARTS now available

This fantastically detailed conversion calculator carries thousands of classified references between metric and British (and U.S.A.) measurements of length, area, volume, liquid measure, weights etc.
Pocket Size 15p Wall Chart 18p

LOW COST DUEL IN LINE I.C. SOCKETS

14 pin type at 16½p each } Now new low profile
16 pin type at 18p each } type

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Full of Short Lead Semiconductors & Electronic Components, approx. 170. We guarantee at least 30 really high quality factory marked Transistors PNP & NPN, and a host of Diodes & Rectifiers mounted on Printed Circuit Panels. Identification Chart supplied to give some information on the Transistors.

11p P & P on this Pak.

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MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, 2½p. 0·0068μF, 0·01μF, 0·015μF, 0·022μF, 0·033μF, 3½p. 0·047μF, 0·068μF, 0·1μF, 4½p. 0·15μF, 6½p. 0·22μF, 8½p. 0·33μF, 12p. 0·47μF, 14p.
160V: 0·01μF, 0·015μF, 0·022μF, 3p. 0·047μF, 0·068μF, 3½p. 0·1μF, 4½p. 0·15μF, 5p. 0·22μF, 5½p. 0·33μF, 6½p. 0·47μF, 8½p. 0·68μF, 12p. 1μF, 14p.

MINIATURE CERAMIC PLATE CAPACITORS

50V: (pF) 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470. 560, 680, 820, 1K, 1K5, 2K2, 3K3, 4K7, 6K8, (μF) 0·01, 0·015, 0·022, 0·033, 0·047, 2½p. each. 0·1, 30V, 4½p.

POLYSTYRENE CAPACITORS 160V 5%

(pF) 10, 15, 22, 33, 47, 68, 100, 150, 220, 330, 470, 680, 1000, 1500, 2200, 3300, 4700, 4p. 6800, 10,000, 4½p.

RESISTORS

CF—High Stab Carbon Film, 5% MF—High Stab Metal Film, 5%.

W.	Type	Range	1–99	100–499	500–999	1000+	Size mm
⅛	CF	22–1M	1	0·75	0·60	0·55	2·4x7·5
¼	CF	22-2M2	1	0·75	0·60	0·55	3·9x10·5
½	CF	22-1M	1	0·75	0·60	0·55	5·5x16
⅛	MF	10-2M7	2	1·54	1·32	1·1	3x7
¼	MF	10-2M2	2	1·43	1·21	0·99	4·2x10·8
1	MF	10-10M	3	1·98	1·81	1·65	6·6x13
2	MF	10-10M	4·5	3·52	3·08	2·75	8x17·5

For value mixing prices, please refer to our catalogue. (price in pence each)
VALUES AVAILABLE—E12 Series only. (Net prices above 100.)

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MINIATURE 0·25W Vertical or horizontal 6p each 1K, 2K2, 4K7, 10K, etc. up to 1M Ω
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2·2μF	63V	6½p	100μF	10V	6½p
3·3μF	63V	6½p	100μF	25V	6½p
4·0μF	40V	6½p	100μF	63V	14p
4·7μF	63V	6½p	150μF	16V	6½p
6·8μF	63V	6½p	150μF	63V	15p
8·0μF	40V	6½p	220μF	6·4V	6½p
10μF	16V	6½p	220μF	10V	6½p
10μF	25V	6½p	220μF	16V	8p
10μF	63V	6½p	220μF	63V	21p
15μF	16V	6½p	330μF	16V	12p
15μF	63V	6½p	330μF	63V	25p
16μF	40V	6½p	470μF	6·4V	9p
22μF	25V	6½p	470μF	40V	20p
22μF	63V	6½p	680μF	16V	15p
32μF	10V	6½p	680μF	40V	25p
33μF	16V	6½p	1000μF	16V	20p
33μF	40V	6½p	1000μF	25V	25p
32μF	63V	6½p	1500μF	6·4	15p
47μF	10V	6½p	1500μF	16V	25p
47μF	25V	6½p	2200μF	10V	25p
47μF	63V	8p	3300μF	6·4	26p

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2½ x 5"	28p	28p
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3¾ x 3¾"	28p	28p
2½ x 1"	7p	7p
2½ x 5" (Plain)	—	14p
2½ x 3¾" (Plain)	—	12p
5 x 3¾" (Plain)	—	22p
Insertion tool	59p	59p
Track Cutter	44p	44p
Pins, Pkt. 25	10p	10p

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AC127	16½p	BC212L	12p
AC128	22p	BC213L	12p
BC107	11p	BC214L	17p
BC108	12p	OC44	18p
BC109	13p	OC71	13p
BC148	12p	OC81	16p
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Carbon Track 5K Ω to 2M Ω, log or lin. Single, 16½p Dual Gang 46p. Log Single with switch 26p
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IN4006	14p
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BA100	10p
OA5	42p
OA47	9p
OA81	11p
OA200	8p

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DIN 2 Pin	12p
3 Pin	13p
5 Pin 180°	15p
Std. Jack	14½p
2.5mm Jack	11p
Phono	5½p

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HI-VOLT: 4/450. 14p. 8/350, 19p. 8/450, 20p. 16/350. 22p. 16/450. 23p. 32/350, 33p. 50/250. 20p. 100/500, 88p.

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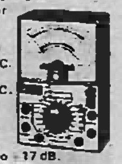
LASKYS

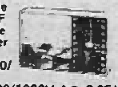
MODEL AF.105 VOM

50,000 opv. Mirror scale. Meter protection. 0-3/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600/1200V DC. 0/30μA/6/60/300 mA/12 Amp. 0/10K/1m/10m 100 Meg Ohms.—20 to +17 dB.
OUR PRICE £12.50 P&P 20p

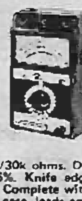
LB4 TRANSISTOR TESTER

Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.
OUR PRICE £4.50 P&P 20p

AUDIOTRONIC Model ATM1

Top value 1,000 opv pocket multi-meter. Ranges:—0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistance: 0/150k ohms. Decibels: −10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.
OUR PRICE £2.95 P&P 15p

U4323 MULTIMETER

20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: 5/50/500 ohms/5/10/100k ohms/1Meg. Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.
OUR PRICE £7.00 P&P 20p

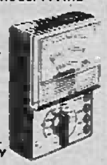
U4312 MULTIMETER

extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/150/60/600mA/1/1.5/6A DC. 0/1.5/6/15/60/150/600mA/1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.
OUR PRICE £9.75 P&P 25p

KAMODEN 72.200 Multitester

High sensitivity tester. 200,000 opv Overload protected. Mirror scale. Ranges:—0/.06/.3/3/30/120/600/1200V DC. 0/3/12/60/300/1200V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. −20 to +63dB. 0/2k/200k/2 Meg/200 Megohms.
OUR PRICE £22.50 P&P 30p

U4341 Multimeter & Transistor Tester

27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.
OUR PRICE £10.50 P&P 20p

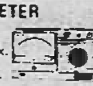
AUDIOTRONIC Model ATM5

Jewel movement, attractively moulded case with edgwise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC. (2500 opv). 0-6/30/300/600V DC. (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. −10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.
OUR PRICE £3.50 P&P 15p

MODEL HIOKI 730X

30,000 opv. Overload protection. 6/30/60/300/600/1200V DC. 12/60/120/600/1200V AC. 60/μA/30mA/300mA. 2K/200K/2 Meg Ohm. 10 to +63 dB.
OUR PRICE £7.50 P&P 15p.

MODEL 500

30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC: 0/50uA/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms.
OUR PRICE £13.95 Carr. paid
Leather case for above £1.75

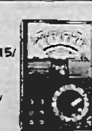
U4317 MULTIMETER

High sensitivity instrument for field and laboratory work. Knife edge pointer. 86mm. mirror scale. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: −5 to +10dB Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.
OUR PRICE £15.00 P&P 20p

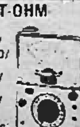
KAMODEN HMG500 insulation resistance tester

Range 0—1,000 Megohms. 500V. Battery operated. Wide range clear meter 4" x 4½". Complete with deluxe carrying case, batteries and instructions.
OUR PRICE £19.95 P&P 30p

MODEL C1092 MULTIMETER

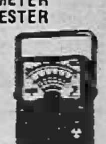
Features 5,000 opv jewel movement and a good selection of range functions. Edgwise ohms adjustment. Ranges: 0—3/15/150/300/1,200V AC (2,500 opv). 0—6/30/300/600 V DC (5,000 opv). DC current. 0—300uA/300mA. Resistance: R x 10, R x 1,000. −10 to +16dB. Complete with battery, test leads and data booklet. Size: 120 x 73 x 28mm.
OUR PRICE £3.75 P&P 35p

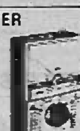
MODEL TE300

30,000opv. Mirror scale. Overload protection. 0/0.6/3/15/60/300/1200V DC. 0/6/30/120/600/1200V AC. 0/30uA/6mA/60mA/300mA/600mA. 0/8k/80k/800k/8 Meg ohms. −20 to +63dB.
OUR PRICE £7.50 P&P 15p

HIOKI 750X VOLT-OHM MILLIAMETER

43 ranges: 0—0.3/0.6/1.5/3/6/12/30/60/150/300/600/1,200V DC. 0—3/6/15/30/60/120/300/600/1,200V AC. Current: 0—30/60uA/1.5/3/15/30/150/300 mA/6/12A. Resistence: 0—3/300k/3/30Mohms. Decibels: −10 to +17dB. Output:—0—3/6/15/30/60/120/300V. Accuracy ± 3% DC, ± 4% AC. Sensitivity: 50,000 opv DC, 5,000 opv AC. 4 inch meter. Built in protection. Size: 57 x 102 x 153mm.
OUR PRICE £11.95 P&P 40p

TMK 100K LAB TESTER

100,000opv. 6½" scale. Buzzer short circuit check. Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.6/2.5/10/50/250/1000V AC. 3/10/50/250/500/1000V DC. current 10/100uA/10/10/100/500mA/2.5/10A. Resistence: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: −10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.
OUR PRICE £19.95 P&P 25p

S100TR MULTIMETER TRANSISTOR TESTER

100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA/6/12A DC 0/10k/1 Meg/100 Meg. −20 to +50dB. 0.01—0.2MFD
Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.
OUR PRICE £15.95 P&P 25p

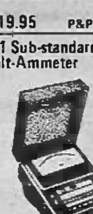
U4324 MULTIMETER

High sensitivity, overload protected. 20,000opv. Ranges: 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/3/30/300mA/3A AC. Resistence: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: −10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.
OUR PRICE £8.00 P&P 20p

MODEL U437 MULTIMETER

10,000opv. A first class instrument manufactured in USSR to the highest standards. Ranges: 2.5/10/50/250/500/1000V DC. 2.5/10/50/250/500/1000V AC. DC current 100uA/1/10/100mA/1A. Resistence 300 ohms/3/30/300k/3 Meg. ohms. Complete with batteries, test leads, instructions and a sturdy steel carrying case.
OUR PRICE £4.95 P&P 25p

HIOKI MODEL 700X

100,000opv. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC. 2k/200k/2M/20MOhms. −20 to +63dB.
OUR PRICE £14.95 P&P 20p

MODEL U4311 Sub-standard Multi-range Volt-Ammeter

Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC. 1% AC. Scale length: 165mm. 0/300/750uA/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A 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 device. Supplied complete with test leads, manual and test certificates.
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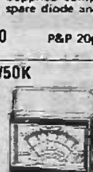
C15 PULSE OSCILLOSCOPE

For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth: 10MHz. Sensitivity at 100kHz VRMS/mm: 0.1—25. HOR. AMP. Bandwidth: 500kHz. Sensitivity at 100kHz VRMS/mm: 0.3—25 Preset triggered sweep 1—3000usec. Free running 20—200 kHz in nine ranges. Calibrator pips. 220 x 360 x 430mm. 115—230V AC.
OUR PRICE £39.00 Carr. paid

MODEL TH12

20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. 0/50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. −20 to +60dB.
OUR PRICE £5.95 P&P 15p

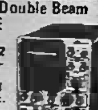
TMK MODEL TW50K

46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistence: 10k/100k/1 Meg/10 Meg ohms. −20 to +81.5dB.
OUR PRICE £8.50 P&P 17p

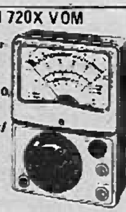
Model HT10084 MULTIMETER

Overload protected, shock proof circuits. 9.5uA Meter with mirror scale. Sensitivity 100kV. Polarity change switch. Ranges: 0.5/2.5/1/50/250/500/1,000 Volts DC. 2.5/10/50/250/1,000 Volts AC. DC resistence 0—20/200k/2/20 Meg. ohms. DC current:— 10/250uA/2.5/25/250 mA/10A. AC current:—0—10A. −20 to +62dB. Operates from 2 x 1.5V batteries. Size: 180 x 134 x 79mm.
OUR PRICE £15.00 P&P 40p

TE40 HIGH SENSITIVITY AC VOLTMETER

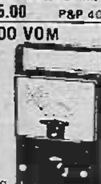
10 Meg input. 10 ranges: 0.001/0.03/0.1/0.3/1/3/11/30/100/300V RMS. 5cps—1.2MHz. −40 to +50dB supplied complete with leads and instructions.
OUR PRICE £17.50 P&P 25p

RUSSIAN C116 Double Beam OSCILLOSCOPE

5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2usec. to 100 milli-sec/cm. Free running time base, 50Hz—1MHz. Built-in time base Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.
OUR PRICE £87.00 Carr. paid

HIOKI Model 720X VOM

A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10/50/250/1000V AC. 0—50uA/250mA. 0—20k/2 Megohms.
OUR PRICE £5.97 P&P 20p

U435 MULTIMETER

20,000opv. Overload protected. Ranges: 75mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.
OUR PRICE £8.75 P&P 20p

MODEL AS.1000 VOM

100,000 opv. Mirror scale. Built-in meter protection. 0.3/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600V AC. 0/10μA/6/60/300mA/12 Amp. 0/2K/200K/2M/200 Meg Ohm. −20 to +17dB.
OUR PRICE £17.50 P&P 20p.

TE65 VALVE VOLTMETER

28 ranges. DC volts 1.5—1500V. AC volts 1.5—1500V. Resistance up to 1000 Megohms. 200/240V AC operation. Complete with probe and instructions.
OUR PRICE £17.50 P&P 30p
Additional probes available: RF £2.12. HV £2.50

MODEL TE15 GRID DIP METER

Transistorised. Operates as Grid Dip, Oscillator, Absorbtion Wave Meter and Oscillating Detector. Frequency range 440kHz—280MHz in six coils. 500uA meter. 9V battery operation. Size: 180 x 80 x 40mm.
OUR PRICE £19.95 P&P 20p

MODEL PL436

20,000 opv DC. 8000 opv AC. Mirror scale 6/3/12/30/120/600V DC. 3/30/120/600V DC. 60/600μA/60/600mA. 10/100K/1 Meg/10 Meg Ohm. −20 to +46dB.
OUR PRICE £6.97 P&P 15p.

U91 Clamp VOLT AMMETER

For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.
OUR PRICE £10.50 P&P 20p

KAMODEN HM720B FET VOM

Input impedence 10 Megohms. Ranges:—0/.25/1/2.5/10/50/1000V DC. 0/2.5/10/50/250/1000V AC. 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms
OUR PRICE £21.00 P&P 30p

LB3 TRANSISTOR TESTER

Tests ICO and B. PNP/NPN. Operates from 9V battery. Instructions supplied.
OUR PRICE £3.95 P&P 20p

Also see following pages

ALL PRICES EXCLUDE VAT

LASKYS

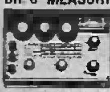
Also see previous page

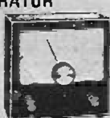
SWR METER Model SWR3

Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%, Impedence 52" Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.
OUR PRICE £4.25 P&P 25p

AT201 Decade ATTENUATOR

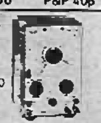
Frequency range 0–200kHz, Attenuator 0–111dB, 0.1dB steps. Impedence 600 ohms. Input power maximum 30dBm. Size: 180 x 90 x 56mm.
OUR PRICE £12.50 P&P 37p

TRANSISTORISED L.C.R. A.C. BR/8 MEASURING BRIDGE

A new portable bridge offering excellent range and accuracy at low cost. Ranges: R 1 11.1 meg 6 Ranges ±1% L.1 H — 111 HENRY 6 Ranges 2 = % C 10pF 1110mFd 6 Ranges ± 2% TURNS RATIO 1 : 1/1000—1 1/100. 6 Ranges ± 1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100 A. Meter indication. Attractive 2 tone metal case. Size 7½ x 5 x 2in.
OUR PRICE £25.00 P&P 25p.

TE16A TRANSISTORISED SIGNAL GENERATOR

5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the handy-man. Operates on 9V battery. Wide easy to read scale. 800kHz modulation.
Size: 149 x 149 x 92mm. Complete with instructions and leads.
OUR PRICE £8.97 P&P 25p

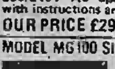
MODEL TE20 RF SIGNAL GENERATOR

Six bands. 120kHz–260MHz. Dual output RF terminals. Separate variable audio output. Accuracy ± 2%. Audio output to 8V. Power requirements: 105–125V, 220–240V AC. Size: 193 x 265 x 150mm. Complete with test leads etc.
OUR PRICE £17.50 P&P 40p

TE-20D RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kHz-500 MHz on 6 bands. Directly calibrated. Variable R.F. attenuator audio output. Xtal socket for calibration. 220/240V a.c Brand new with instructions.
Size 140mm x 215mm x 170mm.
OUR PRICE £17.50 P&P 30p.

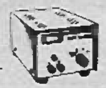
ARF 300 AF/RF SIGNAL GENERATOR

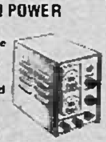
All transistorised compact fully portable. AF sine wave 18Hz to 220 kHz, AF square wave 18Hz to 100k Hz. Output Square/Sine wave 10V. P-P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.
OUR PRICE £29.95 P&P 50p

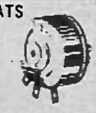
MODEL MG100 SINE SQUARE WAVE AUDIO GENERATOR

Range 19–220,000Hz Sine Wave 19—100,000 Hz Square Wave. Output Sine or Square wave 10v. P. to P. Size 180 x 90 x 90mm. Operation 220/240v. A.C.
OUR PRICE £19.95 P&P 37p.

MCA220 Automatic Voltage Stabiliser

Input 88–125V AC or 176–250V AC. Output 120V AC or 240V AC. 200V/A rating. P&P 50p
OUR PRICE £11.97

PS1008 Regulated POWER SUPPLY UNIT

Solid state. Output 6, 9 or 12V DC up to 3 Amp. Meter to monitor current. Input 220/240V AC. Size: 100 x 82 x 159mm.
OUR PRICE £11.97 P&P 25p

PS200 Regulated POWER SUPPLY UNIT

Solid state. Variable output 5–20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.
OUR PRICE £19.95 P&P 25p

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. ¼" diameter shafts. Bulk quantities available.

25 WATT 10/25/50/100/250/500/1000/2500 Ohms **£1.15** P&P 10p
50 WATT 10/25/50/100/250/500/1000/2500/5000 Ohms. **£1.62** P&P 10p
100 WATT 1/5/10/25/50/100/250/500/1000/2500 Ohms **£2.34** P&P 15p

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

80 WATTS	£2.75	P&P 18p
150 WATTS	£3.50	P&P 18p
300 WATTS	£4.50	P&P 23p
500 WATTS	£6.95	P&P 33p
1000 WATTS	£9.50	P&P 38p
1500 WATTS	£12.50	P&P 43p
2250 WATTS	£20.95	P&P 50p
5000 WATTS	£44.95	P&P £1

CP110 CHASSIS PUNCH SET

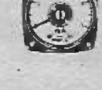
Carefully machined top grade steel. Contains 1/2", 5/8", 3/4", 1" and 1 1/8" punches complete with gripper and accessories.
OUR PRICE £3.00 P&P 40p

YAMABISHI VARIABLE VOLTAGE TRANSFORMERS
Excellent quality at low cost. Input: 230V 50/60Hz. Output 0–260V.
MODEL S260 BENCH MOUNTING

		P&P
1A	£10.50	30p
2.5A	£12.00	35p
5A	£17.50	37p
8A	£30.35	50p
10A	£33.75	75p
12A	£29.50	75p
20A	£85.00	125p
25A	£95.00	130p
40A	£120.00	150p

MODEL S260B PANEL MOUNTING

1A	£10.00	30p
2.5A	£12.00	35p

240° Wide Angle 1mA METERS

MW 1–6 60x60mm
£6.50 P&P 15p
MW 1–8 80x80mm
£6.90 P&P 15p

BVD5 Vernier TUNING DIAL

App. 7:1 ratio planetary drive vernier dial. Log scale 0–180 degrees. Blank scales 1–5. Dial size 128 x 76mm. Overall size 190 x 117 x 41mm. deep including knob and coupling. ¼" diam. shaft
OUR PRICE £1.62 P&P 15p

WALKIE TALKIES

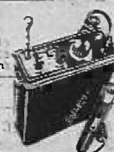
SKYFON 100mW
OUR PRICE £24.95 per pair
P302 Two Channel 300mW
OUR PRICE £52.50 per pair
P1003 Three Channel 1 Watt
OUR PRICE £71.25 per pair
P&P 50p per pair
NB. Licence required for use in UK

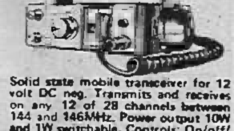
RUH6 Reflex Horn Speaker

Built-in driver unit. Impedence 16 ohms. Power rating 10W. Response 380–7000Hz. Size app. 6" x 6". Weather and shock protected.
OUR PRICE £4.97 P&P 30p

TRIO 9R59DS RECEIVER

Four bands covering 550kHz to 30 MHz continuous and electrical band-spread on 10, 15, 20, 40, and 80 mtrs. 8 valve plus 7 diode circuit. 4 to 8 ohm output and phone jack. SSB–CW, ANL, variable BFO. S Meter and separate band spread dial. IF frequency 445kHz, audio output 1½ watt. Variable RF and AF gain controls. 115/250V AC. with instructions.
Our Price £42.50 CARR. PAID

TRIO TR2200 TRANSCEIVER

Fully transistorised portable VHF transceiver. Will transmit and receive on six channels between 144–146MHz. 1 watt transmitter. 12V DC internal or external supply. Built-in charger for Ni-Cad cells. Power/volume switch, squelch control, channel selector, mic. socket, earphone/external speaker socket. Complete with microphone and 144.48, 144.72 & 145.32 crystals. Size: 134 x 58 x 180mm.
OUR PRICE £79.50 Carr.paid

BELTEK W5400 CAR TRANSCEIVER

Solid state mobile transceiver for 12 volt DC neg. Transmits and receives on any 12 of 28 channels between 144 and 146MHz. Power output 10W and 1W switchable. Controls: On/off/volume, squelch and channel selector. Internal 3" speaker. Complete with dynamic mic. PTT switch, three sets of crystals for 144.48, 144.6 and 145MHz, mounting bracket and instructions. Size: 150 x 70 x 220mm.
OUR PRICE £75.00 P&P 50p

OT55G DIGITAL CLOCK MECHANISM

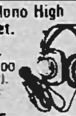
Features 24 hour alarm setting, on/off and auto alarm 'sleep' switch. Illuminated rotary dial with hours, minutes and seconds. Automatically turns off radio, TV, light etc. and with auto-switching will turn on again when required. 240V AC operation. Switch rating 250V–3 Amp.
OUR PRICE £5.95 P&P 30p

KE630 3 Station INTERCOM

Master and two sub-stations. Can be used on desk or wall mounted. Complete with cable and batteries
OUR PRICE £5.25 P&P 50p

LH02S STEREO HEADPHONES

Light weight headphones with padded ear pieces. 4/16 ohms 20–20,000Hz. Complete with 6' lead and plug.
OUR PRICE £1.97 P&P 30p

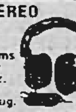
TE1018 Deluxe Mono High Impedence Headset.

Sensitive magnetic headset with soft ear pads. Impedence 2,600 ohms (600 ohms DC). Frequency response 200–4,000Hz.
OUR PRICE £2.25 P&P 30p

DH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms. 20–12,000Hz. Complete with lead and plug.
OUR PRICE £2.50 P&P 30p

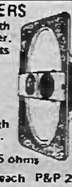
TE1035 Stereo HEADPHONES

Low cost with excellent response. Foam rubber earcups. Adjustable headband. 8 ohms impedence. Frequency response 25Hz–18kHz. Complete with cable and stereo jack plug.
OUR PRICE £2.60 P&P 30p

SH80V MONO/STEREO HEADPHONES

Volume control for each channel. 4/16 ohms impedence. Frequency response 20Hz–18kHz. Complete with 10ft. coiled lead and jack plug.
OUR PRICE £4.97 P&P 30p

BH001 HEADSET and Boom Microphone

Moving coil. Ideal for language teaching, communications etc. Headphone impedence 16 ohms. Microphone impedence 200 ohms.
OUR PRICE £5.95 P&P 30p

EMI LOUDSPEAKERS

Model 350 13 x 8" with single tweeter/crossover. 20–20,000Hz. 15 watts RMS. Available 8 or 15 ohms.
OUR PRICE £7.25 each P&P 37p
Model 450 13 x 8" with twin tweeter/crossover. 55–13,000Hz. 8 watts RMS. Available 8 or 15 ohms
OUR PRICE £3.62 each P&P 25p

JOSTY KIT — HIGH QUALITY CONSTRUCTION KITS
WE ARE APPOINTED STOCKISTS AT ALL BRANCHES

All kits are complete with comprehensive easy to follow instructions and covered by full guarantee.
Post and Packing 15p per kit.

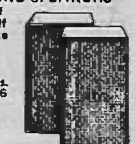
AF20 Mono amplifier	£4.80
AF25 Mixer	£3.60
AF30 Mono pre-amplifier	£2.61
AF35 Emitter amplifier	£2.27
AF80 0.5W mic. amplifier	£4.22
AF305 Intercom	£9.52
AF310 Mono amplifier	£5.91
AT5 Automatic light control	£2.58
AT25 Window wiper robot	£5.82
AT30 Photo cell switch unit	£5.70
AT50 400W triac light dimmer/speed control	£4.80
AT56 2,200W triac light dimmer/speed control	£6.90
AT60 1 channel light control	£7.80
AT65 3 channel light control	£14.55
GP304 Circuit board	£4.94
GP310 Stereo pre-amplifier for use with 2 x AF310	£21.27
GP312 Circuit board	£11.46
GU330 Tremolo unit	£7.50
HF61 Diode detector	£3.32
HF65 FM transmitter	£2.70
HF75 FM receiver	£2.87
HF310 FM tuner	£15.81
HF325 Deluxe FM tuner	£24.12
HF330 Decoder (HF310/325)	£9.96
HF380 lw/vhf aerial amplifier	£4.94
HF395 broadband aerial amp.	£1.77
LF380 Quadraphonic device	£11.36
M160 Multi-vibrator	£1.71
M191 VU Meter	£4.55
M192 Stereo balance meter	£4.97
M1302 Transistor tester	£8.45
NT10 Stabilised power supply 100mA, 9V	£6.15
NT300 Stabilised p. supply	£12.51
NT305 Voltage converter	£4.50
NT315 Power supply 240V AC to 4,5/15V DC, 500mA	£9.57

Amateur Electronics by Josty-Kit, the professional book for the amateur —covers the subject from basic principals to advanced electronic techniques. Complete with circuit board for AE1 to AE10.
OUR PRICE £3.30 (No VAT)
P&P 25p plus VAT.

AE1 100mW output stage	£1.65
AE2 Pre-amplifier	£1.26
AE3 Diode receiver	£2.00
AE4 Flasher	£1.09
AE5 Astable multi-vibrator	£1.05
AE6 Monostable multi-vibrator	£1.02
AE7 RC generator	£1.06
AE8 Bass filter	99p
AE9 Treble filter	99p
AE10 CCIR filter	99p

2 TRANSISTOR RADIO KIT

No Soldering required. All connections made with spring clips. Kit includes all parts and wire including ear-piece. Will receive all normal broadcasts on Medium Wave 535–1605kHz. Operates from standard 9V battery or Solar Cell included.
OUR PRICE £1.30 P&P 30p

SPECIAL BARGAIN !! STEREOSOUND SPEAKERS

Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 watts RMS. 16 watts peak. Complete with Din lead.
OUR PRICE £12.95 P&P 50p

SPECIAL BARGAIN! FERGUSON 3406 HI-FI SPEAKERS

High quality 2 way speaker systems. 25 Watts. 4–8 ohms. 40Hz–18kHz. Size: 560 x 340 x 255mm. approx. Wood grain finish with black fronts.
OUR PRICE £26.95 PR. P&P £1

Model A1018 FM TUNER

6 transistor high quality unit—3 IF stages and double tuned discriminator. For use with most amplifiers. Covers 88–108MHz. Powered by 9V battery.
OUR PRICE £13.50 P&P 30p
Stereo multiplex adapter £6.95 extra.

ALL PRICES EXCLUDE VAT

SEW CLEAR PLASTIC PANEL METERS

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES ETC.

Over 200 ranges in stock—other ranges to order. Quantity discounts available. Send for fully illustrated brochure.

*Items with asterisk are Moving Iron type, all others are Moving Coil

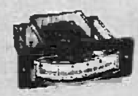
CLEAR PLASTIC MODEL SO640
Size: 85 x 64mm

50uA	£3.80	20V DC	£3.65
100uA	£3.75	50V DC	£3.65
200uA	£3.70	300V DC	£3.65
500uA	£3.65	15V AC	£3.75
50-0-50uA	£3.75	300V AC	£3.75
100-0-100uA	£3.70	VU Meter	£3.90
1mA	£3.65		
5mA	£3.65		
10mA	£3.65		
50mA	£3.65		
100mA	£3.65		
500mA	£3.65		
1A DC	£3.65		
5A DC	£3.65		
10A DC	£3.65		
5V DC	£3.65		

CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm

50uA	£4.60	300V AC	£4.45
100uA	£4.50	VU Meter	£4.90
500uA	£4.30		
50-0-50uA	£4.50		
100-0-100uA	£4.45		
1mA	£4.30		
1A DC	£4.30		
5A DC	£4.30		
20V DC	£4.30		
50V DC	£4.30		
300V DC	£4.30		

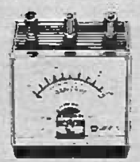
EDGWISE MODEL PE70
Size: 90 x 34mm



50uA	£4.15
100uA	£4.10
200uA	£4.05
500uA	£3.90
50-0-50uA	£4.10
100-0-100uA	£4.05
1mA	£3.85
300V AC	£3.95
VU Meter	£4.30

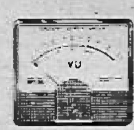
MODEL ED107 EDUCATIONAL METER
Size: 100 x 90 x 150mm including terminals

A range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working.



50uA	£8.50	300V DC	£7.60
100uA	£7.90	500mA/5A DC	£8.60
50-0-50uA	£7.90	5V/50V DC	£8.60
1A DC	£7.60	5V/15V DC	£8.60
5A DC	£7.60	1A/15A DC	£8.60
5V DC	£7.60		
10V DC	£7.60		
15V DC	£7.60		
20V DC	£7.60		
50V DC	£7.60		

CLEAR PLASTIC MODEL MR 85P
Size: 120 x 110mm

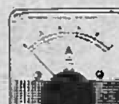


50uA	£5.45	300V DC	£5.20
100uA	£5.40	15V AC	£5.30
200uA	£5.35	300V AC	£5.30
500uA	£5.25	S Meter 1mA	£5.20
50-0-50uA	£5.40	VU Meter	£5.55
100-0-100uA	£5.35	1A AC	* £5.20
500-0-500uA	£5.20	5A AC	* £5.20
1mA	£5.20	10A AC	* £5.20
1-0-1mA	£5.20	20A AC	* £5.20
5mA	£5.20	30A AC	* £5.20
10mA	£5.20		
50mA	£5.20		
100mA	£5.20		
500mA	£5.20		
1A DC	£5.20		
5A DC	£5.20		
15A DC	£5.20		
30A DC	£5.40		
10V DC	£5.20		
20V DC	£5.20		
50V DC	£5.20		
150V DC	£5.20		

CLEAR PLASTIC MODEL SO830
Size: 110 x 83mm

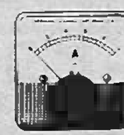
50uA	£4.30	10V DC	£4.10
100uA	£4.25	20V DC	£4.10
200uA	£4.20	50V DC	£4.10
500uA	£4.15	300V DC	£4.10
50-0-50uA	£4.25	15V AC	£4.20
100-0-100uA	£4.20	300V AC	£4.20
1mA	£4.10	VU Meter	£4.40
5mA	£4.10		
10mA	£4.10		
50mA	£4.10		
100mA	£4.10		
500mA	£4.10		
1A DC	£4.10		
5A DC	£4.10		
10A DC	£4.10		
5V DC	£4.10		

CLEAR PLASTIC MODEL MR 45P
Size: 50 x 50mm



50uA	£3.20	300V AC	£3.05
100uA	£3.15	S Meter 1mA	£2.95
200uA	£3.10	VU Meter	£3.40
500uA	£3.00	1A AC	* £2.95
50-0-50uA	£3.15	5A AC	* £2.95
100-0-100uA	£3.10	10A AC	* £2.95
500-0-500uA	£2.95	20A AC	* £2.95
1mA	£2.95	30A AC	* £2.95
5mA	£2.95		
10mA	£2.95		
50mA	£2.95		
100mA	£2.95		
500mA	£2.95		
1A DC	£2.95		
5A DC	£2.95		
10V DC	£2.95		
20V DC	£2.95		
50V DC	£2.95		
300V DC	£2.95		
15V AC	£3.05		

CLEAR PLASTIC MODEL MR 38P
Size: 42 x 42mm



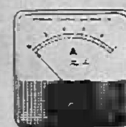
50uA	£3.10	15V DC	£2.80
100uA	£3.05	20V DC	£2.80
200uA	£3.00	50V DC	£2.80
500uA	£2.85	100V DC	£2.80
50-0-50uA	£3.05	150V DC	£2.80
100-0-100uA	£3.00	300V DC	£2.85
500-0-500uA	£2.80	500V DC	£2.85
1mA	£2.80	750V DC	£2.90
1-0-1mA	£2.80	15V AC	£2.90
2mA	£2.80	50V AC	£2.90
5mA	£2.80	150V AC	£2.90
10mA	£2.80	300V AC	£2.90
20mA	£2.80	500V AC	£3.00
50mA	£2.80	S Meter 1mA	£2.80
100mA	£2.80	VU Meter	£3.20
150mA	£2.80		
200mA	£2.80		
300mA	£2.80		
500mA	£2.80		
750mA	£2.80		
1A DC	£2.80		
2A DC	£2.80		
5A DC	£2.80		
10A DC	£2.80		
15A DC	£2.80		
3V DC	£2.80		
10V DC	£2.80		

CLEAR PLASTIC MODEL SD460
Size: 59 x 46mm

50uA	£3.50	10V DC	£3.30
100uA	£3.45	50V DC	£3.30
200uA	£3.40	300V DC	£3.30
500uA	£3.35	15V AC	£3.45
50-0-50uA	£3.45	300V AC	£3.45
100-0-100uA	£3.40	VU Meter	£3.65
1mA	£3.30		
5mA	£3.30		
10mA	£3.30		
50mA	£3.30		
100mA	£3.30		
500mA	£3.30		
1A DC	£3.30		
5A DC	£3.30		
10A DC	£3.30		
5V DC	£3.30		

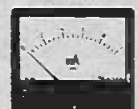
POSTAGE & PACKING 15p

CLEAR PLASTIC MODEL MR 65P
Size: 86 x 78mm



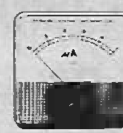
50uA	£3.95	50V AC	£3.80
100uA	£3.85	150V AC	£3.80
200uA	£3.80	300V AC	£3.90
500uA	£3.75	500V AC	£3.80
50-0-50uA	£3.85	S Meter 1mA	£4.10
100-0-100uA	£3.80	VU Meter	£3.70
500-0-500uA	£3.70	1A AC	* £3.70
1mA	£3.70	5A AC	* £3.70
5mA	£3.70	10A AC	* £3.70
10mA	£3.70	20A AC	* £3.70
50mA	£3.70	30A AC	* £3.70
100mA	£3.70	50mA AC	* £3.70
500mA	£3.70	100mA AC	* £3.70
1A DC	£3.70	200mA AC	* £3.70
5A DC	£3.70	500mA AC	* £3.70
10A DC	£3.70		
15A DC	£3.70		
20A DC	£3.80		
30A DC	£3.85		
50A DC	£4.05		
5V DC	£3.70		
10V DC	£3.70		
20V DC	£3.70		
50V DC	£3.70		
150V DC	£3.70		
300V DC	£3.70		
15V AC	£3.80		

BAKELITE MODEL S80 Enlarged Window
Size: 80 x 80mm



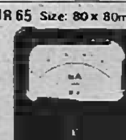
50uA	£4.50
100uA	£4.45
500uA	£4.20
50-0-50uA	£4.45
100-0-100uA	£4.40
1mA	£4.20
1A DC	£4.20
5A DC	£4.20
20V DC	£4.20
50V DC	£4.20
300V DC	£4.20
300V AC	£4.30
VU Meter	£4.70

CLEAR PLASTIC MODEL MR 52P
Size: 60 x 60mm



50uA	£3.70	S Meter 1mA	£3.30
100uA	£3.60	VU Meter	£3.80
500uA	£3.35	1A AC	* £3.30
50-0-50uA	£3.50	5A AC	* £3.30
100-0-100uA	£3.45	10A AC	* £3.30
1mA	£3.30	20A AC	* £3.30
5mA	£3.30	30A AC	* £3.30
10mA	£3.30		
50mA	£3.30		
100mA	£3.30		
500mA	£3.30		
1A DC	£3.30		
5A DC	£3.30		
10V DC	£3.30		
20V DC	£3.30		
50V DC	£3.30		
300V DC	£3.30		
15V AC	£3.40		
300V AC	£3.40		

BAKELITE MODEL MR 65
Size: 80 x 80mm



25uA	£5.25	30V AC	* £3.60
50uA	£4.00	50V AC	* £3.60
100uA	£3.95	150V AC	* £3.60
500uA	£3.65	300V AC	* £3.60
50-0-50uA	£3.95	500V AC	£3.60
100-0-100uA	£3.90	VU Meter	£4.10
500-0-500uA	£3.60	1A AC	* £3.60
1mA	£3.60	5A AC	* £3.60
1-0-1mA	£3.60	10A AC	* £3.60
5mA	£3.60	20A AC	* £3.60
10mA	£3.60	30A AC	* £3.60
50mA	£3.60	50A AC	* £3.60
100mA	£3.60	500mA AC	£3.60
500mA	£3.60	50mV DC	£3.75
1A DC	£3.60	100mV DC	£3.75
2A DC	£3.60		
5A DC	£3.60		
15A DC	£3.60		
30A DC	£3.60		
50A DC	£3.80		
5V DC	£3.60		
10V DC	£3.60		
20V DC	£3.60		
50V DC	£3.60		
150V DC	£3.60		
300V DC	£3.60		

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Project 805	£26.95
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PZ6 Power Supply	£7.98
PZ8 Power Supply	£7.98
Transformer for PZ8	£4.05

SINCLAIR Project 80 Packages

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2 x Z60/Stereo 80/PZ8	£30.45

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For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. Two gain controls, speakers on—off slide switch, stereo headphone socket.

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AUDIOTRONIC LOW NOISE CASSETTES

TYPE	5	10	25
C60	£1.57	£3.00	£7.08
C90	£2.24	£4.25	£10.00
C120	£2.73	£5.17	£12.24

AUDIOTRONIC CrO2 CASSETTES

TYPE	5	10	25
CR60	£3.92	£7.72	£19.12
CR90	£5.32	£10.46	£25.22

AUDIOTRONIC 8 TRACK CARTRIDGES

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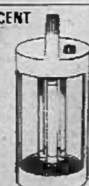

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everyday electronics

PROJECTS...
THEORY....

SOUNDS DIFFERENT

Now, for something quite different, as they say, in sound. We are all familiar with a host of unique sounds (musical or otherwise!) that electronics has been entirely responsible for. But in addition to creating original sounds, electronics is of course very good at imitating sounds, such as those characteristic of traditional musical instruments. Many examples have already appeared, but so far as we are aware the Bagpipes have not been singled out for this favoured treatment—until now.

We wonder why. Anyhow to demonstrate our strict neutrality in matters musical as well as geographical, we offer our readers this latest musical novelty. It is, incidently, yet another example of the inspired use of fairly conventional circuitry. So please remember, all you would-be inventors, it is that original thought for applying electronics to some account in an unusual or novel way, that is all important; the actual circuitry comes quite naturally thereafter, in many cases.

SPEED GUARD

The tendency of motorists to travel at unsafe speeds when caught in fog has a perfectly reasonable explanation, so the experts tell us. It is really because sense of speed is seriously affected when sight of external reference points is lost due to poor visibility, the need to concentrate fully on the road ahead precluding any diversion of attention—even momentarily—from windscreen to speedometer. So an unconscious steady acceleration is all too commonly the result.

In an attempt to overcome this particular problem we understand that the authorities are currently investigating a "head-up" display speedometer, where the appropriate data is projected onto the windscreen and is readable without interfering in any way with the driver's normal view.

It is to be hoped that success is the outcome of this attempt to produce a cheap and relatively simple version of the more sophisticated system already employed in aircraft, so that in time it could become standard equipment for all vehicles. In the meanwhile it occurs to us that the *Speed Guard* described in the March issue of EVERYDAY ELECTRONICS could very well be widely adopted as a fog hazard aid, providing an audible indication that some pre-determined speed (reasonably low—30 m.p.h. for example) has been reached. The addition of an on/off switch is all that would be necessary to make the *Speed Guard* suitable for this kind of function; it could then be easily brought into operation directly visibility deteriorated to a dangerous level.

For a quite modest outlay of about £4 the motorist could equip his vehicle with an extremely useful, and maybe life-saving, electronic aid.

Fred Bennett.

Our June issue will be published on Friday, May 17

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

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VOL. 3 NO. 5 MAY 1974

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

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ELECTRONIC BAGPIPES

BY T. RICHARDSON

Electronic simulation of the bagpipe sound.

THIS instrument is an attempt to simulate, fairly simply, the sound and method of playing the bagpipes. The finished instrument is also capable of producing other types of sound and is fitted with a vibrato effect and switching for the drone sound in the bagpipe simulation.

CIRCUIT

The complete circuit diagram is shown in Fig. 1, TR3 is the main unijunction oscillator (chanter oscillator) which is fine tuned by VR2 wired in series with resistors R19 to R26. These resistors being inside the chanter. Transistor TR2 forms a vibrato oscillator which can be switched off and on as desired, by the tone switch S1. This same switch in another position will operate the drone oscillator (TR1). This is necessary for simulation of bagpipes.

The drone oscillator has a larger value tuning resistor VR1, which allows the drone to be tuned to either the treble or bass end of the scale as desired. Both oscillators are fed to TR4 via resistors R12 and R13; it will be noticed R13 is a higher value than R12, so that the chanter will be predominant while playing the pipes.

Transistor TR4 is a signal amplifier the output of which is fed to a screened lead via the tone forming network comprising C10, C12, C13 and R18. These components suppress some of the higher harmonics, and make a more realistic bagpipe sound. Switch S2 is simply a micro-switch wired in series with battery B1. It is situated in such a position that by squeezing the unit with the elbow, S1 is closed and switches the unit on for playing. The unit is switched off when pressure is released. This leaves both hands free on the chanter to enable the player to start, or end a tune on any note desired.

It will be seen that with the tone switch in position one, the bagpipe sound is produced; in position two only the main oscillator is in circuit. This will give a sound not unlike the clarinet, but adjustments of controls on the amplifier it is plugged into, could make a lot of difference to the tone. In position three, the sound is modulated by the vibrato, and becomes a pleasing sound, not unlike an organ.

CONSTRUCTION

As seen from the Fig. 2. most of the components are mounted on a Veroboard panel measuring 20 holes by 13, the copper strips running along the 20 holes. The strips are cut at the points marked on the underside drawing and all the components are laid out in straight lines from top to bottom; it must be noted that components (C2, R13; C7, R8; C9 and R12) are stood up on end and the junctions are not connected to the panel after wiring.

This panel can be tested on its own, by connecting in VR1 and a temporary connection from VR2 free end to battery positive. Either connect phones across the output or feed into an amplifier, connect the battery positive and negative. This should cause the chanter oscillator to function, adjustment of VR2 should change the pitch by about two or three notes.

Now connect the wire from C1/R2 to negative, and the drone will be heard, VR1 should alter the drone by well over an octave. If all is well, connect a wire from R7 to negative and test the vibrato.

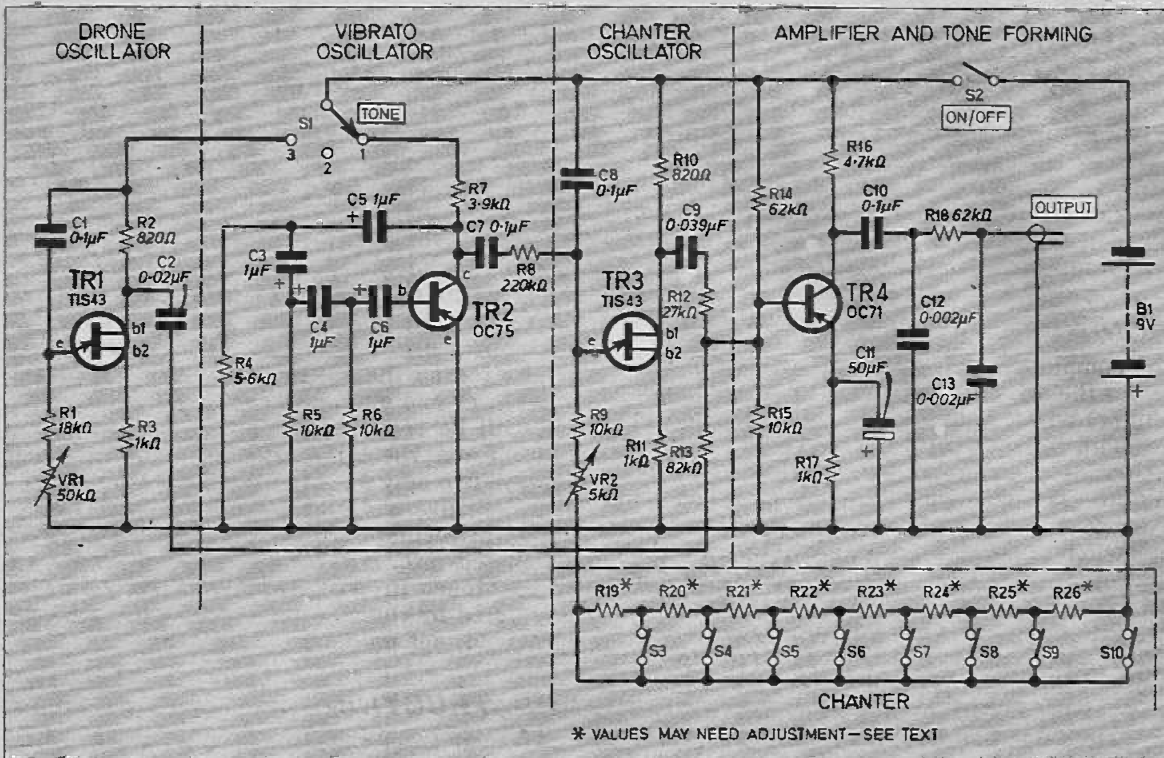


Fig. 1. Complete circuit diagram of the Electronic Bagpipes.

Components....

Resistors

R1	18kΩ	R14	62kΩ
R2	820Ω	R15	10kΩ
R3	1kΩ	R16	4·7kΩ
R4	5·6kΩ	R17	1kΩ
R5	10kΩ	R18	62kΩ
R6	10kΩ	R19	1kΩ
R7	3·9kΩ	R20	3·3kΩ
R8	220kΩ	R21	2·4kΩ
R9	10kΩ	R22	1·2kΩ
R10	820Ω	R23	2·2kΩ
R11	1kΩ	R24	1·5kΩ
R12	27kΩ	R25	2·1kΩ
R13	82kΩ	R26	620Ω

R19–R26: approximate values, may need alteration to tune chanter

All ± 5% ¼W carbon

SEE SHOP TALK

Capacitors

C1	0·1µF
C2	0·022µF
C3	1µF
C4	1µF
C5	1µF
C6	1µF
C7	0·1µF
C8	0·1µF
C9	0·039µF
C10	0·1µF
C11	50µF elect. 12V
C12	0·002µF
C13	0·002µF

C3–C6: may be elect. 12V

Potentiometers

VR1 50kΩ lin carbon
VR2 5kΩ lin carbon

Semiconductors

TR1 TIS43 unijunction
TR2 OC75 germanium *pnp*
TR3 TIS43 unijunction
TR4 OC71 germanium *pnp*

Switches

S1 single pole three way wafer switch
S2 push to make single pole microswitch
S3–S10 push to break single pole miniature push buttons (8 off)

Miscellaneous

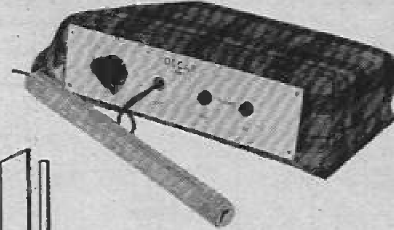
B1 9V PP3 battery
Knob to suit S1, screened lead, 25mm diameter plastic tube 270mm long, materials for case, connecting wire, Veroboard 13 strips by 20 holes by 0·15 inch matrix, 4 BA fixings, plastic or Formica for facia panel.

Approximate cost of components including V.A.T.

excluding case

£6.00

ELECTRONIC BAGPIPES



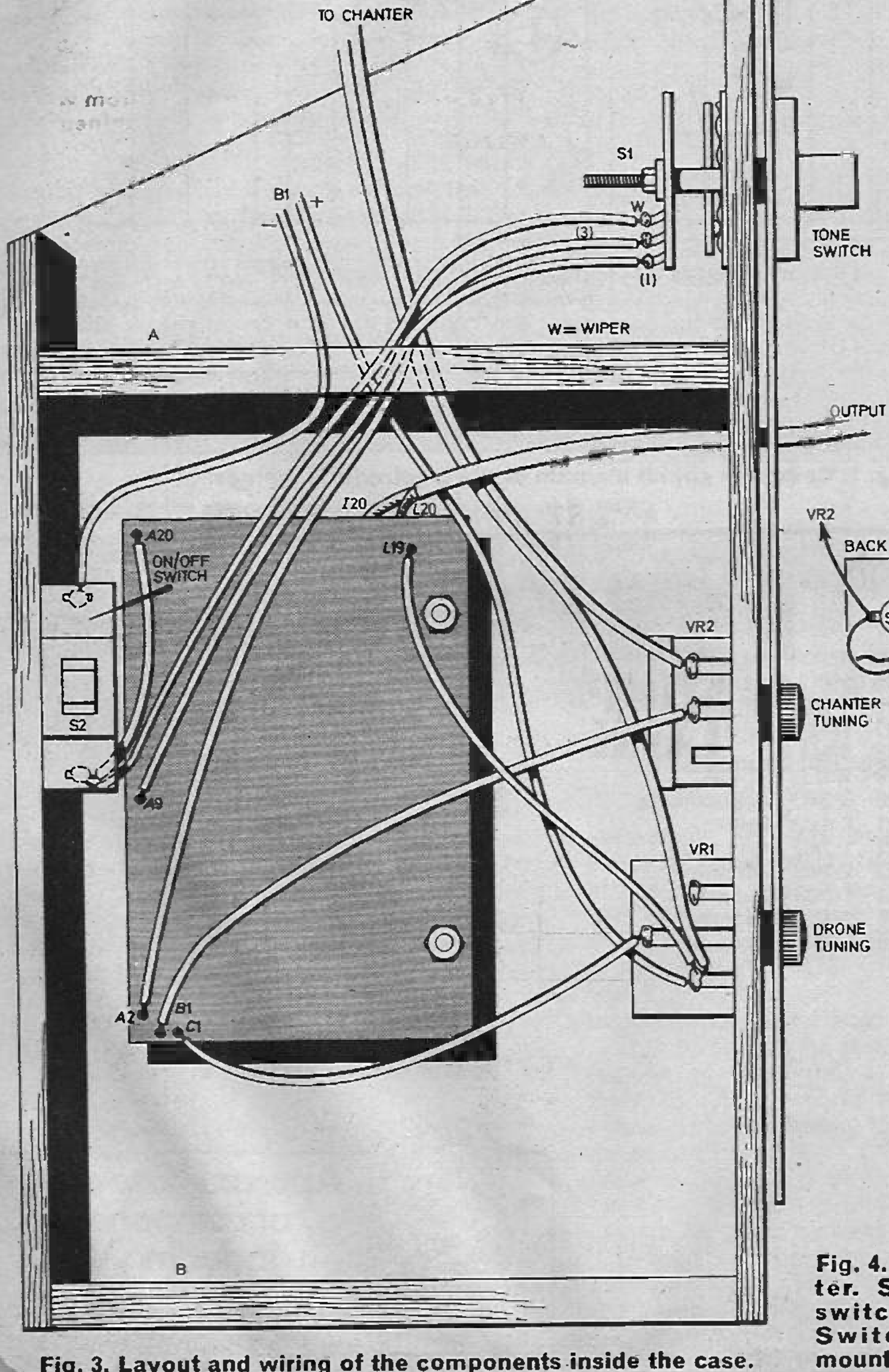


Fig. 3. Layout and wiring of the components inside the case.

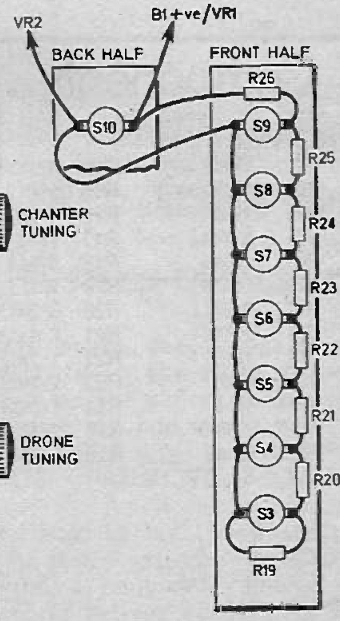


Fig. 4. Wiring of the chanter. Spacing between switches is one inch. Switch S10 should be mounted ½ inch above S9.

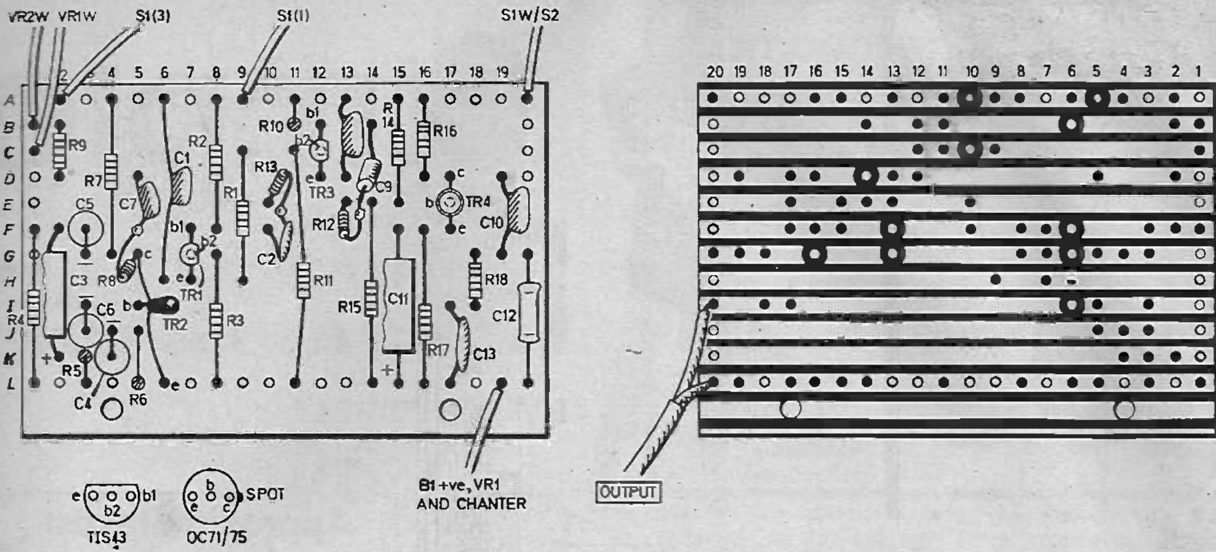


Fig. 2. Component layout and wiring on the Veroboard.

It should be mentioned at this point that R4 (5·6 kilohm) and R8 (220 kilohm) are used in the prototype, but may be adjusted to suit individual requirements, R4 controls vibrato speed and R8 the amplitude. An OC75 transistor or similar is used in the vibrato and must be a high gain type, TR4 is an OC71, but this could be any similar transistor. TR1 and TR3 are both unijunction type TIS43 but similar alternatives can be used.

CASE

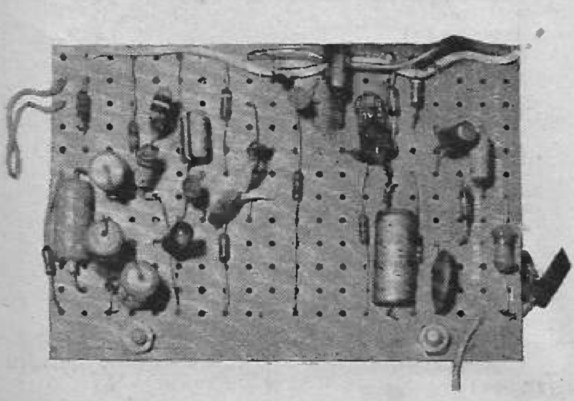
A box must be assembled in the way shown in Fig. 3, but at this stage the top panel is not fixed. The left hand panel in Fig. 3 is 6mm narrower than the rest. The two upright supports (*A* and *B* in Fig. 3) should be tapered from halfway along, to the side panel. This allows the top panel to be squeezed in under the armpit, to actuate the microswitch S2.

After drilling holes on the side panel to accommodate controls VR1 and VR2, and switch S1, the components may be mounted inside the case.

Switch S2 must be bolted to the side panel near the front edge, so that the actuator will be pressed in when the side panel is pushed onto it.

After all the wiring is completed as shown in Fig. 3 the side panel is screwed on, with two screws near the right hand side. Finally the case is covered in thin foam rubber and a tartan bag covers the whole unit. This bag may either be tacked or glued to the control panel, and the fascia screwed on to finish the unit off (see photographs).

Photograph of the component board.



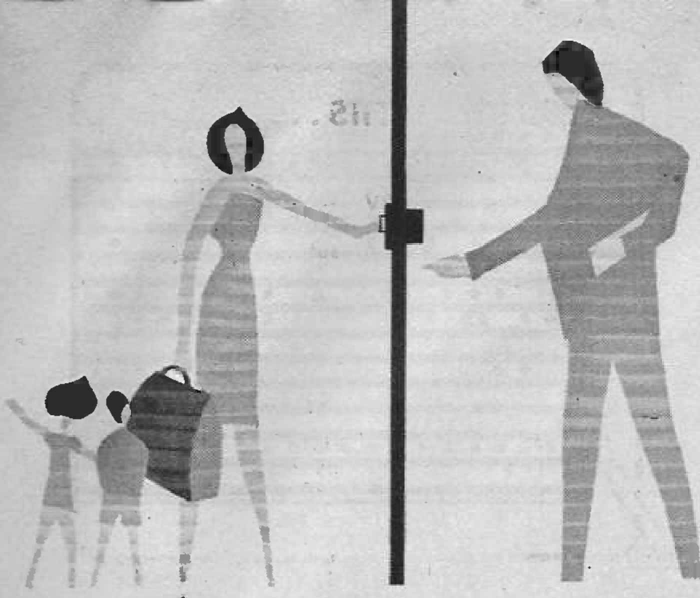
CHANTER

The chanter is made by sawing 25mm diameter plastic tube (such as water pipe etc.) down the centre and drilling suitable sized holes to take miniature push button switches. After wiring to Fig. 4, join the two halves together.

The chanter resistors are chosen to play the diatonic scale. To select the proper key R9 may have to be varied, so as to play the top note of the scale with VR2 near mid travel.

PLAYING

The unit is plugged into an amplifier of almost any type. A suitable design will be published in our July issue. The instrument is placed under the arm, control panel downwards, and squeezed. Switch to position two or three and once you're certain the chanter is tuned properly, switch to position one and tune drone to either top, or bottom note. When fingering this instrument the same method is used as for playing a tin whistle or similar instrument, i.e. the highest note left open is sounded. ▣



Simple Buzzer

BY A.RUSSELL

Approximate cost of components including V.A.T.

£1.50 inclusive

An audible warning device useful for many applications

A balanced armature earpiece can be converted into an effective buzzer by the addition of only a few components. The prototype "converted" earpiece was used in a continuity tester but the buzzer can be used in any application requiring an audible alarm.

CIRCUIT

The circuit diagram of the Simple Buzzer is shown in Fig. 1. and operates as follows.

When the supply is connected, C1 starts to charge up via VR1, and when a certain voltage level is reached at the junction of VR1 and C1, the transistor starts to conduct.

The change in voltage across the earpiece, TL1, induces a voltage in L1 which tends to help TR1 turn on (positive feedback), TR1 thus turns on very quickly. When TR1 is fully on, the voltage induced in L1 reduces to zero and C1 discharges through TR1 base/emitter; as this occurs, the voltage on TR1 base is reduced, and a point is reached when TR1 starts to turn off.

The voltage change across TL1 is now in the opposite direction and this induces a voltage in L1 which assists TR1 to turn off.

When TR1 is fully off the cycle repeats itself—thus producing an audible tone. The frequency of the tone is dependant on the values of VR1 and C1. Reducing VR1 will enable C1 to charge up more rapidly and thus increase the frequency, i.e. a higher pitched tone.

CONSTRUCTION

The components can either be mounted inside the earpiece itself, as in the prototype, or may be mounted seperately on a piece of Veroboard or printed circuit board.

It is necessary to dismantle the earpiece and remove the coil; with this done, wind on 10 turns of 26 s.w.g. enamelled copper wire and replace the coil. Mount the other components in the earpiece as shown in Fig. 2.

If this exact type of earpiece is not used it may be necessary to redesign the layout of the components or alternatively an exterior circuit board will have to be employed.

SETTING UP

Turn the potentiometer VR1 to its maximum resistance position and switch on.

With a small screwdriver, turn VR1 until a tone emanates from the earpiece. If the buzzer

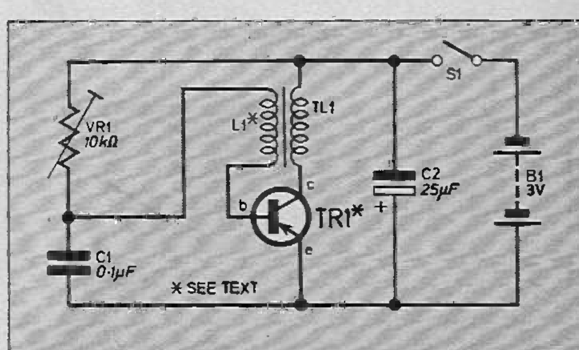
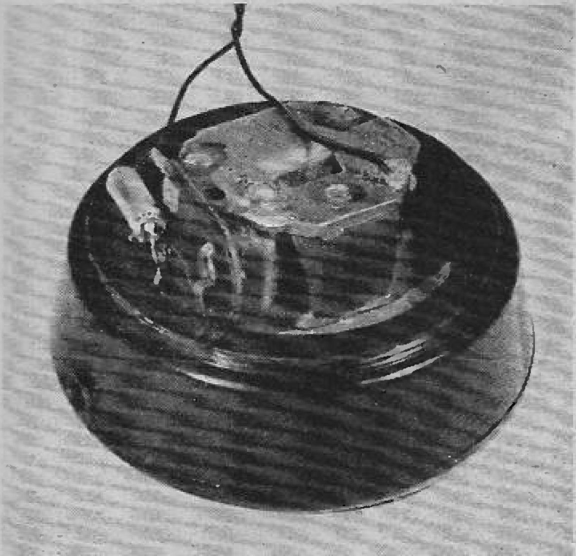


Fig. 1. Circuit diagram of the complete Simple Buzzer.



Photograph of the original unit with part of the case removed.

Components....

Capacitors
C1 $0{\cdot}1\mu F$
C2 $25\mu F$ elect. 12V

Potentiometer
VR1 10kΩ skeleton preset

Transistor
TR1 2N3702 silcon *pnp* or any similar transistor

Miscellaneous
L1 26 s.w.g. enamelled copper wire
S1 on/off switch if required, e.g. door bell push, etc.
B1 3V battery (2 x U2 etc)
TL1 ITBA No. 5 or any balanced armature earpiece of approx. 50 ohms to 100 ohms impedance.
Connecting wire.

refuses to oscillate, even when **VR1** is one quarter of the maximum value, intercharge the connections to the added feedback windings, and repeat the above procedure. The buzzer, when correctly set up can be activated by closing S1. this is useful when used as a door buzzer; if used in an alarm circuit, the switch can be replaced by a set of relay contacts or a thyristor.

COMPONENT NOTES

The earpiece used in the prototype was one from an army field telephone unit, type ITBA No. 5. It has a coil resistance of 50 ohms. This type and similar earpieces should be available from government surplus stores.

The transistor type is not critical, almost any *pnp* transistor with a gain (h_{fe}) greater than 20 would do.

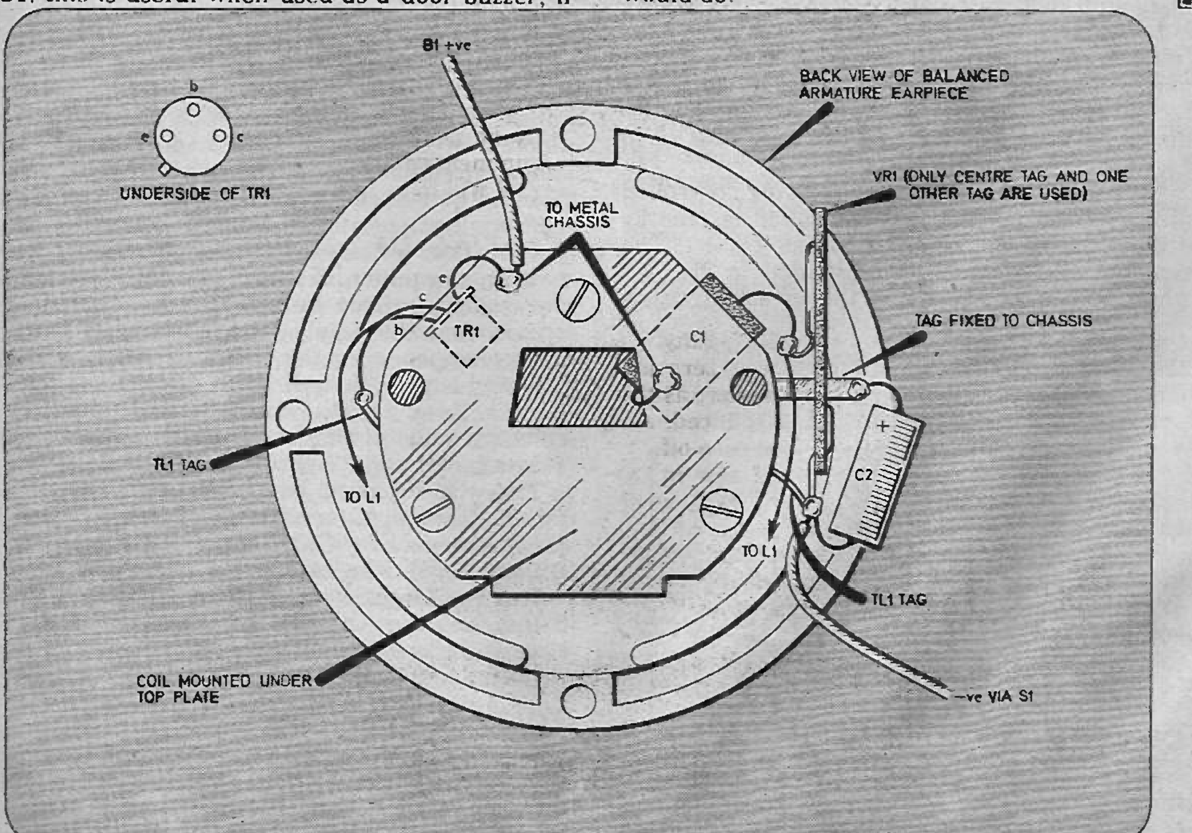


Fig. 2. Complete layout and wiring of the simple buzzer.

TUTOR: PHIL ALLCOCK*

LESSON 8 The Astable and Alternating Current

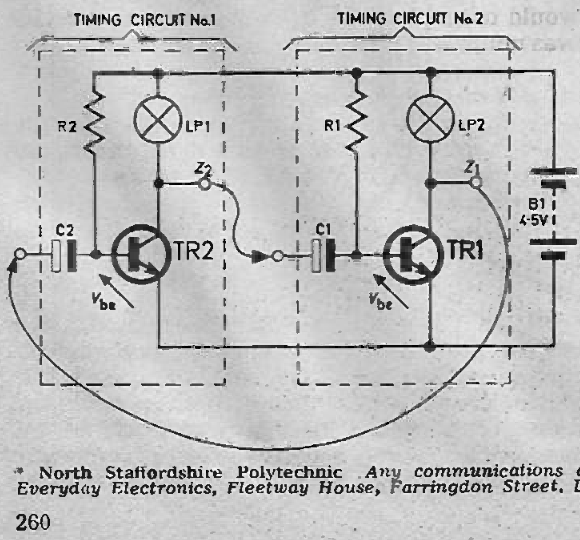
THIS month we examine the astable multivibrator and go on to look at some new ideas and theory relevant to basic circuit elements, in order to extend the range of electronic circuits that can be covered in the remainder of the Teach-In '74 series. The additional components required for the Tutor Board experiments for future parts are listed later.

ASTABLE CIRCUIT

The astable circuit does not have any permanent stable states and switches continuously between two temporary states. The basic idea follows on quite naturally from the previous monostable but the circuit is modified so that a second charge/discharge timing element is introduced between point Z and the base of TR2 in Fig. 7.4 of last month.

Instead of the switching state being controlled directly from point Z it is controlled instead by a duplicate of the coupling circuit C1, R1. The simplest arrangement is illustrated in Fig. 8.1 where it can be seen that the astable consists of two similar timing circuits connected so that the transistor of either circuit acts as the "switch" for the other "half". Consequently the recharging of (say) C2 via R2 determines the instant at which TR2 can switch from *off* to *on* and it is the switching *on* of TR2 which initiates the timing interval during which C1 can recharge via R1.

Fig. 8.1. The astable multivibrator.



This recharging of C1, in turn controls the switch *on* instant of TR1, which in turn controls the start of the timing interval for TR2 again. The cycle of events continues indefinitely and as one transistor switches *on* the other is automatically switched *off* for a time duration determined by the choice of *C—R* values.

It is not necessary to have C1 = C2 or R1 = R2 although the maximum values of R1 and R2 are limited in this circuit by the need to ensure adequate current for the lamps LP1, LP2.

In normal circumstances the circuit will start operating as soon as the supply voltage is connected but occasionally both transistors can switch *on* together, in which case the circuit will not self-start. This failure to start sometimes occurs when the supply voltage builds up slowly, as can happen when the circuit is operated from a power supply derived from the mains, but is less likely to happen when the two timing circuits are made dissimilar by using (say) different values for C1 and C2, with R1 = R2.

The waveforms of base voltage against time for the two transistors are illustrated in Fig. 8.2 for the case where C1 is larger than C2 and R1, R2 are equal. The recharging of C1 via R1 involves the larger time constant and this makes the on/off times unequal. For equal on/off durations the transistors must be "identical" and the two time constants must be equal.

VOLTAGE REVERSAL

In both the monostable and the astable circuit we have seen that the voltage at the base of the transistor reverses at the instant of switching,

* North Staffordshire Polytechnic *Any communications arising from the Teach-In '74 series must be addressed to Everyday Electronics, Fleetway House, Farringdon Street, London E.C.4).*

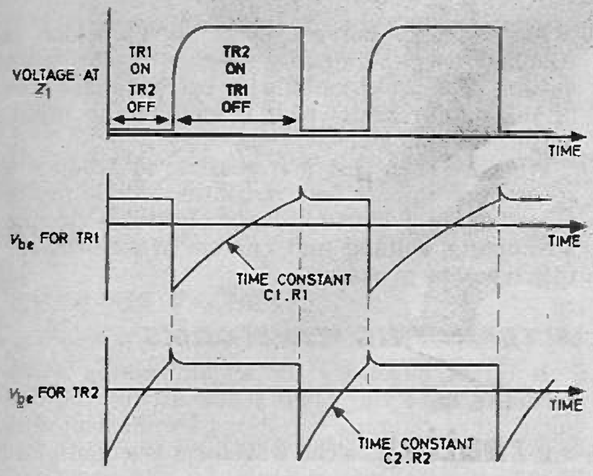


Fig. 8.2. Voltage waveforms for the astable multivibrator.

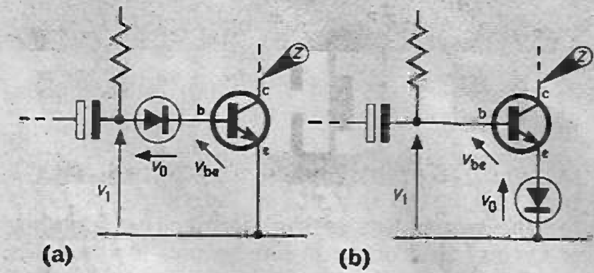


Fig. 8.3(a). Protection by base diode (b) protection by emitter diode.

due to the charge storage characteristic of the capacitor and in some circuits the reverse bias across the base/emitter junction can exceed the safe reverse voltage rating given by the manufacturer. For the BC107 device this rating is given as:—

$$V_{ebo}\ (\text{max}) = 6{\cdot}0 \text{ volts}$$

Consequently when a supply voltage of more than 6·0 volts is employed there is a risk of transistor damage, or circuit malfunction, since we have already shown that the instantaneous value of the reverse bias has a maximum value which is only about 500mV less than the supply voltage used. For the circuits shown in Fig. 7.4 and 8.1 this voltage is about 4·0 volts and is within the transistor rating.

It is often necessary to operate a circuit such as the astable from a supply voltage considerably larger than the 6·0 volt V_{ebo} rating (which is incidentally a typical value for many modern silicon transistors). Certain modifications can be made to the basic circuit to protect the transistor emitter/base junctions from excess reverse voltage and two possibilities are shown in Fig. 8.3.

In Fig. 8.3a a silicon diode is used in series with the transistor base lead so that when the voltage reversal occurs the higher reverse voltage rating of the diode (typically 50 volts or more) protects the transistor junction against possible breakdown. The reverse voltage is shared between the diode and the transistor junction and since the diode will maintain a very high back resistance even when subjected to large reverse voltages, the current flow is severely restricted and breakdown cannot occur.

The forward voltage drop across the diode increases the voltage level at which the transistor turns on, and with a silicon diode the voltage V_1 in Fig. 8.3a will become clamped at about 1·0 volt instead of the previous value of approximately 0·5 volts. Fig. 8.3b works in a similar manner but has the additional effect of raising the voltage level at point Z, when the transistor saturates, due to the diode voltage drop.

Since the change of voltage at point Z determines the negative excursion at the base of the other transistor, the emitter connected diode will reduce this excursion by about 0·5 volts. Note that V_1 for the emitter diode arrangement will be slightly larger than V_1 for the base diode circuit because the emitter connected diode must carry the full emitter current of the transistor and as a result will have a larger forward voltage drop, V_0. The only effect of these small differences is that the circuit timing changes slightly but this need not concern us here.

OFF TIME AND FREQUENCY OF OPERATION

We have seen that the transistor TR1 in Fig. 7.1 turns *off* for a short interval immediately the switch is closed. The "*off time*" can be obtained by considering the waveform shown in Fig. 7.3 which shows that TR1 remains off for the interval ($t_2 - t_1$). During this interval the capacitor voltage V_c changes from +4·0 volts to −0·5 volts and it can be shown that the "*off* time" is given by the following equation.

$$\text{"}\textit{off}\text{ time"} = (\text{C1} \times \text{R1}) \log_e \left[\frac{1}{1-N}\right]$$

Where N is the ratio of the actual change in the voltage V_c, to the maximum change that would occur if the emitter/base clamping action was not present. For our circuit this ratio is:

$$N = \frac{4{\cdot}0 - (-0{\cdot}5)}{4{\cdot}0 - (-4{\cdot}5)} = \frac{4{\cdot}5}{8{\cdot}5} = \frac{9}{17}$$

The symbol $\log_e$ means natural logarithm and is given in books of mathematical tables.

For our circuit:

$$\log_e \left[\frac{1}{1-N}\right] = \log_e \left[\frac{17}{8}\right] = 0{\cdot}75$$

In fact N is always approximately equal to one half because the actual change of capacitor voltage is nearly equal to the supply voltage whilst the maximum voltage change is about twice this value. (For $N = 0{\cdot}5$ the $\log_e$ term would be 0·7 approximately). We have therefore a simple way of estimating the off time as 75 per cent of the

CR constant. If $C1 = 1000\mu F$ and $R1 = 4\cdot7k\Omega$ the off time will be given by:—
"*off* time" = $(0\cdot75 \times 4\cdot7 \times 1000)$ milliseconds, which is approximately $3\cdot5$ seconds.

In the case of the astable circuit one complete sequence of events, called a cycle, will take a time that is the sum of the individual *off* times for the two halves of the circuit. The "number of cycles" that occur in one second is known as the frequency. One cycle per second is called one hertz (Hz).

We can express these circuit parameters as follows:
Total "*off* time" $0\cdot75\ (C1.R1 + C2.R2)$ and if $C1.R1 = C2.R2 = T$ say, then

$$\text{Frequency } \frac{1}{(1\cdot5 \times T)} \text{ Hz. (must be in seconds)}$$

It must be noted that this result is only approximate but does give a simple method of estimating the circuit frequency.

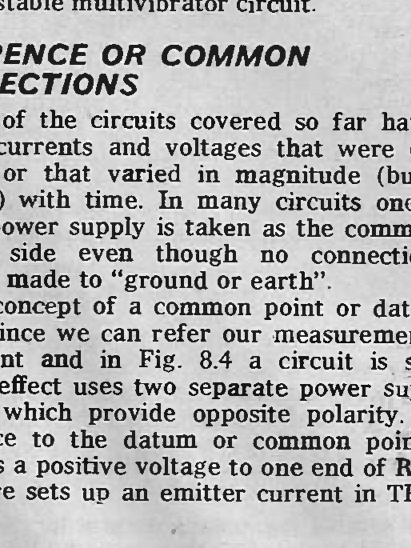
The astable circuit is just one of many oscillator circuits that can generate voltages (in this case at either the transistor collectors or bases) which are periodic i.e. have a repetitive waveform. The normal household mains supply is another example of a periodic (alternating) voltage, and has a smoother waveform than the square wave output produced at the collectors of the astable multivibrator circuit.

REFERENCE OR COMMON CONNECTIONS

Most of the circuits covered so far have involved currents and voltages that were either steady, or that varied in magnitude (but not polarity) with time. In many circuits one side of the power supply is taken as the common or ground side even though no connection is actually made to "ground or earth".

This concept of a common point or datum is useful since we can refer our measurements to this point and in Fig. 8.4 a circuit is shown that in effect uses two separate power supplies B1, B2 which provide opposite polarity. With reference to the datum or common point, B1 provides a positive voltage to one end of R1 and therefore sets up an emitter current in TR1.

Fig. 8.4. Common base amplifier using two power supplies.



The collector current flows via R2 which is supplied with a negative voltage (relative to datum) by B2. The small base current must flow in the datum lead which is *common* to input, output, B1 and B2.

We have seen that it is possible to produce a reversal of voltage polarity in the astable multivibrator (Fig. 8.2) and in many electronic circuits alternating voltage and current waveforms of this type are produced.

ALTERNATING WAVEFORMS

It is not necessary for all alternating waveforms to have the same shape as Fig. 8.2 and some other common variations are illustrated in Fig. 8.5. In Fig. 8.5a the waveform is smooth and there are no abrupt changes.

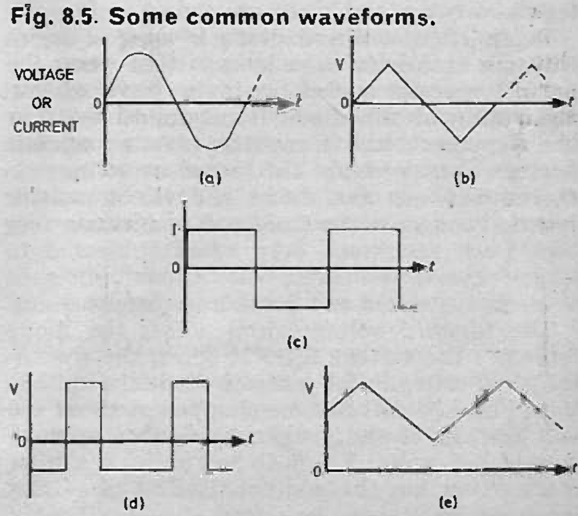
An example of such a waveform is the household mains supply and in this case the waveform is very nearly **sinusoidal**. This simply means that the voltage or current varies with time according to the mathematical sine function and can therefore be expressed by $V = V_m \sin(2\pi ft)$. We will come back to this expression later on.

The Figs. 8.5b and 8.5c show a triangular waveform and a square waveform respectively. Notice that in each of these examples the waveform "shape" repeats itself at regular intervals and that the waveform is symmetrical insofar as the shape of the positive and negative portions are mirror images of each other.

In Fig. 8.5d we have a "repetitive pulse" waveform. The waveform still repeats its particular shape at regular intervals but the waveform symmetry is no longer present since the positive portions are "tall and narrow" whilst the negative portions have smaller amplitude and greater width.

Actually it is somewhat artificial to consider the waveform as two portions, positive and negative, but at this stage we shall find the idea useful for discussion purposes.

Fig. 8.5. Some common waveforms.



The waveform in Fig. 8.5e is not, strictly speaking, an alternating waveform, since it is always positive, but it can be considered to be made up of two parts. If we add a steady positive voltage to an alternating voltage such as that in Fig. 8.5b we can produce a waveform exactly like that in Fig. 8.5e. This idea of breaking a waveform into steady and alternating portions is also very useful.

AVERAGE VALUES

Waveforms that contain alternating and steady components are very common and the steady component is known as the average value of the waveform. The meaning of this is best illustrated by considering the current waveforms shown in Fig. 8.6. In (a) the waveform is symmetrical and the shape repeats itself every two milliseconds. We say that the periodic time is 2ms since this is the time occupied by the waveform in tracing out its characteristic shape for one complete cycle of variation.

The waveform is made up by a series of such cycles and the number of cycles that occur every second is known as the frequency, measured in hertz (Hz). Thus the waveform of Fig. 8.6a can be described by the following:—

shape—squarewave
period—2ms (for one complete cycle)
frequency—500Hz (number of cycles per second)
other features—symmetrical ± 1A, average value zero.

The zero average value results from the perfect symmetry of the positive and negative half cycles. The area under the positive half cycle is (1amp)×(1ms) and represents a flow of charge of one millicoulomb in a given direction through some circuit. The area under the negative half cycle represents an equal amount of charge flowing in the opposite direction. The nett or average flow is therefore zero over one or more complete cycles of the square waveform.

A similar shape is illustrated in Fig. 8.6b but this time the current is either 2A or zero. The period, frequency and peak to peak current swing (2A) are the same as before but this time the average value is not zero. Every complete cycle a charge of 2mC is passed round the circuit in the positive direction—nothing is ever passed back in the reverse direction. The average flow is therefore 2mC every 2ms and is equivalent to an average current of 1 ampere.

This can be seen in Fig. 8.6b since if the top half of each rectangle is removed and used to fill the following space a continuous constant current of +1 ampere results. It is easy to see that by adding a constant current of one ampere to the waveform of Fig. 8.6a the waveform of Fig. 8.6b results.

A.C. THEORY

To extend our knowledge of electronic circuits it is necessary to examine the behaviour of all our previous components under alternating conditions. In fact to gain a full understanding of the behaviour of components it is necessary to consider time varying current or voltage waveforms in general and fortunately this is possible by introducing one fundamental concept—namely the idea of rate of change. If the voltage across a capacitor is varying with time the current flow will be given by

$$i = C \times \text{rate of change of voltage.}$$

If C is in farads and the rate of change is in volts per second the current will be in amperes. If the rate of change of voltage is varying with time then the current will vary in a similar manner. To illustrate some of the possibilities let us consider Fig. 8.7. Diagram (a) shows a voltage which is rising uniformly with time. In this case the rate of change is *constant* and is equal to the slope of the line which is +20 volts per second. Since the capacitor has a fixed value of 1000μF the current will be constant and equal to:

$$\text{Current} = 1000\,(\mu\text{F}) \times 20\,(\text{V/s}) = 20{,}000\,\mu\text{A} = 20\text{mA}$$

As long as the rate of change of voltage is maintained constant at 20 V/s the current will remain at 20mA. After say ten seconds the capacitor voltage will have increased from zero to +200 volts and the charge, Q, stored in the capacitor will be

$$Q = C \times V$$
$$= 1000\,(\mu\text{F}) \times 200\,(\text{V}) = 0{\cdot}2 \text{ coulomb}$$

Notice that this result agrees with the charge transferred by the current flow using

$$Q = i \times t$$
$$= 20\,(\text{mA}) \times 10\,(\text{s}) = 0{\cdot}2 \text{ coulomb}$$

A voltage that rises and falls in a regular way is illustrated in Fig. 8.7b, if this voltage appeared

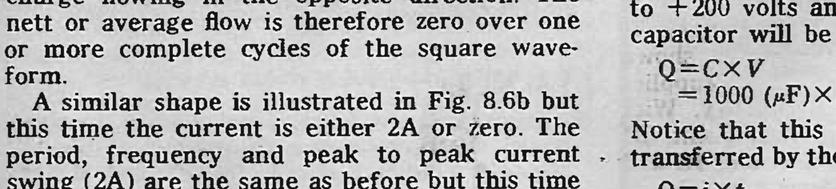


Fig. 8.6. Illustrating average values.

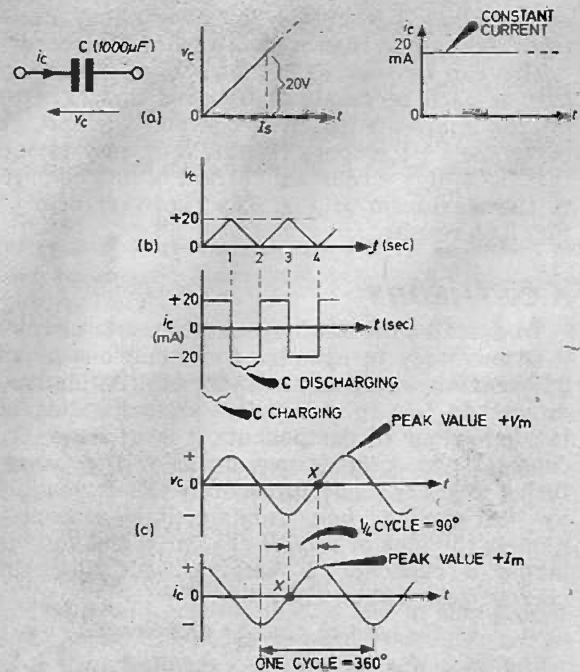


Fig. 8.7. Voltage and current waveforms for a capacitor.

across a capacitor C the resulting current would be a square wave. The current is positive when the voltage has a positive rate of change of +20 volts per second, whereas the current flow is reversed (i.e. negative) when the voltage *falls* at 20 volts per second. A falling voltage gives a negative rate of change.

Notice that the capacitor is charging when the current is positive and discharging when the current is negative, Fig. 8.7c illustrates the behaviour when the capacitor voltage is a sine wave. At the positive and negative voltage peaks the rate of change (i.e. slope of the waveform) is zero. The current waveform has the same sinusoidal shape but it is displaced in time relative to the voltage waveform.

The displacement is seen to be equivalent to a shift of a quarter of one cycle and since one complete cycle corresponds to a change of 360 degrees in the angle θ of a sine function, such as $10 \sin \theta$, the displacement can be expressed as a shift of phase of 90 degrees. The current is said to *lead* the voltage by 90 degrees since it passes through any specified point, such as X, 90 degrees ahead of the corresponding point on the voltage variation.

INDUCTANCE

When current flows in a wire or conductor a magnetic field is set up in the vicinity. If the wire is formed into a coil the magnetic field links the various turns and this gives rise to the property known as inductance. In our previous experiments we have not needed to use this property which is incidentally always present to some degree, just as stray capacitance is always present, in electronic circuits.

Some components utilise the magnetic effects produced by current flow and two well known examples are the relay and transformer.

Next month we shall look at inductance in a.c. circuits and go on to examine reactance, resonance and r.m.s. values.

For the experimental work of the remainder of the Teach-In '74 series, some additional components will be required; these are listed on this page.

Components....

Capacitors *(Additional to those listed in Part 1)*

0·22μF polyester (2 off)

Semiconductors

1N4001	silicon diodes (3 off)
TIS43	unijunction transistor (1 off)
2N3819	field effect transistor (1 off)
BC477	silicon *pnp* transistor (1 off)
BTX30-25	triac (1 off)

Loudspeaker

35Ω 65mm (approx) (1 off)

Miscellaneous

Friedland bell transformer 8V secondary (1 off); Ferrite rod 150 to 200mm long, 10mm (⅜in) diameter (1 off); 30 s.w.g. enamelled copper wire (2 oz. reel); Plastic cotton bobbin (1 off from Woolworths); Reed switch type 6-RSR-A (1 off). 12-way terminal block—similar to that already in use.

TUTOR BOARD EXPERIMENT

Test No. 19

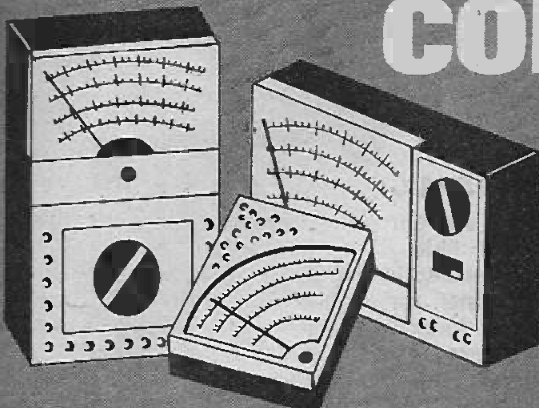
Disconnect the battery and modify the Tutor Board wiring to match the circuit of Fig. 8.1. Use 4·7 kilohm resistors for R1 and R2 and check the operation of the circuit for each of the following capacitor values in turn. Observe capacitor polarity!

1. C1 and C2 both 250μF.
2. C1=1000μF; C2=250μF.
3. C1=1000μF; C2=125μF (made from two 250μF capacitors in series).

The on state for each transistor is indicated by the lamps and the voltage at Z_1 and Z_2 can be examined using the standard 0-10V voltmeter circuit. The layout for this test is left as an exercise for readers. The effect of the different capacitor values can be determined by observing the "on time" of the lamps.

NEXT MONTH ...

FREE ENTRY COMPETITION



Multimeters to be WON

Plus 3 Constructional Projects...

80m and 160m AMATEUR BANDS RECEIVER

Ordinary a.m. receivers are unsuitable for single sideband reception and also for the other main transmission mode used by amateurs, carrier wave (morse code). The most simple type of receiver suitable for amateur band reception is the direct conversion type and the construction of such a receiver covering the 80 metre and 160 metre bands will be described next month.

FREEZER TEMPERATURE ALARM

Many homes now possess a deep freeze unit and it is logical, particularly if the unit is fitted in a garage or other "outbuilding", to have an indicator available in the house to show that a temperature variation has occurred before the contents of the freezer are spoiled. The unit to be described next month indicates any rise or fall in the temperature with an audible and visual warning.

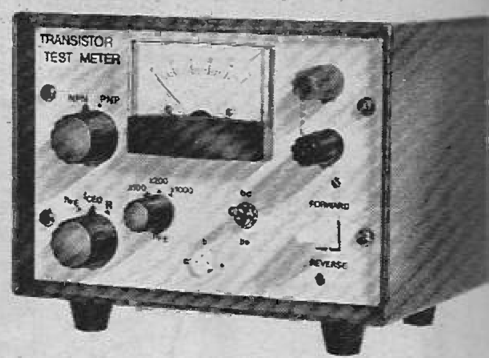
ee TEST GEAR FIVE *5th. Instrument* **R.F. SIGNAL GENERATOR**

everyday electronics

JUNE ISSUE ON SALE MAY 17

TRANSISTOR TESTER

Gives a direct reading of six transistor parameters



ENTHUSIASTS spend a large proportion of their time testing and commissioning electronic circuits. Transistors employed within these circuits can become suspect and therefore a simple transistor test meter is an asset. The Transistor Tester described in this article is cheap and simple to build yet checks the basic parameters of the transistor under test. These parameters are static forward current transfer ratio (h_{FE}), collector leakage current (I_{CEO}) and base/emitter, base/collector forward and reverse resistance.

The instrument functions with a supply voltage between 10 and 20 volts, which is within the range of the *Power Supply Unit* described in the February issue.

TEST SYSTEM

The meter measures gain by injecting a known current I_B into the base of the transistor under test and monitoring the collector current I_C. This gives a direct reading of gain which satisfies the formula:

$$h_{FE} = \frac{I_C}{I_B}$$

Large changes in collector current or collector /emitter voltage affect the transistor gain. The Transistor Tester is designed so that these variations are small enough to be ignored.

As the symbol, I_{CEO} indicates, the meter ascertains the level of collector leakage current by leaving the base open circuit and applying a constant voltage across the collector/emitter junction, V_{CE}. Indicated current flow is the leakage current taken from the collector supply.

Fig. 1 shows that when subjecting an *npn* transistor to resistance checks the transistor acts as two *pn* junctions connected back to back. This enables the junctions of the base/emitter and base/collector to be treated as two diodes. A similar mechanism explains how the system makes resistance checks of *pnp* transistors. However, as the doping in each region is reversed, the diode connections need to be inverted to obtain the same action.

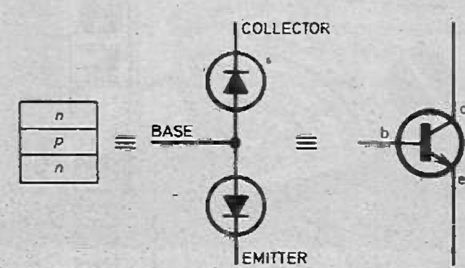


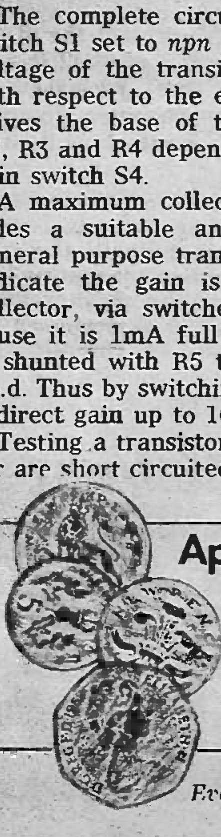
Fig. 1. (a) Schematic layer representation (b) diode representation (c) circuit symbol of an *npn* transistor.

THE CIRCUIT

The complete circuit diagram, Fig. 2, shows switch S1 set to *npn* and therefore the collector voltage of the transistor under test is positive with respect to the emitter. A voltage of 4·7V drives the base of the transistor via resistors R2, R3 and R4 depending on the position of the gain switch S4.

A maximum collector current of 10mA provides a suitable and safe value for testing general purpose transistors. The meter used to indicate the gain is connected in series with collector, via switches S1, S2 and S3, and because it is 1mA full scale deflection (f.s.d.), it is shunted with R5 to give the required 10mA f.s.d. Thus by switching S4 the unit can measure a direct gain up to 1000.

Testing a transistor whose collector and emitter are short circuited will cause a large current



Approximate cost of components including V.A.T.

£7.30

excluding case

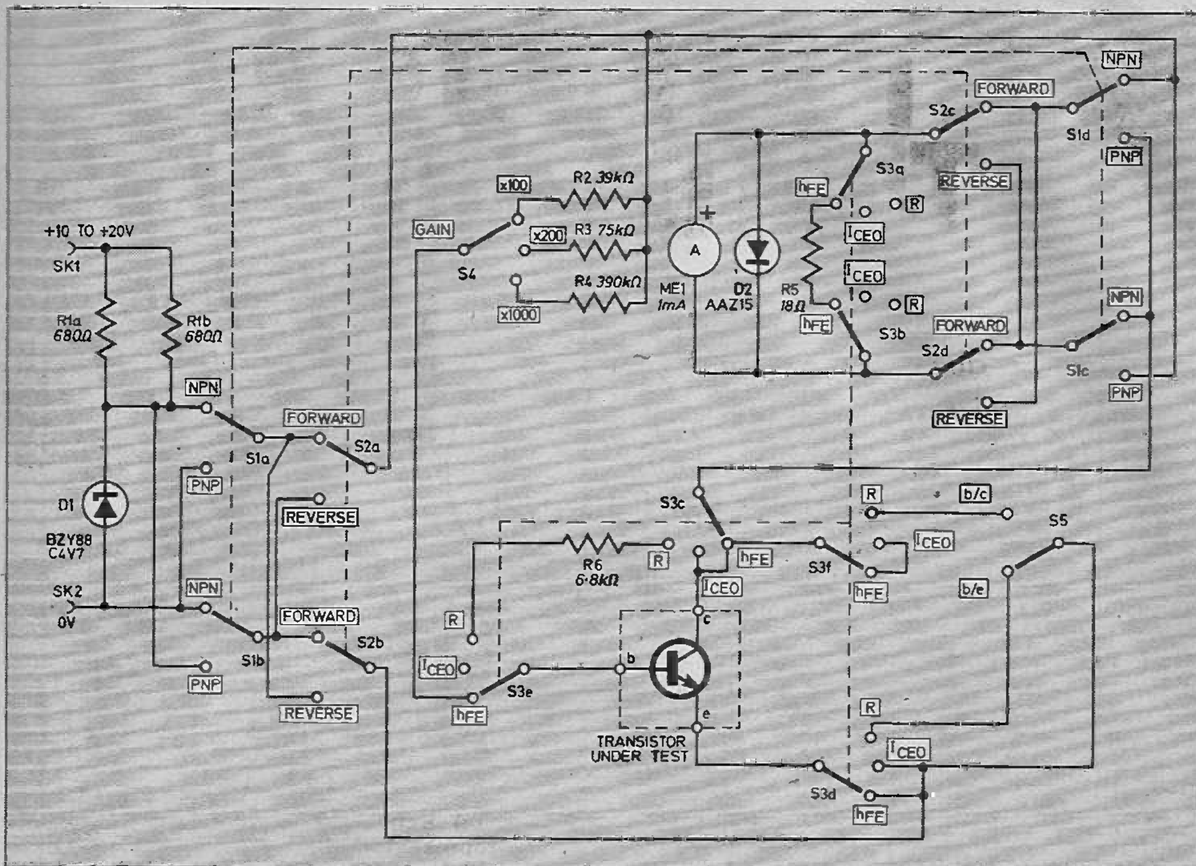


Fig. 2. The complete circuit diagram of the Transistor Tester.

to pass through the meter. To protect the meter against damage, a germanium diode D2 is connected across it. However, the internal resistance of the meter must be about 170 ohms. The short circuit fault in transistors will cause the meter to register hard over in all positions of switch S4, also when S3 is switched to check leakage.

As most leakage currents are in the order of a few microamps the meter is not shunted, so the 1mA f.s.d. will indicate a "leaky" transistor. Switching S3 from position shown removes the shunt resistor R5 and open circuits the base connection (at S3e) thereby giving a direct indication of leakage current (I_{CEO}).

FORWARD/REVERSE RESISTANCE

Testing the forward resistance of the base/emitter junction of an *npn* transistor requires its base to be positive with respect to the emitter. Switching S3 to its resistance position and S5 to its base/emitter position achieves this and the meter in series with the base measures the current flow.

A large base current is not required or advisable for this test and therefore R6 is included to limit this current below 1mA. Hence the meter does not require a shunt when making resistance measurements.

To check the junction is behaving like a diode the forward/reverse switch S2 is changed to its reverse position. This reverses the supply voltage applied to the base/emitter junction, also the meter connections.

As the diode is now reverse biased, only leakage current will flow. One can test the base/collector junction in the same manner with switch S5 in the relevant position.

Most general purpose transistors have a minimum base/emitter breakdown voltage (V_{EBO}) of 5V and as a safety measure the test voltage is set below that limit at 4·7V. The Zener diode D1 and resistors R1a and R1b achieve this and also enable the unit to function with a supply in the range of 10 to 20V.

CONSTRUCTION

The prototype unit was built in an Olsen type 25A metal instrument case with louvres, of approximate size 160×110×100mm, although any similar case will do.

With reference to Figs. 3 and 4, drill the front panel to suit the components and then fit them in position and secure.

TRANSISTOR TESTER

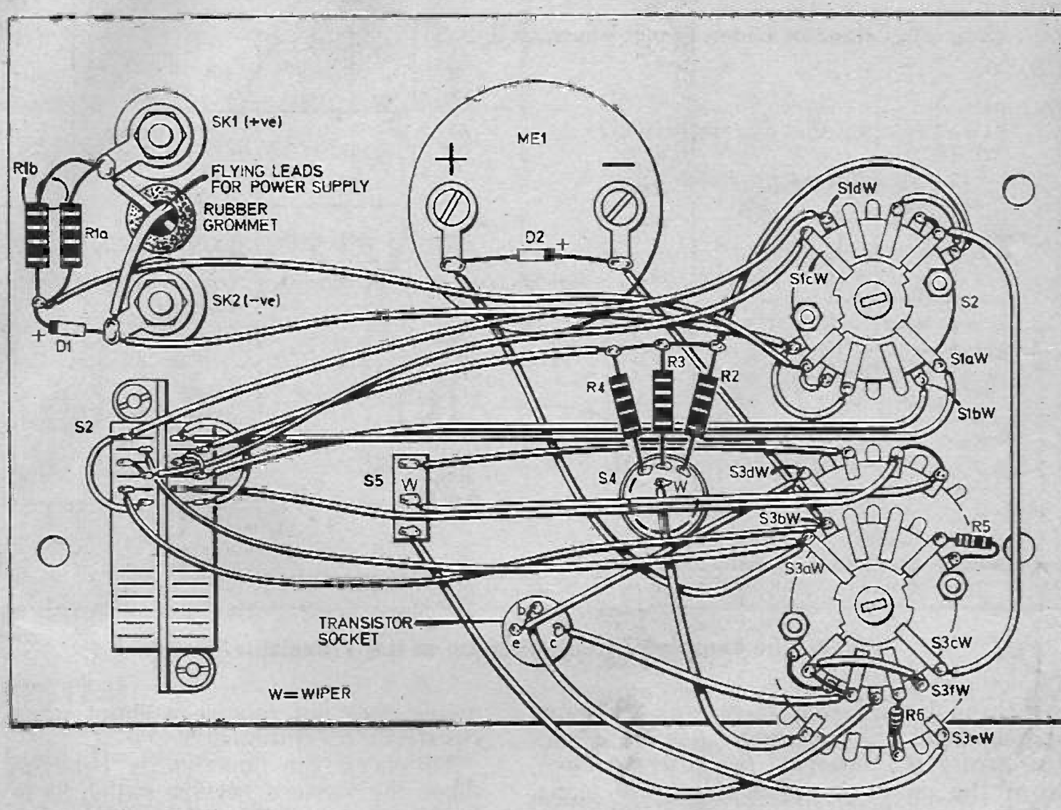
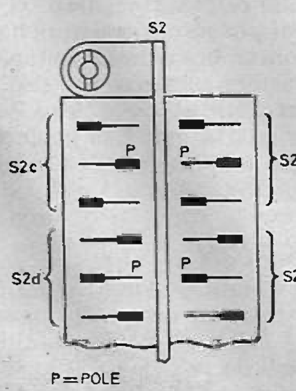
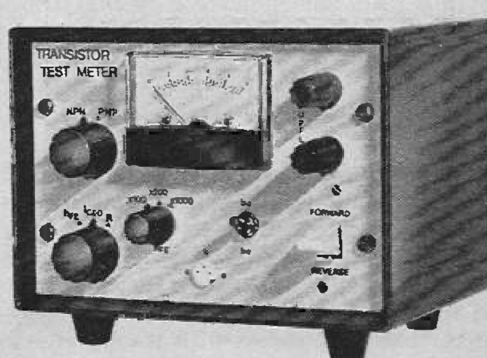


Fig. 3. The positions of the components, all of which are mounted on the front panel showing wiring details. For clarity the top half of S2 is detailed below left.





Photograph of the completed Transistor Tester.

Components....

Resistors

R1a 680Ω $\frac{1}{2}$W
R1b 680Ω $\frac{1}{2}$W
R2 39kΩ
R3 75kΩ
R4 390kΩ
R5 18Ω
R6 6·8kΩ

All $\frac{1}{4}$ W $\pm$ 5% carbon or better, except where stated

SEE **SHOP TALK**

Diodes

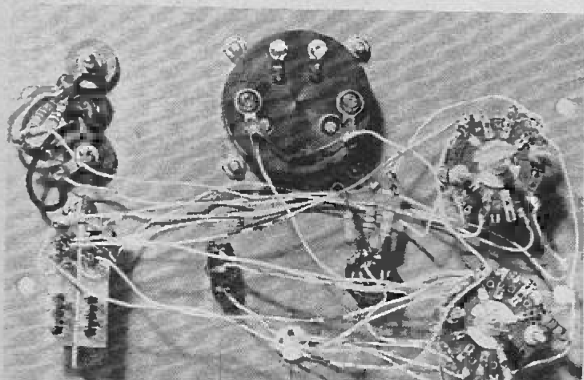
D1 400mW 4·7V Zener diode type BZY88 or similar
D2 AAZ15 germanium or similar

Switches

S1 four-pole two-way Maka
S2 four-pole two-way biased lever type MLK03 4CN/S (Keyswitch)
S3 six-pole three-way Maka
S4 single-pole three-way rotary type
S5 single-pole changeover toggle

Miscellaneous

ME1 1mA d.c. SEW SD460
SK1, 2 heavy duty insulated terminals (one red, one black) (2 off)
Knobs: two large, one small with indicators (3 off); three-pin transistor socket.



Photograph of completed prototype unit removed from case.

The majority of switches used (e.g. S1—3) have several poles and wiring can easily become confused. It is therefore advisable to wire according to Fig. 3 in conjunction with Fig. 2, starting at the left-hand side of the diagram and working methodically through to the right completing each switch position before going on to the next.

Another aid in clarifying this exercise is to cross off on the diagram each wire as it is connected.

When this has been done and thoroughly checked out, the front panel should be labelled as detailed in Fig. 4 and the knobs screwed on.

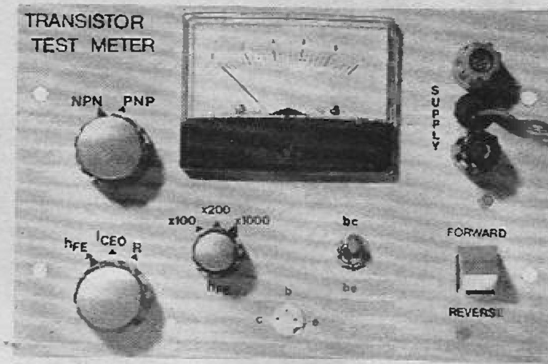


Fig. 4. Details of component positions and labelling on the front panel of the unit.

TEST PROCEDURES

Set the *npn/pnp* switch to its relevant position and place a transistor in the test socket. To check gain, position the test mode switch S3 to h_{FE} and the gain control to its x100 position.

If the meter indication is greater than full scale, switch the gain control until a direct reading can be taken. Multiplying this reading by the gain control position gives the h_{FE} of the transistor under test.

Remember that the parameter h_{FE} is related to collector current when testing high-power transistors, as there is a large difference between the test and normal operating collector currents.

To check that the transistor's collector leakage current is not excessive, position the test mode switch to I_{CEO} and check that the meter registers a small, if any, current flow. Again, if testing a high-power transistor, some of which have a high leakage current, it is advisable to refer to this particular transistor's data before dismissing it as faulty, purely on the strength of high leakage current.

RESISTANCE

If the previous tests give incorrect results the transistor is faulty and a resistance check will confirm this. To perform the latter test, position the mode switch to resistance and the base/collector, base/emitter switch to base/emitter. Check that the meter indicates a current flow; if not the base/emitter is open circuit.

If the meter indicates a current flow, position the forward reverse switch to reverse and check that only leakage current is flowing. If the meter registers a current flow, the base/emitter junction is short circuit or acting as a resistance and not a diode.

Check the base/collector junction by the same procedure, but with the base/emitter, base/collector switch S5 in the relevant position.

The forward, reverse switch action is such that it is non-locking in the reverse position.

This is necessary as inadvertently leaving this switch in the reverse position will alter the sense of the *npn/pnp* switch. Biasing the switch in the forward position resolves this problem.

DIODE TESTING

This system can be used equally well for resistance measurements of a diode. Proceed as for a transistor measurement, but ensure that the *npn/pnp* switch is in the *npn* position and the base/emitter, base/collector switch is in the base/emitter position.

As stated earlier the base connection is now positive with respect to the emitter and therefore they can be used for the respective anode/cathode connection of the diode to be tested. Place the diode in the base and emitter connections of the transistor test socket and operate the forward, reverse switch to check the diode action.

UNKNOWN TRANSISTORS

If a transistor type or lead connections are unknown, adopt the following procedure. Position the mode switch to resistance, and ensuring the base/emitter connection (be) has been selected, place any two of the three transistor leads in the base/emitter test points.

Using the forward and reverse switch, check to see if this connection behaves like a diode. If it does, continue the process combining other pairs of leads until a particular pair give no indication of current flow in either position of the forward reverse switch. This will indicate that these leads are the collector and emitter connections thereby proving the remaining lead is the base.

Connect the known base lead to its relevant position and with either of the remaining leads in the emitter connection, position the *npn/pnp* switch to give a meter reading. As the forward reverse switch is biased in the forward position, the *npn/pnp* switch will indicate transistor type when current flow is registered.

Finally, distinguish between collector and emitter leads by positioning the mode switch to h_{FE} and then interchanging the collector/emitter lead positions until the highest gain reading is obtained. The transistor has now been identified with respect to type and lead connections. ▣

...Counter Intelligence

BY PAUL YOUNG

A retailer discusses component supply matters.

I HAVE often wondered what percentage of the amateur electronic enthusiasts visit exhibitions? The Boat Show is crammed with boating enthusiasts, the Motor Show with motorists and this list could be considerably extended, but I get the impression that the majority of people at an electronic exhibition are from industry or like myself connected with the trade. If I am correct I think it is a great pity.

The only exception to this was the Radio Hobbies Exhibition (now I believe, defunct) which used to be held at the Horticultural Hall, Victoria and later at Seymour Hall, Seymour Place. It was held in November and it was packed full of the amateur fraternity.

All the same we have a very fine "professional" electronics exhibition in London every year around May and smaller exhibitions are held in Leeds and Brighton. If you venture to the Continent there are large exhibitions in Berlin, Hanover and Paris.

I never miss the London ones and in the last 10 years I have only missed the Paris one *once*. It was the fact that I have just read a notice in the press to the effect that the "Salon International des Composants Electroniques" in Paris is on, from the 1-6 April inclusive which prompted this article. This is an international exhibition and some 23 different countries are represented including of course the U.K.

I certainly urge you all (especially if you are London based) to visit one of these exhibitions. You will learn a lot, and be able to examine the most up to date circuitry in electronics, you will also find the staff on the stands most helpful. No matter that you are not placing any orders, they know that the amateur of today may be the chief buyer of a large concern tomorrow.

Paris

If you enjoy the London ones, then be extra daring and next year try Paris. Everyone ought to visit Paris once in their life, so combine two pleasures and do the Eiffel Tower, the Louvre, and the Lido as well!

Having said all that, I would like to make a plea to have an exhibition for the amateur electronics constructor, including the "ham". I think the only way it will come about is if the electronics magazines themselves sponsor it!

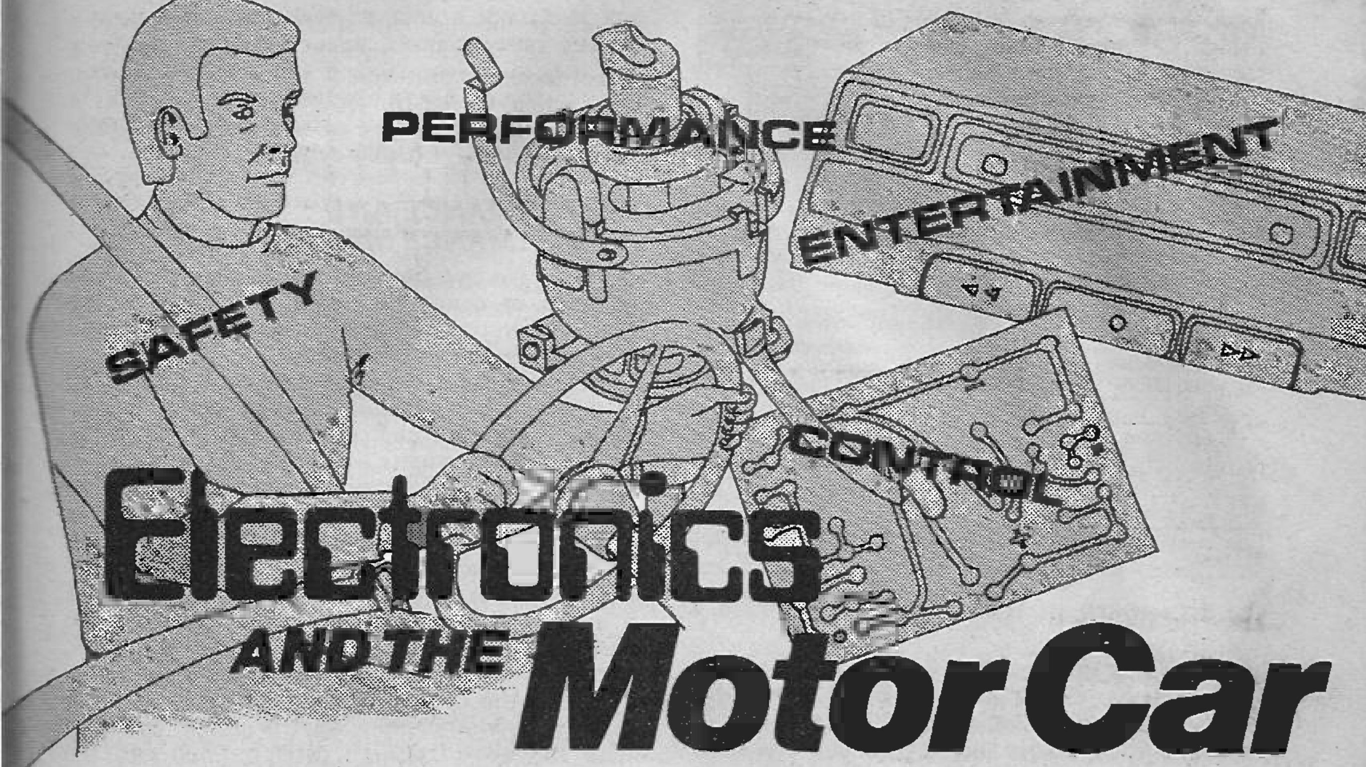
There is at Olympia, an annual "Do It Yourself" exhibition and since they don't take all the space it might be tacked on to that. I am sure we could rely on the support of many component retailers—even to the extent of taking stands.

Should any of you wish to go to either the "R.C.E.M.F." or "Electronics Instruments and Automation" Exhibition (they alternate each year) these are the two London Exhibitions and announcements should be appearing in the press in April giving the dates, or visit your reference library and have a look in "Whats On" at the exhibitions page.

With reference to the Paris exhibition for information write to:

The French Trade Exhibitions,
196 Sloane Street,
London S.W.1

or telephone 01 235 3234. You will also find the French Tourist Office in Piccadilly, London W.1 very helpful on hotels and travel facilities.



Electronics AND THE Motor Car

By C.S.POINTER

THE electronic content of some of the new more advanced cars now reaching the dealers' showrooms is increasing each year. Many of the more expensive cars have as standard equipment or optional extras electronically controlled fuel injection, transistorised ignition, electronic tachometer, stereo cassette player, a.m./f.m. transistor radio, etc.

This trend can be expected to continue in the future with developments such as ignition cut-out systems operated when seatbelts are not correctly worn and automatic control of vehicle speed at a pre-set value. There are many developed systems and production electronic extras available and *some* of these will be covered in this article.

SAFETY DEVICES AND SYSTEMS

Electronics can be used to operate such safety devices as ice warning units (to warn the driver of a temperature approaching freezing point), direction indicators, speed warning devices, automatic headlamp dipping units and emergency flasher units.

One company has developed a system to prevent a car fitted with the system being driven if the seat belts are not correctly worn. This system cuts out the ignition to prevent the car from being driven unless the driver and passenger wear their seatbelts. Fig. 1 shows the system attached to a car, the system operation is as follows.

The weight of a person sitting on the seat operates a sensor in the seat Fig. 1c. The ignition circuit is then broken unless the seatbelt is correctly worn and the sensing circuit is com-

Fig. 1. The seat belt system developed by Mullard and the Ford Motor Company.

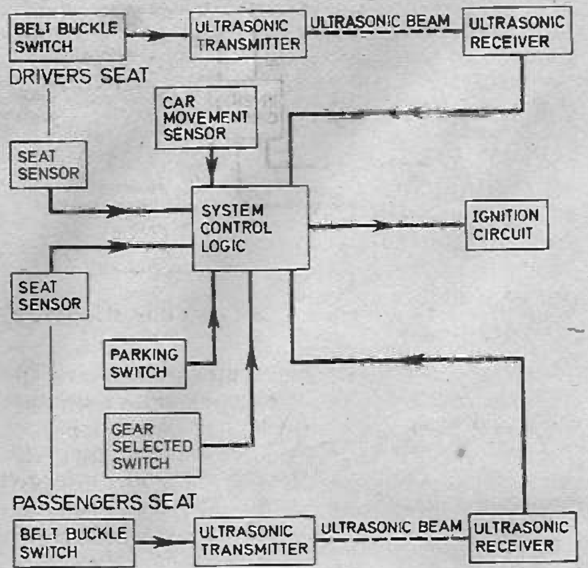


Fig. 2. Control logic of the system shown in Fig. 1.

plete. When the belt buckle Fig. 1b is closed, an ultrasonic transmitter mounted above the car windscreen emits a signal. If the belt is correctly worn across the driver's body then the ultrasonic signal beam will be picked up by an ultrasonic receiver on the belt, Fig. 1a, the signal at the receiver completes the sensing circuit and then the system logic closes the ignition circuit enabling the car to be driven.

The system has been designed to filter out short term interference from such things as cigarette smoke or quick hand movements across the ultrasonic beam. A delayed action and possibly some warning of pending ignition cut-out would be required in the event of the seat-belt being removed whilst the vehicle was in motion.

The system control logic can be arranged so that the car can be parked or garaged in low gear or reverse without the need for the seatbelt to be worn by the driver. The block diagram, Fig. 2, shows a system with the facility for over-riding control for parking as mentioned above.

The passenger seat sensor provides a signal to the system control logic if the passenger seat is occupied, the ignition circuit is then broken unless both seatbelts are correctly used. The delayed action and warning lamp control circuits would be built into the system control logic circuit, the warning lamp being flashed on and off to attract the driver's attention.

There are many safety systems which have been developed in the last few years, these include an experimental radar unit to give the driver warning of obstructions or vehicles ahead of his car in foggy conditions, there are also several anti-lock braking systems.

Anti-lock braking systems have been developed to prevent any one or all of the wheels of the car from locking and putting the car into a skid. A set of wheel sensors detect the onset of wheel lock and transmit a signal to the control unit which varies the operating pressure of a pressure limiting valve in the hydraulic brake line to the wheel brake cylinder, Fig. 3.

PERFORMANCE AND PERFORMANCE MEASUREMENT

There are two fields in which electronics can be used in connection with performance, the first production of performance, the second measurement of performance.

The two main types of electronic unit used in performance production are transistorised ignition systems and electronically controlled fuel injection systems.

Transistorised ignition systems fall into two types, transistor assisted ignition and capacitor discharge ignition. Transistor assisted ignition systems use a transistor amplifier switched by the contact breaker points to switch on and off a high voltage power transistor in the ignition coil primary circuit; since the transistor amplifier input current is small, and non-inductive arcing at the contact breaker points is virtually totally eliminated, point wear is greatly reduced; with the use of a high ratio ignition coil the ignition h.t. voltage is increased, raising ignition efficiency. This system can be used with contact breakerless ignition systems where the transistor amplifier is switched by a magnetic pickup in the distributor.

Fig. 4 shows the block diagram of a transistor assisted ignition system using a magnetic pickup in place of the conventional contact breaker. An oscillator in the amplifier unit connected to the

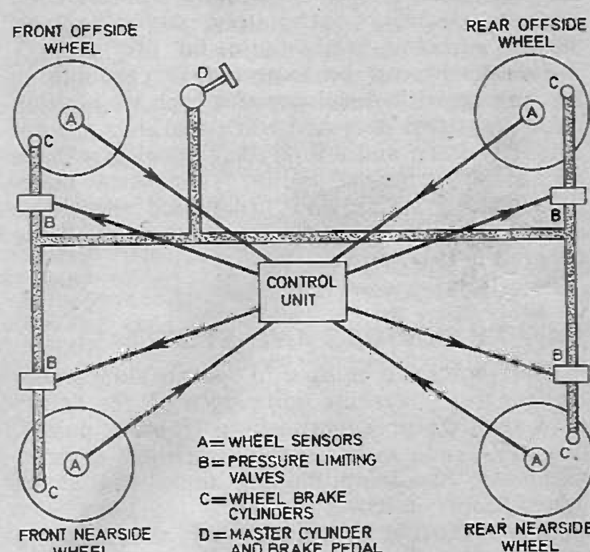


Fig. 3. Block diagram of an antilock braking system for vehicles.

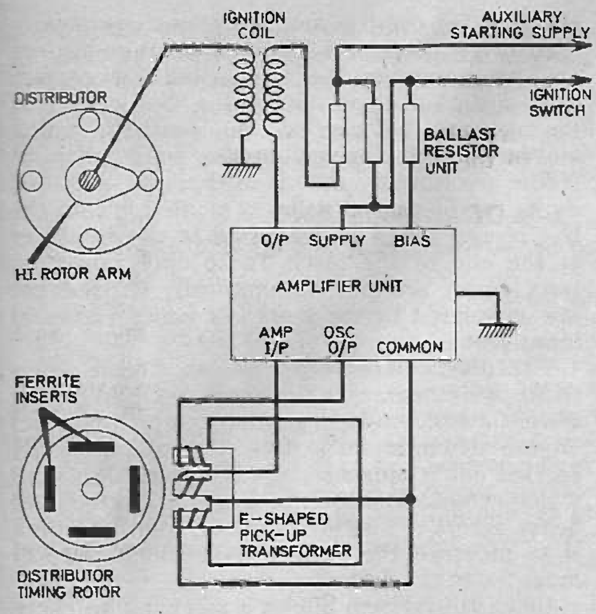


Fig. 4. A transistor assisted ignition system using a magnetic pickup.

pickup supplies a signal voltage to the input windings wound on the outer limbs of the "E" shaped pick-up transformer.

The signal voltage sets up a field around each outer limb, the two fields oppose one another and the magnetic fluxes produced in the centre limb are arranged to cancel, therefore the voltage induced in the output winding wound around the centre limb is very small.

When one of the timing rotor ferrite inserts passes the pick-up transformer, bridging the gap between one of the outer limbs and the centre limb of the transformer, the magnetic fields no longer cancel and the resulting flux induces a voltage in the output winding of the pick-up. The output from the pick-up is fed to the amplifier unit and the presence of a signal resulting

The Lucas Opus 3 (Mk I) ignition system using a magnetic pickup.

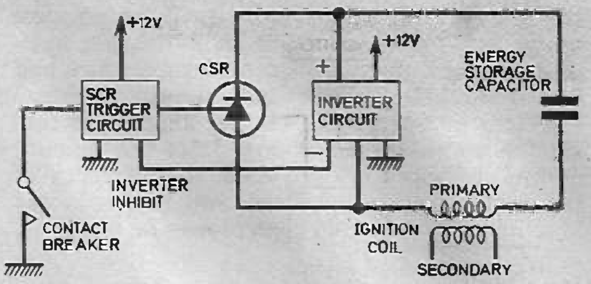


Fig. 5. A block diagram of a capacitor discharge ignition system.

from the ferrite insert lining up with the pick-up turns off the normally conducting power output transistor in the ignition coil primary circuit.

When the power output transistor turns off the current flow to the ignition coil, a large voltage is induced in the coil secondary, the h.t. voltage produced is switched to the appropriate sparking plug by the distributor h.t. rotor and ignition occurs.

Control of ignition timing with vacuum and centrifugal advance can be incorporated in this system by vacuum control of pick-up module position and centrifugal control of timing rotor position. The ballast resistor unit provides bias to the power transistor and also increased ignition coil voltage for cold starting.

This system requires much less maintenance than conventional ignition systems, and will operate efficiently at much higher engine speeds. Since this system is unlikely to go out of adjustment, correct timing is maintained resulting in more control of exhaust emission, fuel economy and constant performance.

Shown in Fig. 5 is the block diagram of a capacitor discharge ignition system. The inverter circuit running at about two thousand cycles per second and rectified by a high voltage bridge, charges the energy storage capacitor to a high voltage (approximately 500 volts).

When the contact breaker points close, the trigger circuit switches on the silicon control rectifier and the storage capacitor is connected across the ignition coil primary. The energy stored in the capacitor causes the coil primary voltage to reach, very quickly, a large negative voltage; the capacitor then discharges and the current in the coil primary passes through zero cutting off the thyristor.

The fast change in the coil primary induces a large voltage in the secondary which supplies h.t. to the plugs via the distributor head rotor arm.

This system will operate more efficiently than normal systems even with fouled plugs and gives easier starting with smoother running from cold. A standard ignition coil can be used since a high ratio coil is not required as used with transistor assisted ignition circuits.

Electronic fuel injection systems are now used on some production cars. One of the units us contains a plug-in printed circuit board plus power transistors mounted on a suitable heat-sink. The unit monitors engine temperature and inlet manifold pressure and operates the fuel injectors to deliver the correct amount of fuel for the operating conditions. Since the amount of fuel delivered is controlled, the efficiency of the engine may be inceased, and fuel economy together with pollution control may be achieved.

DIAGNOSIS

Separate measuring instruments are mainly used for setting up and checking that the car is properly tuned. Many garages have electronic tuning aids for measuring ignition settings and performance, battery charging circuit efficiency and engine performance. These instruments range from those displaying the measured performance on a meter to those displaying waveforms on a screen or giving a digital display or printout.

With the use of an oscilloscope display unit, it is possible to monitor the ignition system performance with the engine running. By displaying on the screen the ignition coil primary

The Crypton "Motorscope" Mk VI—engine analyser shown in use.

voltage waveform, diagnosis can be made of damaged plugs and fouled plugs, open-circuit h.t. cables, etc. The complete waveform for all the engine cylinders can be displayed and the faulty components associated with a particular cylinder can be pinpointed.

A network of dealers are now using a diagnosis system to check customers' cars; all new cars sold by the dealer network being fitted with sockets for connection to the diagnosis equipment, older models not fitted with sockets are connected to the equipment via adaptor leads. For each model to have diagnosis service a programme card supplies data to the diagnosis equipment controlling the tests carried out and giving the correct readings that should be obtained for comparison, within the equipment.

After connection of the equipment to the car and programming the unit using the correct card, a digital display indicates the number of the test to be carried out and the value measured then appears on the digital display. If the measured value is within the specified limits the measured value is printed out on the test record which is presented to the customer at the end of the tests. Those operations and tests which are not automatically carried out are completed by the mechanic using a manual input unit.

The diagnosis covers steering, brakes, electrical equipment, tyre pressures, oil, brake-fluid, water levels, engine cylinder compression and engine dynamic tests. One test automatically carried out is measurement of wheel alignment which is measured by reflecting a projected light beam across a measuring plate; another check is to measure the battery fluid using a sensor mounted in the battery.

Using this system allows a mechanic to check 88 test operations in about half an hour. The police also use electronics to check the speed of vehicles on the road using the Doppler effect

A Crypton timing light being used to set the ignition timing with the engine running.

to measure the speed of a car passing the radar unit.

The most widely used electronic instrument for measuring performance fitted to today's cars is the electronic tachometer unit; this device converts the pulses produced by the ignition circuit contact breaker points into meter deflection current, thus giving a meter reading proportional to the engine speed. The input to some tachometer units is taken from an input sensor which consists of a coil of a small number of turns wound around the contact breaker to coil connection wire.

Next month. This article will be continued and will cover car security, entertainment and communication.

SHOP TALK

By Mike Kenward

BOTH our series of constructional projects concerning test gear (the *E.E. Test Gear Five*), which will finish next month when the *R.F. Signal Generator* is published, and last month's special supplement *Test Gear* may have aroused some interest in many constructors.

The section on multirange meters in the supplement started by saying: "A multirange test meter is probably the first and most useful item of test gear anyone is likely to purchase." This is, of course, quite true and if you do not have any test gear you should look at meters before anything else.

To get a worthwhile instrument you will probably have to spend about £8 or more. However, next month we are presenting an exciting opportunity for you to win a multimeter. A number of good quality meters will be presented as prizes in our free entry competition, so don't miss this chance.

Transistor Tester

One or two problems concerning components for the *Transistor Tester* may arise, mainly with the switches specified. The miniature Maka switches should be generally available—if you have trouble one of the larger London based suppliers should be able to help. You will probably have to buy the parts separately and assemble them. The wafers used on the prototype were two 4 pole, 3 way (used for the 6 pole 3 way switch) and one 4 pole, 3 way (used for the 4 pole, 2 way switch).

Obviously 2 poles are not used on the first switch and one "way" is not used on the second. The switch assembly has a "stop washer" which can be adjusted so that the switch will rotate only through the required number of positions.

The lever key switch is available from Farnell Electronic Components Ltd., Canal Road, Leeds, LS12 2TU. The switch is type MLK03 . 4CN/S and will only move in one direction, without locking. It will only have contacts on one side as shown in the wiring diagram. The switch costs 78p plus 3p for the handle plus 25p small order surcharge plus VAT—we make that about £1·17. Handles are available in a vast range of colours, red, dark green, blue, yellow, grey, ivory, maroon and black being the main ones—state colour required when ordering.

Electronic Bagpipes

Once again the problems with parts for the *Electronic Bagpipes* article seem to be confined to switches. This time very simple, small press to break switches which are available from a few of the larger suppliers. The switches should be miniature types—not exceeding about 35mm overall and must be press to break.

The microswitch used for the on/off switch must be capable of being operated when the side is squeezed and is best if it can be screwed to one side and operated by the other. Most types with a button operator are suitable.

Chanter material will depend on what is available but make sure the switches will go inside—the connection tags may need bending over for this. Most other parts should be readily available.

Egg Timer

All parts for the *Egg Timer* should be generally available, although you may have to shop around a bit for the loudspeaker. The case used in the prototype came from Trampus Electronics, PO Box 29, Bracknell, Berks, but quite a few similar types are available from many suppliers.

Simple Buzzer

The *Simple Buzzer* is built around a balanced armature earpiece. The most important things to check when buying this is that the impedance is correct and that the whole thing can be taken apart. For this reason one of the ex. W.D. types in a plastic case will probably be best.

Stop Press!

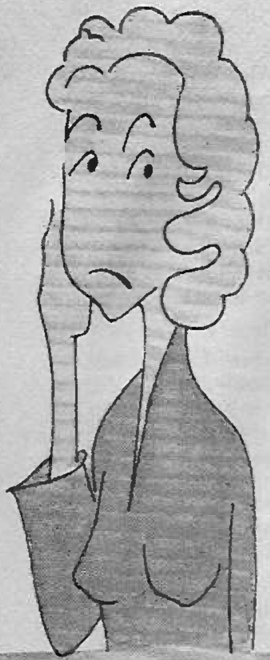
The twin ganged potentiometer for the *Audio Frequency Oscillator* (March 1974) is available from Radio and T.V. Components Ltd., for a total cost of 75p including postage, packing and VAT.

PLEASE TAKE NOTE

In the *Electronic Voltmeter* article last month, Fig. 3 (page 28) some of the resistor numbers are shown incorrectly. The following alterations should be made to the drawing: R12 becomes R10, R8 becomes R7, R5 becomes R4, R10 becomes R8, the unmarked resistor is R5

In *Demo Circuits* last month (page 221) the formulae for inductive reactance and capacitive reactance are shown under the wrong headings, they should be transposed.

In *Teach-In '74* Lesson 6, Fig. 6.3. The wire from B2+ve should go to the centre tag of S1. Lead from D2+ve should go to junction of R3/B1−ve.



. . . WELL ! MAKE THE E.E EGG TIMER!

By R. A. PENFOLD

This device can ensure that your egg is cooked to the same, required constituency, every time.

THE device to be described here is a timer which gives an audible warning when the set time interval has elapsed. Although designed specifically as an egg timer, it can be used for any application requiring an audible alarm output after up to five minutes (approx.).

This simple device is quite compact and it is completely self contained. Power is obtained from an internal 9 volt battery.

Being a piece of household equipment, it must of course be easy to operate. There are only two controls, one being a dial on which the required period of time is set (this is continuously variable from 2 to 5 minutes), and the other is the on/off switch.

When the desired time has been set on the dial, the unit is turned on, and then left. When the set time has elapsed, an audible warning (a howling noise) is produced by the timer. This will continue until the unit is turned off, whereupon it is ready for use again.

The unit is not only suitable for use as an egg timer, but can be used on any process taking a similar time, providing a high degree of accuracy is not required.

BASIC OPERATION

There are really three separate circuits which comprise the timer, bistable and oscillator, and Fig. 1 shows these three stages, and the output waveform of each in block diagram form.

The first stage is the timing part of the circuit, and this produces a short, positive electrical pulse at the end of the timing period. This pulse is used to trigger the second stage of the unit, and this is a bistable multivibrator, which is sometimes just termed a "latch", for reasons which should become obvious.

The latch is required in order to turn the short output pulse from the timer circuit, into a continuous positive output, which is used to operate the third stage. This is an audio oscillator which feeds a loudspeaker. Thus the short pulse from the timer circuit will cause a continuous tone from the loudspeaker which will persist until the unit is turned off.

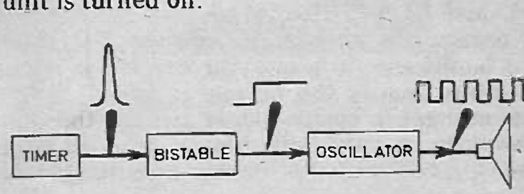
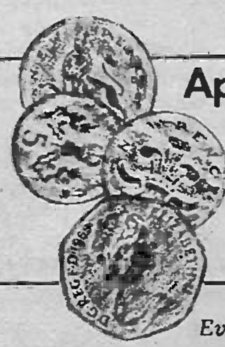


Fig. 1. The block diagram of the Egg Timer.



Approximate cost of components including V.A.T.

£2.35

excluding case

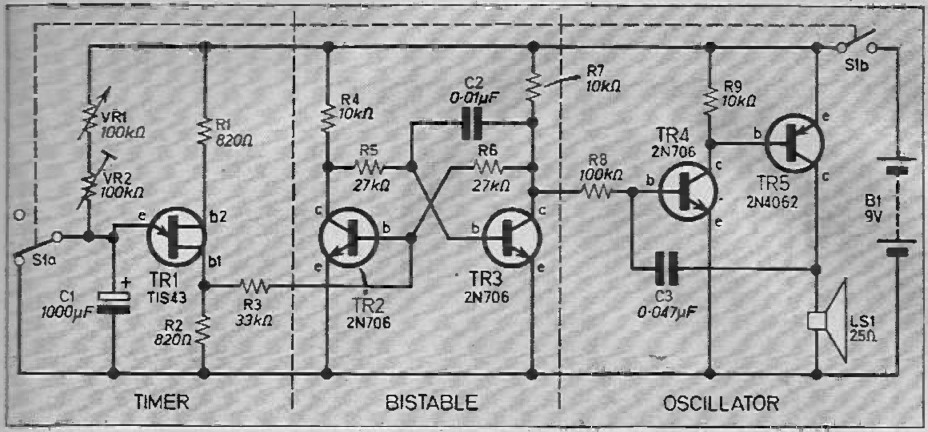


Fig. 2. The complete circuit diagram of the Egg Timer showing the three major sections.

THE CIRCUIT

A complete circuit diagram of the Egg Timer is shown in Fig. 2; dotted lines break the circuit into the three sections outlined above.

Transistor TR1 is a unijunction transistor, and the operation of this is completely different to that of an ordinary transistor. The unijunction has an emitter, two bases, and no collector. With no voltage present at the emitter terminal, the base 1 and base 2 connections of the transistor will have the characteristic of a resistor with a value of a few kilohms between them.

With reference to Fig. 2, with S1 in the on position, there will be a potential of about one volt at TR1 base 1. The input resistance to the emitter of TR1 will be extremely high at low voltages, perhaps several hundred megohms, therefore C1 will begin to slowly charge through VR1 and VR2.

Since C1, VR1 and VR2 all have high values, the voltage across C1 will increase slowly.

Eventually, when there is a potential of a few volts across C1, the triggering point of TR1 will be reached. When this happens, the input resistance to the emitter of TR1 drops to a very low level, and C1 will discharge very rapidly. As this occurs, the resistance between TR1, base 1 and base 2 will drop to about half it's previous level, thus causing the voltage at base 1 to rise to about 4 volts. This will only last for the time it takes for C1 to discharge (a fraction of a second), and then the circuit returns to the beginning of the cycle.

Both VR1 and VR2 can alter the time taken between turn on, and the pulse at TR1 base 1. Potentiometer VR2 is a preset type connected as a variable resistor which is adjusted so that VR1 (which is fitted on the front panel of the timer, and has the dial marked around it) covers the required range of 2 to 5 minutes. Component VR2 has to be a preset, rather than a fixed resistor, so that compensation for the wide tolerances of the electrolytic capacitor used for C1, can be made. The tolerance of this component can be as much as plus 100 per cent and minus 50 per cent.

BISTABLE MULTIVIBRATOR

Transistors TR2 and TR3 form the bistable. When the supply is turned on, the voltage at the collector of each transistor will begin to rise. Due to the component tolerances, the voltage at one collector will rise more quickly than that at the other collector. To ensure that the voltage rises more quickly at the collector of TR2, C2 has been included.

As the voltage at TR3 collector rises, this rise will be coupled by C2 to TR3 base, where it will have the effect of reducing the voltage at TR3 collector. The effect of C2 is only slight, but is enough to ensure correct circuit action.

The voltage at TR2 collector will therefore rise quickly to almost the full supply potential, and this will be coupled through R5 to TR3 base, causing the potential at TR3 collector to go to almost zero. Thus each time the unit is switched on, TR2 will be off (not conducting) and TR3 will be fully on (conducting).

Base 1 of TR1, and the base of TR2 are coupled by R3. Therefore, when base 1 goes positive at the end of the timing period, TR2 base will also go positive. This will cause TR2 collector to go more negative. Because the collectors, and bases of TR2, and TR3 are cross coupled by R5 and R6, a regenerative action will take place. The base of TR3 will go more negative, causing TR3 collector to go more positive, bringing us full circle back to TR2 base which will go still more positive. This regenerative action will continue until the transistors have changed states, with TR3 collector at nearly full supply potential, and TR2 collector at almost earth potential. In other words TR2 is fully on and TR3 fully off.

It is seen from this that the bistable will have only a small output voltage until it is triggered by the short output pulse from TR1, whereupon its output will rapidly swing to a high level, and stay at this level.

AUDIO OSCILLATOR

The audio oscillator is formed by TR4, and TR5. These are both operated as common emitter amplfiers, R9 being the collector load

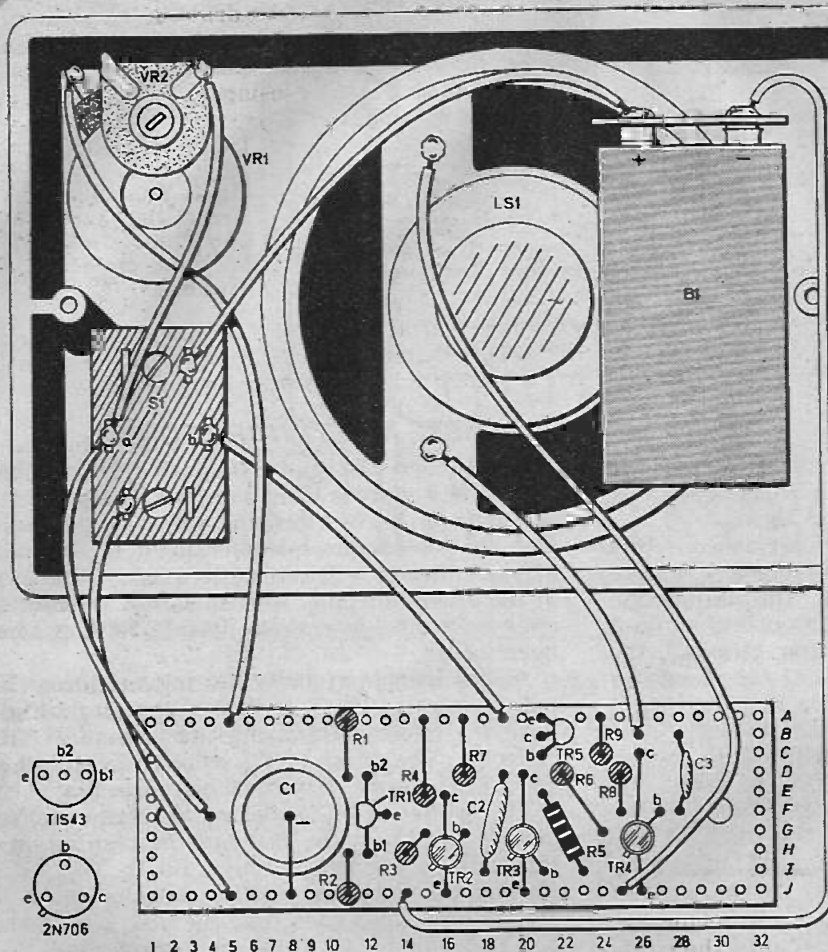
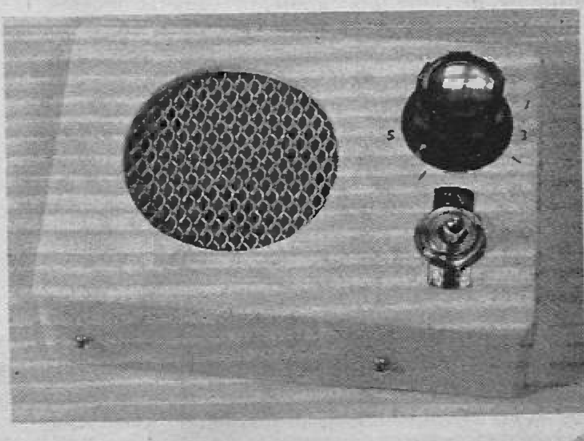


Fig. 3. The layout of the components on the Veroboard wired to the components mounted in the case.

Photograph showing the completed Egg Timer.



EGG TIMER

Components....

Resistors

R1	820Ω
R2	820Ω
R3	33kΩ
R4	10kΩ
R5	27kΩ
R6	27kΩ
R7	10kΩ
R8	100kΩ
R9	10kΩ

All ¼W carbon ±10%

SEE SHOP TALK

Capacitors

C1	1000μF elect. 10V
C2	0·01μF
C3	0·047μF

Semiconductors

TR1 TIS43 unijunction
TR2, 3, 4 2N706 silicon *npn* (3 off)
TR5 2N4062 silicon *pnp*

Miscellaneous

VR1	100kΩ carbon lin.
VR2	100kΩ preset lin.
S1	double-pole double throw toggle or slide switch
LS1	25 ohm loudspeaker approx. 70mm diameter
B1	9 volt PP3

Veroboard, 0·1in. matrix size 10 strips by 32 holes; speaker fret; connectors to suit B1; plastic case size 110 x 72 x 30mm or larger; knob.

resistor for TR4, and LS1 is the collector load for TR5. The input, and the output of the circuit are in phase, and C3 will therefore introduce positive feedback, which will cause the circuit to oscillate when a suitable biasing current is present at TR4 base.

However, the biasing resistor, R8, is connected to the output of the bistable, and will normally be at a very low potential, and will not introduce a proper biasing current. At the end of the timing period when the output of the bistable changes to a higher potential, then the required biasing current is introduced, and the circuit will then oscillate, producing an audible tone from LS1.

When the circuit is turned off, S1a shorts across the terminals of C1, ensuring that this is fully discharged, and that the unit is immediately ready for use again.

CONSTRUCTION

Most of the components are mounted on piece of 0·1in. matrix Veroboard size 10 strips by 32 holes as shown in Fig. 3. All the components with the exception of R5 are mounted vertically.

Begin construction by making the breaks along the copper strips on the underside of the board and then drill the two fixing holes for 6BA clearance (No. 31 twist drill). Now position and solder all the resistors and capacitors in place as detailed and then position and solder the transistors in place using a heatshunt to avoid thermal damage.

The prototype Egg Timer was housed in a commercially available plastic case, size 110×72 ×30mm (internal dimensions). Any case of similar size is equally suitable but do not choose one that is any smaller than employed on the prototype otherwise it may be impossible to fit all the components into it.

Should a metal case be used, steps must be taken to insulate the Veroboard panel from this, and it should be ensured that no other parts are in electrical contact with it.

Make the necessary cut-outs and holes in the case to suit the components and board fixings and then secure the remaining components in position as indicated in Fig. 3.

A cut out about 50mm in diameter should be made in the front of the case, where the loudspeaker is to fit, and a piece of speaker fret glued to the inside of the case to cover the hole. The speaker is then glued to this.

As can be seen, the preset potentiometer VR2 is soldered directly to VR1. Either a horizontal or a vertical mounting type can be used, but in either case it should be orientated so that it can be easily adjusted when soldered in place. Now wire up according to Fig. 3 and when completed fix the board to the inside of the case as shown in Fig. 4.

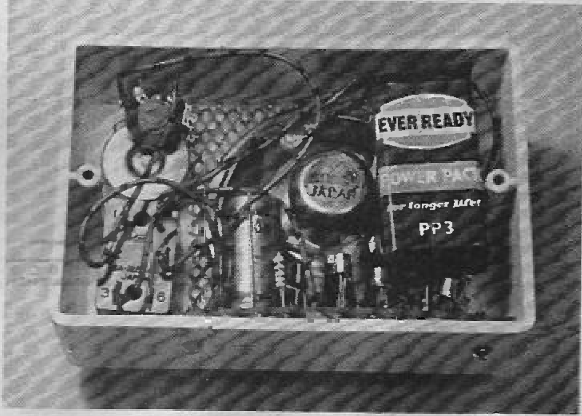
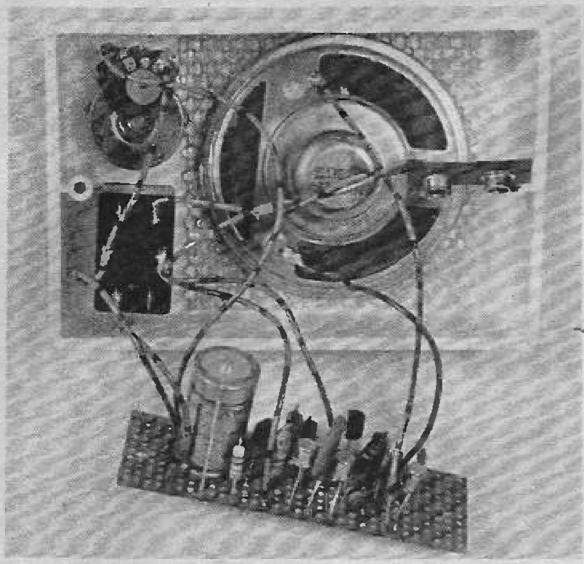


Fig. 4. The completed unit with lid removed.

No battery bracket is detailed as this was found unnecessary; a piece of foam rubber below and above the battery will hold it securely in position when the lid is screwed on.

ADJUSTMENT AND CALIBRATION

The only adjustment required is that of VR1. This should be set with the slider half way around the track at the outset; VR2 is adjusted



Photograph of the completed unit with battery and board removed.

for minimum resistance (turned fully anti-clockwise), and the unit is turned on.

If it is functioning correctly, after about two minutes the alarm will sound. The exact time taken should be monitored. If it takes less than two minutes, the resistance of VR1 must be increased, and if it takes more than two minutes, the resistance of VR1 must be decreased. The process should then be repeated until it takes two minutes (plus or minus a few seconds) for the alarm to sound, from when the timer is turned on.

It is then necessary to calibrate a scale around the control knob of VR2. The two minute has already been found, and now every half minute point up to five minutes must be found, by trial, and error. This is a lengthy business, but there is unfortunately no short cut to this. ▣

Ruminations
By Sensor

A Woman's Work

I suppose that those people unacquainted with the electronics industry tend, when thinking of it, to give it a masculine image—serious looking men with slide rules in their top pocket, scribbling abstruse calculations and speaking to each other in a near incomprehensible jargon. But, while men like these undoubtedly exist, for they are the visionaries and the innovators without whom the industry would soon stagnate, women dominate the scene to a remarkable extent.

In some branches of the industry women make up 95 per cent of the workforce and their jobs range from assembly work (of all degrees of complexity) through planning, drawing office, laboratories and inspection and testing right through to senior management level.

Women, of course, also occupy the secretarial and clerical positions. I knew two young women who gave up secretarial jobs in order to work on the bench, both felt that bench work was much more satisfying than their former jobs and enabled them to employ themselves creatively. Although working conditions were not as good, and the hours worked a little longer than those they enjoyed formerly, they had no regrets about their change of occupation.

As You Like It

I once asked a woman who was doing a minor repetition job, how she could do the same thing day after day without becoming bored beyond endurance. She replied that she enjoyed the work because it left her mind free to think of other things! I have since found this to be a useful way of approaching one's own chores. We all have boring work to do at times, and if we let our hands work automatically we can daydream, think or plan to our hearts content; thus viewed, a monotonous task can be a welcome respite from more demanding employment.

Many of the jobs done by women in the electronics and electrical industries are very demanding indeed and require a high degree of skill. I am thinking, particularly, of some of the soldering work such as soldering the "hair" springs on to a microammeter—a steady hand and a good eye together with a great deal of patience, are essential; I know—I've tried it myself.

Look around your home and you will see the work of our womenfolk—the electricity meter, the light bulbs and electrical fittings, even the wire that connects them together, the T.V., radio and all the domestic appliances were built or made almost entirely by women. And when you reach for the telephone you are touching a woman's work again.

SEMICONDUCTOR PRIMER

By A. P. STEPHENSON

11■ IMPORTANT TRANSISTOR CURVES

Graphs showing the effect of base current and collector voltage on the collector current.

Although collector current is very sensitive to base current, it is hardly affected by collector *voltage*. The graphs in Figs. 11.1 and 11.2 illustrate.

Note

If base current is increased, the collector current also increases by a much *greater* amount.

The ratio $\left(\dfrac{\text{base current}}{\text{collector current}}\right)$ is called the **forward current gain** h_{FE}. In Fig. 11.1, for example, $h_{FE} = 100$.

Note

Unlike the base, the collector voltage is unable to change the collector current by any appreciable amount (except for very low voltages).

As far as collector voltage is concerned, the transistor behaves almost as a **constant current** device see Fig 11.2.

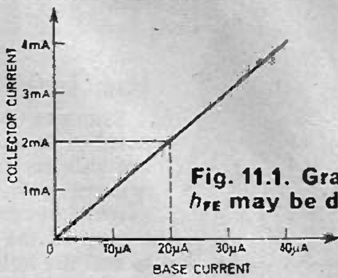


Fig. 11.1. Graph from which h_{FE} may be determined.

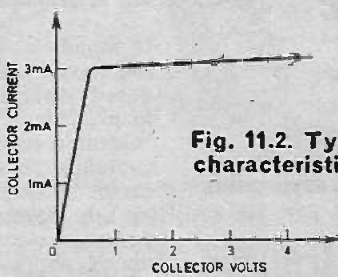


Fig. 11.2. Typical collector characteristics.

12■ BC107, BC108, BC109 TRANSISTORS

These form a useful trio for general audio or video circuitry and have the advantage of cheapness (about 10p each) and easy availability in almost any district.

They are silicon *npn*, planar epitaxial transistors encased in TO-18 form. **BC107** is a higher voltage version, quite suitable as a driver for audio output stages.

BC108 is a general purpose "dogsbody".

BC109 is a low noise version, particularly suitable as an input stage for low level signals.

For military use, they arrive disguised as:

CV 0374882	CV 0375395	CV 0375627
(BC107)	(BC108)	(BC109)

BRIEF SPECIFICATION

PARAMETER	BC107	BC108	BC109	UNITS
$V_{CE\ max}$.	50	30	30	V
$I_{C\ max}$.	200	200	200	mA
Power dissipation max at $<25°C$	300	300	300	mW
$T_{J\ max}$.	175	175	175	deg. C
h_{FE}(at $I_C = 10\mu A$, $V_{CE} = 5V$) (at $I_C = 2mA$, $V_{CE} = 5V$)	90 180	150 300	270 500	typical
h_{fe} (at $I_C = 2mA$, $V_{CE} = 5V$) measured at 1kHz	125 500	125 500	240 900	minimum maximum
f_T (at $I_C = 10mA$, $V_{CE} = 5V$)	300	300	300	MHz
V_{CE} saturation voltage when $\dfrac{I_B}{I_C} = 20$	300	300	300	mV
NOISE at $I_C = 200\mu A$, $R_s = 2k\Omega$ (max) at 1kHz B = 200Hz	10	10	4	dB

Interference

I want to fit a radio in my car. How do I go about suppressing the engine?

The main sources of interference are from the sparking plugs, the generator brushes and the coil. To overcome the loud clicking type of interference from the plugs you must suppress the leads from the distributor to the plugs. Modern cars are usually fitted with carbon leads that are already suppressed and in those cases you need not worry (in fact you will degrade your engine's performance if you try to insert suppressors). You can buy plug suppressors which are in the shape of plug caps; these screw into the cables running from the distributor—all they consist of are high value resistors that go in series with the normal plug lead.

To cure coil interference—which again is a clicking noise—connect a $0 \cdot 1\mu F$ capacitor between the coil's connection to the contact breaker and ground (the car's chassis). Noise from the generator is a loud whine that rises and falls in pitch as you rev the engine. Again connect a $0 \cdot 1\mu F$ capacitor between the generator's main output connection and ground—the main connection of the generator is usually the larger terminal. Do not connect the capacitor between the field coil terminal and ground.

Should interference still persist tighten up the battery connections, check the aerial is properly fitted to the radio and make sure the aerial lead's screening is well connected to the car's chassis at the aerial end. Worn cut-out contacts can produce spurious interference which is difficult to identify. The $0 \cdot 1\mu F$ capacitors we mention can be purchased from any auto spares shop and usually have the correct sized terminals to make fitting easy.

Hum Loop

Someone told me it is good practice to earth a hi fi system—not only for safety reasons but to remove hum. My amplifier was earthed but I had a bit of hum so I earthed the record player only to find the hum got worse. Is there any logical reason for this?

It sounds as though by earthing the record player you have introduced what is called "an earth loop". This is very easy to do and is often a very bad source of hum. Certainly your system should be earthed, but the connection back to the main earthing point (in your case we suspect this was the mains plug) should be by one route only. By connecting separate earths (a) from the amplifier and (b) from the turntable unit to separate (?) mains plugs you form an inductive loop (from the mains earth through the chassis of your amplifier, down the coaxial screening, through the chassis of your turntable and back to mains ground).

If you are unfortunate and have a transformer or similar inductor in the system carrying 50Hz mains the earth loop will pick up currents by induction from the source and this signal is superimposed on your pick up signal giving rise to the worsening hum. It is better to earth the amplifier and make sure that the screening of your pick up cable is grounded to the amplifier's chassis at one end and to the turntable unit's chassis at the other. This way the whole system is earthed but you do not introduce any loops.

Battery Leakage

My electronic flash gun runs off dry batteries and unfortunately these leaked and made a mess inside. However I cleaned out the battery compartment but it still won't work. Could the material from the batteries have caused any problem or is it more likely to be something else?

Almost certainly the material from the battery is the cause of the malfunction. You must check the circuitry inside the gun and remove all traces of the paste. It can cause leakage across capacitors, bridge gaps in printed circuit boards and worse still will actually dissolve the copper from circuit boards. If you see green deposits on the copper wiring of the circuit you can bet that the last has occurred and you may have to do a bit of re-wiring.

If you do attempt to have a go yourself *be warned;* very high voltages at high currents are present in electronic flash guns—do not be deceived by the small batteries! So, be careful if you test it out when it is not in its case; in particular do not touch the terminals of the main capacitor unless you have discharged it first with an insulated handled screwdriver!

Transistor Selection

Your instructional articles always make the operation of a transistor seem very simple and it seems that the only parameter of importance is the h_{fe}. Is this true, and if so why are there so many different types?

It is true that h_{fe} is a very important parameter but there are other obvious ones that are just as critical. There are also a few less obvious ones. One has to consider the reverse breakdown voltage across the base/collector and base/emitter junctions—V_{cbo} and V_{ebo}; also the breakdown voltage between collector and emitter (V_{ceo}). There is always a limit to the collector current you can draw through the device before it fuses internally (I_{cmax}).

A transistor cannot dissipate unlimited power without overheating. Too high an operating temperature changes the base emitter forward voltage drop and this effects the biasing conditions. There is thus a complicated link between power dissipation and operating characteristic—apart from the obvious effect of excessive dissipation melting connections inside the device and ruining it.

Maximum power dissipation

(P_{tot}) has to be specified for a certain temperature differential between the device and its surroundings and whether or not the transistor is on a heat sink. Some not so obvious parameters are that the h_{fe} of a transistor varies depending on the level of collector current: a high collector current causes noise generation inside the device (when amplified it sounds like background hiss) and this is undesirable in the front stages of hi fi amplifiers—some transistors are specially selected to have low noise.

The diode capacities of reverse biased junctions in the transistor *can* influence high frequency circuits and must be allowed for in circuit calculations as must any internal resistance the transistor might have.

Transistors are designed, manufactured and selected to meet permutations on all these parameters (plus a few more) so you can see why there is such a vast number of different types—apart from obvious differences like silicon/germanium, or *pnp/npn*.

Wire Size

When winding coils (e.g. aerial rods or suppression inductors) I can see it is desirable to keep to the right number of turns—this, presumably, sets the inductance —but is the wire thickness important because you usually specify an s.w.g. number?

There are some instances where wire thickness is not important but as a general rule we suggest you stick to recommendations. The coil might be carrying high current (suppressors) and unless the wire is heavy enough it might overheat. In the case of aerial rods, the length of the coil around the rod might be an important factor in setting the inductance (as might be the spacing between turns); changing the wire gauge might affect these.

At high frequencies (short waves) one should always use thicker wire because the a.c. currents only flow along the outer edges of the conductor (skin effect) and to avoid excessive internal d.c. resistance (which reduces the efficiency or "Q" of a tuned circuit) you need as large an outer circumference as possible. Sometimes multistrand (Litz) wire might be specified for the same reason. When winding bobbins for high value inductors it may not be possible to get sufficient turns on if you use a heavier gauge.

Microphony

I have quite a good quality amplifier with a microphone input. If I connect a crystal microphone to this input (which is supposed to be matched for a high impedance input) I get very good reproduction but when I kick the microphone cable I get a "clunking" noise in the loudspeaker. This is not due to pick up in the microphone as I have done this with a very long extension cable—it even happens with no microphone connected to the end! I am using coaxial cable so I cannot see what can possibly be causing the trouble which, while not disastrous, is a bit of a nuisance.

This effect is quite common—particularly with high input impedance amplifiers fed from a predominately capacitive source (such as a crystal microphone). The cause is the capacitance between the central core and the screening of the cable you are using. When you kick the cable, or bend it quickly, you can change the spacing between the core and the screen by a small amount (due to the deformation of the insulating sleeve between them). This change in spacing gives a rise to a very small change in the cable's capacitance.

If there is any standing potential on the core a minute current will flow into, or out of this localised change in capacity. This current is amplified by your system and gives rise to the "clunk" you can hear. We say the cable is *microphonic*. There are two solutions. The first is to ensure that the cable contains twin conductors one of which is connected to the outer screeuing at both ends.

A more expensive way—which will give you better results with a crystal microphone—is to make a microphone pre-amplifier that will reduce the output impedance of the microphone. This should be connected into the circuit as close to the microphone as possible—you can then use much longer cables without affecting the low frequency response and use the low impedance input of your main amplifier.

DOWN TO EARTH

By GEORGE HYLTON

"Is there any simple way of telling how impedance varies with frequency?"

No, there isn't. There seems to be a lot of confusion about the meaning of "impedance". Some people seem to think that impedance must imply a circuit with capacitance or inductance in it—it ain't necessarily so.

A square is a rectangle but all rectangles aren't square. A circuit which offers impedance *may* contain capacitance or inductance, but it *could* contain just resistance, and nothing else.

IMPEDANCE

Impedance is a *general* term, which includes resistance, inductive reactance, capacitive reactance, or any combination of these. Impedance, in a.c. circuits, is like resistance in d.c. ones. It describes the ability of a circuit to impede the flow of current, irrespective of what is doing the impeding.

A 100 ohm resistor has an impedance of 100 ohms. In this case, the impedance doesn't vary with frequency. But a 1μF capacitor has an impedance which decreases as the frequency increases, while a 1 henry inductor has an impedance which increases with frequency. But place this inductor and capacitor in series and you find that the impedance of the combination varies with frequency in an unexpected way.

At low frequencies it's high. At high frequencies it's high. But at about 160Hz it is very low. Place the same two components in parallel, and the combined impedance is low at all frequencies except near 160Hz, when it becomes very high. Impedance can be very puzzling.

REACTANCE

What some people mean by "impedance" is the special kind which should be called reactance, that is, the impedance of a capacitor or an inductor. These impedances vary with frequency, and although measured in ohms are really rather special quantities. They have a sort of polarity; if you think of inductive reactance as positive then capacitive reactance is negative. This explains the strange behaviour of the series and parallel *LC* circuits.

SERIES AND PARALLEL

The starting point for this understanding is a knowledge of the net resistance of two resistances in series and parallel:

Series combination $R = R1 + R2$

Parallel combination $R = R1R2/(R1 + R2)$

The rules for two impedances Z1 and Z2 are the same:

Series combination $= Z1 + Z2$

Parallel combination $= Z1Z2/(Z1 + Z2)$

On the face of things, this doesn't seem to cast any light on *LC* circuits and their resonant frequencies. But that's because we haven't put the signs in. If Z1 is an inductive reactance, and Z2 a capacitive reactance, then to allow for the "polarity" if we put Z1 for inductive reactance we must put $-Z2$ for capacitive reactance.

Thus the series *LC* circuit has an impedance of $Z1 - Z2$, and it's obvious that if Z1 and Z2 each have the same number of ohms, as they must have at one special frequency, then the combination has an impedance of zero.

The parallel combination becomes a fraction with $-Z1Z2$ at the top and $Z1 - Z2$ at the bottom, and if $Z1 - Z2 = 0$ the combination is something divided by zero. As any mathematician will tell you, the result of dividing any number by zero is an infinitely large number. Hence the very high impedance of the parallel *LC* circuit at its resonant frequency.

OPERATOR "j"

There's just one snag. The simple "positive inductive, negative capacitive" approach gives the parallel-resonant *LC* circuit a *negative* impedance. Measurement shows that this is not so. At resonance, the impedance is just a high *resistance*. So the simple "positive-negative" approach isn't the whole story. In order to make the maths correspond with reality, mathematicians play a trick. They call the inductive reactance jZ1 and the capacitive reactance $-jZ2$.

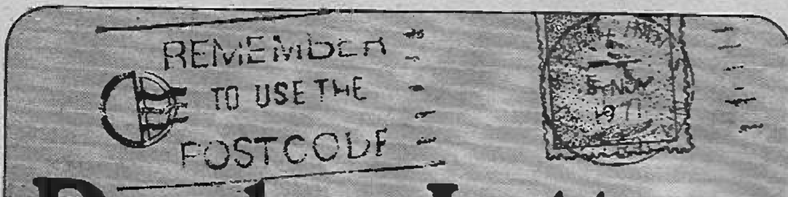
The series *LC* circuit is now $jZ1 - jZ2 = j(Z1 - Z2)$ which is zero, as before, when $Z1 = Z2$, since $j \times 0 = 0$. The parallel *LC* circuit becomes:

$$\frac{(jZ1) \times (-jZ2)}{jZ1 - jZ2} = \frac{-j^2 Z1Z2}{j(Z1 - Z2)}$$

and when $Z1 = Z2$, this becomes $-j^2Z1Z2/0$, which is infinity times $-j^2$. Now comes the clever bit. Let $-j^2 = 1$. So infinity times $-j^2$ becomes infinity times 1, or just plain infinity.

That embarrassing negative sign has disappeared. The "j" is called an "operator", which is a mathematical name for something you invent to make it possible to get your sums right, and which obligingly disappears from the scene when you've finished.

"He constructed a device, fixed it to the lock and opened the door —I knew we shouldn't have let him subscribe to EVERYDAY ELECTRONICS*!"*



Readers Letters

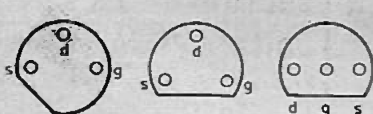
F.E.T. Connections

With reference to your January '74 EVERYDAY ELECTRONICS *Fetset* I must point out that I have just spent two hours trying to sort out why the diagram given for the field effect transistor differs from the actual component I received.

As a beginner in this field perhaps you may be able to help me know the difference between the three connections of any transistor. I hope you can find time to explain.

J. Waterhouse,
Lancs.

Various transistors have different leadout configurations and the only way to find these is to consult the published data. Some transistors are made with more than one leadout configuration and usually a suffix letter is added to the number to denote the different construction. Three different connections for the f.e.t. are shown below.



Malaysian Praise

I have been a regular reader of your fabulous magazine since I started reading it in January '73. I must say that it is both instructive and educational.

My enthusiasm in electronics grew with the regular reading of your magazine and I am sure many of my fellow Malaysian readers are finding your mag. just as interesting.

I have built some of your projects e.g. the *General Purpose Amplifier, Egg Timer, Waa Waa* unit etc, and they all worked wonderfully. My compliments to you and your staff!

Poon Chee Seng,
Malaysia

Reactance

I am a regular reader of EVERYDAY ELECTRONICS. There has been a slight error in the print of your April issue.

It is in the article *Demo Circuits* by Mike Hughes. The equation for inductive reactance is $X_L = 2\pi fL$ and that of capacitive reactance is $X_C = \frac{1}{2\pi fC}$ but instead you had the equation for capacitive reactance below inductive reactance and that for inductive reactance below capacitive reactance.

This, I think is a bit misleading for beginners, as your magazine is primarily intended for beginners in electronics.

To conclude I would like to say that it is one of the most interesting informative magazines that I have come across. I appreciate the wonderful service and knowledge we derive from it.

Y. Bayat,
London.

Somehow the two equations have been transposed. The equations are correct but appear under the wrong headings. We are sorry about this.

Electronics Club

I thought I would write and tell you about our school electronics club. I am in the third year at Kirkcaldy High School.

In the senior school there is an electronics club which meets every Monday, Tuesday and Thursday. The club supply us with resistors, capacitors, solder, soldering irons, p.c. board etc., for our projects. We have to pay for some components such as semiconductors, transformers and IC's which the club has not got in stock.

We read your magazine and enjoy building the projects you print, so we hope you will keep us supplied.

G. Wilson,
Fife.

We will certainly keep the supply of constructional projects flowing—there are four in this issue.

What do you know?

CAPACITORS

1. Calculate the total value of the following capacitors wired in series:—0·1μF, 0·02μF and 0·47μF.
2. Calculate the total value of the following capacitors wired in parallel:—0·001μF, 0·05μF and 0·0047μF.
3. You have a "flat" type capacitor with coloured bands around it. The colours are brown, black, orange, black, red, this is reading from the top (away from the leads) to bottom. State the value of the capacitor, its tolerance and voltage.
4. Is it necessary to always use an exact value electrolytic e.g. if 8μF is quoted could a 10μF normally be used and if so why?

ANSWERS

1. $\frac{1}{C_t} = \frac{1}{0{\cdot}1} + \frac{1}{0{\cdot}02} + \frac{1}{0{\cdot}47}\mu F$

$C_t = \frac{1}{62{\cdot}13} = 0{\cdot}016\mu F$

2. $C_t = 0{\cdot}001 + 0{\cdot}05 + 0{\cdot}0047 = 0{\cdot}0557\mu F$.
3. The value is 10,000pF ∓ 20% at 250V.
4. Most electrolytic capacitors have a tolerance of −20% +100%. Therefore the circuit must be able to cope with a large range of values and it is normally permissible to use a capacitor of slightly higher value.

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CH3. 7·5mH 25p CH4. 10mH 25p
CH5. 1·5mH 25p

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BA6	3"	×	2"	×	1"	34p
BA7	7"	×	5"	×	2½"	66p
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BA9	6"	×	4"	×	2"	54p

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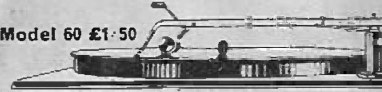

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C 8	10	Reed Switches	0·55
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PS 41	Jack ¼" Switched	0·17
PS 42	Jack Stereo Switched	0·28
PS 43	Phono Single	0·06
PS 44	Phono Double	0·10
PS 45	Car Aerial	0·09
PS 46	Co-Axial Surface	0·09
PS 47	Co-Axial Flush	0·14

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PS 23	D.I.N. 5 Pin 180°	0·17
PS 24	D.I.N. 5 Pin 240°	0·17
PS 25	Jack 2·5mm Plastic	0·10
PS 26	Jack 3·5mm Plastic	0·12
PS 27	Jack ¼" Plastic	0·24
PS 28	Jack ¼" Screened	0·28
PS 29	Jack Stereo Plastic	0·22
PS 30	Jack Stereo Screened	0·32
PS 31	Phono Screened	0·14
PS 32	Car Aerial	0·15
PS 33	Co-Axial	0·17

PLUGS

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PS 2	D.I.N. 3 Pin	0·12
PS 3	D.I.N. 4 Pin	0·15
PS 4	D.I.N. 5 Pin 180°	0·14
PS 5	D.I.N. 5 Pin 240°	0·15
PS 6	D.I.N. 6 Pin	0·15
PS 7	S.I.N. 7 Pin	0·16
PS 8	Jack 2·5mm Screened	0·10
PS 9	Jack 3·5mm Plastic	0·09
PS 10	Jack 3·5mm Screened	0·12
PS 11	Jack ¼" Plastic	0·13
PS 12	Jack ¼" Screened	0·18
PS 13	Jack Stereo Screened	0·29
PS 14	Phono	0·06
PS 15	Car Aerial	0·15
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MT50/1	1	£2·42	35p
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ACOS GP96-1. 100mV at 1cm/sec £2·65
TTC J-2005. Crystal/Hi Output 95p
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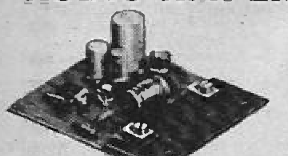
AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f=1KHz	0·25%
LOAD IMPEDANCE	—	8 – 16 Ω
INPUT IMPEDANCE	f – 1KHz	100 k Ω
FREQUENCY RESPONSE Œ 3dB	Po – 2 WATTS	50 Hz – 25KHz
SENSITIVITY for RATED O/P	Vs = 25V. Rl = 8 Ω f – 1KHz	75mV. RMS
DIMENSIONS	—	3" × 2½" × 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (RL = 8 Ω f = 1 KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL 10. 3 watts RMS £2·19
AL 20. 5 watts RMS £2·59
AL 30. 10 watts RMS £3·01

POWER SUPPLIES

PS 12. (Use with AL10 & AL20) 88p
SPM 80. (Use with also AL30 & AL50) £3·25
FRONT PANELS SP 12 with Knobs £1·10

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20) £4·35
PA 100. (Use with AL30 & AL50) £13·15

TRANSFORMERS

T461 (Use with AL10) £1·38 P & P 15p
T538 (Use with AL20) £1·93 P & P 15p
BMT80 (Use with AL30 & AL50) £2·15 P & P 25p

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA 12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 84mm × 35mm.

Frequency response— 20Hz – 50KHz (–3dB)
Bass control— ± 12dB at 60Hz
Treble control— ± 14dB at 14KHz
*Input 1. Impedance 1 Meg. ohm
Sensitivity 300mV
†Input 2. Impedance 30 K ohms
Sensitivity 4mV

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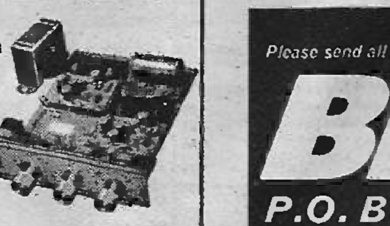
The STEREO 20



The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls, Transformer, Power supply and Power amps. 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. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ± 12dB at 60Hz typically 0·25% at 1 watt. Treble con. ± 14dB at 14kHz.

£14·45

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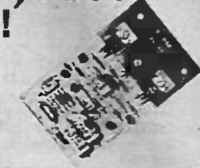
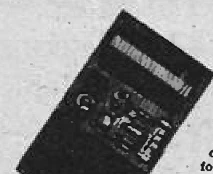


- Max Heat Sink temp. 90°c.
- Frequency Response 20Hz to 100KHz
- 0·1% Distortion
- Distortion better than 1% at 1KHz
- Supply voltage 10-35 volts
- Thermal Feedback
- Latest Design Improvements
- Load—3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm × 105mm × 13mm

Especially designed to a strict specification. Only the finest components have been used and the latest solid state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F enthusiast.

STABILISED POWER MODULE SPM80



AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address Intercom Units, etc. Handbook available 10p **PRICE £3·25**

TRANSFORMER BMT80 £2·15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

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

SPECIFICATION

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

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

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

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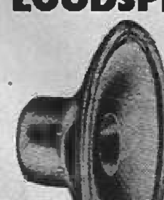

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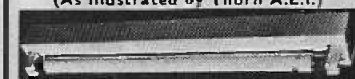

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