R. BATES

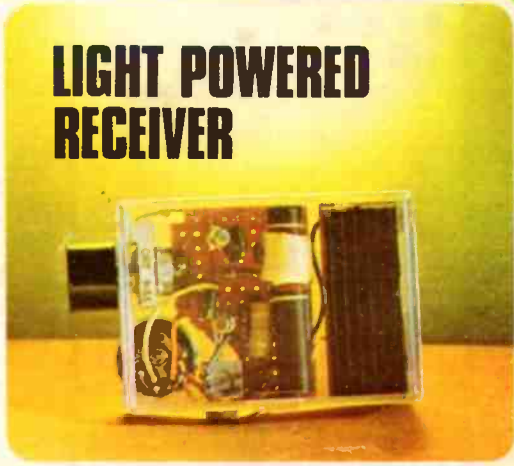
An exciting hobby.... for everyone

everyday electronics

APRIL 74
20p

SPECIAL THIS MONTH —
Pull-out Feature...
TEST GEAR

LIGHT POWERED RECEIVER



...*keep tuned up with*
Transistor Assisted Ignition

e e
TEST GEAR FIVE

3rd INSTRUMENT
Electronic Voltmeter

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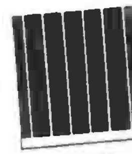
HOME RADIO (Components) LTD., Dept. EE, 234-240 London Road, Mitcham, CR4 3HD. Phone 01-648 8422

A SELECTION of the more unusual items from the famous HOME RADIO (Components) CATALOGUE...

LIGHT SENSITIVE DEVICES — SILICON PHOTO-VOLTAIC CELL



SD103

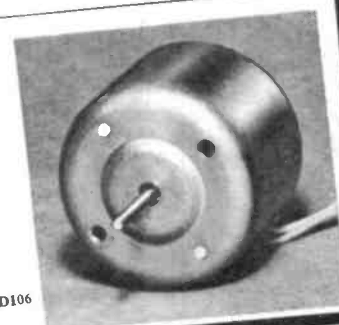
Maker: FERRANTI

These cells were developed for the space programme. They may be used to power transistorised radios, small electric motors or operate light meters. For example, they will generate enough current to operate our SD104, SD10 5and SD106 motors when exposed to 100 watt lamp. Although we give an output current and voltage these are nominal and taken in strong sunlight. The voltage will vary with the amount of current being consumed.

Cat. No.	*Maker's No.*	*Maker*	*Volts*	*mA*	*Size*
SD103	FRB150	Ferranti	1·1v	100	¾ × ¾ × ·012 in. (19 × 19 × ·3 mm.)

PRICE (Including VAT and Postage) £1.89

SMALL ELECTRIC MOTORS



SD106

Cat. No.	*Maker's No.*	*Size Dia. Length*	*Voltage*
SD106	M5	33 × 28 mm.	6 V

Note: The SD106 will run off 2 of our SD103 Photo Voltaic silicon cells connected in series if illuminated by sunshine or 100 watt lamp at 1 ft.

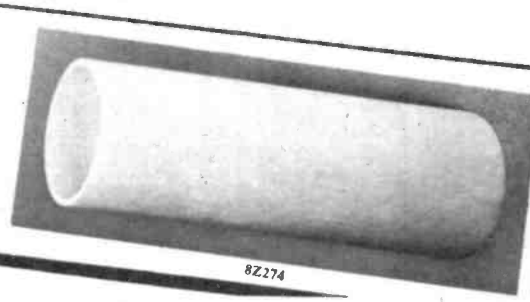
PRICE (Including VAT and Postage). £2.84

SILICON GLASS TUBING

This tubing will withstand temperatures up to 250°C.

Cat. No.	*Maker's No.*	*Length*	*Outside Dia.*
8Z274	LTG54	6 in. (152 mm.)	2 in. (51 mm.)

PRICE (Including VAT and Postage) £2.54



8Z274

When purchasing any of the above items, please state "As per your advertisement".

It goes without saying that our catalogue lists in profusion run-of-the-mill goods like Resistors, Capacitors, Pots and Coils, so we would like to bring to your notice one or two of the more exotic items. Take the first one . . . the SD103 cell. Apartfrom its rarity, it's very useful. Recently we built a little 3-transistor radio with loudspeakers, and we found that three of these cells would operate it. Regarding the mini motor and the silicon glass tubing, your ingenuity will immediately suggest ways in which you can make good use of them. These are but 3 of *millions* (all right then—*thousands*) of exciting components in our catalogue.

By now you are reaching for your pen and cheque book, but don't just buy the items shown here; get the catalogue and feast your eyes on all 240 pages. At 77 pence it's almost a gift—especially as by using the vouchers as directed you can reclaim 50p.

POST THIS COUPON
with cheque or P.O. for 77p.

The price of 77p applies only to customers in the U.K. and to BFPO addresses

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Henry's

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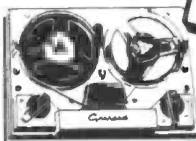
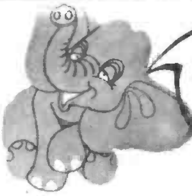
Hi Fi and Transistors – Up to date Brochures on request

HENRY'S CATALOGUE
Due to rapid price changes, shortages of paper and raw materials, all prices in the existing catalogues no longer apply. Call or phone for latest prices. A new catalogue will be available for Aug/Sept. 1974.



UK's LARGEST RANGE OF KITS & GADGETS



TEST EQUIPMENT

MULTIMETERS

(carr. etc. 30p)

ITI-2	20K/V Slimline	5·95
M210 (Case £1·25)	20K/Volt Slimline de-luxe	8·75
TLH33D	2K/Volt Robust	7·50
U437	10K/Volt Steel case. AC up to 40 KHz	4·95
U4324	20K/Volt with AC current ranges	8·00
AF105 (Case £1·90)	50K/Volt	11·95
U4313	20K/Volt AC current. Steel case	10·50
U4341	Plus Built in transistor tester	10·50
Model 500 (Case £1·95)	30K/Volt	9·95

OTHER EQUIPMENT

SE250B	Pocket Signal Injector	2·10 carr. 15p
SE500	Pocket Signal Tracer	1·70 carr. 15p
TE15	Grid Dip meter 440kHz–280mHz	15·00 carr. 30p
TE40	AC Millivoltmeter 1·2mHz	19·75 carr. 35p
TE65	28 Range valve voltmeter	22·50 carr. 40p
TE20D	120kHz–500mHz RF Generator	18·95 carr. 40p
TE22D	20Hz–200kHz Audio Generator	19·95 carr. 40p
SE350A	Deluxe Signal Tracer	12·50 carr. 20p
SE400	Volts/ohms/R-C sub./ -RF field/RF gen.	14·75 carr. 20p

New Revolutionary Supertester 680R

680R Multi-tester £18·50

Accessories	
Transistor tester	11·00
Electronic voltmeter	18·00
Ampclamp	11·95
Temperature probe	11·95
Guass meter	11·95
Signal Injector	5·95
Phase Sequence	5·95
EHT Probe	5·95
Shunts 25/50/100A	4·50

A SELECTION OF INTERESTING ITEMS

C3025	Compact transistor tester	6·95 p & p 15p
Q4002	Photoelectric System	£13·70
E1310	Stereo mag. cart. preamp.	4·80 p & p 25p
Easiphone D1201	telephone amplifier	7·50 p & p 25p
D1203	Teleamp. with PU coil	4·95 p & p 20p
LL1	Door Intercomm. and chime	8·40 p & p 25p
1 Kw Dimmer/controller		3·00 p & p 10p
9" Twin spring unit	For	3·30 p & p 15p
16" Twin spring unit	Reverbs	6·65 p & p 25p
US50 Ultrasonic Switch Transmitter/Receiver		£12·75
VHF 105 Aircraft Band Convertor		4·50 p & p 15p
B2005 4 Ch. mic. mixer		4·20 p & p 15p
B2004 2 ch. Stereo mixer		6·75 p & p 15p
PK3 Kit. Etch your own printed circuits		£1·95 p & p 20p
C3041 1-250 MHz		£4·25
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EXCLUSIVE: SPECIAL OFFERS

MW/LW CAR RADIO
+ or – Earth with speaker and fixings. £6·50 carr./packg. 30p.

8 TRACK CAR STEREO
(– Earth) with speakers in Pods & fixings. £12·50 carr/packg. 40p.

Portable Battery Cassette Tape Player £7·25.
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RH630 £4·50
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Rotel RA310 15+15 watt Stereo Amplifier (List £52·00) £34·52.

Wein W500 Battery/Mains Cassette Recorder £12·75

AKAI GXC40
Stereo cassette recorder. £59·95 carr/packg. 50p.
Pair Akai ADM microphones. £6·95 carr/packg. 20p.

PORTABLE CASSETTE TAPE PLAYER—
for car or carry around. £7·25 carr/packg. 20p.

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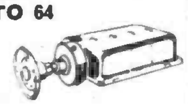
MAINS UNIT for BC808, BC811M £2·85 (state model)

HANIMAX H101 STEREO COMPACT RECORD PLAYER 2 x 7 watts
Complete with Speakers (List £54·50) Price £39·95 Plus free pair of stereo phones.

SPECIAL PURCHASES

UHF TV TUNERS CHANNELS 21 TO 64

Brand new transistorised geared tuners for 625 Line Receiver IF output. £2·50. Post 20p.



EASY TO BUILD KITS BY AMTRON— EVERYTHING SUPPLIED

Model No.		
310	Radio control receiver	2·98
300	4-channel R/C transmitter	5·95
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455	AM signal generator	12·33
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115	8 watt Amplifier	3·90
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125	Stereo control unit	5·70
130	Mono control unit	3·80
605	Power supply for 115	4·55
610	Power supply for 120	4·55
615	Power supply for 2 x 120	5·73
230	AM/FM aerial amplifier	2·93
240	Auto packing light	5·90
275	Mic. preamplifier	6·08
570	LF generator 10Hz–1mHz	15·80
575	Sq. wave generator 20Hz–20Khz	14·60
590	SWR meter	12·85
620	NI-CAD Charger 1·2–12v	8·00
630	STAB Power supply 6-12v 0·25-0-1A	8·15
690	DC motor speed Gov.	2·87
700	Electronic Chaffinch	7·00
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760	Acoustic switch	10·75
780	Metal Detector (electronics only)	9·65
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835	Guitar preamp.	4·25
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875	CAP. Discharge ignition for car engine (–Ve Earth)	13·15
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670	Buffer Battery Charger	6·55
885	Capacitive Contact Alarm	6·25
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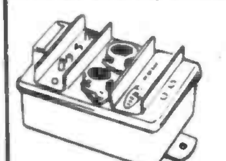
820	Electronic Digital Clock	58·50



ALL KITS OFFERED SUBJECT TO STOCK AVAILABILITY

Prices correct at time of preparation. Subject to change without notice.

BUILD THIS TUNER

MW/LW Radio Turner to use with any amplifier. Features Mullard RF/IF module Ferrite aerial, built in battery. Excellent results. Size 7" x 2½" x 3½". All parts £4·85, carr. 15p.

MULTI-USE & RADIONIC KITS

10–1	10 Projects	3·60
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X20	20 (Elec.) Projects	4·95
X40	40 (radio) Projects	9·45

(carr./packing 40p)

All transistor circuits with hand books

BUILD THIS RADIO

Portable MW / LW radio kit using Mullard RF/IF module. Features MW — bandspread for extra selectivity. Slow motion tuning. Fibre glass PVC cabinet. 600MW output. All parts £7·98 (battery 22p). carr. etc. 32p.

GARRARD BATTERY TAPE DECK

GARRARD 2 speed 9 volt tape decks. Fitted record/play and oscillator/Erase heads. Wind and rewind controls. Takes up to 4" spools. Brand new complete with head circuits.
£9·50 carr. 30p

TOP QUALITY SLIDER CONTROLS

60mm stroke high quality controls complete with knobs (post, etc. 15p any quantity).

Singles Log and Lin 5K, 10K, 22K, 50K, 100K, 250K, 500K, 1 Meg. 45p each.

Ganged Log and Lin 10K, 22K, 50K, 100K, 250K, 65p each. (Quantity discounts available)

Complete with knobs.

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4 TRACK MONO or 2 TRACK STEREO
'17' High Impedance £2·00
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Erase Heads for '17' and '18' 75p
'63' 2 track mono, Hi imp. £1·75
'43' Erase Head for '63' 75p
(Post, etc. 15p any quantity).

SINCLAIR, MINIATURE AMPLIFIERS & TUNER/DECODER

AMPLIFIERS (carr., etc. 20p)

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555, 3 watt 12 volt 4·10
E1208, 5 watt 12 volt 5·10
608, 10 watt 24 volt 4·95
410, 10 watt 28 volt 4·95
E1206, 30 watt 45 v. 9·95
E1210, 2½ + 2½ watts 12 volt 7·75
RE500, 5 watt IC mains operated Amplifier with controls 6·30
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Audio Filter Unit 6·95
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Z60 25 Watt Amp. 8·95
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PZ6 Mod. (S Tab) 1 on 2 Z40 7·98
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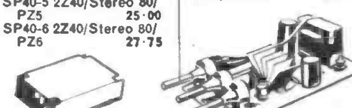
TRANSFORMER FOR PZ8 3·95
Project 605 Kit 19·95
Project 805 26·95



POWER SUPPLIES FOR EVERY PURPOSE

(All cased unless stated chassis)

470C 6/7½/9 volt 300 MA (Includes Multi-Adaptor for Tape Recorders, etc.)	2·15 post 20p
Car Lighter Voltage Adaptors 300mA (State voltage 6v, 7½v, 9v)	1·95 ea. post 25p
SC202 3/6/7½/9 volt 400mA	3·65 carr. 30p
HC244R Stabilised version	4·90 carr. 30p
P500 9 volt 500mA	3·20 post 20p
P11 24 volt 500mA (chassis)	2·90 post 20p
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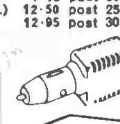
P12 4½–12 volt 0·4–1 amp	7·15 post 30p
SE101A 3/6/9/12 volt 1 amp (Stab.)	12·50 post 25p
RP164 6/7½/9/12 1 amp (Stab.)	12·95 post 30p

FIBRE OPTICS

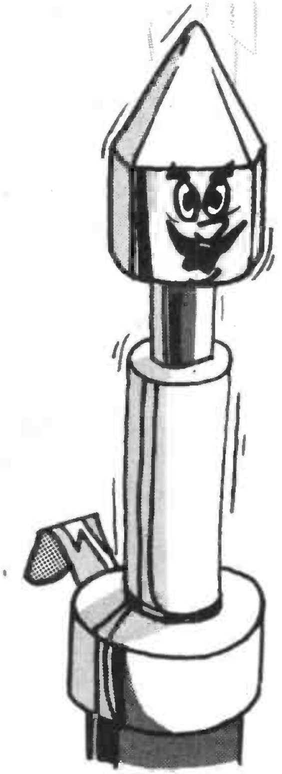
0·01 Diam. Mono Filament £3·00 per 50 metre reel
0·13 Diam. 64 Fibres Sheathed. £1·00 per metre
SPRAYS 15mm Diam. (Mares Tail Sprays £16·50 7mm. Diam. £5·00)



All types offered subject to availability. Prices correct at time of press E & OE. 10% VAT TO BE ADDED TO ALL ORDERS. UK post etc. 15p per order unless stated.

Henry's RADIO LIMITED
EDGWARE ROAD, W2

SEE FACING PAGE FOR ADDRESSES



The Hot-Head

You know his type...always blowing hot and cold... getting overheated just when you need him to be controlled and efficient. It's the same with some people's soldering irons.

Hopelessly inefficient heat control can make soldering operations a nightmare; if this is what soldering means to you it's time you woke up to Antex.

Choose a new model from the comprehensive Antex range of soldering instruments, with low-leakage characteristics, unique construction advantages and really precise heat control.

Choose ANTEX—the warm hearted iron (and keep your cool)

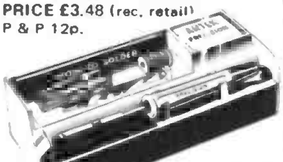
MODEL X25 ▶
220-240 Volts or 100-120 Volts. The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live". Tested at 1500v. A.C. This 25 watt iron with its truly remarkable heat-capacity will easily "out-solder" any conventionally made 40 and 60 watt soldering irons, due to its unique construction advantages. Fitted long-life iron-coated bit 1/8". 2 other bits available 3/32" and 3/16" Totally enclosed element ceramic and steel shaft. Bits do not "freeze" and can easily be removed.
PRICE £2.05
(rec. retail) P & P 10p.
Suitable for production work and as a general purpose iron.

MODEL G ▶
18 watt miniature iron, fitted with long-life iron-coated bit 3/32" Voltage 240, 220 or 110
2 other spare bits available 1/8" and 3/16"
PRICE £2.26 (rec. retail) P & P 10p.

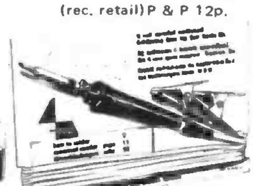
◀ MODEL CCN
220 volts or 240 volts.
The 15 watt miniature model CCN also has negligible leakage.
Test voltage 4000v. A.C.
Totally enclosed element in ceramic shaft.
Fitted long-life iron-coated bit 3/32".
4 other bits available 1/8", 3/16", 1/4" and 3/64" including Heat Shield.
PRICE £2.48 (rec. retail) P & P 10p.

◀ MODEL C
Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 3/64" to 3/16". Voltages 240, 220, 110, 50 or 24.
PRICE £2.05 (rec. retail) P & P 10p.

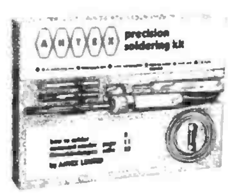
MODEL SK.1 KIT
Contains 15 watt miniature iron fitted with 3/16" bit. 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.
PRICE £3.48 (rec. retail) P & P 12p.



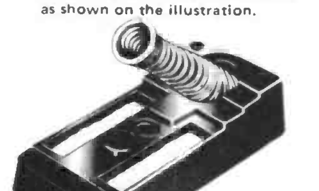
MODEL MLX KIT
Battery operated 12v. 25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet with booklet "How to Solder".
PRICE £2.54
(rec. retail) P & P 12p.



MODEL SK.2 KIT
Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32" heat sink, solder, and "How to Solder" booklet.
PRICE £3.25 (rec. retail) P & P 10p.



ST3 Stand — This stand is made from high grade insulation material with a chromium plated strong steel spring. It is suitable for all models and replaces all previous stands. The two sponges at the side which are easily replaceable serve to keep the soldering bits clean. Spare bits can be accommodated as shown on the illustration.



PRICE: £1.00
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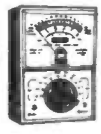
the DESIGN CENTRE

LASKYS

INCORPORATING LASKYS RADIO AND G. W. SMITH & CO. (RADIO).

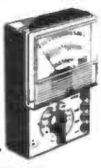
AUDIOTRONIC Model ATM1



Top value 1,000 opv pocket multimeter. 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

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 28mm.

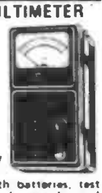
OUR PRICE £3.50 P&P 15p

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 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&P25p

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 +50dB.

OUR PRICE £5.95 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

MODEL TE300

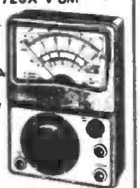
30,000opv. Mirror scale. Overload protection. 0/0.6/3/15 60/300/1200V DC. 0/6/30/120/600/1200V AC. 0/30uA 6mA/60mA/300mA 600mA. 0/8k/80k/800k/8 Meg ohms. –20 to +63dB.

OUR PRICE £7.50 P&P 15p

ALL PRICES EXCLUDE VAT

Also see following pages

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

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. Resistance: 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

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

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

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 360 MULTIMETER

High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale, overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC. 5/10/50/250/1000V AC. Current: 0.01mA/0.5/5/50/500mA/10A. Resistance: 0.1/1/10/100 ohms/1/10/100k ohms. 10/100M ohms. Decibels –20 to +62dB. Battery operated. Size 180 x 140 x 80mm. Supplied complete with test leads etc.

OUR PRICE £13.95 P&P 25p

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

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 £10.95 Carr. paid

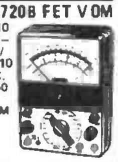
Leather case for above £1.75

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. Resistance: 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

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 £14.95 P&P 30p

370WTR MULTIMETER

Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/250/500/1000V DC 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: –20 to +62dB.

OUR PRICE £17.50 P&P 25p

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.

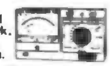
OUR PRICE £17.50 P&P 25p

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.

OUR PRICE £49.00 P&P 50p

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.

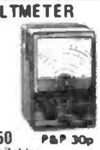
OUR PRICE £15.00 P&P 20p

Model HT100B4 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

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

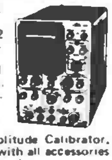
Additional probes available: RF £2.12. HV £2.50

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 ay 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

RUSSIAN CI16 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

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

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.

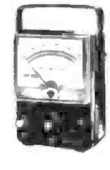
OUR PRICE £10.50 P&P 20p

LB3 TRANSISTOR TESTER

Tests ICO and B. PNP/NPN. Operates from 9V battery. Instructions supplied.

OUR PRICE £3.95 P&P 20p

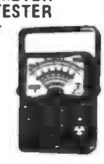
KAMODEN HM350 TRANSISTOR TESTER



High quality instrument to test reverse leak current and DC current. Amplification factor of NPN, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads carrying handle.

OUR PRICE £12.50 P&P 30p

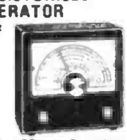
S100TR MULTIMETER TRANSISTOR TESTER



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

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.

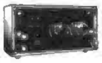
OUR PRICE £17.50 P&P 40p

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

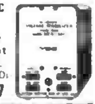
AT201 Decade ATTENUATOR



Frequency range 0–200kHz. Attenuator 0–111dB, 0.1dB steps. Impedence 600 ohms. Input power maximum 30dBm. Size: 180 x 90 x 55mm.

OUR PRICE £12.50 P&P 37p

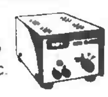
MCA220 Automatic Voltage Stabiliser



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

OUR PRICE £11.97

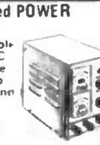
PS100B Regulated POWER SUPPLY UNIT



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.

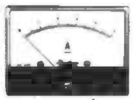
OUR PRICE £19.95 P&P25p

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.

CLEAR PLASTIC MODEL SD640
Size: 85 x 64mm



50uA	£3.35	20V DC	£3.20
100uA	£3.30	50V DC	£3.20
200uA	£3.30	300V DC	£3.20
500uA	£3.25	15V AC	£3.30
50-0-50uA	£3.35	300V AC	£3.30
100-0-100uA	£3.30	VU Meter	£3.45
1mA	£3.20		
5mA	£3.20		
10mA	£3.20		
50mA	£3.20		
100mA	£3.20		
500mA	£3.20		
1A DC	£3.20		
5A DC	£3.20		
10A DC	£3.20		
5V DC	£3.20		

CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm

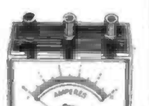
50uA	£4.55	300V AC	£4.00
100uA	£4.35	VU Meter	£4.75
500uA	£4.10		
50-0-50uA	£4.35		
100-0-100uA	£4.30		
1mA	£3.96		
1A DC	£3.95		
5A DC	£3.95		
20V DC	£3.95		
50V DC	£3.96		
300V DC	£3.95		

EDGWISE MODEL PE70
Size: 90 x 34mm

50uA	£4.15
100uA	£3.95
200uA	£3.75
500uA	£3.50
50-0-50uA	£3.95
100-0-100uA	£3.85
1mA	£3.50
300V AC	£3.50
VU Meter	£4.25

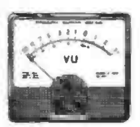
MODEL ED107 EDUCATIONAL METER
Size: 100 x 90 x 150mm including terminals

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	£7.60	300V DC	£6.55
100uA	£7.05	500mA/5A DC	£7.70
50-0-50uA	£7.05	5V/50V DC	£7.70
1A DC	£6.55	5V/15V DC	£7.70
5A DC	£6.55	1A/15A DC	£7.70
5V DC	£6.55		
10V DC	£6.55		
15V DC	£6.55		
20V DC	£6.55		
50V DC	£6.55		

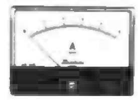
CLEAR PLASTIC MODEL 85P
Size: 120 x 110mm



50uA	£4.85	300V DC	£4.30
100uA	£4.70	15V AC	£4.35
200uA	£4.45	300V AC	£4.35
500uA	£4.30	S Meter 1mA	£4.30
50-0-50uA	£4.70	VU Meter	£5.00
100-0-100uA	£4.45	1A AC	* £4.30
500-0-500uA	£4.30	5A AC	* £4.30
1mA	£4.30	10A AC	* £4.30
1-0-1mA	£4.30	20A AC	* £4.30
5mA	£4.30	30A AC	* £4.30
10mA	£4.30		
50mA	£4.30		
100mA	£4.30		
500mA	£4.30		
1A DC	£4.30		
5A DC	£4.30		
15A DC	£4.30		
30A DC	£4.35		
10V DC	£4.30		
20V DC	£4.30		
50V DC	£4.30		
150V DC	£4.30		

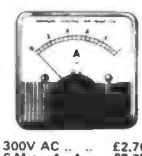
*Items with asterisk are Moving Iron type, all others are Moving Coil

CLEAR PLASTIC MODEL SD830
Size: 110 x 83mm



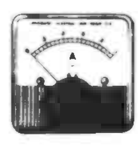
50uA	£3.75	10V DC	£3.40
100uA	£3.70	20V DC	£3.40
200uA	£3.65	50V DC	£3.40
500uA	£3.45	300V DC	£3.40
50-0-50uA	£3.75	15V AC	£3.65
100-0-100uA	£3.70	300V AC	£3.65
1mA	£3.40	VU Meter	£3.85
5mA	£3.40		
10mA	£3.40		
50mA	£3.40		
100mA	£3.40		
500mA	£3.40		
1A DC	£3.40		
5A DC	£3.40		
10A DC	£3.40		
5V DC	£3.40		

CLEAR PLASTIC MODEL 45P
Size: 50 x 50mm



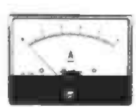
50uA	£3.00	300V AC	£2.70
100uA	£2.85	S Meter 1mA	£2.75
200uA	£2.75	VU Meter	£3.00
500uA	£2.70	1A AC	* £2.65
50-0-50uA	£2.90	5A AC	* £2.65
100-0-100uA	£2.75	10A AC	* £2.65
500-0-500uA	£2.65	20A AC	* £2.65
1mA	£2.65	30A AC	* £2.65
5mA	£2.65		
10mA	£2.65		
50mA	£2.65		
100mA	£2.65		
500mA	£2.65		
1A DC	£2.65		
5A DC	£2.65		
10V DC	£2.65		
20V DC	£2.65		
50V DC	£2.65		
300V DC	£2.65		
15V AC	£2.70		

CLEAR PLASTIC MODEL 38P
Size: 42 x 42mm



50uA	£2.80	15V DC	£2.50
100uA	£2.70	20V DC	£2.50
200uA	£2.65	50V DC	£2.50
500uA	£2.50	100V DC	£2.50
50-0-50uA	£2.75	150V DC	£2.50
100-0-100uA	£2.65	300V DC	£2.50
500-0-500uA	£2.50	500V DC	£2.50
1mA	£2.50	750V DC	£2.50
1-0-1mA	£2.50	15V AC	£2.55
2mA	£2.50	50V AC	£2.55
5mA	£2.50	150V AC	£2.55
10mA	£2.50	300V AC	£2.55
20mA	£2.50	500V AC	£2.55
50mA	£2.50	S Meter 1mA	£2.55
100mA	£2.50	VU Meter	£2.90
150mA	£2.50		
200mA	£2.50		
300mA	£2.50		
500mA	£2.50		
750mA	£2.50		
1A DC	£2.50		
2A DC	£2.50		
5A DC	£2.50		
10A DC	£2.50		
15A DC	£2.50		
20A DC	£2.50		
3V DC	£2.50		
10V DC	£2.50		

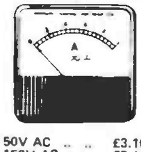
CLEAR PLASTIC MODEL SD460
Size: 59 x 46mm



50uA	£3.10	10V DC	£2.85
100uA	£3.05	50V DC	£2.85
200uA	£3.00	300V DC	£2.85
500uA	£2.80	15V AC	£3.00
50-0-50uA	£3.10	300V AC	£3.00
100-0-100uA	£3.05	VU Meter	£3.20
1mA	£2.85		
5mA	£2.85		
10mA	£2.85		
50mA	£2.85		
100mA	£2.85		
500mA	£2.85		
1A DC	£2.85		
5A DC	£2.85		
10A DC	£2.85		
5V DC	£2.85		

POSTAGE & PACKING 15p

CLEAR PLASTIC MODEL 65P
Size: 86 x 78mm

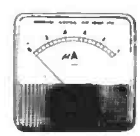


50uA	£4.10	50V AC	£3.10
100uA	£3.45	150V AC	£3.10
200uA	£3.35	300V AC	£3.10
500uA	£3.05	500V AC	£3.10
50-0-50uA	£3.45	S Meter 1mA	£3.15
100-0-100uA	£3.40	VU Meter	£4.10
500-0-500uA	£2.85	1A AC	* £2.85
1mA	£2.85	5A AC	* £2.85
5mA	£2.85	10A AC	* £2.85
10mA	£2.85	20A AC	* £2.85
50mA	£2.85	30A AC	* £2.85
100mA	£2.85	50mA AC	* £2.85
500mA	£2.85	100mA AC	* £2.85
1A DC	£2.85	200mA AC	* £2.85
5A DC	£2.85	500mA AC	* £2.85
10A DC	£2.85		
15A DC	£2.85		
20A DC	£2.85		
30A DC	£3.10		
50A DC	£3.20		
5V DC	£2.85		
10V DC	£2.85		
20V DC	£2.85		
50V DC	£2.85		
150V DC	£2.85		
300V DC	£2.85		
15V AC	£3.10		

BAKELITE MODEL S80 Enlarged Window
Size: 80 x 80mm

50uA	£3.85
100uA	£3.75
500uA	£3.35
50-0-50uA	£3.75
100-0-100uA	£3.65
1mA	£3.00
1A DC	£3.30
5A DC	£3.30
20V DC	£3.30
50V DC	£3.30
300V DC	£3.30
300V AC	£3.30
VU Meter	£4.05

CLEAR PLASTIC MODEL 52P
Size: 60 x 60mm



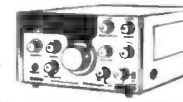
50uA	£3.85	S Meter 1mA	£2.85
100uA	£3.30	VU Meter	£3.95
500uA	£2.90	1A AC	* £2.75
50-0-50uA	£3.35	5A AC	* £2.75
100-0-100uA	£3.25	10A AC	* £2.75
1mA	£2.75	20A AC	* £2.75
5mA	£2.75	30A AC	* £2.75
10mA	£2.75		
50mA	£2.75		
100mA	£2.75		
500mA	£2.75		
1A DC	£2.75		
5A DC	£2.75		
10V DC	£2.75		
20V DC	£2.75		
50V DC	£2.75		
300V DC	£2.75		
15V AC	£2.85		
300V AC	£2.85		

BAKELITE MODEL 65
Size: 80 x 80mm

25uA	£5.05	30V AC	* £2.85
50uA	£3.90	50V AC	* £2.85
100uA	£3.30	150V AC	* £2.85
500uA	£3.00	300V AC	* £2.85
50-0-50uA	£3.35	500V AC	£2.85
100-0-100uA	£3.30	VU Meter	£4.00
500-0-500uA	£2.85	1A AC	* £2.85
1mA	£2.85	5A AC	* £2.85
1-0-1mA	£2.85	10A AC	* £2.85
5mA	£2.85	20A AC	* £2.85
10mA	£2.85	30A AC	* £2.85
50mA	£2.85	50A AC	* £2.85
100mA	£2.85	500mA AC	£2.85
500mA	£2.85	50mV DC	£3.20
1A DC	£2.85	100mV DC	£3.20
2A DC	£2.85		
5A DC	£2.85		
15A DC	£2.85		
30A DC	£2.85		
50A DC	£2.85		
5V DC	£2.85		
10V DC	£2.85		
20V DC	£2.85		
50V DC	£2.85		
150V DC	£2.85		
300V DC	£2.85		

SUPER VALUE TOP QUALITY TRIO equipment

TRIO JR599 RECEIVER



Nine wave-bands covering 1.8–29.7 MHz, 144–146MHz and 10MHz WWV SSB, CW, AM and FM. AF output is more than 1 watt. S Meter. Squelch control. BFO. Variable AF and RF controls. 4–16 ohm output and jack for phones. Power requirement 100/240V AC, 12/14V DC. Size: 270 x 140 x 310mm.

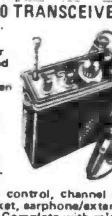
Our Price £132.50 CARR. PAID

TRIO 9R59DS RECEIVER

Four bands covering 550kHz to 30 MHz continuous and electrical bandspread 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

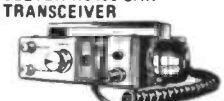
TRIO TR2200 TRANSCEIVER



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

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

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NB. Licence required for use in UK

KE630 3 Station INTERCOM

Master and two sub-stations. Can be used on desk or wall mounted. Complete with cable and batteries

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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 Ohms **£1.15** P&P 10p

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

ALL PRICES EXCLUDE VAT

Also see previous page

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

80 WATTS	£2.75	P&P 18p
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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.

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Excellent quality at low cost. Input: 230V 50/60Hz. Output 0–260V.

MODEL S260 BENCH MOUNTING

		P&P
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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

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

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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.

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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.

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Light weight headphones with padded ear pieces. 4/16 ohms 20–20,000Hz. Complete with 6' lead and plug.
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Sensitive magnetic headset with soft ear pads. Impedence 2,600 ohms (600 ohms DC). Frequency response: 200–4,000Hz.
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Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms 20–12,000Hz. Complete with lead and plug.
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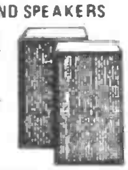
SPECIAL BARGAIN!! PHONIC 10 Two Way Speakers

Matched pair of compact book-shelf speakers of unique design. Incorporating a 2" high frequency unit & 6" woofer. 8 ohms impedence. Size: 348 x 228 x 110mm.
OUR PRICE £8.85 Pair P&P 50p

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.
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AF25 Mixer	£3.60
AF30 Mono pre-amplifier	£2.61
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LF380 Quadraphonic device	£11.36
M160 Multi-vibrator	£1.71
M191 VU Meter	£4.55
M192 Stereo balance meter	£4.97
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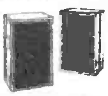
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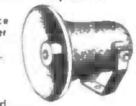
Built-in driver unit. Impedence 16 ohms. Power rating 10W. Response 380–7000Hz. Size app. 6" x 6". Weather and shock protected.
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RECORD DECKS P&P 50p

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MP60/M44–7	£17.50
HT70/TPD/ADC K7E	£21.25
610/TPD/ADC K8	£19.25

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SP25 Mk3/M44E	£18.25
SP25 Mk3/M44–7	£17.80
SP25 Mk3/M55E	£18.80
SP25 Mk3 Module/M75–6	£19.45
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AP76/M44E	£28.00
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GL75/G800	£40.90
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GL78/G800E	£48.15
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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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80M	£1.15	£5.40	£10.25

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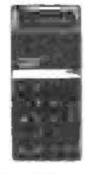
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Active Filter Unit	£6.95
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PZ6 Power Supply	£7.98
PZ8 Power Supply	£7.98
Transformer for PZ8	£4.05

SINCLAIR Project 80 Packages

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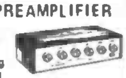
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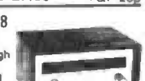
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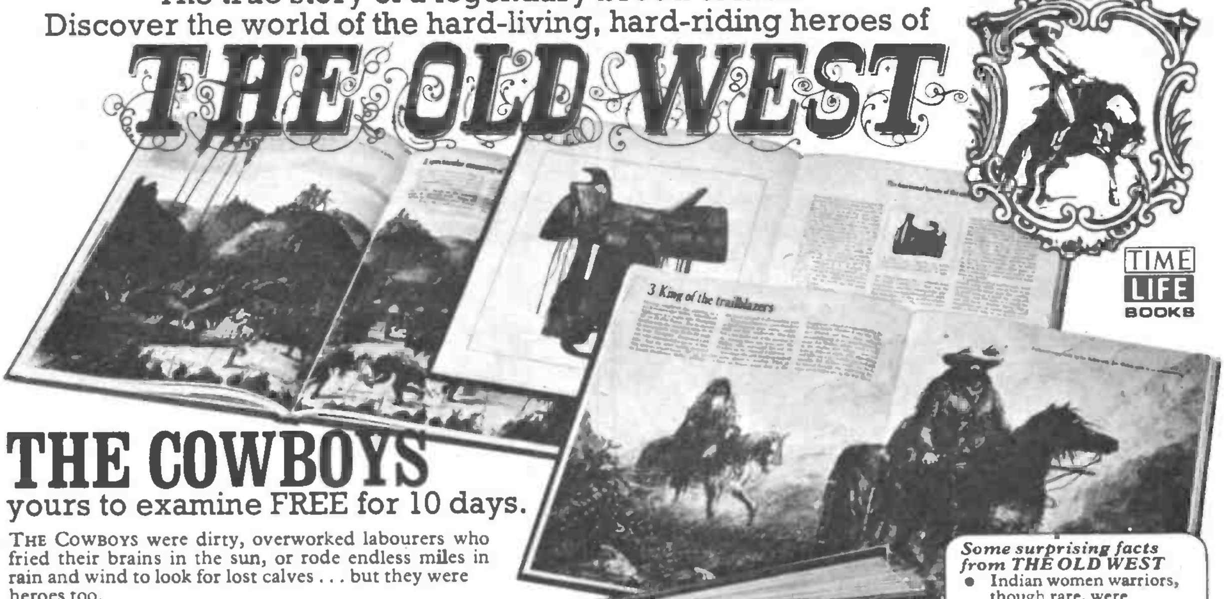

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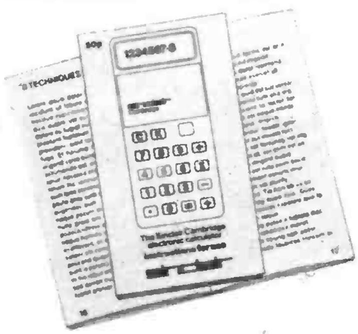

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PROJECTS...
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CONDITIONS OF EMPLOYMENT

A word of much required good cheer to those of you who are motorists. In these times of expensive petrol and astronomical servicing charges, EVERYDAY ELECTRONICS shows a way to effect some financial savings. The *Transistor Assisted Ignition* described in this month's issue is indeed a timely project, since it reduces points wear, so eliminating the need for regular retuning, and gives overall improved engine performance.

Not all our readers are motorists of course. But there is another very good reason for examining this project in some detail. It happens to throw another light on that question of "order of complexity" discussed here last month.

At a first glance, the *Transistor Assisted Ignition* seems to fit into the "simple project" category quite well. Three transistors, a diode, three resistors, and a switch are the circuit components involved. Yes, it is simple enough in material terms. There is however another factor that sometimes assumes a large and decisive part when determining the "classification" of a project. We are referring to the nature of the application and the conditions under which the project will be expected to perform.

In the case of the *Transistor Assisted Ignition*, it goes without saying that complete dependability under fairly arduous working conditions is absolutely essential. This unit is no passive passenger, but it becomes a vital and integral working part of the engine. The electronic components themselves can be relied upon to give satisfactory service under conditions far more severe than those likely to be experienced in a motor car. So everything stands or falls on the quality of the mechanical assembly, wiring up, and, especially, the soldering of each connection. All of which is literally in the hands of the individual constructor.

It is for this reason that the *Transistor Assisted Ignition* unit, while seeming to be a simple project, cannot be recommended as one for the inexperienced to sharpen their teeth on.

While all newcomers (whether motorists or not) should ponder over our cautionary advice relating to this particular design, they should also appreciate that high standards of workmanship should not be reserved just for special jobs, but must become in due course second nature and so be applied automatically to all electronic constructional work undertaken, at all times.

Our May issue will be published on Friday, April 19

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. 4 APRIL 1974

CONSTRUCTIONAL PROJECTS

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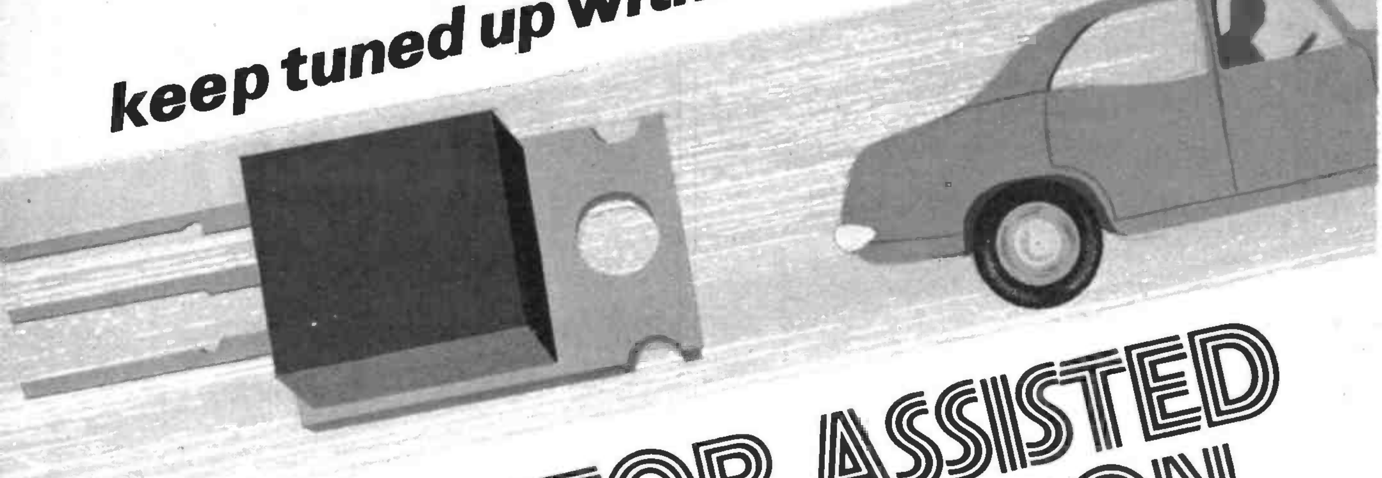


TRANSISTOR ASSISTED IGNITION

Eliminates electrical wear of contact breaker points

Top performance on cars is becoming increasingly expensive to maintain. One of the maintenance problems is deterioration of the points, or contact breaker.

Each revolution of a four cylinder engine requires the points to produce two sparks to fire the engine. The points start to deteriorate after a few hundred miles as a result of producing all these sparks and by the time the car is serviced, at say 6000 miles, the points may be in a very poor condition. This deterioration affects the timing, reduces the power available at the plugs and can give a noticeable drop in performance.

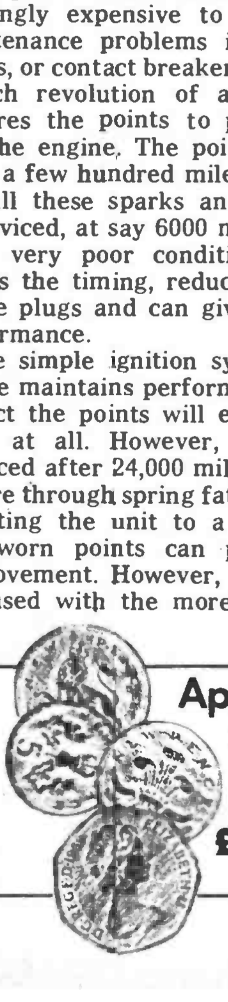
The simple ignition system described in this article maintains performance between services; in fact the points will experience no *electrical* wear at all. However, the points should be replaced after 24,000 miles to reduce the risk of failure through spring fatigue.

Fitting the unit to a vehicle which already has worn points can produce an immediate improvement. However, this unit should not be confused with the more complicated "capacity discharge-ignition systems" which are designed to improve performance.

Warning. Although simple, this project should not be attempted as a first project. A high standard of soldering is necessary for the unit to work under the adverse conditions found in a car engine compartment.

Beware, also, that the unit is designed for cars fitted with a **negative earth system only**, you should verify this before starting the project.

Such a simple design is not easy to achieve for positive earth cars due to the lack of comparable *pnp* transistors.



Approximate cost of components including V.A.T.

£4.50 inc. case

THE CIRCUIT

A switch is incorporated into the unit so the normal car circuit can be easily restored in the event of failure, or suspected failure. This feature, together with the circuit design requires that the capacitor (sometimes referred to as a condenser) be removed from the distributor and fitted into the unit (see "testing" and "installation" later).

The complete circuit diagram is shown in Fig. 1. The points are connected via switch S1a (in the position shown) and resistor R2 to transistor TR1. When the points are open, TR1 is cut off by R1, fed from the positive battery connection. Each time the points close the base of TR1 is connected to earth through R2 switching it into its conduction state. The current passing through the points is about 13mA, instead of the 3 amps or so normally required.

The current flowing through the collector of TR1 and R3 in turn switches on TR2, which in turn switches on TR3 thereby connecting the coil to earth every time the points close. Thus

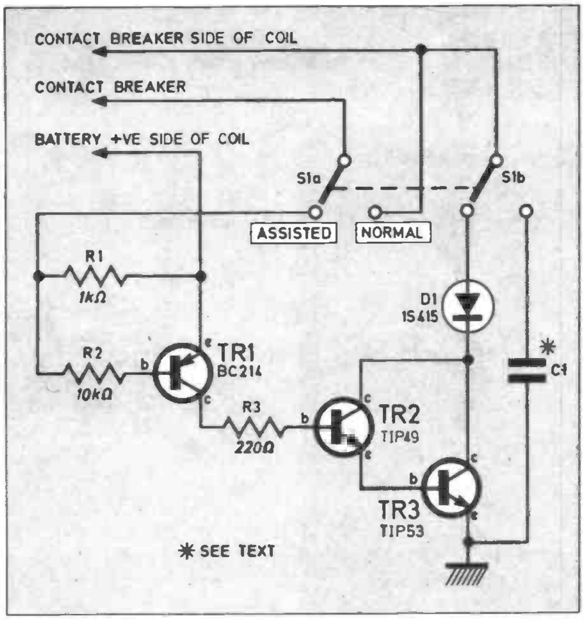


Fig. 1. The complete circuit diagram of the Transistor Assisted Ignition.

TR3 takes the place of the points and passes the 3 amps or so required by the coil. Diode D1 is necessary to protect TR2 and TR3 from high voltage spikes generated when the points open.

If S1 is switched to the "normal" position the points are connected directly to the coil. In this position the capacitor is connected across the points in the conventional manner, except that the capacitor is housed in the diecast case instead of the distributor.

CONSTRUCTION

The prototype unit was housed in a diecast aluminium case measuring 115×90×50mm. All the components are mounted on the lid of the case as shown in Fig. 2. The exact positioning of the components is not critical and can be estimated from the full-size photograph of Fig. 2. Begin construction by drilling all the components fixing holes in the lid.

The characteristics of diode D1 are not critical, any rectifier capable of passing three to four amps at 450 volts may be fitted. The one used in the prototype is stud mounted and fitted onto a small aluminium bracket as shown in Fig. 2.

Components R1, R2, R3 and TR1 are the only components not bolted directly onto the lid. Solder these components onto a five-way tag strip which is bolted to the lid using two 6BA spacers.

The capacitor C1 must be removed from the distributor and mounted without modification to its leads, the capacitor can then easily be returned to the distributor if required. All distributor capacitors are bolted to earth with a metal clip. The lid must be drilled to suit the particular capacitor fitted to the car.

The wire attached to the capacitor is taken to an insulated terminal and screwed into position. Make the insulated terminal by bolting a 4BA nylon screw and nut through the lid and then screwing a 25mm 4BA tapped metal spacer onto the nylon screw thread projecting above the nylon nut.

The diode and power transistors must be mounted very carefully on their mica washers; insulating bushes must be used for fixing TR2 and TR3; check after fitting that they are properly insulated from metal lid. If in doubt use two mica washers on the transistors, or mica washers from larger power transistors.

It is advisable to lock all the nuts with a small dab of paint around the screw thread projecting from each nut. Now wire up according to Fig. 2. All the interconnections must be made with wire capable of carrying five amps. The four flying leads, brown, red, orange and green should be of flexible wire and passed out through a small grommet fixed to the centre of the lid.

All wiring must be mechanically fixed to each solder point and soldered to a high standard. Under the adverse operating conditions which this unit has to work poor soldering will very quickly give rise to failure.

Components....

SEE SHOP TALK

Resistors
R1 1kΩ
R2 10kΩ
R3 220Ω
All ¼watt ±10% carbon

Semiconductors
TR1 BC214 silicon *pnp*
TR2 TIP49 silicon *npn*
TR3 TIP53 silicon *npn*
D1 1S415 or similar 3 to 4 amp 450V stud cathode type

Miscellaneous
S1 double-pole double-throw 250V 3A
Diecast aluminium box, 115 x 90 x 50mm; 5 way tag strip; mica washers and bushes to suit TR2 and TR3; insulating washer/bush to suit D1; 25mm long 4BA tapped metal spacer; 4BA nylon nut and bolt; 6BA nuts, bolts and washers (6 off each); 6BA 6mm long spacers (2 off); rubber grommet; solder tags, 2BA (2 off) 4BA (1 off).

TESTING

No car owner will willingly fit an untested unit to his car, nor allow the capacitor to be removed from the distributor. Fortunately the unit can easily be tested without removing the capacitor.

First remove the centre lead from the distri-

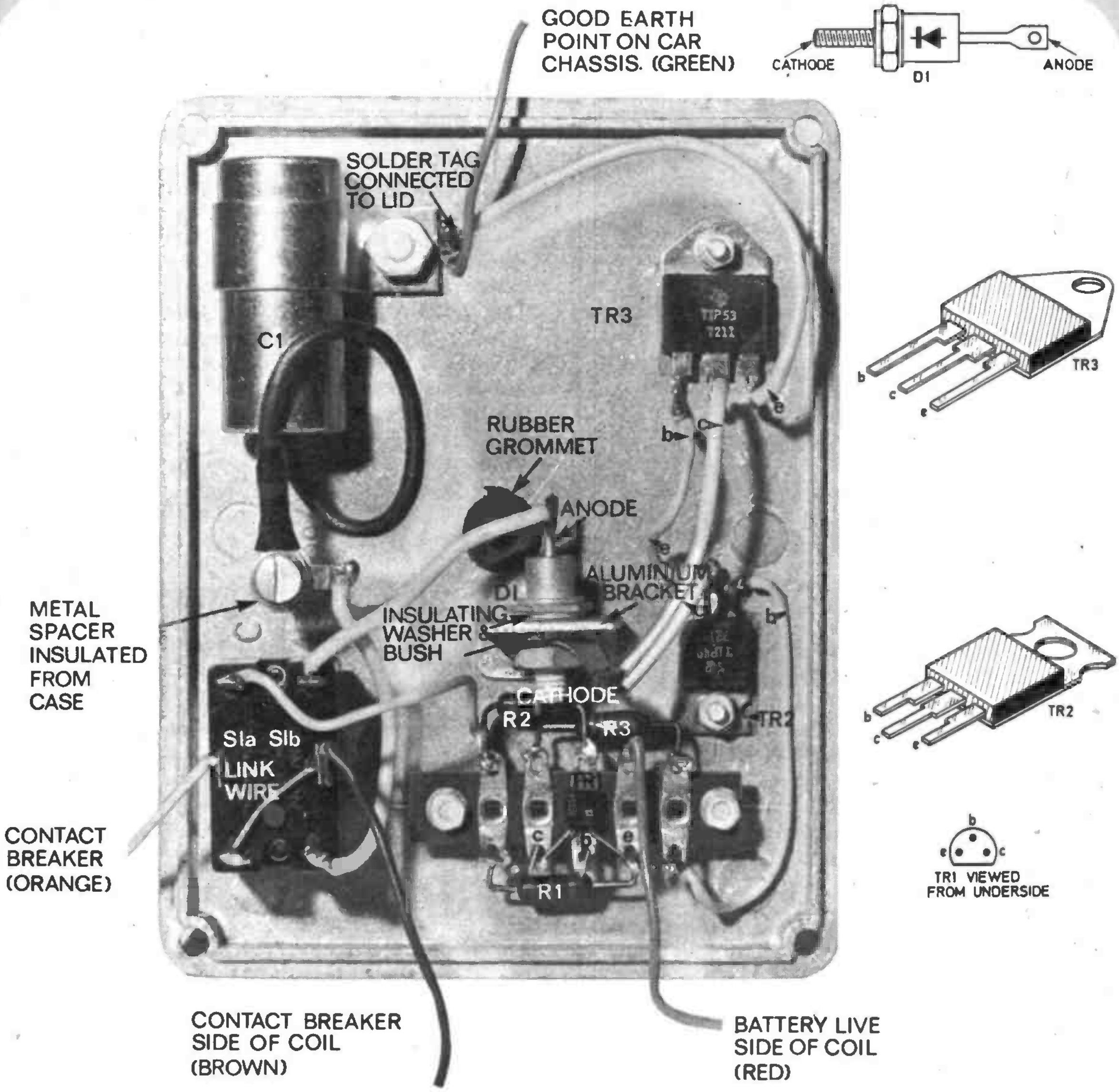
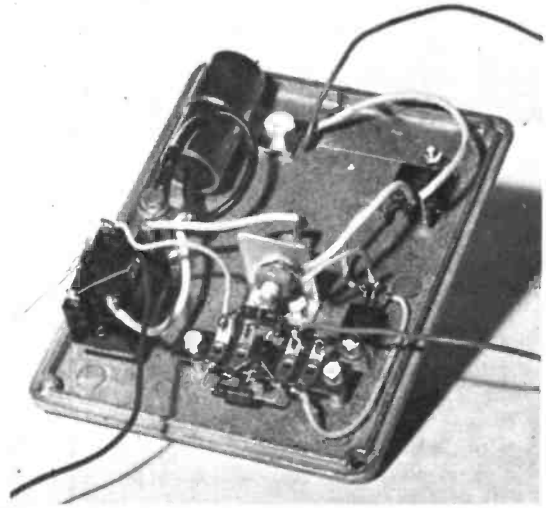


Fig. 2 (above). Position and wiring up details of the components on the lid of the diecast box.

Photograph (right) giving an alternative view of the completed unit.

TRANSISTOR ASSISTED IGNITION



butor and fix it with adhesive tape so that the metal end is about 6mm from some earthed point on the car. This will enable you to see when a spark is generated.

Secondly disconnect from the ignition coil, the wire leading to the contact breaker. This connection may be labelled CB on some coils. Twist the brown lead from the ignition unit onto this connection. The red lead is twisted onto the other side of the coil without removing the existing wiring. Thirdly, connect the green wire to an earth point such as under the mounting clip of the coil. The system is now ready to test.

Switch the unit to "assisted" and switch on the car ignition, then dab the orange wire on and off an earthed point. Each time the orange wire breaks contact from earth it should make a spark leap from the centre lead of the coil to its nearest earth point 6mm away.

The "normal" switch position may be tested the same way, but don't touch the bare end of the orange wire. Use an insulated screwdriver to push the wire firmly against the earth point for this test. When this test is complete turn the ignition off and reconnect the two leads so that the car is ready for use again. At this point the installation must be carefully planned.

INSTALLATION

At this stage the diecast base is untouched in any way and its mounting will depend upon the car to which it is fitted.

The unit must be fitted in a cooler part of the engine (in an air stream if possible) and reasonably near to the coil and distributor. It must also be mounted on some form of shock absorber.

Various types of shock absorber may be used as they are not critical. Some readers may wish to adopt the following simple suggestion.

First drill two holes in the base to take rubber grommets through which 6 or 4BA screws with washers may be fitted. Place the unit on a rubber or foam mat, drill through the section chosen to mount the unit on, and bolt to the base tightly.

In this way the body of the case will be isolated with the rubber or foam mat and the screws are isolated from the box with the rubber grommets. Rubber feet could be fitted instead of the mat with equally satisfactory results.

Having fitted the case in an appropriate position, place the lid assembly onto it and trim the brown, red, orange and green leads to the desired length.

The red and brown wires going to the coil usually require car connectors, as does the orange lead feeding the distributor. These connectors, can be obtained from your local car accessory dealer and must be soldered onto the wires. The earth wire will probably need an OBA solder tag.

Having soldered the appropriate tags onto the wires the unit is now ready for its final installation. First remove the capacitor from the distributor and fit it onto the lid with a suitable nut and bolt. Then fit the unit into its diecast box and screw down tightly.

Disconnect the lead feeding the points and fit the orange wire in its place. Tape up the old lead and tie it down out of harms way. Similarly remove the CB lead from the coil and replace it with the brown lead. Connect the red wire to the other side of the coil and the green wire to earth and the system is ready for testing.

Switch the unit to "normal" and start the car engine, the engine should run quite normally in this position.

It is **not** advisable to switch over to the "assisted" position with engine running, so switch off the engine, and then switch over and restart the car. The engine should run as before except that the points will not wear (electrically) as long as the transistor system is in circuit.

TEST RESULTS

The prototype unit was used for three months on a 1971 Rover 2000SC covering about 3000 miles in this time. Before fitting the unit, deterioration in the vehicles performance, when running at peak revs, was noticeable after 500 miles. After a 1000 miles of running on normal points severe misfiring occurred at high speeds. The Transistor Assisted Ignition cured these faults and improved the smoothness of the engine at normal speeds. New points were fitted after a week's testing and the points remained in perfect condition for the duration of the test.

The unit has now been fitted for some weeks onto a 1971 Vauxhall Viva Estate. This vehicle normally burns points very severely between the 6000 mile services. The impaired performance can be eliminated by having new points fitted and the engine retimed.

After several weeks use with the Transistor Assisted Ignition system there was no deterioration of the points whatsoever.

There is little doubt, that with the aid of this unit, changing points and re-timing is not necessary. This saves the total cost of the system within 6000 miles. ▣

Photograph of the completed unit.

TEACH-IN '74

FOR BEGINNERS IN ELECTRONICS... THEORY AND EXPERIMENTS

TUTOR: PHIL ALLCOCK*

LESSON 7 Basic Circuits

NEARLY all of the work covered so far has been concerned with circuits in which the current was unidirectional i.e. the current flow was always in a given direction and did not at any time reverse. Not all circuits behave in this way however and this month we shall find that the current in certain components does in fact change direction during the circuit operation.

MONOSTABLE CIRCUIT

The **monostable circuit** belongs to the same family as the **bistable**, described last month. As might be inferred from the circuit name, only **one** stable state exists and the circuit will always revert to this stable state if we give it enough time to recover from some externally applied disturbance. Before considering a complete monostable circuit it will be instructive to examine the operation of the basic timing circuit shown in Fig. 7.1.

Let us suppose that we have built this circuit on our Tutor Board (this is in fact required later on) and that the circuit has been left undisturbed for several seconds with the switch S1 open. What is the state of the circuit?

To answer this question we must recall some of our earlier theory relating to the charge and discharge of capacitors. We know for example that when a capacitor is connected in series with a resistance, to a battery, a current will flow until the capacitor has fully charged. When the charging is complete the current must be zero and the capacitor can be disconnected (if required) without altering the "steady state" conditions in the circuit.

If we examine Fig. 7.1 carefully we see that these principles can be applied to determine the steady state conditions of the timing circuit.

The capacitor C1 is connected to the battery via the resistance of lamp LP1, and the "diode" formed by the emitter-base junction of transistor, TR1. This "diode" is in the correct direction to allow the capacitor to charge and if we assume that the circuit has reached its steady state the current flowing in LP1 must be zero.

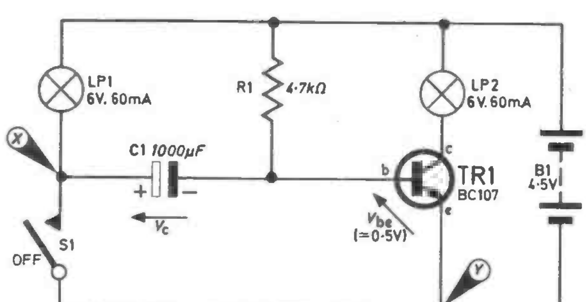
We can therefore consider the charged capacitor as "removed" from the circuit and this then leaves us with a simpler circuit consisting of R1, LP2, and TR1. Transistor TR1 must be *on* since base current will flow via the base resistor R1. As V_{be} is about 0·5V for an *on* transistor, the base current will be approximately 850μA (corresponding to a voltage of 4·0 volts across 4·7 kilohms) and LP2 will be on.

Transistor TR1 will in fact be saturated and the voltage across the lamp LP2 will be about 4·4 volts if we take $V_{ce\ sat}$ as 0·1 volt. Notice that since the current in LP1 is zero when C1 is fully charged the capacitor will be charged up to the voltage difference across R1, i.e. 4·0V approximately. (This voltage is the battery voltage less the value of V_{be}.)

NEW CONDITIONS

From the above we know the *steady state* circuit conditions and these will exist in the circuit

Fig. 7.1. Basic transistor timing circuit.



* 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).*

providing we leave the switch open. The circuit can however be disturbed by closing S1 and this disturbance must obviously have an effect on the (previously steady) currents and voltages that we have worked out. How can we find the new conditions?

To answer this second question let us suppose that we can examine the circuit conditions "immediately" after the switch closes. By "immediately" we mean that *no* time has elapsed since the closure of the switch and therefore no change in the charge on C1 can have taken place. (Recall that charge equals current×time.) Consequently C1 will still be charged to the voltage difference that existed just before the switch closure i.e. 4·0 volts.

The state of the circuit just after S1 closes is shown in Fig. 7.2 and it can be seen that the transistor is now *off* since the base must be at −4·0 volts with respect to the emitter and the base-emitter junction is therefore **reverse biased**. An alternative viewpoint is to note that the voltage at point *X* in Fig. 7.1 has been "pulled down" from +4·5V to zero by the shorting action of the switch S1.

Since C1 cannot instantaneously change its charge (and therefore voltage) the voltage at the transistor base must experience an equal change to that at point *X* and thus falls from +0·5V to −4·0V, a change of 4·5 volts.

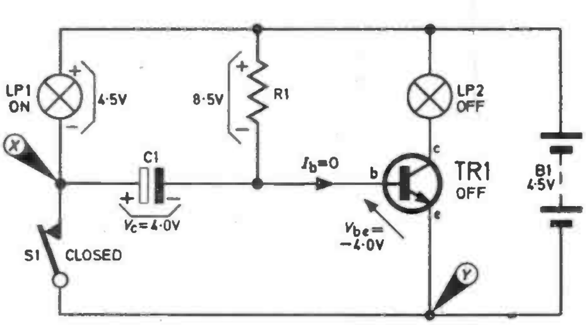
Since TR1 turns off when S1 closes, the base current I_b will fall to zero and LP2 will extinguish. Note that LP1 will be turned on by the action of the switch. The conditions illustrated in Fig. 7.2 only apply immediately after the switch closes since C1 must start to re-adjust its state of charge to match the new conditions.

The voltage difference across R1 at this instant is 8·5 volts since the capacitor voltage and the battery voltage act in the same direction. The instantaneous current in R1 must therefore be

$$\frac{8\cdot 5}{4\cdot 7} = 1\cdot 8\text{mA}$$

and flows in a direction which tends to reduce the capacitor voltage V_c to zero and recharge C1 with opposite polarity. This is illustrated in Fig. 7.3 which shows the variation of V_{be} and V_c with time.

Fig. 7.2. Voltages for circuit of Fig. 7.1, just after switch closes.



The switch is assumed to close at some time t_1, and by the time t_2 the capacitor voltage has reversed and is limited to about 0·5 volts by the "diode action" of the emitter-base junction of TR1. The transistor will conduct again at time t_2 and hence LP2 will light. Without this clamping effect, the capacitor voltage charge would continue, as shown by the dotted line, until V_c reached −4·5V.

This voltage clamping action is indeed fortunate since without it the capacitor would tend to charge up with reversed polarity—an undesirable state of affairs if C1 is a polarised electrolytic capacitor. The clamping action in the given circuit limits this reverse voltage to about 0·5 volts.

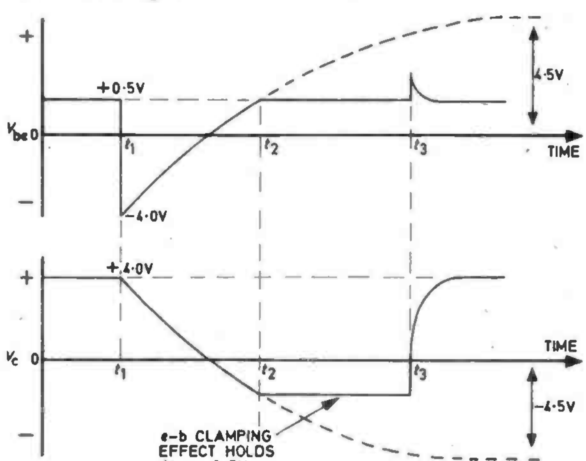
If the switch is restored to its initial open state at some time, say t_3, the capacitor will return rapidly to its initial steady state conditions V_c = +4·0V). This rapid recharching occurs via the relatively low resistance of the lamp LP1 and the forward biased base-emitter junction of TR1.

This action is also illustrated in Fig. 7.3 and the slight increase in V_{be} due to the recharging current flowing via TR1 is clearly seen. Note that the lamp LP2 is turned off only for the time interval between t_1 and t_2 and that this temporary off state is initiated by the closure of the switch S1.

TRANSISTOR SWITCH

We have now examined all the changes that can take place in our basic timing circuit. To convert the circuit of Fig. 7.1 into a recognisable

Fig. 7.3. Variation of voltages with time for the circuit of Fig. 7.1.



t_1 = TIME AT WHICH S1 CLOSES : TR1 TURNS OFF
t_2 = END OF TIMING PERIOD : TR1 TURNS ON
t_3 = SWITCH OPENS : C1 RECHARGES VIA LP1

monostable circuit all we need to do is to replace the mechanical switch S1 by a transistor "switch" in such a way that t_2 and t_3 become one and the same instant. Fig. 7.4 shows the final circuit arrangement and is drawn deliberately "opened out" to show the similarities with the original timing circuit of Fig. 7.1.

The potentiometer VR1 is not essential to the circuit operation and can be assumed to be set to give $R_e=0$. (The use of VR1 will be explained in this month's experimental work.) A second BC107 transistor TR2 is used as an electronic equivalent of the mechanical switch.

As long as TR1 is saturated (its normal steady state) the voltage between *Z* and *Y* will be insufficient to bias TR2 *on*. Transistor TR2 therefore appears as an open circuit between collector and emitter since negligible collector current can flow under the above conditions.

If the circuit is **momentarily** disturbed by shorting point *X* to point *Y* the timing cycle is initiated and the voltage at point *Z* changes to +4·5V as TR1 turns off. This voltage is sufficient to turn TR2 *on* by providing base current via R2, and TR2 takes on the role of an approximate short circuit.

Even though the initial momentary short circuit between *X* and *Y* is removed the switching action of TR2 maintains "closed switch" conditions between *X* and *Y* and the full cycle of events takes place. When the timing period ends TR1 conducts again and automatically resets the initial state of the switch by turning TR2 off. Because of the dependence of the state of TR2 on the voltage at point *Z*, the timing period ends and C1 recharges at virtually the same instant (i.e. t_2 equals t_3 in Fig. 7.3).

In typical applications one or both of the lamps may be replaced by fixed resistors or some electromechanical device such as a relay. The initial disturbance is often produced by applying a brief voltage pulse at a suitable point in the circuit and some of the possibilities are explored in the Tutor Board experimental tests which follow.

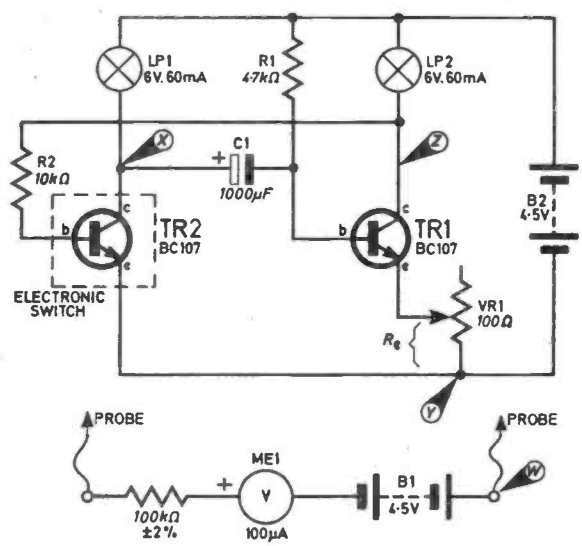


Fig. 7.4. Monostable timing circuit. The voltmeter circuit is required for test number 18.

Next month we shall look at the astable circuit, which we were unable to cover this month, and explore circuit behaviour a little further.

TUTOR BOARD EXPERIMENTS

Test No. 17

Build the basic timing circuit (Fig. 7.1) using the layout shown in Fig. 7.5. Note that in this circuit the switch is not used to connect the power supply battery but is used to create the initial disturbance that starts the timing process. Make the connections to the battery after the rest of the circuit has been assembled and carefully checked. With the switch S1 open check that a "steady state" is obtained with the following conditions:

1. Lamp LP2 on, lamp LP1 off.
2. V_{be} approximately +0·5 volt. (Use the standard 0-10V voltmeter circuit with the positive probe connected to the base of TR1.)
3. Measure the voltage between points *X* and *Y* which should be about 4·5 volts. This check verifies that LP1 is wired correctly and that the bulb filament is intact.

When you are satisfied that your circuit conditions are correct, close the switch and watch the two lamps, LP1 should light whilst LP2 should extinguish for several seconds. Compare the "off time" of LP2 with the theoretical time given previously. Do not expect the "off time" to be exactly as predicted by the theory since the tolerance on C1 will be very large, typically +100 per cent to −50 per cent. Open the switch and check that the initial conditions are restored.

The above sequence of operations can be repeated with the standard 0-10V voltmeter connected across R1. Ensure that the voltmeter positive lead is connected to the "battery" end of R1. When the circuit is in its steady state (switch open) the voltmeter will indicate approximately 4·0 volts.

Observe the voltmeter as the switch is closed. The meter reading should rise to about 8·5 volts and then fall back slowly to 4·0 volts as C1 discharges. This test verifies that V_{be} does reverse and momentarily reaches −4·0 volts just after the switch closes.

It is important to realise that the full "off time" will only be achieved if the switch remains closed during the timing period. This can be checked on the Tutor Board circuit by restoring S1 to its open position after say one second, C1 will rapidly recharge (via LP1), and LP2 will turn on immediately the switch opens.

When you are happy with the operation of the basic timing circuit the layout can be extended by the addition of a second BC107 stage to make the monostable circuit shown in Fig. 7.4. A suitable layout is given in Fig. 7.6 and the battery should be disconnected before the circuit changes are made.

Test No. 18

Set VR1 to give zero resistance in the emitter lead of TR1 ($R_e = 0$). Connect the battery and check that the correct steady state conditions are obtained (LP1 off, LP2 on). Using a spare lead momentarily join point *X* to point *Y*. The lead can be fastened at point *Y* and the free end tapped on point *X* briefly. This circuit disturbance should be sufficient to start the timing sequence which can be checked out as in the previous test.

Since the monostable resets itself after the end of the timing period a second tap of the lead (at point *X*) will start the sequence all over again.

The circuit can be triggered into operation in other ways. To illustrate this, rotate VR1 a small amount to make R_e about 10 ohms. (This will require the pointer of VR1 to turn through approximately 30 degrees since the full 100 ohms corresponds to a rotation of about 300 degrees.) If this is done slowly the circuit will not be visibly disturbed but the presence of the 10 ohms will increase the voltage at point Z and turn TR2 on **slightly**.

If the "flying" lead is now used to momentarily join point Z to point *Y* the circuit will be triggered into operation as the lead is **removed** from point Z. If your circuit does not respond in this way increase the rotation of VR1 a **small** amount and try again until the triggering process works correctly.

Note that whilst points Z and *Y* are joined together by the flying lead, TR2 must be off. When the lead is **removed** from Z TR2 conducts slightly and the voltage at *X* will fall by a small amount due to the collector current of TR2

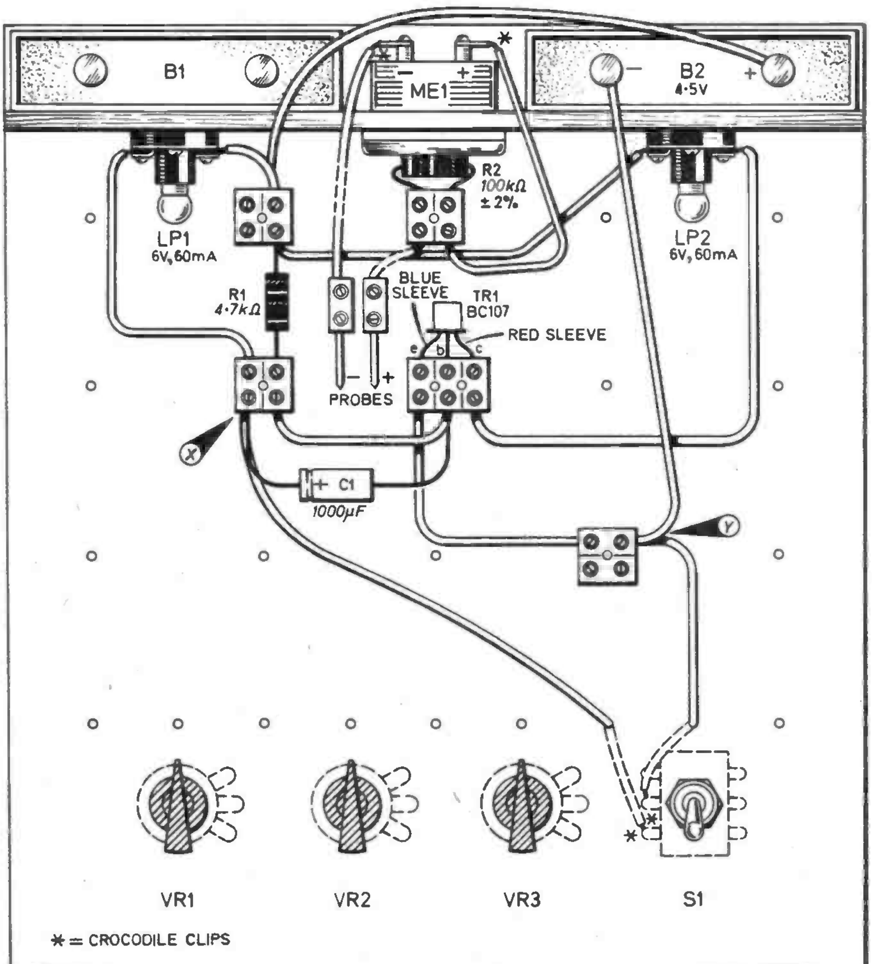


Fig. 7.5. Tutor Board layout for the circuit of Fig. 7.1. To be used with Test No. 17.

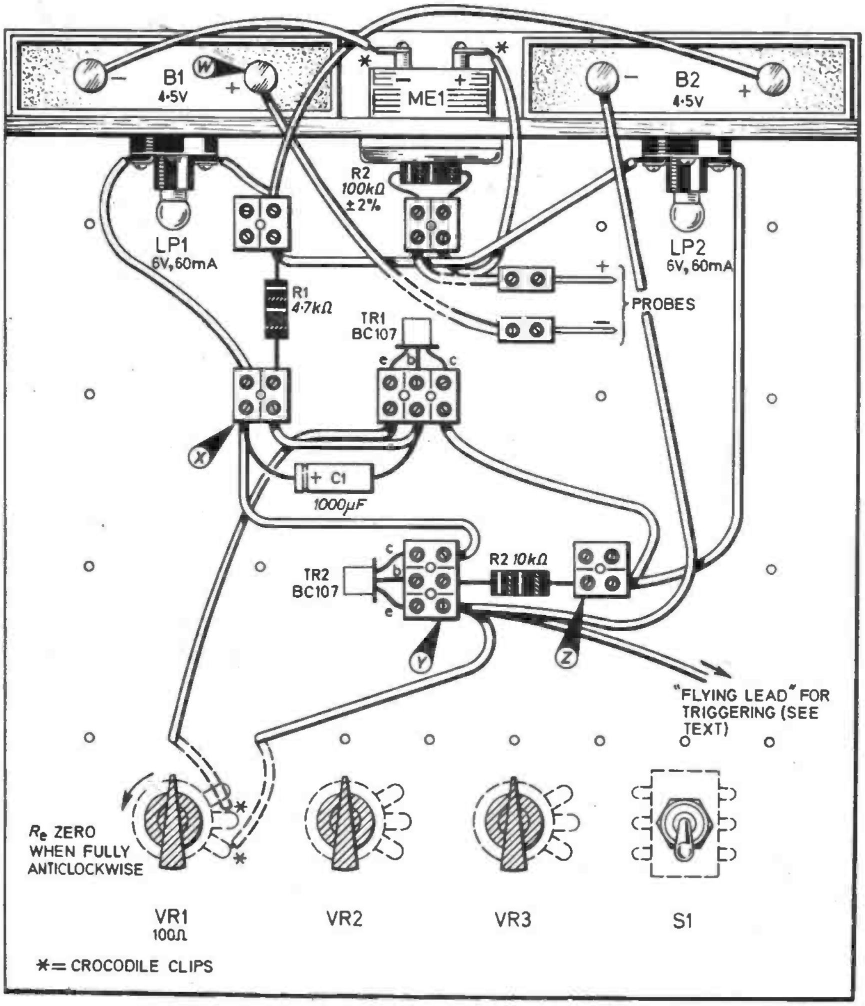


Fig. 7.6. Layout and wiring for the circuit shown in Fig. 7.4.

flowing via LP1. (This voltage change is itself insufficient to turn the lamp LP1 on.)

The voltage change is transferred to the base of TR1 in the usual way (by virtue of the charge storage action of C1) and will tend to turn TR1 off. This tendency raises the voltage at point Z further and a regenerative switching action takes place that initiates the normal timing sequence.

A third way in which the circuit can be triggered is by momentarily joining the base of TR2, via a 47 kilohm resistor, to the battery positive. This has the effect of turning TR2 on, so that in this case the timing sequence starts as the connection is made. Take care not to join the base directly to the battery as this will ruin the transistor!

The negative excursion at the base of TR1 can be observed using the modified voltmeter arrangement shown in Fig. 7.4. By joining points Y and *W* together and connecting the probe to TR1 base the voltmeter will read the base voltage with respect to a level of $-4\cdot5$ volts (due to B2). Thus a voltage of $-4\cdot0$ volts on the base would give a reading of $+0\cdot5$ volts on the meter, since $-4\cdot0$ volts is "more positive" than the $-4\cdot5$ volts reference level by this amount.

PLEASE
TAKE NOTE

The Integrated Circuit Data Chart presented free with last month's issue requires the following corrections that have come to light since it was printed. The μA739c is available in base style C.

The 747 series should be base C and the LM377N base C. The NE555 is also available in base style Q.

In circuit 10, capacitor C4 should be 6·8nF and C5 1·5nF not 6·8μF.

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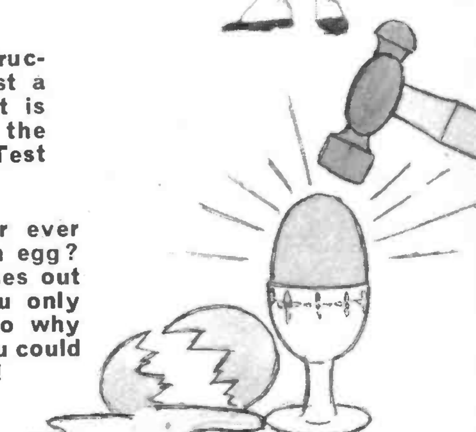
ee TEST GEAR FIVE

TRANSISTOR TESTER

At some time or other all constructors will find the need to test a transistor and this instrument is designed to do just that. Its the fourth instrument in our EE Test Gear Five series.

EGG TIMER



Does your wife or mother ever leave you to boil your own egg? It's infuriating when it comes out like water or solid and you only have yourself to blame. So why not build our egg timer? You could let her use it sometimes too!

All in the May issue of...

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A simple m.w. receiver that can be powered by solar cells.

THIS RECEIVER is of compact construction, being only approximately 80 x 58 x 22mm. outside dimensions, and is powered by light—either daylight or artificial.

The radio employs the Ferranti ZN414, 10 transistor integrated linear circuit, and this has only three leads, yet provides so much amplification that a very simple circuit operating with an internal ferrite rod aerial is practical. The typical power gain of this i.c. is 72dB, and it includes automatic volume control and demodulation, giving an audio output of 30mVr.m.s.

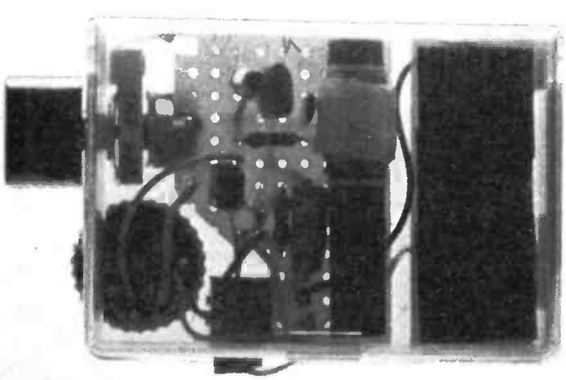
In the present receiver, the i.c. is followed by a single audio amplifier transistor, and this results in excellent headphone volume.

SOLAR CELLS

The efficiency of the solar cells for the Light Powered Receiver is so high that this receiver will work satisfactorily indoors, provided light is reasonably good; however, the cells are quite expensive and should not be regarded as some form of gimic. Should a small pocket radio working from a battery be preferred, it should be noted that this receiver can be run from a single dry cell, without any circuit changes.

LIGHT POWERED RECEIVER

By F.G. RAYER



CIRCUIT DIAGRAM

The circuit for the receiver is shown in Fig. 1. Coil L1 is the ferrite rod winding, tuned by the small compression trimmer C1. A threaded shaft is available for this trimmer, so that it can be adjusted with a small control knob for tuning.

Input from the ferrite rod winding is to lead 2 of the i.c., and audio output is obtained from lead 1. Resistor R1 is a feedback resistor to give correct working conditions, and C2 a by-pass capacitor.

Potentiometer VR1 is a miniature 5 kilohm edge-control potentiometer, used with R2 in parallel because this is necessary to provide the correct working load for the i.c. Audio signals from the audio gain control VR1 go to the base of the audio amplifier TR1. This stage gives considerable amplification. Phones (TL1) are plugged into a small jack socket (SK1).

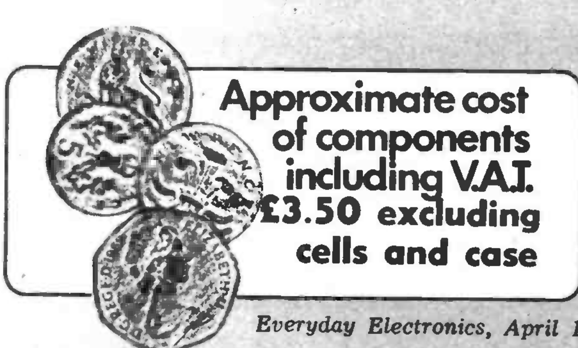
The three solar cells in series provide approximately 1·4V, and the circuit is intended for this voltage. The large capacitor C5 is necessary to avoid hum when illumination is from a source of artificial light such as a household lamp operating from a.c., as C5 serves as a reservoir, smoothing the output from the solar cells under these conditions; C5 is not required for battery operation but may be left in circuit if required.

CASE PREPARATION

The construction of this receiver is quite compact, but not so cramped that wiring is difficult. The type of small plastic box used has a transparent lid. Holes are first drilled to clear the spindle of C1, and to take the jack outlet (SKI)), as in Fig. 2. Drills should be sharp and used with only light pressure.

Control C1 is mounted by cutting a small bracket from scrap metal, and securing this with a short 8BA bolt. This bolt will later fix the circuit board in position.

A slot for VR1 is made by drilling one or two holes, then enlarging and shaping the aperture with a small file. This component is fixed by a further small bolt.



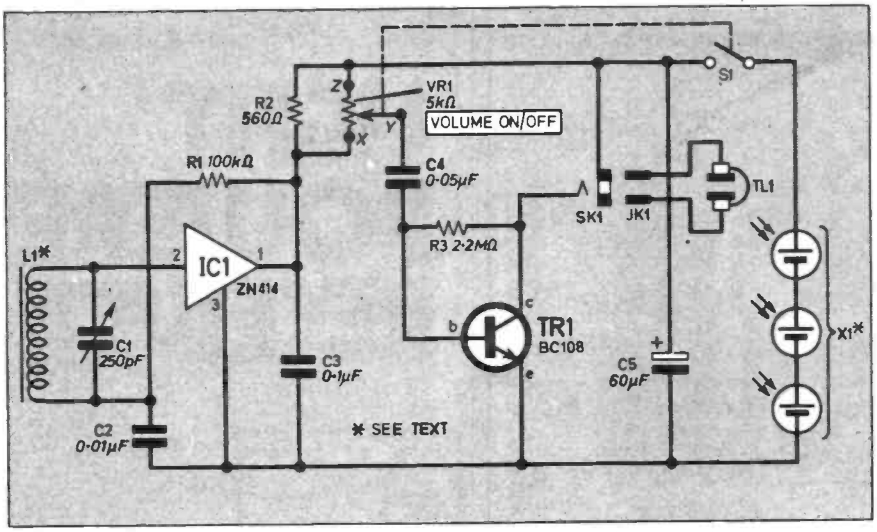


Fig. 1. The complete circuit diagram of the receiver.

CIRCUIT BOARD

The circuit board is plain Veroboard (0·15 inch matrix) measuring 50 x 38mm, and cut to clear VR1 and the jack socket, as in Fig. 2.

The resistors and fixed capacitors can then be positioned with their leads as in Fig. 2. Place C5 in the polarity shown. The board is then turned over, and soldered connections are made. In most places the wire ends of the resistors and capacitors will be long enough. Elsewhere, 26 s.w.g. or similar connecting wire may be used. Short circuits are avoided by placing 1mm. sleeving on the leads where this is necessary.

Two pins are inserted for positive and negative connecting points. Alternatively, projecting wires can be left here. Check that the board will be able to fit flat in the case, as there is not much spare depth.

Base connections for the i.c. and TR1 are also shown. Place the wires so that they come as in Fig. 2, and solder them underneath. Prolonged heating is unnecessary, and should be avoided—if the iron is the correct temperature and the bit clean, the joints will be made in a second or so and the iron should then be removed at once. Heat clips or sinks on the leads while soldering are an added precaution.

Provide flying leads from R2, C4, and TR1 collector, as in Fig. 2. When the circuit board wiring is completed, the board is fitted, and held with a nut. These leads can then be cut to length and soldered to X and Y on VR1. At the same time wire up the switch contacts S1 to Z and phone outlet SK1, as shown.

FERRITE AERIAL

The rod is 50mm long and 9mm ($^3/_8$inch) in diameter, wound with 26 s.w.g. enamelled copper wire. Anchor the wire 6mm. from one end of the

Components....

SEE SHOP TALK

Resistors
R1 100kΩ
R2 560Ω
R3 2·2MΩ
All $\frac{1}{4}$W ± 5% carbon

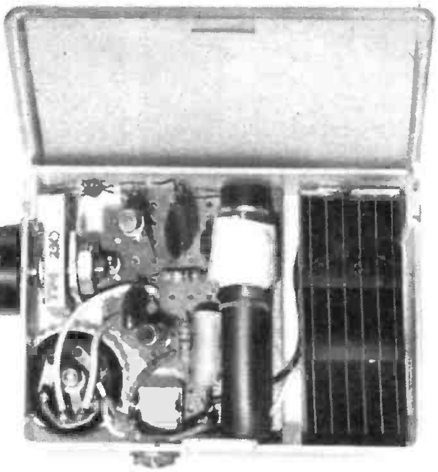
Capacitors
C1 20-250pF nut mounting trimmer with spindle
C2 0·01μF (Mylar film)
C3 0·1μF (Mylar film)
C4 0·05μF (Mylar film)
C5 60μF elect. 4V

Potentiometer
VR1 5kΩ miniature edge type with switch

Semiconductors
IC1 ZN414 integrated circuit
TR1 BC108 silicon *npn*
X1 FRB150 Ferranti silicon photovoltaic cell (3 off) or 1·5V HP7 battery.

Miscellaneous
L1 71 Turns 26 s.w.g. enamelled copper wire (see text)
SK1 3·5mm jack socket
JK1 3·5mm jack plug
TL1 2,000Ω impedance headphones or miniature magnetic earpiece. Case 80 x 58 x 22 mm plastic box with clear perspex lid, ferrite rod for L1 50mm x 9mm ($\frac{3}{8}$ inch) diameter, small knob for C1, plain perforated circuit board 50mm x 38mm and 50mm x 20mm both 0·15inch matrix, 8BA fixings, connecting wire.

LIGHT POWERED RECEIVER



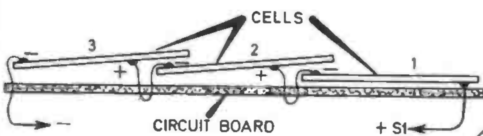
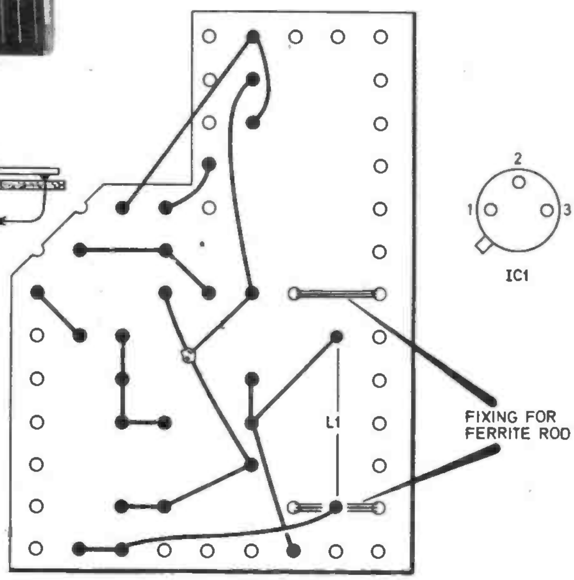
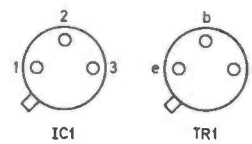
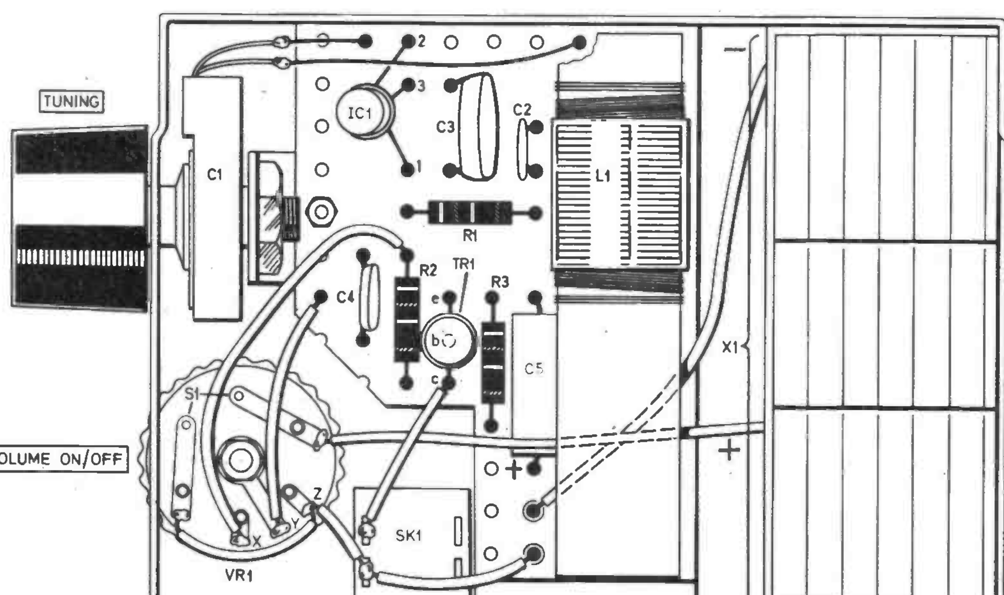


Fig. 3. Mounting of the silicon photovoltaic cells.

Fig. 2. Complete layout and wiring of the receiver. Under side wiring of the circuit board is shown.







rod, with insulation tape, a touch of adhesive, or by binding with cotton.

The whole winding is in three layers. The first layer is 34 turns side by side. A layer of thin insulation tape is then put on over this, and the second layer is wound, and has 22 turns. A further layer of insulation tape is put on, and the third layer is wound, having 15 turns, also side by side. Secure the end with tape or adhesive; there are 71 turns in all. Make sure all the turns are made in the same direction ie. clockwise when looking at one end of the rod.

Place the rod so that the wire ends pass through the board. One end is cleaned and tinned, and runs to R1, C2, then up through a hole to one tag of C1. The second end runs to lead 2 on IC1, then up to C1.

The rod is most easily fixed by adhesive, or by taking cotton round it and through the holes in the board, drawing tight and finishing with a knot and a little adhesive.

This winding, with the parallel capacitor shown, tunes approximately 1,400-550kHz. The higher frequency limit, reached with C1 fully unscrewed, can be raised by using fewer turns, or by having the winding nearer the end of the rod. This may be worth noting, as though this winding should prove satisfactory, the exact coverage obtained with a home-wound coil may vary slightly.

SOLAR BATTERY

The FRB150 (Ferranti) silicon photovoltaic cells are mounted on a piece of paxolin or Veroboard about 50mm long and 20mm wide, as in Fig. 3. Each cell has a metal edge on top which is negative, and the back is positive. Both these surfaces can be soldered normally.

Solder about 80mm of thin wire (say 32s.w.g.) on the back of cell 1, Fig. 3, and a short piece of wire on to the top metal edge. Thread these wires through holes in the board so that they hold the cell in position. Prepare cells 2 and 3 by soldering wires to the back, and metal edge on top. Cell 2 is then fitted, and its wires are passed through holes.

Cell 3 is fitted in a similar manner, with a longer lead from negative (top edge). The adjacent positive and negative wires are then soldered together, as shown, and excess is cut off. Cells 2 and 3 have to tilt slightly, but the back of cell 3 may touch the top of cell 2, or the back of cell 2 touch the top of cell 1, without harm.

This solar battery may be tested with a meter on a 2·5V or similar range, and will give some 1·2V or more, according to the light intensity.

Place insulated sleeving on the leads, run these as in Fig. 2, and solder them to the switch and negative pin.

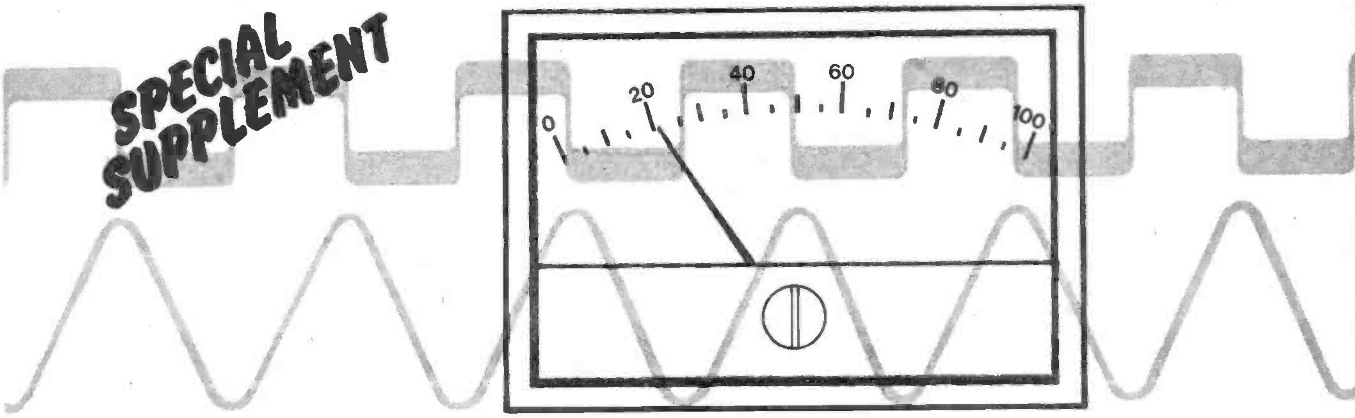
USING THE RECEIVER

By far best reception is obtained by using a good headset of 2000 ohms, or a similar medium or high impedance headset. This will be comfortable, and good quality reproduction can be expected. If portability is essential, a miniature magnetic earpiece (1,000Ω) may be plugged in.

Volume will depend somewhat on the level of illumination, but should easily be adequate, and can be reduced by VR1. The ferrite aerial is directional, so the receiver may have to be turned to give best results from a particular transmitter.

If this receiver is wanted for battery use only, C5 is not necessary. Attach leads to a 1·5V dry cell, and fit this in the place which would be occupied by the solar cells. Take care that positive and negative leads are correctly connected, the zinc case of the cell being negative.

An on off switch has been provided and is linked to VR1. The circuit can be turned off when not in use; this is of course important if a battery is used to supply the receiver. ▣



TEST GEAR

To many people electronics is a rather mysterious and abstruse subject because they are unable to *see* what goes on. If, for example a car engine or a clock mechanism is stripped down, it is usually possible to see how the device works. However, a radio or television is just a mass of wires and components with no hope of *seeing* how it works. In order to see what is happening in electronic devices it is necessary to use **test gear.** Test gear, combined with a knowledge of how the various components work, gives an understanding of how an electronic device operates.

SELECTION

A vast range of specialised instrumentation has been developed for the electronic industry, giving a baffling selection of instruments to choose from. The object of this supplement is to discuss the type of instrument readers are most likely to buy and show the various factors which need consideration before making a choice. **The supplement is not intended as a survey or a buyers guide;** each person must consider his own needs (and cash available) when deciding which instrument to purchase.

When electronic instruments are purchased (like many other commodities) you get what you pay for. In a highly competitive market manufacturers supply test gear at the most economic price they can; so, for the same class of instrument, price is a good guide to quality. However, be wary and shop around, there can be as much as 20 per cent difference in price between one retailer and another for an identical instrument.

Once a suitable instrument has been selected compare prices between the retailers offering that instrument for sale. Do not try to compare the price of different types of instruments to assess value. For example, an oscilloscope will cost a lot more than a simple test meter because of its increased complexity. The price range shown against each instrument gives an indication of the quality obtained for a specific sum of money.

MULTI-RANGE TEST METERS
£2.50 to £60

A multi-range test meter is probably the first and most useful item of test gear anyone is likely to purchase. These instruments normally read, a.c. voltage, d.c. voltage, d.c. current and resistance. The better class instruments also have provisions for a.c. current measurements. Factors affecting price are: number of ranges, a.c. current, sensitivity, accuracy, length and clarity of scale, anti-parallax mirror, overload protection, ease of use, ruggedness. Each of these points must be carefully considered before deciding which instrument to buy.

Number of Ranges. Most instruments provide an adequate number of d.c. voltage ard resistance ranges but the cheaper instruments reduce the number of d.c. current ranges. One can eliminate many cheaper instruments from the choice by deciding that currents from a few micro-amps to one, or even ten amps need to be measured.

Many instruments offer a decibel scale related to 1mW in 600 ohms. This scale is of little or no value and need not influence the choice in any way.

A.C. Current. A.C. current ranges always add to the cost of the instrument because it is necessary to provide a special current transformer. If a.c. current measurements are considered unnecessary, a multi-range meter costing considerably less money may be obtained.

Sensitivity. Test meter sensitivity is always quoted in "ohms per volt" This means quite simply; the resistance added by connecting the meter to the circuit under test. This load resistance is; *sensitivity × the voltage range used.*

For example a meter having a sensitivity of 10,000 ohms per volt, set to its 10 volt range, loads the circuit with 100,000 ohms. The same instrument switched to 0·5 volts will load the circuit with 5,000 ohms. It is important to know these figures so that the effect of the meter can be taken into consideration when taking voltage measurements.

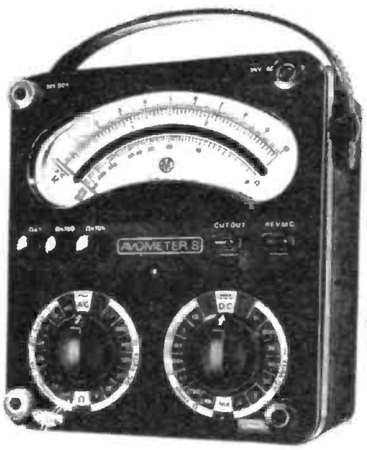


Fig. 1 (left). An example of a top quality multirange meter, the AVO model 8.

Fig. 2 (right). The TMK 700 test meter, costing about half the price of the AVO 8.

The meter resistance is in parallel with the component it is connected across. In general an instrument having a sensitivity of 10,000 ohms per volt is satisfactory, but anyone wishing to save cost could manage with a 1000 ohms/V instrument if they are careful to allow for the shunting effect of the meter resistance.

Accuracy. The overall accuracy will affect an instruments price considerably, but many instruments offered for sale do not quote a figure. A good instrument would quote d.c. voltage accuracy of about 2 per cent with the accuracy of each function separately specified to something better than 3 per cent. If the accuracy is not given ask for it; anything worse than 5 per cent is of limited value and could only be regarded as a rough and ready indicator.

Whilst looking for test meters one occasionally sees an instrument specified as "sub standard" and finds that it is rather expensive. A sub standard is in fact a *very accurate* instrument, against which all top grade instruments are calibrated. The sub standard is itself calibrated against the standard volt, amp or ohm, hence its name. It is not a term used to describe inferior models rejected from a production batch (these are "seconds").

Length and Clarity of Scale. It pays to examine the scale to see how easy it is to read. Top class instruments use two scales 0-100 and 0-25 and all ranges are multiples of these two scales to make readings very simple to take. Some of the cheaper instruments use one scale for 10, 50 and 250 multiples. These are difficult to interpret and are frequently further complicated with another scale for a.c. measurements.

Do not be misled by thinking that a large number of scales make a good instrument, (impressive though they are). An instrument having a multiplicity of scales is difficult to use in practice. The better quality instrument will have simpler scales, whilst providing the same range of functions as the cheaper instrument.

Anti-Parallax Mirror. Meters with a mirror scale are used by closing one eye and lining up the other eye so that the reflection of the needle pointer in the mirror is exactly behind the actual pointer. This makes for accurate readings as meter scales can be read to 1 per cent or less by this method.

However, the mirror scale is of little use unless meter accuracy and clarity of reading is of a high standard. A mirror scale is no more than embellishment on instruments of less than 3 per cent accuracy and should not be regarded automatically as a sign of quality.

Overload Protection. The more expensive meters offer some form of overload protection some having a mechanical cut out, whilst others use diodes to protect the movement against excessive current. Economies can be made by omitting this feature, but mistakes are inevitable and could lead to an expensive repair to the delicate movement.

Ease of Use. Some instruments have only two input terminals and a simple range switch. The simplicity of the switching and terminal arrangement, together with a clear scale, are necessary to obtain measurements quickly and accurately.

To compare different instruments prepare a list of voltage, current, (both a.c. and d.c.) and resistance to see how different meters would make these measurements. Although tedious, it is better to find out if an instrument is difficult to use *before* it has been purchased.

Ruggedness. Multi-range meters are always in use and they need to be rugged, however this is a

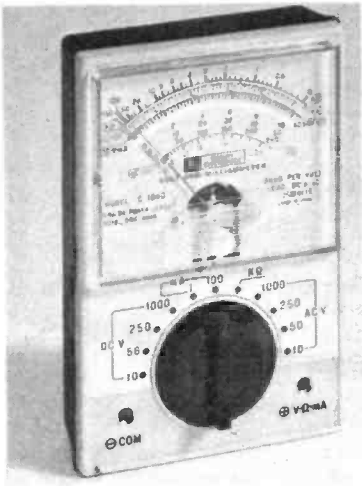


Fig. 3. A typical low cost meter. The TCC model C1000.

very difficult feature to assess without dropping them on the floor. Ruggedness increases the price, also the more rugged instruments can probably be spotted by its general appearance of quality.

Examples. The AVO model 8 multi-range meter is shown in Fig. 1. Costing about £45, this instrument is generally considered the "Rolls-Royce" model. It has all the necessary features and is very popular with professional engineers. The instrument will last a lifetime, so anyone with this kind of money to spare would find it a wise investment.

A TMK model 700 costing about £20 is shown in Fig. 2. This meter is typical of the many instruments in this price bracket which offer good value for money. The instrument provides similar facilities to the AVO, but it is not built to the same standards.

A typical low cost instrument is shown in Fig. 3, impossible to build in the home workshop at the price of £2·50; it makes a nice gift for the beginner. This instrument has a much lower sensitivity than the other two, (1000 ohms per volt). In use the shunting effect of the instrument must not be neglected.

In practice many constructors find that an instrument costing around £10 meets most of their requirements and there are many meters of this type available.

TRANSISTORISED METERS
£20 to £200

Attention is now turned to transistorised meters. These used to be called "valve voltmeters" but most instruments now use field effect transistors instead of valves. The main characteristic of these instruments is a very high input impedance (or sensitivity) in the range 1 to 10 megohms. This means that the instrument does not load the circuit under test to any appreciable extent.

The more expensive models provide most of the facilities of an ordinary multi-range meter, but have the advantage of the very high input impedance.

An Alternative? "Should these instruments be purchased in preference to a good multi-range meter?" The answer to this question will generally be no. Because the instrument is operated by valve or transistor amplifiers they drift, therefore before any measurement is taken the meter must be set to zero. They are not so easy to use. As they are built with active components (transistors) they are not so reliable as ordinary meters and require calibration from time to time.

Transistorised meters are probably most useful in repair workshops already provided with ordinary multi-range meters. The selection of an appropriate instrument will depend upon the facilities already provided and the range of measurements considered necessary, but not possible using their existing instruments.

Having decided the necessary ranges, selection procedures will be similar to those used for multi-range meters, except for comparing maximum operating frequency on the a.c. ranges, (which are higher than the normal multi-range meter).

A medium priced (£50) multi-range instrument which measures both a.c. and d.c. voltages with an input resistance of 10 megohms is shown in Fig. 4. This instrument will also measure a.c. current, d.c. current, and resistance up to 500 meg-ohms. If the current ranges are considered unnecessary, lower cost instruments may be obtained measuring a.c. volts, d.c. volts and resistance.

Millivoltmeters. Amplification enables transistorised meter ranges to be extended down to 1 millivolt or less, so the technique is used to produce a range of meters generally classed as millivoltmeters. This classification covers a wide range of a.c., d.c. and r.f. measuring instruments having very specialised applications.

TRANSISTOR TESTERS
£7 to £30

It is possible to get transistor testers which display the transistor characteristics on the face of a cathode ray tube, but these are very expensive instruments designed for highly specialised work. The transistor testers sold in the £7 to £30 range are more in the nature of **transistor checkers.**

Transistor characteristics are far from constant, in fact it would

Fig. 4. A medium priced transistorised meter made by Eagle Laboratories, type K200.

be difficult to find anything less constant. For example, large signal d.c. amplification h_{FE} varies with, collector current, base current, collector voltage and temperature. Signal amplification β varies with frequency and amplitude as well as those variables already mentioned, so any check of a transistors characteristics has little meaning unless all the conditions are known.

Test conditions and circuit conditions should be the same for a meaningful test. Thus any pretention to accuracy is defeated by the devices being tested. However, the transistor tester is quite handy for go/no-go testing, especially when the suspected component may be compared with a new one.

Most transistor testers offer the same facilities, I_{co}, h_{FE} and the ability to test diodes, *pnp* and *npn* transistors. It is usually possible to sort out if an unknown transistor is an *npn* or a *pnp*. However, the ultimate test for any transistor is whether or not it works properly in the circuit in which it is used.

Little effort is needed to select a transistor tester, as long as h_{FE} can be measured up to 500 or more and I_{co} up to 10mA, with provision for reading currents less than 100μA, the instrument will probably be satisfactory.

As with multi-range meters ease of use and scale clarity are important, so different makes and models should be compared until the most suitable instrument is found. Having found an appropriate instrument shop around to find the retailer offering the best price.

Fig. 5. The Nombrex model 35 power supply unit. This unit can supply from 1 to 30 volts at a current of up to one amp.

One of the many low cost checkers available is the Future Electronics model FTC 401. This particular model will check I_{co} and β for a wide range of transistors and costs less than £8.

STABILISED POWER SUPPLIES
£20 to £70

Strictly, a stabilised power supply is not test gear, but as an item of workshop equipment it is invaluable. Anyone interested in building or experimenting with a variety of electronic projects will use up batteries at an alarming rate.

There is no pleasure in building power supplies after the first one or two, and doing so delays the results from a new project, even though a power supply may be necessary eventually. A bench supply can be used for test circuits and as a power source for specialised items of test gear employed in the workshop.

The Transistor Tester that will be described in the May EVERYDAY ELECTRONICS in the *EE Test Gear Five* series.

The following factors affect the cost of a power supply: single or twin, fully floating, voltage range, maximum current, current limit, short circuit protection, ripple specifications, output impedance. Selection is simple, buy the best twin that the budget will allow. Failing this build one of the designs published from time to time in EVERYDAY ELECTRONICS or *Practical Electronics*.

Single or Twin. The term single or twin means quite simply that the case contains one power supply (single) or two power supplies (twin). Sooner or later two power supplies will be necessary if only to drive operational amplifiers, therefore if a single pack is purchased, another will possibly be necessary later.

Fully Floating. If the supply is fully floating then both the positive and negative terminals are isolated from earth and the pack can be made either positive or negative simply by connecting the opposite terminal to earth, *this is a necessary feature.*

Voltage Range. The range over which the power supply voltage may be adjusted is the voltage range. Packs which will set right down to zero volts cost more than those with a minimum of 1 to 2 volts. High voltages will also cost more money, for transistor work choose supplies in the 20-30 volts maximum range, with a minimum setting in the 0-1 volt range.

Maximum Current. The more current a power supply gives the more costly, for general purpose use 0·5 to 1 amp is considered adequate.

The Audio Signal Generator described in the March issue of Everyday Electronics. This instrument can be built for a total cost of about £10.

Current Limit. Some power supplies provide a current limit where a specific current drain cannot be exceeded. This is a useful feature for experimental work where, for example, a limit of 100mA could be set to prevent damage to power driver transistors.

Short Circuit Protection. Some form of short circuit protection is necessary for the inevitable error so this feature is often combined with the current limit facility. The current limit method of protection is much more satisfactory than either a fuse or a cut out and should be employed wherever possible.

Ripple and Impedance. As stabilised power supplies with a low ripple content and low output impedance are quite simple to design, manufacturers often compete with each other to obtain the best specification, however it does cost more money to produce a superior design.

A ripple rating of less than 20 millivolts at full load, with an output impedance less than one ohm is adequate for most projects.

The power supply illustrated in Fig. 5, the Nombrex Model 35, costs less than £25. It is fully floating, 1 to 30 volts, it has current limit adjustable from 0 to 1 amp (giving automatic short circuit protection) and a ripple rating of less than 10 millivolts. The instrument is typical of the "value for money" power supplies now available.

AUDIO SIGNAL GENERATORS
£18 to £500

Audio signal generators are used for a wide range of tests, other than the most obvious one of checking audio amplifiers. For example, the are used for checking the sound circuits of radio and television receivers in repair workshops or in more general use, they can be employed as a signal source for testing experimental circuits to check that individual parts of an electronic system are functioning correctly.

Many audio signal generators also provide a square wave output. This can be very handy for those who posses an oscilloscope, but is of limited value without one. If the "rise time" of the square wave is suitable it could be useful to anyone working with digital circuits.

The subject of square wave testing, especially with high fidelity amplifiers, appears in articles from time to time, but an oscilloscope is necessary to carry out these tests.

Factors affecting the cost of audio signal generators are: frequency range, accuracy and stability, output impedance, maximum output voltage, termination impedances, attenuator, attenuator calibration, sine and square wave, distortion level, rise time.

As with all instruments cost can be saved by relaxing the specification and facilities demanded from the instrument. The main difference between a cheap signal generator and the most expensive will be in the accuracy of their specifications. However, this is one instrument where a great deal of useful work can be carried out with a low cost model. Taking each point in turn, instruments should be carefully compared to find the one which meets the specification necessary.

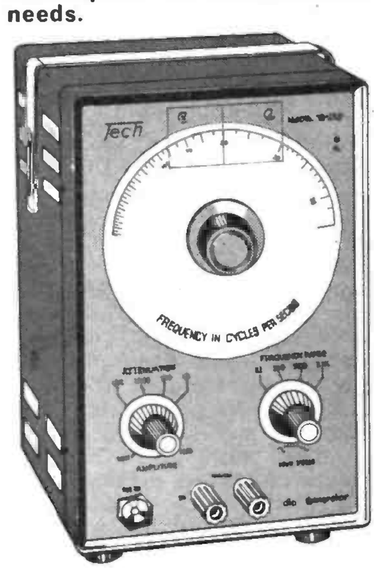
Frequency Range. The frequency range offered is generally from 10Hz to 100kHz with the more expensive instruments giving anything up to 1MHz. In practice 20Hz to 100kHz will be satisfactory for the majority of applications.

Accuracy and Stability. The accuracy and stability of the instrument has an enormous effect on cost, but accuracies better than 5 to 10 per cent are seldom necessary.

Output Impedance. The output impedance is usually 50 ohms, 600 ohms or 1 kilohm. For a given output voltage the instrument has to supply twenty times the power to drive 50 ohms compared to 1 kilohm. Many professional engineers will compromise with 600 ohms, but unless the instrument is to be used with telecommunications circuits even this is unnecessary. Most users will find that they can settle for 1 kilohm output impedance.

Maximum Output Voltage. Similarly the maximum output voltage should be carefully considered, (remember power is proportional to E^2). One volt **maxi-**

Fig. 6. An audio signal generator made by Tech. The TE22D is adequate for most amateur needs.



mum is probably sufficient for most applications.

Termination Impedances. Some instruments provide the facility for internal or external connection of the load impedance, this facility is only necessary with instruments having an accurately calibrated attenuator.

Attenuation. Some form of attenuation is usually provided and its accuracy will affect price considerably. It is usually better to pick the instrument with the most accurate attenuator as this is a useful feature.

Sine and Square Wave. The sine-square facility is of little value unless an oscilloscope is or will be available, so this feature need not influence the choice.

Distortion Level. Even with an oscilloscope distortion is of little interest (it can even be a definite advantage), so this feature need not affect the choice.

Rise Time. If square waves are provided rise time will affect the price. For digital work 0·1 microseconds is barely adequate and faster pulses are seldom offered. Having regard to the fact that fast rise time square waves may easily be generated with a single integrated circuit, this feature may also be disregarded.

When purchasing an audio generator decide; the frequency range, output voltage, output impedance and attenuator accuracy needed. Then select the most suitable instrument from a comparison of these features. The Tech model TE 22D which provides a useful range at the cost of £18 is shown in Fig. 6.

R.F. SIGNAL GENERATORS
£16 to £600

Like a.f. oscillators r.f. signal generators are most useful instruments, in fact for those concerned with communications receivers and their maintenance they are more useful. Similarly a low cost instrument is capable of giving plenty of useful service. Factors affecting cost are: frequency range, calibration accuracy, output impedance, attenuator accuracy. All of these points should be carefully compared when making a selection between r.f. generators.

Frequency Range. The frequency range will obviously depend upon the application for which the generator is required, however, it would be wise to select the widest possible range.

Calibration Accuracy. Frequency calibration accuracy is much more important with an r.f. generator because it will be used to calibrate receivers, therefore select for the best frequency calibration accuracy possible.

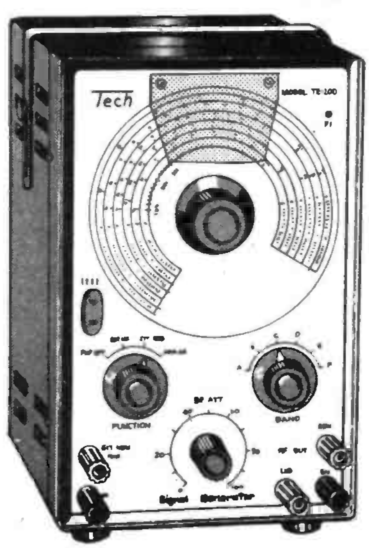
Output Impedance. The r.f. generators output impedance is not too important for general use, but if 50 or 75 ohms is available the signal can be fed down a terminated cable, thereby making the instrument much more attractive.

Output voltage is **not** important for an instrument used mainly for the alignment of receivers and may be disregarded.

Attenuator Accuracy. An accurate attenuator is of value, but far more important is the need to attenuate the signal down to micro-volt levels making some form of attenuator necessary. If an accurate attenuator is considered desirable, it is necessary for the instrument to be very well screened and not radiate to an adjacent receiver when its output socket is covered.

The Tech model TE-20D r.f. signal generator is shown in Fig 7. This instrument has the useful facility of a crystal input socket. With the aid of a quartz crystal spot checks of the frequency calibration can be made. This generator costs less than £18.

Fig. 7. The Tech model TE20D r.f. signal generator. This model incorporates a crystal input for calibration checks.



WOBBULATORS

A special design of r.f. generator for use with oscilloscopes is known as a wobbulator. This device is designed to work in conjunction with the oscilloscope time base so that it sweeps over a band of frequencies. By this means the equipment can be arranged to sweep over an i.f. band and the characteristics of the i.f. channel displayed on the trace of the oscilloscope.

The alignment of receivers, particularly f.m. and communications receivers, can be very precisely adjusted using this type of equipment.

PULSE AND WAVEFORM GENERATORS

There are many other specialised generators available; producing square waves, pulses, saw tooth and other waveforms. These generators incorporate variable frequency, variable voltage, variable rise time, variable pulse widths, variable delay times, oscilloscope trigger pulses and various other facilities.

Such instruments are for the professional engineer who needs them as an indispensible tool for use with his oscilloscope. The instruments are of little or no value to the beginner, but they are advertised from time to time in electronic publications.

Second-hand instruments of this nature are occasionally offered for sale, but they are useless without a good quality oscilloscope; therefore a "bargain" should not be bought unless it is intended to purchase an oscilloscope also.

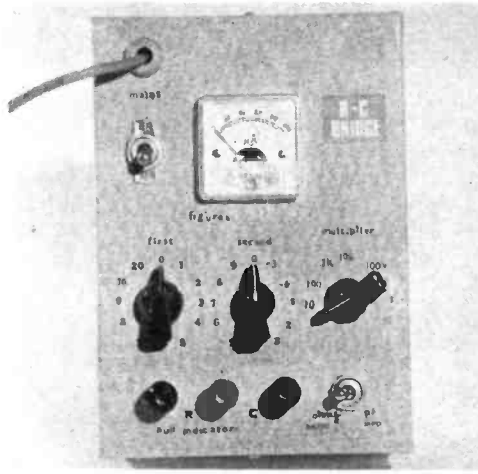
L.C.R. BRIDGES
£15 to £1,500

L.C.R. stands for inductance, capacitance and resistance. A vast range of different L.C.R. bridges are manufactured. The selection of an appropriate instrument depends entirely on the application and type of work undertaken by the user. Bridges are made to operate at r.f. as well as lower frequencies because components change their characteristics at different frequencies.

Most readers will, for the present, be concerned mainly with the rough and ready measurements of components laying unidentified in their spares boxes, so this application only will be considered. The cheaper instruments are usually sold as two types; one measuring capacitance and resistance, the other inductance.

Resistance can be measured quite well on a multi-range meter, but not to the accuracy of a good bridge. A useful precaution is to check the specified accuracy of the multi-range meter you normally use to see if the bridge under consideration is significantly better. If not resistance measurements may be disregarded. An additional point to remember is the fact that resistors are inexpensive enough to throw away if they are so damaged that the colour code does not indicate their value.

Hence the R.C. bridge is mainly used for capacitance measurements where two factors should be compared. One is the range of capacitors the instrument will measure and the other is the accuracy with which these measurements may be carried out. An R.C. bridge is of limited value and may be regarded as a luxury instrument.



The R.C. bridge, construction details of which will be published in a future issue of *Practical Electronics*.

The inductance bridge is of more use. Coils are not sold in the same way as resistors and capacitors, therefore, their inductance is not easily determined. There are formulas for calculating inductance, but these, in addition to being complicated, are inaccurate. Many users will want to wind their own r.f. coils and chokes, making an inductance bridge much more useful than the R.C. bridge, unfortunately they are more expensive. The main points to look for are: inductance range measured, ease of balance on small inductances, measurements with d.c. current flowing.

Range. When consideration is given to the range of inductances measured most users will be interested in small inductances of a few microhenries.

Ease of Balance. Small inductances are the most difficult to balance so it is advisable to try out the bridge with small inductances to see if a sensible balance is possible. This feature is much more important than measured accuracy because 5, 10 or 15 per cent is of little consequence in most applications, especially when many coils are adjustable.

D.C. Current Flowing. If measurements of iron cored inductors is contemplated it is necessary to measure the inductance with a d.c. current flowing. Iron cored inductances vary depending upon the amount of d.c. flowing. For example a 10 henry choke may drop to 4 or 5 henries with 200mA flowing through its windings.

A typical low cost inductance bridge marketed for less than £25, is shown in Fig. 8.

Fig. 8. The inductance bridge marketed by Nombrex. This type of instrument will meet the needs of most private constructors.

OSCILLOSCOPES £75 to £2000

An oscilloscope is a very expensive item of equipment where, unlike most of the other instruments, a cheap oscilloscope is of little value. Professional design engineers seldom use oscilloscopes costing less than £1,000, they will also have available equipment such as; waveform generators, pulse generators, wobbulators and

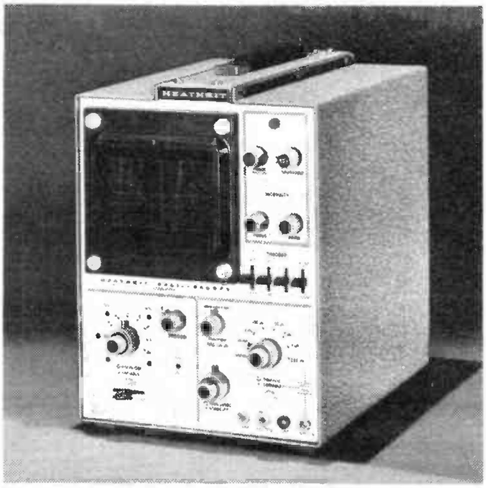


Fig. 9. The Heathkit model 10-103 general purpose oscilloscope. At about £100 this is not an instrument many enthusiasts are likely to purchase.

signal generators to use with their oscilloscope. Without this ancilliary equipment even a good quality oscilloscope is of little value.

There is a vast range of oscilloscopes to suit all manner of work, so it is not possible to identify factors affecting quality or price. However it is possible to indicate how some of the cheaper instruments could be used.

An instrument costing £75 or possibly less could be used for classroom demonstration. Various wave shapes can be shown and for anyone able to take the time and trouble to set up a wobbulator, i.f. bandwidth, filter characteristics, amplifier bandwidth and similar circuits may be demonstrated. Of course, the ideal classroom demonstration would use a large screen oscilloscope which is much more expensive.

Instruments in the £100 to £150 range could be used for receiver alignment when set up with a wobbulator; or for audio amplifier work, in which case a double beam model is recommended. Here again the equipment should be permanently set up to do the job required.

For general purposes electronic work the minimum recommendation is: d.c. measuring capability, d.c. to 5MHz amplifier bandwidth, a triggered time base. An oscilloscope having these facilities with appropriate controls for the time base range, brilliance controls etc., could be used to some effect.

From time to time second hand oscilloscopes become available at a reasonable price. If the circuit diagram and service manual is also available these could be a good buy for anyone able to repair them. For the rich enthusiast the most economic way of getting a reasonable instrument is to purchase a kit, Fig. 9 shows the Heathkit model 10—103, which costs less than £100.

CONCLUSION

Finally, when choosing test gear, buy the best that can be afforded and buy in the right sequence. First acquire a top quality multi-range meter, the best of these is cheaper than most other instruments. Secondly a stabilised power supply is required to drive equipment that is built. Thirdly, a signal source is necesssary, for hi fi addicts an a.f. generator and for the radio fiend an r.f. generator.

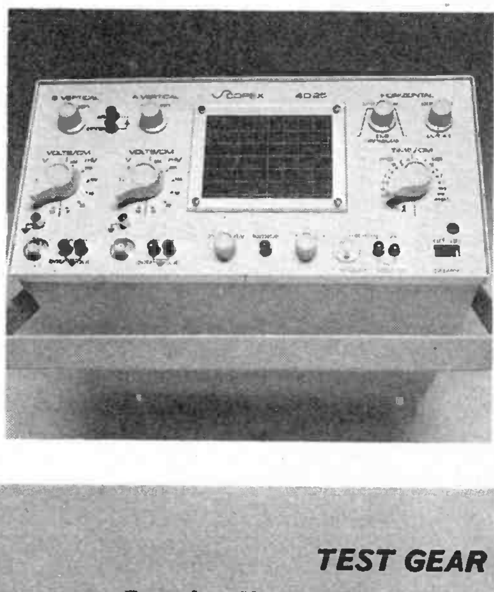
Transistor testers and L.C.R. bridges are luxuries, all right if they can be afforded. For those contemplating an oscilloscope, remember that oscillators, wobbulators, square wave generators or pulse generators are necessary to drive it, depending upon the type of work the equipment is to do.

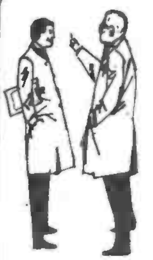
Above all **don't be put off by the cost,** most of these things can be made from designs published in EVERYDAY ELECTRONICS and *Practical Electronics,* building your own test gear can be as fascinating and useful as any other project.

The following equipment has been, or will be, described in EVERYDAY ELECTRONICS in the issues mentioned: *Power Supply Unit* (February 1974), *Audio Frequency Oscillator* (March 1974), *Electronic Voltmeter* (April 1974), *Transistor Tester* (May 1974), *Radio Frequency Generator* (June 1974).

Our companion magazine, *Practical Electronics,* also publishes articles detailing the construction of test gear. The R.C. bridge shown on page 7 will be published shortly. Unfortunately we are not able to supply back issues of the magazines. ▣

A professional type oscilloscope. This is the Scopex 4D25, a twin beam oscilloscope that costs about £175.





SHOP TALK

By Mike Kenward

WE often receive readers' letters either requesting information that we have published or enclosing a cheque or postal order for a kit of parts for a particular project. We must point out that we do not sell any components. The "approximate cost" included on constructional articles is a total cost of the components that can be purchased from suppliers advertising in the magazine. We compile this cost for your guidance from prices quoted in catalogues and advertisements.

If you make sure you have read the relevent issue before writing to us and enclose an s.a.e. with your letter then it will help us to help you. One other point, we do mention at the beginning of each issue that we cannot supply back issues of our magazine. We are sorry about this but it is simply not possible so please don't send us money for back issues or reprints of articles because all we can do is return the money.

If you do want back numbers you may find that a large library keeps them and many can provide photostats of particular articles.

Before we look at this month's projects we have been asked by Texas Instruments Ltd., to publish their apologies for a delay (approximately 21 days) in sending out copies of their book "Understanding Solid State Electronics". This is due to the very big response to their advertisement in the February issue of E.E.

Transistor Assisted Ignition

The main problem with parts for the *Transistor Assisted Ignition* is the supply of transistors. When we checked with Texas they were only able to supply the TIP53 and a TIP50 (an equivalent for the TIP49). In fact a TIP54 may be used instead of the 53 and a 50 instead of the 49 so if you can get any of these they are suitable.

A. Marshall and Son are trying to stock up with suitable devices and they should cost about £1·53p for TIP53 and 63p for TIP49 but they may have to supply the equivalents. They can also supply the BC214.

The rectifier should also be available but any 600V 3A silicon, stud mounting diode will do, should the 1S415 prove difficult. The BYZ 11 is a suitable substitute with the same connections as the 1S415.

A. Marshall and Son (London) Ltd., 42 Cricklewood Broadway, London NW2 3HD are offering all the semiconductors for £2·85 including postage, packing and V.A.T.—a 10 per cent reduction on the individual prices.

Electronic Voltmeter

The third instrument in the E.E. Test Gear Five series is the *Electronic Voltmeter*. Most of the parts for this unit are readily available. The knobs and case were detailed last month and will be detailed again when the last instrument is published (in two months time) since the space we have is very limited.

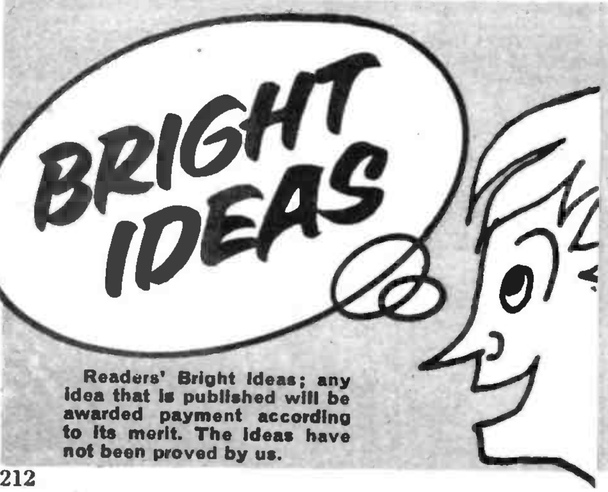
The moving coil meter used in the design can be any 100μA meter but remember that the larger it is the more accurately it can be read—but it does have to fit in the case! The prototype used a SEW SD460 type which has an appearance and finish in keeping with the design.

Light Powered Radio

The cells used in the *Light Powered Radio* were originally developed by Ferranti for the space programme and are not cheap devices (about £1·65 each from Home Radio Components Ltd). However should this cost deter you from building, the radio can be powered by a single 1½ volt battery.

Home Radio can also supply a spindle for the trimmer capacitor specified. The earphone used with the radio **must** be a magnetic type —many of them are crystal types and these will not work.

If the radio is powered by the light cells mentioned above one side of the case must be transparent to allow light to reach the cells, otherwise any small plastic case will do. A soap container is about the right size.



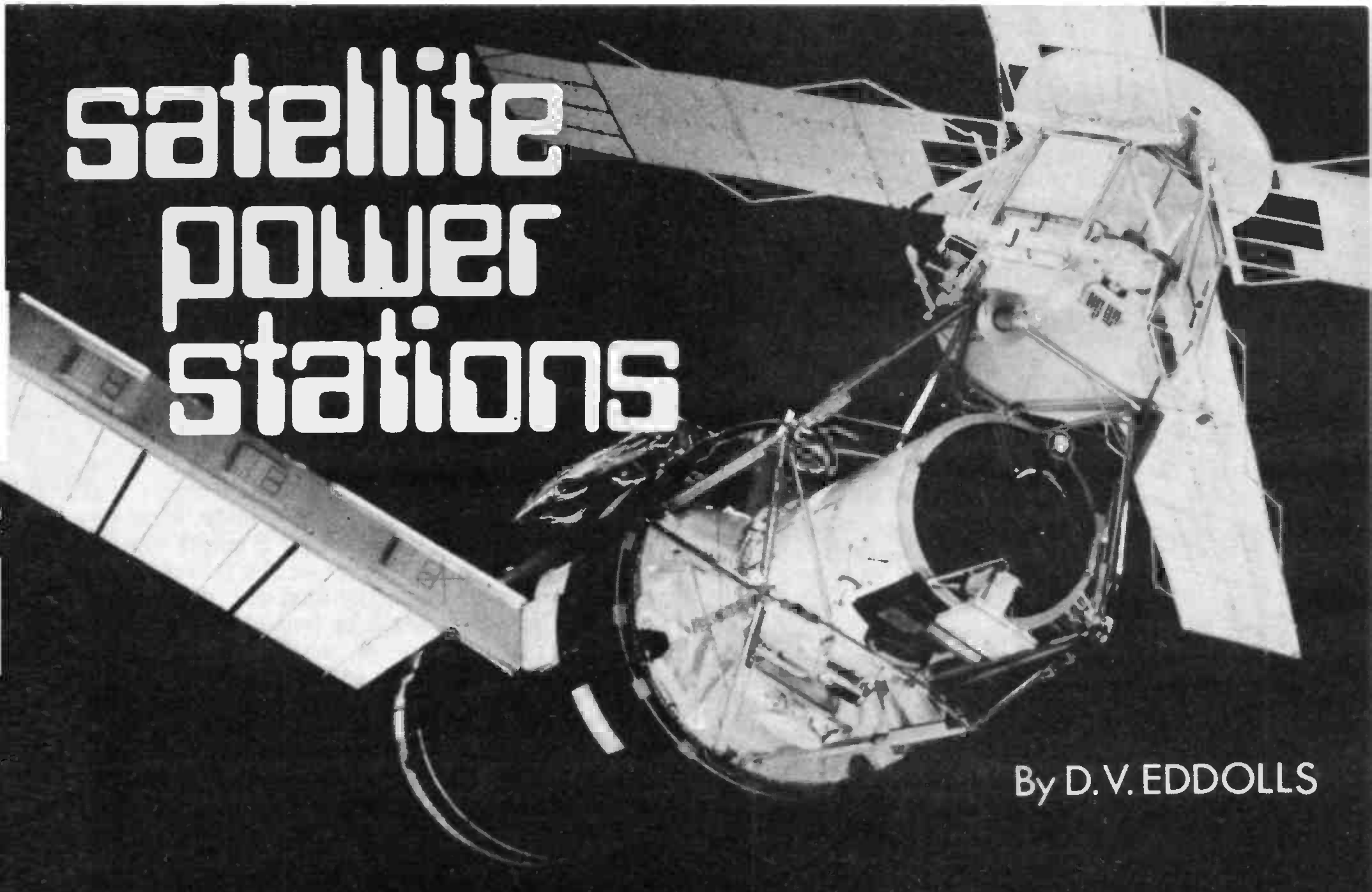
Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

I would like to submit an idea for your Bright Ideas column. It is a device for easily measuring current consumption in radio or cassette players using HP7 or U2 type batteries etc.

It is almost impossible to insert test meter probes between the batteries and contacts as the springs in the holder force them together. To overcome this problem, either cut a strip of double sided copper clad board or two strips of single sided board and glue together, about 10cm long and 7mm wide; the copper sides should be thinly tinned to prevent oxidation. When completed the strip is sharpened at one end and can be inserted between the batteries and contacts. The meter probes can now be touched against the sides of the strip and the current read.

N. J. Moyes,
Croydon, Surrey.

satellite power stations



By D. V. EDDOLLS

Most electronic equipment is dependent in some way upon electricity from the national grid. Yet ninety per cent of our power stations use coal, gas or oil—fossil fuels that are rapidly being exhausted. An alternative method of producing power is the direct conversion of sunlight to electricity.

The advantages of generating electricity from sunlight are that it is inexhaustible and pollution free. The disadvantage of siting a solar generator on earth is the reduction in available sunlight by the atmosphere, rain and clouds, and, of course, no generation is possible at night.

However, these disadvantages could be overcome by the space programme and three electronic devices. This article describes how satellites, silicon solar cells, magnetrons and point contact diodes may be used to tap the sun's energy in the year 2000.

SOLAR CELLS

Sunlight incident on a silicon *pn* junction (Fig. 1) raises electrons to higher energy levels. This results in either a current or voltage being produced in the external circuit. If the circuit resistance is high compared with the junction resistance a voltage is generated. If the circuit resistance is low a current is produced.

Silicon solar cells are used to produce electricity from sunlight in many parts of the world. Skylab, shown in the heading photograph, and other satellites are dependent for their electricity on solar cell panels.

An American scientist, Dr. Peter Glaser, is studying the possibility of using satellites with large solar cell panels to supply the world's electricity.

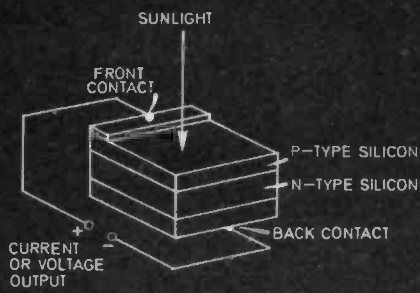


Fig. 1. Silicon solar cell.

SATELLITE POWER STATIONS

A satellite power station, Fig. 2, in orbit 22,300 miles above the equator would circle the earth once each day, remaining stationary relative to any point on the ground. Its solar cell panels would always point towards the sun. They would receive the full intensity of the sun's light summer and winter, day and night.

The satellite would only pass through the earth's shadow for about an hour around mid-night near the spring and autumn equinoxes. A break in supply when this happened would be avoided by having two satellites 8,000 miles apart. This would ensure that at least one was always receiving sunlight.

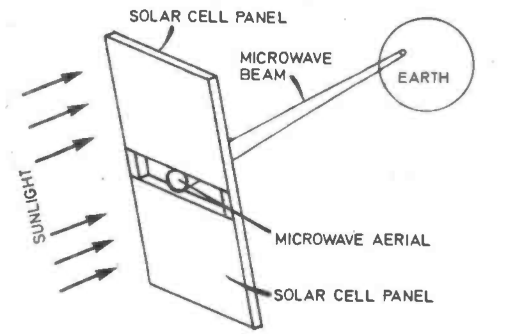


Fig. 2. Satellite solar power station. Electricity generated from sunlight is transmitted to earth at a microwave frequency.

New York uses electricity at the rate of 10 million kilowatts. This could be generated by an array of solar cells 12 square miles in area. The total area of the solar panel including collectors to focus sunlight onto the solar cells would be about 40 square miles.

TRANSMISSION TO EARTH

For transmission to earth the solar cell output would be converted from d.c. to 3,000MHz. This could be done using the magnetron valve, which was developed in 1940 and made radar possible in World War II.

In the magnetron shown in Fig. 3, clouds of high energy electrons are made to circle the cathode by crossed electric and magnetic fields. The electrons deliver most of their energy to an r.f. circuit, generating high frequency pulses, before being captured by the anode.

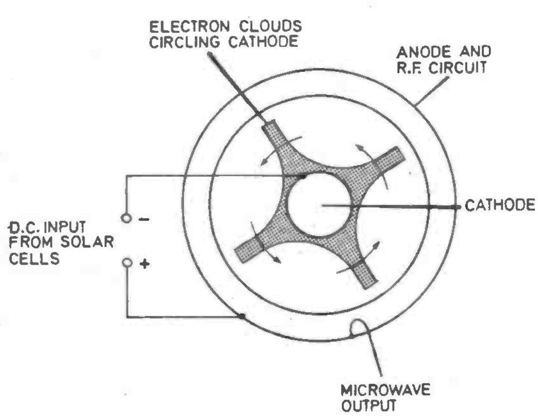


Fig. 3. Principle of operation of the magnetron valve.

On earth these valves operate in a glass vacuum envelope which is bulky and heavy. The vacuum of space is better than any produced on earth making this envelope unnecessary. In addition there would be no residual impurities to poison the electrodes and shorten the life of the valve.

In principle the high frequency pulses generated by the magnetron could be beamed to earth using a reflecting dish aerial. However, problems in construction and operation of a rigid aerial with the required size and tolerances would be enormous.

PHASED ARRAYS

A better approach is to use a large number of generators, each one feeding a single dipole aerial. By using a small part of the power from each generator to excite the next one, the output from all the valves could be locked to the same frequency. The array of aerials would then radiate as a single large source.

Systems of this type, called phased arrays, are already widely used in military radar applications. A modified form of the magnetron would be used which has both a microwave input and output and operates as a broad band amplifier. Such valves, called amplitrons, have efficiencies of between 80 and 90 per cent.

Magnetrons and amplitrons give maximum power and efficiency in the frequency range 1,000MHz to 10,000MHz—30cm to 3cm wavelength.

The effect of the ionosphere, which reflects radio waves making long distance radio communication possible, can be ignored at these wavelengths. The important factors are atmospheric absorption and the size of the aerial system.

Absorption by oxygen, water vapour, rain and clouds increases at short wavelengths, but longer wavelengths require a larger aerial system. The preferred wavelength is likely to be 10cm where loss in the atmosphere is only a few per cent.

EARTH RECEIVER

More than 90 per cent of the signal from the satellite will arrive at the earth's surface. Here, the most satisfactory receiver will be an array of half-wave dipoles, each dipole feeding a bridge rectifier, Fig. 4. The advantage of this system is that its efficiency is not strongly dependent on the signal's direction.

This property of non-directivity is essential if two satellites are used to avoid a break in supply when one passes through the earth's shadow. It will also allow the array of dipoles to be laid close to the ground, following rolling landscape.

Point contact diodes would be used in the bridge rectifier. These are a robust and reliable modern equivalent of the cat's whisker and crystal (EVERYDAY ELECTRONICS, August 1973).

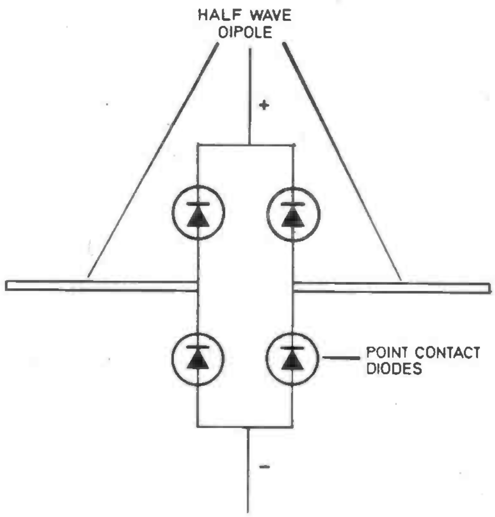


Fig. 4. Basic element of the earth receiver.

The semiconductor surface is coated with a metal film and contact made by a fine point on a metallic spring. These devices can achieve conversion efficiencies up to 70 per cent and dissipate 10 watts.

Each receiver would cover an area of about 20 square miles. Since the microwave signal is not appreciably attenuated by rain or cloud, the receiver can be sited anywhere in the world and electricity generated where it is needed. The only pollution would be heat from the rectifiers.

PRECAUTIONS

However, special precautions must be taken to prevent the microwave beam moving off the receiver area. This would result in a loss of electrical power and expose human and animal life to microwave radiation.

Microwave energy produces a heating effect in human and animal tissue, as demonstrated by the use of microwave ovens. The energy density at the centre of the beam will be about 100 milliwatts per square centimetre. This is ten times the continuous exposure level generally considered safe for man.

The direction of the microwave beam can be controlled by adjusting the phase of the signal from each transmitting dipole. Microwave energy is strongly radiated towards a point at which the signals from all the dipoles are in phase. In practice the array would be divided into a large number of sub-arrays and the phase of the signal from each sub-array independently controlled.

A reference generator at the centre of the earth receiver would be used to lock the direction of the microwave beam. The phase of the signal from each sub-array in the satellite aerial would be electronically compared with the reference signal and adjusted to give the required beam direction.

COST

The cost of orbiting a satellite solar power station would be about £500 for every kilowatt produced. This is twice the cost of building and commissioning an offshore nuclear power station. Against this high cost must be balanced freedom from pollution and an inexhaustible supply of energy—the sun.

The intensity of sunlight falling on the earth is high enough to satisfy all our energy requirements. If the American development programme is successful, satellite power stations using electronic devices could solve the world's electricity supply problem. ▣

What do you know?

LOUDSPEAKERS

1. You have an 8 ohm 10 watt loudspeaker, an 8 ohm 2 watt loudspeaker a 16 ohm 3 watt loudspeaker and a 4 ohm 3 watt loudspeaker. The record player you are building requires an 8 ohm 3 watt speaker, it has an output of 2·5 watts. Which speaker would you use or consider most suitable?
2. You wish to drive four similar loudspeakers from a power amplifier the output impedance of which is 8 ohms what impedance speakers would you get and how would you wire them up?
3. A transistor radio you are repairing requires a replacement loudspeaker of 75 ohm impedance you are only able to get an 80 ohm type, what effect would this have on the output?

ANSWERS

1. The 8 ohm 10 watt speaker would be the most suitable but the 8 ohm 2 watt one could be used provided the volume was not turned fully up. The 16 ohm and 4 ohm types should not be used, although the 16 ohm type would only reduce the output level; the 4 ohm one could damage the amplifier. Physical size does not matter, electrically speaking.
2. You must get 8 ohm speakers, these could be wired two in series, in parallel, with two in series. Or wired, two in parallel, in series with two in parallel.
3. The 80 ohm speaker would probably make no *noticeable* difference although it might cause a very slight reduction in the output level.

ELECTRONIC VOLTMETER

TEST GEAR FIVE

Can measure d.c. voltages from a few millivolts to 1000 volts.

A HIGH impedance voltmeter is useful in any work involving electronic circuits because ordinary voltmeters load the circuit under test and give misleading results. Use of a high impedance instrument will not interfere with the circuit operation, so "in situ" measurements are possible.

The instrument described in this article, the Electronic Voltmeter, has an input resistance of 1·01 megohms whatever range the instrument is switched to, and 10 megohms if the x10 probe is used. The instrument is completely isolated from earth and therefore readings across components in any part of a circuit are possible.

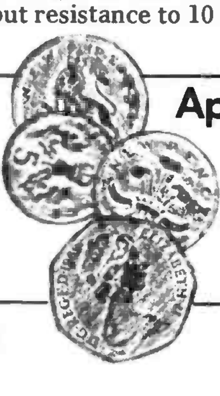
The shunting effect of the 1 megohm input resistance can usually be ignored. For example, suppose it is necessary to find the voltage developed across a 1 kilohm resistor. When the meter circuit is connected, the resistance value of 1 kilohm is shunted by 1 megohm so we have

$$\text{actual resistance} = \frac{R1 \times R2}{R1 + R2} = \frac{1000 \times 1}{1001} \text{ kilohms}$$

This is, of course, near enough to the original value for the difference to be ignored.

The effect of the shunt resistance of this instrument is only significant when measurements across resistors in excess of 100 kilohms are attempted. Therefore, for all practical purposes, the input resistance of this voltmeter may be ignored in the majority of transistor circuit applications.

Advantage is taken of the constant input resistance by making a x10 probe which extends the range of the instrument and increases the input resistance to 10 megohms.



Approximate cost of components including V.A.T. £6.40 excluding case

THE INSTRUMENT

The instrument has four ranges 100mV, 1V, 10V and 100V d.c. having an input resistance 1·01 megohms. When the x10 probe is used these ranges become 1V, 10V, 100V and 1000V d.c. with an input resistance of 10 megohm. A null balance control enables the meter to be set to zero with the input terminals shorted.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Electronic Voltmeter is shown in Fig. 1.

The voltage to be measured is applied via SK1 and SK2 across resistors R1 and R2 wired in series. The values of R1 and R2 are such that one-thousandth of the input voltage is developed across R2. This potential is amplified by the integrated circuit IC1.

With the range switch S2 in the position shown, the gain of IC1 is determined by the ratio of R4 (feedback resistor) to R3. From last month's article you will recall that the gain is given by the formula

$$\text{Gain} = 1 + \frac{R4}{R3}$$

The feedback resistor values are chosen to give gains of x2, x20, x200 and x2000 which amplify the input voltages to approximately 2 volts. This amplified output voltage is applied to

ME1, a 100μA meter movement, via paralleled resistors R10 and R11.

The instrument requires a null balance to set the meter to zero when there is no signal input. This is achieved by connecting VR1 to the offset inputs of the integrated circuit (pins 1 and 5).

Power for the unit is obtained from two 9 volt batteries. The voltmeter draws a current of about 1mA from the batteries which consequently last for a long time. Switch S1 disconnects both batteries when the instrument is not in use.

CHOOSING THE METER

Several different meters will work satisfactorily in this circuit, providing that R10 and R11 are chosen to suit the movement. However, larger current meters will load the batteries. For example, a 10mA movement is unsatisfactory because the replacement cost of batteries swamp any savings in meter cost.

A 1mA movement gives a battery drain of 2mA against the 1mA consumption obtained with the use of a 100μA movement. A 50μA movement gives no appreciable saving and has the disadvantage of being calibrated 1-5 instead of 1-10. For all round economy, a 100μA movement has been selected.

Readers may like to use a 100-0-100μA movement to indicate both positive and negative voltages. If such a meter is chosen the design procedure is identical to that of the ordinary 100μA movement.

SELECTING R10 AND R11

With the specified 100μA meter, calculation of the series resistance to give full scale deflection is as follows. Divide the integral circuit output voltage (1·98 volts) by the meter current to obtain the total resistance R_t.

Components....

SEE SHOP TALK

Resistors

R1	1MΩ	R8	1MΩ
R2	10kΩ	R9	1MΩ
R3	1kΩ	R10	300kΩ selected
R4	1kΩ	R11	20kΩ
R5	1kΩ	R12	200kΩ selected
R6	18kΩ	R13	2·2MΩ
R7	200kΩ	R14	3·3MΩ
		R15	3·3MΩ

All ¼ watt ± 2% high stability types

Integrated Circuit

IC1 741 differential operational amplifier, 8 pin d.i.l. type

Miscellaneous

VR1	10kΩ carbon linear
ME1	100μA d.c. meter type SD460 or similar
S1	double-pole on/off switch
S2	single-pole four-way wafer switch
B1, B2	PP3 9V battery (2 off)
SK1, 2	insulated screw terminals, 1 red, 1 black

Veroboard 34 strips x 44 holes x 0·1in. matrix; 8 pin d.i.l. integrated circuit holder; two knobs one with indicator; 6BA nuts, bolts, washers and spacers (4 off each); Veropins; metal case type Olsen 25A with louvres or similar; exhausted Bic ball point pen.

$$R_t = \frac{1\cdot98}{100 \times 10^{-6}} \text{ ohms}$$

Next subtract the meter resistance R_m (580 ohms with the movement used).

Therefore, $R_t - R_m = R_s$ (the series resistor)= 19·22 kilohms. This means that the combination of R10 in parallel with R11 must equal R_s (19·22 kilohms). As R11 is 20 kilohms we have

$$R10 = \frac{20 \times 19\cdot22}{1\cdot2} \text{ kilohms} = 320 \text{ kilohms}$$

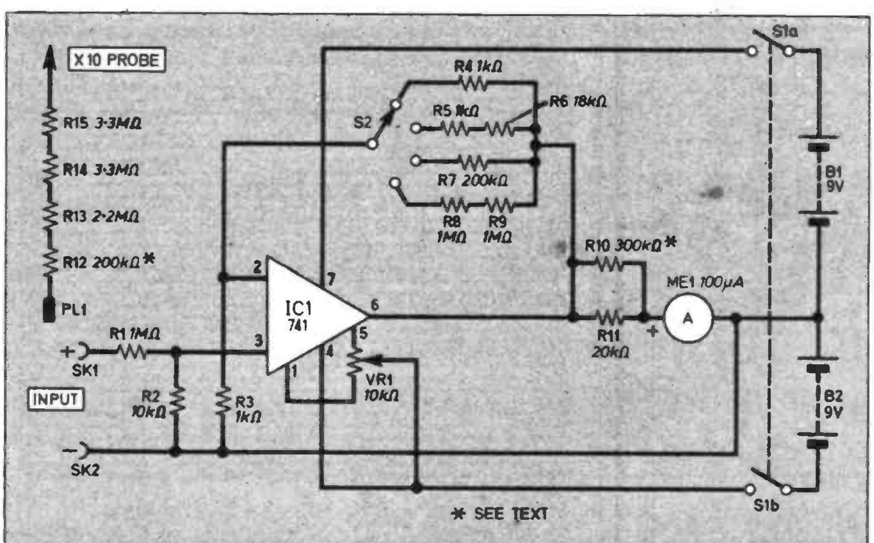


Fig. 1. The complete circuit diagram of the Electronic Voltmeter and x10 probe.

ELECTRONIC VOLTMETER

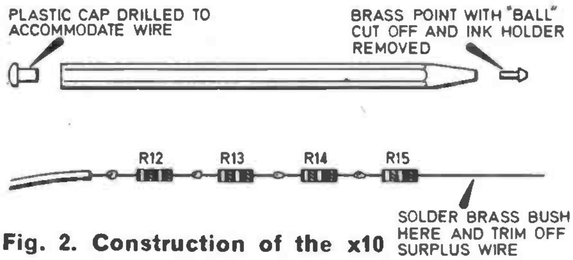


Fig. 2. Construction of the x10 probe.

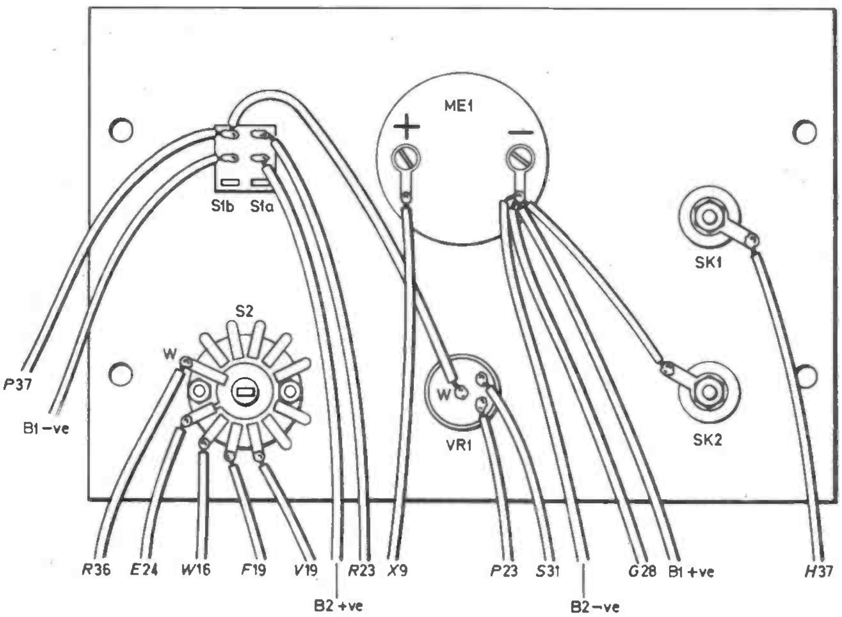


Fig. 4. Positioning and wiring up of the components on the rear of the front panel.

W=WIPER

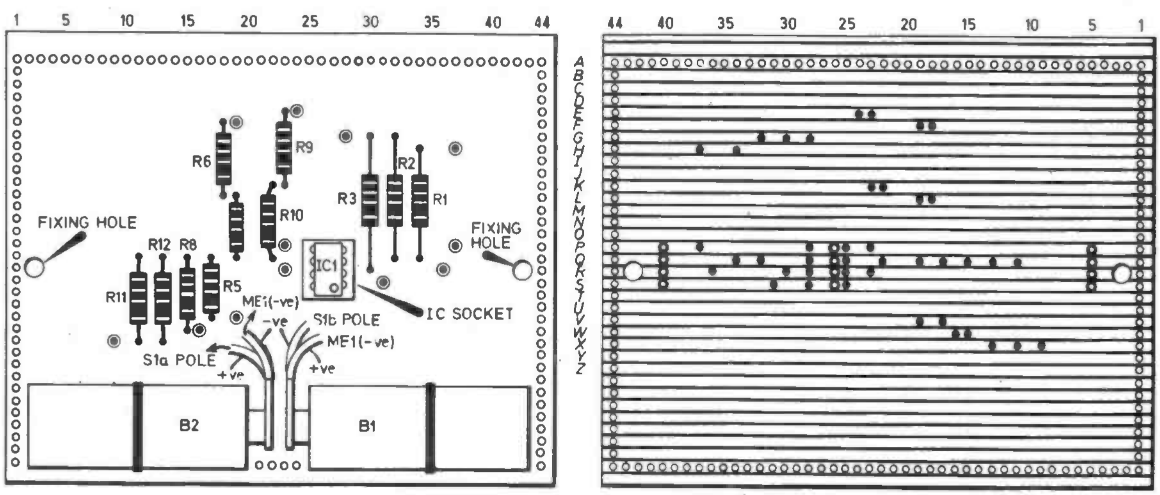


Fig. 3. Layout of the components on the topside of the veroboard and the copper regions to be removed from the underside. Note the polarity of the integrated circuit.

In practice 300 kilohms is sufficiently accurate, but readers may put 20 kilohm resistor in series with R10 if they wish to achieve a higher degree of accuracy. However, with 2 per cent resistors, the meter is unlikely to be better than ±4 per cent. It can be calibrated with respect to another instrument by shunting R10 with large resistors, or by putting small resistors in series with R10 until the instrument agrees with the voltmeter it is compared with.

To achieve the highest possible accuracy the instrument is calibrated on each range with shunt or series resistors across R4, (R5, R6), R7, (R8, R9). Trimming these resistors is not really necessary as ±4 per cent is better than most of the cheaper meter movements, however, it is desirable to buy the best 100μA movement that can be afforded.

THE PROBE

The probe is constructed from an old ball point pen, see Fig. 2. Four resistors capable of fitting inside the barrel of the ball point pen are soldered together. A 9 megohm resistance is required, but no resistor may be used with a resistance value of more than 3·3 megohm for safety reasons. Four standard values will make up the required value; they are, 3·3 megohm+3·3 megohm+2·2 megohm+200 kilohm. Because resistors of this high value are usually wide tolerance the chain may be checked against another meter before assembly into the ball point pen. Accuracy is achieved by selecting different values for the 200 kilohm resistor so that it compensates for any errors in the other three resistors.

To assemble the probe, feed the resistor chain into the barrel of the pen, as indicated in Fig. 2. Push the brass bush into the barrel and solder to R15. Pass the flexible wire through the end cap which is then fixed into the barrel with aid of a little adhesive such as Evo-Stik.

The probe assembly is safe to use on voltages up to 1000 volts, but do not attempt to use it with higher voltages.

CONSTRUCTION DETAILS

The prototype Electronic Voltmeter was built in a standard metal instrument case of dimensions 165×115×115mm.

The component board consists of a piece of 0·1in. matrix Veroboard size 34 strips by 44 holes. The layout of the components on the topside of the board and the breaks along the copper strips on the underside are shown in Fig. 3. Veropins are used for all flying lead connections from the board to the front panel mounted components, although this is not essential.

Begin construction by drilling the two fixing holes as indicated and then make the breaks along the copper strips as detailed. Now insert and solder in position the Veropins followed by the i.c. holder and resistors. The i.c. should not be in its holder whilst soldering is being carried out.

A simple method of holding the batteries in position is to solder two Veropins either side of the battery. These pins are bent to allow an elastic band to be hooked between them thereby holding the battery in position.

The component layout on the front panel is shown in Fig. 4; with reference to this and the photograph of the front panel, make the necessary cut-outs in the front panel to accommodate these components, and then secure in place. Now wire up as detailed in Figs. 3 and 4 and then insert the integrated circuit in its holder, paying special attention to polarity, indicated by an indentation at one end of the i.c.

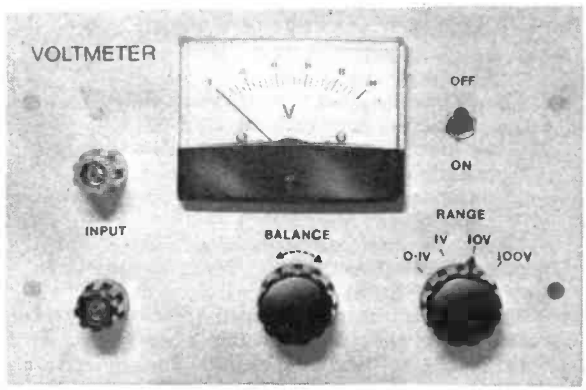


Fig. 5. Details of front panel labelling.

The labelling on the front panel of the prototype was done with Letraset and then sprayed with Letraset protective gloss to provide a very neat and professional finish, see Fig. 5.

The component board should now be bolted to the base of the case using 6BA nuts, bolts, washers and 10mm spacers so that it is raised above the metal base. Screw on the front panel and the unit is complete and ready for testing.

TESTING

Switch on the unit and check that the balance control will swing the meter movement positive and negative. To achieve an accurate null, set the range switch to 0·1V and adjust the meter to read zero with the input terminals shorted together. Switch to an appropriate range and connect the meter to a known d.c. voltage.

If the unit should fail to work immediately switch off and check the wiring. A mistake in the wiring can easily damage the i.c. and meter movement so it is a wise precaution to double check the wiring to these components before switching on the unit.

Another useful precaution is to check that the copper tracking has been fully removed between the integrated circuit pins, because small amounts of track shorting between pins is a common fault. ■

SEMICONDUCTOR PRIMER

By A.P. STEPHENSON

9 ■ MANUFACTURERS' DATA SYMBOLS

Some of the important data symbols used by manufacturers of transistors and the correct way to handle them.

ABSOLUTE MAXIMUM RATING D.C.

$V_{ce\ max}$ Maximum voltage allowed between collector and emitter.
$I_{c\ max}$ Maximum collector current allowed.
$I_{b\ max}$ Maximum base current allowed.
$P_{tot\ max}$ Maximum steady power allowed to be dissipated within the transistor at 25 degrees centigrade (or at temperature specified).

These figures are dangerous since they represent **absolute** values. Designers seldom use at these limits.

The P_{tot} is rapidly reduced if temperature rises, and a massive heat sink is necessary if this figure is taken literally. For amateur designers, it is wise to *halve* the above figures.

GENERAL INFORMATION

Static forward current transfer ratio. This is the most important single item in the list, since it gives the ratio of **collector current** to **base current**. To set the d.c. operating potentials, the h_{FE} must be known.

Small signal current gain. This again is the ratio of collector to base current, but is concerned with *small changes*, ie. how much collector current changes for a small change in base current. Can be used to calculate input resistance, output resistance etc.

Note: any symbol with *small letters* for subscripts refers to *signals*, not d.c. Capitals signify static d.c. values. V_{ce} (sat) is the *lowest* voltage the collector will fall due to the current through the collector load resistor. The "top diode" is forward biased at this condition, normally around 0·3 volts.

10 ■ THE FOUR "h Parameters"

Although manufacturers will, if requested, supply enormous amounts of data on each transistor type, they normally publish a few important items only. Of these items, h_{fe} is always given.

The "*h* parameters" are **small-signal** tests resulting in certain figures, useful to designers. For a transistor operating in the common emitter mode they are defined as follows:

h_{fe} = small signal current gain $\left(\frac{I_c}{I_b}\right)$

(Measured with collector at signal ground)

h_{ei} = input impedance $\left(\frac{V_b}{I_b}\right)$

h_{oe} = output admittance $\left(\frac{I_c}{V_c}\right)$

h_{re} = voltage feedback ratio $\left(\frac{V_b}{V_c}\right)$

The independent variable in all of those ratios is the term in the *bottom*. The figures published are not constants, and are only true for a given set of d.c. operating voltages and currents.

Only h_{fe} is of general practical interest since the ratio of **collector current** to **base current** is the fundamental amplifying property of a transistor.

The other three "*h* parameters" are, in most applications, of academic interest only, because their values are swamped out by external circuit components.

Their main purpose appears to be a form of sadistic torture inflicted on bewildered students giving rise to orgies of useless algebra and unnecessarily accurate arithmetic.

By their use, calculation for say R1 could be some absurd answer like 46·842 kilohm. Without these three, a simple calculation would probably have yielded 47 kilohm anyway.

DEMO CIRCUITS

13

By MIKE HUGHES

The Series Resonant Filter

WE can make use of the fact that capacitors and inductors have values of **reactance** (resistance to a.c.) that vary with frequency. There are various configurations involving one, or both, types of these components with resistors that can give us circuits that will attenuate high frequencies or low frequencies or alternatively both high and low frequencies leaving only a central frequency that can pass unhindered.

All these circuits are called **filters**—for obvious reasons—and the subject of this month's experimental circuit is the latter; i.e. one that will only allow one selected frequency to pass through it—all other frequencies will be prevented from passing. Because the circuit selects only one frequency we called it a **tuned** filter. There are many different types of tuned filters and the one we have chosen to describe is the basic LCR series resonant circuit. The term LCR merely implies that we are using an inductor, capacitor and resistor in series to obtain the desired effect.

REACTANCE

For a given value of inductance we can obtain different reactances at different frequencies—as frequency increases inductive reactance increases for a given component. The same sort of thing happens with capacitors but capacitive reactance **decreases** as frequency increases.

We can calculate figures for reactance from simple equations for both the capacitor and the inductor:

For an inductor: inductive reactance

$$X_C = \frac{1}{2\pi fC}$$

For a capacitor: capacitive reactance

$$X_L = 2\pi fL$$

where the respective reactances are in ohms, f is in hertz, C is in farads and L is in henries, π is a constant equal to 3·142 (approx.)

PHASE

When an alternating current flows through reactive components it undergoes a degree of change in its phase. In normal resistive circuits we can say that at an instant in time the current is directly proportional to the applied driving voltage but in the case of, for example, the capacitor the current is proportional to the rate at which the driving voltage is changing. If there is no change of voltage, theoretically no current will flow through a capacitor—once a degree of equilibrium has been reached.

If we assume the voltage changes as a sinusoidal wave (sine wave) the maximum rate of change is when the voltage crosses over the central zero line; if this change is in a positive going direction we will get maximum positive current flowing in the capacitor. The converse happens with an inductor; assuming the d.c. resistance of an inductor is zero then a steady current flowing through it will not produce any potential difference across its ends. However if the current fluctuates we get induced reverse voltages across the ends of the inductor.

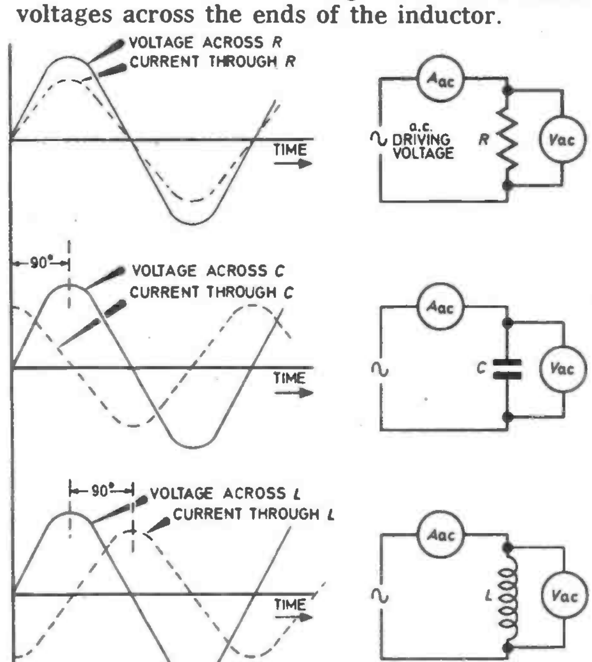


Fig. 13.1. Voltage and current relationships for resistance, capacitance and inductance.

The greater the rate of change in current the greater will be the induced voltage and it will always be of opposite polarity to the direction of current change. You can see the respective voltage and current waveforms we are talking about in Fig. 13.1. Notice that the driving voltage is 90 degrees out of step with the current in the case of the capacitor and inductor but are in phase for the resistor. If you look carefully you will see that if you compare the waveforms for the capacitor and the inductor the respective currents are 180 degrees out of phase for a given direction of voltage.

IMPEDANCE

All this leads up to the fact that you cannot simply assume there is a direct proportional relationship between driving voltage and current in a reactive circuit. We have to take into account the phase of the wave when we convert from voltage to current. This therefore means that the total resistance of a circuit containing reactive devices is rather special. We cannot simply add together the various reactances and resistances of a circuit to get total circuit resistance. Instead we must calculate reactances for a given frequency and combine these values with any d.c. resistance—taking into account the respective phase of the alternating signal being applied and from these facts we calculate what we call circuit **impedance**—which is the equivalent to what would normally have been total circuit resistance when dealing with d.c.

For an LCR series circuit the impedance can be calculated from the equation

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

The important thing to notice is that there is obviously a case when X_C exactly equals X_L and when this happens the circuit's impedance equals the circuit's resistance and this will be a minimum value of impedance, i.e., for any imbalance between X_C and X_L the circuit impedance will always be greater than the resistance element.

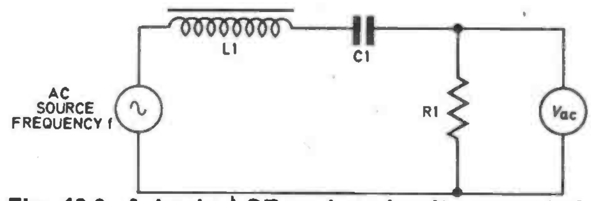


Fig. 13.2. A basic LCR series circuit connected across an a.c. source of voltage. We assume that there is little or no resistance or reactance inside the source.

RESONANT FREQUENCY

Look at the LCR circuit of Fig. 13.2. We will assume that we are measuring the r.m.s. a.c. voltage across the resistor. This could be calculated by applying the usual potential divide technique; taking the r.m.s. value of source voltage and multiplying by R1 and dividing by the total circuit impedance.

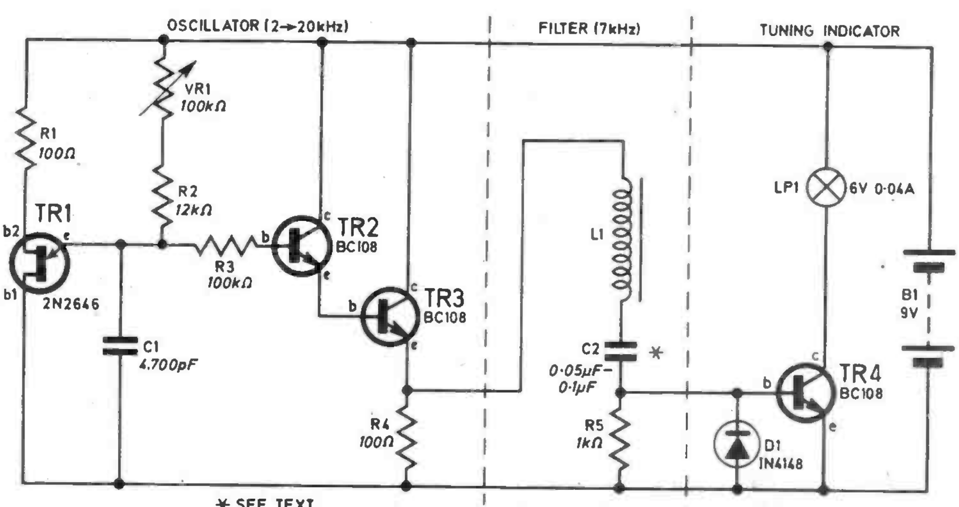
$$V_{out} = \frac{R1 \times V_{in}}{Z}$$

Normally Z is always greater than R1 as we have just seen, but at one frequency Z will equal R1 and when that happens the output voltage will (theoretically) equal the input voltage; at all other times it will be less. The frequency at which this occurs can be calculated by saying that we must have the inductive reactance and capacitive reactance the same. This is when:

$$2\pi fL = \frac{2\pi fC}{1}$$

from this we can see that $f = \frac{1}{2\pi\sqrt{LC}}$

Fig. 13.3. Demonstration circuit incorporating an LCR filter.



The frequency that gives us a net result of zero circuit reactance is called the resonant frequency and from the above description you can see that the output signal will be a maximum; at all other frequencies—whether higher or lower—the output will be less.

PRACTICAL DEMONSTRATION

This can be demonstrated by the practical circuit of Fig. 13.3. Although it may look complex the circuit can be split into three stages. We have shown a variable frequency oscillator comprising TR1, 2 and 3—this is similar to the unijunction oscillator we have featured in an earlier part. The output should, ideally, be a sinewave but it is not easy to produce a simple sinewave oscillator having a wide range of frequencies and this circuit produces a sawtooth which although not ideal is good enough for demonstration. We need a low output impedance from the oscillator so TR3 is used as an emitter follower; a low impedance is essential so that it does not significantly affect the impedance of the filter circuit—which is shown as the second stage.

As it is unlikely that you would have an oscilloscope to measure the output signal across R5 we are removing any negative going excursions with D1 and every time the signal at the top end of D1 becomes more positive than 600mV we will force base current into TR4 which will make LP1 light up. We suggest that you wind your own inductor for L1 on a 100mm length of $^3\!/_8$ inch (approx. 10mm) diameter ferrite aerial rod, you will need 700 turns of 36 s.w.g. enamelled copper wire. This can be pile wound on the rod over about a 50mm length and will give an inductance of about 10mH. If C2 is made to be $0{\cdot}05\mu F$ this will give a resonant frequency of about 7kHz.

The oscillator stage has a range of from 2kHz to 20kHz so resonance should be obtained within the adjustment of VR1. Thus when VR1 is set to give a frequency of about 7kHz the output from across R5 should be maximum and this is indicated by the lamp lighting to maximum. As soon as the oscillator is set to other frequencies the lamp will dim and go out. You can change C2 to $0{\cdot}1\mu F$ and the resonant frequency will reduce to about 5kHz but again you can tune in the lamp to maximum illumination by re-adjusting VR1.

In effect the series resonant filter allows maximum current to flow through it at the resonant frequency. This is the converse of what happens in the case of the parallel resonant filter (or tuned circuit) that we shall look at in the next part.

...Counter Intelligence

BY PAUL YOUNG

A retailer discusses component supply matters.

On the wall behind my desk hangs a large map of the world. Stuck into it are a quantity of blue headed pins. Timbuctu, Katmandu, Pekin and Moscow, anywhere of any size has a pin. It looks most impressive. The other day a cynical friend called on me and spotting the map, said "Hello, what's all this then" and climbed on my desk for a closer look. Putting on my best "Pride of achievement face" I said, "Oh! just a few of our overseas customers." "Oh! yes," said the c.f., "what about this blue pin in the middle of the Antarctic Ocean?" Quite unruffled I replied, "Oh, that indicates goods we supplied to a British Antartic survey ship which sank!"

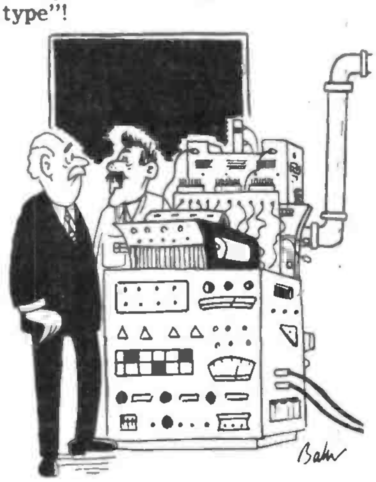
At this point I confessed that the whole of our overseas business did not bring us in even £1,000 a year. There are other hazards too besides ships sinking. One parcel of components we sent to Biafra University was returned to us three years later with a few bullet holes in it and the cryptic remark written on the front, "Unable to get through".

The main problem is that our overseas friends can get most of their requirements locally (and good luck to them) but occasionally they want a transformer or coil that's only available in the U.K. So they write to one of us, usually sending normal postage and airily demanding it to be sent airmail.

The order probably comes to about 75p and we have the time consuming job of looking up the postal regulations for the country concerned, filling in customs forms and the net result is that we lose plenty on the transaction!

Now we are desperately sorry for the Cobber in Woolamaloo who lacks this vital piece, but we are even more sorry for the plight we find ourselves in, i.e. working hard to lose money!! We have tried every way to get round it, including employing a shipping agency, but to no avail. In the end we have reluctantly had to tell our would-be customers that their only solution is to find a friend in the U.K. who will purchase the goods on their behalf.

It is surprising how many seem to find that they have got friends or relatives in the old country! So if you are approached by strangers asking you to be their pen friends, make sure you find out first what their hobby is, unless you are the "good samaritan type"!



"I've been working on it for years —it's a pencil sharpener."

DOWN TO EARTH

By GEORGE HYLTON

> "I have a mains power pack which should deliver 9V at 100mA but the actual voltage output is 12V with no load connected. Can I connect a 9·1 volt, 1W Zener diode across the output to bring the voltage down to a safe level for operating 9V battery equipment? Also, can I connect a 6 volt Zener to use the unit to supply 6V battery equipment?"

There's not enough information about the power unit to enable me to answer the questions definitely. Here's how to find out.

The output voltage of all ordinary transformer-rectifier-smoothing-capacitor mains power units ("battery eliminators") falls as the current taken increases. If you take measurements and graph the results you get something like Fig. 1. The precise quantities vary from unit to unit, of course, but the general shape of the output curve is similar.

The power unit whose performance is shown in Fig. 1 gives an output of 9·1 volts when about 70 milliamps is drawn. The effect of connecting a 9·1 volt Zener across its output, in the absence of any other load, would be to cause 70 milliamps to flow through the Zener and the output to fall to 9·1 volts. (Point *B* on the graph.)

Under these conditions the Zener works at 9·1 volts, 70 milliamps and therefore dissipates 9·1 × 70 = 637 milliwatts. This is well within the power rating of a 1 watt (= 1000 milliwatts) Zener, so all is well.

TOLERANCES

Or is it? Everything electrical has a *tolerance.* Zener diodes have voltage tolerances of 5 per cent, 10 per cent, 20 per cent, for example. A 9·1 volt, 10 per cent tolerance Zener could have an actual operating voltage of anything from about 8 volts to 10 volts. If a 10 volt (actual) Zener is connected to the power unit (point *A* on the graph) it draws 40 milliamps and dissipates 400 milliwatts. (The output voltage now rises to 10 volts, of course.) If the actual Zener voltage is 8 volts, 120 milliamps is drawn and this Zener dissipates 960 milliwatts, which is getting a bit too close to the 1 watt rating for comfort, (point C).

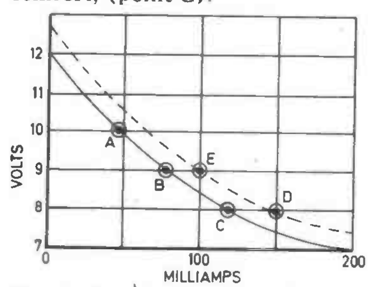


Fig. 1. Graph showing the performance of a power supply unit.

MAINS VOLTAGE VARIATIONS

The mains voltage also has a "tolerance", or, at least, it's liable to variations. A rise of a few per cent might give the power unit the output characteristics shown dotted. The low-limit (8 volts) Zener now has a working point (point *D*) of 8 volts, 150 milliamps, and dissipates 1200 milliwatts (1·2 watts) which is way above its rating.

Obviously, a 20 per cent tolerance Zener could be even further off the mark while a 5 per cent tolerance Zener would give something close to the desired performance.

So far we've considered only the safety of the Zener. But what about the safety of the power unit? If the maximum current rating is 100 milliamps, then too much current is taken when the Zener voltage is near the low limit and the unit may be damaged.

Clearly, connecting a Zener across the outputs of power units is a risky business unless you know just what you are dong. This answers the query about connecting a 6 volt Zener. This will draw far too much current (about 280 milliamps, judging from the way the curve is going as it runs off the edge of the graph). This is a huge overload—and of course the Zener itself would dissipate 6 × 280 = 1680 milliwatts (1·68 watts) Goodbye, mains transformers! Goodbye, 1 watt Zener!

SERIES RESISTOR

To provide 6 volts safely, add a series resistor (Fig. 2). With the power unit and the mains at the local high, the output of the unit itself could be 9 volts, 100 milliamps (dotted curve, point *E*). For 6 volts, it's necessary to get rid of 3 volts at 100 milliamps in the added resistance *R* of Fig. 2. This calls for $R = 3/0{\cdot}1 = 30$ ohms.

The resistor must dissipate 3 × 100 = 300 milliwatts. The nearest standard value is 33 ohms, 330 milliwatts (eg. Mullard CR25 type) but it would be working near the limit (and this time no allowance has been made for Zener tolerance). Its better to use two 56 ohm, 5 per cent, 330 milliwatt resistors in parallel, giving 28 ohms, 660 milliwatts, or two 15 ohm, 330 milliwatt resistors in series. The Zener itself would dissipate 6 × 100 = 600 milliwatts. Readers are invited to estimate for themselves the effect of the Zener tolerances.

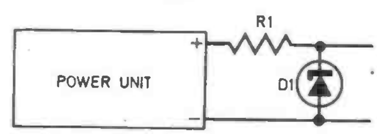


Fig. 2. Adding a resistor in series with the Zener diode.

If you have a power unit, a multi-meter, and a selection of resistors which can be used as dummy loads, you can easily find the graph of the output. (Half a dozen readings at widely differing currents are enough to enable the curve to be drawn.) You then get a clear picture of what you can or cannot do to your power pack and Zeners. If you don't know the local mains variations, take 10 per cent if you are an optimist or 20 per cent if a pessimist.

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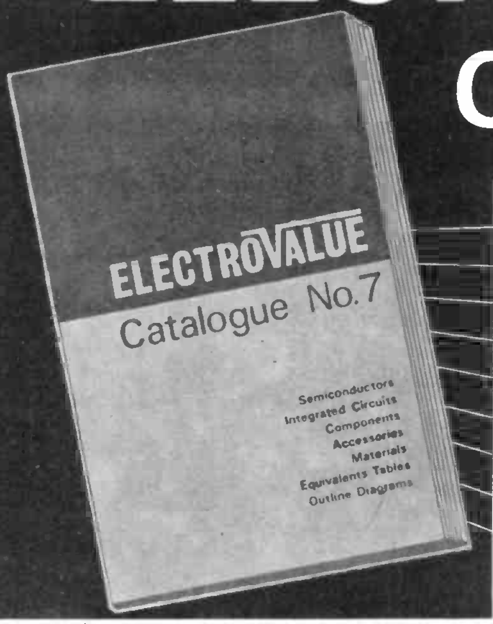
ELECTROVALUE

CATALOGUE 7



An A to Z guide to component buying

On the index page of Catalogue 7, between "Aluminium Boxes" and "Zener Diodes" are over 200 references to contents amounting in all to thousands of items, classified, described, often priced and illustrated. There are many technical diagrams and data. At 25p, Catalogue 7 is excellent value by any standard. With the 25p Refund Voucher it costs you virtually nothing when you order £5-worth or more.

25p INCLUDING 25p REFUND VOUCHER ALLOWABLE ON ORDERS £5 OR MORE NET VALUE

★ A SELECTION FROM EV CATALOGUE 7

TRANSISTORS
and semi-conductors of many types from simple diodes to ICs photo-sensitive devices, threshold switches, etc. etc.

MINITRON DIGITAL INDICATORS
3015F Seven segment filament, compatible with standard logic modules. 0–9 and decimal point; 9mm characters in 16 lead DIL. Now available in 8mA or 15mA segment ratings £1·20.
Suitable BCD decoder driver 7447 £1·15.
3015G showing + or — & 1 & dec. pt. £1·20.

DALY ELECTROLYTIC CAPACITORS
In cans, plastic sleeved
1000mF/25V 28p 1000/50 41p 5000/100 £2·91
5000mF/25V 62p 2000/50 57p
5000/50 £1·18

POLYESTER CAPACITORS TYPE C.280
Radial leads for P.C.B. mounting. Working voltage 250V d.c.
0·01, 0·015, 0·022, 0·033, 0·047 ea. 3p
0·068, 0·1, 0·15 ea. 4p
0·22 5p; 0·33 7p; 0·47 8p; 0·68 11p; 1·0 14p; 1·5 21p; 2·2 24p.

SILVERED MICA CAPACITORS
Working voltage 500V d.c.
Values in pFs—2·2 to 820 in 32 stages, each 6p.
1000, 1500 7p; 1800 8p; 2200 10p; 2700, 3600 12p; 4700, 5000 15p; 6800 20p; 8200, 10,000 25p.

POTENTIOMETERS
ROTARY, CARBON TRACK, Double wipers for good contact and long working life
P.20 SINGLE linear 100 ohms to 4·7 megohms, ea. 14p.
P.20 SINGLE log. 4·7 Kohms to 2·2 megohms, ea. 14p.
JP.20 DUAL GANG linear 4·7 Kohms to 2·2 megohms, ea. 42p.
JP.20 DUAL GANG log. 4·7 Kohms to 2·2 megohms, ea. 44p.
JP.20 DUAL GANG Log/antilog 10K, 22K, 47K, 1 megohm only ea. 48p.
JP.20 DUAL GANG antilog 10K only, 48p.
2A DP mains switch with any of above 14p extra.
Decades of 10, 22 and 47 only available in ranges above.

SLIDER POTENTIOMETERS
Linear or log. 10K to 1 meg. in all popular values ea. 30p.
Escutcheon plates, black, white or light grey, ea. 10p
Control knobs blk/wht/red/yel/grn/blue/dk. grey/lt grey, ea. 6p.

ELECTROLYTIC CAPACITORS
Axial Lead

σF	3V	6·3V	10V	16V	25V	40V	63V	100V
0·47	—	—	—	—	—	—	11p	8p
1·0	—	—	—	—	—	11p	—	8p
2·2	—	—	—	—	11p	—	8p	9p
4·7	—	—	—	11p	—	8p	9p	8p
10	—	—	—	—	8p	9p	8p	8p
22	—	—	8p	—	9p	8p	8p	10p
47	8p	—	9p	8p	9p	8p	10p	13p
100	9p	8p	8p	8p	9p	10p	12p	18p
220	8p	8p	9p	10p	10p	11p	17p	28p
470	9p	10p	10p	11p	13p	17p	24p	45p
1,000	11p	13p	13p	17p	20p	25p	41p	—
2,200	15p	18p	23b	26p	37p	41p	—	—
4,700	26p	30p	39p	44p	58p	—	—	—
10,000	42p	46p	—	—	—	—	—	—

This is EV Service

DISCOUNTS
Available on all items except those shown with NETT PRICES. 10% on orders from £5 to £15. 15% on orders £15 and over.

PACKING AND POSTAGE FREE
in U.K. For mail orders for £2 list value and under, there is an additional handling charge of 10p.

GUARANTEE OF QUALITY
All goods are sold on the understanding that they conform to manufacturers' specifications and satisfaction is guaranteed as such—no rejects, 'seconds' or sub-standard merchandise is offered for sale.

V.A.T. *Prices quoted do not include V.A.T., for which 10% must be added to total nett value of order. Prices subject to alteration without notice. S.A.E. with written enquiries please.*

RESISTORS

Code	Watts	Ohms	1–9	10–99	100 up (see note below)
C	1/20	82–220K	9	8	7·5
C	1/3	4·7–470K	1·3	1·1	0·9 nett
C	1/2	4·7–10M	1·3	1·1	0·9 nett
C	3/4	4·7–10M	1·5	1·2	0·97 nett
C	1	4·7–10M	3·2	2·5	1·92 nett
MO	½	10–1M	4	3·3	2·3 nett
WW	1	0·22–3·9	9	8	8
WW	3	1–10K	7	7	6
WW	7	1–10K	8	8	8

Codes: C—carbon film, high stability, low noise.
MO—metal oxide, Electrosil TR5, ultra low noise.
WW—wire wound, Plessey.
Values: All E.12 except C1/3, C3/4, MO 1/2
10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24; as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.
Tolerances: All 5% except MO 1/2 at 2%. WW. at 10% ± 0·05Ω
Prices are in pence each for quantities of the same ohmic value and power rating. NOT mixed values. (Ignore fractions of one penny on total value of resistor order.)
100 price rates for units of 100 only.

ZENER DIODES full range E24 values: 400mW: 2·7V to 36V, 14p each; 1W: 6·8V to 82V, 21p each: 1·5W: 4·7V to 75V, 48p each, Clip to increase 1·5W rating to 3 watts (type 266F) 5p.

TRANSFORMERS—MAINS

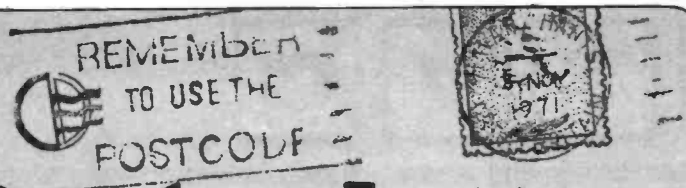
MT3 30V/2A plus 4 taps	£3·70
MT103 50V/1A plus 4 taps	£3·40
MT104 50V/2A plus 4 taps	£4·70
MT127 60V/2A plus 4 taps	£5·10
13TO5 13V/½A, CT	£1·66
28TO5 + 12V, 2-0-2V	£1·70

GIRO ACCOUNT No. 38/671/4002
All postal communications, mail orders etc. to Head Office at Egham address, Dept EE.4.

28, ST. JUDES ROAD, ENGLEFIELD GREEN EGHAM, SURREY TW20 0HB
Telephone Egham 3603; Telex 264475. Shop hours: 9–5.30 daily. Sats. 9–1.0 p.m.

NORTHERN BRANCH: 680, Burnage Lane, Burnage Manchester M19 1NA
Telephone (061) 432 4945
Shop hours: 9–1 and 2–5.30 daily. Sats. 9–1.0 p.m.

U.S.A. CUSTOMERS are invited to contact ELECTROVALUE AMERICA, P.O. Box 27, Swarthmore PA 19081.



Readers Letters

Test Gear Five

I am a complete beginner in the field of electronics and as such I thought that the best way to start would be with the *E.E. Test Gear Five* series.

However, one or two problems have arisen, one specific to the *Power Supply Unit* and the others more general. In the project explanation it does not say where the transistor TR3 should be specifically placed nor how to mount it with the bushes and mica washer, could you please explain.

Turning to the cases! I would like to know how best to cut and drill the case for insertion of meters, switches etc. Also are there any specific positions for these components.

Still on the subject of cases I would like to know the best way of writing the different words or symbols on the front panels and what are the best materials to use.

To finish I would like to say how interesting and informative your magazine is and I will doubtless be purchasing it regularly from now on to increase my knowledge and enjoyment of electronics.

G. McMahon,
Lancs.

Transistor TR3 is mounted on the back panel beside the component board. The body of the transistor is outside the case and insulated from it by the mica washer. The two pins pass through clearance holes in the case and the transistor is bolted on with the plastic bushes being inserted on the inside to insulate the bolts from the case. A tag under one bolt forms the collector connection.

Metal cases are best cut with twist drills in a hand brace or in an electric drill with speed reduction. A hacksaw (junior type) and a couple of files are also useful for shaped holes or large cut outs.

The positioning of components in the case does not have to be "exact" but you should make sure no two parts touch each other.

Letraset is the easiest and neatest way of lettering instruments—sheets of lettering of this type are available from many large stationery suppliers. A spray of clear varnish after lettering will provide protection.

We feel that we must warn you that we do not consider you should build the Test Gear Five *unless you have first constructed one or two smaller items to provide some "experience."*

I am writing to congratulate you on your magazine of which I have got every copy so far. I would also like to say that in every copy of EVERYDAY ELECTRONICS I have found something worthwhile to construct and your new series the *E.E. Test Gear Five* will be all I need to complete my set of instruments, except for one thing—an oscilloscope. As these instruments are very expensive on the market I was wondering if you were going to show a plan for the construction of one at your exceedingly low prices, which you always endeavour to keep to.

S. D. Wylie,
Kirkaldy.

It is very doubtful that we will ever be able to publish an oscilloscope design. Our sister magazine Practical Electronics would be more likely to cover such a subject but it is difficult to design a good quality project for less than the available kits.

Publications

I have today received my first copy of your magazine (Jan. '74) and am grateful for the article *Teach-In '74*. Being a newcomer to electronics I am uncertain of which of the many publications to buy on a regular basis. I see from the magazine that *Practical Electronics* complements yours. I am wanting to learn basics with overall knowledge but my particular interest will be in electronic control systems to operate machinery of various types. So many of the books available deal with the radio side which although no doubt valuable is not immediately of interest.

Could you kindly advise me on the choice of magazine, either EVERYDAY ELECTRONICS or *Practical Electronics*, to order as a source of learning and stimulation.

P. G. Smart,
St Helier,
Jersey.

For the beginner in electronics, EVERYDAY ELECTRONICS *is ideal for there are articles such as* Teach-In, Demo Circuits *and* Down to Earth *which describe in detail the basic building blocks in electronics. As well as these the constructional articles are described in detail in both theory of operation and construction.*

Basically Practical Electronics *is for the more experienced reader/constructor since theory is in general more complex and construction more intricate.*

'Group One'

May I through the courtesy of your columns bring to the attention of component retailers the way we are attempting to deal with an urgent problem which affects all of us. I refer to the shortage of electronic components.

There are many buying groups operating successfully in commodities ranging from groceries to television sets but we believe we are the first (and perhaps the only one) dealing in electronic components. We are the poor relation of this industry and it is the manufacturer who can buy bigger quantity who comes first.

"Group One" has been functioning for about 3 years during which time it has prevented the total disappearance of many vital components by large purchases. To give us more buying power we would like to recruit more members. Would any electronic component retailer who is interested, please contact me.

A. Sproxton,
Home Radio (Components) Ltd.

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. 17" × 10½" × 6½" 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" × 8¼" 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

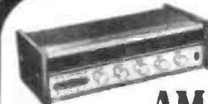
Viscount R 102 amplifier	£24·20	+ £1 p & p
2 Duo Type III A speakers	£39·00	+ £4.00 p & p
Garrard SP25 with MAG. cartridge de luxe plinth and hinged cover	£21.00	+ £1.75 p & p.
	total £84.20	

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 + £1.60 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.

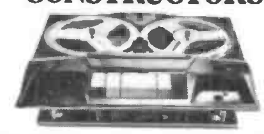
8 TRACK CARTRIDGE PLAYER*

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**

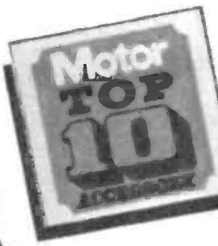
PE TAPE LINK CONSTRUCTORS



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 $\frac{5}{16}$ ins. deep approx.

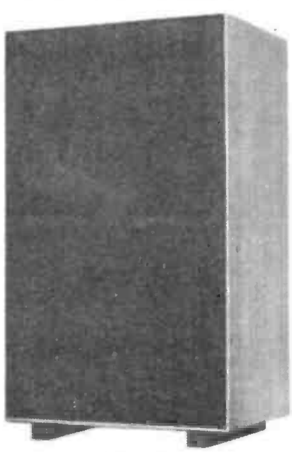
NOTE: The ability to solder on a printed circuitboard is necessary to complete this kit successfully. Circuit diagram and comprehensive instructions 55p free with kit.

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



Recommended retail selling price, £86·00.

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

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.

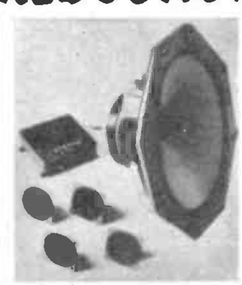
Frequency Response
20 Hz 20,000 Hz.
Impedence 8 ohms

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 3¼″ 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.

OUR PRICE £25·00 + £1·50 p & p Special Offer.

BARCLAYCARD

Just write your order giving your credit card number

DO NOT SEND YOUR CARD

- Mail orders to Acton. Terms C.W.O. All enquires Stamped Addressed Envelope. Goods not despatched outside U.K.
- Leaflets available for all items listed.* Send stamped addressed envelope.

R T-V C

Radio and TV Components (Acton) Ltd.
21 High Street, Acton, London W3 6NG(E)
323 Edgware Road, London W2
Edgware: 9 a.m.-5.30 p.m. Half day Thurs.
Acton: 9.30 a.m.-5 p.m. Closed all day Wed.

MAINS OPERATED CONTACTOR

220/240v. 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10 amps. Extremely well made by a German Electrical Company. Overall size 2½ × 2 × 2in. £2·20 each.

1 R.P.M. MOTOR+GEAR-BOX

Made by the famous Chamberlain & Hookham Ltd. These could be made to drive clock or similar. Really robust reliable unit. Price £1·10 each.

AUTO—ELECTRIC CAR AERIAL

with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. £6·35 plus 25p post and insurance.

MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only £1·10, plus 20p postage.

MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 25p each.

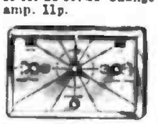
MULTI-SPEED MOTOR

Six speeds are available 500, 850 and 1,100 r.p.m. and 8,000, 12,000 & 15,500 r.p.m. Shaft is ¼ in. diameter and approximately 1 in. long. 230/240v. Its speed may be further controlled with the use of our Thryrister controller. Very powerful and useful motor size approx. 2 in. dia. × 5 in. long. Price 97p plus 23p postage and insuranec.

SLIDE SWITCHES

Slide Switch. 2-pole changeover panel mounting by two 6B.A. screws. Size approx. 1in × ⅜in rated 250V lamp. 8p each. 10 for 73p. Ditto as above but for printed circuit 6p each, 10 for 53p. Sub Miniature Slide Switch. DPDT 19mm (⅜in approx.) between fixing centres. 20p each or 10 for £1·90. 8P Change over spring return 250v 1 amp. 11p.

15A ELECTRICAL PROGRAMMER



Learn in your sleep: Have radio playing and kettle boiling as you awake—switch on lights to ward off intruders—have warm house to come home to. All these and many other things you can do if you invest in an electrical programmer Clock by famous maker with 15 amp. on/off switch. Switch-on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price £2·15 + 20p p & p or with glass front chrome bezel 83p extra.

BALANCED ARMATURE UNIT

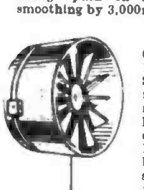
500 ohm, operates as speaker or microphone, so useful in intercom or similar circuits, 37p each.

12 VOLT 1½ AMP POWER PACK

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

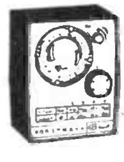
Heavy Duty Mains Power Pack. Output voltage adjustable from 15–40V in steps—maximum load 250W—that is from 6 amp at 40V to 15amp at 15V. This really is a high power heavy duty unit with dozens of workshop uses. Output voltage adjustment is very quick—simply interchange push on leads. Silicon rectifiers and smoothing by 3,000mF. Price £6·33 plus 65p post

EXTRACTOR FAN



Cleans the air at the rate of 10,000 cubic ft. per hour. Suitable for kitchens, bathrooms, factories, changing rooms, etc., it's so quiet it can hardly be heard. Compact, 5½" casing with 5½" fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets. £2·75 + 20p P. & P.

HORSTMANN 24-HOUR TIME SWITCH



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

Programme	Hot Water	Central Heating
0	Off	Off
1	Twice Daily	Off
2	All Day	Off
3	Twice Daily	Twice Daily
4	All Day	All Day
5	Continuously	Continuously

Suitable, of course, to programme other than central heating and hot water, for instance, programme upstairs and downstairs electric heating or heating and cooling or taped music and radio. In fact there is no limit to the versatility of this Programmer. Mains operated. Size 3in. × 3in. × 2in. deep. Price £3·85 as illustrated but less case.

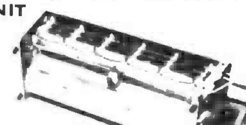
TEACH IN '74

A new beginners series started with the October issue of this magazine, we will be supplying all the parts for this. The initial kit covering all components required for the first 6 months is available post and VAT included—price £7. A special feature about our version of this kit is the 4½" × 3" meter 0–100uA meter. As the author says, a large meter is so much easier to read than a small one.

TRANSISTOR ASSISTED IGNITION
LIGHTPOWERED RECEIVER
ELECTRONIC VOLT METER

To receive parts for these and other feature projects, send the quoted approximate amounts and any cash adjustment can be made later.

TANGENTIAL HEATER UNIT



This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters. Comprises motor, impeller, 2kW. element allowing switching 1, 2kW. and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only needs control switch, £2·75. Don't miss this. Control Switch, 44p. P. & P. 40p.

PORTABLE RADIO CASE DE-LUXE

A similar size to the above but a more expensive design. Used with the Good Companion de-luxe model. £2·20 plus 50p post and insurance.

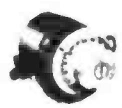
KETTLE ELEMENTS

Made by the famous A.E.I. Co. Complete with washers and combined fixing ring and plug shroud. Normal 2 round pin and flat pin earth connection and overload reset push button. 2 Models—1⅛in (approx.) suitable for Swan and other similar models—1⅜in (approx.) suitable for G.E.C., Hotpoint, etc. All quick boil 2½kW elements at 240V. Price £1·38.

SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in × 18in £1·69. 13in × 10in £1·21.

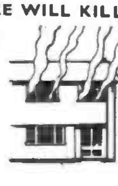
HORSTMANN "TIME & SET" SWITCH



(A30 Amp Switch.) Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc. up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Two models 15 amp £1·98, 30 amp £2·58 p & p 25p each.

OUR 1974 CATALOGUE LISTING HUNDREDS OF BARGAINS. NOW AVAILABLE. PRICE 30p POST PAID.

SMOKE WILL KILL—GAS WILL KILL—FIRE WILL KILL

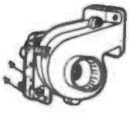


But, if you install SAGA (our smoke and gas alarm) your family will have the latest electronic protection, against these killers. Saga uses a fantastic electronic sensor which "smells" smoke and gas and sounds the alarm immediately, in a neat case measuring approx. 5in × 3½in × 2½in, it has its own internal alarm, also a connector for additional bells. You just plug it in to the mains and hang it near the ceiling. Saga uses so little electricity that it will hardly move the meter, leave it on always to give night and day protection. One year's guarantee, also 7-day cash return offer, £6·99 plus 30p post and service.

SOIL HEATER

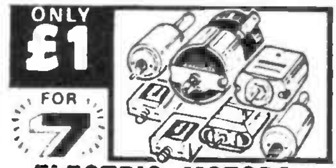
Or could be used on bench for seed trays. Comprising mains transformer to reduce to safe voltage also heater wire. £1·50 plus 20p p. & p.

CENTRIFUGAL BLOWER



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

Sensational "once in a lifetime offer" because Mullard over-produced—definitely not repeatable once our stocks (now over half sold) are cleared. HI-FI 4 transistor amplifier complete in case ready to use, batt., car or mains operated—freq. range 50hz–15Khz—distortion better than ·2%. Comes complete with guarantee and data FREE to purchasers. Great handbook published by Mullard "tells all you need to know" to build your own stereo. Complete Unilex Stereo System £11·30, pair of speakers for same £3·80.

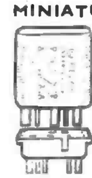


ELECTRIC MOTORS

7 powerful battery motors as used in racing cars and power models. Output and types vary to make them suitable for hundreds of different projects—tools, toys, models, etc. All brand new, reversible and for 1½ to 12v. Bats., wiring diagrams included. Post and VAT 30p.

FREE Details of how to make miniature power station.

MINIATURE SEALED RELAY



American made. Our Ref. No. REL A1. Measures only ⅞" wide × ½" thick and ⅞" high and it's a double change over, we don't know the contact rating but estimate this at 3/5 amps. The coil resistance is 600 ohms and 9–12 volt will close it. Ideal for models and miniaturised equipment. It's a plug in relay but we supply complete with base. Price 33p including base.

TELESCOPIC AERIAL

for portable, car radio or transmitter. Chrome plated—six sections, extends from 7½ to 47in. Hole in bottom for 6BA screw. 42p. KNUCKLED MODEL FOR F.M. 55p

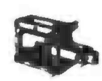
TREASURE TRACER

Complete Kit (except wooden battens) to make the metal detector as the circuit in Practical Wireless, August issue. £3·30 plus 20p post and insurance

IMMERSION HEATERS BY REMPLOY

Standard fitting for domestic water tanks, made by the famous Remploy Company. Complete with sealing washers suitable for 200–240 volts A.C. Depth into tank 11". 2kw or 3kw £1·65 plus 20p each post and insurance.

MAINS OPERATED SOLENOIDS



Model TT2—small but powerful 1" pull—approx. size 1½" × 1¼" × 1⅛". 66p. Model 400/1 ⅜" pull. Size 2⅛" × 2" × 1⅜". 83p. Model TT10 1½" pull. Size 3" × 2½" × 2½". £1·98 plus 20p post and insurance.

MACLAREN THERMOSTAT

Make and break 20 amp A.C. with the sensor probe coupled by 2 feet capillary covering range of 10—100°C—complete with large engraved control knob. Price 83p.

MACLAREN THERMOSTAT

Make and break 20A a.c. with the sensor probe coupled by a 2 feet capillary covering range of 10-100°C—complete with large engraved control knob. Price 83p.

12 WAY SUB-MINIATURE MULTI-CORE CABLE

7·0076 copper cores each core P.V.C. insulated and of different colour. P.V.C. covered overall and approx. 3/16in thick. Price 22p per yard.

TERMS:—
Add 10% V.A.T.
Send postage where quoted—other items, post free if order for these items is £6.00, otherwise add 20p.

J. BULL (ELECTRICAL) LTD.

(Dept. E.E.), 7 Park Street, Croydon CRO 1YD

Callers to: 102/3 Tamworth Road, CROYDON.

The largest selection

BRAND NEW FULLY GUARANTEED DEVICES

Type	Price p
AC107	22
AC113	20
AC115	22
AC117K	32
AC122	13
AC125	19
AC126	19
AC127	20
AC128	20
AC132	16
AC134	16
AC137	16
AC141	20
AC141K	32
AC142	20
AC142K	28
AC151	17
AC154	22
AC155	22
AC156	22
AC157	27
AC165	22
AC166	22
AC167	22
AC168	27
AC169	16
AC176	22
AC177	27
AC178	31
AC179	31
AC180	22
AC180K	32
AC181	22
AC181K	32
AC187	24
AC187K	25
AC188	24
AC188K	25
ACY17	28
ACY18	22
ACY19	22
ACY20	22
ACY21	22
ACY22	18
ACY27	20
ACY28	21
ACY29	39
ACY30	31
ACY31	31
ACT34	23
ACY35	23
ACY36	31
ACY40	19
ACY41	20
ACY44	39
AD130	42
AD140	53
AD142	53
AD143	42
AD149	55
AD161	39
AD162	39

Type	Price p
AD161 and AD162(MP)	75
ADT140	55
AF114	27
AF115	27
AF116	27
AF117	27
AF118	39
AF124	33
AF125	33
AF126	31
AF127	31
AF139	33
AF178	55
AF179	55
AF180	55
AF181	55
AF186	55
AF239	41
AL102	72
AL103	72
ASY26	28
ASY27	33
ASY28	28
ASY29	28
ASY50	28
ASY51	28
ASY52	28
ASY54	28
ASY55	28
ASY66	28
ASY57	28
ASY58	28
ASY73	28
ASZ21	44
BC107	12
BC108	12
BC109	13
BC113	11
BC114	17
BC115	17
BC116	17
BC117	20
BC118	11
BC119	33
BC120	88
BC125	13
BC126	20
BC132	13
BC134	20
BC135	13
BC136	17
BC137	17
BC139	44
BC140	33
BC141	33
BC142	33
BC143	33
BC145	50
BC147	11
BC148	11
BC149	13

Type	Price p
BC150	20
BC151	22
BC152	19
BC153	31
BC154	33
BC157	20
BC158	13
BC159	13
BC160	50
BC161	55
BC167	13
BC168	13
BC169	13
BC170	13
BC171	16
BC172	16
BC173	16
BC174	16
BC175	24
BC177	21
BC178	21
BC179	21
BC180	27
BC181	27
BC182	11
BC182L	11
BC183	11
BC183L	11
BC184	13
BC184L	13
BC186	31
BC187	31
BC207	12
BC208	12
BC209	13
BC212L	12
BC213L	12
BC214L	16
BC225	28
BC226	39
BC301	30
BC302	27
BC303	35
BC304	40
BC440	34
BC460	40
BCY30	27
BCY31	29
BCY32	33
BCY33	24
BCY34	28
BCY70	16
BCY71	22
BCY72	16
BCZ10	22
BCZ11	28
BCZ12	28
BD115	68
BD116	88
BD121	66
BD123	72
BD124	76

Type	Price p
BD131	55
BD132	66
BD133	72
BD135	44
BD136	44
BD137	50
BD138	55
BD139	61
BD140	66
BD155	88
BD175	66
BD176	66
BD177	72
BD178	72
BD179	77
BD180	77
BD185	72
BD186	72
BD187	77
BD188	77
BD189	83
BD190	83
BD195	94
BD196	94
BD197	99
BD198	99
BD199	£1·05
BD200	£1·05
BD205	88
BD206	88
BD207	£1·05
BD208	£1·05
BDY20	£1·10
BF115	27
BF117	50
BF118	77
BF119	77
BF121	50
BF123	55
BF125	50
BF127	55
BF152	61
BF153	50
BF154	50
BF155	77
BF156	53
BF157	61
BF158	61
BF159	66
BF160	44
BF162	44
BF163	44
BF164	44
BF165	44
BF167	24
BF173	24
BF176	39
BF177	39
BF178	33
BF179	33
BF180	33
BF181	33

Type	Price p
BF182	44
BF183	44
BF184	28
BF185	33
BF187	30
BF188	44
BF194	13
BF195	13
BF196	16
BF197	16
BF200	50
BF222	£1·05
BF257	50
BF258	66
BF259	94
BF262	61
BF263	61
BF270	39
BF271	33
BF272	88
BF273	39
BF274	39
BFW10	66
BFX29	30
BFX84	24
BFX85	33
BFX86	24
BFX87	27
BFX88	24
BFY50	22
BFY51	22
BFY52	22
BFY53	19
BPX25	94
BSX19	17
BSX20	17
BSY25	17
BSY26	17
BSY27	17
BSY28	17
BSY29	17
BSY38	20
BSY39	20
BSY40	31
BSY41	31
BSY95	14
BSY95A	14
Bu105	£2·20
C111E	55
C400	33
C407	28
C424	28
C425	55
C426	39
C428	22
C441	33
C442	33
C444	39
C450	24
MAT100	21
MAT101	22
MAT120	21

Type	Price p
MAT121	22
MJE2955	95
MJE3055	62
MJE3440	55
MPF102	46
MPF104	41
MPF105	41
OC19	39
OC20	70
OC22	52
OC23	54
OC24	62
OC25	42
OC26	32
OC28	55
OC29	55
OC35	46
OC36	55
OC41	22
OC42	27
OC44	17
OC45	14
OC70	11
OC71	11
OC72	16
OC74	16
OC75	17
OC76	17
OC77	28
OC81	17
OC81D	17
OC82	17
OC82D	17
OC83	22
OC139	22
OC140	22
OC169	28
OC170	28
OC171	28
OC200	28
OC201	31
OC202	31
OC203	28
OC204	28
OC205	39
OC309	44
OCP71	48
ORP12	48
P20	55
P21	50
P346A	22
P397	46
ST140	14
ST141	19
TI843	33
UT46	30
ZN414	£1·20
2G301	21
2G302	21
2G303	21
2G304	27
2G306	44

Type	Price p
2G308	39
2G309	39
2G339	22
2G339A	18
2G344	20
2G345	18
2G371	18
2G371B	13
2G373	19
2G374	19
2G377	33
2G378	18
2G381	18
2G382	18
2G401	33
2G414	33
2G417	28
2N388	39
2N388A	61
2N404	22
2N404A	31
2N524	46
2N527	54
2N598	46
2N599	50
2N696	14
2N697	15
2N698	27
2N699	39
2N706	09
2N706A	10
2N708	13
2N711	33
2N717	39
2N718	27
2N718A	55
2N726	31
2N727	31
2N743	22
2N744	22
2N914	16
2N918	33
2N929	23
2N930	23
2N1131	22
2N1132	24
2N1302	16
2N1303	16
2N1304	19
2N1305	19
2N1306	23
2N1307	23
2N1308	26
2N1309	26
2N1613	22
2N1711	22
2N1889	35
2N1890	50
2N1893	41
2N2147	79
2N2148	63
2N2160	66

Type	Price p
2N2192	39
2N2193	39
2N2194	39
2N2217	24
2N2218	22
2N2219	22
2N2220	24
2N2221	22
2N2222	22
2N2368	19
2N2369	16
2N2369A	16
2N2411	27
2N2412	27
2N2646	52
2N2711	23
2N2712	23
2N2714	23
2N2904	19
2N2904A	23
2N2905	23
2N2905A	23
2N2906	17
2N2906A	20
2N2907	22
2N2907A	24
2N2923	16
2N2924	16
2N2925	16
2N2926(G)	14
2N2926(Y)	12
2N2926(O)	11
2N2926(R)	11
2N2926(B)	11
2N3010	77
2N3011	16
2N3053	19
2N3054	51
2N3055	55
2N3391	16

Type	Price p
2N3391A	18
2N3392	16
2N3393	16
2N3394	16
2N3395	19
2N3402	23
2N3403	23
2N3404	31
2N3405	46
2N3414	17
2N3415	17
2N3416	31
2N3417	31
2N3525	83
2N3614	74
2N3615	82
2N3616	82
2N3646	10
2N3702	13
2N3703	13
2N3704	14
2N3705	13
2N3706	13
2N3707	14
2N3708	09
2N3709	10
2N3710	10
2N3711	10
2N3819	31
2N3820	55
2N3821	39
2N3823	31
2N3903	31
2N3904	33
2N3905	31
2N3906	30
2N4058	13
2N4059	11
2N4060	13
2N4061	13

Type	Price p
2N4062	13
2N4284	19
2N4285	19
2N4286	19
2N4287	19
2N4288	19
2N4289	19
2N4290	19
2N4291	19
2N4292	19
2N4293	19
2N5172	13
2N5294	60
2N5457	35
2N5458	35
2N5459	44
2N6211	75
2S301	55
2S302A	46
2S302	46
2S303	61
2S304	77
2S305	86
2S306	86
2S307	86
2S321	62
2S322	46
2S322A	46
2S323	62
2S324	77
2S325	77
2S326	77
2S327	77
2S701	46
40361	44
40362	50

DIODES AND RECTIFIERS

Type	Price p
AA119	9
AA120	9
AA129	9
AAY30	10
AAZ13	11
BA100	11
BA116	23
BA126	24
BA148	16
BA154	13
BA155	16
BA156	15
BY100	17
BY101	13
BY105	19
BY114	13
BY126	16
BY127	17
BY128	17
BY130	18

Type	Price p
BY133	23
BY164	55
BYX38/30	46
BYZ10	39
BYZ11	33
BYZ12	33
BYZ13	28
BYZ16	44
BYZ17	39
BYZ18	39
BYZ19	31
CG62 (OA91 Eq.)	6
CG651 (OA70-OA79 Eq.)	7
OA5	39
OA58L	23
OA10	39
OA47	8

Type	Price p
OA70	8
OA79	8
OA81	8
OA85	10
OA90	7
OA91	7
OA95	8
OA200	7
OA202	8
SD10	6
SD19	6
1N34	8
1N34A	8
1N914	7
1N916	7
1N4148	7
1S021	11
1S951	7

LINEAR I.C's—FULL SPEC.

Type No.	Price 1	25	100+
72702	50p	48p	45p
72709	35p	33p	30p
72710	45p	43p	40p
72741	40p	38p	35p
72741C	45p	43p	40p
72741P	38p	36p	34p
72748P	38p	36p	34p
SL201C	59p	45p	40p
SL701C	50p	45p	40p
SL702C	50p	45p	40p
TAA263	80p	70p	60p
TAA293	£1·00	95p	90p
TAA350A	£1·85	£1·80	£1·70
µA703C	280	26p	24p
µA709C	35p	33p	30p
µA711	45p	43p	40p

NUMERICAL INDICATOR TUBES

CD66 .. .. £1·87
GR116 .. .. .. £1·70
3015F Minitron .. .. £1·50

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

ZN414 .. .. .. £1·20 each
I.C. Radio Rec. incl. full cir. data.

DTL 930 SERIES LOGIC I.C's

Type	Price 1	25	100+
BP930	15p	14p	13p
BP932	16p	15p	14p
BP933	16p	15p	14p
BP935	16p	15p	14p
BP936	16p	15p	14p
BP944	16p	15p	14p
BP945	30p	28p	25p
BP946	15p	14p	13p
BP948	30p	28p	25p
BP951	70p	65p	60p
BP962	15p	14p	13p
BP9093	45p	43p	40p
BP9094	45p	43p	40p
BP9097	45p	43p	40p
BP9099	45p	43p	40p

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

VOLTAGE REGULATORS

TO.3 Plastic 1·5 Amps
UA.7805. 5v. (Equiv. to MVR 5V) £1·76
UA.7812. 12v. .. .. MVR 12V) £1·76

74 Series T.T.L. I.C's

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

Type	1 £ p	25 £ p	100+ £ p	Type	1 £ p	25 £ p	100+ £ p	Type	1 £ p	25 £ p	100+ £ p
7400	0·18	0·17	0·16	7448	1·10	1·07	1·05	74122	1·50	1·45	1·40
7401	0·18	0·17	0·16	7450	0·18	0·17	0·16	74123	3·00	2·90	2·80
7402	0·18	0·17	0·16	7451	0·18	0·17	0·16	74141	0·85	0·82	0·79
7403	0·18	0·17	0·16	7453	0·18	0·17	0·16	74145	1·65	1·55	1·45
7404	0·18	0·17	0·16	7454	0·18	0·17	0·16	74150	2·90	2·80	2·70
7405	0·18	0·17	0·16	7460	0·18	0·17	0·16	74151	1·10	1·05	1·00
7406	0·39	0·34	0·31	7470	0·32	0·29	0·27	74153	1·30	1·20	1·10
7407	0·39	0·34	0·31	7472	0·32	0·29	0·27	74154	1·98	1·90	1·75
7408	0·20	0·19	0·18	7473	0·41	0·39	0·35	74155	1·50	1·45	1·35
7409	0·20	0·19	0·18	7474	0·41	0·39	0·35	74156	1·50	1·45	1·35
7410	0·18	0·17	0·16	7475	0·50	0·48	0·46	74157	2·00	1·90	1·80
7411	0·28	0·27	0·26	7476	0·44	0·43	0·42	74160	2·10	2·00	1·90
7412	0·39	0·34	0·31	7480	0·74	0·71	0·64	74161	2·10	2·00	1·90
7413	0·32	0·31	0·30	7481	1·30	1·25	1·20	74162	4·40	4·15	3·85
7416	0·48	0·44	0·42	7482	0·96	0·95	0·94	74163	4·40	4·15	3·85
7417	0·48	0·44	0·42	7483	1·20	1·15	1·05	74164	2·20	2·10	2·00
7420	0·18	0·17	0·16	7484	1·10	1·05	1·00	74165	2·20	2·10	2·00
7422	0·55	0·53	0·50	7485	3·50	3·30	3·30	74166	3·20	3·10	3·00
7423	0·55	0·53	0·50	7486	0·35	0·34	0·33	74174	2·50	2·40	2·30
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7426	0·50	0·46	0·44	7490	0·74	0·71	0·64	74176	1·85	1·75	1·65
7427	0·50	0·46	0·44	7491	1·10	1·05	1·00	74177	1·85	1·75	1·65
7428	0·55	0·53	0·50	7492	0·74	0·71	0·64	74180	1·50	1·40	1·30
7430	0·18	0·17	0·16	7493	0·74	0·71	0·64	74181	5·00	4·50	4·00
7432	0·50	0·46	0·44	7494	0·85	0·82	0·75	74182	2·00	1·90	1·75
7433	0·75	0·73	0·70	7495	0·85	0·82	0·75	74184	3·20	3·10	3·00
7437	0·70	0·68	0·65	7496	0·96	0·93	0·86	74190	2·15	2·10	2·00
7438	0·70	0·68	0·65	74100	1·50	1·45	1·40	74191	2·15	2·10	2·00
7440	0·18	0·17	0·16	74104	1·07	1·04	1·00	74192	2·15	2·10	2·00
7441	0·74	0·71	0·64	74105	1·07	1·04	1·00	74193	2·15	2·10	2·00
7442	0·74	0·71	0·64	74107	0·44	0·42	0·40	74194	2·98	2·86	2·75
7443	1·20	1·15	1·10	74110	0·60	0·55	0·50	74195	2·00	1·95	1·90
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100	0·28	0·37	0·52	0·52	0·55	0·64	0·70	1·54
200	0·39	0·41	0·54	0·54	0 63	0·67	0·83	1·76
400	0·48	0·52	0·62	0·62	0·74	0·83	1·03	1·93
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100	0·04	0·07	0·06	0·15	0·18	0·26	0·83
200	0·06	0·10	0·07	0·16	0·22	0·27	1·10
400	0·07	0·15	0·08	0·22	0·30	0·41	1·38
600	0·08	0·18	0·11	0·26	0·38	0·50	2·05
800	0·11	0·19	0·12	0·28	0·41	0·61	2·20
1000	0·12	0·28	0·16	0·33	0·51	0·70	2·75
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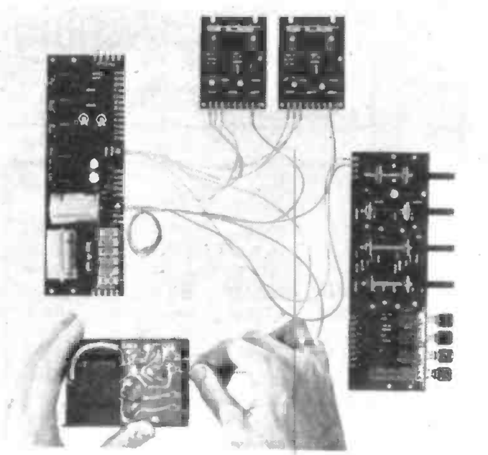

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CONSTRUCTION AIDS. Screws, nuts, spacers, etc., in small quantities. Aluminium panels punched to spec. or plain sheet supplied. Fascia panels etched aluminium to individual requirements. Printed circuit boards-masters, negatives and boards, one-off or small numbers. Send 6p for list. RAMAR CONSTRUCTOR SERVICES, 29 Shelbourne Road, Stratford-on-Avon, Warks.

PHILIPS CASSETTE RECORDER SPARES. SAE with enquiries. Sueway Ltd., 94 Derby Lane, Liverpool L13 3DW.

NEW PRODUCTS. Panel mounting holders for ORP12 L.D.Rs. in polished aluminium 25p. Control knobs 11/16 dia. in aluminium with colour coded ends 18p, state colour. Any turned part supplied. 7p for list. Post 10p. Electro-Mech Products, 7 Chantry Avenue, Bideford, Devon.

FIBRE OPTICS—OPTIKIT 103 contains 2 m. Crofon 1610, 64 Strand Light Conduit plus 5 metres each FP20, FP40, FP60 Plastic Monofibre (diameter 0·5, 1·0, 1·5 mm). Price £4·84 including booklet, pp., VAT. FIBRE OPTIC SUPPLIERS, (EE), P.O. Box 702, London W10 6SL.

2N5777 SILICON PHOTODARLINGTON AMPLIFIER sensitive light detector, much superior to CdS light cell. Price 1 off 55p, 5 of £2·53 inc. data, VAT, pp. FIBRE OPTIC SUPPLIERS, (EE), P.O. Box 702, London W10 6SL.

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Acramet and Acrespeed thermocouples, from IC are:-

Extremely accurate for fluid, gas or metal temperature measurement.

Individually calibrated and carry a certificate plus a one year guarantee.

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Details available on request.

International Combustion Limited.
Superheater Works, Ashburton Rd., Trafford Park, Manchester.
Tel. 061-872 2581.

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Hundreds of new resistors, capacitors, pots, switches. Also crystals, computer panels & loads of odds & ends. Only £1·65 (40p)

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Wide variety from 5p at shop for callers. Or in packs: 3lbs asstd. panels £1 (30p); 7lb £2 (40p); 56lb £13 (c/pd); 12 high quality panels with trimpots, IC's, power transistors etc. £2 (30p). 50 panels £7 (60p); Pack of boards containing at least 500 components inc at least 50 transistors 60p (20p).

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Very sensitive 4 valve amplifier with tone & volume controls giving 3 watts into 3 ohms. Only £1·65 (40p); Also available in cabinet with 7 x 4" speaker and non-standard tape deck. Mains operated, fully tested. £3 (£1 up to 200 miles, £1·20 over) Suitable cassette £1 (30p). Spare head 30p.

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Anhydrous to mil-spec. 1lb 50p (20p) 3lb £1·20 (30p), 10lb £3·50 (60p).
SURPLUS COMPONENTS: 500 asstd resistors £1 (20p); 300 capacitors all types £1 (30p); 25 10X crystals 75p (30p); 40 asstd. pots £1 (30p).
VAT NOT INCLUDED—ADD 10% TO TOTAL.
Carr in brackets, small parts 4p. SAE List.

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H.C. Copper, P.V.C. Insulated 24 A.W.G. (0.2 m.m.²) in P.V.C. Colours Black, Yellow, Blue or White. Reels 8ozs £0·95; 1lb £1·80; 2lbs £3·50; 4lbs £6·75 including VAT and postage larger Reels available C.W.O.

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BOFFIN PROJECTS, 4 CUNLIFFE ROAD, STONELEIGH, EWELL, SURREY
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Or for more details, send 15p for lists, plus free design project sheet.

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DEPT. E.E., ELSTOW STORAGE DEPT.
KEMPSTON HARDWICK,
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C.W.O. PLEASE. POST AND PACKING PLEASE ADD 10p TO ORDERS UNDER £2.

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Callers Welcome Mon. to Sat. 9 a.m. 5 p.m.

PLEASE ADD 10% VAT

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½W Iskra high stability carbon film—very low noise—capless construction.
⅓W Mullard CR25 carbon film—very small body size 7·5 x 2·5 mm.
¼W 2% ELECTROSIL TR5.

Power watts	Tolerance	Range	Values available	Price 1–99	Price 100+
½	5%	4·7 Ω–2·2M Ω	E24	1p	0·9p
½	10%	3·3M Ω–10M Ω	E12	1p	0·9p
¼	2%	10 Ω–1M Ω	E24	3·5p	3p
½	10%	1 Ω–3·9 Ω	E12	1p	0·9p
⅓	5%	4·7 Ω–1M Ω	E12	1p	0·9p
4	10%	1 Ω–10 Ω	E12	6p	5·5p

Quantity price applies for any selection. Ignore fractions on total order.

DEVELOPMENT PACK

0·5 watt 5% Iskra resistors 5 off each value 4·7 Ω to 1M Ω. E12 pack 325 resistors £2·40. E24 pack 650 resistors £4·70.

POTENTIOMETERS

Carbon track 5k Ω to 2M Ω, log or linear (log ¼W, lin ½W). Single, 12p. Dual gang (stereo), 40p. Single D.P. switch, 24p.

SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 500 Ω and decades to 5M Ω. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, 5p each. Miniature 0·25W, 7p each.

TRANSISTORS

AC107	15p	AF126	20p	BF115	25p	OC42	12p	2N3707	12p
AC126	12p	AF139	32p	BF173	20p	OC44	12p	2N3708	10p
AC127	15p	AF178	32p	BF177	28p	OC45	12p	2N3709	11p
AC128	15p	AF180	40p	BF178	32p	OC70	12p	2N3710	11p
AC131	12p	AF181	40p	BF179	32p	OC71	12p	2N3711	11p
AC132	12p	BC107	12p	BF180	32p	OC72	12p	2N3819	32p
AC176	15p	BC108	12p	BF181	32p	OC81	12p	2N4062	12p
AC187	22p	BC109	12p	BF194	14p	OC82D	12p	2N4286	20p
AC188	22p	BC147	12p	BF195	14p	2N2646	60p	2N4289	20p
AD140	50p	BC148	12p	BF197	15p	2N2904	20p	40360	35p
AD149	45p	BC149	12p	BF200	32p	2N2926	10p	40361	35p
AD161	33p	BC157	14p	BFY50	20p	2N3054	58p	40362	40p
AD162	36p	BC158	14p	BFY51	20p	2N3055	60p	40408	40p
AF114	20p	BC159	14p	BFY52	20p	2N3702	13p	ZTX108	15p
AF115	20p	BC187	22p	BUY105	225p	2N3703	12p	ZTX300	15p
AF116	20p	BD131	75p	OC26	45p	2N3704	13p	ZTX302	20p
AF117	20p	BD132	75p	OC28	50p	2N3705	12p	ZTX500	15p
AF118	38p	BD133	75p	OC35	50p	2N3706	11p	ZXT503	20p

ZENER DIODES

400mW 5% 3·3V to 30V, 12p.

WIRE WOUND POTS.

3W, 10, 25, 50 Ω and decades to 100k Ω, 35p.

DIODES

RECTIFIER

BY127	1250V	1A	12p
1N4001	50V	1A	7p
1N4002	100V	1A	8p
1N4004	400V	1A	8p
1N4006	800V	1A	10p
1N4007	1000V	1A	10p

SIGNAL

OA85	7p
OA90	5p
OA91	5p
OA202	7p
1N4148	5p
BA114	8p

SLIDER POTENTIOMETERS

86mm x 9mm x 16mm, length of track 59mm.
SINGLE 10K, 25K, 100K log. or lin. 40p.
DUAL GANG, 10K + 10K etc. log. or lin. 60p.
KNOB FOR ABOVE, 12p.
FRONT PANEL, 65p.

18 Gauge panel 12in x 4in with slots cut for use with slider pots. Grey or matt black finish complete with fixings for 4 pots.

BRUSHED ALUMINIUM PANELS

12in x 6in, 25p
12 in x 2½in, 10p
9in x 2in, 7p

THYRISTORS

2N5060	50V	0·8A	30p
2N5064	200V	0·8A	47p
106F	50V	4A	40p
106D	400V	4A	55p

ALUMINIUM BOXES

AB7	2¾" x 5¼" x 1½"	50p	AB14	7" x 5" x 2½"	84p
AB8	4" x 4" x 1½"	50p	AB15	8" x 6" x 3"	108p
AB9	4" x 2¾" x 1½"	50p	AB16	10" x 7" x 3"	122p
AB10	4" x 5¼" x 1½"	50p	AB17	10" x 4½" x 3"	108p
AB11	4" x 2½" x 2"	60p	AB18	12" x 5" x 3"	120p
AB12	3" x 2" x 1"	44p	AB19	12" x 8" x 3"	160p

HEATSINKS—REDPOINT

2W	24p	4W	45p	TO5	Clip	5p	TO1	Single	5p
3W	36p	6W	60p	TO18	Clip	5p	TO1	Double	8p

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MT30/2	0–12–15–20–24–30V	2A	£2·85
MT50/½	0–19–25–33–40–50V	½A	£1·90
MT50/1	0–19–25–33–40–50V	1A	£2·55
MT50/2	0–19–25–33–40–50V	2A	£3·50
MT60/½	0–24–30–40–48–60V	½A	£2·10
MT60/1	0–24–30–40–48–60V	1A	£2 80
MT60/2	0–24–30–40–48–60V	2A	£3 80

MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, 2½p. 0·0068μF, 0·01μF, 0·015μF, 0·022μF, 0·033μF, 3p. 0·047μF, 0·068μF, 0·1μF, 4p. 0·15μF, 6p. 0·22μF, 7½p. 0·33μF, 11p. 0·47μF, 13p.
160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, 3p. 0·1μF, 3½p. 0·15μF, 4½p. 0·22μF, 5p. 0·33μF, 6p. 0·47μF, 7½p. 0·68μF, 11p. 1·0μF, 13p.

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0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF, 2½p. 0·04μF, 0·05μF, 0·068μF, 0·1μF, 3½p.

CERAMIC DISC CAPACITORS

100pF to 10,000pF, 2p each.

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(μF/v) 1/63, 1·5/63, 2·2/63, 3·3/63, 4·7/63, 6·8/40, 6·8/63, 10/25, 10/63, 15/16, 15/40, 15/63, 22/10, 22/25, 22/63, 33/6·3, 33/16, 33/40, 47/4, 47/10, 47/25, 47/40, 68/6·3, 68/16, 100/4, 100/10, 100/25, 150/6·3, 150/16, 220/4, 220/6·3, 220/16, 330/4, 6p. 47/63, 100/40, 150/25, 220/25, 330/10, 470/6·3, 7p. 68/63, 150/40, 220/40, 330/16, 1000/4, 10p. 470/10, 680/6·3, 11p. 100/63, 150/63, 220/63, 1000/10, 12p. 470/25, 680/16, 1500/6·3, 13p. 470/40, 680/25, 1000/16, 1500/10, 2200/6·3, 18p. 330/63, 680/40, 1000/25, 1500/16, 2200/10, 3300/6·3, 4700/4, 21p.

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0·1μF	35V	2·2μF	35V	22μF	16V
0·22μF	35V	4·7μF	35V	33μF	10V
0·47μF	35V	6·8μF	25V	47μF	6·3V
1·0μF	35V	10μF	25V	100μF	3V

VEROBOARD

	0.1	0.15
2½ x 3¾	22p	16p
2½ x 5	24p	24p
3¾ x 3¾	24p	24p
3¾ x 5	27p	27p
17 x 2½	75p	57½p
17 x 3¾	100p	78p
17 x 5 (plain)	—	82p
17 x 3¾ (plain)	—	60p
17 x 2½ (plain)	—	42p
2½ x 5 (plain)	—	12p
2½ x 3¾ (plain)	—	11p
Pin insertion tool	52p	52p
Spot face cutter	42p	42p
Pkt. 50 pins	20p	20p

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Standard screened	18p	2·5mm insulated	8p
Standard insulated	12p	3·5mm insulated	8p
Stereo screened	35p	3·5mm screened	13p
Standard socket	15p	2·5mm socket	8p
Stereo socket	18p	3·5mm socket	8p

D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin Plug 12p. Socket 8p.
4 way screened cable, 15p/metre.
6 way screened cable, 22p/metre.

BATTERY ELIMINATOR £1.50

9V mains power supply. Same size as PP9 battery.

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1600μF	64V	74p	2500μF	64V	80p	4500μF	16V	50p
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2500μF	50V	58p	3200μF	16V	50p	5000μF	50V	£1·10

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLT

0·01μF	10p	0·047μF	13p	0·22μF	20p
0·022μF	12p	0·1μF	13p	0·47μF	22p

POLYSTYRENE CAPACITORS 160V 2½%

10pF to 1,000pF E12 Series Values, 4p each.

SMOKE AND COMBUSTIBLE GAS DETECTOR—GDI

The GDI is the world's first semiconductor that can convert a concentration of gas or smoke into an electrical signal. The sensor decreases its electrical resistance when it absorbs deoxidizing or combustible gases such as hydrogen, carbon monoxide, methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air or smoke. This decrease is usually large enough to be utilized without amplification. Full details and circuits are supplied with each detector.
Detector GDI, £2. Kit of parts for detectors including GDI and P.C. board but excluding case. Mains operated detector £5·20. 12 or 24V battery operated audible alarm £7·30. As above for PP9 battery, £6·40.

PRINTED BOARD MARKER 97p

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

METERS

1½" Scale-500uA, 1mA, 10mA, 100mA £1·90

BULGIN MAINS CONNECTORS

3 Pin 1½A	Chassis Plug	10p	
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3 Pin 3A	Chassis Plug	10p	
	Line Socket	14p	
3 Pin 5A	Chassis Plug	16p	
	Line Socket	15p	
3 Pin 1½A	Chassis Socket	18p	
	Line Plug	13p	
3 Pin 3A	Chassis Socket	21p	
	Line Plug	23p	
2 Pin 5A	Line Plug	20p	

THERMISTORS

VA1005	15p
VA1026	15p
VA1033	15p
VA1055S	15p
VA1066S	15p
VA1077	15p
R53	£1·35

WAVECHANGE SWITCH 23p

1p 12W, 3p 4W, 2p 2W, 2p 6W, 4p 3W

ROTARY MAINS SWITCH

D.P. 2A 32p

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709	14 pin DIL	40p
741	8 pin DIL	40p
741	14 pin DIL	38p
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747	14 pin DIL	85p
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DIL Sockets 14 pin and 16 pin 16p

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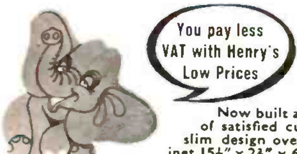

Now built and used by thousands of satisfied customers. Features slim design overall size in cabinet 15½" x 2¾" x 6¾". 6-IC's, 10 transistors, stabilisers Gardners low field transformer. Fibre Glass PC Panel, complete chassis work. Now available built and tested as well as in kit form. HIGH QUALITY & STABILITY ARE PREDOMINATE FEATURES — DEVELOPED BY TEXAS ENGINEERS FOR PERFORMANCE, RELIABILITY AND EASE OF CONSTRUCTION. FACILITIES. On/off switch indicator, headphones socket, separate treble, bass, volume and balance controls, scratch and rumble filters, mono/stereo switch, input selector; Mag. P.U., Radio Tuner, Aux. Can be altered for Mic., Tape, Tape-head, etc. Constructional details Ref. No. 21 30p. Distributed by Henry's throughout UK. FREE—Teak cabinet with complete kit.

Kit price **£28·50** (+VAT+50p carr/packing) or built and tested **£35·00** (+ VAT + 50p carr/packing) as illustrated.

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A completely new high stability stereo FM tuner Features variable capacity diode tuning, stabiliser power supply, IC Decoder, high gain low noise. IF stages. LED indicators. Tuning meter, AFC, easy to construct and use. Mains operated. Slim modern design with fibre glass PC, teak cabinet, etc. Available as a kit to build or ready built. Overall size 8" x 2¾" x 6¾". Produced to give high performance with a realistic price. (Parts list and constructional details Ref. No. 5 30p). Henry's are sole distributors UK and Europe.

KIT PRICE **£21·00** (+ VAT)
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DISCO MINI A complete portable disco, fitted mixer/preamp, 2 decks all facilities. £98·50
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DISCO MIXER/PREAMPLIFIERS (OP for up to 6-100 watt amplifiers)
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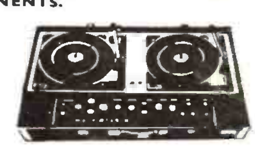

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PZ5 Mod. for 1 or 2 Z40	£4·98
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All items post paid.

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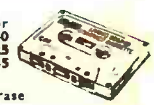

	3 for	6 for	10 for	25 for
C 60	£1·10	£1·98	£3·00	£7·40
C 90	£1·46	£2·80	£4·60	£11·25
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SPECIAL OFFERS

EMI 13" x 8"—full range speakers (post 20p each or 30p pair)
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350 20 watt C/o Tweeters 8 or 15 ohms £7·80 each
* Polished wood cabinet £4·80 post 35p.

8 ohms full range (post 20p)				
FR4	4"	5 watt		£4·75
FR65	6½"	10 watt		£6·30
FR8	8"	15 watt		£8·50
FR23	9 x 6"	15 watt		£8·90
BASS & MID RANGE—8 ohms (post 20p)				
AA12	5"	15 watt		£3·75
B110	5½"	15 watt		£7·20
B200	8"	15 watt		£8·50
B139/2	13" x 8"	30 watt LF		£13·75
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FHT6	15 watt		8 ohms	£3·35
K2011	30 watt		8 ohms	£4·80
T27	KEF			£5·50
Axcent 100	30 watt		8 ohms	£5·52
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SN75	3kHz var. C/o			£3·10
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