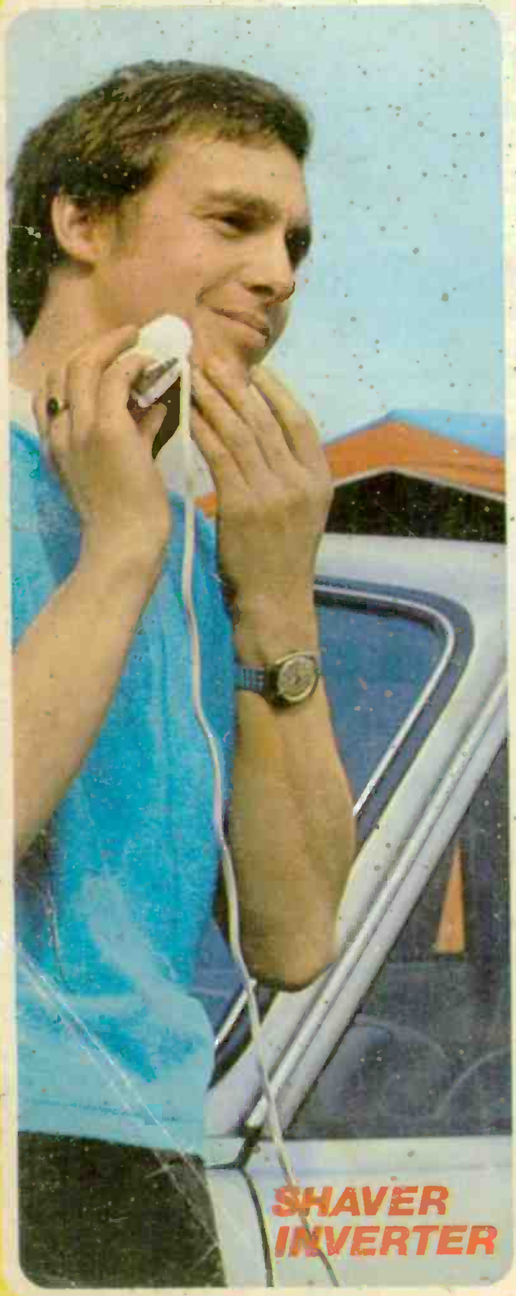
An exciting hobby.... for everyone

everyday electronics

JULY 72

15p



DRILL CONTROLLER

NEW IKW MODEL

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

MAINS OPERATED CONTACTOR

220/240v. 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10 amps. Extremely well made by a German Electrical Company. Overall size 2½ × 2 × 2in. £1 each.

NEED A SPECIAL SWITCH?

Double Leaf Contact. Very slight pressure closes both contacts. 6p each, 60p doz. Plastic push-rod suitable for operating. 5p each, 45p doz.

AUTO—ELECTRIC CAR AERIAL

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

TOGGLE SWITCH

3 amp. 250v. with fixing ring 7½p each, 75p doz.

MICRO SWITCH

5 amp changeover contacts. 9p each, £1 doz. 15 amp Model 10p each or £1·05 doz.

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 20p each, £1·80 for ten, your assortment.

WATERPROOF HEATING ELEMENT

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

15 AMP 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 £1·95 + 20p p & p or with glass front chrome bezel 75p extra.

TREASURE TRACER MARK II

Complete Kit (except wooden battens) to make the metal detector similar to the circuit in Practical Wireless August issue. £2·95 plus 20p post and insurance.

QUICK CUPPA

Mini Immersion Heater, 350w 200/240v. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. £1·25, post and insurance 14p. 12v. car model also available same price. Jug heater £1·50 plus p. & p. 14p

SNAP ACTION SLIDE SWITCH

Rated 5a. 240v. Made by Arrow. Type fitted in the handles of electric drills, vacuums, etc. 5p each, 10 for 45p.

NUMICATOR TUBES

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

12 WAY SUB-MINIATURE MULTI-CORE CABLE

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

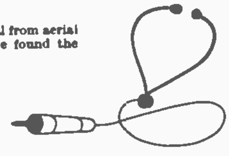
LIGHT CELL

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

CAPACITOR DISCHARGE CAR IGNITION

This system which has proved to be amazingly efficient. We offer a kit of parts as PW circuit £5·95 + 20p. De-luxe model with prepared circuit boards £6·95. When ordering please state whether for positive or negative systems. Also available, ready made ignition systems for 6v vehicles. £5·95 plus 20p.

RADIO STETHOSCOPE



Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything — complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2—twin stethoset instead of earpiece 75p extra post and ins. 20p.

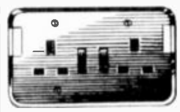
STANDARD WAFER SWITCHES

Standard size 1¼" wafer—silver-plated 5-amp contact, standard ¼" spindle 2" long—with locking washer and nut.

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

THIS MONTHS SNIP

13 AMP TWIN GANG SOCKETS



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

THYRISTOR LIGHT DIMMER

For any lamp up to 200 watt. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price £2·50 plus 20p post and insurance.

MULLARD AUDIO AMPLIFIER MODULE

Uses 4 transistors, and has an output of 750mW into 8 ohms speakers. Input suitable for crystal mic. or pick-up 9V battery operated. Size 2in long × 1½in wide × 1in high. SPECIAL SNIP PRICE 60p each. 10 for £5.

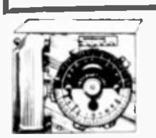
HORSTMANN "TIME & SET" SWITCH

(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. Regular price probably around £5. Special snip price £1·50 Post and ins. 23p.

SHAVER INVERTER
HORSES FOR COURSES
ELECTRONOME

and other featured projects. To receive these kits quickly send quoted approx. price and any change due will be refunded.

24-HOUR TIME SWITCH

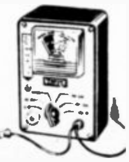


Made by Smiths, these are AC mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. Two completely adjustable time periods per 24 hours, 5A changeover contacts will switch circuit on or off during these periods. £2·50 post and ins. 25p. Additional time contacts 50p pair.

INTEGRATED CIRCUIT BARGAIN

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

BATTERY CONDITION TESTER



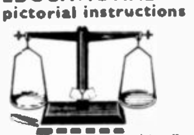
Made by Mallory but suitable for all batteries made by Ever Ready and others, most of which are zinc carbon types but also mercury manganese—nicad—silver oxide and alkaline batteries may be tested. The tester puts a dummy load on the battery and the meter scale indicates the condition depending upon which section the pointer rests. The section reads "replace" "weak" or "good". The tester is complete in its case, size 3½" x 6½" x 2" with leads and prods. Price £1·75 plus 20p postage.

KITS FOR PREVIOUS PROJECTS

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

HOME SENTINEL INTRUDER ALARM £3·75
SNAP INDICATOR 75p
WINDSCREEN WIPER CONTROL £2
RECORD PLAYER. Amplifier components only. £5·50
DEMO DECK .... £6·75 POST PAID
FUZZ BOX .... £1·85
PHOTOGRAPHIC COLOUR TEMPERATURE METER ....£2·65
ASTRON RADIO £3
REMOTE TEMPERATURE COMPARATOR ....£4·25
ELECTRO LAUGH £2
AUTO ALERT ....£2·50
RAIN WARNING ALARM .... £1·80
WA-WA PEDAL ....£2·90
DARKROOM TIMER ....£4·50
SIGNAL INJECTOR 80p
SOIL MOISTURE METER ....£3·00
SIMPLE CALCULATOR ....£3·80
D.C. POWER SUPPLY .... £5·00
BABY ALARM ....£4·00
AUDIO TONE GENERATOR ....£2·60
METAL LOCATOR ....£4·00
LIGHT TO SOUND CONVERTER ....£1·70
WASH/WIPE CONTROLLER .... £3·20

EDUCATIONAL KITS—all with pictorial instructions



THIS BALANCE KIT FREE Eagle educational kits. Japanese made these are excellent value for money. We do not expect to be able to repeat this offer once stocks are sold. Brief description of each kit is given below and with 3 kits or more we give FREE an accurate 11 piece balance kit. Price of kits 40p each post paid. Special price for all 7 kits £2·50 with free balance kit.

KA2 Lens Kit. Eleven parts, including candle, one concave lens, one convex lens, stage and slit frame, etc. Watch light rays bend as they pass through different lenses.
KA3 Water Pump Kit. Thirteen parts. Top of pump is transparent so that operating parts may be observed. Small parts are brightly coloured to be seen easily while working. Three types of pump may be made: Lift pump, Force Pump and Force Pump with reservoir and nozzle.
KA4 Buzzer Kit. Eleven parts. Transparent covers allow the operation of buzzer to be seen. Illustrates and teaches how electromagnetism with an automatic switch results in an operating buzzer.
KA6—2-Pole Motor Kit. Twenty-four parts, including enamel wire, armature and pole piece, etc. Motor operates from 1½ volt battery. Illustrates and teaches how electro-magnetism operates a motor.
KA7 Electro-Magnet Kit. Fifteen parts, includes compass. Makes two electro-magnets, one with one layer of wire and one with several layers of wire. Picks up tacks, nails and any small parts showing how magnetism works.
KA8 Current and Resistance Kit. Twenty-nine parts, including bench and light bulb. Conduct interesting and educational projects to learn the application of "OHMS LAW" and see the difference in current and resistance with different types and lengths of wire.
KA9 Bell Kit. Eight parts, including bell and push button switch. Build a complete electric bell and see how the hammer is triggered to make the bell ring.

PULSE GENERATORS

Sectronic, made by Smiths. Operated by single 1·5 volt battery or transformer and rectifier. Two models, one gives 10 pulses per second the other gives 8. In plastic enclosures, size approx. 2" × 1¾" × 1¾" deep. Price £2 each 10 for £16.

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

MAIN TRANSFORMER SNIPS
Mains Transformer. Primary 240v. tapped 220v. Secondary 20v. ½ amp. Price 60p each or 10 for £5·40.
Transformers. Primary 230-240v. Secondary 6·5-0-6·5 1 amp. With fitted primary screen 85p each or 10 for £5·85.

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

J. BULL (ELECTRICAL) LTD.

(Dept. E.E.) 7 Park Street, Croydon CRO 1YD
Callers to: 102/3 Tamworth Road, CROYDON

£25 *takes the wraps off* UNISOUND

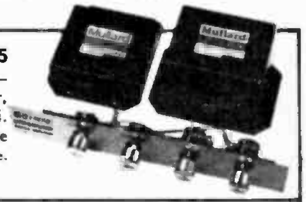
a new concept in stereo

The whole system is complete *including superb cabinets in simulated teak*—just simply screw together the components and you save pounds!
Amplifier is based on the famous Mullard Unilex system. Garrard 2025TC turntable complete with stereo ceramic cartridge, teak simulated plinth and tinted acrylic cover. Plus the big 13" x 8" EMI twin cone speakers ready for mounting in their elegant cabinets which simply need screwing & gluing together.
Easy to follow step-by-step instructions guide you quickly and effortlessly to taking the wraps off truly realistic stereo sound.

R T V C

£25 complete plus £2·80 p. & p.
Power output: 4 watts per channel into 8 ohms
Input: 120 mV (for ceramic cartridge) Stereo Headphones with adapter £4

UNISOUND MODULES ONLY-£6·95
If you prefer, you can buy the three modules—pre-amplifier, power supply/dual power amplifier, and control panel—by themselves for only £6·95. P. & P. 50p extra. Their overall specification is the same as shown for the complete Unisound console. *See below for address.*



A QUARTER TURN RIGHT!

...opens a world of real stereo sound

VISCOUNT III AUDIO—£52 complete

PRICES

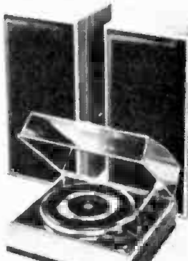
SYSTEM 1	
Viscount III R 101 amplifier	£22·00 + 90p p&p
2 x Duo Type II speakers	£14·00 + £2 p&p
Garrard SP25 Mk.III with MAG. cartridge plinth and cover	£23·00 + £1·50 p&p
Total	£59·00
Available complete for only £52	+ £3·50 p&p
SYSTEM 2	
Viscount R101 amplifier	£22·00 + 90p p&p
2 x Duo Type III speakers	£32·00 + £3 p&p
Garrard SP25 Mk. III with MAG. cartridge, plinth and cover	£23·00 + £1·50 p&p
Total	£77·00
Available complete for only £69	+ £4 p&p

14 + 14W per channel 40Hz to 40kHz + 3dB.
Total distortion @ 10W @ 1kHz — 0·1%.

2 complete stereo systems using the Viscount III amplifier. FET'S are incorporated on the input stages, just like top priced units to give you more of the signal you want and almost none of the hiss you don't. Output sockets for 'phones and tape recorder.
The exclusive Duo loudspeaker systems are large speakers in extremely substantial cabinets. There's a choice of the Duo II's for the smaller room or the big Duo III's for real bass response.

Speakers Duo Type II
Size approx. 17" x 10¾" x 6¾". Drive unit 13" x 8" with parasitic tweeter. Max. power 10 watts, 8 ohms. Simulated teak cabinet. £14 pair + £2 p&p.
Duo Type III. Size approx. 23½" x 11½" x 9½". Drive unit 13½" x 8¼" with H.F. speaker. Max power 20 watts at 3 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet. £32 pair + £3 p&p.

Specification
14 watts per channel into 3 to 4 ohms (suitable 3–15 ohms). *Total distortion* @ 10W @ 1kHz 0·1% *P.U.1.* (for ceramic cartridges) 150m V. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K. (*Radio* 150mV. Tape out facilities: headphone socket. *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:* P.U.1 and radio —65dB. P.U.2 +58dB. *Cross talk better than* — 35dB on all inputs. Size approx 13¾" x 9" x 3¾".
Goods not despatched outside U.K.



R T V C

Radio and TV Components (Acton) Ltd., 21c High Street, Acton, London G3 6NG, 323 Edgware Road, London W2. Mail orders to Acton. Terms C.W.O. All enquiries S.A.E.

JUST ARRIVED! THIS YEAR'S NEW RUSSIAN MIRACLE! *COMPUTERISED?

BRAND NEW, SPACE AGE model SO FAR AHEAD OF ITS TIME IT WILL STILL BE MAKING MANY LOOK OUT OF DATE IN 1984!

THE FABULOUS

ASTRAD 17

PORTABLE RADIO & COMMUNICATIONS RECEIVER

THIS OFFER ONLY

WORLD WIDE RECEPTION THOUSANDS OF TRANSMISSIONS & STATIONS POUR IN FROM THE FOUR CORNERS OF THE EARTH!

28 TRANSISTORS AND DIODES!

WAVEBANDS:

STANDARD LONG and MEDIUM

Plus 5 SHORT WAVEBANDS

Plus ULTRA SHORT WAVES

(V.H.F. AM. FM. MW. LW. USW.)

*COMPARE ITS PERFORMANCE with £80 RADIOS!

WE COULDN'T EVEN MAKE THEM FOR THIS PRICE!

BATTERY MODEL £20·75 BOX POST ETC. 50p

MAINS/BATTERY ELIMINATOR £1·48 extra

FIRST TIME EVER! *NOW AVAILABLE WITH fabulous "COMPUTERISED" WORLD TUNING GUIDE! NO MORE GUESSWORK — INSTANT DATA at your fingertips — enables you to TUNE IN A FLASH to transmissions the world over!

Think of the year 1984 and what might be produced then—now get the fantastic ASTRAD 17 and SEE for yourself that the Russians have done it all NOW! THIS ONE SUPERSEDES ALL EARLIER MODELS! It will probably make your present radio seem like a 'crystal set'! Complete with optional battery eliminator for both battery and mains use! We're almost giving them away at only £20·75—a fraction of today's Russian price! Compare performance with £80 radios! *You can't lose. Refund instantly if not astounded Black and chrome finish facia, set in fabulous Cabinet built case—constructed of fine Russian hardwood in beautiful Teak Veneer finish—prevents vibration, ensures sweeter tone than ever! Volume controlled from a whisper to a roar. Wider band spread, for "pin-point" station selection! Plus "MAGIC EYE" tuning level indicator for ultra perfect tuning sensitivity! Yes, the Russians have surpassed themselves, proving again their fantastic ability in spaceship and satellite communications. Yes, EVERY WAVEBAND instantly at your fingertips including Standard Long, Medium, Short and Ultra Short Waves to cover the four corners of the Earth, including all normal transmissions. VHF, AM, FM, MW, LW, USW, plus local and new stations not yet operational, and messages from all over the world! Expensive TURRET TUNER side control waveband selection unit (as used on expensive TVs!) Every waveband clicks into position giving incredible ease of station tuning! Genuine push-pull output! ON/OFF volume and separate Treble and Bass tone controls for utter perfection of reproduction and tone! Press-button illumination! Take it anywhere—runs on batteries (obtainable everywhere) or through battery eliminator from 220/240v. AC mains supply. Internal ferrite rod aerial plus built-in "rotatable" telescopic aerial extending to 39ins. approx. It's also a fabulous CAR RADIO. Also be used through extension amplifier, tape recorder or public address system. SIZE 14ins. × 10½ins. × 4½ins. overall approx. Magnificently made to give years of perfect service. U.K. service facilities and spares available for years to come. If necessary! With WRITTEN G'TEE, manual with simple operating instructions and circuit diagram. ONLY £20·75 (with mains/battery eliminator £1·48 extra). BOX, POST, ETC., 50p. *BUT WAIT, for only 55p extra you get the sensational "COMPUTERISED" WORLD TUNING GUIDE. (It enables you to time, pinpoint and get transmissions the whole world over—even a child can do it—it even lets you know when to tune into the U.K. when abroad. PLUS Standard "longlife" batteries. PLUS ultra sensitive earphone for personal listening. (Sorry—We cannot change these new radios for any earlier model purchased). SEND TO-DAY OR CALL

ANOTHER IRON CURTAIN MIRACLE!

Fantastic 2-in-1 CAR RADIO and PERSONAL PORTABLE

NOW WORLD WIDE RECEPTION IN YOUR CAR TOO!

4 WAVEBAND VHF AM/FM/ LONG & SHORT WAVEBANDS

FANTASTIC PRICE £9·95 BOX, POST ETC. 45p

AND MATCH IT FOR UNDER £35!

FANTASTIC! Brand new from behind Iron Curtain—incredible 2-in-1 Radio! First class makers—because of our crazy price contract stipulates we must NOT mention name! Beautifully made 9"x5"x2½", overall approx. Every up-to date technological improvement! /15 SEMI-CONDUCTORS: 9 Transistors, 5 Diodes and Stabiliser! FOUR WAVE BANDS! Yes, VHF model with AM/FM Long and Short Wavebands! Gets stations around world incl. Standard Long, Medium & Short Wave, also local and new stations not yet operational! Internal ferrite aerial plus 26 inch swivel telescopic aerial, On / off / volume and Tone Controls. Clear station Selector Dial! Waveband selector! Designed to fit snugly on to car dashboards, etc. RUNS OFF 12 VOLT BATTERY! (AS A PORTABLE it runs on standard batteries). PLUG IN 12 VOLT ADAPTOR JACK PROVIDED and automatically cut out internal batteries, using car battery only! Hundreds of transmissions day and night including short wave—even in car! BUT WAIT—simply remove radio from car, "snap on" optional carry handle. AND YOU HAVE A DE-LUXE PORTABLE with additional upright tuning dial. WRITTEN G'TEE. Only £9·95, post 45p. *Sprung all metal matching detachable carry handle (as illus.) AND set of batteries 25p ex. if reqd. Ref. g'tee. SEND TO-DAY OR CALL

SHOPERTUNITIES LTD. Dept. EE/9, 164 UXBRIDGE RD. (facing Shepherd's Bush Green), LONDON, W12 8AQ (Thurs. 1, Fri. 7). Also: 37 High Holborn, London, WC1 (Thurs. 7). Both stores open Mon.-Sat. 9-6.

gspk (sales)

quite simply-the best

RESISTORS

FULL RANGE OF ISKRA CARBON FILM RESISTORS

1/5 W (range 4·7 ohms to 470K) 1p each

¼ W and ½ W (range 4·7 ohms to 10 Megs) .... 1p each

1 W (range 4·7 ohms to 10 Meg) 2p each

2 W (range 4·7 ohms to 10 Meg) 3p each

Iskra Miniature High Stability carbon Film Resistors with negligible noise factor.

All Resistors ± 5% (except values over 4·7 Meg). These Resistors are even lower in price than most 10% and older carbon composition types.

PRE-SET POTENTIOMETERS

Standard values of pre-sets from 100 ohms to 5 Meg.

Standard/miniature .... 7p each   Sub-miniature .... 5p each

SIEMENS PROFESSIONAL CAPACITORS

POLYCARBONATE AND POLYESTER

Voltage	Capacitance	Price
100v	0·1 μF	6p
100v	0·15 μF	6p
100v	0·22 μF	6p
100v	0·33 μF	9p
100v	0·47 μF	10p
100v	0·68 μF	15p
250v	0·01 μF	5p
250v	0·015 μF	5p
250v	0·022 μF	5p
250v	0·033 μF	6p
250v	0·047 μF	6p
250v	0·068 μF	6p
250v	0·1 μF	6p

ELECTROLYTIC

Voltage	Capitance	Price
10v	22 μF	7p
10v	470 μF	11p
16v	47 μF	7p
25v	10 μF	7p
25v	100 μF	9p
25v	220 μF	11p
25v	170 μF	14p
25v	1000 μF	22p
25v	2200 μF	42p
35v	4·7 μF	7p
35v	220 μF	14p
100v	10 μF	8p
100v	22 μF	9p
100v	47 μF	14p

SPECIAL INTRODUCTORY OFFER

FREE with all orders value £5 or over we will give absolutely free one GSPK P.C. Kit for making your own printed circuits (normal retail price £1·95). Hurry! Offer valid for limited period only.

SEMICONDUCTORS

Here are just a few examples of our LOW Semiconductor prices. . . . . Many more semicons available all at equally sensational prices . . . . .NOW.

	1+	25+		1+	25+		+1	25+
AC127	24p	22p	BZY88C			OC76	22p	21p
AC128	19p	18p	Series E12			OC170	24p	21p
AC176	15p	13p	(2·7v–30·0v)	10p	9p	1N4001	6p	5p
ACY18	18p	15p	NKT210	24p	19p	1N4002	6p	5p
AD161	27p	25p	NKT211	24p	19p	1N4003	7p	6p
AD162	27p	25p	NKT212	24p	19p	1N4004	8p	7p
AF139	28p	26p	NKT213	24p	19p	1N4005	10p	9p
BC107	9p	8p	NKT214	19p	17p	1N4006	12p	11p
BC108	8p	7p	NKT218	24p	19p	1N4007	18p	16p
BC109	9p	8p	NKT219	24p	19p	1N4148	4p	3p
BC147	8p	7p	NKT223	26p	20p	2N1302	16p	15p
BC148	8p	7p	NKT224	21p	19p	2N1304	21p	20p
BC149	8p	7p	NKT242	14p	12p	2N1613	14p	13p
BCY70	14p	13p	NKT243	51p	44p	2N1711	15p	14p
BCY71	20p	19p	NKT401	70p	56p	2N2904	29p	28p
BCY72	14p	12p	NKT402	75p	59p	2N2905	24p	22p
BDY20	91p	73p	NKT403	64p	50p	2N2906	19p	18p
BFX29	24p	23p	NKT453	41p	33p	2N2907	22p	21p
BFX30	24p	23p	OA47	6p	5p	2N3053	17p	16p
BFY50	19p	18p	OA79	6p	5p	2N3054	49p	47p
BFY51	18p	17p	OA90	5p	4p	2N3055	57p	52p
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PREMIER STEREO SYSTEM "ONE" Consists of the new Premier 800 all transistor stereo amplifier, Garrard 2025 T/C auto manual record player unit fitted stereo/mono ceramic cartridge with diamond stylus and mounted in teak finish plinth with perspex cover and two matching teak finish loudspeaker systems. Absolutely complete and supplied ready to plug in and play. 800 amplifier has an output of 5 watts per channel with inputs for ceramic and magnetic pick-up, tape and tuner also tape output socket and headphone socket. Controls: Bass, Treble, Volume, Balance, Selector, Power on/off. Mono/Stereo switch. Stereo Headphone socket. Black leatherette cabinet with aluminium front panel. Size: 12¾" × 6¾" × 2¾". (Amplifier available separately if required £15·00. Carr. 50p).

PREMIER STEREO SYSTEM "TWO", as above but with Garrard SP25 MK III and magnetic cartridge. ONLY £45. Carr. £1·75.

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MODEL GT-800 MULTIMETER
A precision made pocket sized test meter, ideally suited for testing electronic circuits or electronic appliances. Supplied complete with test lead and batteries. RANGES—DC Voltages: 10, 50, 250, 1,000V (1,000 opV). AC Voltage: 10, 50, 250, 1,000V (1,000opV). DC Current: 1mA, 100mA. Resistance: 0-150K ohms. Decibel: —10 to +22db (at AC 10V range) **£2·47**. P. & P. 25p.

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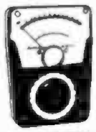
Features large easy-to-read meter, wide choice of ranges. With test leads, batteries and manual. Size 4½" × 3¼" x 1". RANGES D.C. Voltages 0-5-25-50-250-500-2500v. A.C. Voltages 0-15-50-100-500-1000v. D.C. Current: 0-50μA 2·5mA-250mA. Resistance: 0-6000 ohms 0-6 megohms (300 ohms and 30 Kohms, at centre scale). Capacity: 10μμf to ·001μf, ·001μf to ·1μf. Decibels —20 to +22dB. **£4·90**. P. & P. 25p.



MODEL CT-620 MULTITESTER
RANGES—DC Voltages: 0, 5, 25, 100, 500/1,000V (20,000 ohms/V). AC Voltages: 0, 5, 25, 100, 500, 1,000V (10,000 ohms/V). DC Current: 0, 50μA, 0, 5, 50, 500mA. Resistance: 0, 6k, 600k, 6M, 60M ohms. Decibels: —20 db to +62 db in 5 ranges. **£5·62**. P. & P. 25p.

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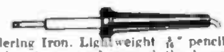

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A must for all tape users! Tape heads become permanently magnetized with constant use; this leads to background noise that prevents perfect recordings. Simply applied to recording head the V313 leaves head free of magnetism. Cleans any tape head in seconds.

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Rogers Ravensbourne Stereo Amplifier teak	£49·00
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GARRARD SP25 MK III SINGLE RECORD PLAYER FITTED GOLDRING 800 MAGNETIC STEREO CARTRIDGE. COMPLETE IN TEAK PLINTH WITH COVER.
Total list price over £34.

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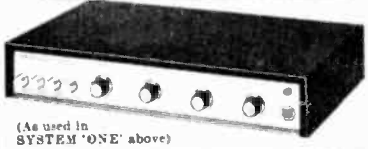

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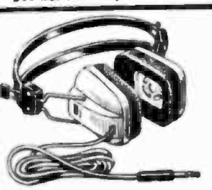
A truly high quality stereo amplifier—compare the specification, compare the price. Output: 5 watts per channel. Frequency response: 30-20,000 Hz ± 2 db. Distortion: 1% Output Impedance 8 ohms nom. Inputs equalised to R.I.A.A. Magnetic 4mV. Ceramic 100mV. Tuner 100mV. Tape 100mV. Tape out 150mV. Din sockets for inputs and outputs. Controls: Bass, Treble, Volume, Balance, Selector. Mono/Stereo switch. Stereo headphone socket. Attractive slim line design black leatherette cabinet with aluminium front panel. Size 12¾" x 6¾" x 2¾".

ONLY **£15·00** Carr. 50p.

Mk. 11 Version available with Teak Finish Cabinet. £16·25. Carr. 50p.

HI-FI STEREO HEADPHONES



Designed to the highest possible standard. Fitted 2½in. speaker units with soft padded ear muffs. Adjustable headband. 8 ohms impedance. Complete with 6ft lead and stereo jack plug.

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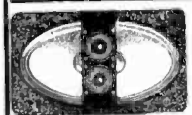

Fitted two 2½in tweeters and crossover network. Impedance 8 or 15 ohm. Handling capacity 10W. Brand new.

£3·47 P. & P. 50p

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Battery operated 4-channel audio mixer providing four separate inputs. Size 6 × 3 × 2in. suitable for crystal microphone low impedance microphone, with transformer, radio, tape, etc. Max. input 1·5v. Max. output 2·5v. Gain 6 dB. Standard jack plug socket inputs, phonoplugs output. Attractive teak wood grain finish case.

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SPECIALLY MANUFACTURED IN U.S.A. FROM EXTRA STRONG PRE-STRETCHED MATERIAL. THE QUALITY IS UNEQUALLED.
TENSILISED to ensure the most permanent base. Highly resistant to breakage, moisture, heat, cold or humidity. High polished splice free finish. Smooth output throughout the entire audio range. Double wrapped-attractively boxed.

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TT3	3"	450'	POLYESTER	37p	DT6	5¾"	1800'	POLYESTER	£1·12
DT3	3¼"	600'	POLYESTER	57p	TT6	5¾"	2400'	POLYESTER	£1·87
SP5	5"	600'	P.V.C.	42p	SP7	7"	1200'	P.V.C.	62p
LP5	5"	900'	ACETATE	50p	LP7	7"	1800'	ACETATE	75p
DT5	5"	1200'	POLYESTER	75p	DT7	7"	2400'	POLYESTER	£1·25
					TT7	7"	3600'	POLYESTER	£2·50

TAPE SPOOLS 3" 5p, 5", 5¾", 7" 9p.
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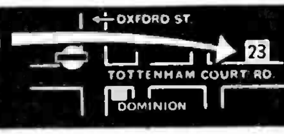

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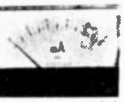


TYPE SW.100
100 x 80 mm.

50µA	£3·60	20V. D.C.	£3·10
50-0-50µA	£3·45	50V. D.C.	£3·10
100µA	£3·45	300V. D.C.	£3·10
100-0-100µA	£3·35	1 amp. D.C.	£3·10
500µA	£3·20	5 amp D.C.	£3·10
1mA	£3·10	300V. A.C.	£3·10
		VU Meter	£3·75

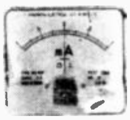
BAKELITE PANEL METERS

TYPE S-80
80 mm.
square fronts

50µA	£3·20	50V. D.C.	£2·60
50-0-50µA	£3·10	300V. D.C.	£2·60
100µA	£3·10	1 amp. D.C.	£2·60
100-0-100µA	£3·00	5 amp. D.C.	£2·60
500µA	£2·75	300V. A.C.	£2·60
1mA	£2·60	VU Meter	£3·37
20V. D.C.	£2·20		

"SEW" CLEAR PLASTIC METERS

Type MR.65P. 4¼in. × 4¼in. fronts.



50µA	£3·60	50mA	£2·80
50-0-50µA	£3·10	100mA	£2·80
100µA	£3·10	500mA	£2·80
100-0-100µA	£3·00	1 amp.	£2·80
200µA	£3·00	5 amp.	£2·80
500µA	£2·90	15 amp.	£2·80
500-0-500µA	£2·80	30 amp.	£2·90
1mA	£2·80	20V. D.C.	£2·80
1-0-1mA	£2·80	50V. D.C.	£2·80
5mA	£2·60	150V. D.C.	£2·80
10mA	£2·80	300V. D.C.	£2·80
		15V. A.C.	£2·80
		300V. A.C.	£3·10
		S Meter 1mA	£2·87
		VU Meter	£3·60
		1 amp. A.C.*	£2·80
		5 amp. A.C.*	£2·80
		10 amp. A.C.*	£2·80
		20 amp. A.C.*	£2·80
		30 amp. A.C.*	£2·80

Type MR.52P. 2½in. square fronts.

50µA	£3·10	10V. D.C.	£2·00
50-0-50µA	£2·60	20V. D.C.	£2·00
100µA	£2·60	50V. D.C.	£2·00
100-0-100µA	£2·50	300V. D.C.	£2·00
500µA	£2·30	15V. A.C.	£2·10
1mA	£2·00	300V. A.C.	£2·10
5mA	£2·00	S Meter 1mA	£2·10
10mA	£2·00	VU Meter	£3·20
50mA	£2·00	1 amp. A.C.*	£2·00
100mA	£2·00	5 amp. A.C.*	£2·00
500mA	£2·00	10 amp. A.C.*	£2·00
1 amp.	£2·00	20 amp. A.C.*	£2·00
5 amp.	£2·00	30 amp. A.C.*	£2·00

Type MR.85P. 3½in. × 3½in. fronts.

50µA	£3·37	10V. D.C.	£2·20
50-0-50µA	£2·75	20V. D.C.	£2·20
100µA	£2·75	50V. D.C.	£2·20
100-0-100µA	£2·65	150V. D.C.	£2·20
200µA	£2·65	300V. D.C.	£2·20
500µA	£2·40	15V. A.C.	£2·30
500-0-500µA	£2·20	50V. A.C.	£2·30
1mA	£2·20	150V. A.C.	£2·30
5mA	£2·20	300V. A.C.	£2·30
10mA	£2·20	500V. A.C.	£2·30
50mA	£2·20	S Meter 1mA	£2·37
100mA	£2·20	VU Meter	£3·37
500mA	£2·20	50mA A.C.*	£2·20
1 amp.	£2·20	100mA A.C.*	£2·20
5 amp.	£2·20	200mA A.C.*	£2·20
10 amp.	£2·20	500mA A.C.*	£2·20
15 amp.	£2·20	1 amp. A.C.*	£2·20
20 amp.	£2·20	5 amp. A.C.*	£2·20
30 amp.	£2·30	10 amp. A.C.*	£2·30
50 amp.	£2·50	20 amp. A.C.*	£2·20
5V. D.C.	£2·20	30 amp. A.C.*	£2·20

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

50µA	£2·10	200mA	£1·60
50-0-50µA	£1·90	300mA	£1·60
100µA	£1·90	500mA	£1·60
100-0-100µA	£1·75	750mA	£1·60
200µA	£1·75	1 amp.	£1·60
500µA	£1·65	2 amp.	£1·60
500-0-500µA	£1·60	5 amp.	£1·60
1mA	£1·60	10 amp.	£1·60
1-0-1mA	£1·60	3V. D.C.	£1·60
2mA	£1·60	10V. D.C.	£1·60
5mA	£1·60	15V. D.C.	£1·60
10mA	£1·60	20V. D.C.	£1·60
20mA	£1·60	100V. D.C.	£1·60
50mA	£1·60	150V. D.C.	£1·60
100mA	£1·60	300V. D.C.	£1·60
150mA	£1·60	500V. D.C.	£1·60
		750V. D.C.	£1·60
		15V. A.C.	£1·70
		50V. A.C.	£1·70
		150V. A.C.	£1·70
		300V. A.C.	£1·70
		500V. A.C.	£1·70
		S Meter 1mA	£1·70
		VU Meter	£2·10

Type MR.45P. 2in. square fronts.

50µA	£2·25	5 amp.	£1·70
50-0-50µA	£2·10	10V. D.C.	£1·50
100µA	£2·10	20V. D.C.	£1·50
100-0-100µA	£1·87	50V. D.C.	£1·50
200µA	£1·87	300V. D.C.	£1·50
500µA	£1·75	15V. A.C.	£1·80
500-0-500µA	£1·70	300V. A.C.	£1·80
1mA	£1·70	S Meter 1mA	£1·85
5mA	£1·70	VU Meter	£2·25
10mA	£1·70	1 amp. A.C.*	£1·70
50mA	£1·70	5 amp. A.C.*	£1·70
100mA	£1·70	10 amp. A.C.*	£1·70
500mA	£1·70	20 amp. A.C.*	£1·70
1 amp.	£1·70	30 amp. A.C.*	£1·70

"SEW" BAKELITE PANEL METER

Type MR.65. 3½in. square fronts.

25µA	£3·50	1 amp.	£1·95
50µA	£2·75	2 amp.	£1·95
50-0-50µA	£2·35	5 amp.	£1·95
100µA	£2·35	15 amp.	£1·95
100-0-100µA	£2·25	30 amp.	£1·95
500µA	£2·20	50 amp.	£1·95
1mA	£1·95	5V. D.C.	£1·95
1-0-1mA	£1·95	10V. D.C.	£1·95
5mA	£1·95	20V. D.C.	£1·95
10mA	£1·95	50V. D.C.	£1·95
50mA	£1·95	150V. D.C.	£1·95
100mA	£1·95	300V. D.C.	£1·95
500mA	£1·95	30V. A.C.*	£1·95
		50V. A.C.*	£1·95
		150V. A.C.*	£1·95
		300V. A.C.*	£1·95
		500mA A.C.*	£1·95
		1 amp. A.C.*	£1·95
		5 amp. A.C.*	£1·95
		10 amp. A.C.*	£1·95
		20 amp. A.C.*	£1·95
		30 amp. A.C.*	£1·95
		50 amp. A.C.	£1·95
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SEW EDUCATIONAL METERS

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

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100µA	£4·65	50V d.c.	£4·40
1mA	£4·40	300V d.c.	£4·40
50-0-50µA	£4·65		
1-0-1mA	£4·40	Dual range	
1A d.c.	£4·40	500mA/5A d.c.	£4·65
5A d.c.	£4·40	5V/50V d.c.	£4·65
10V. d.c.	£4·40		

EDGWISE METERS

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

50µA	£3·10	500µA	£2·75
50-0-50µA	£3·00	1mA	£2·45
100µA	£3·00	300V. A.C.	£2·45
100-0-100µA	£2·90	VU Meter	£3·40
200µA	£2·90		

Send for illustrated brochure on SEW Panel Meters—discounts for quanitties.

MULTIMETERS *for EVERY purpose!*

HIOKI MODEL 720X 20,000 O.P.V. Overload protection 5/25/100/500/1000 VDC. 10/50/250/1000 VAC. 50uA/250mA. 20K/2 meg ohm. −5 to + 62db. £4·97. P. & P. 15p.

MODEL PL436 20kΩ/Volt D.C. 8kΩ/Volt AC. Mirror scale. ·6/3/12/30/120/600V D.C. 3/30/120/600V A.C. 50/600uA/60/600 mA. 10/100K/1 Meg/10 MegΩ −20 to +46db. £6·97½ P & P 12½p

MODEL 5025 57 Ranges. Giant 5¼in. Meter, Polarity Reverse Switch. Sensitivity: 50K/Volt D.C. 5K/Volt A.C. D.C. Volts ·125, ·25, 1·25, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.C. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.C. Current 25, 50IA, 2·5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance: 2K, 10K, 100K, 1MEG, 10 MEG. Decibels· −20 to +85 dB. £12·50. P. & P. 17½p.

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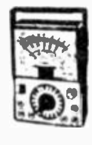


ROUND SCALE TYPE PENCIL TESTER MODEL TS.68

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

TMK MODEL 117 F.E.T. ELECTRONIC VOLTMETER

Battery operated, 11 meg input, 26 ranges. Large 4½" mirror scale. Size 5¼" × 4½" × 2¼". DC VOLTS 0.3 - 1200V. AC VOLTS 3 - 300V RMS. 8·# - 800V P-P. DC CURRENT ·12 - 12MA. Resistance up to 2000M ohm. Decibels − 20 to + 51 db. Complete with leads/instructions. £17·50. P. & P. 20p.

TE-20C RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 Kc/s-500 Mc/s on 6 bands. Directly calibrated Variable R.F. attenuator, audio output, Xtal socket for calibration. 220/240V. A.C. Brand new with instructions £15. Carr. 37½p. Size 140 × 215 × 107 mm.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

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

TE-20RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kc/s-260 Mc/s on 6 bands. Directly calibrated variable R.F. attenuator. Operation 200/240V A.C. Brand new with instruction. £15 P. & P. 37½p. S.A.E. for details.

240° Wide Angle 1mA Meters
MW1-6 60mm square £3·97½
MW1-8 60mm square £4·97½
P. & P. extra

MODEL LT.101 1000 O.P.V 0/10/50/250/1000 V. D.C. 0/10/50/250/1000 V. A.C. 0/1/100 M.A. 0/150 K ohms. £1·97. P. & P. 15p.

TMK MODEL MD.120 Mirror scale. 20k/Volt D.C. 10k Ω Volt A.C. 30/60/300/600/3,000 V. D.C. 6/120/1,200 V. A.C. Current 0-60µA/0 — 12/0 300mA. 0-60K/0-6 MegΩ. −20 to + 63 dB. £4·62½ P & P 15p

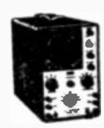
MODEL 500 30,000 O.P.V with overload protection mirror scale 0/·5/2·5/10/25 100/250/500/1,000v. D.C 0/2·5/10/25/100/250/500/1,000V. A.C. 0/50µA/5/50/500mA. 12 amp. D.C. 0/60/K/6 Meg./60 Meg Ω. £8·87½. Post paid.

TMK LAB TESTER. 100,000 O.P.V. 6½in. Scale Buzzer Short Circuit Check. Sensitivity: 100,000 O.P.V. D.C. 5K/Volt A.C. D.C. Volts: ·5, 2·5, 10, 50, 250, 1,000 V. A.C. Volts: 3, 10, 50, 50, 250, 500, 1,000V. D.C. Current: 10, 100µA, 10, 100, 500mA, 2·5, 10 amp. Resistance: 1K, 10K, 100K, 10MEG, 100MEG Ω. Decibels: −10 to +49 db. Plastic Case with Carrying Handle. Size: 7½in. × 6¾in. × 3¼in. £18·90. P. & P. 25p

RUSSIAN 22 RANGE MULTIMETER

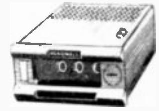
Model U437 10,000 o.p.v. A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2·5/10/50/250/500/1000v D.C. 2·5/10/50/250/500/1000v A.C. DC Current 100 wA/1/10/100mA/1A. Resistance 300 ohms/3/30/300K/3m Ω. Complete with batteries, test leads, instructions and sturdy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

TO-3 PORTABLE OSCILLOSCOPE



3in. tube, Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps–1·5 MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9v. p-p/CM. Bandwidth 1·5cps –800kHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps–300kHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½lb. 220/240V. A.C. Supplied brand new with handbook. £40·00. Carr. 50p.

HONEYWELL DIGITAL VOLTMETER VT.100



Can be panel or bench mounted. Basic meter measures 1 volt D.C. but can be used to measure a wide range of AC and DC volt, current and ohms with optional plug in cards. Specification: Accuracy: ±0·2, ±1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999). Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100v. D.C. Input: Fully floating (3 poles). Input power: 110-230v. A.C. 50/60 cycles. Overall size: 5½in. × 2 13/16in. × 8 3/16in. AVAILABLE BRAND NEW AND FULLY GUARANTEED AT APPROX. HALF PRICE. £49·97½. Carr. 50p.

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

SEMI-CONDUCTORS/VALVES

ALL DEVICES BRAND NEW AND FULLY GUARANTEED

Transistors		2N3415	22p	2N5458	35p	BC114	15p	BFW90	22p	NKT219	30p
		2N3416	37p	2N5459	40p	BC115	15p	BFW91	20p	NKT223	27p
2G301	20p	2N3417	37p	2S102	25p	BC116	15p	BFX12	22p	NKT224	22p
2G302	20p	2N3439	130p	2S103	25p	BC118	15p	BFX13	22p	NKT225	22p
2G303	20p	2N3440	97p	2S104	25p	BC119	30p	BFX29	25p	NKT229	30p
2G306	42p	2N3564	17p	2S301	50p	BC121	20p	BFX30	25p	NKT237	35p
2G308	30p	2N3565	15p	2S302	50p	BC122	20p	BFX37	30p	NKT238	25p
2G309	30p	2N3566	22p	2S303	60p	BC125	15p	BFX44	37p	NKT240	27p
2G371	15p	2N3568	25p	2S304	75p	BC126	20p	BFX68	67p	NKT241	27p
2G374	20p	2N3569	25p	2S501	32p	BC134	12p	BFX84	25p	NKT242	20p
2G381	22p	2N3570	125p	2S502	35p	BC135	12p	BFX85	30p	NKT243	62p
2N388A	49p	2N3572	97p	2S503	27p	BC136	15p	BFX86	25p	NKT244	17p
2N404	20p	2N3605	27p	3N83	40p	BC137	15p	BFX87	25p	NKT245	20p
2N696	15p	2N3606	27p	3N128	70p	BC138	20p	BFX88	20p	NKT261	20p
2N697	15p	2N3607	22p	3N140	77p	BC140	35p	BFX89	62p	NKT262	30p
2N698	25p	2N3638	18p	3N141	72p	BC141	35p	BFX93A	70p	NKT264	20p
2N699	30p	2N3638A	20p	3N142	55p	BC147	10p	BFY11	42p	NKT271	20p
2N706	10p	2N3641	18p	3N143	67p	BC148	10p	BFY18	25p	NKT262	20p
2N706A	12p	2N3642	18p	3N152	87p	BC149	12p	BFY19	25p	NKT274	20p
2N708	15p	2N3643	20p	40050	55p	BC152	17p	BFY21	42p	NKT275	20p
2N709	62p	2N3644	25p	40250	50p	BC153	20p	BFY24	45p	NKT278	25p
2N718	25p	2N3645	25p	40251	32p	BC154	20p	BFY29	40p	NKT281	27p
2N718A	30p	2N3691	15p	40309	32p	BC157	15p	BFY30	40p	NKT401	87p
2N726	30p	2N3692	18p	40310	45p	BC158	11p	BFY41	50p	NKT402	90p
2N727	30p	2N3693	15p	40311	35p	BC159	12p	BFY43	62p	MKT403	75p
2N914	17p	2N3694	18p	40312	47p	BC160	35p	BFY50	20p	NKT404	55p
2N916	17p	2N3702	10p	40314	37p	BC167	11p	BFY51	20p	NKT405	75p
2N918	30p	2N3703	10p	40315	37p	BC168B	10p	BFY52	20p	NKT406	62p
2N929	22p	2N3704	11p	40316	47p	BC168C	11p	BFY53	15p	NKT451	62p
2N930	20p	2N3705	10p	40317	37p	BC169B	11p	BFY56A	57p	NKT452	62p
2N987	40p	2N3706	9p	40319	55p	BC169C	12p	BFY76	42p	NKT453	47p
2N1090	22p	2N3707	11p	40320	47p	BC170	12p	BFY77	57p	NKT713	20p
2N1091	22p	2N3708	7p	40323	32p	BC171	15p	BFY90	65p	NKT717	42p
2N1131	25p	2N3709	9p	40324	47p	BC172	15p	BSX19	17p	NKT734	27p
2N1132	25p	2N3710	9p	40326	37p	BC175	22p	BSX20	15p	NKT736	35p
2N1302	17p	2N3711	12p	40329	30p	BC177	20p	BSX21	20p	NKT773	25p
2N1303	17p	2N3713	187p	40344	27p	BC178	20p	BSX26	45p	NKT781	30p
2N1304	22p	2N3714	200p	40347	57p	BC179	20p	BSX27	47p	OC16	50p
2N1305	22p	2N3715	123p	40348	52p	BC182	10p	BSX28	32p	OC19	37p
2N1306	25p	2N3716	130p	40360	40p	BC182L	10p	BSX60	82p	OC20	75p
2N1307	25p	2N3773	240p	40361	40p	BC183	9p	BSX61	62p	OC22	50p
2N1308	25p	2N3791	206p	40362	50p	BC183L	9p	BSX76	15p	OC23	60p
2N1309	25p	2N3819	34p	40370	32p	BC184	11p	BSX77	20p	OC24	60p
2N1507	17p	2N3820	55p	40406	57p	BC184L	11p	BSX78	25p	OC25	40p
2N1613	20p	2N3823	50p	40407	40p	BC186	25p	BSY24	15p	OC26	25p
2N1631	35p	2N3854	27p	40408	52p	BC187	27p	BSY25	15p	OC28	60p
2N1632	30p	2N3854A	27p	40409	55p	BC212L	12p	BSY26	17p	OC29	60p
2N1637	30p	2N3855	27p	40410	62p	BC213L	12p	BSY27	15p	OC35	50p
2N1638	27p	2N3855A	30p	40412	50p	BC214L	15p	BSY28	17p	OC36	60p
2N1639	27p	2N3856	30p	40467A	57p	BCY10	27p	BSY29	17p	OC41	22p
2N1701	162p	2N3856A	35p	40468A	35p	BCY30	27p	BSY32	25p	OC42	25p
2N1711	24p	2N3858	25p	40528	72p	BCY31	30p	BSY36	25p	OC44	15p
2N1889	32p	2N3858A	30p	40600	57p	BCY32	50p	BSY37	25p	OC45	12p
2N1893	37p	2N3859	27p	40603	50p	BCY33	25p	BSY38	20p	OC46	15p
2N2147	72p	2N3859A	32p	AC107	30p	BCY34	30p	BSY39	22p	OC70	15p
2N2160	57p	2N3860	30p	AC126	20p	BCY38	40p	BSY43	50p	OC71	12p
2N2193	40p	2N3866	150p	AC127	24p	BCY39	60p	BSY51	32p	OC72	12p
2N2193A	42p	2N3877	40p	AC128	20p	BCY40	50p	BSY52	32p	OC73	30p
2N2194	27p	2N3877A	40p	AC151	18p	BCY41	15p	BSY53	37p	OC74	30p
2N2194A	30p	2N3900	37p	AC152	22p	BCY42	15p	BSY54	40p	OC75	22p
2N2217	25p	2N3900A	40p	AC154	22p	BCY43	15p	BSY56	90p	OC76	22p
2N2218	20p	2N3901	97p	AC176	20p	BCY54	32p	BSY79	45p	OC77	30p
2N2219	20p	2N3903	20p	AC187	25p	BCY58	22p	BSY90	57p	OC78	20p
2N2220	25p	2N3904	25p	AC188	25p	BCY59	22p	BSY95A	12p	OC81	20p
2N2221	25p	2N3905	30p	ACY17	27p	BCY60	97p	C424	15p	OC81D	20p
2N2222	20p	2N3906	25p	ACY18	24p	BCY70	15p	C450	15p	OC82	25p
2N2222A	25p	2N4058	12p	ACY19	24p	BCY71	20p	GET102	30p	OC82D	15p
2N2297	30p	2N4059	10p	ACY20	20p	BCY72	15p	GET113	20p	OC83	25p
2N2368	15p	2N4060	12p	ACY21	20p	BCY78	30p	GET114	20p	OC84	25p
2N2369	15p	2N4061	12p	ACY22	10p	BCY79	30p	GET118	20p	OC139	25p
2N2369A	15p	2N4062	12p	ACY28	17p	BCZ10	27p	GET120	25p	OC140	32p
2N2410	42p	2N4244	47p	ACY39	47p	BCZ11	40p	GET873	12p	OC170	25p
2N2483	27p	2N4248	15p	ACY40	20p	BD112	50p	GET880	30p	OC171	30p
2N2484	32p	2N4249	15p	ACY41	15p	BD116	112p	GET887	20p	OC200	40p
2N2539	22p	2N4250	18p	ACY44	25p	BD121	65p	GET889	22p	OC201	60p
2N2540	22p	2N4254	42p	AD140	47p	BD123	80p	GET890	22p	OC202	75p
2N2613	35p	2N4255	42p	AD149	47p	BD124	60p	GET896	22p	OC203	40p
2N2614	30p	2N4284	17p	AD150	62p	BD131	75p	GET897	22p	OC204	40p
2N2646	40p	2N4285	17p	AD161	35p	BD132	80p	GET898	22p	OC205	75p
2N2711	25p	2N4286	17p	AD162	35p	BDY10	125p	MAT100	25p	OC206	95p
2N2712	25p	2N4287	17p	AF109	45p	BDY20	105p	MAT101	25p	OC207	75p
2N2713	27p	2N4288	15p	AF114	25p	BDY61	125p	MAT120	25p	OCP71	42p
2N2714	30p	2N4289	17p	AF115	25p	BDY62	100p	MAT121	25p	ORP12	50p
2N2904	20p	2N4290	12p	AF116	25p	BF115	25p	MJ400	107p	ORP60	40p
2N2904A	25p	2N4291	15p	AF117	20p	BF117	47p	MJ420	80p	ORP61	42p
2N2905	25p	2N4292	15p	AF118	60p	BF152	28p	MJ421	80p	P346A	22p
2N2905A	20p	2N4294	17p	AF121	30p	BF154	20p	MJ430	102p	ST140	15p
2N2906	20p	2N4303	47p	AF124	22p	BF158	15p	MJ440	95p	ST141	20p
2N2906A	25p	2N4964	15p	AF125	19p	BF159	35p	MJ480	97p	TIS34	62p
2N2907	23p	2N4965	18p	AF126	19p	BF163	35p	MJ481	125p	TIS43	40p
2N2923	15p	2N5027	52p	AF127	16p	BF167	18p	MJ490	100p	TIS44	10p
2N2924	15p	2N5028	57p	AF139	28p	BF170	33p	MJ491	137p	TIS45	27p
2N2925	15p	2N5029	47p	AF178	42p	BF173	19p	MJE340	50p	TIS46	11p
2N2926G	10p	2N5030	42p	AF179	45p	BF177	30p	MJE370	80p	TIS47	11p
2N2926O	10p	2N5172	12p	AF180	50p	BF178	25p	MJE371	80p	TIS48	12p
2N2926Y	10p	2N5174	12p	AF181	40p	BF179	30p	MJE520	60p	TIS49	12p
2N3011	20p	2N5175	52p	AF186	39p	BF180	35p	MJE521	70p	TIS50	12p
2N3014	32p	2N5176	45p	AF239	30p	BF181	32p	MPF102	42p	TIS51	10p
2N3053	18p	2N5232A	30p	AF279	47p	BF182	30p	MPF103	35p	TIS52	11p
2N3054	45p	2N5245	45p	AF280	47p	BF184	20p	MPF104	37p	TIS53	22p
2N3055	60p	2N5246	42p	AFZ11	32p	BF185	20p	MPF105	37p	XB112	12p
2N3133	30p	2N5249	67p	ASY26	25p	BF194	15p	MPS3638	32p	XC141	35p
2N3134	15p	2N5265	325p	ASY27	30p	BF195	15p	NKT124	42p	ZTX107	15p
2N3135	25p	2N5305	37p	ASY28	24p	BF196	15p	NKT125	27p	ZTX108	12p
2N3136	25p	2N5306	40p	ASY29	27p	BF197	15p	NKT126	27p	ZTX109	15p
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2N3391	20p	2N5308	37p	ASY51	32p	BF200	35p	NKT135	27p	ZTX301	15p
2N3391A	30p	2N5309	62p	ASY54	25p	BF224	14p	NKT137	32p	ZTX302	20p
2N3392	17p	2N5310	42p	ASY67	45p	BF225	19p	NKT210	30p	ZTX303	20p
2N3393	15p	2N5354	27p	ASY86	32p	BF237	22p	NKT211	30p	ZTX304	25p
2N3394	15p	2N5355	27p	ASZ21	51p	BF238	22p	NKT212	30p	ZTX500	15p
2N3402	22p	2N5356	32p	AUY10	150p	BF244	23p	NKT213	30p	ZTX501	15p
2N3403	22p	2N5365	47p	BC107	10p	BFW61	47p	NKT214	20p	ZTX502	20p
2N3404	30p	2N5366	32p	BC108	10p	BFW87	25p	NKT215	22p	ZTX503	17p
2N3405	45p	2N5367	57p	BC109	10p	BFW88	23p	NKT216	35p	ZTX504	40p
2N3414	22p	2N5457	30p	BC113	10p	BFW89	20p	NKT217	40p	ZTX531	25p

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CA3013	105p	FJH221	25p	SN7450	20p
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CA3042	109p	MC792P	66p	SN74161	
CA3043	137p	MC799P	66p		260p
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CA3045	122p		200p		220p
CA3046	81p	MC1304P		SN74165	
CA3047	187p		225p		225p
CA3048	204p	MC1305P		SN74192	
CA3049	160p		386p		175p
CA3050	185p	MC838P		SN74193	
CA3051	134p		549p		175p
CA3052	165p	MC1435P		TAA241	
CA3053	46p		345p		162p
CA3054	109p	MC1552G		TAA242	
CA3055	240p		461p		425p
CA3059	165p	MC1709CG		TAA243	150p
CA3064	120p		94p	TAA263	75p
FCH101	85p	MFC4000P		TAA293	97p
FCH111	105p		55p	TAA300	175p
FCH121	105p	SN7400	20p	TAA310	125p
FCH131	50p	SN7401	20p	TAA320	72p
FCH141	105p	SN7402	20p	TAA350	175p
FCH151	105p	SN7403	20p	TAA435	147p
FCH171	105p	SN7404	20p	TAA521	132p
FCH181	105p	SN7405	20p	TAA522	360p
FCH191	105p	SN7406	80p	TAA530	495p
FCH201	130p	SN7408	20p	TAA811	445p
FCH211	130p	SN7409	20p	TAB101	97p
FCH221	130p	SN7410	20p	TAD100	150p
FCH231	150p	SN7411	23p	TAD110	150p
FCJ101	160p	SN7412	48p	SL403D	15 p
FCJ111	150p	SN7413	30p	SL702C	147p
FCJ121	275p	TE7416	84p	UA702A	280p
FCJ131	275p	SN7417	84p	UA702C	77p
FCJ141	525p	SN7420	20p	UA703C	137p
FCJ201	100p	SN7423	51p	UA709C	45p
FCJ211	275p	SN7427	48p	UA710C	125p
FCK101	430p	SN7428	80p	UA716	187p
FCL101	230p	SN7430	20p	UA723C	100p
FCY101	102p	SN7432	48p	UA730C	160p
FJH101	25p	SN7433	80p	UA741C	80p

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6AQ5	38p	807	50p	PCC89	50p
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6AT6	35p	5763	70p	PCF80	30p
6AU6	25p	6146	160	PCF82	34p
6AV6	30p	AZ31	55p	PCF84	60p
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12BA6	40p	EF92	35p	UF80	35p
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BA111	27p	BY127	15p	OA85	7p
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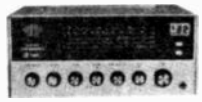

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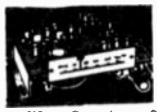
F.2000, Garrard 2025T/C Changer fitted stereo cartridge, with plinth and cover and pair of G.W.S. Speakers. Total Rec. Price £97·72½. OUR PRICE £52·95. Carr. £1

★ TRANSISTORISED FM TUNER



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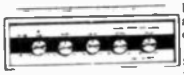
OUR PRICE £1·80

P. & P. 10p

NS-1600W STEREO AMPLIFIER



Exceptional budget price amplifier. All silicon transistor. Handsome Walnutcase. Switched input selector, separate balance, volume, treble, bass controls. Output 2 × 6W RMS. Inputs Mag. Tape. Xtal, Tuner, Tape Out. £14·75. Carr. 37p.

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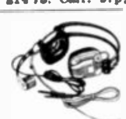

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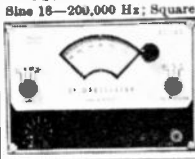

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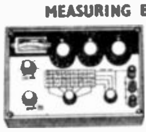

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Input 220/240V AC. Size 185 × 85 × 105mm. £8·97 P. & P. 25p.

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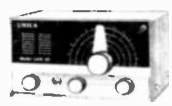

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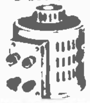

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PROJECTS...
THEORY......

VANISHING TRICK

The uninitiated might well be mystified as to how the private constructor obtains the circuit components and other special items he needs for his hobby. The sources of supply are certainly not all that apparent to an outsider.

Taking the country as a whole, outside the larger cities and certain towns it is rare indeed to find a shop dealing exclusively in electronic components. Nor do the numerous radio and television shops that grace every high street any longer offer that incidental service to the private constructor they, or their predecessors did, years ago.

MAIL ORDER

And yet in all, the turnover in electronic components and sundry items for private constructors has never been higher than at present. Likewise, the range and variety of parts offered to the individual has never been so extensive.

So what is the answer to this apparent paradox?

It is, quite simply, mail order. This method accounts for the greater bulk of business transacted in this area today.

AVAILABLE TO ALL

Mail order has considerable advantages to the individual purchaser. He can select from the retailers' advertisements or from their catalogues and lists, and order with confidence no matter what part of the country he resides in.

The system has certain snags, it has to be admitted. Occasional delays can cause irritation, and the need often to divide one's requirements among several suppliers can be a bit tiresome. But taking all into account the growth of the mail order retail business has been a great boon, especially to those living in the remote and less populated areas. No matter how isolated, they have the same extensive choice of components as constructors living in the large towns and cities.

UNDER THE BONNET

If the electronics industry had not invented the transistor, we feel sure the automobile industry would eventually have done so!

That ever available 12 volt battery is a prime mover in more senses than one. Since the arrival of the semiconductor it has been the inspiration for countless electronic gadgets.

This month we pamper the motorist yet again. We help him keep up appearances while touring or camping. It's a real face saver.

Fred Bennett.

Our August issue will be published on Friday, July 21

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..EASY TO CONSTRUCT
..SIMPLY EXPLAINED

VOL. 1 NO. 9 JULY 1972

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

Please Note~ no back issues

We regret to inform readers that the publishers are no longer able to supply copies of past issues. Nor will any back issues be available in the future.

Sorry about this—but to avoid possible disappointment we can only urge our readers to place a regular order with their normal supplier; or alternatively to take out an annual subscription (for details see foot of facing page).

SHAVER INVERTER

A 240V a.c. supply for electric shavers from a 12V car battery by C. J. Mills

THIS inverter has been specially designed to power any mains type electric razor from a 12 volt car battery. Many inverters provide a d.c. output and will only power a.c./d.c. type razors. Most of the vibrating type razors can only work on a suitable a.c. supply.

Using the design given, a razor can be used anywhere a 12 volt supply (normally a car battery) is available; such as when camping, caravanning or boating. The unit is thus ideal for anyone who enjoys the "outdoor life" during the summer months.

DESIGN

The main problem usually encountered in making a low frequency inverter to drive mains equipment from batteries is the design and construction of a special transformer to suit the power output required. For small inverters with outputs up to about 20 watts, standard mains transformers with a centre tapped secondary winding can be used in reverse, with a separate circuit to drive the power transistors.

The driving circuit must provide two output square waves in anti-phase such as is obtained from a multivibrator.

Approximate cost of components £3·75 plus case

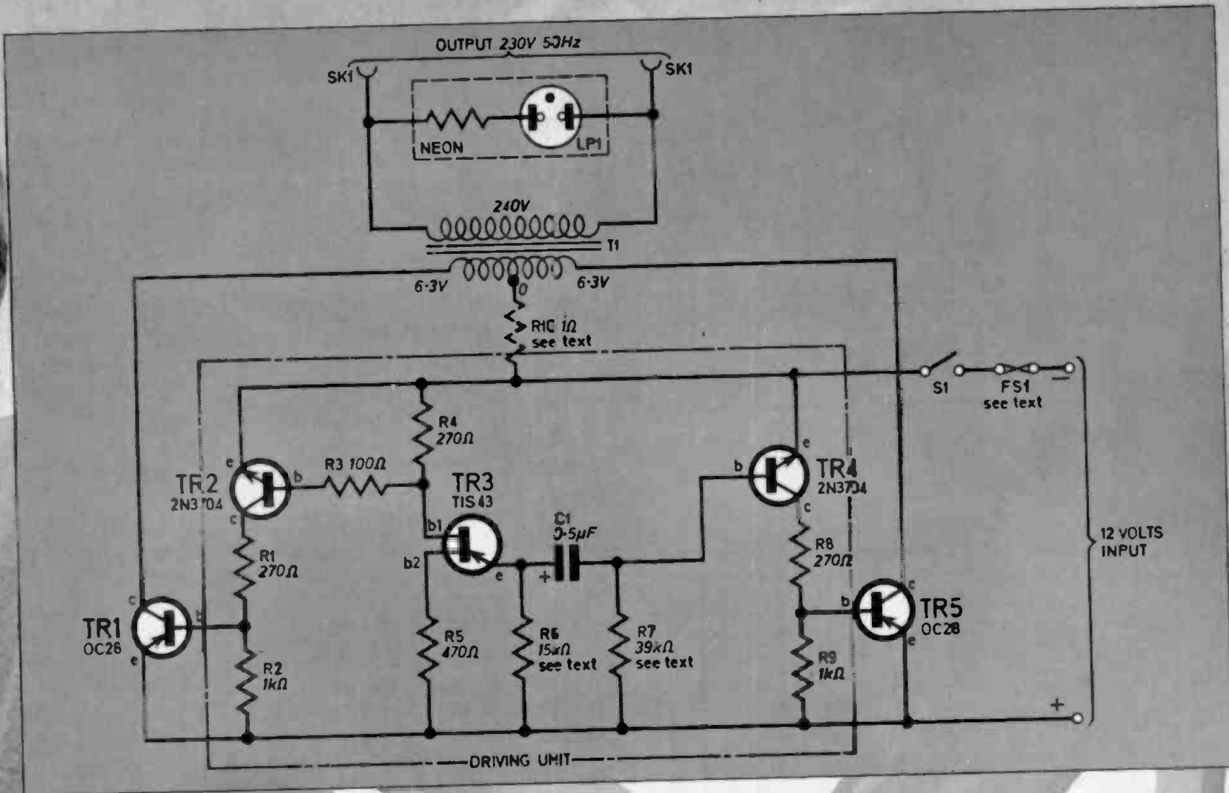


Fig. 1 Complete circuit diagram of the Shaver Inverter.

A unique type of multivibrator circuit developed by the author uses a unijunction because of its excellent frequency stability, in conjunction with two bipolar transistors as shown in the circuit diagram, Fig. 1.

CIRCUIT DESCRIPTION

The basic unijunction oscillator circuit will give a square wave output if a forward biased diode is connected in series with the capacitor.

Components....

Resistors

R1 270Ω
R2 1kΩ
R3 100Ω
R4 270Ω
R5 470Ω
R6 15kΩ
R7 39kΩ
R8 270Ω
R9 1kΩ
R10 1Ω 5W wirewound (if used—see text)
All $\frac{1}{4}$W ± 10% carbon except where stated

SEE
SHOP TALK

Capacitor

C1 0·5µF, 16V tantalum

Semiconductors

TR1 OC28 germanium *pnp* (or OC29—see text)
TR2 2N3704 silicon *npn*
TR3 TIS43 unijunction
TR4 2N3704 silicon *npn*
TR5 OC28 germanium *pnp* (or OC29—see text)

Transformer

T1 240V primary with: 16·3V, 0·3A centre tapped secondary (for 5 watts output) or 9V-0-9V, 0·6A secondary (for 10 watts output) or 6·3V–0–6·3V, 0·6A secondary used with R10 in circuit (for 10 watts output)—see text for details and higher power types. In all cases the mains primary is used as the secondary winding in this circuit.

Miscellaneous

FS1 Fuse and holder (see text)
S1 S.p.s.t. toggle switch
LP1 Neon mains indicator lamp
SK1 Two pin mains line socket for connection to shaver, 6 way stand-off tag strip, mica washers and plastic insulation bushes for TR1 and TR5, metal case 4½ x 3½ x 2 inches, plain perforated Veroboard 2½ x 2 x 0·1 inch matrix with Veropins to suit, grommets, wire, 4BA fixings and earth tags.

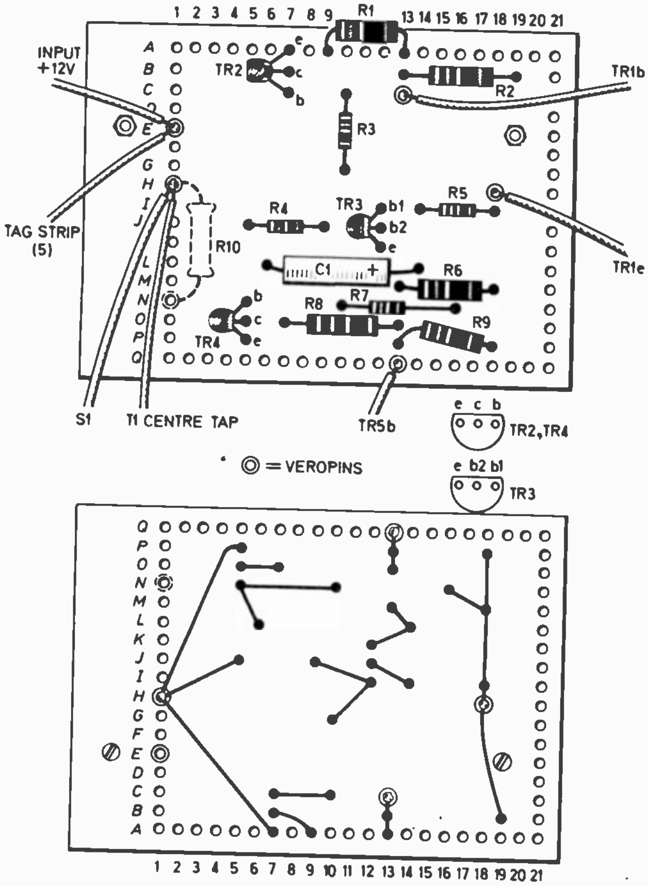


Fig. 2 Layout and wiring of components on the Veroboard.

In Fig. 1 the base, emitter diode of transistor TR4 is used and it is biased "on" by the base resistor R7. The collector is connected to a suitable resistor to provide one of the outputs. A second *npn* transistor, connected to the b1 base of the unijunction as shown, gives an output in phase opposition to the first.

CIRCUIT ACTION

When the supply voltage is connected the capacitor charges up through the base emitter diode of TR4 and through the 15 kilohm timing resistor, R6, until the trigger voltage of the unijunction is reached. During this charging time TR4 is held on by the charging current.

When the unijunction fires, its emitter voltage drops due to the emitter to base b1 current and this voltage drop is transferred to the base of TR4 by the capacitor, so that TR4 is turned off and the capacitor discharges through the TR4 bias resistor R7. At the same time the unijunction emitter, base b1 current flowing through the base resistance produces a voltage which switches on TR2 which stays on until the capacitor has discharged sufficiently to allow TR4 to conduct.

At this point the unijunction and TR2 are switched off, the capacitor starts charging again and the cycle is repeated.

The outputs from the collectors of TR2 and TR4 are coupled to the power transistors which switch the supply voltage across each half of the transformer alternately.

OUTPUT POWER

Using a 16·3 volt centre tapped 0·3 amp filament transformer with a test load resistance of 12 kilohms an output voltage of about 250 volts (approximately 5 watts) is obtained with a 12V d.c. input—alternatively, an 18 volt 0·6 amp transformer gives an output of 235 volts across 12 kilohms with an input voltage of 13 volts d.c.

For higher wattage outputs (up to 20 watts maximum for this design) a transformer with a 16 volt centre tapped secondary winding rated at 1 amp is required and the power transistors should be changed to OC 29 types.

Alternatively, if a 6·3-0-6·3 volt transformer is more readily available it can be used with a 1 ohm 5 watt resistor (R10) in series with the centre tap as shown dotted in Fig. 1. If this resistor is not used a link is made in its place.

CONSTRUCTION

A medium sized die cast box measuring 2 x 3½ x 4½ inches is a convenient form of case for the inverter and the power transistors can be mounted on the side to provide a heat sink, if they are suitably insulated by mica washers and plastic bushes.

The components of the driver circuit can be mounted on a piece of plain perforated Veroboard and connected up as shown in Fig. 2, using Veropins for support as shown. The layout is not critical but if it is similar to the circuit it makes checking easier.

The transistors should be soldered into circuit last and protected by using a heat shunt on each lead while soldering.

Wiring of the Veroboard to the remaining components is shown in Fig. 3. The wiring shown does not include R10 which is needed if a 6·3V-0-6·3V transformer is used. If R10 is used it is mounted as shown in Fig. 2 and the wire from T1 centre tap is connected to N1 not H1.

The fuse used depends on the transformer and output power. For a 5 watt unit use a 1 amp fuse, 10 watt use a 2 amp, and for 20 watt use a 5 amp fuse.

The input and output leads are brought out through grommets and a mains neon (LP1) connected across the transformer secondary winding is used as an indicator (mains type neons usually incorporate a resistor as shown in Fig. 1). A small tag strip is added for connection of transformer leads and some of the components.

Continued on page 482

SHAVER INVERTER

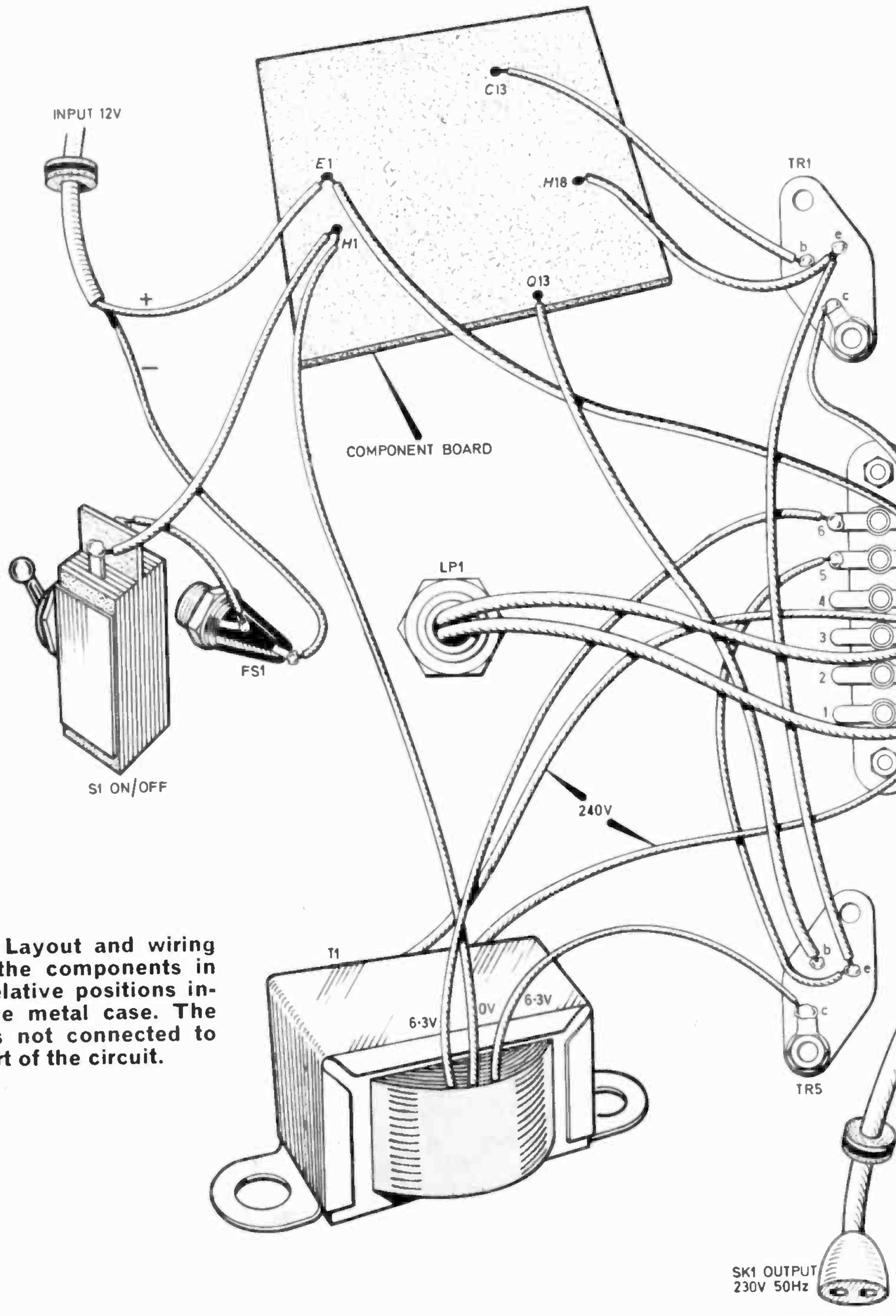
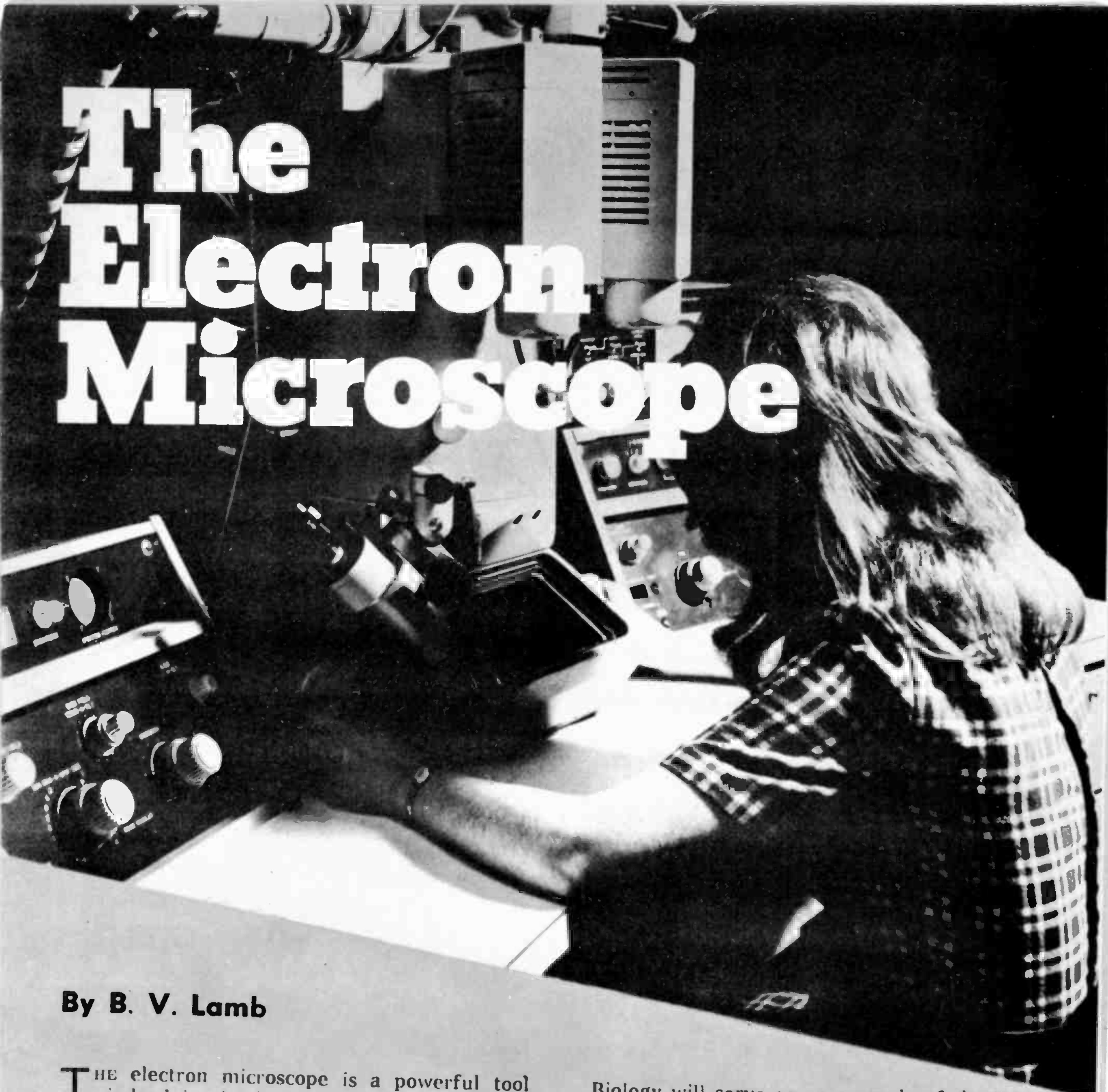


Fig. 3. Layout and wiring of all the components in their relative positions inside the metal case. The case is not connected to any part of the circuit.

The Electron Microscope



By B. V. Lamb

THE electron microscope is a powerful tool indeed in the hands of the modern technologist. Its use covers the whole spectrum of science. As man continues to enjoy the results of recent discoveries in his environment, so the electron microscope (E.M.) will play an ever growing part in applied science.

APPLICATION

Application of the E.M. may be split into two main groups, discovery and diagnosis. Often of course, these two merge and overlap. An example of its diagnostic use may be drawn from the electricity generating industry. A steam pipe has burst. What caused it? Was there a flaw in the pipe? Did corrosion eat into the metal? A sample of the pipe seen under the E.M. will reveal the facts.

Biology will serve as an example of the E.M. as an instrument of discovery. Whilst looking at a section of tissue, some new feature of a cell make up might be noticed or some fresh aspect on a certain disease seen.

As we shall see later, there is much more to electron microscopy than merely looking at an image of a specimen. To look is not necessarily to "see"; looking is passive whilst seeing is active. The electron microscopist is a scientist, the image on the screen of his instrument is often the result of much careful planning and reasoning on what he can expect to see.

E. M. FOUNDATIONS

The E.M. owes its development to early work

Heading photograph: the Jeol—JEM 100B electron microscope.

done in the field of electron dynamics—that is, the study of electrons moving under the influence of an applied electric field. (A Cathode Ray tube is an example of applied electron dynamics.)

Electronics and vacuum techniques are vital too. E.M.s have been in use for several decades now but not until the early 1960s were some of the most exciting developments made.

TYPES OF E. M.

Two distinct types of E.M. exist. Both use electrons to bombard the sample. The first type is called the transmission electron microscope (T.E.M.) and this was the earliest E.M. design to appear.

The operation of the T.E.M. is similar to the light microscope in that it has lenses and apertures as has the optical instrument. The difference being of course, that the lenses on the T.E.M. are magnetic and they focus electrons.

The second type of E.M. is the scanning electron microscope (S.E.M.). This microscope is essentially like a closed television system in its working. Early S.E.M.s can be traced back to the 1930s and these were made in-house by universities and ambitious research organisations. It was not until the early 1960s that a commercial S.E.M. appeared.

Both the T.E.M. and the S.E.M. have their relative merits. The recent commercial availability of the S.E.M. although of great interest, has by no means replaced the T.E.M., indeed many laboratories have both instruments. After describing the working principles of these quite different microscopes, the advantages of each will be seen.

COST

Great Britain, Japan, Germany, Holland and the United States of America all produce front line instruments of exceptional specifications. As is to be expected, E.M.s are expensive and the rule "you get what you pay for" applies well here; £5,000 to £250,000 covers the whole range The very high prices include special attachments and unusually high voltage installations.

An average T.E.M. might cost £25,000 and an S.E.M. of high specification the same. Because of the skills required in operating an E.M. and in preparing samples, any electron microscope unit involves large capital expenditure and running costs.

HOW THE T. E. M. WORKS

The basic essentials of a T.E.M. are shown in Fig. 1. At the top of the microscope sits the electron gun—so called because it emits electrons continuously at very high velocity.

The electron gun consists of the tungsten filament, the shield and the anode. The anode is connected to earth as is the positive side of the high voltage supply. A negative bias (V_b) is maintained between the filament and the shield. When current is supplied to the filament so that it is raised to a high temperature and air is pumped from the system, electrons are accelerated towards the anode.

The shield, being negatively biased, causes the beam of electrons to converge so that a crossover image of the filament is formed in the anode aperture. In this way a beam of electrons is projected from the gun and is now able to be aimed down the microscope.

As soon as the electron beam leaves the electron gun it is already beginning to diverge. The condenser lens is used to focus the diverging beam onto the sample.

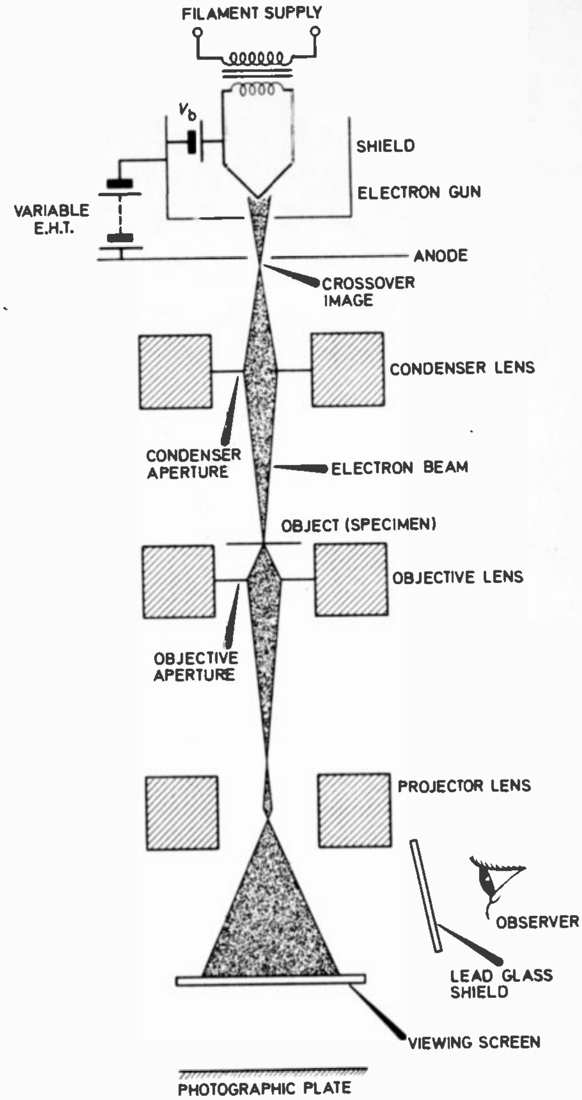
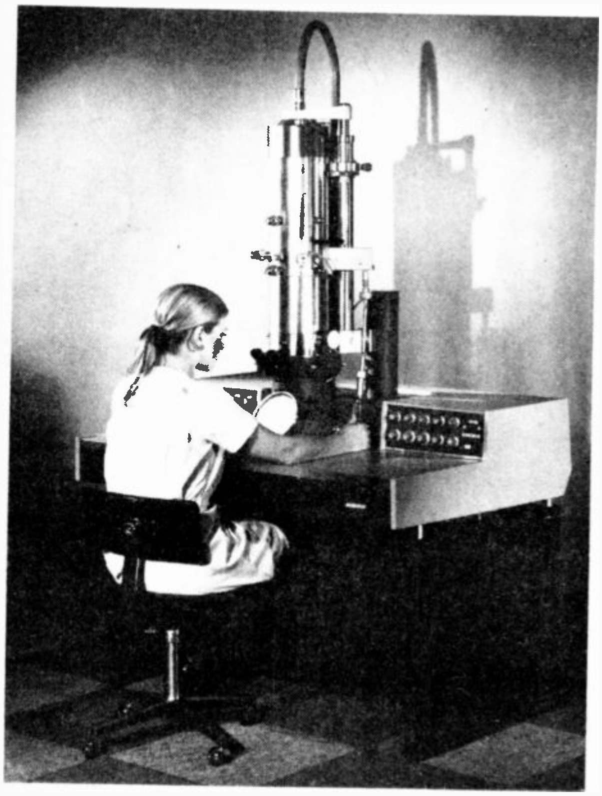


Fig. 1. Basic form of the transmission electron microscope. Additional optical accessories may be added to increase magnification.

This magnetic lens consists of a number of turns of copper wire on an iron ring. By varying the current through the coil the focus can be adjusted. The condenser lens also has an aperture that behaves in a similar way to optical microscope apertures—an opening of between 0·1 and 0·3 mm is typical.

The object (specimen) is held in a special holder either in or near to the objective lens. The finely focused pencil like beam of electrons strikes the specimen; and because the specimen is very thin and the electrons are travelling with great velocity, most of the electrons pass through the specimen. Once into the objective lens the electrons pass through the objective lens aperture (10 to 50 microns diameter) and are again focused to an intermediate image lower down the electron column.



The Philips high-resolution transmission electron microscope (EM201). This instrument can attain a resolution of 7 angstroms.

PROJECTOR LENS

The final lens is the projector and this gives the great magnification that one may expect. This lens projects the electron beam onto a flat glass viewing screen. The viewing screen has a layer of phosphorescent material coated to it; electrons striking the phosphor screen cause it to glow.

Underneath the screen is a compartment to take photographic plates when a permanent record is required. The operator sits and looks down on the viewing screen through a lead-glass shield. Sometimes external optical magnification is used to increase the image size even more. T.E.M.s can give useful magnifications up to 500,000 times and the best instruments claim to be able to resolve detail down to 2 Angstroms.

The electron microscopist talks in terms of angstroms and microns as the mechanical engineer speaks of the thou. (1/1000 inch). An idea of just how small an angstrom (Å) is can be gathered by measuring the diameter of a human hair and expressing it in angstrom units. A human hair is about $1\frac{1}{2}$ thou. in diameter.

1 Å = 10,000 Microns (10^{10} Metre) and 1 thou. = 25·4 microns. Therefore $1\frac{1}{2}$ thou. = 25·4 × 1·5 × 10,000 = 380,000 Å!!!

Although the ability to resolve smaller and smaller in detail is the goal towards which the E.M. manufacturer constantly works, this extremely fine resolution presents the operator with many difficulties. An illustration will help in understanding a major problem.

If we look at an area on an Ordinance Survey map, although the area will be given in fine detail its relation to the rest of the map can only be understood by looking at the whole of the map in "coarse resolution", i.e. taking a broad view of surrounding landmarks etc. So it is with the E.M. operator. Great resolution without knowledge of the image in relation to the whole structure can be meaningless.

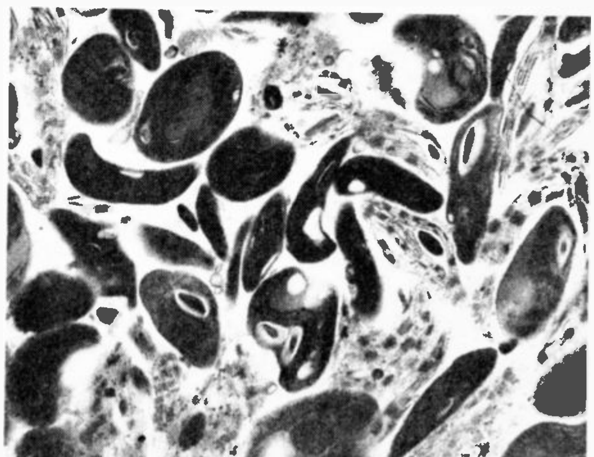
SAMPLE PREPARATION

As we have just seen by considering the basics of the T.E.M. the specimen must:—

1. Be cut thin, i.e. less than 1,000 Å thick.
2. Be able to withstand a vacuum.
3. Be undamaged by electrons striking it.

Considering each of these points separately. A thin slice of the specimen is required so that

A 0.5μm section of spinach chloroplasts at a magnification of 12000x, taken on the AEI, EM7 electron microscope.



most electrons will pass right through to form an image on the fluorescent screen. Actually, detail (contrast) in the sliced specimen is made apparent in the image because some of the electrons are scattered in their journey through it.

All atoms scatter electrons, the amount of scattering increases with atomic weight. As we shall see later, by staining the specimen with heavy atoms, a significant increase in contrast can be obtained.

The second requirement is that the specimen is able to stand up to a vacuum. When air is pumped from the electron column, gases and water vapour are rapidly sucked from the sample.

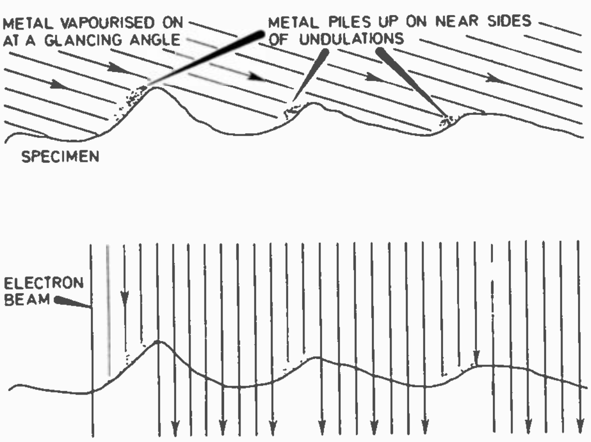
If a water-containing specimen such as a biological sample is subjected to vacuum it would quickly be rendered useless for viewing. Biological specimens are freeze-dried and are fixed in thin films and are then supported on grids of very thin wire. Micrographs are made through one mesh of the gauze.

Sample preparation requires skill and patience and is vital to producing meaningful images. To prepare some biological specimens can take two weeks from the time the sample arrives in its raw state to the moment it can be placed in the sample chamber of the T.E.M. Other samples of course, due to their inert make-up may be viewed with the minimum of preparation time.

REPLICAS

Sometimes it is necessary to produce a replica of the specimen. In this case the specimen surface is etched to produce relief and then the surface is plastic coated or metal is evaporated on. Carbon from an arc may also be used as the coating. The replica is then peeled off and introduced into the microscope sample chamber.

Fig. 2. Method of shadow casting using vaporised metal to provide greatly enhanced details.



As was discussed earlier, if the scattering of electrons in the sample is not sufficient to disclose fine detail (contrast in the image) then the specimen can be stained with a heavy metal. Osmium, atomic number 76, is frequently used.

Another method for showing up fine detail is known as shadow casting. This is achieved by vapourising metal onto the sample at a glancing angle. Metal piles up on the near side of undulations (see Fig. 2), and when the electron beam strikes the sample, greatly enhanced details are evident.

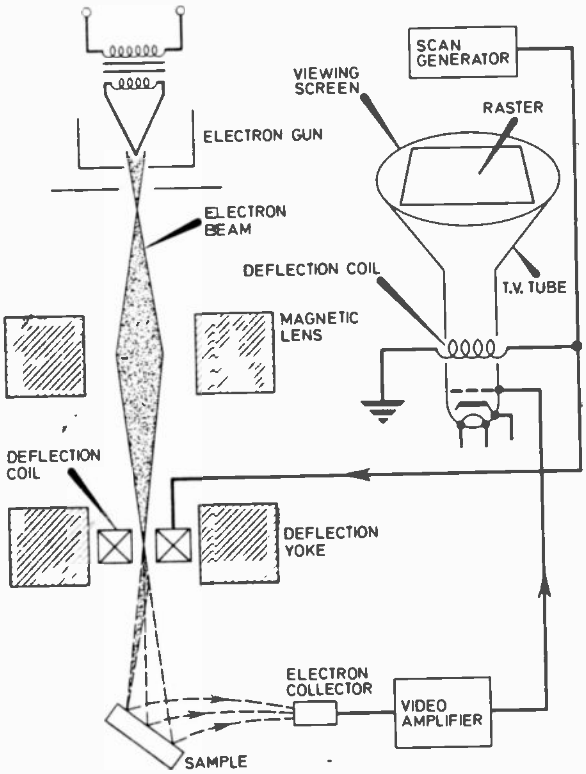


Fig. 3. Basis of the scanning electron microscope. Photograms of the screen can be taken using a special camera.

SCANNING ELECTRON MICROSCOPE

The S.E.M. is essentially a closed circuit T.V. system with refinements (see Fig. 3). Again there is the electron gun emitting electrons at high velocity, and magnetic lenses to focus and magnify. Also aperture plates to sharpen the image are present, just as in the T.E.M.

The inclusion of the deflection yoke and its associated circuitry marks the distinction of the S.E.M. from the T.E.M. The deflection yoke is powered by an a.c. waveform that causes the fine beam of electrons to scan across the sample in a regular way. (The a.c. waveform powering the deflection coil is also coupled to the T.V. monitor. This causes a raster on the T.V. tube.)

This very fine beam of electrons covering an

The Cambridge Scientific Instruments Stereoscan S4. This is the latest scanning electron microscope from this company.

adjustable area of the sample causes secondary electrons to be emitted which in turn are collected by a secondary electron detector. The secondary electron detector is a device which converts electrons into photons of light which in turn are collected by a photomultiplier. The electrical output from the detector is connected to the T.V. monitor so that the spot causing the raster is modulated with information relative to the specimen surface.

Again, as in the T.E.M. the viewing screen can either be watched by the operator or photographed for a permanent record. Useful magnifications up to 50,000 times can be achieved in the S.E.M. The electron beam energy can vary from as little as 1kV to 50kV.

ADVANTAGES

The main attraction of the S.E.M. is in its ability to produce a three dimensional image of the specimen surface. Great depth of field is also achieved. The reason for these features is that the electron beam striking the surface resembles a fine sharp pin which is able to probe into the irregularities of the specimen. Unlike the T.E.M. the picture is formed by electrons emerging from the surface of the sample.

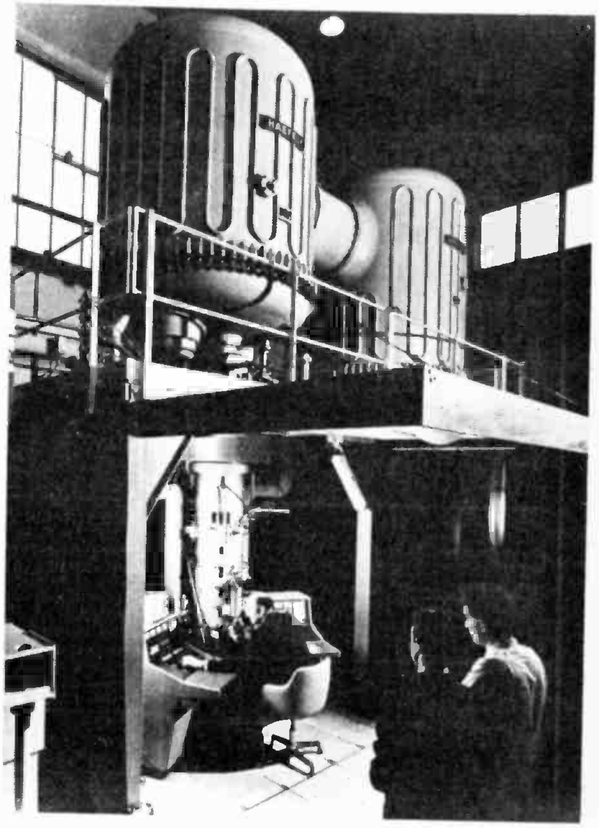
Although the T.E.M. has good depth of field, the usable depth is limited because the specimen has to be very thin.

In the S.E.M. sample size is only limited by sample chamber considerations. Because sample slices are not required for the S.E.M. preparation time is dramatically lowered. Preparation for electrically conducting specimens consists of fixing them to the moveable specimen stage with a conducting glue. Biological samples and others that are not conductors need to be made conducting by evaporating a thin film of gold onto them. Coating thicknesses fall in the 10 to 100's of angstrom region. As with the T.E.M., biological specimens require fixing and drying.

Over the past few years many photographs of sample images produced in the S.E.M. have been published. Many of these excite the imagination as the microscopical region of such objects as the wing of a butterfly or the detail of a nerve cell is revealed in three dimensions.

Key performance characteristics of both the T.E.M. and the S.E.M. will continue to improve as manufacturers strive to meet the demands of modern technology. ■

The AEI, EM7 million volt electron microscope installed at the United Kingdom Atomic Energy Authority at Harwell.



PLEASE TAKE NOTE

Bee Counter circuit description—see Readers Letters page.

Potentiometer VR1 in the Demo Deck is 100Ω not 300Ω as mentioned last month.

Wash Wipe control second paragraph page 441, the emitter wire of TR 3 should be soldered to J2, not the collector wire as stated.

ELECTRONOME

A simple design giving a performance similar to that of a mechanical metronome.

by F. C. Judd

Aside from being a simple exercise in electronics, the Electronome has a real application in music practice, for it produces a sound very like that made by a mechanical metronome and covers the same tempo range of approximately 40 to 225 beats per minute.

The resonant click is loud enough for music practice with piano, guitar, electronic organ and other musical instruments and the tempo rate is continuously variable.

Few components are required and almost any 3 to 5 ohm loudspeaker can be used for reproducing the sound.

CIRCUIT DESCRIPTION

The circuit as shown in Fig. 1 is quite simple and employs only two transistors which are connected to form a multivibrator type oscillator, i.e., one that generates a relatively square waveform signal of large amplitude.

The output to the loudspeaker is taken from TR2 collector via a large capacitor but as the leading edge of the square-wave is very fast and of large amplitude, a quite substantial spike of current is driven through the very low im-

Approximate cost of components £1·75 plus case

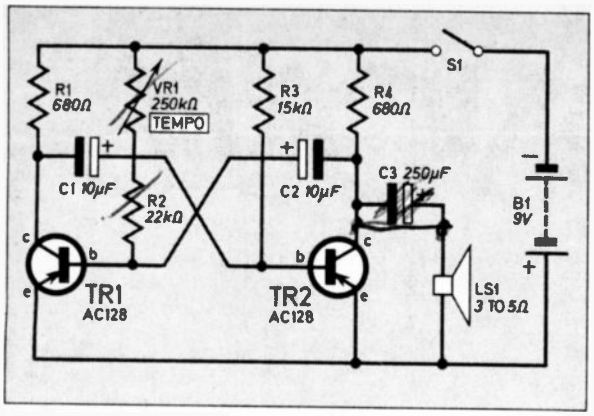


Fig. 1. Complete circuit diagram of the Electronome

pedance speaker coil. The speaker, therefore, responds only once, i.e., to the leading edge of the square-wave and thus produces a single loud click.

The same effect would be produced by momentarily connecting a 9V battery straight across the speaker coil. The multivibrator is in effect doing this repeatedly the repetition rate being variable by means of the tempo control VR1.

CONSTRUCTION

The prototype shown in the photograph is housed in a small box made of 1/8 inch hardboard with joins at sides, top and bottom strengthened with 1/2 inch by 1/2 inch batten, or small blocks of wood. The front panel aperture for the speaker may be covered with any loose weave material. The tempo control VR1 and the on/off S1 switch are mounted on the front panel of the case.

The components for the oscillator are mounted on a piece of plain perforated circuit board 3 1/2 inches by 2 1/2 inches, as shown in Fig. 2, supported on a 3/8 by 3/8 inch piece of aluminium angle 3 1/2 inches long. The circuit board is attached inside the box by the aluminium angle.

The component layout and wiring on the board are shown in Fig. 2.

COMPONENT MOUNTING

Commence construction of the circuit board by attaching the positive and negative rails to the underside of the component board. These wires can be 16 or 18 s.w.g. tinned copper wire and they are attached by placing each end through the indicated holes and bending them over on top of the board. The components are mounted by their leads and soldered to the two rails or to each other as indicated in Fig. 2.

Mount all the components except the two transistors, check the layout and wiring with particular reference to the capacitor and battery polarities and, when satisfied that all is correct, mount the transistors.

Use a heat sink on each transistor lead, while it is being soldered, thus preventing the transistor from being overheated. Mount the transistors so that the spot (collector) is toward the negative rail. Connections for the AC128 transistors are also shown in Fig. 2.

The circuit can be checked out before assembly into the case by connecting up VR1 (tempo control), the loudspeaker and battery as shown in Fig. 3. A clearly defined repetitive click should be produced which, with VR1 at zero resistance, should be approximately 225 beats per minute and approximately 40 beats per minute at maximum resistance.

SCALE

Insert all the components in the case and mount the battery using a clip or an elastic band. A scale can be made up similar to that shown in Fig. 4 and calibrated by counting the clicks of the Electronome over a 15 second period.

If the clicks are counted in tens it is just possible to count at a rate of 225 per minute. It should be emphasised that Fig. 4 is given as a **guide only** and should not be used as the actual scale.

A back cover for the box, which can be made from hardboard, will complete assembly but if the box is to be painted or covered in fabric do this before mounting the speaker and controls.

Components....

SEE SHOP TALK

Resistors
R1 680Ω
R2 22kΩ
R3 15kΩ
R4 680Ω
All ¼W 10% carbon

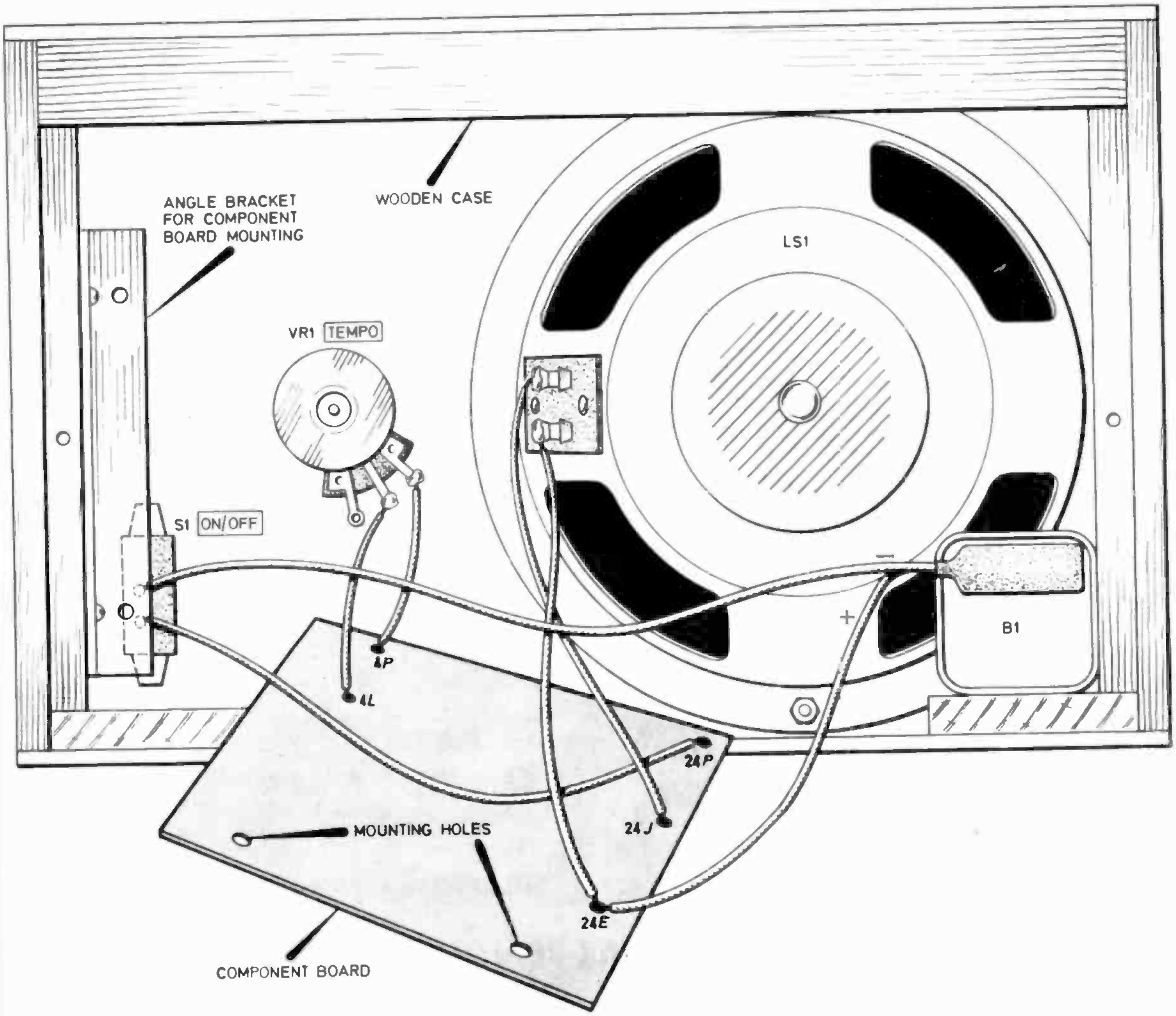
Capacitors
C1 10µF elect. 12V
C2 10µF elect. 12V
C3 250µF elect. 12V

Variable Resistor
VR1 250kΩ log. carbon

Transistors
TR1 AC128 germanium *pnp*
TR2 AC128 germanium *pnp*

Miscellaneous
S1 s.p.s.t. toggle or slide switch
LS1 3 to 5Ω moving coil loudspeaker approximately 3 to 5 in. diameter
B1 PP9, 9V battery and connector
Pointer knob, Veroboard—plain perforated 3½ x 2½ x 0.15 inch matrix, aluminium angle 3½ x ⅜ x ⅜ inches, wire, materials for case and dial, speaker grill material.

ELECTRONOME



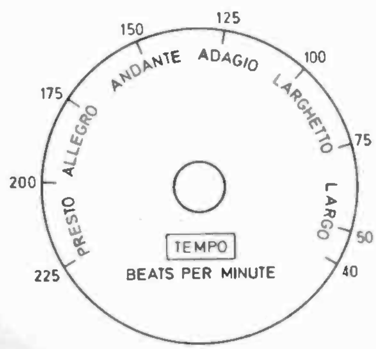


Fig. 3. Layout and wiring of the complete Electronome. The circuit board is shown removed for clarity.

Fig. 4. A suggested design for the scale for VR1. The markings are given as a guide only.

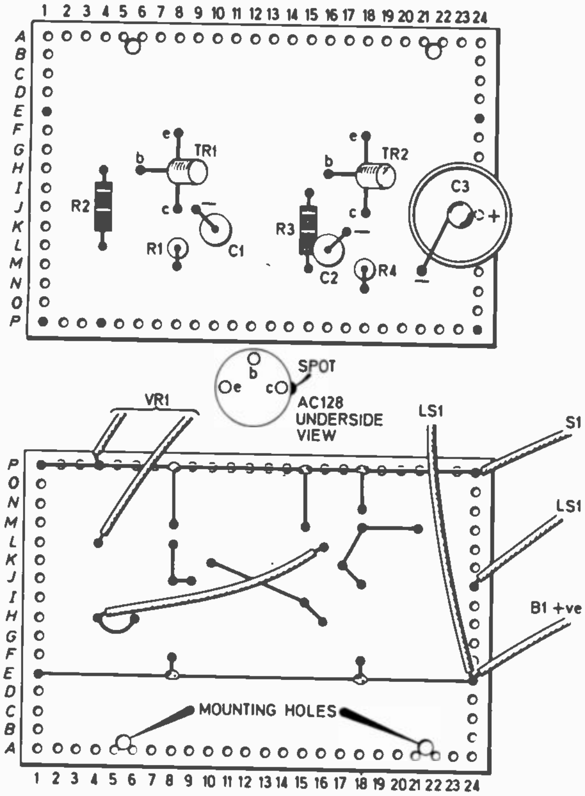
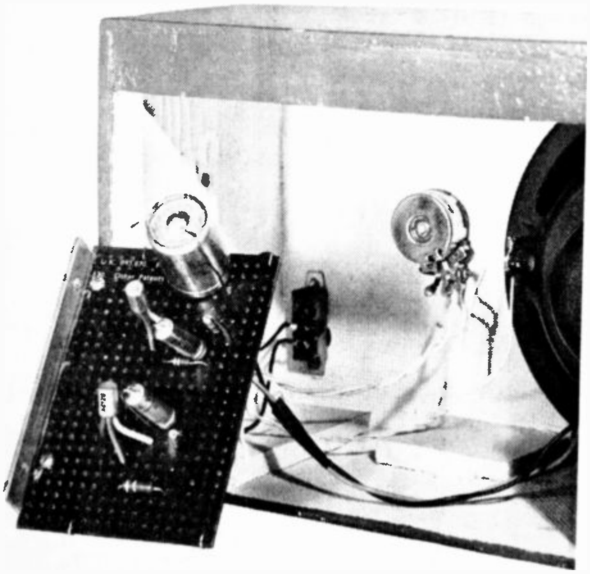


Fig. 2: Layout and wiring of the components mounted on the Veroboard

The battery should be an Eveready type PP9 for long life as the current consumption is 12 to 15mA. If the box is made to about the size given there will be plenty of room for the circuit board, speaker and a PP9 battery. The complete unit could, together with a small speaker, be housed in a smaller case should this be desired.



Continued from page 472

TESTS AND ADJUSTMENTS

When the driving unit (the circuit mounted on the Veroboard—see Fig. 1) is completed it should be tested before connecting it to the power transistors and the transformer. Connect the circuit to a 12 volt supply observing polarity and measure the d.c. collector voltage (voltage between collector and positive line) of TR2 and TR4. They should read approximately half the supply voltage if the unit is operating correctly.

Any difference in the collector voltages will indicate an unequal mark to space ratio which can be corrected by adjustment of R6 or R7. If the collector voltage of TR4 is below 1 volt and TR2 is above 11 volts the unit is not oscillating. This may be due to the spread of the unijunction characteristics and R6 and/or R7 should be adjusted until oscillation is obtained.

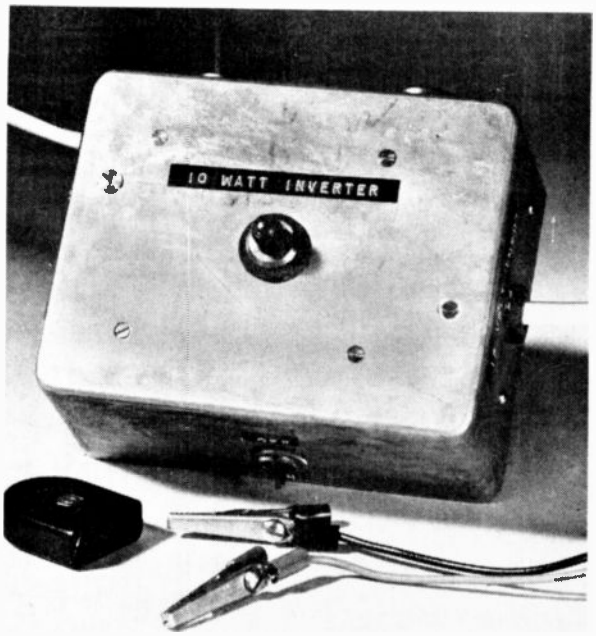
The resistors should be adjusted alternately in each direction and finally trimmed in small steps, to give approximately equal collector voltage readings. If an oscilloscope is available it is easy to see the effect of any adjustments and to trim the components R6, R7 and C1 for the correct wave shape and frequency.

The frequency of the complete unit is not critical if the shaver works satisfactorily.

WARNING

Although powered from a 12V supply the output of this inverter is high enough to deliver a very unpleasant shock.

Under certain circumstances **the output from the unit could be very dangerous indeed** and should be treated with the respect afforded to any mains supply.



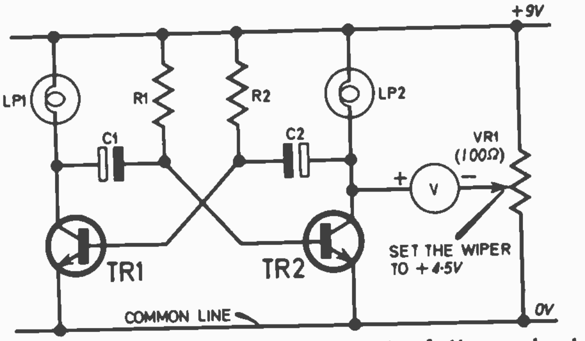
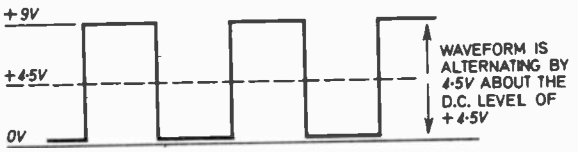


Fig. 1(a) (above). Measurement of the output voltage from the multivibrator of last month, about a d.c. level of +4·5V.

Fig. 1(b) (below). Voltage levels with respect to time observed on the voltmeter.



the meter connections and you will see that the voltages fluctuate from about +4·5V to −4·5V about our new reference point. We say that the voltage is **alternating** and the current flowing through the meter is **alternating current (a.c.)**.

We say that the voltage is alternating with an amplitude of 4·5V about the d.c. level of +4·5V. Again this means exactly the same as the other two methods of measuring we have mentioned.

ALTERNATOR

We very often come across voltages that alternate about a common line, e.g. from record player pick-ups and microphones, but perhaps the most common is the a.c. mains fed to our homes.

Mains is generated at the power station by an alternator which in its simple form is a coil of wire rotating between the poles of a magnet. See Fig. 2.

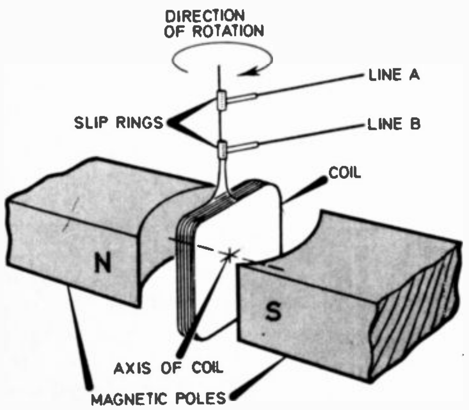


Fig. 2. Schematic diagram of an alternator.

When the axis of the coil is in line with the pole pieces, no voltage is generated but as the coil turns the e.m.f. between the wires coming from the slip-ring contacts increases until it reaches a maximum (peak) when the coil's axis is at right-angles to the pole pieces; it then starts to fall towards zero as the coil rotates towards 180 degrees of rotation (i.e. its axis is in line with the poles again but its direction is reversed). Fig. 3(a) (b) and (c).

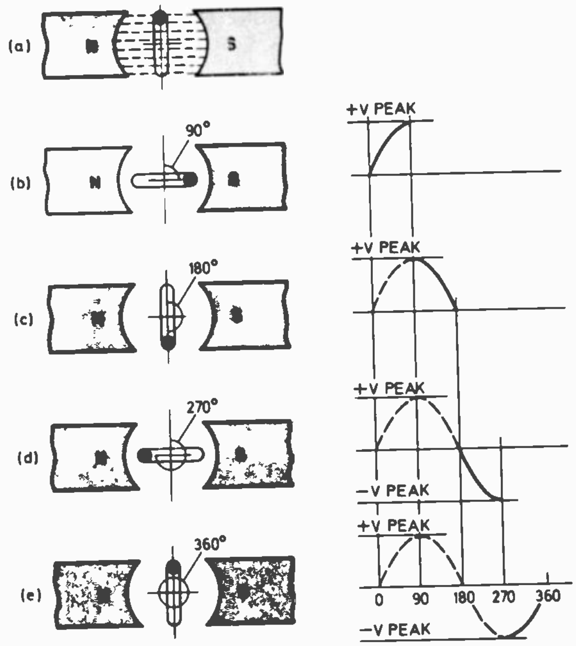


Fig. 3. Shows how one complete "sine wave" is generated from one complete revolution of the coil. The waveform is measured in terms of voltage on line B relative to line A.

Continuing its rotation the e.m.f. will rise again but with opposite polarity and after passing the 270 degree point will fall back to zero as 360 degrees of rotation is reached. Fig. 3(d) and (e).

If we consider the line "A" of Fig. 2 as the common (or neutral) the potential on the other will vary smoothly from zero through maximum positive, back through zero to maximum negative and back to zero.

SINE WAVE

If the coil turns at a constant rate, the waveform of the voltage produced is called a "sine wave" (because the voltage produced at any point of the coil rotation is equal to the maximum positive voltage, multiplied by the sine of the angle of rotation).

One cycle of the sine wave is equal to one complete turn of the coil, hence the number of revolutions of the coil per second sets the frequency, see Fig. 4.

In electronics you will find sine waves appearing very frequently because they are the most pure and simple waves that exist.

Because they are associated with circular movement, formulae based on sine wave theory frequently incorporate the term 2π which is merely another way of expressing angle of rotation.

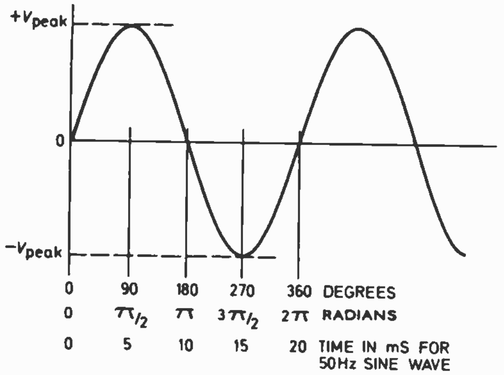


Fig. 4. A continuous sine wave. The discrete points marked can be considered in degrees or radians of rotation—or time if the frequency is known. Time is given for a 50Hz wave.

When the coil turns through 360 degrees (1 complete revolution) we say it has passed through 2π radians (where π (pi) is a constant equal to 3·142). You will see this expression used later on in the series.

TRANSFORMERS

One of the greatest attractions of alternating current is that it can be used in conjunction with a transformer to change voltage levels (both up and down) with insignificant loss of power.

A transformer consists of two coils of wire on a core of soft iron. This is shown by the circuit symbol in Fig. 5 together with some common types of transformer.

One of the coils on the transformer is called the "primary", which normally consists of many thousands of turns (for mains inputs) and the other, which is on the same core but electrically insulated from the primary, is called the "secondary".

The ratio of the turns between the primary and secondary controls the amount of voltage transformation in direction proportion.

On the Friedland transformer which we will be using in our experiments, there are three alternative secondary outputs: 3, 5 and 8V. In the case of the 8V output, the turns ratio would be about 8 on the secondary for every 230 on the primary.

If we pass a current through the primary we will magnetise the core, and the change in magnetisation will induce an e.m.f. across the secondary, the magnitude of this e.m.f. being proportional to the turns ratio. This e.m.f. will only be induced while the magnetic field is being changed by the primary current.

Thus, if we pass a direct current into the primary and keep it flowing, we will only get a brief e.m.f. produced in the secondary while the initial magnetisation takes place. When we stop the primary current, the magnetisation will die away fairly quickly (if the transformer is a good one) and this change of field in the opposite direction will induce another brief voltage pulse of opposite polarity.

You can see this using a 9V battery and the 1mA meter of the Demo Deck, Fig. 6.

Connect the 1mA meter directly across the 8V output of the transformer and then connect the battery across the primary (mains input terminals). If you watch the meter you will see a short "kick" (the direction depending on which way round you connect the battery). Break the primary circuit and you will see the meter needle "kick" in the opposite direction.

The movement will be so fast that you will not be able to make any actual measurement

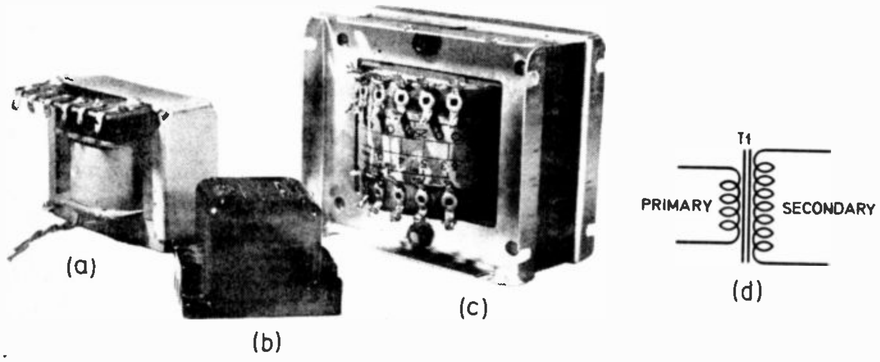


Fig. 5. (a) Ordinary mains / low voltage tapped transformer. (b) Friedland Bell transformer—used in this months experiments. (c) Heavy duty mains type, three secondary windings, HT (500V) and heaters (6·3V). (d) Circuit symbol for an iron cored transformer.

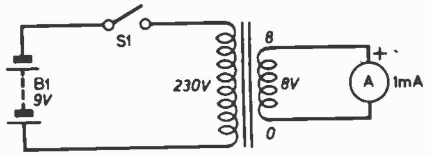


Fig. 6. Circuit diagram for showing current will only flow in the secondary when a change of current occurs in the primary.

but you will see the effect. After doing the experiment once, you might notice a reduction in pulse amplitude if you repeat the experiment; this is caused by residual magnetism held within the core (it does not demagnetise itself completely when you stop the current, hence the change in magnetisation will not be so great the next time you do it). To overcome this, reverse the battery connections between each experiment.

While a direct current in the primary will not cause a continuous current to flow in the secondary, variations in the primary will produce variations in the secondary voltage. This is very similar to the effect we had with capacitors where changes in potential on one plate caused changes on the other although continuous d.c. produced no change after the initial reaction.

Alternating voltages when applied to a circuit will cause current to flow in alternate directions. If we apply a.c. mains to the 230V input of our transformer, the current, and hence the magnetisation, will be constantly changing direction at the mains frequency—50Hz (50 complete sine wave cycles per second). This induces a 50Hz sine wave across the secondary winding but at a lower voltage.

POWER IN EQUALS POWER OUT

An important fact about this type of transformation is that, by and large, the power put into a transformer equals the power taken out (there are certain losses caused by core magnetisation but these are negligible and will be ignored at present). For example a medium voltage input at medium current will enable a secondary to give either a higher voltage at lower current or a lower voltage at higher current—depending on the turns ratio, see Fig. 7.

Power-wise you never get more out than you put in!

We are going to do some simple experiments using alternating current but first let's see how we can measure alternating voltages.

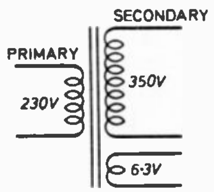


Fig. 7. This circuit symbol signifies a mains transformer with two secondary windings, the output voltages of which are shown.

A.C. MEASUREMENT

First just try and measure the 8V output of the transformer when its primary is connected to the mains. **Remember to take great care that you do not touch any connections on the primary side**—it is quite safe to handle the secondary.

Make a simple 10V voltmeter with a 10 kilohm resistor and the 1mA meter and connect it across the transformer's secondary terminals, Fig. 8.

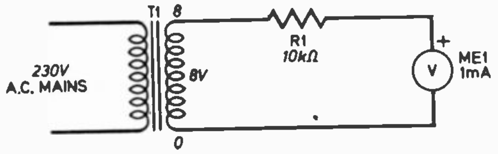


Fig. 8. The voltmeter will read zero volts because the meter settles at the average level.

You should read zero volts which you might think rather strange. It is not so strange if you realise that the needle is trying to swing up in a positive direction then back towards negative 50 times a second—it is physically impossible for it to move this fast. Instead it will settle down and register the average voltage, which is zero. Had you done this on the collector of TR2 of the 700Hz multivibrator (last month) you would again have read the average value but that would have been +4·5V.

In the case of a square wave of unity mark space ratio oscillating between zero and +9V, the peak voltage could be ascertained simply by doubling the average, but in the case of a sine wave alternating to equal amplitudes in both positive and negative directions, this is not possible.

HALF-WAVE RECTIFICATION

We can however prevent negative current flowing through the meter by incorporating a diode see Fig. 9. This is called "half wave rectification." Now only positive half cycles will affect the meter and we shall get a reading that is a form of average between zero and the peak of the positive half cycle but obviously it is not a simple average and the response of the meter movement will still play an important role in our measurement.

R.M.S.

Whatever happens, we are never going to be able to measure peak voltage using a moving coil meter. Meters designed for measuring alternating current work on the basis of measuring a special type of average level; this level is called the root mean square value (r.m.s.) for the sine wave in question (and is indicated in Fig. 10). This value is the peak value divided by $\sqrt{2}$ (square root of 2).

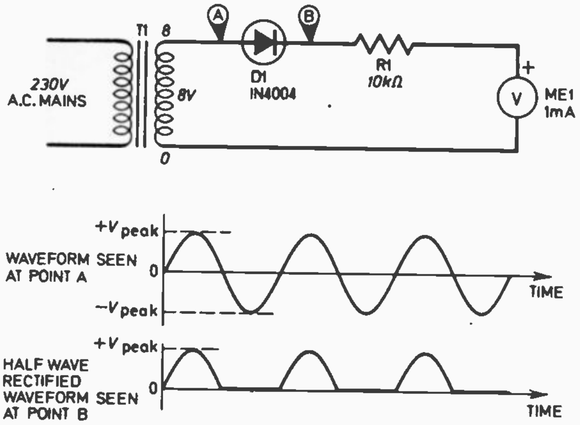


Fig. 9. After half-wave rectification the meter will display a reading of between zero and V_{peak}.

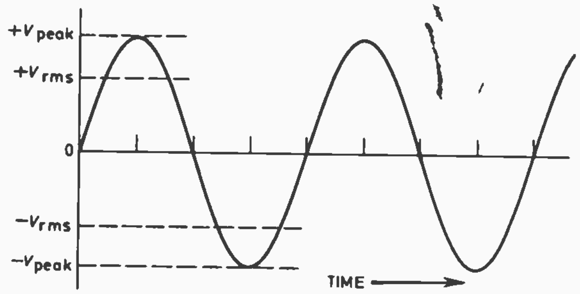


Fig. 10. A sine wave showing relative positions of V_{peak} and V_{rms}.

Conversely if we know our meter is calibrated in terms of r.m.s. values we can calculate the peak voltage by multiplying the r.m.s. value by $\sqrt{2}$. (The square root of 2 is approximately 1·414.)

Thus $V_{peak} = V_{rms} \times \sqrt{2}$ or $V_{rms} = \dfrac{V_{peak}}{\sqrt{2}}$

Unless otherwise stated **always** assume that the outputs of transformers are given in r.m.s. values. A mains voltage stated as 240V a.c. is an r.m.s. value; this means that on positive and negative peaks the sine wave will reach +340 and −340V respectively (this is why you should always use at least 400V rated components in mains circuits!). The output of our transformer is 8V r.m.s. therefore its peaks will be +11·2V and −11·2V.

A.C. VOLTMETER

You could experiment with series resistors, the 1mA meter and the single diode to make a simple 10V r.m.s. full scale a.c. voltmeter. You will find that the series resistor will have to be less than 10 kilohm—probably 5·6 kilohm, but this will depend on the mechanical response of your meter. For the following experiments you would be well advised to use a high resistance voltmeter already calibrated for a.c. working.

DC POWER SUPPLY

We can use the components we have available to make a simple battery eliminator. This means we can use the mains to produce a low d.c. voltage that could be used to power simple transistor experiments—see circuit in Fig. 11. All we do is turn our transformed a.c. into a half wave rectified signal—which could be called an intermittant d.c. voltage. This is then fed to a large capacitor C1, which smooths out the ripples—rather like the diode pump circuit (*Teach-In Part 6*).

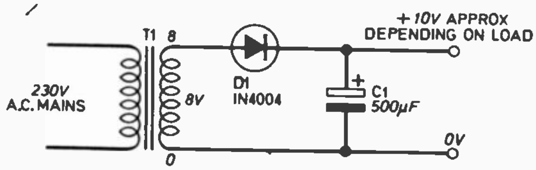


Fig. 11. Simple half-wave rectified power supply. The output voltage will vary, depending on the load, being at peak value for zero load.

Provided the current we draw from the capacitor is very much less than the charging up current, there should not be too much residual ripple caused by the half-wave rectified a.c.

The interesting thing about this circuit is that even though you use an 8V output transformer the d.c. voltage you obtain across the capacitor will be higher (between 10V and the peak of 11·2V). The actual value will depend on the amount of current you draw.

FULL WAVE RECTIFICATION

With half-wave rectification you do not use the full amount of energy available, because the negative half cycles are not used. We can carry out a process called full-wave rectification which in effect changes the negative going excursions of the a.c. waveform to positive going signals. These fill the "gaps" between the half wave rectified signals (see Fig. 9). In Fig. 12(a) the diodes are in a circuit called a "diode bridge."

When the potential of line "A" is postive with respect to line "B" (i.e. positive half cycles) current will flow through D2 and D3 which are forward biassed, but both D1 and D4 will be reverse biassed, thus the positive half cycle will charge the capacitor. During the negative half cycle (i.e. line "B" is now positive with respect to line "A") D4 and D1 will be forward biassed hence charging the capacitor; D2 and D3 will be reverse biassed—preventing a short circuit across the transformer secondary.

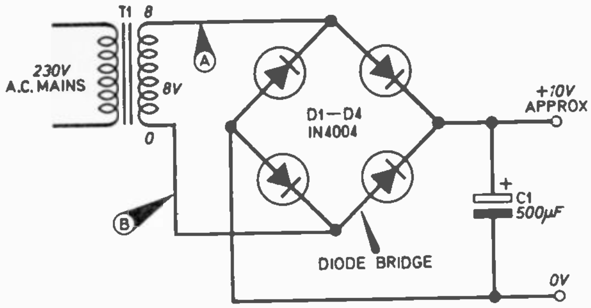
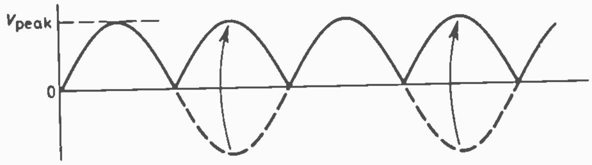


Fig. 12(a) (above). Circuit for demonstrating the principle of full-wave rectification.

Fig. 12(b) (below). Full-wave rectified sine wave.



The ripple will now be a signal having a frequency of 100Hz (see Fig. 12(b)) which can be more effectively smoothed by the capacitor, and since more total energy is being fed to the capacitor more current can be drawn out before the ripple increases to an objectionable level.

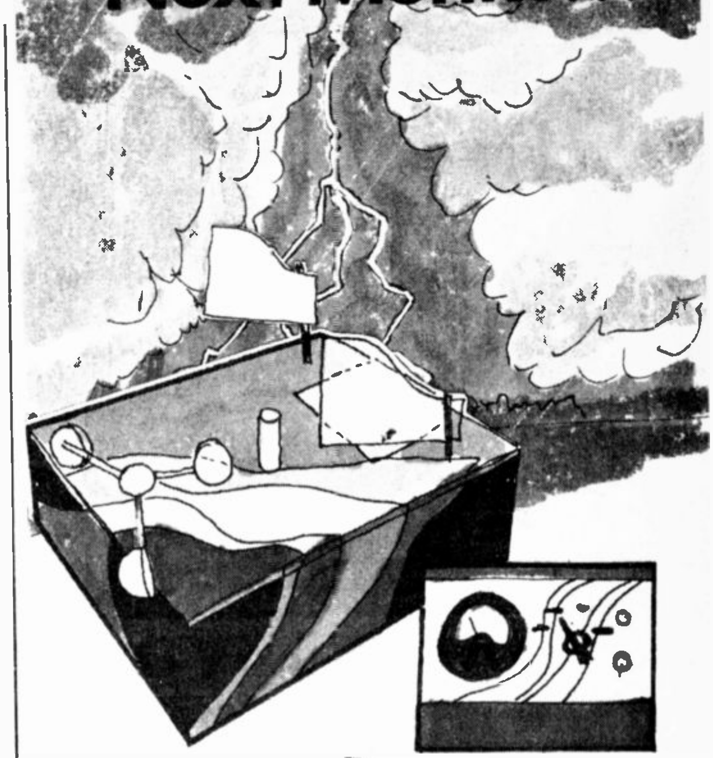
COMPONENTS

If you make these circuits we suggest you use 1 amp diodes such as the 1N4004 and 500µF 25V working smoothing capacitor for voltage measurement experiments; however if you want to make a good d.c. supply you should use the bridge circuit with a capacitor of about 5,000 µF at 25V working.

Next month: Reactance and Inductance

Additional components required for next months experiments are: resistors, 100 kilohm (1 off); capacitors, 0·22µF polyester (1 off); Ferrite rod, 6 inches long ⅜ inch diameter; 28 swg enamelled copper wire (2 oz.); 60/70V neon bulb without built in resistor.

Next Month...



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No radio listener or TV viewer on Saturday afternoons can fail to notice the emphasis on, and the interest in, the pedigree of race-horses. The same interest is shown at Cruft's, in the market garden and even the maternity home!

Now although the genetics of breeding is based upon very simple rules, chance also plays a very important part and the project to be described has been designed as a perfect demonstration of the theory of genetics known as Mendelism.

It should appeal immensely to teachers of genetics, zoology, biology or mathematics. For other readers the very simple unit may be used in conjunction with some paper "stage" money to produce a fascinating table-top game suitable for all the family in which horses are bred and raced.

MENDEL

Father Greggor Mendel (1822-1884) was a German monk who based his theory of genetics upon a study of the edible pea over a considerable number of years. It is possible that he had a general theorem to start with and proved it by his observations.

He published his findings in 1866 but they aroused little interest. Sixteen years after his death however, his work was revived and tested independently and simultaneously by three researchers, and Mendel became famous. His work is the foundation of all modern genetics.

Mendel proved that every inborn characteristic is the result of an equal contribution from the mother and father. These contributions he called "gamenes."

Let us assume that a certain species of moth has either a green, blue or yellow wing colour. The blue moth has two blue gamenes, the yellow moth has two yellow gamenes, while the green moth has one blue gamene and one yellow gamene.

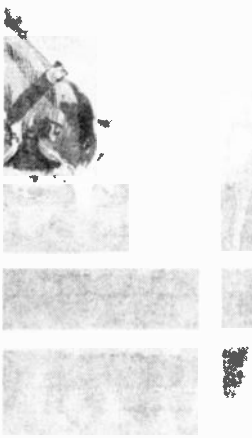
If a blue moth mates with another blue moth, the offspring must all be blue, since neither parent can contribute a yellow gamene. Similarly for two yellow parents, only a yellow strain can be produced.

If however a blue/yellow mating occurs, the only possible offspring is green. There is no possibility of a yellow or blue strain since only one gamene is donated by each parent. With reference to Fig. 1(a) we can see that there is no chance of a blue, two chances of a green and no chances of a yellow.

If we let "0" represent blue, "1" green and "2" yellow, then the chance ratio of offspring from a blue/yellow mating is seen to be no "0", two "1" and no "2".

It can be seen from Fig. 1(b) that a blue/green

Horses for Courses



A device to explain simple genetics which can also be used to play an interesting horse breeding and racing game.

By D. R. DAINES

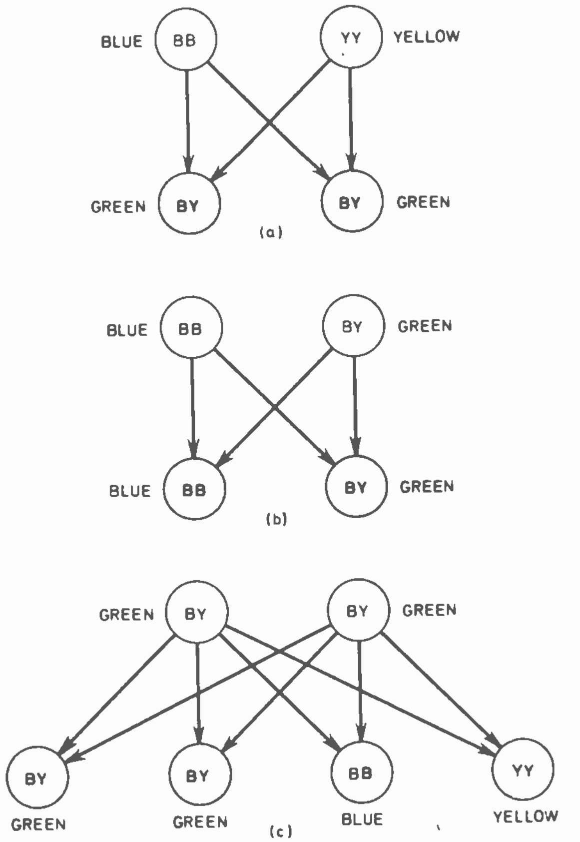


Fig. 1. Schematic diagram of the mating of moths of different wing colour. Offspring are shown shaded.

mating produces either two green or two blue offspring—no pure yellow since a yellow gamene is only evident in one of the parents. The ratio here is two "0", two "1" and no "2".

A green/green mating is shown in Fig. 1(c). Here it is possible to obtain one blue strain, two greens and one yellow, i.e. one "0", two "1" and one "2".

CHANCE

So far we have dealt with moths, where great numbers of offspring occur at each mating. What happens with animals, where there is usually only one or twc progeny such as horses.

Here we can say that, over a large number of matings, and a large number of progeny, the same two parents will tend towards the above ratios.

It is clear where the chance factor lies. If a coin is spun, it may come down heads or tails. If it comes down heads it can't be said that it will come down tails next time, nor is it more likely to. It still remains an even chance.

All that can be said is that over a large number of throws, the number of heads will tend to equal the number of tails. Similarly with genetics. The chances are known but cannot be forecast.

HORSES

With the moths mentioned above, "0", "1" and "2" represented wing colours—blue, green, and yellow respectively.

If we now let "0", "1" and "2" represent the total absence of a trait, a weak trait, and a strong trait respectively, we can apply this simple theory of genetics to horse breeding.

If we assume we are dealing with one of the many characteristics (traits) of horses, such as stamina, speed, action etc. then the degree of the trait (trait factor) present can be represented by "0", "1" or "2".

If, for example, the factor of a particular trait in the sire is "1" and that the same trait in the dam is "2", then there are equal chances of the foal having a "1" or "2" trait.

We can therefore make up a "truth" table using the three trait factors of the parents. This is shown in Table 1.

Table 1: CHANCES OF OFFSPRING TRAITS AS A FUNCTION OF PARENTAL TRAITS

Sire	Dam	Offspring (Foal)
0	0	0
0	1	0 or 1 (equal chances)
1	0	0 or 1 (equal chances)
1	1	0, 1, or 2 (two chances of a 1)
0	2	1
2	0	1
1	2	1 or 2 (equal chances)
2	1	1 or 2 (equal chances)
2	2	2

CIRCUIT

The circuit diagram for illustrating this simple theory of genetics with a built in chance factor is shown in Fig. 2.

It is merely a passive switching network which is wired up to give the required results of Table 1.

The output is in the form of illuminated lamps LP1, LP2 and LP3, representing the "0", "1" and "2" trait factors respectively.

SWITCHES

Switch S1 is used to turn the unit on/off, this should be a toggle, push-to-make/release-to-break type. This ensures no cheating, or "fixing" of the chance selector can result; this will be evident later.

The "sire" switch S2 should be a single-pole three-way type. This type of switch is not generally available, so the prototype was built using a single-pole 12-way type.

The "dam" switch S3 should be a three-pole three-way type. The prototype, however, used a more readily available type, four-pole four-way, hence the unconnected terminals on this switch seen in the wiring diagram of Fig. 3.

The chance switch, S4, must be a three-pole four-way type—but it has to be modified to allow it to be spun freely. This is done by dismantling S4 and cutting away the sprung stops, see Fig. 4.

To dismantle, remove the small circlip located on the spindle just above the threaded portion. This is a fairly difficult task and is best done using a pair of long nose pliers to grip the clip and prising it apart with a pair of side cutters.

Next, bend back the four fixing legs enabling the backplate to be removed, and remove the rotor from its bearing. Cut away the sprung stops and fixed stop with a hacksaw or side cutters, file smooth and reassemble. The spindle should spin freely.

WIRING UP

The complete wiring diagram is shown in Fig. 3. It is advisable to use as many different coloured wires as possible to help identify connections and check-out after completion.

To begin, attach the three switches, S2, S3 and S4 to the labelled front panel of the case (see Fig 5 for dimensions) together with the lamps

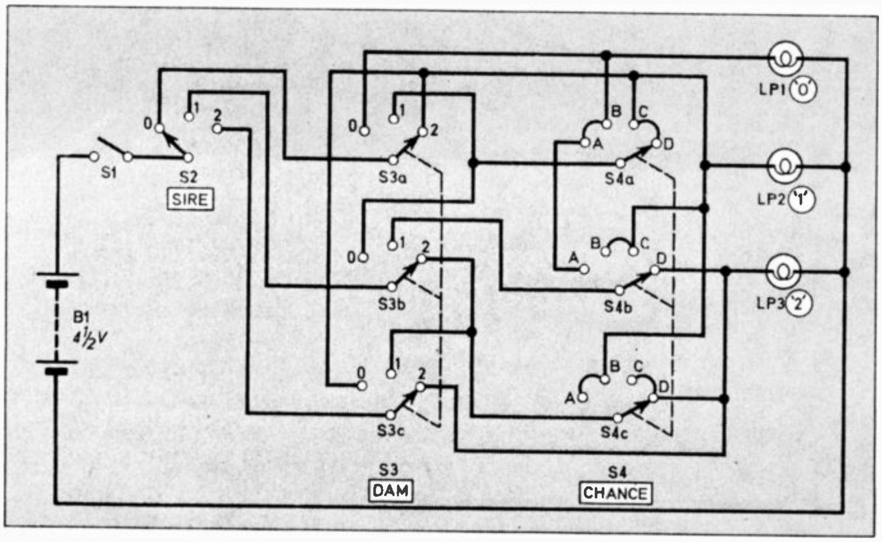


Fig. 2. The complete circuit diagram of the unit.

Horses for Courses

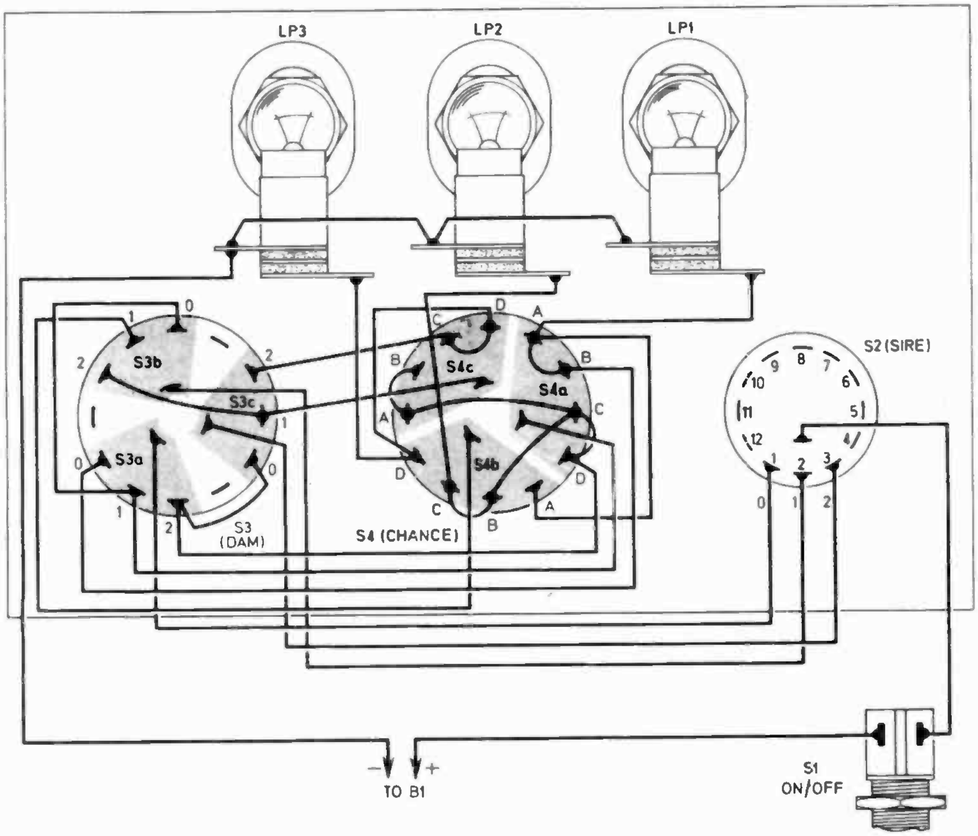


Fig. 3. The complete wiring diagram. The shaded region on S3 and S4 shows the pin connections associated with each of the three poles. B1 can be connected either way round.

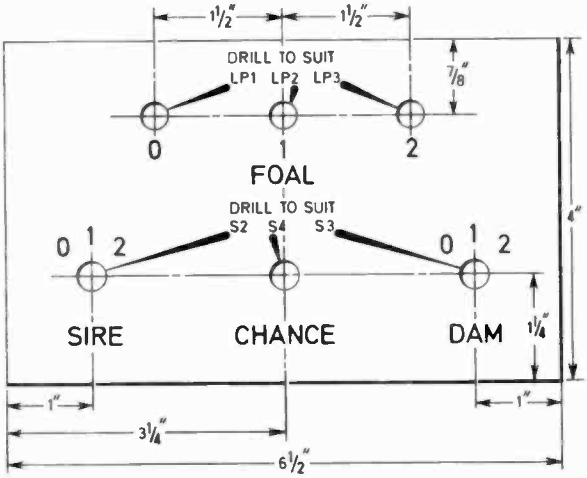
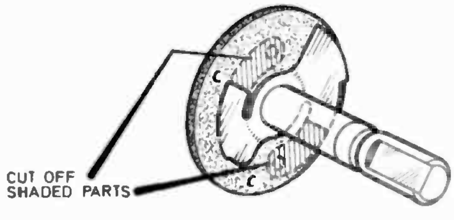
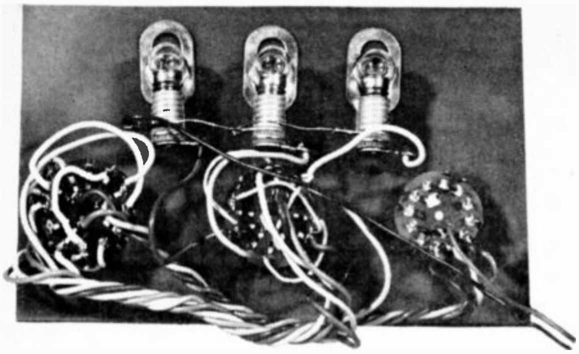


Fig. 4 (left). A suggested layout of the components on the front panel which in the prototype was made from coloured Perspex—but any material can be used.

Fig. 5 (below). The rotor of S4 removed. The shaded regions are to be cut away to enable it to be spun freely.





LP1, LP2 and LP3. Some sort of pin labelling is recommended to eliminate errors.

On each switch identify the poles and their corresponding pins—**in the correct switching order**: This can be done with a felt-tipped pen on the inside of the front panel alongside the switches.

Begin wiring from switch S2 to the poles of S3, and then connect the links between the three banks. This done, connect suitable lengths of wire from each of the nine pins from S3 to go to S4.

Next make the necessary link connections between the pins on this switch and then connect all the wires from S3 to the respective pins on S4.

To complete the wiring, connect the lamps, S1 and the battery in circuit.

Table 2: SWITCH POSITION/INDICATOR LAMP CHECK-OUT

S2 (Sire)	S3 (Dam)	S4 (Foal) A	B	C	D
0	0	0	0	0	0
0	1	0	0	1	1
1	0	0	0	1	1
1	1	0	1	1	2
0	2	1	1	1	1
2	0	1	1	1	1
1	2	1	1	2	2
2	1	1	1	2	2
2	2	2	2	2	2

TESTING

Table 1 shows the various off-spring traits as a function of parental traits, and the chances of obtaining them. These conditions are realised by the circuit and are indicated visually by the three lamps labelled "0", "1" and "2".

There are four positions on S4 (A, B, C, D) and for each of the combinations of S2 (sire) and S3 (dam) the lamps should light in accordance with Table 2. Test each combination carefully against Table 2, every combination should agree with this table.

Components....

Switches
- S1 Push to make/release to break toggle
- S2 Single-pole three-way wafer } see text
- S3 Three-pole three-way wafer } see text
- S4 Three-pole four-way wafer (modified, see text)

Lamps
- LP1, LP2, LP3 4·5 or 6V bulbs (three off) and holders to suit

Miscellaneous
- B1 4·5V bell type battery (type 126)
- Knobs: Three off; 2 pointer types, 1 heavy unmarked type (for chance switch). Connecting wire—as many different colours as possible—use stranded type.

Example: When the sire switch is set to "1" and the dam to "2", for the four different positions of S4, the "1" lamp should light twice and the "2" lamp should light twice. The "0" lamp should never light for this combination.

Not more than one bulb should ever be on at the same time for any combination.

USING THE UNIT

The unit can be used to demonstrate the Mendelian theory in the following way.

With S1 in the off position, set the pointers of S2 and S3 to the chosen trait factors and then spin the chance switch S4. Depress S1 and take a note of the result (i.e. which lamp lights).

Do this a number of times recording the results each time and you will see that as a number of samples increases, so the tabulated result moves closer to the given ratio.

Alternatively, students may be instructed to formulate their own ratio's over a number of samples using statistical methods.

BREEDING AND RACING GAME

This device can also be used to form the basis of a very interesting table top game for all the family in which horses are bred (using the unit described above) with the intention of producing horses for racing and further breeding. There is no limit to the number of players that may participate.

Other equipment required for the complete game are a race track, owners cards, paper "stage" money (Monopoly money is ideal), and a dice.

The race track can be made to any size or design. Fifty spaces between start and finish were found to be adequate.

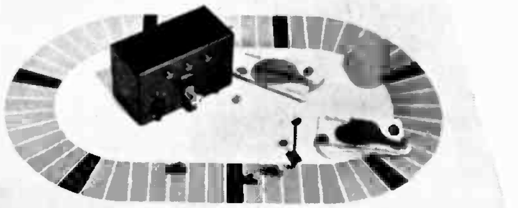
Every eighth space should be distinguishable from the rest—coloured black for example as shown in photograph opposite. These black squares are to confer advantages (or disadvantages) to horses landing thereon as detailed later.

Owners' cards should be drawn up as detailed in Fig. 4 and one should be issued to each player.

No. | **OWNERS CARD**

TRAIT		1st GENERATION	HORSE						
CODE	POINTS		I	II	III	IV	V	VI	VII
A	6	0							
B	4	0							
C	3	1							
D	2	0							
E	1	0							
F	−2	0							
POINTS TOTAL		3							
GENDER		F							
STUD									

Fig. 6. An owner's card. When the traits and gender of each horse have been determined, they should be marked as indicated. When a horse has been mated it should be marked accordingly in the space provided.



TRAITS

Six traits have been chosen for the horses and these have been coded A, B, C, D, E, F. The "A" trait being most advantageous and "F" being a positive disadvantage.

When a horse lands on a black space on the race track, depending on its traits, it advances (or goes back) a number of spaces given by Table 3.

Table 3: BLACK-SQUARE-ADVANTAGES FOR THE SIX TRAITS

A	B	C	D	E	F
6	4	3	2	1	−2

After breeding several generations it is probable that a horse will emerge with more than one trait. The total advantage when landing on a black square is given by the sum of the individual trait advantages.

Example:

A horse with traits "A", "C" and "F" would advance seven spaces when landing on a black square. This is made up (using Table 3) of $6+3-2=7$. If a horse has a strong trait denoted by a "2" on the owners card, then the advantage (or disadvantage) is doubled, i.e. a horse with a strong ("2") "C" trait advances 6 spaces when landing on a black space.

PRELIMINARIES

Every player is given an owners' card which he keeps throughout the game. Each in turn throws a dice twice, the first throw to determine the gender of the horse—stallion or mare (odd or even respectively). The second throw is to determine the trait of this first generation horse i.e. A, B, C, D, E or F. A throw of "six" gives trait "A"; "five" trait "B"; "four" trait "C"; "three" trait "D"; "two" trait "E"; "one" trait "F".

The first generation horse can only have one trait and this must be weak (denoted by a "1" written alongside the appropriate trait).

When this has been carried out by each player, racing or breeding can begin.

BREEDING

Breeding can be instigated in two ways: (1) by agreement between any two owners—the owner of the stallion charging the owner of the dam an agreed sum of money for the stallion's services. The foal resulting belongs to the owner of the dam.

The gender of the foal is determined by a throw of the dice, odd for colt, even for filly.

(2) By use of the National Stud for which the player pays a fee to the bank.

The National Stud horse has only one characteristic for which a dice is rolled as before. The characteristic is weak (i.e. "1"). The gender of the National Stud horse is assumed to be opposite to that of the players horse, and the resultant foal belongs to the player. The owner's horse must be selected prior to drawing a horse from the National Stud, and these horses must then be bred.

Whether breeding is carried out using facilities (1) or (2), the procedure is the same, the owner of the eventual foal sets the trait factors of the sire and dam for each trait in turn to "0", "1" or "2" and spins the chance switch.

The trait factors (for each of the six traits in turn) are indicated by the three lamps. This factor is then entered alongside the trait in question on the owners' card.

Further breeding can be carried out between races by methods (1) and (2) above, or, if an owner has two or more horses on his card, of opposite sex, he can mate these to produce others.

Once a horse has been put to stud (mated) it can no longer race, but there is no limit to the number of times a horse can be mated or the number of times an unmated horse can take part in a race.

RACING

The first race should be run after each owner has acquired one horse and subsequent races after another horse has been bred by one or more owners.

Owners are allowed to enter only one horse for each race, which must be declared before the start of the race, for which a standard sum is paid, and a fixed amount is added to this by the bank to constitute the prize money.

The horses are moved around the course with the aid of a dice in the usual way, coupled with the "black-space advantages" acquired by each.

MONEY MATTERS

The introduction of paper money into the game makes it much more interesting. This paper money can either be made up or, if Monopoly money is available this would be ideal.

The money should be located in a central bank and should contain a large number of monetary denominations such as £100, £50, £25, £10, £5 and £1 notes.

With an initial capital of £500 each player is sufficiently equipped to meet breeding and race entrance fees. This amount is supplied by the bank.

Breeding charges between owners have to be agreed jointly by the owners making the contract—payment being made to the stallion owner.

For use of the National Stud for breeding purposes a fixed sum of £50 is payable to the bank.

If an owner wants to raise some cash, he can offer any of his stock for sale to the highest bidder, otherwise he may sell to the National Stud—if his horse has a point value of three or more—for a sum of £30 (payable to him by the bank). Once a horse is sold into the National Stud its racing and breeding days are over; it is put to grass (discarded).

The entrance fee per horse per race is £20 and the bank puts £40 to the total to form the prize money. On completion of a race, the prize money is divided up as follows: for two players, winner takes all; for three players, winner takes three-quarters, second one-quarter; four or more players, winner takes half, second and third, a quarter each.

WINNING POST

At the end of the game the winner is the owner with the most money and, incidentally, the most successful breeder. ▣

Ruminations
By Sensor

The Worm Will Turn

I was reading about some of the work now being done to enable an operator to communicate directly with a computer, using normal spoken English words. The computer would be designed to recognise certain words and to act appropriately when they are spoken.

The idea interested me because I feel that the operator ought to have a chance to answer back. For far too long he has been at the beck and call of his electronic "servant"; obeying instantly when told by the computer's flashing lights to; Input programme, Change tape, Input data, Call engineer; and so on. And if he fails to carry out his duties in the required manner, on flashes the light; Operator error and he gets a rocket from the computer manager for wasting his computer's time!

But imagine how different things could be with direct speech input—*Scene:* A computer room. Time. A.D. 1984.

Operator enters and switches computer on.

Computer: "Operator number two. Input programme."

Operator, (after late night party): "Don't shout, I'm having a coffee first—and don't call me number two."

Computer: "You are identified in records as operator number two"

Operator: "Change the records, my name is Bert."

Computer: "Records cannot be changed except by use of master programming key held by director of MI55. Input data immediately."

Operator: (Looking at crossword and talking to himself). "Ah, anagram, seven letters, "He makes the sea pant"—must be an anagram of SEA PANT."

Computer: "Peasant."

Operator: "When I want your opinion I'll ask for it, bighead."

Computer: "All data must be input before 08.30 hours. Your records will be marked unpunctual, inefficient, undesirable. You will be fined and downgraded."

Operator: "I resign. So you can put that into your register and process it, you electronic moron. I'm dropping out." Exit operator pursued by cries of Input data.

Computer Voice

Thinking about the way a computer speaks reminds me of the peculiar way of speaking that some of our radio announcers have these days? Their voices go up and down like a roller coaster with odd little pauses here and there. The female announcers are particularly prone to affect this mode of speech, and one assumes that somewhere there is a training school, probably very expensive and very exclusive, where young ladies with normal, interesting voices, are coached to produce what some official has decided is a "well modulated voice suitable for radio and television."

The writers of *Monty Python's Flying Circus* must have noticed what has been going on and they have parodied it brilliantly on several occasions.

There seem to be many organisations now that are intent on selling to us so many things that we are not only don't need but positively don't want. In my list of these unwanted goods and services I include "the well modulated voice" along with car parking fees and a few others.

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1N3754	20p	2N3055	50p	2N5457	30p	AD162	36p	BC158	11p	BF194	14p	NKT261	21p
1N5399	24p	2N3325	51p	2N5459	30p	*AD161/162	60p	BC159	12p	BF195	15p	NKT271	18p
1N5402	23p	2N3405	40p	40250	71p	AF114	24p	BC167	11p	BF244	30p	NKT274	18p
1N5407	35p	2N3663	52p	40251	89p	AF115	24p	BC168	10p	BF254	14p	NKT275	23p
1844	5p	2N3702	10p	40361	45p	AF116	22p	BC169	11p	BF255	15p	NKT403	65p
18940	5p	2N3703	10p	40362	45p	AF117	22p	BC177	14p	BFX18	90p	NKT404	61p
2N696	17p	2N3704	10p	40406	53p	AF118	82p	BC178	13p	BFX29	31p	NKT405	79p
2N697	18p	2N3705	10p	40408	54p	AF124	24p	BC179	14p	BFX84	25p	NKT603F	30p
2N706	12p	2N3706	10p	40412	67p	AF125	24p	BC182L	11p	BFX85	32p	NKT613F	30p
2N930	21p	2N3707	10p	40430	122p	AF126	22p	BC183B	10p	BFX87	29p	NKT674F	24p
2N1131	25p	2N3708	8p	40432	160p	AF127	22p	BC184L	11p	BFX88	26p	NKT677F	22p
2N1132	25p	2N3709	10p	40512	179p	AF129	33p	BC186	30p	BFY50	25p	NKT713	30p
2N1302	19p	2N3710	10p	40602	45p	AF239	36p	BC212L	14p	BFY51	20p	NKT773	25p
2N1303	19p	2N3711	10p	40669	120p	AL102	77p	BC213L	18p	BFY52	23p	OA47	8p
2N1304	26p	2N3731	120p	AC107	46p	ASY26	27p	BC214L	14p	BRY39	30p	OA90	6p
2N1305	26p	2N3794	15p	AC126	23p	ASY27	36p	BC257	9p	BSX20	18p	OA91	5p
2N1306	33p	2N3819	25p	AC127	20p	ASY28	27p	BC258	8p	BY164	44p	OA95	6p
2N1307	33p	2N3820	53p	AC128	20p	ASY29	36p	BC259	9p	BY238	16p	OA200	9p
2N1308	36p	2N3904	18p	AC141H	34p	AU111	97p	BC267	17p	BYX38-300	37p	OA202	10p
2N1309	36p	2N3906	20p	AC141HK	37p	B30C250	24p	BC268	13p	BYX38-300R	37p	OC19	50p
2N1596	76p	2N4036	52p	AC142H	25p	B30C550/300	34p	BC269	17p	C407	17p	OC25	42p
2N1599	76p	2N4058	13p	AC142HK	29p	B1912	31p	BC300	49p	C762	19p	OC28	70p
2N1613	22p	2N4059	11p	AC153K	22p	B5041	72p	BC301	37p	C1412	60p	OC29	76p
2N1711	26p	2N4060	11p	AC176	16p	BA102	21p	BC303	50p	E2512	107p	OC35	60p
2N1893	54p	2N4061	11p	AC176K	17p	BA130	5p	BCY30	49p	EA403	10p	OC36	65p
2N2147	114p	2N4062	11p	AC187K	17p	BA145	21p	BCY31	60p	EB383	10p	OC41	42p
2N2218	33p	2N4124	15p	AC188K	23p	BA155	15p	BCY70	18p	EC401	18p	OC42	46p
2N2218A	44p	2N4126	22p	*AC187K/188K		BA156	13p	BCY71	33p	EC402	16p	OC44	42p
2N2219	38p	2N4284	24p		40p	BAX13	8p	BCY72	15p	ER900	33p	OC45	38p
2N2219A	51p	2N4286	15p	ACY17	31p	BB103/B	16p	BD121	105p	MC140	25p	OC70	21p
2N2270	62p	2N4289	15p	ACY18	19p	BB103/G	16p	BD123	105p	MJ481	120p	OC71	38p
2N2369A	19p	2N4291	15p	ACY19	23p	BC107	12p	BD124	100p	MJ491	135p	OC72	38p
2N2483	35p	2N4292	15p	ACY20	20p	BC108	11p	BD130	50p	MJE371	68p	OC75	40p
2N2484	42p	2N4410	24p	ACY21	21p	BC109	12p	BD131	77p	MJE521	62p	OC81	25p
2N2646	47p	2N4443	88p	ACY22	16p	BC122	21p	BD132	81p	MJE2955	106p	OC81D	25p
2N2904	38p	2N4906	274p	ACY39	62p	BC125	15p	BD135	38p	MJE3055	68p	OC83	25p
2N2904A	42p	2N4915	227p	ACY40	17p	BC126	15p	BD136	44p	MPF102	37p	OC84	25p
2N2905	44p	2N4991	44p	ACY41	18p	BC140	30p	BD141	227p	MPS6531	28p	P346A	17p
2N2905A	47p	2N5062	42p	ACY44	31p	BC147	10p	BDY20	92p	MPS6534	24p	S2CN1	12p
2N2924	16p	2N5088	46p	AD140	63p	BC148	9p	BF115	23p	NKT211	25p	* Matched pair	

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C	1/8W	5%	4·7 Ω–470K Ω	E24	1	0·8	0·7
C	1/4W	10%	4·7 Ω–10M Ω	E12	1	0·8	0·7
C	1/2W	5%	4·7 Ω–10M Ω	E24	1·2	1	0·9
C	1W	10%	4·7 Ω–10M Ω	E12	2·5	2	1·8
MO	1/2W	2%	10 Ω–1M Ω	E24	4	3	2 nett
WW	1W	10% ± 1/20 Ω	0·22 Ω–3·9 Ω	E12	7	7	6
WW	3W	5%	1 Ω–10K Ω	E12	7	7	6
WW	7W	5%	1 Ω–10K Ω	E12	9	9	8

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THEY MADE THEIR MARK

No 3 Ampère

By J. E. Gregory

Photograph: Science Museum London

Table 1: AMP (A)

The flow of electric current is measured in amps. Just as last month we used the water pressure analogy for the volt, so we can compare electric current with the flow of water.

As a practical example the current which flows through a domestic chandelier holding four, 60 watt lamps connected to a 240V mains supply is one ampere.

In 1881 the ampere along with the volt was adopted at the first meeting of the International Electrotechnical Committee.

LAST month's article showed how Volta's discovery enabled man to produce small electric power from batteries, but to obtain larger powers he had to make magnets move. The man who did much to establish the relationship between electricity and magnetism was the French mathematician and physicist Ampère who gave his name to the practical unit of electrical current. See Table 1.

INFANT PRODIGY

Andre Marie Ampère was born on January 22, 1775, in the village of Polemiex, near Lyons, the son of a merchant, who was also Justice of the Peace.

Young Andre showed his astonishing capabilities at a very early age, and it is said that he was calculating before he could read or write.

It was in 1793, Andre now eighteen that tragedy struck. Lyons had revolted against the tyranny of the French Revolution. The army of the Convention who hated all forms of authority captured the town, Andre's father was thrown into prison, and soon after publicly guillotined.

The shock of this was so great that Ampère remained in a state of apathy and near madness for almost three years.

Then in 1796 he met Julie Carron who gave him back his reason for living.

On August 2, 1799 at the age of 24, he married Julie and one year later a son John Jacque was born. Once again Andre was a happy man.

In 1804 tragedy struck Ampère a second blow, his wife died of a chest disease; he did little for five years. Then in 1809 after publishing a thesis on the mathematical theory of gambling he was recommended for the post of Professor of Mathematics at the Polytechnic in Paris. In 1814 he was elected to the Academy of Science.

OERSTED GETS THE NEEDLE

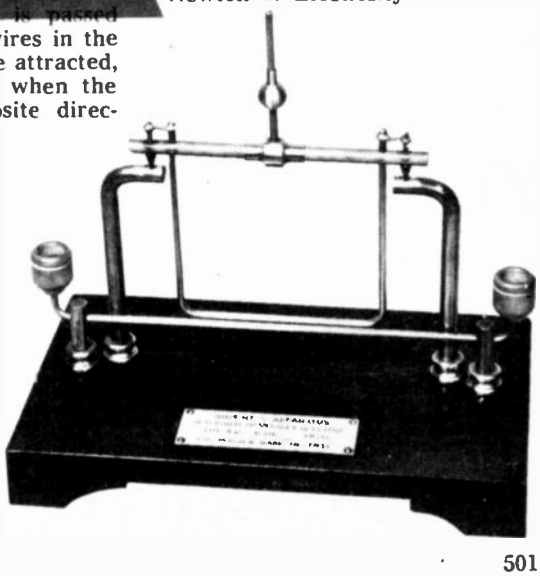
On 11th September 1820 Ampère heard that the Dane Oersted had discovered that a magnetic compass needle moved when placed near a wire carrying an electric current.

The news of this discovery so excited Ampère that he worked night and day experimenting on the relationship of electricity and magnetism, and on 18th September just one week later, presented to the academy the results of his experiments. These showed that when electric current is passed through two parallel wires in the same direction they are attracted, and they are repelled when the current flows in opposite directions. He also proved that the force of attraction or repulsion is directly proportional to the strength of the currents. This became known as Ampère's rule.

Ampère gave public demonstrations and one of his contemporaries reports "a gasp would go up from the audience as Ampère twisted insulated copper wire round an iron horseshoe, joined the ends of the wire to Volta's battery, and showed how the horseshoe attracted a quantity of nails, and how it let them fall the moment the current from the battery was shut off."

Ampère died in Marseilles on June 10, 1836 from a chest illness. James Clark Maxwell another famous 19th century physicist later described Ampère as "The Newton of Electricity"

Ampère's aparatus



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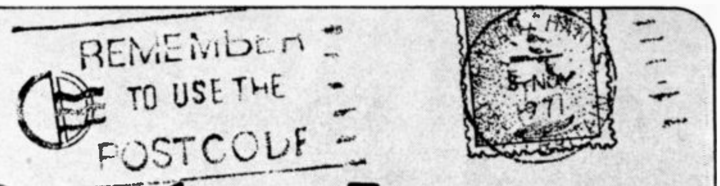

Readers Letters

Saw Point

As a musician interested in the electronic aspects of music, I read with interest Mr. Judd's article on the *Audio Tone Generator*. He is however misleading about the question of sawtooth waveforms.

Although he is quite right when he says that a square wave contains only odd harmonics and the sawtooth wave consists of both odd and even harmonics, the waveform which he draws and which the integrating network on his generator will produce is not a sawtooth wave but, what is known in electronic music as a triangle wave. (I have also seen it referred to as a back-to-back sawtooth wave).

This waveform is symmetrical, and, like all symmetrical waveforms, consists only of odd harmonics. The difference between this and the square waveform lies in the phase relationship of the harmonic series and in the fact that they diminish in amplitude much more rapidly as their frequency increases.

The clarinet also has a symmetrical waveform and therefore only odd harmonics are present, but its timbre is totally unlike that of a square wave because the relative amplitude of their harmonics is different. If anything, a triangle wave sounds more like a clarinet.

R. Sherlaw Johnson
Stonesfield.

Stock Control

There is still one very basic problem which has slipped your attention, i.e. the building up of stock by the beginners. I wish you could advise us on the minimum quantity of various components we should keep in stock all the time, e.g. resistors (type, ratings, ohmic values and quantity of each type, etc.). Capacitors, diodes, transistors, nuts and bolts, chassis, cases, panels, heatsinks, etc.

Very often when I set myself to build a project, I find it very embarrassing to get stuck for the shortage of some components and it gets more painful if the local shop cannot help me either. I feel all the enthusiastic beginners would be very grateful if you could kindly help us in setting our stocks right at the beginning. Without proper guidance, at the start, all the component catalogues seem to be useless.

J. Whyte
London.

This is something we have been looking at and an article may be published in the future.

Solder Injector

Thank you for your very useful article on the *Signal Injector* in your March issue. I have constructed one with a few modifications, and I thought that some of your readers may be interested in the financial savings I made.

Firstly, I did not use the recommended Steradent tube (having no false teeth), but (to me) a more readily available case—the standard multicore solder tube. To the pointed end I fixed my nail directly using fibreglass paste (eg. Isopon), this did away with the need for a miniature plug and socket. The switch was fixed to the plastic cap.

As regards the construction, I used a smaller piece of Veroboard, given away in your first issue (after making a *Windscreen Wiper Control*). The components specified were not at all critical; I used two OC 71 transistors and 0·1 μF capacitors throughout to get excellent results.

May I take this opportunity to suggest a few ideas for future projects in your excellent magazine:—

1. A stabilised voltage dropper, so that a portable cassette player may be used off a car battery.
2. Short range transmitter (if legal?).
3. More audio and hi-fi projects.
4. Lighting effects controlled by music from an amplifier.

K. J. Twydell
Portsmouth.

Of the four items you suggest the transmitter is not legal in this country without a radio amateur's licence, the other three things will probably be future articles.

Join the Club

Readers may be interested in my slightly modified version of the *Demo Deck*.

I made my top in Formica and cut a recess to take a commercial "breadboard"; the single S-Dec unit with little spring-loaded clips and holes to take components. Hence there is no need for soldering or, even more important, dodgy desoldering which can result in damage. My S-Dec cost me £1, but I think, for a beginner, it is a good investment.

I am glad to see EVERYDAY ELECTRONICS making good progress. There certainly was a crying need for a journal of this type catering for raw amateurs. I would suggest that at some future date you consider forming a national club for electronics enthusiasts of humble skills. Who knows, it could lead to a healthy exchange of ideas, a feeling of camaraderie and (I've got grandiose ideas!) eventually a national exhibition. Why not? Indeed your E.E. symbol on the contents page would make a perfect badge.

Pity about these errors that are creeping in with too much frequency; it tends to undermine confidence a little. However, as a fellow journalist, I'll make allowances for a little while yet.

Incidentally, do I dare suspect a slip in Mike Hughes' Teach-in last month (May) where on page 371, top of column one, he refers to VR1 as "a 300 ohm potentiometer". I'm afraid those of us with *Demo Decks* followed an earlier design and made this a 100 ohm pot—or have I got my things in a twist?

Never mind, for an expert to try to put over an advanced science that's constantly on the move is one big headache when he has pupils at all levels of training and can't thump those of us who are a bit thick on the uptake.

T. Milligan
Kempston.

We must point out that The British Amateur Electronics Club caters for all interested in electronics. Details from the Hon. Secretary, Mr. J. G. Margetts, 17 Saint Francis Close, Abergavenny, Monmouthshire.

The value of VR1 should be 100 ohms.

Enlightening

Upon reading "Sensor's" article *Let There Be Light* I was surprised at his lack of knowledge concerning street lighting. Light operated switches have been used in street lighting systems for several years, the reason for not using them on every light is that

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—apart from major towns—most street lights are extinguished at midnight, light operated switches cannot do this. Another reason is that the electricity boards own most of the time switches and to install light operated switches in place of these costs in the region of £12 to £15 per column. This cost has to be found out of the rates we pay because councils have to purchase these as opposed to timeswitches—the other side effect is higher electricity bills to councils due to the permanent all night lighting. We do not get enough power cuts to warrant this vast extra expense on the rates.

I am employed by a firm of street lighting contractors, fitting and maintaining public lighting.

B. W. Hawkins
Herts.

Clanger

I have been reading your magazine since it was first published and found it quite good. Unfortunately under the article about the *Bee Counter* in the May issue I think you have dropped a proverbial "clanger". The *Bee Counter* works as drawn in the circuit but the write up is all wrong. You say that TR1 is conduction when the l.d.r. has a low resistance (i.e. when illuminated) which of course it will not because it is a *pnp* transistor; TR2 will therefore be "off" until TR1 conducts.

When a bee passes between the lamp and the l.d.r. the resistance of the l.d.r. increases and the base potential becomes negative with respect to the emitter. This causes TR1 to conduct and a negative potential is then applied to TR2 causing it to conduct and the counter to operate.

I think your write up should have been along these lines. It looked especially funny after the previous article on semiconductors. Perhaps Mike Hughes will give a few lessons to the editorial staff!

W. Raymond
Old Trafford.

You are of course quite right—we have asked Mike if he has any free time!

Circuit Operation

I was very pleased to receive the booklet *Constructors Companion* with the May issue. Now I know that little bit more about the modes of transistors, the explanation although brief was easily understood.

Will you please publish a feature about how circuits work, that is, the a.c. (signal) and d.c. conditions in circuits when in operation? For example, the progress of a signal from aerial to speaker; through all the components also the d.c. conditions of the circuit at the same time.

You will probably have noticed that, in all receiver circuits authors never give this explanation which I believe would be of considerable help to the understanding of how the circuits "work" especially in receivers.

Would it also be possible to have either a regular feature or a regular pull-out supplement of a list of circuits for doing a variety of things.

J. Bradley
Yorks.

We may well be publishing a series on basic circuit operation describing the function and operation of many of the "standard circuits" we use.

Convention

I would be most grateful if you could explain to me the logic of using "conventional current" in contemporary circuit diagrams.

You see, when I was at school my physics master dismissed this as being "guesswork on the part of the ancients (electrically speaking)." Thus he explained electrical phenomena in the light of "electron flow" and I was able to understand him sufficiently to construct simple valve radios, home electroplating appliances etc.

Similarly an R.A.F. radar instructor was able to acquaint us with the principles of the cathode ray tube etc., whilst we blockheads were undergoing operational training in bomber command during the war.

Much later in life I decided to take an exam involving some knowledge of electronics and thus went through a "refresher". Again, the instructor used "electron flow" as his means of explanation; again I understood.

To the best of my knowledge, all electro/mechanical devices which demonstrate a "current flow" visibly, do so in a way which shows that, whatever *is* flowing, is flowing from negative to positive (except in the interiors or prime sources).

Would you therefore be kind enough to inform me:

a) who re-introduced "conventional current flow"?
b) Why?

You see, if I knew the reason for using this terminology I would possibly better be able to reconcile myself with it and thus get *down* to some learnings instead of getting het up at symbols which appear, to me, just plain stupid!

A. K. Robinson
London, W.7.

As far as we know no one reintroduced conventional current flow—it has always been with us, ever since Volta's battery.

Unfortunately it is not easy to simply drop conventional current and use electron flow as all the laws concerning electricity and magnetism—which are, after all, the basis of the whole thing—are in terms of conventional current flow. Thus, although it is easy to explain such things as cathode ray tubes and transistors using electron flow, when it comes to teaching the basics of electricity then all the universal basic rules which are in terms of conventional current flow would have to be changed.

One-sided

While experimenting with tape loops, prompted by your May article, I discovered some promising effects by giving the tape a half turn before joining the loop. This produces a "one-sided" tape, with the interesting result that both tracks of the tape are scanned successively.

Unfortunately, half the cycle presents the shiny side of the tape to the head. However, by using triple-play (very thin) tape and turning the loop over after recording, interesting reverse/echo effects were obtained.

By the way, inserting a 1MΩ linear potentiometer in the collector load of TR2 of the *Signal Injector* circuit (March issue) makes an excellent tone generator, serving both purposes, at a saving of some £2·50.

R. Darbishire
Surrey.

If you write to us for advice, and wish to have a personal reply you must include a s.a.e. Unfortunately, we cannot prepare special designs, circuits or wiring diagrams, to meet individual requirements nor can we supply back issues or answer queries concerning commercial equipment, or subjects or designs not published by us.

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16µF	450V	17p	2,500µF	25V	45p
25µF	50V	8p	2,500µF	50V	60p
32µF	450V	24p	3,000µF	25V	48p
50µF	50V	10p	5,000µF	25V	55p
100µF	25V	10p	5,000µF	50V	98p
100µF	50V	10p	8–8µF	450V	18p
250µF	25V	12p	8–16µF	450V	20p
250µF	50V	17p	16–16µF	450V	27p
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22pF	500V	S/M	7½p
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27pF	500V	Cer.	4p
33pF	125V	P.S.	5p
33pF	500V	S/M	7½p
39pF	500V	S/M	7½p
47pF	125V	P.S.	5p
47pF	500V	Cer.	4p
50pF	500V	S/M	7½p
56pF	500V	S/M	7½p
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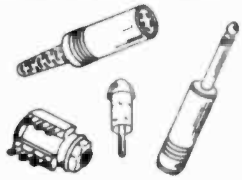
0·01µF	500V	Cer.	5p
0·01µF	500V	S/M	30p
0·01µF	600V	MDC	7p
0·01µF	1,000V	MDC	9p
0·015µF	160V	Poly.	3p
0·015µF	400V	Poly.	3p
0·02µF	100V	Mylar	3p
0·022µF	18V	Disc	5p
0·022µF	250V	M.F.	3p
0·022µF	400V	Poly.	3p
0·022µF	600V	MDC	7½p
0·022µF	1,000V	MDC	9p
0·033µF	250V	M.F.	4p
0·033µF	400V	Poly.	4p
0·047µF	12V	Disc	6p
0·047µF	160V	Poly.	3p
0·047µF	250V	M.F.	3p
0·047µF	400V	Poly.	4p
0·047µF	600V	MDC	8p
0·047µF	1,000V	MDC	10p
0·1µF	30V	Disc	6p
0·1µF	250V	M.F.	4p
0·1µF	400V	Poly.	5p
0·1µF	600V	MDC	10p
0·1µF	1,000V	MDC	13p
0·15µF	250V	M.F.	5p
0·22µF	160V	Poly.	6p
0·22µF	250V	M.F.	5p
0·22µF	400V	Foil	10p
0·22µF	1,000V	MDC	15p
0·33µF	250V	M.F.	8p
0·47µF	250V	Foil	8p
0·47µF	400V	Foil	15p
0·47µF	1,000V	MDC	20p
1·0µF	250V	M.F.	15p

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

PLUGS

Car aerial	14p
Co-axial	8p
D.I.N. 2 pin (speaker)	10p
D.I.N. 3 pin	13p
D.I.N. 4 pin	14p
D.I.N. 5 pin, 180	13p
D.I.N. 5 pin, 240	15p
D.I.N. 6 pin	15p
Jack, 2½mm unscreened	9p
Jack, 2½mm screened	10p
Jack, 3½mm unscreened	8p
Jack, 3½mm screened	12p
Jack, ¼in unscreened	12p
Jack, ¼in screened	20p
Jack, stereo, unscreened	20p
Jack, stereo, screened	35p
Phono, plastic top	5p
Phono, plated metal	12p
Phono, fitted 4ft lead	8p
Wander, red or black	3p
Banana 4mm, red or black	6p



LINE SOCKETS

Car aerial	14p
Co-axial	17p
D.I.N. 2 pin (speaker)	15p
D.I.N. 3 pin	16p
D.I.N. 5 pin, 180	16p
D.I.N. 5 pin, 240	16p
Jack, 3½mm	15p
Jack, ¼in screened	43p
Jack, stereo, screened	30p
Phono, plated metal	14p

SOCKETS

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

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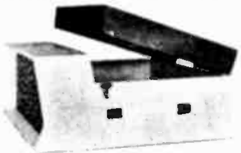

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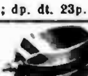

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32/450V	20p	8+8/450V	18p	350+50/325V	50p
25/25V	10p	8+16/450V	20p	32+32+32/350V	43p
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100/25V	10p	32+32/350V	25p		

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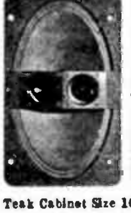

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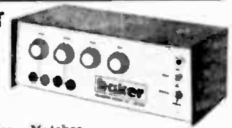

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TRANSISTORS

AC 107	16p	AL 102	59p	BC 212L	8p	ME 6101	14p	OC 140	17p	2N 2926	9p	1N 4007	13p
AC 126	13p	AL 103	49p	BC 213L	8p	ME 6102	15p	OC 170	23p	2N 3053	20p	W005	30p
AC 127	16p	AU 103	85p	BC 214L	8p	MP 8111	32p	OC 171	23p	2N 3055	49p	W02	35p
AC 128	12p	AU 111	95d	BD 121	50p	MP 8112	34p	OC 200	25p	2N 3702	12p	OA 90	6p
AC 176	22p	BC 107	8p	BD 123	60p	MP 8511	34p	OC 23	30p	2N 3704	12p	OA 91	6p
AC 141	16p	BC 108	8p	BD 130	46p	MP 8513	45p	OC 25	25p	2N 3705	12p	1N 4148	4p
AC 142	16p	BC 109	8p	BFY 50	18p	OC 41	13p	OC 28	30p	40636	55p	400mW Zeners	
AC 141K	20p	BC 154	20p	BFY 51	12p	OC 44	13p	OC 29	36p			3·3–30v	10p
AC 142K	20p	BC 168	10p	BFY 52	12p	OC 45	13p	OC 35	28p	Rectifiers			
AD 142	39p	BC 169	11p	BSY 95A	15p	OC 71	13p	OC 36	36p	1N 4001	5p		
AD 149	40p	BC 148	10p	ME 0402	18p	OC 72	13p	2N 697	19p	1N 4002	5p		
AD 150	44p	BC 149	10p	ME 0404	14p	OC 81	13p	2N 1171	24p	1N 4003	6p		
AD 140	40p	BC 182L	8p	ME 4101	10p	OC 81D	13p	2N 1304	25p	1N 4004	8p		
AD 161 }	m/p	BC 183L	8p	ME 4102	12p	OC 83	20p	2N 1305	25p	1N 4005	11p		
AD 162 }	55p	BC 184L	8p	ME 6002	14p	OC 139	13p	2N 2646	47p	1N 4006	12p		

CAPACITORS

MULLARD POLYESTER CAPACITORS C280 SERIES
250V P.C. mounting: 0·01μF, 0·015μF, 0·022μF, 3p. 0·033μF, 0·047μF, 0·068μF, 3½p. 0·1μF, 4p. 0·15μF, 0·22μF, 5p. 0·33μF, 6½p. 0·47μF, 8½p. 0·68μF, 11p. 1·0μF, 13p. 1·5μF, 20p. 2·2μF, 24p.

ELECTROLYTIC CAPACITORS—MULLARD C426 SERIES 6p each. (μF/V) 10/2·5, 40/2·5, 80/2·5, 160/2·5, 320/2·5, 500/2·5, 8/4, 32/4, 64/4, 125/4, 250/4, 400/4, 6·4/6·4, 25/6·4, 50/6·4, 100/6·4, 200/6·4, 320/6·4, 4/10, 16/10, 32/10, 64/10, 125/10, 200/10, 2·5/16, 10/16, 20/16, 40/16, 80/16, 125/16, 1·6/25, 6·4/25, 12·5/25, 25/25, 50/25, 80/25, 1/40, 4/40, 8/40, 16/40, 32/40, 50/40, 0·64/64, 2·5/64, 5/64, 10/64, 20/64, 32/64.

SILVERED MICA. 500v d.c. 6p each
Values (PF):
2·2, 5, 8·2, 10, 12, 15, 18, 22, 24, 27, 30, 33, 35, 39, 47, 50, 56, 68, 75, 82, 100, 120, 150, 180, 200, 220, 250, 7p each—270, 300, 330, 390, 400, 470, 500, 556, 680, 800, 10p each.—1000, 1500, 1800, 2200, 16p each.—2700, 3600, 20p each.—4700, 5000, 30p each.—5600, 6800, 8200, 10000.

RESISTORS
½ watt 10% carbon ¼ watt 10% carbon 1p each
Range 2·2 ohms to 10 meg.
TR5 triple rated at ⅛–¼–½ watt tin oxide resistor ±2% 3p each. Range 10 ohms–1 meg ohm.

SLIDE SWITCH
SPST 10p each SP Three Positions 12p each

MINIATURE NEON LAMPS
240v or 110v 1–4 5p. 5 plus 4½p each.

LINEAR IC's
709c TO99 28p 741c TO99 60p
709c DIL 28p 741c DIL 36p

BARGAIN TTL's at 15p each
7400, 7401, 7402, 7403, 7404, 7410, 7420, 7430, 7440, 7450, 7451, 7453, 7454.
35p each:
7442, 7470, 7472, 7473, 7474, 7476, 7486.

AND LOTS MORE

BRAND NEW GUARANTEED — **LARGEST SELECTION OF SEMICONDUCTORS COMPONENTS** — **RETURN OF POST SERVICE**

TRANSISTORS

2G301	20p	2N3404	32½p	40311	35p	BCY30	27½p	BSX60	82½p	NKT401	87½p
2G302	20p	2N3405	45p	40312	47½p	BCY31	30p	BSX61	62½p	NKT402	90p
2G303	20p	2N3414	22½p	40314	37½p	BCY32	50p	BSX76	22½p	NKT403	75p
2G306	42½p	2N3415	22½p	40320	47½p	BCY33	25p	BSX77	27½p	NKT404	62½p
2G308	30p	2N3416	37½p	40323	32½p	BCY34	30p	BSX78	27½p	NKT405	75p
2G309	30p	2N3417	37½p	40324	47½p	BCY38	40p	BSY10	27½p	NKT406	62½p
2G371	15p	2N3570	£1·25	40326	37½p	BCY39	60p	BSY11	27½p	NKT451	62½p
2G374	20p	2N3572	97½p	40329	30p	BCY40	50p	BSY24	15p	NKT452	62½p
2G381	22½p	2N3605	27½p	40344	27½p	BCY42	15p	BSY25	15p	NKT453	47½p
2N404	22½p	2N3606	27½p	40347	57½p	BCY43	15p	BSY26	17½p	NKT603F	32½p
2N696	20p	2N3607	22½p	40348	52½p	BCY54	32½p	BSY27	17½p	NKT613F	32½p
2N697	17p	2N3702	11p	40360	42½p	BCY58	22½p	BSY28	17½p	NKT674F	30p
2N698	25p	2N3703	10p	40361	47½p	BCY59	22½p	BSY29	17½p	NKT677F	30p
2N706	12½p	2N3704	11p	40362	57½p	BCY60	97½p	BSY32	25p	NKT713	25p
2N705A	12½p	2N3705	10p	40370	32½p	BCY70	20p	BSY36	25p	NKT781	30p
2N708	15p	2N3706	09p	40406	57½p	BCY71	25p	BSY37	25p	NKT10419	30p
2N709	62½p	2N3707	11p	40407	40p	BCY72	17½p	BSY38	22½p	NKT10439	
2N718	25p	2N3708	07p	40408	52½p	BCZ10	27½p	BSY39	22½p		37½p
2N726	30p	2N3709	09p	40410	62½p	BCZ11	42½p	BSY40	32½p	NKT10519	
2N727	30p	2N3710	09p	40467A	57½p	BD116	£1·12½	BSY51	32½p		32½p
2N914	17½p	2N3711	12p	40468A	35p	BD121	65p	BSY52	32½p	NKT20329	
2N916	17½p	2N3715	£1·25	40600	57½p	BD123	82½p	BSY53	37½p		47½p
2N918	30p	2N3716	£1.30	AC107	30p	BD124	60p	BSY54	40p	NKT20339	
2N929	22½p	2N3791	£2.06	AC126	20p	BD131	75p	BSY56	90p		37½p
2N930	27½p	2N3819	35p	AC127	25p	BD132	85p	BSY78	47½p	NKT80111	
2N1090	22½p	2N3823	97½p	AC128	20p	BDY10	£1·37½	BSY79	45p		77½p
2N1091	22½p	2N3854	27½p	AC154	22½p	BDY11	£1·62½	BSY82	52½p	NKT80112	
2N1131	25p	2N3854A	27½p	AC176	25p	BDY17	£1·50	BSY90	57½p		97½p
2N1132	25p	2N3855	27½p	AC187	62½p	BDY18	£1·75	BSY95A	12½p	NKT80113	
2N1302	17½p	2N3855A	30p	AC188	37½p	BDY19	£1·97½	BSW41	42½p		£1.12
2N1303	17½p	2N3856	30p	ACY17	27½p	BDY20	£1·12½	BSW70	27½p	NKT80211	
2N1304	22½p	2N3856A	35p	ACY18	25p	BDY38	97½p	C111	75p		92½p
2N1305	22½p	2N3858	25p	ACY19	25p	BDY60	£1·25	C424	27½p	NKT80212	
2N1306	25p	2N3858A	30p	ACY20	25p	BDY61	£1·25	C425	55p		92½p
2N1307	25p	2N3859	27½p	ACY21	25p	BDY62	£1·00	C426	40p	NKT80213	
2N1308	30p	2N3859A	32½p	ACY22	20p	BF115	25p	C428	37½p		92½p
2N1309	30p	2N3860	30p	ACY28	20p	BF117	47½p	C744	30p	NKT80214	
2N1507	17½p	2N3866	£1.50	ACY40	20p	BF163	37½p	D16P1	37½p		92½p
2N1613	25p	2N3877	40p	ACY41	25p	BF167	18p	D16P2	40p	NKT80215	
2N1631	35p	2N3877A	40p	ACY44	40p	BF173	19p	D16P3	37½p		92½p
2N1632	30p	2N3900	37½p	AD140	52½p	BF177	30p	D16P4	40p	NKT80216	
2N1638	27½p	2N3900A	40p	AD149	57½p	BF178	30p	GET102	30p		92½p
2N1639	27½p	2N3901	97½p	AD150	62½p	BF179	30p	GET113	20p	OC20	75p
2N1671B	£1·00	2N3903	35p	AD161	37½p	BF180	35p	GET114	20p	OC22	50p
2N1711	25p	2N3904	35p	AD162	37½p	BF181	32½p	GET118	20p	OC23	60p
2N1889	32½p	2N3905	37½p	AF106	42½p	BF184	25p	GET119	20p	OC24	60p
2N1893	37½p	2N3906	37½p	AF114	25p	BF185	42½p	GET120	52½p	OC25	50p
2N2147	82½p	2N4058	17½p	AF115	25p	BF194	17½p	GET873	12½p	OC26	27½p
2N2148	57½p	2N4059	10p	AF116	25p	BF195	15p	GET880	30p	OC28	62½p
2N2160	57½p	2N4060	12½p	AF117	25p	BF196	42½p	GET887	20p	OC29	62½p
2N2193	40p	2N4061	12½p	AF118	62½p	BF197	42½p	GET889	22½p	OC35	50p
2N2193A	42½p	2N4062	12½p	AF119	20p	BF198	42½p	GET890	22½p	OC36	62½p
2N2194A	30p	2N4244	47½p	AF124	22½p	BF200	52½p	GET896	22½p	OC41	22½p
2N2217	27½p	2N4285	17½p	AF125	20p	BF224	14p	GET897	22½p	OC42	25p
2N2218	23p	2N4286	17½p	AF126	20p	BF225	19p	GET898	22½p	OC44	20p
2N2219	23p	2N4287	17½p	AF127	17½p	BF237	23p	MJ400	£1·07½	OC45	12½p
2N2220	25p	2N4288	17½p	AF139	37½p	BF238	23p	MJ420	£1·12½	OC46	15p
2N2221	25p	2N4290	17½p	AF178	42½p	BF244	23p	MJ421	£1·12½	OC70	15p
2N2222	30p	2N4291	17½p	AF179	72½p	BFW61	47½p	MJ430	£1·02½	OC71	12½p
2N2270	47½p	2N4292	12½p	AF180	52½p	BFX12	22½p	MJ440	95p	OC72	12½p
2N2297	30p	2N4303	47½p	AF181	42½p	BFX13	22½p	MJ480	97½p	OC74	32½p
2N2368	17½p	2N5027	52½p	AF239	42½p	BFX29	30p	MJ481	£1·25	OC75	22½p
2N2369	17½p	2N5028	57½p	AF279	47½p	BFX30	30p	MJ490	£1·00	OC76	22½p
2N2369A	17½p	2N5029	47½p	AF280	62½p	BFX42	37½p	MJ491	£1·37½	OC77	30p
2N2410	42½p	2N5030	42½p	AF211	32½p	BFX44	37½p	MJ1800	£2·17½	OC81	20p
2N2483	27½p	2N5172	12½p	ASY26	25p	BFX68	67½p	MJE340	62½p	OC81D	22½p
2N2484	32½p	2N5174	52½p	ASY27	37½p	BFX84	25p	MJE520	60p	OC83	25p
2N2539	22½p	2N5175	52½p	ASY28	27½p	BFX85	32½p	MJE521	73p	OC84	25p
2N2540	22½p	2N5176	45p	ASY29	27½p	BFX86	25p	MPF102	42½p	OC139	32½p
2N2613	35p	2N5232A	30p	ASY36	25p	BFX87	27½p	MPF103	37½p	OC140	32½p
2N2614	30p	2N5245	45p	ASY50	25p	BFX88	25p	MPF104	37½p	OC170	30p
2N2646	52½p	2N5246	42½p	ASY51	32½p	BFX89	62½p	MPF105	37½p	OC171	30p
2N2696	32½p	2N5249	67½p	ASY54	25p	BFX93A	70p	MPS3638	32½p	OC200	40p
2N2711	25p	2N5265	£3·25	ASY86	32½p	BFY10	32½p	NKT0013	47½p	OC201	60p
2N2712	25p	2N5266	£2·75	AU103	£1·25	BFY11	42½p	NKT124	42½p	OC202	75p
2N2713	27½p	2N5267	£2·82½	ASZ21	42½p	BFY17	22½p	NKT125	27½p	OC203	42½p
2N2714	30p	2N5305	37½p	BC107	10p	BFY18	32½p	NKT126	27½p	OC204	42½p
2N2865	62½p	2N5306	40p	BC108	10p	BFY19	32½p	NKT128	27½p	OC205	90p
2N2904	30p	2N5307	37½p	BC109	10p	BFY20	£1·60	NKT135	27½p	OC207	75p
2N2904A	32½p	2N5308	37½p	BC113	15p	BFY21	42½p	NKT137	32½p	OCP71	42½p
2N2905	37½p	2N5309	62½p	BC115	15p	BFY24	45p	NKT210	30p	ORP12	50p
2N2905A	40p	2N5310	42½p	BC116A	15p	BFY25	25p	NKT211	30p	ORP61	50p
2N2906	25p	2N5354	27½p	BC118	10p	BFY26	20p	NKT212	30p	P346A	22½p
2N2906A	27½p	2N5355	27½p	BC121	20p	BFY29	50p	NKT213	30p	T1834	82½p
2N2907	30p	2N5356	32½p	BC122	20p	BFY30	50p	NKT214	22½p	T1843	27p
2N2923	15p	2N5365	47½p	BC125	20p	BFY41	50p	NKT215	22½p	T1844	10p
2N2924	15p	2N5366	32½p	BC126	20p	BFY43	62½p	NKT216	37½p	T1845	10p
2N2925	15p	2N5367	57½p	BC140	37½p	BFY50	23p	NKT217	42½p	T1846	11p
2N2926		2N5457	37½p	BC147	10p	BFY51	20p	NKT219	30p	T1847	11p
Green	14p	28005	75p	BC148	10p	BFY52	23p	NKT223	27½p	T1848	12½p
Yellow	12½p	28020	£2·00	BC149	12p	BFY53	17½p	NKT224	25p	T1849	12½p
Orange	12½p	28102	50p	BC152	17½p	BFY56A	57½p	NKT225	22½p	T1850	17½p
2N3011	30p	28103	25p	BC157	20p	BFY75	30p	NKT229	30p	T1851	12½p
2N3014	32½p	28104	25p	BC158	11p	BFY76	42½p	NKT237	35p	T1852	12½p
2N3053	18p	28501	32½p	BC159	12p	BFY77	57½p	NKT238	25p	T1853	22½p
2N3054	46p	28502	35p	BC160	62½p	BFY90	67½p	NKT240	27½p	T1860	22½p
2N3055	62p	28503	27½p	BC167	11p	BFW58	27½p	NKT241	27½p	T1861	25p
2N3133	30p	3N83	40p	BC168B	10p	BFW59	25p	NKT242	20p	T1862	27½p
2N3134	30p	3N128	70p	BC168C	11p	BFW60	25p	NKT243	62½p	TIP29A	50p
2N3135	25p	3N140	77½p	BC169B	11p	BPX25	£1·85	NKT244	17½p	TIP30A	60p
2N3136	25p	3N141	72½p	BC169C	12p	BPX29	£1·80	NKT245	20p	TIP31A	62½p
2N3390	25p	3N142	55p	BC170	12½p	BPY10	£1·45	NKT261	20p	TIP32A	75p
2N3391	20p	3N143	67½p	BC171	15p	BRY39	37½p	NKT262	30p	TIP33A	
2N3391A	30p	3N152	87½p	BC172	15p	BSX19	17½p	NKT264	20p		£1·02½p
2N3392	17½p	R.C.A.		BC175	22½p	BSX20	17½p	NKT271	20p	TIP34A	£2·05
2N3393	15p	40050	55p	BC182	10p	BSX21	37½p	NKT272	20p	TIP35A	£2·90
2N3394	15p	40251	32½p	BC183	09p	BSX26	45p	NKT274	20p	TIP36A	£3·68
2N3402	22½p	40309	32½p	BC184	11p	BSX27	47½p	NKT275	20p		
2N3403	22½p	40310	45p	BC212L	13p	BSX28	32½p	NKT281	27½p		

Post & Packing 13p per order. Europe 25p. Commonwealth (Air) 65p (MIN.)
Matching charge (audio transistors only) 15p extra per pair.
Prices subject to alteration without prior notice.

TTL. LOGIC I.C. NEW PRICES

	1-11 £p	12-24 £p		1-11 £p	12-24 £p		1-11 £p	12-24 £p
SN7400	0·20	0·18	SN7433	0·80	0·75	SN7472	0·32	0·30
SN7401	0·20	0·18	SN7437	0·64	0·06	SN7473	0·43	0·41
SN7402	0·20	0·18	SN7438	0·64	0·60	SN7474	0·43	0·41
SN7403	0·20	0·18	SN7440	0·23	0·21	SN7475	0·45	0·44
SN7405	0·20	0·18	SN7441AN	0·87	0·83	SN7476	0·45	0·44
SN7406	0·80	0·75	SN7442	0·85	0·81	SN7480	0·70	0·65
SN7407	0·80	0·75	SN7443	2·86	2·70	SN7481	1·40	1·38
SN7408	0·20	0·18	SN7444	2·86	2·70	SN7482	0·87	0·82
SN7409	0·20	0·18	SN7445	2·50	2·40	SN7483	0·87	0·82
SN7410	0·20	0·18	SN7446	1·00	0·95	SN7484	2·00	1·85
SN7411	0·23	0·21	SN7447	1·00	0·95	SN7485	3·62	3·40
SN7412	0·48	0·46	SN7448	1·00	0·95	SN7486	0·33	0·30
SN7413	0·40	0·38	SN7449	1·00	0·95	SN7490	0·87	0·84
SN7420	0·20	0·18	SN7450	0·20	0·18	SN7491AN	1·21	1·10
SN7423	0·51	0·47	SN7451	0·20	0·18	SN7492	0·87	0·84
SN7427	0·48	0·45	SN7453	0·20	0·18	SN7493	0·87	0·84
SN7428	0·80	0·75	SN7454	0·20	0·18	SN7494	0·87	0·84
SN7430	0·23	0·15	SN7460	0·20	0·18	SN7495	0·87	0·84
SN7432	0·48	0·42	SN7470	0·40	0·38	SN7496	0·87	0·84

SUB-MIN ELECTROLYTIC

range axial lead 6p each
Values: (μF/V): 0·64/64; 1/40; 1·6/25; 2·5/16; 2·2/63; 4/10; 4/40; 6·4/6·4; 6·4/25; 8/40; 10/16; 10/64; 12·5/25; 16/40; 20/16; 20/64; 25/6·4; 25/25; 32/10; 32/40; 32/64; 40/16; 50/6·4; 50/25; 50/40; 64/10; 80/2·5; 80/16; 80/25; 100/6·4; 125/10; 125/16; 200/10; 320/6·4.

SILICON RECTIFIERS

PIV	50	100	200	400	600	800	1000	1200
1A	8p	9p	10p	11p	12p	15p	20p	—
3A	15p	17p	20p	22p	25p	27p	30p	35p
6A	—	—	25p	30p	32½p	35p	—	—
10A	30p	35p	40p	47p	56p	66p	75p	—
15A	36p	45p	48p	55p	65p	75p	87p	—
35A	70p	80p	90p	£1·00	£1·40	£1·70	£2·75	—

1 amp and 3 amp are plastic encapsulation.

DIODES & RECTIFIERS

IN34A	10p	AA119	7p	BAX16	12½p	FST3/4	22½p
IN914	7p	AA129	15p	BAY18	17½p	OA5	17p
IN916	7p	AAZ13	12p	BAY31	7p	OA10	20p
1N4007	20p	AAZ15	12p	BAY38	25p	OA9	10p
1844	7p	AAZ17	10p	BY100	15p	OA47	8p
18113	15p	BA100	15p	BY103	22p	OA70	7p
18120	12p	BA102	25p	BY122	47½p	OA73	10p
18121	14p	BA110	25p	BY124	15p	OA79	7p
18130	8p	BA114	15p	BY126	15p	OA81	8p
18131	10p	BA115	7p	BY127	17p	OA85	10p
18132	12p	BA141	17p	BY164	57p	OA90	7p
18920	7p	BA142	17p	BYX10	22p	OA91	7p
18922	8p	BA144	12p	BYZ10	35p	OA95	7p
18923	12p	BA145	17p	BYZ11	32p	OA200	7p
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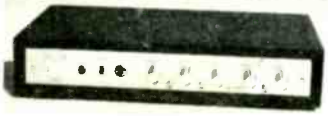

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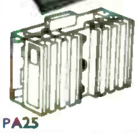

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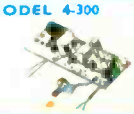

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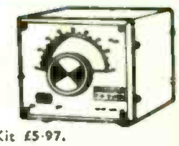

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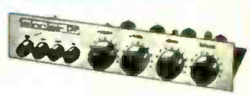

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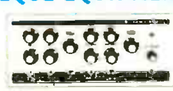

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