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everyday electronics

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ULTRASONIC REMOTE CONTROL

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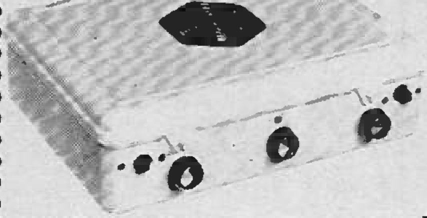
New Beginner's Series

BEGIN HERE

NEW EDU-KIT MAJOR

COMPLETELY SOLDERLESS ELECTRONIC CONSTRUCTION KIT.

BUILD THESE PROJECTS WITHOUT SOLDERING IRON OR SOLDER.



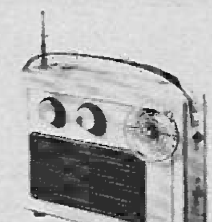
★ 4 Transistor Earpiece Radio ★ Signal Tracer ★ Signal Injector ★ Transistor Tester NPN-PNP ★ 4 Transistor Push Pull Amplifier ★ 5 Transistor Push Pull Amplifier ★ 7 Transistor Loudspeaker Radio MW/LW ★ 5 Transistor Short Wave Radio ★ Electronic Metronome ★ Electronic Noise Generator ★ Batteryless Crystal Radio ★ One Transistor Radio ★ 2 Transistor Regenerative Radio ★ 3 Transistor Regenerative Radio ★ Audible Continuity Tester ★ Sensitive Pre-Amplifier.

★ 24 Resistors ★ 21 Capacitors ★ 10 Transistors ★ 3½ loudspeaker ★ Earpiece ★ Mica Baseboard ★ 3 12-way connectors ★ 2 Volume controls ★ 2 Slider Switches ★ 1 Tuning Condenser ★ 3 Knobs ★ Ready Wound MW/LW/SW Coils ★ Ferrite Rod ★ 6½ yards of wire ★ 1 yard of sleeving, etc. ★Parts price list and plans 50p (FREE with parts).

Total Building Costs £7·23 P P & Ins. 44p. (Overseas P & P £1·85p.) (+ 8% VAT 57p)

NEW ROAMER NINE

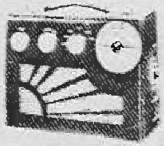
WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors, 9 Tunable wavebands as Roamer Ten, built in ferrite rod aerial for MW/LW. Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600 mw transistors. 9 Transistors and 3 diodes, tuning condenser with V.H.F. section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange control. Attractive all white case with red grille and carrying strap. Size 9½" × 7" × 2½" approx. Parts Price list and Plans 40p (FREE with parts)

Total Building Costs £6·95 P P & Ins. 44p. (Overseas P & P £1·85p) (+ 8% VAT 55p)

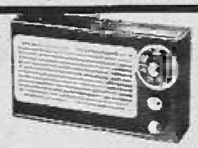
ROAMER TEN



with VHF including aircraft. 10 Transistors. Latest 4" 2 watt Ferrite Magnet Loudspeakers, 9 Tunable Wavebands. MW1, MW2, LW, SW1, SW2, SW3, Trawler Band, VHF and Local Stations also Aircraft Band, Built in Ferrite Rod Aerial for MW/LW. Chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600 mw Transistors. Car Aerial and Tape Recording Sockets. 10 Transistors plus 3 Diodes. Ganged Tuning Condenser with VHF section. Separate coil for Aircraft Band. Volume on/off. Wave Change and tone Control. Attractive Case in black with silver blocking. Size 9" × 7" × 4". Easy to follow instructions and diagrams. Parts price list and plans 50p (FREE with parts).

Total building costs £8·50 P. P. & Ins. 52p (Overseas P. & P. £1·85) (+ 8% VAT 68p)

NEW EVERYDAY SERIES



Build this exciting New series of designs

E.V. 5 5 Transistors and 2 diodes. MW/LW. Powered by 4½ volt Battery. Ferrite rod aerial, tuning condenser, volume control, and now with 3" loudspeaker. Attractive case with red speaker grille. Size 9" × 5½" × 2½" approx. Parts price list and Plans 20p. Free with parts.

Total Building Costs £2·95 P P & Ins. 30p (Overseas P & P £1·25p) (+ 8% VAT 23p)

E.V. 6 Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt battery. Ferrite rod aerial. 3" loudspeaker, etc., MW/LW coverage. Push Pull output. Parts price list and Plans 30p. Free with parts.

Total Building Costs £3·60 P & P Ins. 30p (Overseas P & P £1·25p) (+ 8% VAT 29p)

E.V. 7 Case and looks as above. 7 Transistors and 3 diodes. Six wavebands. MW/LW. Trawler Band. SW1. SW2, SW3, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. 3" loudspeaker. Parts price list and easy build plans 35p. Free with parts.

Total Building Costs £4·08 P P & Ins. 31p (Overseas P & P £1·85) (+ 8% VAT 32p)

"EDU-KIT"

Build Radios, Amplifiers, etc. from easy stage diagrams. Five units including master unit to construct

Components include: Tuning Condenser: 2 Volume Controls: 2 Slider Switches: Fine 3" Tone Moving Coil Speaker: Terminal Strip: Ferrite Rod Aerial: Battery Clips: 4 Tag Boards: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three ⅛" Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction. Parts price list and plans 40p (FREE with parts).

Total Building Costs £5·50 P P & Ins. 35p (Overseas P & P £1·85) (+ 8% VAT 44p)

POCKET FIVE

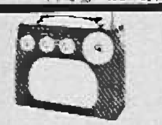
Now with 3" loudspeaker

3 Tunable wavebands. M.W./L.W. and Trawler Band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, attractive Black and Gold Case. Size 5½" × 1¼" × 3½" approx. Plans and parts price list 20p. (Free with parts).

Total Building Costs £2·50 P P & Ins. 26p (Overseas P &P £1·25p) (+ 8% VAT 20p)

ROAMER EIGHT Mk 1

NOW WITH VARIABLE TONE CONTROL



7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Chrome plated Telescopic aerial can be angled and rotated for peak short wave listening. Push pull output using 600mW transistors. Car aerial and Tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Latest 4" 2 watt Ferrite Magnet Loudspeakers. Air spaced ganged tuning condenser Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts price list and plans 50p (FREE with parts).

Total Building Costs £6·98 P P & Ins. 47p (Overseas P. & P. £1·85) (+ 8% VAT 56p)

ROAMER SIX

Case and looks as Trans-Eight

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3, Trawler band plus an Extra Medium waveband for easier tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Plans and parts price list 35p (FREE with parts).

Total Building Costs £3·98 P P & Ins. 31p (Overseas P. & P. £1·85) (+ 8% VAT 32p)

TRANSONA FIVE

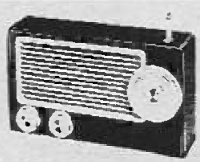
now with 3" loudspeaker

Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and parts price list 20p (Free with parts).

Total Building Costs £2·75 P P & Ins. 26p (Overseas P & P £1·25p) (+ 8% VAT 21p)

TRANS EIGHT

8 TRANSISTORS and 3 DIODES



6 Tunable Wavebands; MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 3in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 35p (FREE with parts).

Total Building Costs £4·48 P P & Ins. 33p (Overseas P & P £1·25) (+ 8% V.A.T. 36p)

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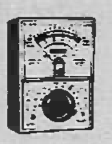
AUDIOTRONIC Model ATM1
Top value 1,000 opv pocket multimeter. Ranges:– 0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistance: 0/150k ohms. Decibels: –10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.

OUR PRICE £3.25 P&P 15p

AUDIOTRONIC Model ATM5
Jewel movement, attractively moulded case with edgwise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC (2500 opv). 0-6/30/300/600V DC. (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. –10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.

OUR PRICE £3.95 P & P 20p

MODEL TH12
20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. 0/50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. –20 to +50dB.

OUR PRICE £5.95 P&P 30p

HIOKI 720X VOM
A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10/50/250/1000V AC. 0–50uA/250mA. 0–20k/2 Megohms.

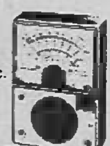
OUR PRICE £5.97 P&P 30p

MODEL PL436
20,000 opv DC. 8000 opv AC. Mirror scale. 6/3/12/30/120/600V DC. 3/30/120/600V DC. 60/600µA/60/600mA. 10/100K/1 Meg/10 Meg Ohm. –20 to +46 dB.

OUR PRICE £6.97 P&P 30p

U4323 MULTIMETER
20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: x 10, x 100, x 1,000, x 10,000 (50Ω, 500Ω, 5kΩ, 50kΩ centre scale) Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.

OUR PRICE £7.70 P&P 30p

HIOKI 730X
30,000 opv. Overload protection. 6/30/60/300/600/1200V DC. 12/60/120/600/1200V AC. 60/µA/30mA/300mA. 2K/200K/2 Meg Ohm. –10 to +63dB.

OUR PRICE £7.50 P&P 30p

U4324 MULTIMETER
High sensitivity, overload protected. 20,000opv. Ranges: 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/3/30/300mA/3A AC. Resistance: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: –10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.

OUR PRICE £9.25 P&P 30p

U435 MULTIMETER
20,000opv. Ranges: 75mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.

OUR PRICE £8.75 P&P 30p

U4312 MULTIMETER
extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/150/60/600mA/1/1.5/6A DC. 0/1.5/6/15/60/150/600mA/1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.

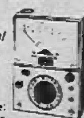
OUR PRICE £10.25 P&P 50p

U91 Clamp VOLT AMMETER
For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.

OUR PRICE £13.50 P&P 30p

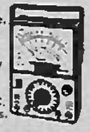
MODEL 500
30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms.

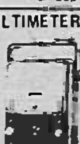
OUR PRICE £13.95 Carr. paid
Case for above £1.75

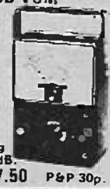
HIOKI 750X VOLT-OHM-MILLIAMETER
43 ranges: 0–0.3/0.6/1.5/3/6/12/30/60/150/300/600/1,200V DC. 0–3/6/15/30/60/120/300/600/1,200V AC. Current: 0–30/60uA/1.5/3/15/30/150/300mA/6/12A. Resistance: 0–3/300k/3/30Mohms. Decibels: –10 to +17dB. Output:– 0–3/6/15/30/60/120/300V. Accuracy ± 3% DC. ± 4% AC. Sensitivity: 50,000 opv DC. 5,000 opv AC. 4 inch meter. Built in protection. Size: 57 x 102 x 153mm.

OUR PRICE £11.95 P&P 40p

TMK MODEL TW50K
46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistance: 10k/100k/1 Meg/10 Meg ohms. –20 to +81.5dB.

OUR PRICE £12.50 P&P 20p

HIOKI MODEL 700X
100,000opv. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC. 2k/200k/2M/20MOhms. –20 to +63dB.

OUR PRICE £14.95 P&P 30p

Model HT100B4 MULTIMETER
Overload protected, shock proof circuits. 9.5uA Meter with mirror scale. Sensitivity 100kV. Polarity change switch. Ranges: 0.5/2.5/1-/50/250/500/1,000 Volts DC. 2.5/10/50/250/1,000 Volts AC. DC resistance 0–20/200k/2/20 Meg. ohms. DC current:– 10/250uA/2.5/25/250 mA/10A. AC current:–0–10A. –20 to +62dB. Operates from 2 x 1.5V batteries. Size: 180 x 134 x 79mm.

OUR PRICE £17.50 P&P 40p

MODEL AS.100D VOM
100,000 opv. Mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600V AC. 0/10µA/6/60/300mA/12 Amp. 0/2K/200K/2M/200 Meg Ohm. –20 to +17dB.

OUR PRICE £17.50 P&P 30p

MODEL C7202EN
20,000 o.p.v. DC. 10,000 o.p.v. AC Mirror Scale. 5/25/50/250/500/1000/2500 V. DC. 10/50/100/500/1000 V. AC. DC Resistance x 10, x 1000 (30Ω centre scale) DC Current 50uA/2·5mA/250mA. –20 to +68 dB.

OUR PRICE £6.50 P & P 30p

KAMODEN HM720B FET VOM
Input impedance 10 Megohms. Ranges:– 0/.25/1/2.5/10/50/1000V DC. 0/2.5/10/50/250/1000V AC. 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms

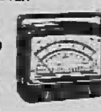
OUR PRICE £21.00 P & P 40p

KAMODEN 360 MULTIMETER
High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale, overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC. 5/10/50/250/1000V AC. Current: 0.01mA/0.5/5/50/500mA/10A. Resistance: 0.1/1/10/100 ohms/1/10/100k ohms/1/10/100M ohms. Decibels –20 to +62dB. Battery operated. Size: 180 x 140 x 80mm. Supplied complete with test leads etc.

OUR PRICE £17.50 P & P 40p

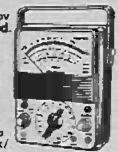
TMK MODEL 117 FET ELECTRONIC VOLTMETER
Battery operated. 11 Meg input. 26 ranges. Large 4½" mirror scale. Size: 149 x 117 x 60mm. 0.3–12000V DC. 3–300V RMS AC. 8–800V P-P. DC current 0.12–12mA. Resistance up to 2000MOhms. Decibels: –20 to +51dB. Supplied complete with leads and instructions.

OUR PRICE £18.50 P&P 20p

TMK 100K LAB TESTER
100,000opv. 6½" scale. Buzzer short circuit check. Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.5/2.5/10/50/250/1000V AC. 3/10/50/250/500/1000V DC. current 10/100uA/10/100/2.5/10A. Resistance: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: –10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.

OUR PRICE £19.95 P&P 30p

370WTR MULTIMETER
Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/250/500/1000V DC. 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: –20 to +62dB.

OUR PRICE £19.95 P&P 30p

KAMODEN 72.200 Multitester
High sensitivity tester. 200,000 opv Overload protected. Mirror scale. Ranges:–0/.06/.3 3/30/120/600/1200V DC. 0/3 12/60/300/11200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. –20 to +63dB. 0/2k/200k/2 Meg/200 Megohms.

OUR PRICE £22.50 P&P 30p

U4317 MULTIMETER
High sensitivity instrument for field and laboratory work. Knife edge pointer, 86mm. mirror scale. Overload protection. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: –5 to +10dB Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.

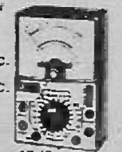
OUR PRICE £16.50 P&P 40p

MODEL C7208FM
30,000 opv DC. 15,000 opv AC. 6/3/15/60/300/600/1200 V. DC. 6/30/120/600/1200 V. AC. DC Resistance x 1, x 10, x 100, x 1000 (50Ω centre scale) DC Current 30uA/3/30/600mA. –20 to +63dB.

OUR PRICE £8.95 P & P 30p

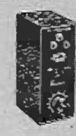
MODEL U4311 Sub-standard Multi-range Volt-Ammeter
Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.6% DC. 1% AC. Scale length: 165mm. 0/300/750uA/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A AC. 0/75/150/300/750mV/1.5/3/7.5/15/30/75/150/300/750V DC. 0/750mV/1.5/3/7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.

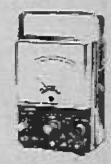
OUR PRICE £52.00 P&P 50p

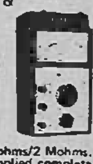
MODEL AF.105 VOM
50,000 opv. Mirror scale. Meter protection. 0/-3/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600/1200V DC. 0/30µA/6/60/300 mA/12 Amp. 0/10K/1m/10m/100 Meg Ohms. –20 to +17 dB.

OUR PRICE £12.50 P&P 30p

LB3 TRANSISTOR TESTER
Tests ICO and B. PNP/NPN. Operates from 9V battery. Instructions supplied.

OUR PRICE £3.95 P&P 20p

LB4 TRANSISTOR TESTER
Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.

OUR PRICE £4.50 P&P 20p

KAMODEN TT35 TRANSISTOR TESTER
High quality instrument to test reverse leak current and DC current. Amplification factor of NPN, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads carrying handle.

OUR PRICE £17.50 P & P 40p

U4341 Multimeter & Transistor Tester
27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.

OUR PRICE £10.50 P&P 30p

S100TR MULTIMETER TRANSISTOR TESTER
100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA/6/12A DC 0/10k/1 Meg/100 Meg. –20 to +50dB. 0.01–0.2 MFD Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.

OUR PRICE £19.95 P&P 25p

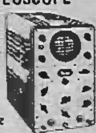
SWR METER Model SWR3
Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%. Impedance 52' Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.

OUR PRICE £4.25 P&P 30p

ALL PRICES EXCLUDE VAT

Also see following pages

CI5 PULSE OSCILLOSCOPE



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

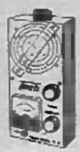
OUR PRICE £43.00 Carr. paid

RUSSIAN CI16 Double Beam OSCILLOSCOPE

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

OUR PRICE £87.00 Carr. paid

MODEL TE15 GRID DIP METER



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

OUR PRICE £19.95 P&P 30p

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

A new portable bridge offering excellent range and accuracy at low cost. Resistance: 6 ranges: 0.1 ohm-11.1 megohm ± 1% Inductance: 6 ranges: 1 microhenry 111 henries ± 2% Capacity: 6 ranges: 10pf-1110 mfd ± 2% Turns Ratio: 6 ranges: 1:1/1000-1:11100 ± 1% Bridge Voltage at 1,000cps. Operated from 9-volt battery. 100 micro-amp meter indication. Size 7¾" x 5" x 2"

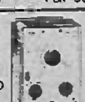
OUR PRICE £25.00 P&P 30p

TE16A TRANSISTORISED SIGNAL GENERATOR

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

OUR PRICE £8.97 P&P 30p

TE-200 RF SIGNAL GENERATOR



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

OUR PRICE £17.50 P&P 50p

TE22 SINE SQUARE WAVE AUDIO GENERATOR

Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedance 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.

OUR PRICE £24.95 P&P 50p

ARF 300 AF/RF SIGNAL GENERATOR

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

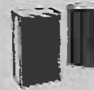
OUR PRICE £37.50 P&P 50p

MODEL MG100 SINE SQUARE WAVE AUDIO GENERATOR

Range 19-220,000Hz Sine Wave 19—100,000 Hz Square Wave. Output Sine or Square wave 10v. P. to P. Size 180 x 90 x 90mm. Operation 220/240v. A.C.

OUR PRICE £19.95 P&P 50p

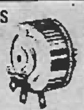
SPECIAL BARGAIN! FERGUSON 3406 HI-FI SPEAKERS



High quality 2 way speaker systems. 25 Watts. 4—8 ohms. 40Hz—18kHz. Size: 560 x 340 x 255mm. approx. Wood grain finish with black fronts.

OUR PRICE £22.50 PR. P&P £1

POWER RHEOSTATS



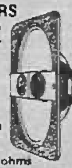
High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Single hole fixing. ¼" diameter shafts. Bulk quantities available.

25 WATT 10/25/50/100/500/1000/2500 ohms. £1.15 P&P 10p

50 WATT 10/50/100/250/500/1500/5000 ohms. £1.62 P&P 10p

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

EMI LOUDSPEAKERS



Model 350 13 x 8" with single tweeter/crossover. 20—20,000Hz. 15 watts RMS. Available 8 or 15 ohms.

OUR PRICE £7.50 each P&P 37p

Model 450 13 x 8" with twin tweeter/crossover. 55—13,000Hz. 8 watts RMS. Available 8 or 15 ohms

OUR PRICE £3.62 each P&P 35p

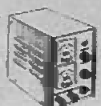
SPECIAL PURCHASE LIMITED QUANTITY!

Tannoy 12" DR/8 Bass Speakers

8 ohms. 30 watt. Heavy duty, ideal for Hi-Fi P.A. Group.

OUR PRICE £12.50. P&P 60p

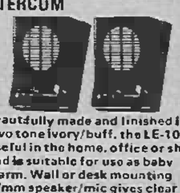
PS200 Regulated POWER SUPPLY UNIT



Solid state. Variable output 5—20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.

OUR PRICE £19.95 P&P 50p

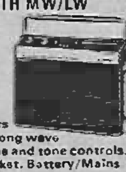
AUDIOTRONIC LE-102A INTERCOM



Beautifully made and finished in two tone ivory/buff, the LE-102A is useful in the home, office or shop and is suitable for use as baby alarm. Wall or desk mounting 57mm speaker/mic gives clear 2-way communication with on/off and volume control on master unit. Operates on 9V batt. Approx. 60ft lead.

OUR PRICE £3.95 P & P 30p

TRITON 4318 PORTABLE 8 TRACK CARTRIDGE PLAYER WITH MW/LW RADIO



Will play 8 track stereo cartridge monaurally. Channel selector switch. Covers medium and long wave bands. Volume and tone controls. Earphone socket. Battery/Mains operation.

OUR PRICE £11.95 P & P 50p

EA41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated. Simply plug in microphone, guitar etc. and output to your amplifier. Volume control and depth of reverberation control. Beautiful walnut cabinet. 184 x 77 x 108mm.

OUR PRICE £7.50 P&P 30p

SPECIAL PURCHASES! RECORD DECK PACKAGE

by Famous Manufacturer

GARRARD SP25 Mark 111 with G800 cartridge in luxurious plinth with cover.

OUR PRICE £13.95 P & P 75p

GARRARD SP25 Mark 111 Record deck fitted KS 40A cartridge.

OUR PRICE £9.95 P & P 50p

LH02S STEREO HEADPHONES

Light weight headphones with padded ear pieces. 4/16 ohms 20—20,000Hz. Complete with 6' lead and plug.

OUR PRICE £1.97 P&P 30p

DH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms. 20- 12,000Hz. Complete with lead and plug.

OUR PRICE £2.25 P&P 30p

TE1035 Stereo HEADPHONES

Low cost with excellent response. Foam rubber earcups. Adjustable headband. 8 ohms impedence. Frequency response 25Hz—18kHz. Complete with cable and stereo jack plug.

OUR PRICE £2.60 P&P 30p

SDH8V MONO/STEREO HEADPHONES

Volume control for each channel. 4/16 ohms impedence. Frequency response 20Hz—18kHz. Complete with 10ft. coiled lead and jack plug.

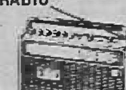
OUR PRICE £4.97 P&P 30p

BH001 HEADSET and Boom Microphone

Moving coil. Ideal for language teaching, communications etc. Headphone impedence 16 ohms. Microphone impedence 200 ohms.

OUR PRICE £5.95 P&P 30p

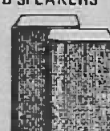
HANIMEX HRC 3075 CASSETTE RADIO



Covers Medium and FM wavebands. Slider volume and tone controls. Battery/Mains operation. Will record direct from radio or through built in condenser microphone. Complete with batteries, earphone, and cassette.

OUR PRICE £24·30 P & P 50p

SPECIAL BARGAIN !! STEREOSOUND SPEAKERS



Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 watts RMS. 16 watts peak. Complete with Din lead.

OUR PRICE £12.95 PAIR P&P 50p

FM TUNER CHASSIS

6 transistor high quality tuner. Size only 153 x 101 x 63mm 3 IF stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Covers 88—108MHz. Ready built, ready for use. Fantastic value for money.

OUR PRICE £8.95 P&P 20p

Stereo Multiplex Adaptor £5 95 extra

SPECIAL OFFER! SAVE OVER 50%

AMSTRAD 8000/2 Stereo amplifier 7 watts per channel rms. Inputs for tuner tape, phono. Headphone socket. List price £29.95.

OUR PRICE £12.95 P & P 60p

SPECIAL OFFER! CONVERT YOUR STEREO SYSTEM TO 4D SOUND FOR UNDER £16.

Exclusive offer of GOODWIN 4-CHANNEL CONVERTER and a pair of AD15 10 watt 8 ohm bookshelf speakers enables you to add 4D sound to your existing system. Complete with simple connection details. Normal retail value £25.50.

OUR PRICE £15.80 P & P £1.

GOODWIN CONVERTER available separately £3.95 P & P 50p.

Model A1018 FM TUNER

6 transistor high quality unit—3 IF stages and double tuned discriminator. For use with most amplifiers. Covers 88—108MHz. Powered by 9V battery.

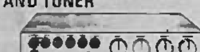
OUR PRICE £13.50 P&P 30p

Stereo multiplex adapter £5 95 extra.

ELECTRONIC CALCULATORS

We carry a tremendous range of both pocket and desk calculators from as little as £9. Owing to the demand it is not possible to include them in this advertisement, so send for our latest price list or call into any branch.

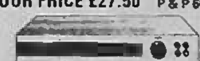
SINCLAIR SYSTEM 2000 STEREO AMPLIFIER AND TUNER



2000 AMPLIFIER

Amplifier output 8 watts per channel RMS. Distortion less than 0·06%. Silicon transistors. Two pick-up plus radio and tape inputs, tape output and scratch filter. Excellent Value. List £39.95

OUR PRICE £27.50 P & P 60p.

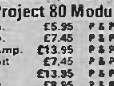


2000 FM TUNER

Excellent selectivity and sensitivity. Twin dual-varicap tuning. 4 pole ceramic filter. 19 transistor stereo demodulator giving 40 dB separation. Distortion 0·2% output. Fantastic Value. List £39.95

OUR PRICE £27.50 P & P 60p.

SINCLAIR IC12 INTEGRATED CIRCUIT AMPLIFIER



complete with printed circuit mounting board.

OUR PRICE £1.50 P & P 15p.

SINCLAIR Project 80 Modules

Z40 Power Amp.	£5.95	P & P 15p
Z60 Power Amp.	£7.45	P & P 15p
Stereo 80 Pre-Amp.	£13.95	P & P 15p
Active Filter Unit	£7.45	P & P 15p
FM Tuner	£13.95	P & P 15p
Stereo Decoder	£8.95	P & P 15p
PZ5 Power Supply	£5.95	P & P 30p
PZ6 Power Supply	£8.95	P & P 30p
PZ8 Power Supply	£8.45	P & P 30p
Transformer for PZ8	£4.05	P & P 50p
IC 20 Stereo Amp. kit	£7.95	P & P 15p
PZ20 Power Supply kit	£6.46	P & P 30p

SINCLAIR Project 80 Packages

2xZ40 Stereo 80/PZ5	£28.60	P & P 35p each
2xZ40 Stereo 80/PZ8	£31.30	
2xZ60/Stereo 80/PZ8	£33.55	

TE1021 Stereo Listening Station

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

OUR PRICE £2.25 P&P 15p

AUDIOTRONIC LOW NOISE CASSETTES

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

AUDIOTRONIC 8 TRACK CARTRIDGES

TYPE	Each	5	10
40M	85p	£4.00	£7.50
80M	£1.15	£5.40	£10.25

P&P Cassettes 3p, Cartridges 5p each OVER 10 of either POST FREE!

MP7 MIXER-PREAMPLIFIER

5 Microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. Size: 235 x 127 x 76mm. Inputs: Mics. 3 x 3mV 50k; 2 x 3mV 600 ohms. Phono. Mag. 4mV 50k; Phono Ceramic 100mV 1 Meg. Output 250mV 100k.

OUR PRICE £8.97 P&P 20p

AUDIOTRONIC AHA101 Stereo Headphone Amplifier

All silicon, transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. INPUTS: 5mV and 100mV. OUTPUT: 50mV per channel.

OUR PRICE £8.50 P&P 30p

JOSTY KIT

HIGH QUALITY CONSTRUCTION KITS

WE ARE APPOINTED STOCKISTS AT ALL BRANCHES

All kits are complete with comprehensive easy to follow instructions and covered by full guarantee.

Post and Packing 15p per kit.

AF20 Mono amplifier	£5.61
AF25 Mixer	£3.29
AF30 Mono pre-amplifier	£3.20
AF35 Emitter amplifier	£2.42
AF80 0.5W mic. amplifier	£4.86
AF305 Intercom	£7.67
AF310 2 Mono Amplifier	£7.55
M160 Multi vibrator	£2.18
M1302 Transistor tester	£8.33
M191 VU Meter	£5.37
M192 Stereo balance meter	£5.93
LF380 Quadraphonic device	£8.42
AT5 Automatic light control	£3.75
AT30 Photo cell switch unit	£6.68
AT50 400W triac light dimmer/speed control	£5.18
AT56 2,200W triac light dimmer/speed control	£6.75
AT60 1 channel light control	£10.82
AT65 3 channel light control	£16.52
GU330 Tremolo unit	£8.10
HF61 Diode detector	£3.87
HF65 FM transmitter	£3.21
HF75 FM receiver	£3.66
HF310 FM tuner	£16.32
HF325 Deluxe FM tuner	£26.33
HF330 Decoder (HF310/325)	£10.55
GP310 Stereo pre amplifier for use with 2 x AF310	£22.98
GP312 Circuit board	£10.02
GP304 Circuit board	£5.33
HF380 tv/vhf aerial amplifier	£6.02
HF395 broadband aerial amp.	£2.10
NT10 Stabilised power supply 100mA, 9V	£6.27
NT300 Stabilised p. supply	£13.16
NT310 Power Supply 240 V AC or 2 x 18 V D C. at 2 amps	£5.64
NT305 Voltage converter	£5.64
NT315 Power supply 240V AC to 4.5/15V DC. 500mA	£12.06

Amateur Electronics by Josty-Kit, the professional book for the amateur—covers the subject from basic principals to advanced electronic techniques. Complete with circuit board for AE1 to AE10 listed below.

OUR PRICE £3.30 (No VAT) P&P 25p plus VAT.

AE1 100mW output stage	£1.55
AE2 Pre-amplifier	£1.32
AE3 Diode receiver	£2.05
AE4 Flasher	£1.26
AE5 Astable multi-vibrator	£1.14
AE6 Monostable multi-vibrator	£1.11
AE7 RC generator	£1.08
AE8 Bass filter	£1.05
AE9 Treble filter	£1.05
AE10 CCIR filter	£1.05

Also see previous page

ALL PRICES EXCLUDE VAT

SEW PANEL METERS

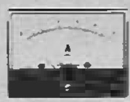
SEW PANEL METERS ARE STOCKED AT OUR 3 LISLE ST., 311 EDGWARE RD., & 152 FLEET ST., BRANCHES or order by post.

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

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

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

CLEAR PLASTIC MODEL SD640
Size: 85 x 64mm



50uA	£3.80	10V DC	£3.65
100uA	£3.75	20V DC	£3.65
200uA	£3.70	50V DC	£3.65
500uA	£3.66	300V DC	£3.65
50-0-50uA	£3.75	15V AC	£3.75
100-0-100uA	£3.70	300V AC	£3.75
1mA	£3.65	VU Meter	£3.90
5mA	£3.65		
10mA	£3.65		
50mA	£3.65		
100mA	£3.65		
500mA	£3.66		
1A DC	£3.65		
5A DC	£3.65		
10A DC	£3.65		
5V DC	£3.65		

CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm

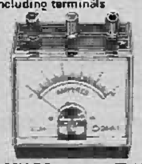
50uA	£4.60	150V AC	£4.45
100uA	£4.50	300V AC	£4.45
500uA	£4.30	VU Meter	£4.90
50-0-50uA	£4.50		
100-0-100uA	£4.45		
1mA	£4.30		
1A DC	£4.30		
5A DC	£4.30		
20V DC	£4.30		
50V DC	£4.30		
300V DC	£4.30		

EDGWISE MODEL PE70
Size: 90 x 34mm

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

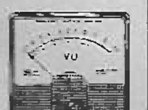
MODEL ED107 EDUCATIONAL METER
Size: 100 x 90 x 150mm including terminals

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



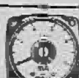
50uA	£8.50	20V DC	£7.60
100uA	£7.90	50V DC	£7.60
50-0-50uA	£7.90	300V DC	£7.60
1mA	£7.60	500mA/5A DC	£8.60
1-0-1mA	£7.60	5V/50V DC	£8.60
1A DC	£7.60	5V/15V DC	£8.60
5A DC	£7.60	1/5A DC	£8.60
5V DC	£7.60	1A/15A DC	£8.60
10V DC	£7.60		
15V DC	£7.60		

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



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

240° Wide Angle 1mA METERS



MW1-6 60 x 60 mm £6.50 P & P 15p
MW1-8 80 x 80mm £6·90 P&P 15p

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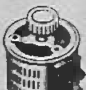

		P&P
1A	£10.50	50p
2.5A	£12.00	50p
5A	£17.50	50p
8A	£30.35	£1.00
10A	£33.75	£1.00
12A	£35.40	£1.00
20A	£85.00	£1.50
25A	£95.00	£1.50
40A	£120.00	£1.50

MODEL S260B PANEL MOUNTING
2.5A £12.00 50p

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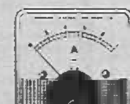
CLEAR PLASTIC MODEL SD830
Size: 110 x 83mm

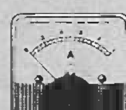
50uA	£4.30	10V DC	£4.10
100uA	£4.25	20V DC	£4.10
200uA	£4.20	50V DC	£4.10
500uA	£4.15	300V DC	£4.10
50-0-50uA	£4.25	15V AC	£4.20
100-0-100uA	£4.20	300V AC	£4.20
1mA	£4.10	VU Meter	£4.40
5mA	£4.10		
10mA	£4.10		
50mA	£4.10		
100mA	£4.10		
500mA	£4.10		
1A DC	£4.10		
5A DC	£4.10		
10A DC	£4.10		
5V DC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

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



50uA	£3.20	300V AC	£3.05
100uA	£3.15	S Meter 1mA	£2.95
200uA	£3.10	VU Meter	£3.40
500uA	£3.00	1A AC	* £2.95
50-0-50uA	£3.15	5A AC	* £2.96
100-0-100uA	£3.10	10A AC	* £2.95
500-0-500uA	£2.95	20A AC	* £2.95
1mA	£2.95	30A AC	* £2.95
5mA	£2.95		
10mA	£2.95		
50mA	£2.95		
100mA	£2.95		
500mA	£2.95		
1A DC	£2.95		
5A DC	£2.95		
10V DC	£2.96		
20V DC	£2.95		
50V DC	£2.95		
300V DC	£2.95		
15V AC	£3.05		

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



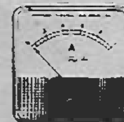
50uA	£3.10	20V DC	£2.80
100uA	£3.05	50V DC	£2.80
200uA	£3.00	100V DC	£2.80
500uA	£2.85	150V DC	£2.80
50-0-50uA	£3.05	300V DC	£2.85
100-0-100uA	£3.00	500V DC	£2.85
500-0-500uA	£2.80	750V DC	£2.90
1mA	£2.80	15V AC	£2.90
1-0-1mA	£2.80	50V AC	£2.90
2mA	£2.80	150V AC	£2.90
5mA	£2.80	300V AC	£2.90
10mA	£2.80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

CLEAR PLASTIC MODEL SD460
Size: 59 x 46mm

50uA	£3.50	10V DC	£3.30
100uA	£3.45	20V DC	£3.30
200uA	£3.40	50V DC	£3.30
500uA	£3.35	300V DC	£3.30
50-0-50uA	£3.45	15V AC	£3.45
100-0-100uA	£3.40	300V AC	£3.45
1mA	£3.30	VU Meter	£3.65
5mA	£3.30		
10mA	£3.30		
50mA	£3.30		
100mA	£3.30		
500mA	£3.30		
1A DC	£3.30		
5A DC	£3.30		
10A DC	£3.30		
5V DC	£3.30		

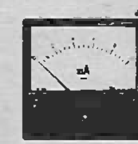
POSTAGE & PACKING 15p

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



50uA	£3.95	300V DC	£3.70
100uA	£3.85	15V AC	£3.80
200uA	£3.80	50V AC	£3.80
500uA	£3.75	150V AC	£3.80
50-0-50uA	£3.85	300V AC	£3.90
100-0-100uA	£3.80	500V AC	£3.80
500-0-500uA	£3.70	S Meter 1mA	£4.10
1mA	£3.70	VU Meter	£3.70
1-0-1mA	£3.70	1A AC	* £3.70
5mA	£3.70	5A AC	* £3.70
10mA	£3.70	10A AC	* £3.70
50mA	£3.70	20A AC	* £3.70
100mA	£3.70	30A AC	* £3.70
500mA	£3.70	50mA AC	* £3.70
1A DC	£3.70	100mA AC	* £3.70
5A DC	£3.70	200mA AC	* £3.70
10A DC	£3.70	500mA AC	* £3.70
15A DC	£3.70		
20A DC	£3.80		
30A DC	£3.86		
50A DC	£4.05		
5V DC	£3.70		
10V DC	£3.70		
15V DC	£3.70		
20V DC	£3.70		
50V DC	£3.70		
150V DC	£3.70		

BAKELITE MODEL S80 Enlarged Window
Size: 80 x 80mm

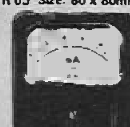


50uA	£4.50
100uA	£4.45
500uA	£4.20
50-0-50uA	£4.45
100-0-100uA	£4.40
1mA	£4.20
1A DC	£4.20
5A DC	£4.20
20V DC	£4.20
50V DC	£4.20
300V DC	£4.20
300V AC	£4.30
VU Meter	£4.70

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

50uA	£3.70	S Meter 1mA	£3.30
100uA	£3.50	VU Meter	£3.80
500uA	£3.35	1A AC	* £3.30
50-0-50uA	£3.50	5A AC	* £3.30
100-0-100uA	£3.46	10A AC	* £3.30
1mA	£3.30	20A AC	* £3.30
5mA	£3.30	30A AC	* £3.30
10mA	£3.30		
50mA	£3.30		
100mA	£3.30		
500mA	£3.30		
1A DC	£3.30		
5A DC	£3.30		
10V DC	£3.30		
20V DC	£3.30		
50V DC	£3.30		
300V DC	£3.30		
15V AC	£3.40		
300V AC	£3.40		

BAKELITE MODEL MR 65 Size: 80 x 80mm



25uA	£5.25	300V DC	£3.60
50uA	£4.00	30V AC	* £3.60
100uA	£3.95	50V AC	* £3.60
500uA	£3.65	150V AC	* £3.60
50-0-50uA	£3.95	300V AC	* £3.60
100-0-100uA	£3.90	500V AC	* £3.60
500-0-500uA	£3.60	VU Meter	£4.10
1mA	£3.60	1A AC	* £3.60
1-0-1mA	£3.60	5A AC	* £3.60
5mA	£3.60	10A AC	* £3.60
10mA	£3.60	20A AC	* £3.60
50mA	£3.60	30A AC	* £3.60
100mA	£3.60	50A AC	* £3.60
500mA	£3.60	500mA AC	* £3.80
1A DC	£3.60	50mV DC	£3.75
2A DC	£3.60	100mV DC	£3.76
5A DC	£3.60		
10A DC	£3.60		
15A DC	£3.60		
30A DC	£3.60		
50A DC	£3.80		
5V DC	£3.60		
10V DC	£3.60		
15V DC	£3.60		
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AL10/AL20/AL30 AUDIO AMPLIFIER MODULES

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

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

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

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

AUDIO AMPLIFIER MODULES

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

POWER SUPPLIES

PS 12. (Use with AL10, AL20, AL30) 68p
SPM 80. (Use with AL60) £3·25
FRONT PANELS SP 12 with Knobs £1·10

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20) £4·35
PA 100. (Use with AL30 & AL60) £13·15

TRANSFORMERS

T461 (Use with AL10) £1·38 P & P 15p
T538 (Use with AL20, AL30) £1·93 P & P 15p
BMT80 (Use with AL60) £2·15 P & P 25p

PA 12. PRE-AMPLIFIER SPECIFICATION

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

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

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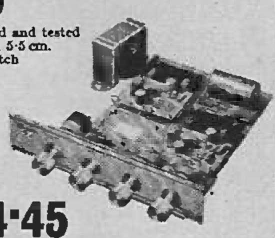
The STEREO 20



The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls. Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ±12dB at 60Hz typically 0·25% at 1 watt. Treble con. ±14dB at 14kHz.

£14·45

TC20 TEAK VENEERED CABINET

For Stereo 20 (front board undrilled) size 10½" x 8½" x 3", £3·95. plus 30p postage

SHP80 STEREO HEADPHONES

4-16 ohms impedance. Frequency response 20 to 20,000Hz Stereo/mono switch and volume controls £4·95

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- Frequency Response 20Hz to 100KHz
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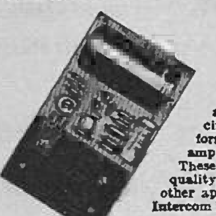
- Supply voltage 15-50 volts
- Thermal Feedback
- Latest Design Improvements
- Load—3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm × 105mm × 13mm

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

STABILISED POWER MODULE SPM80

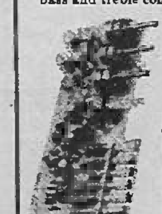


SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer BMT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address Intercom Units, etc. Handbook available 10p **PRICE £3·25**

TRANSFORMER BMT80 £2·15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

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



SPECIFICATION

Frequency Response	20Hz − 20KHz ± 1dB
Harmonic Distortion	better than 0·1%
Inputs: 1. Tape Head	3·25 mV into 50K Ω
2. Radio, Tuner	75 mV into 50K Ω
3. Magnetic P.U.	3 mV into 50K Ω

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

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

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SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £25.30 FREE p. & p.

MK 60 AUDIO KIT

Comprising: 2 x AL60, 1 x SPM80, 1 x BTM80, 1 x PA 100, 1 front panel, 1 kit of parts to include on-off switch, neon indicator, stereo headphone sockets plus instruction booklets. Complete Price: £28·75 plus 30p postage

TEAK 60 AUDIO KIT

Comprising: Teak veneered cabinet size 16¾" x 11¼" x 3½". other parts include aluminium chassis, heatsink and front panel bracket, plus back panel and appropriate sockets etc. Kit price: £9.95 plus 30p postage

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The Sinclair Scientific is an altogether remarkable calculator.

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Yet even ready-built, the Sinclair Scientific costs a mere £32.35 (including VAT).

And as a kit it costs under £20!

Forget slide rules and four-figure tables!
With the functions available on the Scientific keyboard, you can handle *directly*

- sin and arcsin,
- cos and arccos,
- tan and arctan,
- automatic squaring and doubling,
- $\log_{10}$, antilog_{10}, giving quick access to x^y (including square and other roots),
- plus, of course, addition, subtraction, multiplication, division, and any calculations based on them.

In fact, virtually all complex scientific or mathematical calculations can be handled with ease.

So is the Scientific difficult to assemble?
No. Powerful though it is, the Sinclair Scientific is a model of tidy engineering.

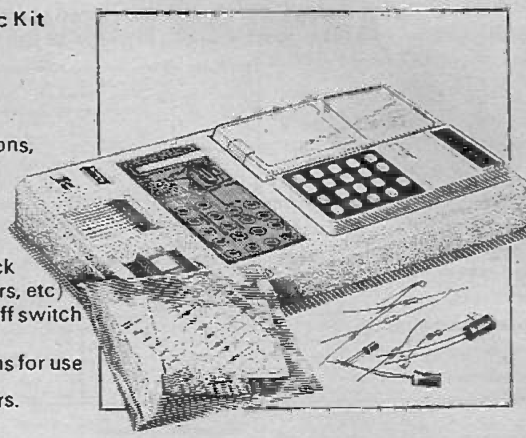
All parts are supplied – all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our Service Department will back you throughout if you've any queries or problems.

Of course, we'll happily supply the Scientific or the Cambridge already built, if you prefer – they're still exceptional value. Use the order form.

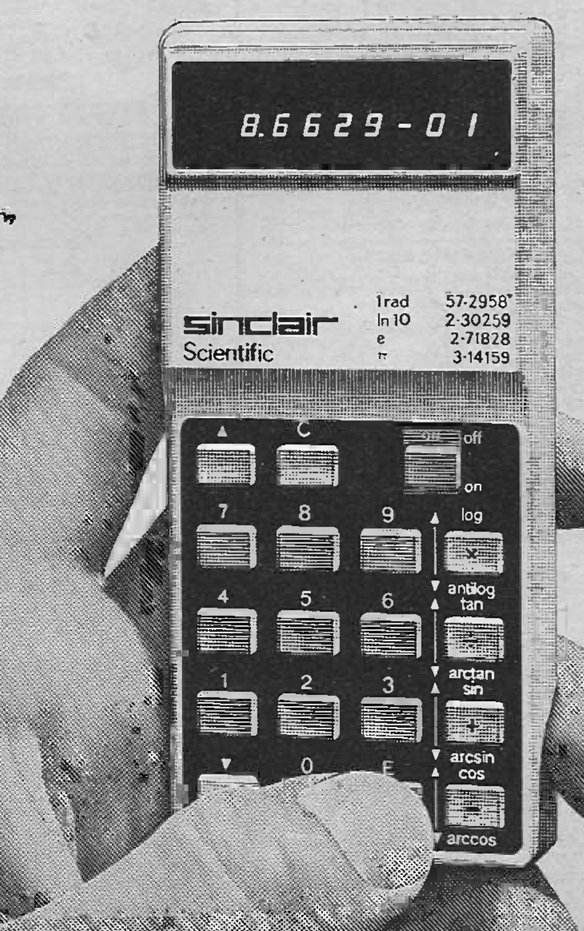
Components for Scientific Kit (illustrated)

1. Coil
2. LSI chip
3. Interface chips
4. Case mouldings, with buttons, windows and light-up display in position
5. Printed circuit board
6. Keyboard panel
7. Electronic components pack (diodes, resistors, capacitors, etc)
8. Battery assembly and on/off switch
9. Soft carrying wallet
10. Comprehensive instructions for use

Assembly time is about 3 hours.



Features of the Sinclair Scientific



● **12 functions on simple keyboard**
Basic logs and trig functions (and their inverses), all from a keyboard as simple as a normal arithmetic calculator's. 'Upper and lower case' operation means basic arithmetic keys each have two extra functions.

● **Scientific notation**
Display shows 5-digit mantissa, 2-digit exponent, both signable.

● **200-decade range**
10^{-99} to 10^{+99}.

● **Reverse Polish logic** Post-fixed operators allow chain calculations of unlimited length – eliminate need for an = button.

● **25-hour battery life**
4 AAA manganese alkaline batteries (e.g. MN2400) give 25 hours continuous use. Complete independence from external power.

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THEORY.....

TRANSMITTING IN FREE SPACE

Just eighty years ago (as near as makes no difference) a young man barely in his twenties persevering with his experiments in an attic finally achieved the success he so earnestly sought. A key depressed at one end of the room caused a buzzer to sound at the opposite end of the room. There were no physical connections between the transmitting and receiving apparatus. Thus was wireless telegraphy born.

That initial success of young Guglielmo Marconi set in train great and staggering developments in communications without the use of intervening wires. Today, life as we know it would not be possible without the great variety of services we have become dependent upon (knowingly or unknowingly) and which are bourne along on electromagnetic waves.

Yet, somewhat ironically, the technique that gives freedom from wires is not freely available for all and sundry to use for themselves as they wish. (Conld young Guglielmo ever have imagined the restrictions that would be imposed upon future generations of amateur experimenters by his own brilliant success!)

It is a fact, though apparently not always properly understood, that any form of transmission in the radio frequency spectrum is subject to regulations based on the Wireless and Telegraphy Act. It is illegal to make transmissions (regardless of power) without a proper licence from the Home Office (Radio Regulatory Division). There are various kinds of transmitting licences. These are granted for specific purposes and permit operation only within particular frequency bands allocated exclusively for such purposes.

This in a few wôrds makes clear the legal position in the UK, frustrating though it may be to budding experimenters. It should explain also why we do not (despite frequent requests) publish designs for radio transmitters, other than those intended for few exceptional applications where licences to operate will be granted with the minimum of formality to ordinary members of the general public. Model control and metal sensing devices are two obvious examples.

All is not lost, however. Sound or pressure waves operating above normal human hearing range can be employed in a rather similar fashion to electromagnetic waves for remote control, signalling, and certain other purposes over short distances through air.

Ultrasonic waves cannot provide a complete alternative to radio waves of course. But for certain limited purposes they offer an ideal solution to the problem of how to dispense with undesirable interconnecting wires. Furthermore, this technique has the great advantage that it can be used without let or hindrance from officialdom—as yet!

Fred Bennett.

Our January Issue will be published on Wednesday, December 18

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. EASY TO CONSTRUCT
. SIMPLY EXPLAINED

VOL. 3 NO. 12 *DECEMBER 1974*

CONSTRUCTIONAL PROJECTS DATA CHECK CARD

GENERAL FEATURES

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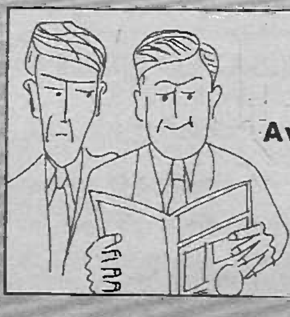

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It's invisible... it's inaudible... Make it ULTRASONIC

A simple ultrasonic transmitter and receiver employing integrated circuits for ease of construction and reliability.

This article describes how a simple ultrasonic transmitter and receiver can be constructed for a host of applications such as remote control, intruder alarm, signalling system, leak testing, garage door opening, object counter etc.

When a 40kHz ultrasonic beam from the transmitter falls on the receiver, a relay in the latter closes and can be used to carry out any desired operation. The maximum operating range in the open air is about 12 metres (40 feet).

Integrated circuits are employed in the design so that the number of components required is greatly reduced. Unlike many other ultrasonic circuit designs, the relay specified for this receiver is not a delicate reed relay, but one which has two pairs of large change over contacts. Each pair of contacts can switch up to 10A at 250V a.c.

TRANSDUCERS

The transducers used in the circuits to be described contain piezoelectric "bimorph" plates which resonate at the ultrasonic frequency concerned. These plates are a few square millimeters in area and are sealed in the transducer.

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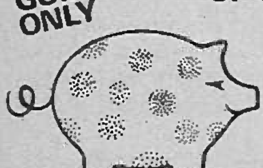
ESTIMATED COST* OF COMPONENTS including V.A.T.



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*Based on prices prevailing at time of going to press

In the transmitter a square-wave voltage of the ultrasonic frequency is applied to the transducer. The latter produces ultrasonic pressure waves which are just like sound waves except that their frequency is much too high for them to be detected by the human ear. Ultrasonic waves are much more directional than ordinary sound waves.

A similar transducer in the receiver converts the incoming waves into a 40kHz electrical signal.

The voltage across the terminals of the receiver transducer varies greatly with its distance from the transmitter, but is normally in the range of some tens of microvolts up to hundreds of millivolts. This signal must therefore be amplified considerably before it can be used to operate a relay.

The transducers will operate only at or near to their resonant frequency. If the transmitter circuit feeds signals to the transmitter transducer at any other frequency, the ultrasonic output will be very small.

The transducer in the transmitter behaves like a miniature loudspeaker which will operate at only one frequency, whilst the one in the receiver acts like a microphone which is sensitive only to signals near to its resonant frequency.

A relatively new type of miniature transducer, the 96D-40, was selected for use in the prototype equipment. It is available as the "T" and "R" versions which are designed for use in the transmitter and in the receiver respectively.

Although it is possible to interchange these units, optimum results can be expected only if a "T" type unit is used in the transmitter and an "R" type unit in the receiver.

Both types have an identical appearance. They have a metal grille at the front of the unit through which the ultrasonic waves pass. There are two connecting pins at the back, one of which is connected to the metal case of the device.

THE RECEIVER

The low level signal from the tranducer in the receiver must be amplified at 40 kilohertz to bring the level up to a few volts. The gain work for you — (No licence required!)

REMOTE CONTROL

PART 1 RECEIVER

By J.B. DANCE

required is around 80db if the transmitter is well away from the receiver.

The two transducers are themselves frequency selective and it is not necessary to include circuits to control the bandwidth of the system.

The amplification at 40 kilohertz *can* be carried out using discrete transistors, but it was felt that the use of an integrated circuit would be desirable to reduce the circuit complexity. A type TAA 930B i.c. was selected.

This device contains four cascaded wide-band differential amplifier stages and is intended for use in the sound section of television receivers at a 5·5 megahertz intermediate frequency.

Each amplifier stage is coupled to the succeeding one by an internal emitter-follower buffer stage in an arrangement which allows a high gain to be obtained with good stability.

RECEIVER CIRCUIT

The complete circuit of the receiver unit is shown in Fig. 1. All of the decoupling capacitors are 10 microfarads in value so that the impedance of these capacitors is less than 0·5 ohm at 40 kilohertz.

The output from the "R" type transducer is applied to the input of the TAA 930B pins 4 and 6.

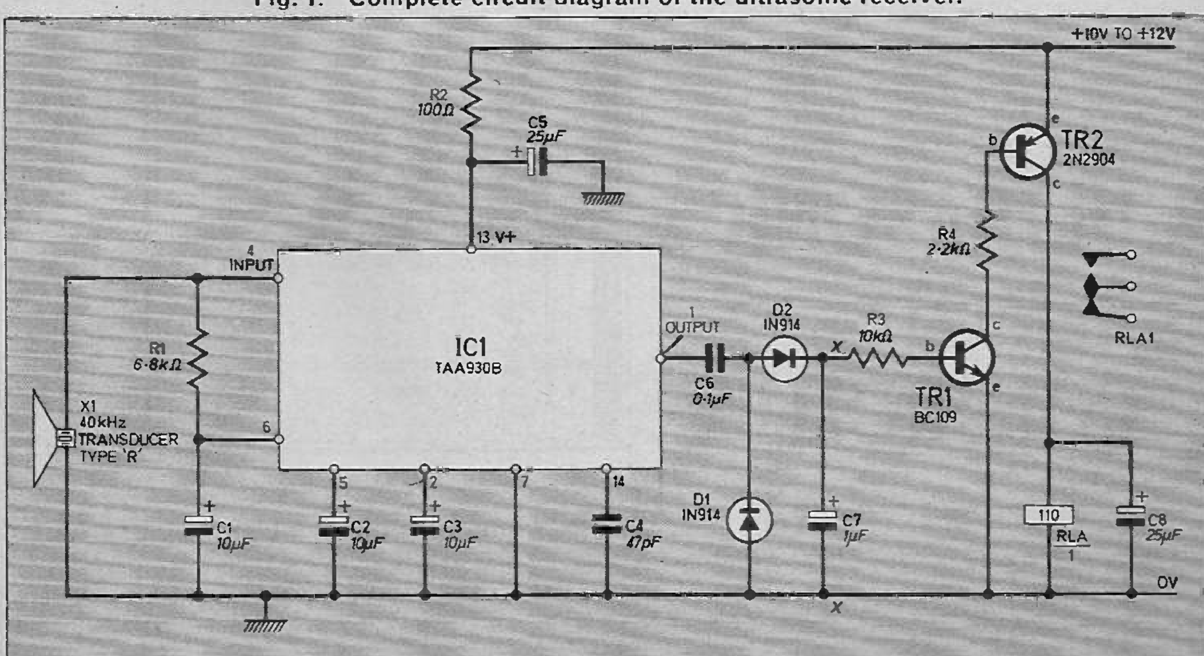
In order that the metal case of the transducer can be earthed, the connection to pin 6 is made via C1.

The input impedance of the TAA 930B is typically 15 kilohm, but the resistor R1 must be included in the circuit to bias the input stage correctly. The input capacitance of the device, 8 picofarads, is negligible when compared with that of the transducer.

The differential amplifier stages of the TAA 930B incorporates a limiter circuit so that the output at pin 10 of the device is twice the emitter-base voltage of a forward biased silicon transistor.

In pratice this means that a square wave output of just over 1 volt at 40 kilohertz is

Fig. 1. Complete circuit diagram of the ultrasonic receiver.



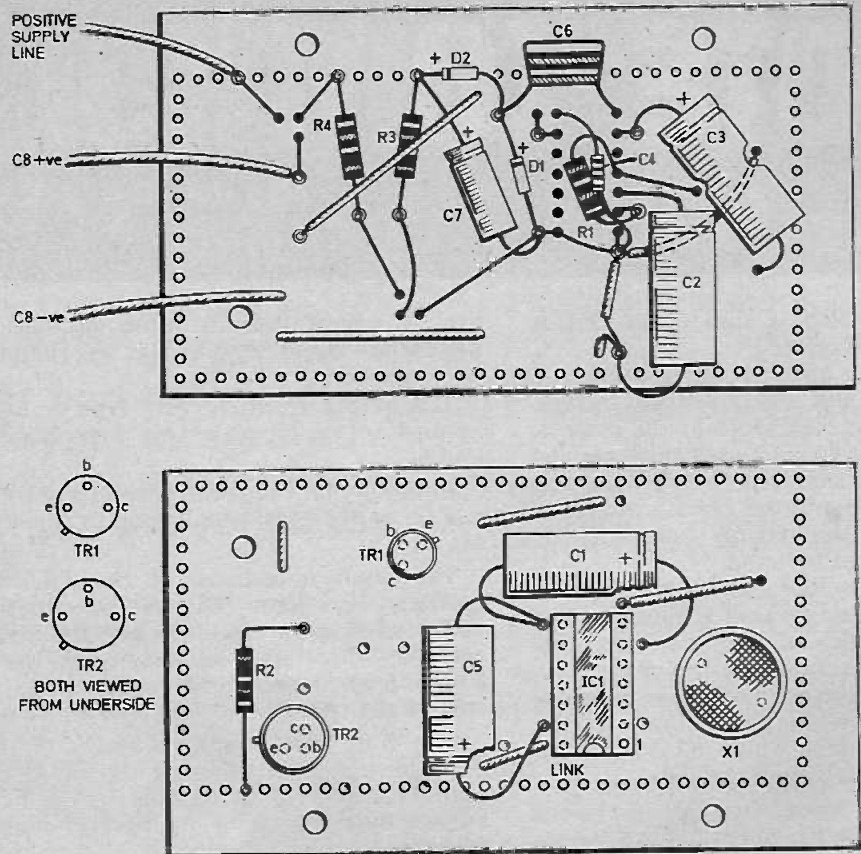


Fig. 2. Layout and wiring of both sides of the component panel.

ULTRASONIC REMOTE CONTROLLER

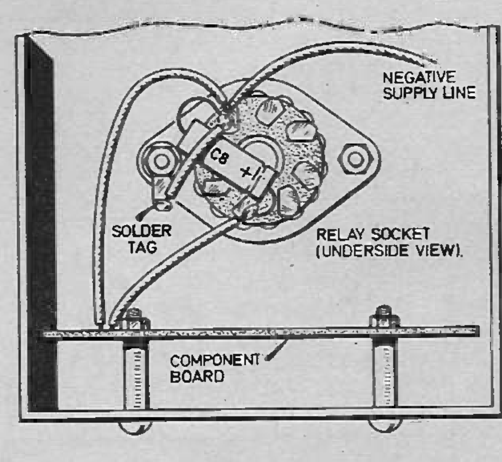


Fig. 3. Wiring of RLA1 and C8 to the circuit panel. RLA1 socket has been mounted in the case side so that space is left inside the case for a battrey or power supply.

obtainable at pin 10 no matter what the input level from the transducer provided that the latter exceeds the minimum threshold of 50 microvolts at pin 4.

Initially it had been intended to use the output from pin 10. However, this signal is internally coupled to further circuits inside the integrated circuit which were designed for use as an f.m. detector. It was found that a 40 kilohertz signal of about 8 volts could be obtained from pin 1 of the device and this proved very satisfactory for the operation of the succeeding circuits shown in Fig. 1.

A 47 picofarad capacitor, C4, is connected from the output of pin 14 to ground, since this was found to improve r.f. stability.

The voltage at pin 14 is fed through an internal emitter-follower to pin 1 where a low impedance output (100 to 150 ohm) is available. The capacitor C6 blocks the steady voltage at the output.

DIODE PUMP

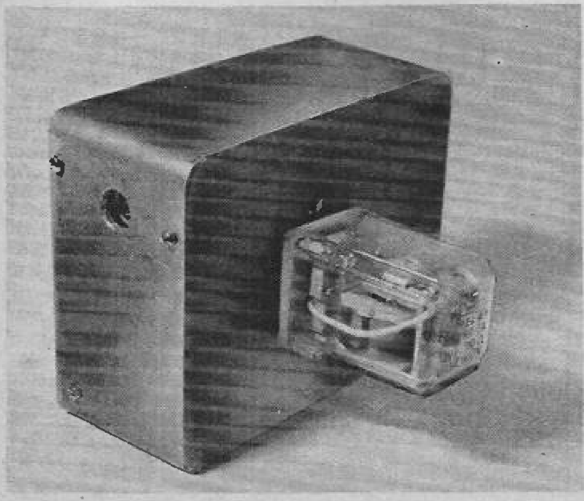
The two diodes D1 and D2 form a diode pump circuit. Each cycle of the 40 kilohertz voltage at pin 1 causes a certain amount of charge to be "pumped" into C7.

A high impedance voltmeter connected across C7 will give a reading up to about 8V as the transmitter transducer is pointed at the receiver transducer. The voltmeter may consist of a 50μA meter in series with a 200 kilohm resistor.

RELAY DRIVE CIRCUIT

When the voltage across C7 exceeds about 0·5 volt, a current is driven into the base of the high gain transistor TR1 and causes it to conduct. A current of about 5 milliamps can then flow from the base of TR2 into the collector of TR1.

Photograph of the completed unit.



Components....

SEE SHOP TALK

Resistors
R1 6·8kΩ
R2 100Ω
R3 10kΩ
R4 2·2kΩ
All ±10% ¼W carbon

Capacitors
C1 10μF elect. 15V
C2 10μF elect. 15V
C3 10μF elect. 15V
C4 47pF polystyrene 15V
C5 25μF elect. 15V
C6 0·1μF polyester 63V
C7 1μF elect. 15V
C8 25μF elect. 25V

Semiconductors
TR1 BC109 silicon *npn*
TR2 2N2904, 2N2905 or 2N1132 silicon *pnp*
D1, D2 IN914 (2 off)
IC1 TAA930B integrated circuit and holder
X1 96D-40(R) ultrasonic transducer [96D-40(T) required for the transmitter] (Hall Electronics)

Miscellaneous
RLA1 12V relay (coil resistance 100Ω or greater) with at least 1 set of changeover contacts rated as required (R.S. plug-in type 1A used in prototype); socket to suit relay if required; 0·1 inch matrix component board 90 x 50mm; connecting wire; on-off switch if required; battery and connectors (see text); case approx. 120 x 100 x 55mm; 6BA fixings.

The *pnp* transistor TR2 therefore becomes saturated and almost the whole of the supply voltage appears across the output relay.

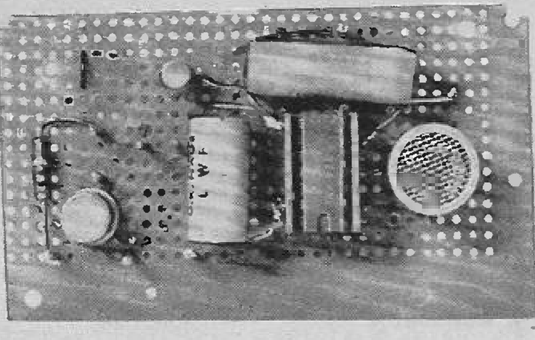
The capacitor C8 absorbs the transient voltage generated when the current ceases to flow through the relay. It also increases the time constant of the circuit and helps to prevent the relay from "chattering" rapidly when the input signal is barely adequate to switch on the relay.

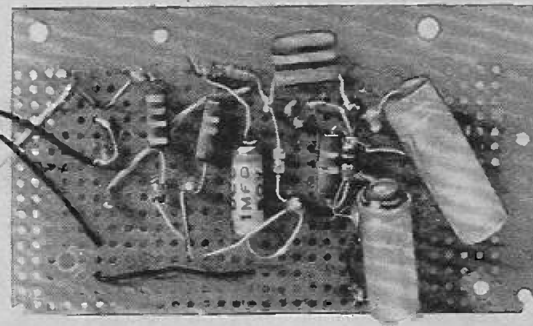
POWER SUPPLY

The absolute maximum permissible power supply voltage to the TAA 930B is 15 volts, but 12 volts should be regarded as the upper limit for the circuit of Fig. 1. The current required by the device is about 15 milliamps from a 12 volts supply or about 11 milliamps from a 9 volt supply.

When the relay is switched on, an additional current of about 100 milliamps will be required.

In some applications a smaller relay may be used. This will reduce the current taken by the receiver when the relay is energised and this can be important if the power supply is a battery.





Two photographs showing the construction of the prototype circuit board.

RECEIVER CONSTRUCTION

The prototype receiver was housed in an Eddystone die-cast box size 120 x 95 x 55mm. The circuit is built on a piece of 0·1in matrix board size 85 x 50mm. Both sides of the board are used for mounting the components and the layout of each side is shown in Fig. 2. Cut the board to size and drill the fixing holes.

Begin construction by inserting the Veropins and integrated circuit holder and then one by one, position and solder the other components on the board, leaving the transistors and diodes till last. A heatshunt should be used on the latter when soldering. The pin of the transducer connected to its metal case should be earthed.

The die-cast box should now be prepared to accept the relay socket and the latter fitted in place.

Now offer up the board to one of the shorter sides of the case and a 12mm diameter hole drilled in line with the transducer and the fixing holes drilled to secure the board in this position.

Mount the component board using 6BA fixings and spacers to ensure that the transducer does not touch the die-cast box, otherwise vibrations from the relay may be picked up, and then wire the board to the relay socket (Fig. 3).

In some applications the receiver will be switched on for long periods. It is then most convenient to employ a mains power supply in the box rather than a battery; a suitable supply can be obtained from the *Battery Eliminator, E.E. Nov. '74.*

Next month: the transmitter, testing and applications.

Ruminations
By Sensor

Down on the Farm

Electronics is slowly finding a place in agriculture. The electronically operated fencer is now used extensively throughout the industry and has earned the respect of the farmer and his stock. Cattle are not slow to discover when a fencer is not working and invariably do so before the farmer does. They then seem to take a particular pleasure in dragging the wire around the field and pulling all the insulator posts out of the ground, this, of course, in addition to breaking out of the grazing area where the electric fence was intended to keep them.

The result of their uncontrollable wanderings is, at best, a great nuisance; hence the farmer's insistence on reliability.

Perhaps surprisingly, electronic equipment can be more robust than the equipment is replaces—the simple transistor operated grain moisture meter comes to mind in this category. It's predecessor was more a laboratory instrument than a general farm tool, consequently, it was not used as often or as widely as was desirable. Kept in a box at the back of the wardrobe in the farmer's bedroom, it could well be overlooked during the hustle and bustle of harvest time.

X Marks the Spud

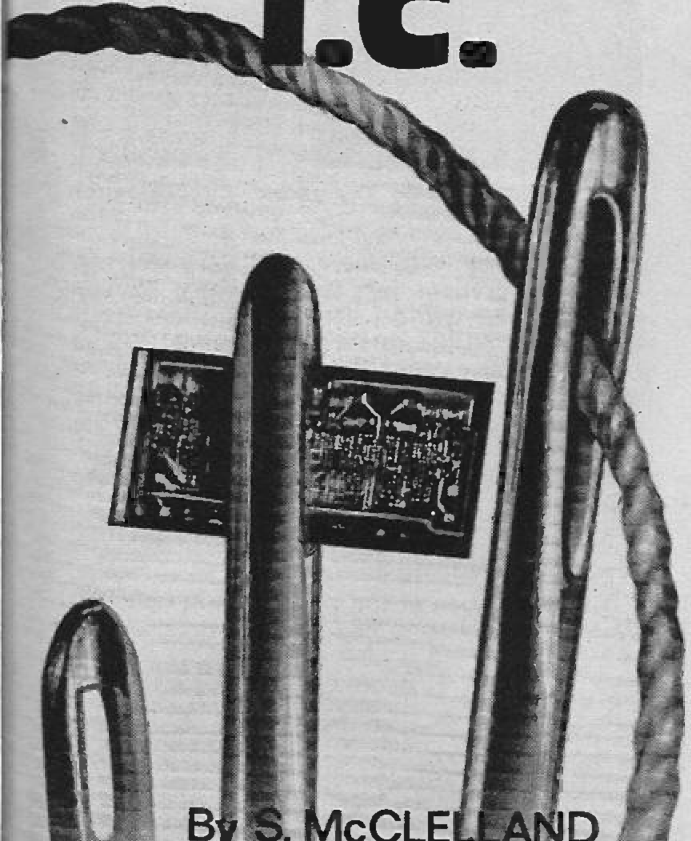
The electronic potato harvester is currently the most exciting development in farm machines. It enables one man—the tractor driver—to carry out the harvesting. On the earlier potato harvesters, a squad of workers rode on the machine and sorted stones and clods of earth from the potatoes as they were raised from the ground; the new machine is fitted with an electronic sorting unit in which X-ray beams distinguish potatoes from stones and earth clods and actuate sorting fingers to separate the crop from the rubbish.

Every effort has been made to simplify the electronic equipment, and simple replacement parts are available that can be fitted easily by the tractor driver.

The savings in time and labour are considerable and the electronic unit is claimed to be reliable in operation. Other vegetables and bulbs can be harvested with the aid of special fitments.

The manufacturers point out that the electronic sorting devices works at faster-than-human speeds, is more accurate and does not need a tea-break. However the tractor driver still needs his tea-break—but electronics may have the answer to this, too, a tractor guided by a magnetic tape can be made to follow a predetermined course around the field and will continue to run until it breaks down or runs out of fuel!

the WORLD of the I.C.



By S. McCLELLAND

THE integrated circuit, or i.c., as it is generally known, is possibly the ultimate concept in electronics. It certainly stretches one's imagination even to think of an entire electronic circuit on a tiny silicon chip—a chip perhaps no larger than the central dot of the marker used at the end of this article!

However, the increasing importance of i.c.s in electronics is not only because of their minute size but also because they offer us increased reliabilty over conventional circuits.

Often they alone can perform as specified over long periods of time in extreme and variable conditions, and provide the vital link from man or machine to civilisation. In this context, the Apollo moon-programme immediately springs to mind.

These microcircuits also have much more down-to-earth applications—domestic uses in circuitry for colour TV sets and ultra-miniature radios, and commercial uses as in ever more complex computers and pocket calculators.

Simple to use and even simpler to replace, integrated circuits are producing an electronics revolution comparable with the impact of the transistor itself.

FROM THE TRANSISTOR

To begin with, let's look at a conventional low power silicon transistor. If it's of the usual cylindrical can type, it will occupy a small volume, typically rather less than a cubic centimetre.

However, the active part of the device, the silicon chip, is very much smaller than this (perhaps one thousandth of the volume of the can). Even then, the actual transistor is considerably smaller than the chip. In other words, the vast bulk of the physical transistor is either unused or used only for the protection and support of its tiny semiconductor. Not much more volume would be needed if more transistors were included in the package. In fact, if we could find some way of electrically isolating the transistors, we could even produce many of them on the same chip.

This can be achieved but one would think that the only components permitted in such an assembly would be those normally produced from semiconductors, i.e. transistors and diodes.

However due to the unusual properties of semiconductors, particularly those of the *pn* junction, other components such as resistors and capacitors can be formed. In fact, almost all the components to be found in a normal electronic circuit can be manufactured simultaneously on the same silicon chip, even, in theory at least, an entire circuit.

We have arrived at the i.c.

TO THE I.C.

The technology of the i.c. although complete in itself, has much in common with that of the transistor. Both usually begin life, for example, as a very pure crystal of silicon which is doped to give *p* or *n* type silicon.

The actual manufacturing processes of both devices are similar too. They rely on the phenomenon of diffusion—the name given to the entrance and subsequent spread of one substance into another. In this case, special impurity atoms are allowed to diffuse into the silicon wherever *p* and *n* type regions are wanted. Devices of both types which are conventional (i.e. are not field-effect) are made by the same process. It is the silicon planar epitaxial process.

MAKING AN I.C.

In the silicon planar process, i.c. chips, like transistors, are mass produced in thin slices, which is why they are such inexpensive pieces of a highly complex technology.

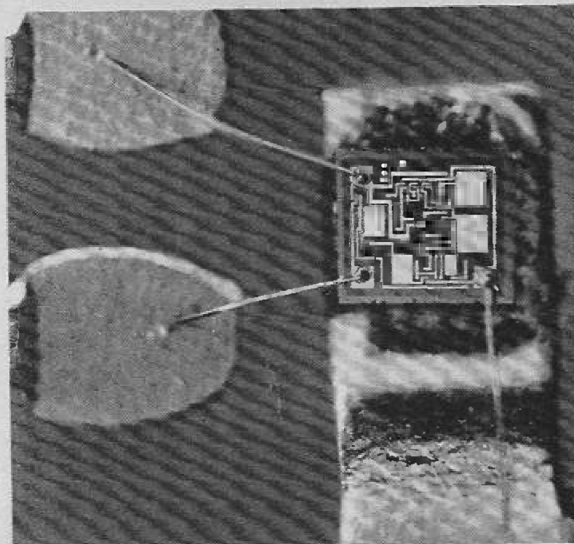
They begin life as a circular slice of *p* type silicon upon which a very thin layer of *n* type silicon is specially grown. This layer is called the epitaxial layer and it will be the one to receive the impurity diffusions. We now have a composite slice about 25cm² in area and only about 0·3mm thick but it will yield many hundred i.c. chips. Let us follow the manufacture of a single *npn* transistor of one of these chips in the slice.

FORMING TRANSISTORS

The slice has a layer of silicon oxide formed on it initially by heat treatment. In the area selected for the base of the transistor the oxide layer is etched away, exposing the slice beneath (Fig. 1).

This etching is defined and controlled by a method rather like "photographic stencilling" using a photographic mask and light sensitive chemicals. The process is similar to making a printed circuit board or contact print in photography. The slice is now placed in an atmosphere of *p* type impurity which diffuses into the epitaxial layer via its etched areas. The unetched oxide acts as a barrier to diffusion elsewhere.

After the formation of this *p* type (base) region, the slice is re-coated with oxide and the etching process is repeated with a smaller area of oxide. This time *n* type impurity is allowed to diffuse into central part of the base region to form the emitter region.



The Ferranti ZN414 integrated circuit—much magnified.

The slice is once more oxidised and then etched to prepare for the deposition of aluminium which will act as the component interconnections on the surface of the slice. A final etching removes the unwanted metal. Thus it can be seen that in cross section the familiar *npn* transistor structure is built up. All the regions reach the surface of the slice, the epitaxial layer itself acting as the collector of the transistor.

N+ REGIONS

The description of the silicon planar epitaxial process as applied to i.c.s above is considerably

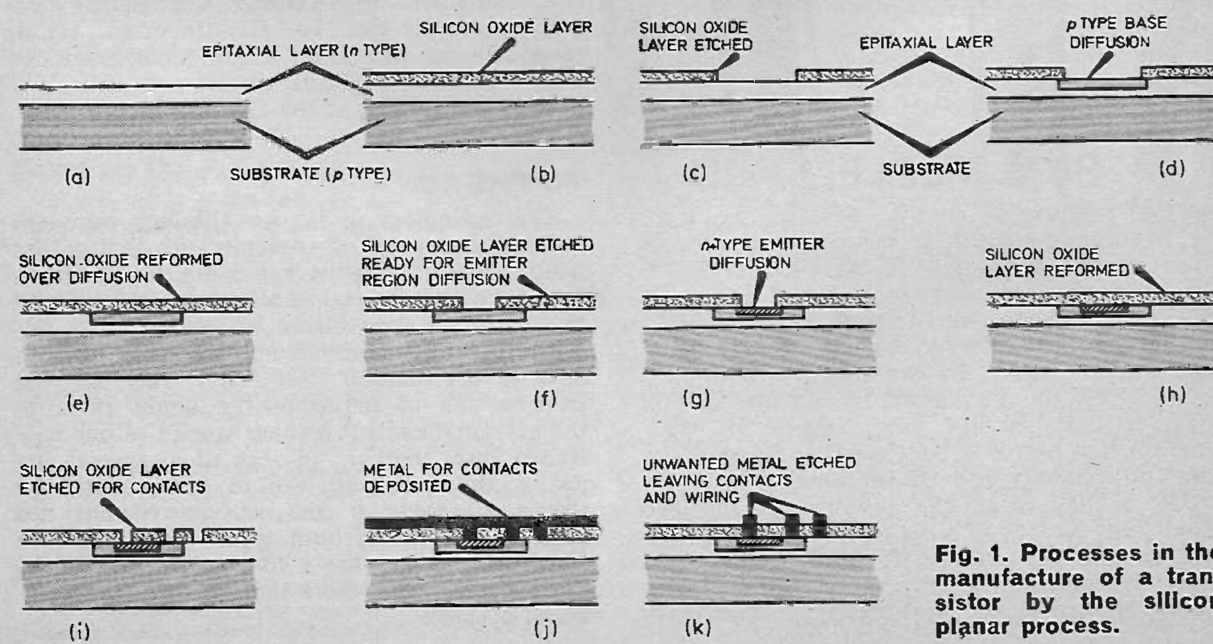


Fig. 1. Processes in the manufacture of a transistor by the silicon planar process.

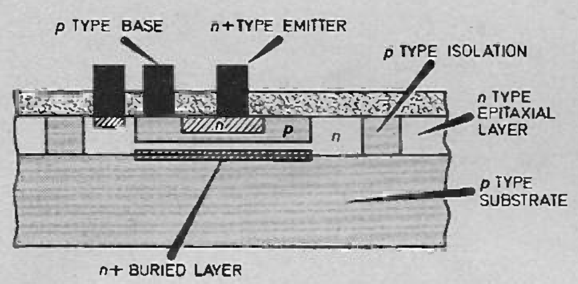


Fig. 2. Schematic drawing of an actual i.c. transistor.

simplified. In practice the first diffusion is not the base diffusion but a diffusion of n type material into the p type substrate before the epitaxial layer has been grown, forming an $n+$ region (Fig. 2).

This diffusion takes place under the collector region of the transistor and will of course be covered over by the epitaxial layer. It is therefore called the "buried layer" and its function is to combat the collector resistance problems which arise from having the collector in such a configuration.

Two other $n+$ regions will be seen. One is the actual emitter diffusion, the other a diffusion which takes place simultaneously at the position of the collector contact to reduce contact resistance.

OTHER COMPONENTS

If a diode is required in the circuit, a transistor is made as above, and then one of its pn junctions is simply short-circuited to leave a diode junction.

Capacitors, provided they are of small value, can be formed from diodes by employing the capacitative properties of the pn junction. Resistors, too, are easily formed. They are merely p type diffusions in the epitaxial layer of varying length and thickness.

ISOLATION

All the components above—transistors, diodes, capacitors and resistors will be formed in the same epitaxial layer of the same i.c. chip. They will therefore be electrically interconnected through this layer as well as by the wiring on top of the slice. Clearly, these short-circuits are unacceptable in i.c. chips but the amazing versatility of the pn junction comes to our rescue once again.

A p type "ring" is formed by diffusion around the position of each component by diffusion. The diffusion takes place early in the manufacturing process—between the buried $n+$ diffusion and the base diffusion—and penetrates the epitaxial layer so deeply that it reaches the p type layer underneath it. Thus a "shell" of p type material surrounds each component.

Holding a 120 component decade counter chip.

When this is connected to a negative potential, a reverse biased pn junction is formed between it and the epitaxial layer and the short circuits are eliminated.

ENCAPSULATION

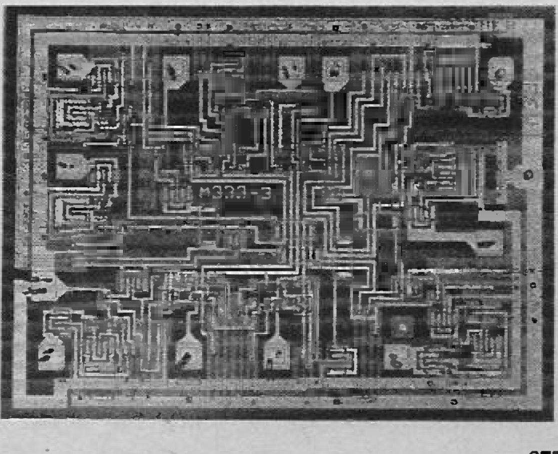
Each i.c. on the slice is tested before the slice is broken up into individual, identical chips each of which is bonded to a supporting "header" in preparation for packaging. The package will protect the tiny delicate i.c. chip and enable it to be easily connected to circuits in the outside world.

There are several types of i.c. packages available, the more usual ones being the TO-configurations (like conventional transistor housings) and the dual-in-line (d.i.l.) configurations which are rectangular blocks of plastic. The metal "flatpack" system is also available.

MOS DEVICES

Until now only bipolar i.c.s have been discussed, but there also exists a i.c. technology

An enlarged view of an i.c. chip.



parallel to, and employing, field effect transistors (f.e.t.s). These are the metal-oxide-silicon (MOS) devices. There are three contacts. source, gate and drain in f.e.t.s, roughly corresponding to the emitter, base and collector respectively in bipolar devices.

Here, however, the resemblance ends. Because of the different principles on which MOS devices operate, they can be made considerably smaller than bipolar devices of similar function. This arises partly because no isolating channels between components are needed. The fact that the device doesn't need an epitaxial layer either makes some stages of the manufacturing processes easier but the device has certain special problems associated with it, particularly concerned with the gate.

The design of the MOS makes is particularly suitable for digital applications, and it is very useful where size is at a premium. For example, the Sinclair Executive pocket calculator uses an MOS chip containing 7,000 transistors. (This calculator now costs less than £30).

CDI TECHNOLOGY

Although MOS devices are more suitable for some applications than bipolar devices, they are less suitable for other applications. Thus, until recently, no general technology has existed. However, several paths have been explored and the collector diffusion isolation (CDI) process, largely developed by Ferranti Ltd., appears to be an extremely promising one.

Already, using this technology which combines the advantages of the two previously mentioned technologies, Ferranti have introduced a t.r.f. i.c. tuner, the ZN414. This chip needs only a few external components to turn it into a radio receiver—yet the actual chip is only about $0{\cdot}5mm^2$ in area!

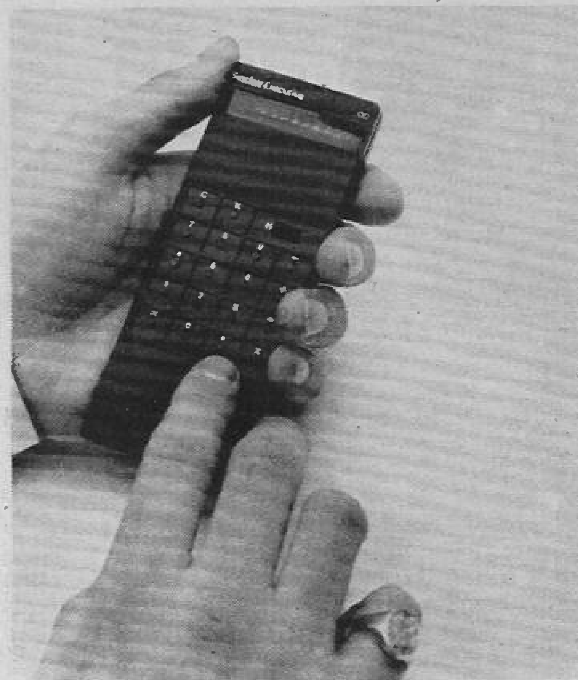
SPECIFICATION

In each stage of the manufacture of an i.c., precision work is required for the device to perform as specified. For example, the epitaxial layer in bipolar i.c.s must be carefully grown although it is only of the order of a hundredth of a millimetre thick, while exacting manufacturing techniques, indeed, are needed to form a silicon oxide layer about one ten thousandth of a millimetre thick for MOS device gates!

Even before the manufacture proper of an i.c., the amount of impurities in the silicon crystal to be processed must be known with little error. In an i.c., as in every other semiconductor device the semiconductor properties of the silicon depends on the extent to which it is "doped" with p and n impurities.

TEMPERATURE

The semiconductor properties also depend upon the temperature at which the device is operated and this is another critical factor which must enter its design.



The Sinclair Executive pocket calculator.

For military purposes an i.c. has often to be designed to withstand an incredible temperature range—one of 180 degrees C is typical. This is equivalent to requiring the i.c. to operate below arctic temperatures and then, not long afterwards, at temperatures well above the boiling point of water! Commercial applications don't usually call on i.c.'s to be so rugged. They employ less tolerant devices with temperature characteristics more like conventional transistors.

LINEAR AND DIGITAL

All electronic devices—whether integrated or discrete—fall into two classes, those which are linear and those which are digital in operation. Linear devices have no particular electrical states of operation but instead function over a continuous range. Amplifiers, for example, are in this class—they must provide a faithful reproduction of a continuously changing input signal.

Digital devices, on the other hand, are designed to handle only particular levels of signal—usually only two levels in fact. Thus, at any time digital devices will be in only one of two states. Bistables are a good example of this type of device. Both linear and digital devices are found in i.c. form, but because the latter is the more important type, only it and the principles underlying it will be discussed.

An engineer works on a visual display unit which employs MOS memory chips.

BINARY OPERATION

The two states in digital electronics are usually taken to be an "on" or "high" state and an "off" or "low" state. In practice the high level will be of the order of a few volts (positive, with *npn* devices) and the low level about 0 volts.

So that we can perform calculations with digital systems we assign numerical values to the two states—the high state is "1", the low state "0". Using only these two numbers we can build up a counting system—called the **binary system** to distinguish it from our normal or denary counting methods using ten as a base.

LOGIC

If we can predict the output of a digital circuit i.e. whether the output will be "0" or "1" for a given input or combination of inputs at "0" or "1", we say the circuit is operating **logically** i.e. we are using the principles of logic to get our results. Conversely, if we want to produce a certain output from a certain input or combination of inputs we can again use logic principles to tell us what basic circuit (called a **logic element or function**) or arrangement of basic circuits we need to achieve this.

If you have been wondering what i.c.s have to do with this, this is where they come in. There are only a few logic elements but large numbers of them are often needed to make a digital system. They can be regarded as the building blocks of digital devices, so each element must be as cheap as possible to manufacture and use.

Integrated circuits offer us, by the mass production methods of their manufacture real economy, and also reliability and a great complexity in a very small space. Thus they are ideally suited to the requirements of large digital systems.

DTL AND TTL

In most industrial fields, there is more than one solution to a given problem. It is no less true in microelectronics where there are several different ranges of i.c.s with the same logic function. The differences have arisen from the manufacturers' attempts to improve speed or power dissipation, say of a logic element, and it is really a matter of the customer deciding for himself what particular electrical characteristics are important in his digital systems and then deciding accordingly.

Thus we have in bipolar digital i.c.s, logic elements the active components of which are diodes and transistors using diode-transistor-logic (DTL) and also logic elements the active components of which are only transistors using transistor-transistor logic (TTL). Some other abbreviations for alternative systems the reader may find are RTL (resistor-transistor logic) and ECL (emitter-coupled logic). TTL is now used extensively and the others are seldom found.

USING I.C.S

Although i.c.s are internally far more complicated than transistors the constructor should find them considerably easier to work with than discrete components.

The same basic rules still apply to i.c.s as to discretes, and they include:

(1) Using soldering irons specifically adapted to such miniature work and soldering as quickly as possible. In fact, soldering problems can be largely eliminated if you use an i.c. holder.

(2) Checking that i.c. leads are correctly connected up and that no shorts are present at i.c. package connections.

(3) Checking power supplies especially in digital systems.

THE FUTURE—L.S.I. AND T.S.I.

In the future more and more electronic circuits will become integrated. In the predictable future there seems to be an era of total system **integration** (t.s.i.) where entire, almost ready to use, circuit systems are manufactured on a single chip.

We have seen the beginnings of this already with large scale integration (l.s.i.) techniques where much of the system is already integrated and needs relatively few discrete interface components to make it work. So, for as long as consumer demand continues, we can look forward to further exciting and spectacular developments in the world of the integrated circuit. ◼

ACKNOWLEDGEMENTS

The author wishes to thank the following firms for their help: Ferranti Ltd., Mullard Ltd., Sinclair Radionics Ltd., Texas Instruments Ltd.

BEGIN HERE

PART ONE
BASIC COMPONENTS

By DONALD MAYNARD

FOR a newcomer to electronics, the prospect of building anything from a circuit diagram can be daunting. In this short series of articles it is intended to help newcomers by giving them practical information about components and also about methods of construction.

In this first part we take a look at resistors, capacitors, inductors, transformers and potentiometers. The second part is concerned with semiconductors and we will go on to see how to test the various components and how to assemble them together to make up a circuit.

RESISTORS

A resistor is a component which dissipates power, usually in the form of heat. Its use is summed up in the relationship called Ohm's law:

$$V=I\times R$$

where V is the voltage across the resistor in volts, I is the current through the resistor in amps and R is the value of the resistor in ohms. The symbols for a resistor are shown in Fig. 1.1. Either we can use the resistor to change the voltage at a point in the circuit, or we can use it to alter the current at a given point.

The resistor's value can be determined from the coloured bands around it. There are three bands which give us this information (Fig. 1.2). The bands are coloured and each band corresponds to a number as shown in Table 1.1.

If the bands are brown, red and orange for example, then the value is $12\times1{,}000$ or 12,000 ohms; 1,000 ohms is usually called a **kilohm** or kΩ while 1,000,000 is called a **megohm** or MΩ. The last band indicates the tolerance, or variation, in the actual resistor value. Gold indicates a plus or minus 5 per cent ($\pm5\%$) tolerance while silver shows that it is plus or minus 10 per cent ($\pm10\%$). If no band is present the tolerance is ±20 per cent. Some older types of

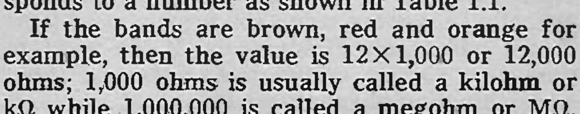


Fig. 1.1 Symbols for a resistor. Typical values have been shown beside the symbol as on a circuit diagram.

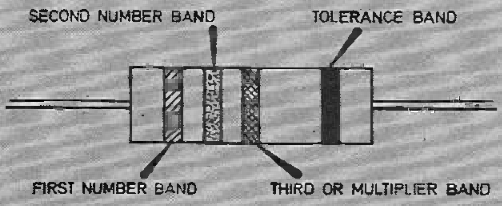


Fig. 1.2 The resistor and significance of the coloured bands

TABLE 1.1 Resistance Colour Code

Colour	Number	Multiplier
Black	0	×1
Brown	1	×10
Red	2	×100
Orange	3	×1,000 (kΩ)
Yellow	4	×10,000
Green	5	×100,000
Blue	6	×1,000,000(MΩ)
Violet	7	×10,000,000
Grey	8	×100,000,000
White	9	×1,000,000,000

Tolerance—no band ±20%, silver band ± 10%, gold band ± 5%, red band ±2%, brown band ±1%. Gold and silver are sometimes used as multipliers, they represent ×0·1 and ×0·01 respectively.

resistor have the colours in the form of a general body colour (1st. number), one end another colour (2nd. number) and a spot or band in the middle (multiplier).

In general, the larger the resistor, the more power it can handle. The rating in watts can vary from ⅛W up to several watts. This power is simply the voltage (V) multiplied by the current (I) through it. Using Ohm's law we can say that the power (P) dissipated by a resistor is $P = V \times I = I^2R = \frac{V^2}{R}$ where R is the resistor's value.

There is no electrical disadvantage in using a resistor that is physically larger than required, only the disadvantage of increased mechanical size and possibly cost.

CAPACITORS

The old name for a capacitor was condenser, but the new name is more in keeping with its function. It has the capacity for storing energy. The simplest way of thinking about a capacitor is that it will pass an alternating current (a.c.) through it but not a direct current (d.c.).

The other important point is that if a d.c. voltage, say from a battery, is applied across a capacitor, ideally that voltage will remain there until either a component such as a resistor connected across it, or you happen to touch both ends simultaneously, when the capacitor will

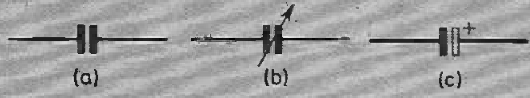
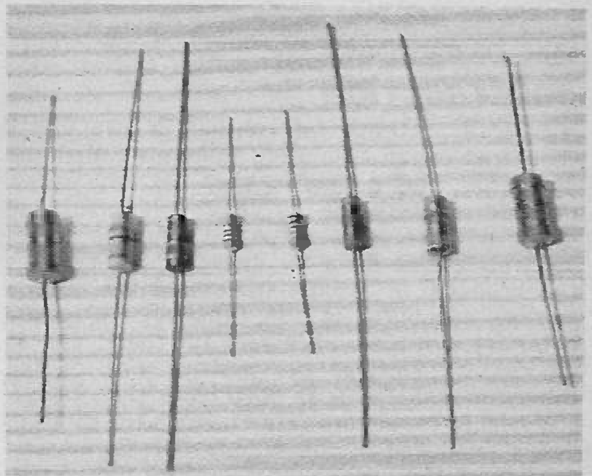
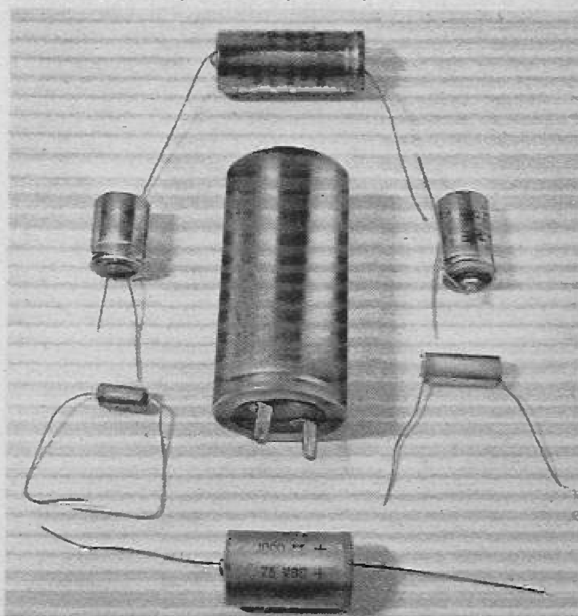


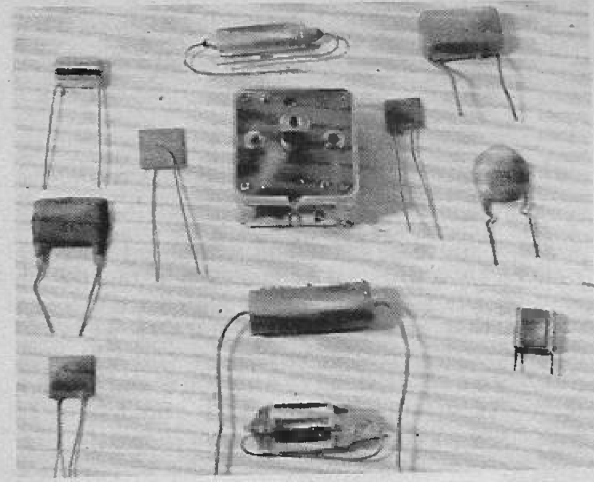
Fig. 1.3 Symbols for capacitors (a) fixed (b) variable (c) electrolytic

lose its voltage by passing a current through you! In case this makes you decide to give up without going any further, I had better hasten to add that at most of the voltages we meet these days—9, 12, 18, or similar—no sensation will be felt at all. Beware, though, if the voltage should be a hundred or more it could be very dangerous. Various symbols are shown in Fig. 1.3.



A selection of resistors (above) and some electrolytic capacitors (below).





A selection of capacitors—a variable type is shown in the centre.

CONSTRUCTION

Basically, a capacitor consists of two plates separated by an insulating material called the dielectric. The dielectric may be air, paper, ceramic, polystyrene or any other suitable material. For larger values of capacitance an electrolyte is used for the dielectric and this has the property of greatly increasing the energy storage capability of the capacitor. A steady potential is usually necessary for these, and so on circuit diagrams the positive side of the capacitor is shown as an open block (Fig. 1.3.c).

Variable capacitors (Fig. 1.3.b) have rotating vanes separated by an air gap. The amount of overlap of the vanes, and therefore the capacitance, is then variable.

Capacitance is measured in Farads, although a one Farad capacitor would be very large indeed. Practically, capacitors are marked either in microfarads (μF) or in picofarads (pF). There are a million picofarads in one microfarad, and a million microfarads in one Farad. Occasionally one meets nanofarads (nF) and one nanofarad is a thousand picofarads.

Some small capacitors are colour coded in a similar fashion to resistors (Fig. 1.4). The values can be worked out in pF from Table 1.1. The bottom two bands indicate the tolerance and working voltage.

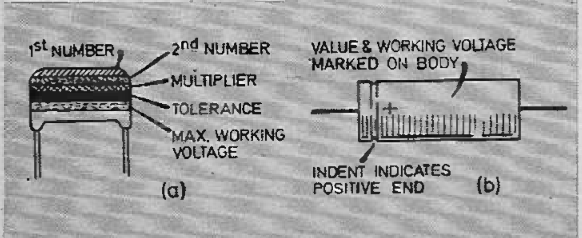


Fig. 1.4 (a) Colour coding of a "banded" capacitor (b) an electrolytic capacitor.

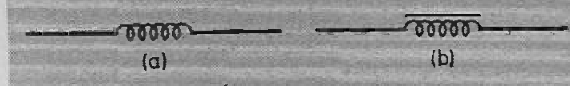


Fig. 1.5 Symbols for an inductor (a) air cooled (b) with a core of ferro-magnetic material.

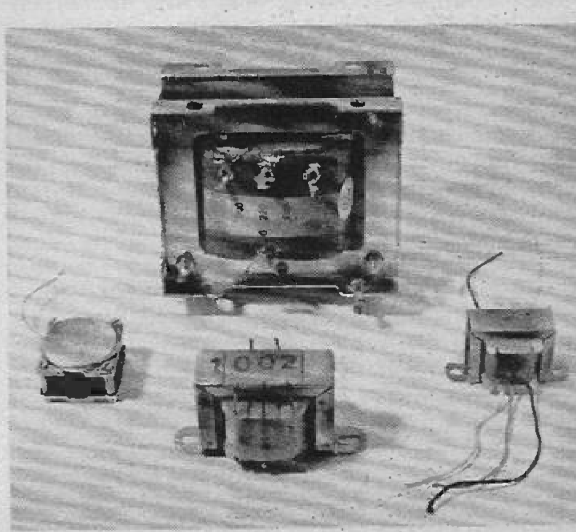
It is important that the working voltage of the capacitor is not exceeded and that, in the case of the electrolytic capacitor, the polarity is correct. (Note the indented positive end shown in Fig. 1.4.b).

INDUCTORS

Inductors may be considered to be the inverse of capacitors in that they tend to pass a direct current but not an alternating one. They are coils of wire usually wound around a former. To obtain higher values of inductance, some form of ferrous material may be used in the core and round the outside of the coil.

An important feature of the inductor is that if a voltage source is removed from across it, a "back e.m.f." is set up in the coil which will try and maintain the original current. Symbols for the inductor are shown in Fig. 1.5. The unit of inductance is the Henry, although we usually use millihenrys or microhenrys (mH and μH respectively). There are a thousand microhenrys to one millihenry and a thousand millihenrys in one Henry.

Inductors are perhaps the most difficult component to identify once they have left the manufacturers box. Often they are wound by the constructor himself on either home-made or commercial formers. When they are used to stop



A selection of transformers—a pot core type inductor is shown on the left.

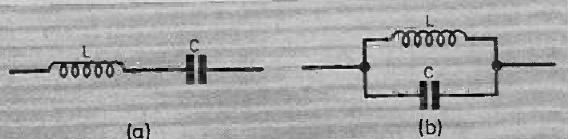


Fig. 1.6 Tuned circuits (a) series connected (b) parallel connected.

a.c. signals from appearing in other parts of the circuit they are usually called radio frequency chokes (r.f.c.). Inductors may also be used with capacitors to form tuned circuits.

TUNED CIRCUITS

A tuned circuit (Fig. 1.6), consisting of an inductor L and a capacitor C, will, ideally, either pass one frequency and stop all others, or else will stop one frequency and pass the others. A measure of the selectivity of a circuit is its Q (for quality) factor.

At the resonant frequency (f_0, measured in hertz or cycles per second) the series circuit (Fig. 1.6.a) has a low loss but the parallel circuit (Fig. 1.6.b) has a high loss. When we talk about loss in this context we mean the ratio of voltage across, to current in, the circuit. This is also termed its impedance (Z). The impedance of specific components sometimes has another name, e.g. resistance (R) for resistors and reactance (X) for inductors and capacitors.

TRANSFORMERS

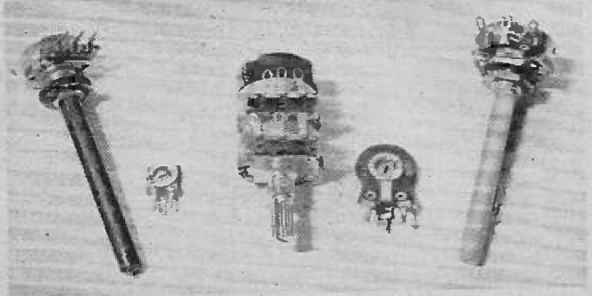
Transformers are used to modify alternating voltages or currents, and also to isolate one part of a circuit from another. Two transformers are shown in Fig. 1.7. We can denote everything on the primary, or input, side by the suffix "1", the secondary, or output side, having the suffix "2"; T_1 and T_2 are the number of turns on the primary and secondary respectively. Then:

$$\frac{V_2}{V_1} = \frac{T_2}{T_1} \qquad \frac{I_2}{I_1} = \frac{T_1}{T_2}$$

and

$$\frac{Z_2}{Z_1} = \frac{V_2 \times I_2}{V_1 \times I_1} = \left(\frac{T_2}{T_1}\right)^2$$

In a transformer for converting mains voltage (240 volts) to a low voltage, say 6 volts, the


A selection of preset and standard potentiometers.

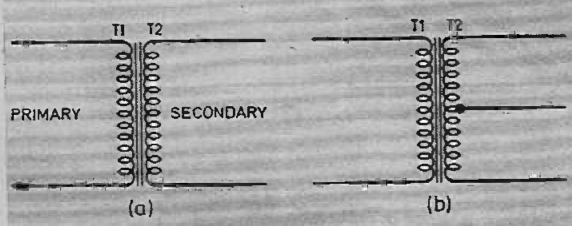


Fig. 1.7 Symbols for transformers—both are with laminated cores (a) with two winding (b) with a tapped secondary winding.

primary winding will have many turns of relatively fine wire while the secondary will have far fewer turns but of thicker wire to take a heavier current.

If the transformer is tapped (Fig. 1.7.b), a voltage will appear across each winding proportional to the number of turns in each section. The overall voltage across the secondary will still be in accordance with the relationship shown above. For any transformer its size will depend on the secondary current required. The larger the current the larger the transformer.

Some transformers (those used in the intermediate frequency [i.f.] sections of radios for example) are purchased with capacitors connected across the windings. This has the effect of tuning the transformer in much the same way as when we connected the inductor and capacitor together. This causes the transformer to be selective in the band of frequencies that can pass from input to output.

POTENTIOMETERS

The potentiometers that we meet are used as variable resistors or as potential dividers. Shown schematically in Fig. 1.8, they are made either of a high resistance wire wound round a former, or else they utilise a track made from a carbon compound. The slider (B or E) moves along the carbon track or coiled wire changing the relative resistance between A to B and B to C (or D to E and E to F). If B is connected to A, then we have a variable resistor from effectively zero up to the maximum value of resistance i.e. A to C.

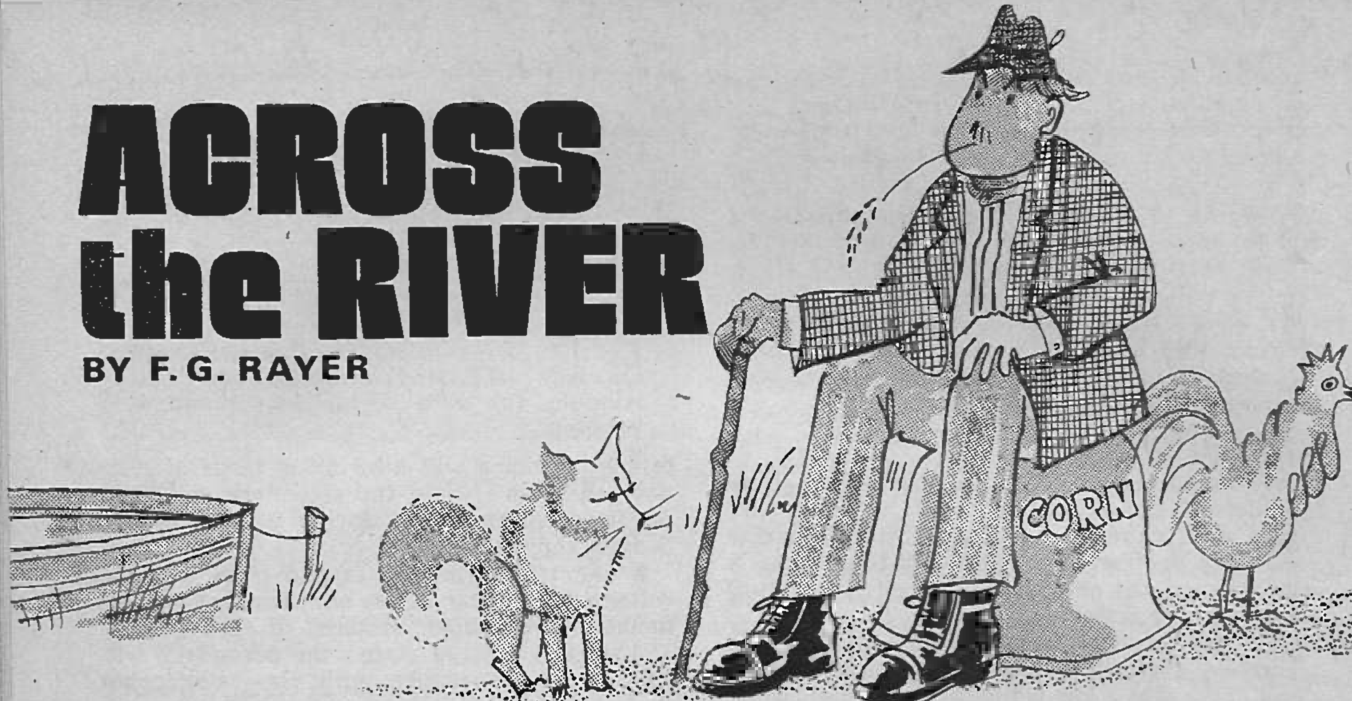
Values are again in ohms but in addition we may have a linear, logarithmic or antilogarithmic variation in resistance as the spindle is turned. If unspecified, a linear type would normally be used. Logarithmic types are used for volume controls as the human ear responds to change in volume in a logarithmic, rather than linear way.

Fig. 1.8 Symbols for a potentiometer.

Next month: semiconductor devices.

ACROSS the RIVER

BY F. G. RAYER



An interesting electronic puzzle for all the family.

THIS solo game is played electronically, and is derived from an old puzzle. Once the solution is seen, it is extremely easy, but until this moment it can be very puzzling. The whole unit is self contained, and can be handed to any one who wishes to try their skill.

A story leads up to the presentation of the puzzle, and the attempt at a solution is then made by moving switches, which are wired to produce a warning sound when an error is made.

STORY

Once upon a time a farmer was carrying a fox, a hen, and a sack of corn. When he reached the east bank of a shallow river he found that he could only carry any one item at a time in the small boat. His problem is to get the items to the west bank of the river safely.

If he carries the corn over first, thus leaving the hen with the fox on the east bank, the fox will attack the hen. If he carries the fox over first time, leaving the hen with the corn, the hen will eat the corn. On the other hand, if he carries the hen over to the west bank first, leaving the fox and corn together on the east bank, this is so far in order, and he can leave the hen safely on the west bank, and return to fetch the fox or corn. But now, if he carries the fox over; and leaves it with the hen on the west bank, the fox will attack the hen while he returns for the corn. Should he take the corn over at this stage, the hen on the west bank will eat it while he returns for the fox.

So what does the farmer do to transport his items, one at a time, with safety?

The problem may appear impossible, but a solution does in fact exist. It will be observed from the story that hen and corn, or fox and hen, may safely be on one bank together when the farmer is present, as he would of course prevent the danger to hen or corn, which may arise when he is not present.

CIRCUIT

The complete circuit diagram is shown in Fig. 1; TR1, TR2 and the associated components form an oscillator, and values were chosen in an attempt to produce a sound which might be looked upon as that made by a startled hen.

However, almost any two audio *pnp* transistors are likely to work satisfactorily in a multivibrator of this type, and none of the component values are critical. They may, in fact, be modified to change the sound produced, as may the battery voltage.

The switch network completes the circuit only when a mistaken move is made (e.g., fox left alone with hen) and this sounds the warning speaker.

In Fig. 1, all the switches are at the east bank

FOR GUIDANCE ONLY

ESTIMATED COST* OF COMPONENTS including V.A.T.

£2.20 excluding case

*Based on prices prevailing at time of going to press

position. The problem is thus to move them all to the other position without completing the circuit. A maximum of two switches are allowed to be moved at one time, one being the farmer.

As example, if the farmer should take the fox across, the battery negative circuit is completed via *A* of S2, *B* of S3, *C* of S4 and *D* of S1, sounding the warning. (That is, hen is eating corn which is an unsatisfactory attempt).

SWITCHES AND LOUDSPEAKER

In the prototype the four switches were mounted on the removable lid of a plastic case of dimensions 160×90×50mm. A metal case is also suitable provided precautions are taken to ensure there is no shorting of the battery or other components against the case walls.

Four standard-size slide switches were chosen as these are inexpensive, robust, and more easily operated than miniature types.

Begin construction by making the slots and fixing holes in the front panel (lid) to accommodate the slide switches and then drill a matrix of holes to suit the loudspeaker. Glue (or screw) the latter in position and then secure the four switches. Now wire up in accordance with Fig. 2.

OSCILLATOR BOARD

The oscillator components were wired on a short length of standard tagboard, as shown in Fig. 2, a screw afterwards fixing this to the base of the case. The transistors should be soldered in last of all and a heatshunt used on their leads to prevent thermal damage.

As mentioned previously, C1 and C2 need not be the same values, nor need the two transistors be the same type number. Reducing the values of R2 and R3 will raise the pitch, and increasing the values of C1 and C2 will lower it.

Solder two flying leads to the tag board and connect these to the loudspeaker and solder the lead between board and S1. Finally solder the two battery leads in position and secure the board to the base of the case, and connect the battery. The battery can be held in position by means of a Terry-clip or a home-made aluminium bracket.

Components....

Resistors
R1 5·6kΩ
R2 100kΩ
R3 1MΩ
All ¼W carbon ±10%

SEE SHOP TALK

Capacitors
C1 0·047μF
C2 0·047μF

Transistors
TR1 AC128 germanium *pnp* or similar
TR2 AC128 germanium *pnp* or similar

Miscellaneous
S1, 2, 3, 4 d.p.d.t. standard slide switch 4 off)
LS1 80 ohm loudspeaker (65mm dia.)
B1 9 volt PP4
Battery clips for PP4; plastic or metal case, 160 x 90 x 50mm; standard tagboard 3-way.

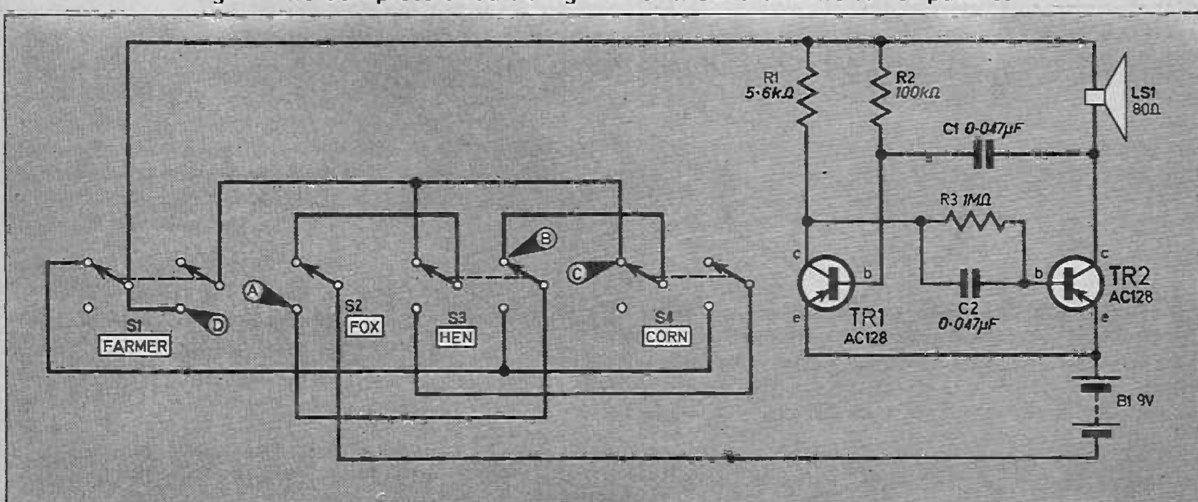
LABELS AND USE

Labels should be marked CORN, HEN, FOX and FARMER and placed near the appropriate switches.

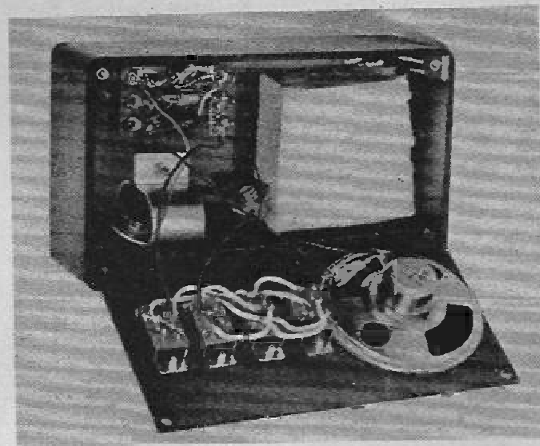
Some embellishment would be possible for children, such as a panel drawn and painted with a river, with pictures for the corn, hen, etc., as in our heading design.

Though the "old story" was preferred, it would

Fig. 1. The complete circuit diagram for the Across the River puzzle.



ACROSS the RIVER



Photograph of the completed prototype.

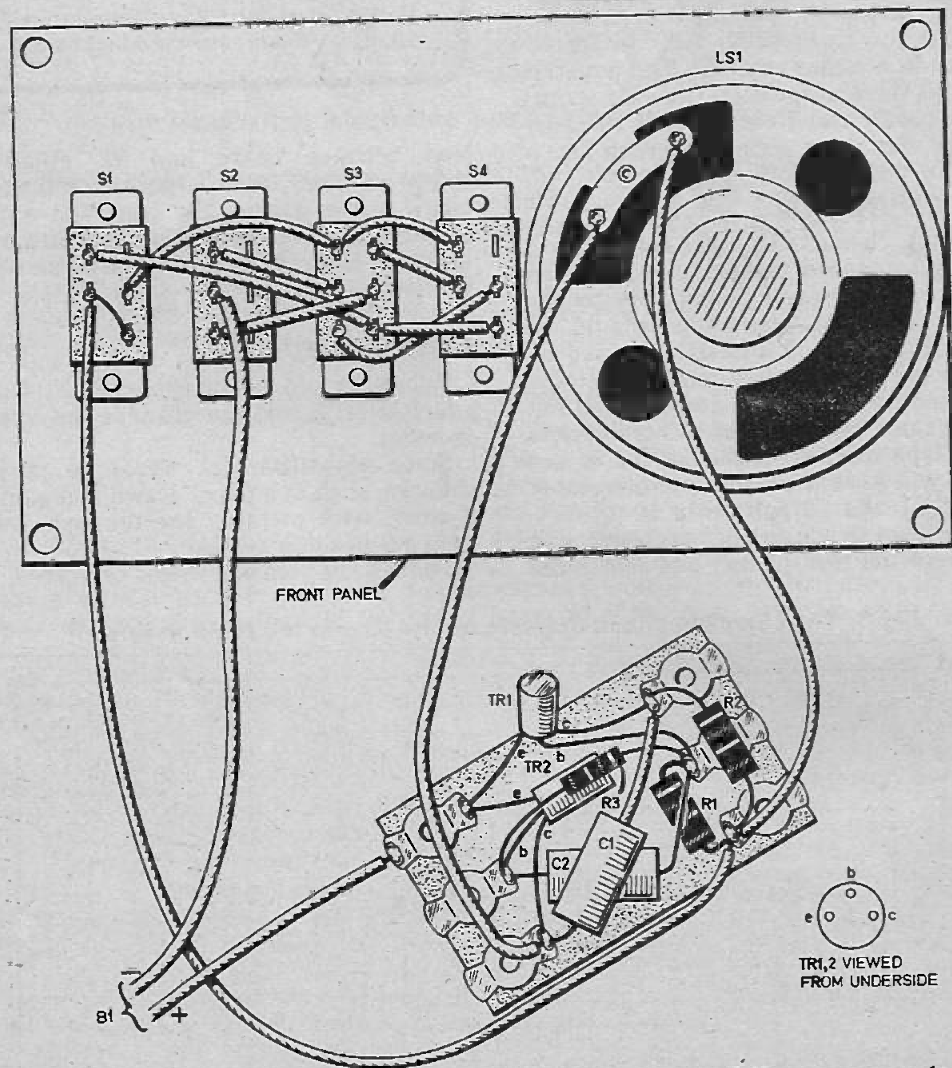


Fig. 2. The layout of the components on the tag board and complete wiring up details.

be possible to modify or up-date this. For example, the Corn, Hen, Fox and Farmer may become a Bomb, Violent Anarchist, Pacifist and Policeman respectively.

If the Violent Anarchist is left alone with the Bomb, he will explode it, while if Pacifist and Violent Anarchist are left alone, the Violent Anarchist will attack the Pacifist. Though it is, of course, in order to leave the Bomb with the Pacifist, unattended by the Policeman.

Check that wiring is correct by following the moves already given. No warning is produced with all switches at the East Bank or all at the West Bank, or with Fox and Corn unattended either side, or with any combination where the Farmer is present.

SOLUTION

As with many things, this is easy when the secret is known. All start at the East Bank.

(1) Farmer carries Hen over, leaving Fox and Corn at East Bank.

(2) Farmer returns to East Bank.

(3) Farmer carries Fox to West Bank.

(4) Farmer returns to East Bank taking Hen with him.

(5) Farmer carries Corn to West Bank.

(6) Farmer returns to East Bank.

(7) Farmer carries Hen to West Bank. ▣

...Counter Intelligence

BY PAUL YOUNG

A retailer discusses component supply matters.

AT THE end of September (when the birds migrate south in search of millionaire husbands) the British winter will soon be on us, between then and Christmas many thousands will join the ranks of the electronic hobbyist. This is hardly surprising when you weigh up the advantages.

All you need is the corner of a kitchen table, a few simple tools, some bits and pieces and an indulgent wife or mother. Then for a few hours a day you are a would be Faraday, Fleming, or Davey. Even if intially, your knowledge is nil, there are such excellent magazines as EVERYDAY ELECTRONICS to guide you along the right lines.

We retailers naturally have a vested interest in keeping it that way. We know that inevitably we must lose a few novices by the sheer frustration of being unable to obtain the right parts easily and quickly.

BEGINNERS

It is with the beginners and particularly the last few in mind, that I direct this article. With any hobby, a certain amount of patience is required and electronics is no exception, so let me assume that you're raring to go and just need a few vital components to get started. How do you set about it. A few of you may be fortunate enough to have some good shops locally but the majority will have to rely on mail order firms which brings me to my first point, which is this. No one firm will be able to supply 100 per cent of your wants and it is as well to accept that from the very beginning.

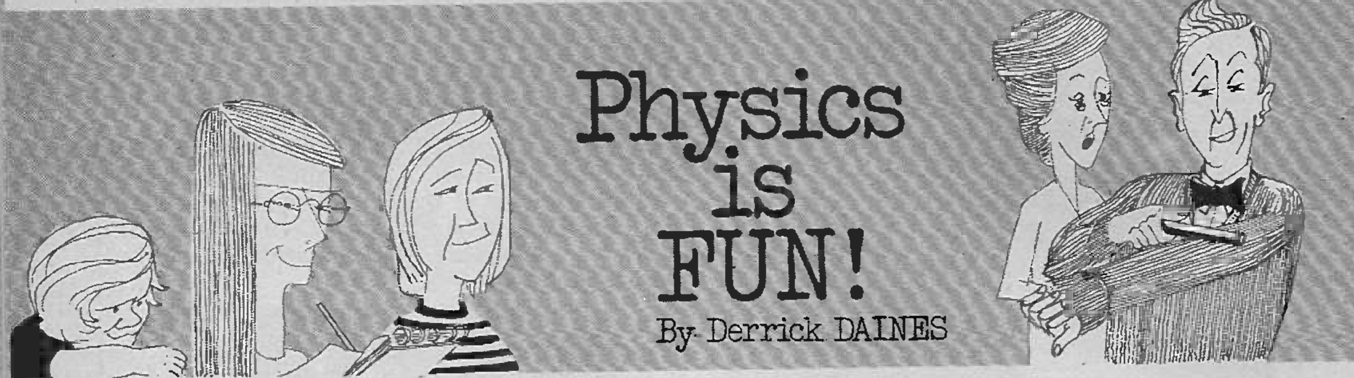
So your first task is to read through the more popular electronic magazines and purchase as many varied component catalogues as you can afford. I assure you this is a good investment and even if your outlay is a pound or two, spread over a year or so its fairly small, and many firms return their catalogue price when you make purchases. If you find all your wants in any one of them, try that firm out first, but be resigned to dealing with three or four.

Now to deal with the actual ordering. If the firm concerned enclose an order form—use it. It is quicker for them to deal with their own order forms than scraps of paper. If not, I suggest you buy a duplicate order book not smaller than 200 x 120mm from W. H. Smiths or Rymans. These have about 100 duplicate pages and carbon paper. Put your address at the top in block letters and then put down your requirements, with the quantity you require first.

If the firm has catalogue numbers use them, if not make sure your descriptions are adequate, i.e., if you order a pot, say if its log. or lin. do not forget to write down colours if applicable. Now carefully check prices and totals and if you pay by cheque do make sure (a) you sign it, (b) the date is correct, (c) that the words and figures agree.

DELAY

Don't be worried if a week or ten days goes by before the arrival of your goods, that excellent organisation the Post Office is very undermanned at present. One way of avoiding frustration is to plan ahead i.e., while you are constructing one project select your next project and order the bits for that.



Physics is FUN!

By Derrick DAINES

OPPOSITE CHARGES

I am told that I have left one or two things unexplained.

(1) Why do the tufts of the electroscope not fly apart until the charged plastic sheet is lifted off the table?

(2) Why does the hair of the head lift when a charged sheet is brought near it, but not actually touching?

(3) Why do all these static experiments work best in a dry atmosphere?

The first two questions are really the same question couched in different terms. But let's do experiments to see it.

Charge a plastic sheet by rubbing it with wool; prove it with the electroscope. Now lay the sheet down again—the tufts of the electroscope collapse. Remove the electroscope and pass the hand over the sheet, stroking it gently. Replace the electroscope and lift the sheet. The electroscope remains collapsed.

Stroking with the hand conducts away the charge

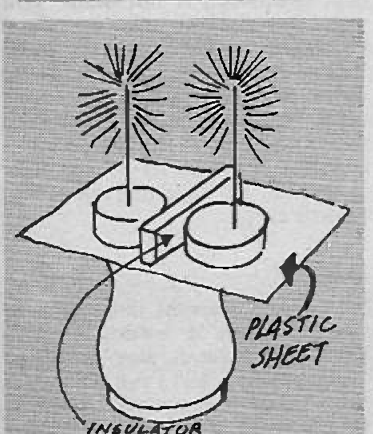


Fig. 1. On removing a charged plastic sheet the tufts remain extended.

Make a second tufted electroscope (it won't take long). Now put the discharged plastic sheet on a tall insulator, such as a vase or china mug, and on it put the two tufted electroscopes, just touching.

Charge another sheet of plastic film and bring it up close to one of the tufts. Both tufts will fly out, just what we would expect! Take the charged sheet away—both tufts collapse. Fine—nothing odd about that. Now try this.

Bring the charged sheet near to one of the tufts again—both fly apart. Now holding the sheet steady, slide between the metal boxes of the electroscopes an insulator, such as a piece of glass or plywood about 50mm wide. Leave it there and remove the charged sheet. The tufts stay up, Fig. 1.

What on earth has happened? Let us assume for the sake of argument that the charged sheet had a negative charge on it. The tufts nearest to it become positively charged.

As long as the two metal boxes were touching, the second tuft also had a positive charge, but when we insert the insulator the second tuft assumed a negative charge. Removing the charged sheet thus left the two tufts of opposite polarity attracting each other and hence unable to collapse.

You can prove that they are opposite polarity by bringing the charged sheet close to each tuft in turn and observing their different behaviour; one repelled by the sheet, one attracted by it, Fig. 2.

We can say then that when a charge is brought close to an insulator a charge of opposite polarity is induced on its surface. This is of vital consequence to electronics, since capacitors depend entirely upon this effect.

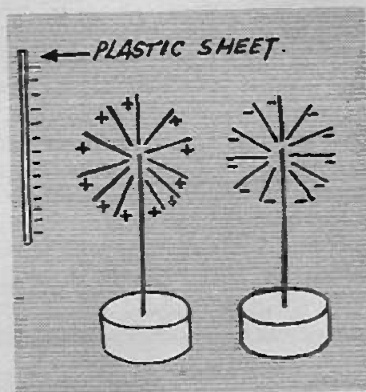


Fig. 2. Bringing a charged plastic sheet up to the two electroscopes shows that the tufts are oppositely charged.

When the charged sheet is lying on the table, an equal and opposite charge is therefore present on the surface of the table! We will return to this point another time, Fig. 3.

As for the third question, dry atmosphere, you can see that if the table and sheet have equal and opposite charges, there is a tendency for the negative electrons to migrate across the gap, thus cancelling out. This tendency is increased in a damp atmosphere. This, too, we will return to another time.

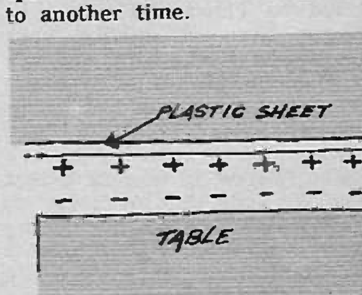
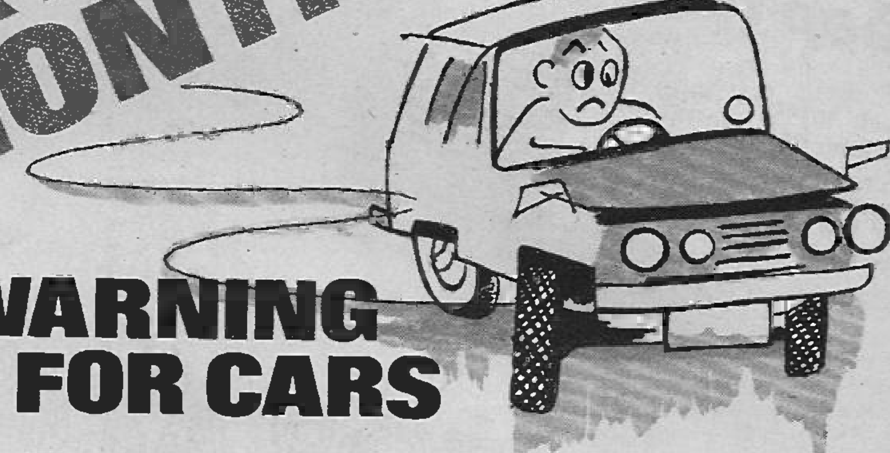


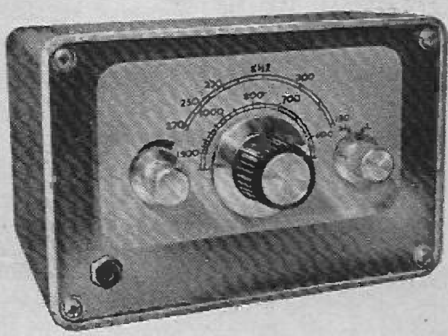
Fig. 3. A charged plastic sheet lying on a table top causes the table to acquire an equal and opposite charge.

NEXT MONTH...



ICE WARNING FOR CARS

Don't get caught out by ice this winter! Build this simple device to give you an audible and/or visual warning when the temperature outside the car falls to freezing point.



2 Band SUPERHET TUNER...

A m.w. and l.w. tuner that can be used with almost any amplifier. Employing ready-made i.f. transformers this tuner is easy to build but provides good sensitivity and selectivity.

RAIN ALARM

Just right for beginners! This very simple and inexpensive device can be a great help to the housewife at this time of the year.

everyday electronics

JANUARY ISSUE ON SALE 18 DECEMBER

keep tuned up with...

Great interest in this system has warranted this revised article which embodies details for BOTH 6V and 12V systems.

TRANSISTOR ASSISTED IGNITION

6V VERSION

Eliminates electrical wear of contact breaker points

THE Transistor Assisted Ignition system described in the April issue of EVERYDAY ELECTRONICS can be adapted for use with 6 volt systems without any great difficulty. However, it is first necessary to check the current taken by the coil to ensure that it is not excessive. The current is checked by inserting a current meter capable of measuring 5 amp or more in series with the contact breaker connection. Next remove the distributor cap, switch on the ignition and then short the points with an insulated screwdriver. Any current reading less than 4 amps is satisfactory and you may proceed with the project.

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

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

PRINCIPLE

Each revolution of a four cylinder engine requires the points to produce two sparks to fire the engine. The points start to deteriorate after a few hundred miles as a result of producing all these sparks and by the time the car is serviced, at say 6,000 miles, the points may be in a very poor condition. This deterioration affects the timing, reduces the power available at the plugs and can give a noticeable drop in performance.

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

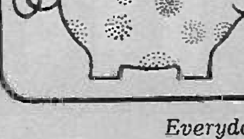
Fitting the unit to a vehicle which already has worn points can produce an immediate improvement. However, this unit should not be confused with the more complicated "capacity discharge-ignition systems" which are designed to improve performance.

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

THE CIRCUIT

A switch is incorporated into the unit so the normal car circuit can be easily restored in the event of failure, or suspected failure. This feature, together with the circuit design requires

FOR GUIDANCE ONLY



ESTIMATED COST* OF COMPONENTS
including V.A.T.
£4.50
excluding case

*Based on prices prevailing at time of going to press

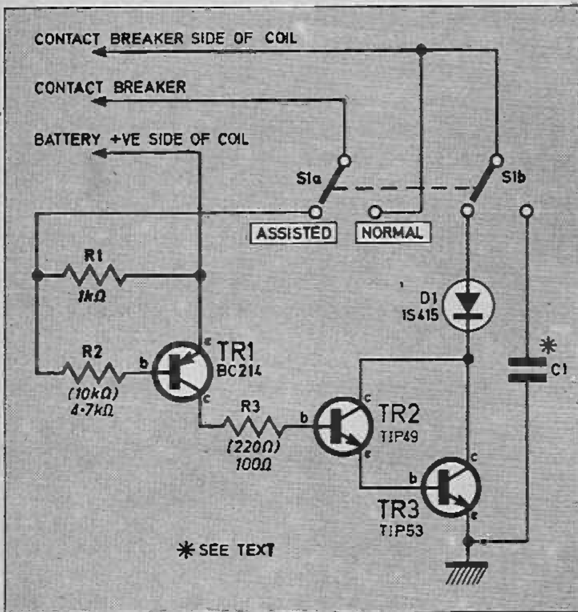


Fig. 1. The complete circuit diagram of the Transistor Assisted Ignition. Values in brackets are for the 12V version.

that the capacitor (sometimes referred to as a condenser) be removed from the distributor and fitted into the unit (see "testing" and "installation" later).

The complete circuit diagram is shown in Fig. 1. The points are connected via switch S1a (in the position shown) and resistor R2 to transistor TR1. When the points are open, TR1 is cut off by R1, fed from the positive battery connection. Each time the points close the base of TR1 is connected to earth through R2 switching it into its conduction state. The current passing through the points is about 7mA (13mA for 12V system), instead of the 3 amp or so normally required.

The current flowing through the collector of TR1 and R3 in turn switches on TR2, which in turn switches on TR3 thereby connecting the coil to earth every time the points close. Thus TR3 takes the place of the points and passes the 3 amps or so required by the coil. Diode D1 is necessary to protect TR2 and TR3 from high voltage spikes generated when the points open.

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

CONSTRUCTION

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

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

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

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

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

TESTING

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

First remove the centre lead from the distributor and fix it with adhesive tape so that the

Components....

SEE SHOP TALK

Resistors
R1 1kΩ
R2 4·7kΩ (10kΩ, 12V)
R3 100Ω (220Ω, 12V)
All ¼ watt ±5% metal oxide

Semiconductors
TR1 BC214 silicon *pnp*
TR2 TIP49, TIP50, or TIP53 silicon *npn*
TR3 TIP53 silicon *npn*
D1 1S415 or similar 4 amp 450V stud cathode type

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

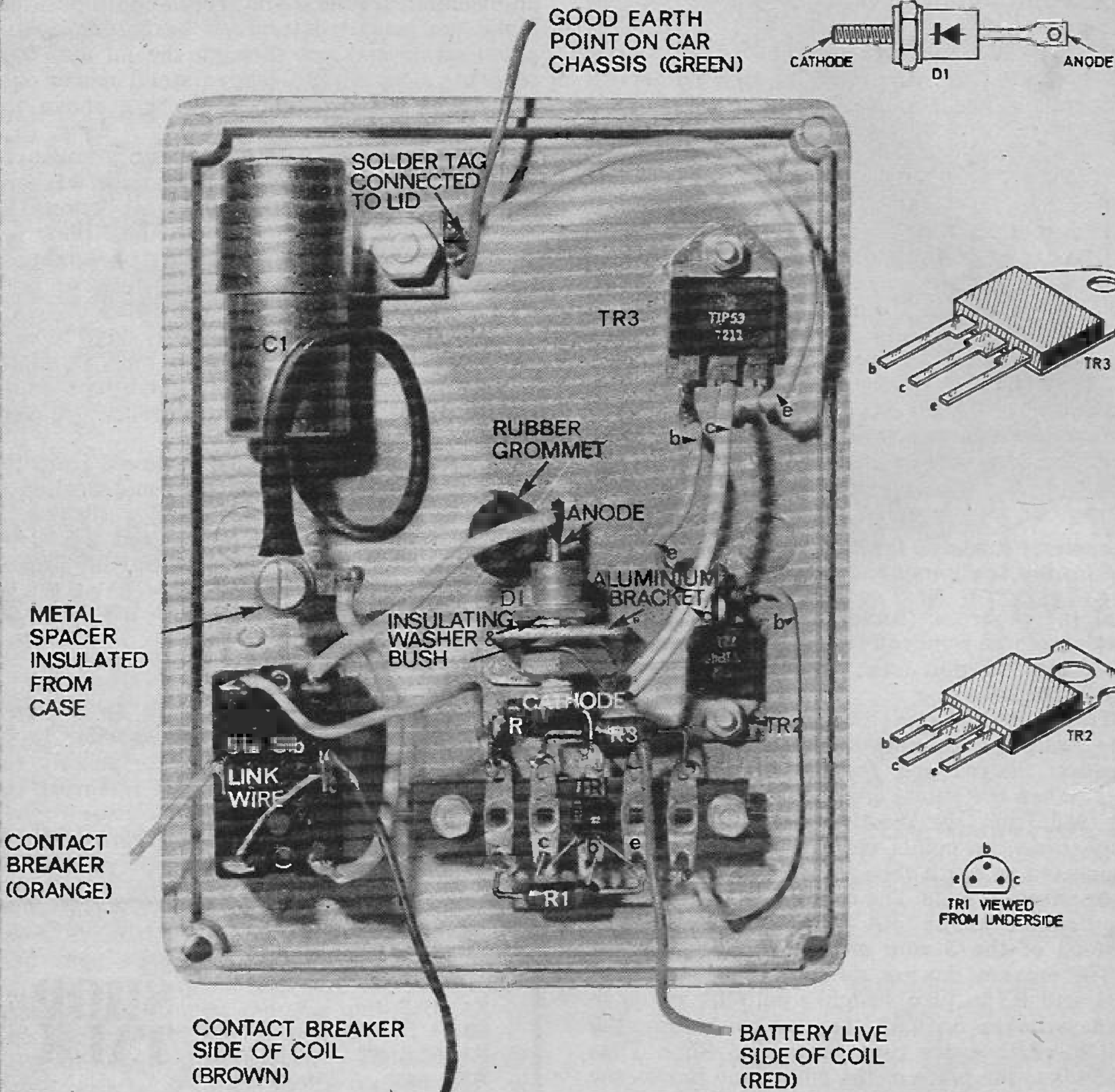
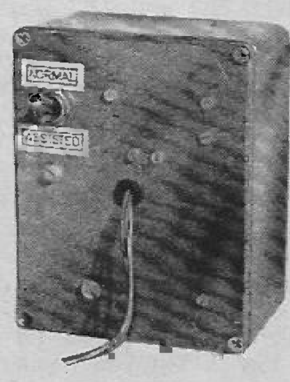


Fig. 2 (above). Position and wiring up details of the components on the lid of the diecast box. Wires leave the case through the grommet.

TRANSISTOR ASSISTED IGNITION



Photograph of the completed unit.

metal end is about 6mm from some earthed point on the car. This will enable you to see when a spark is generated.

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

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

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

INSTALLATION

The unit is installed in a cool part of the engine compartment not forgetting to mount it on some form of rubber shock absorbers. It is very important to remove the capacitor (condenser) from the distributor and refit it into the unit immediately prior to installation.

Due to the inherent voltage drop of about 1·2 volts across D1 and TR3 the system may not be able to provide a good enough spark for cold starting or for starting with a low battery voltage. This voltage drop will be no more than that experienced with a normal system operating with worn points. (The points should be cleaned, or a new set installed, and adjusted before installation.)

To overcome the starting difficulty simply switch to the normal position during very bad weather or when the battery voltage is low. Because the points will have been saved from electrical wear by the ignition system they will be able to provide a much better spark than would be the case had the normal system been in continual use—thus in an indirect way the system can help with cold weather starting. It is not advisable to switch over to the assisted position with the engine running.

There is no doubt that with this system changing the points and retiming can be carried out at very much greater intervals than would otherwise be the case, thus saving the cost of the unit in a relatively short period. ▣

EVERYDAY ELECTRONICS "MULTIMETER" COMPETITION

Winners

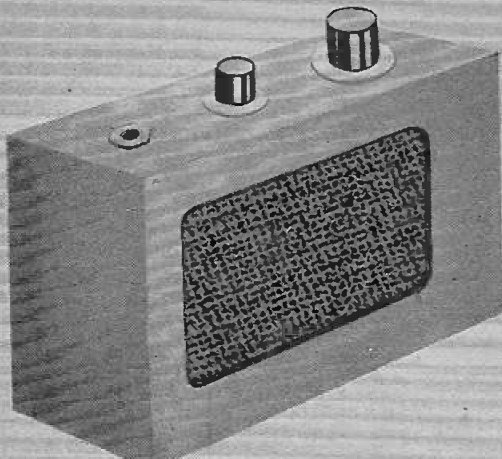
First: (Chinaglia Dino multimeter) Mr. Frederick J. Pavey, Petersfield, Hants

Second: (Chinagla Minor multimeter) Mr. David E. Young, Ashford, Kent.

Third: (Chinaglia Minor multimeter) Mr. K. Reed, Bracknell, Berks.

Runners-up: (each wins a Chinaglia Cito pocket multimeter) Mr. W. Barry, East Boldon, Co. Durham; Mr. I. Brownlee, Stranraer; Mr. M. Coles, Clynder, Dunbartonshire; Mr. I. Juliff, Livingston, West Lothian; Mr. P. Kimmance, Horton, Bristol; Mr. J. Malham, Selby, Yorks; Mr. C. Mannix, Liverpool; Mr. J. Noonan, Stoke Poges, Bucks; Mr. N. Patrick, Orpington, Kent; Mr. R. Thomson, Salford, Lancs.

Left: Mr. Frederick J. Pavey (right) being presented with the Dino multimeter (1st prize) by the editor, Mr. F. E. Bennett (left) in the presence of sponsor Mr. Alberto Coniglio (Managing Director, Chinaglia U.K.). Right: runner-up, Mr. David E. Young receives his Minor multimeter.



M.W. REFLEX RECEIVER

By R.A. PENFOLD

THIS article describes a five transistor m.w. receiver, which for simplicity uses a t.r.f. circuit. It is not of the pocket portable type, and measures approximately 200×150×90mm., which allows a well spaced layout to be used, and this greatly simplifies construction.

The internal 150×100mm loudspeaker can be driven by a maximum output power of around 250mW r.m.s. A home made plywood case with an aluminium front panel is used.

The set does not have a performance equal to that of a more complicated superhetrodyne circuit, but stations, Radio 1, 3, and 4, plus a few continental stations can be received at full volume on the prototype receiver. A class B output stage is used, and this gives a reasonable battery life (type PP3) at normal listening levels.

REFLEX CIRCUIT

The circuit diagram of the receiver is shown in Fig. 1. This consists of a reflex stage, TR1, followed by a conventional four transistor a.f. amplifier using a complementary output stage.

A reflex amplifier is one which gives amplification at r.f., and when the r.f. signal has been detected, then amplifies the resultant audio signal. Thus a single transistor provides two stages of gain and Fig. 2 shows the effective circuitry around TR1 during r.f. amplification and detection (Fig. 2a), and during a.f. amplification (Fig. 2b).

Referring to Figs. 1 and 2, L1 is the tuned winding on the ferrite aerial, and C2 is the tuning capacitor. The high impedance signals across L1 are matched into the low input impedance of TR1 by L2. Capacitor C4 provides d.c. blocking.

Resistor R1 is the biasing resistor for TR1, and L3 is its collector load. Components R2 and C3 form an r.f. decoupling network, and prevent the r.f. signal from entering other parts of the circuit via the supply lines.

Coils L3 and L4 form a wideband transformer, and unlike L1 and L2 which only operate over a narrow range of frequencies at one time, these operate satisfactorily over the entire m.w. band.

The signal across L3 is therefore induced into L4, and from here fed via C5 to an ordinary diode detector, D1. Capacitor C4 smoothes the positive r.f. half cycles remaining after detection, leaving an insignificant d.c. bias, and the required audio signal.

In Fig. 2 there are two capacitors marked "C4", but if reference is made to Fig. 1 it will be seen that this is in fact one component, and that it is used twice. It will also be seen that the audio signal across C4 is coupled into the base circuit of TR1 via L2.

At audio frequencies L3 has a negligable reactance, and appears as a virtual short circuit, and can be ignored. Resistor R1 still operates as the biasing resistor, and R2 now becomes the collector load for TR1.

The reactance of C6 is too high at audio frequencies to have any noticeable effect on the circuit, and can also be ignored. This leaves the simple a.f. amplifier circuit of Fig. 2b. The amplified audio signal appears across R2, and is coupled via C7 to the volume control, VR1.

REGENERATION

The two main disadvantages of this type of circuit are that the r.f. amplification is fairly low, there being only one stage of this, and the selectivity (the ability of the receiver to reject signals in close proximity to the desired one) is poor as there is only one tuned circuit. Both these can be improved by adding regeneration, and this is the purpose of C3.

FOR GUIDANCE ONLY

ESTIMATED COST* OF COMPONENTS including V.A.T.

£4.60 excluding case

*Based on prices prevailing at time of going to press

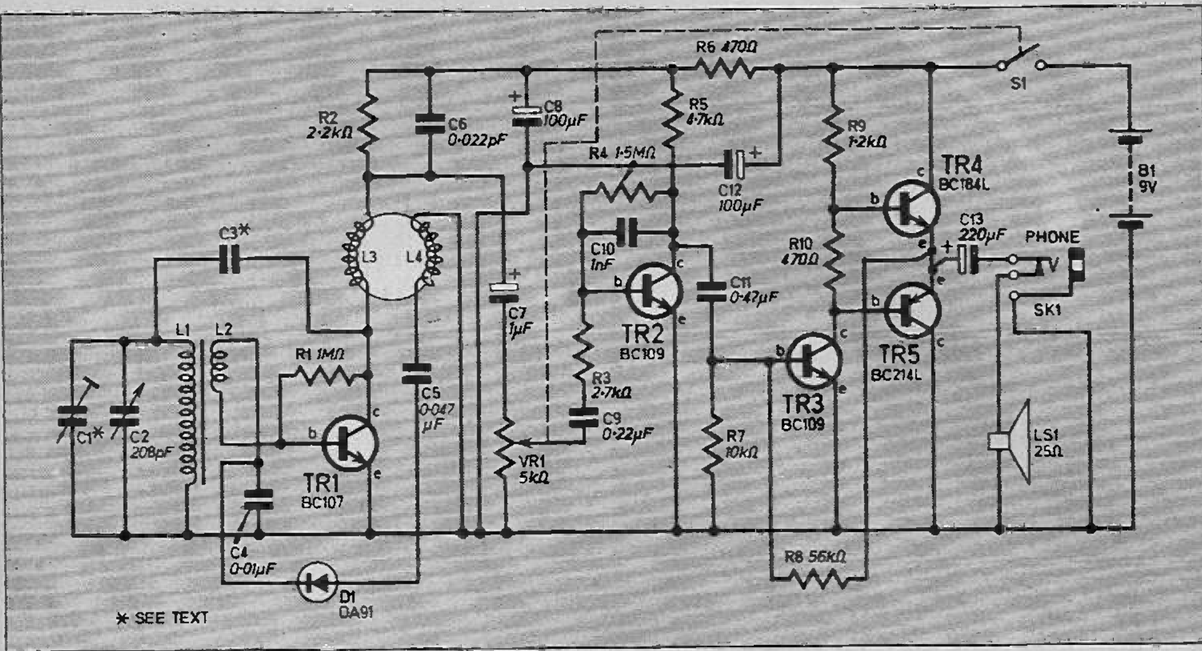


Fig. 1. The complete circuit diagram of the receiver.

This merely couples some of the amplified r.f. at TR1 collector back to the tuned circuit, where it is sent back through the circuit for amplification for a second time. This differs from reflexing in that the signal has not been detected, and is still at r.f.

There is a limit to the amount of regeneration that can be applied, and if this is exceeded, TR1 will oscillate, and the receiver will be unable to resolve signals properly. Capacitor C3 has an extremely low value, and merely consists of two pieces of wire in close proximity to one another.

AUDIO AMPLIFIER

The amplifier is quite conventional, and has a high gain common emitter input stage, TR2, a common driver stage, TR3, and a complementary emitter follower output stage, TR4 and TR5.

A break contact on the earphone socket disconnects one of the speaker leads when the earphone plug is inserted. Any type of earphone can be used, although ideally a magnetic phone of about 60 to 250 ohms impedance should be used.

WIDEBAND TRANSFORMER

There is no ready made component suitable for use as the wideband transformer, and this is home made using an FX1593 ferrite ring, and two lengths of 38 s.w.g. enamelled copper wire. Details of this are shown in Fig. 3.

There is no need to keep the two windings particularly neat, but an attempt should be made to keep the turns of each coil running in the same general direction along the core.

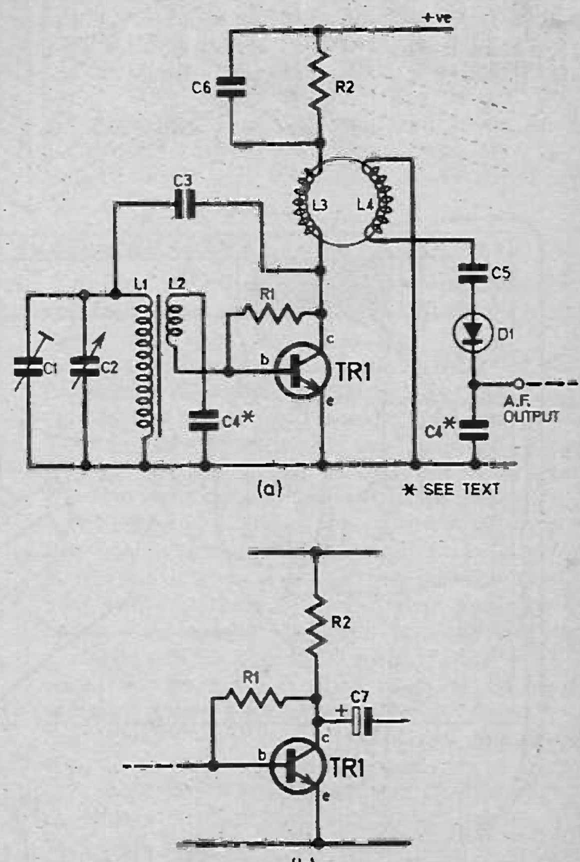
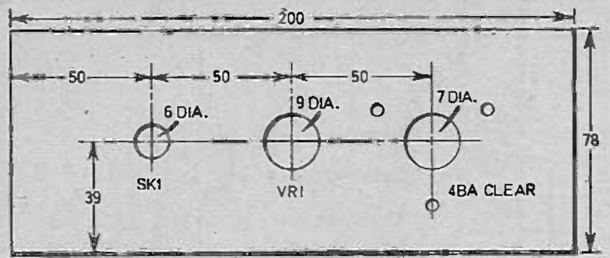


Fig. 2. The same circuit being used to amplify r.f. and then detected r.f. (a.f. signals).



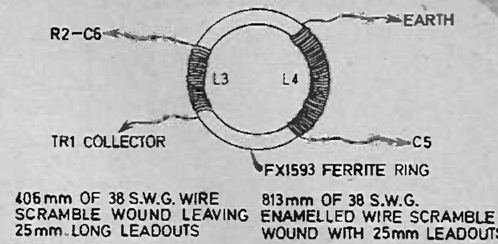


Fig. 3. Winding details of the wideband transformer.

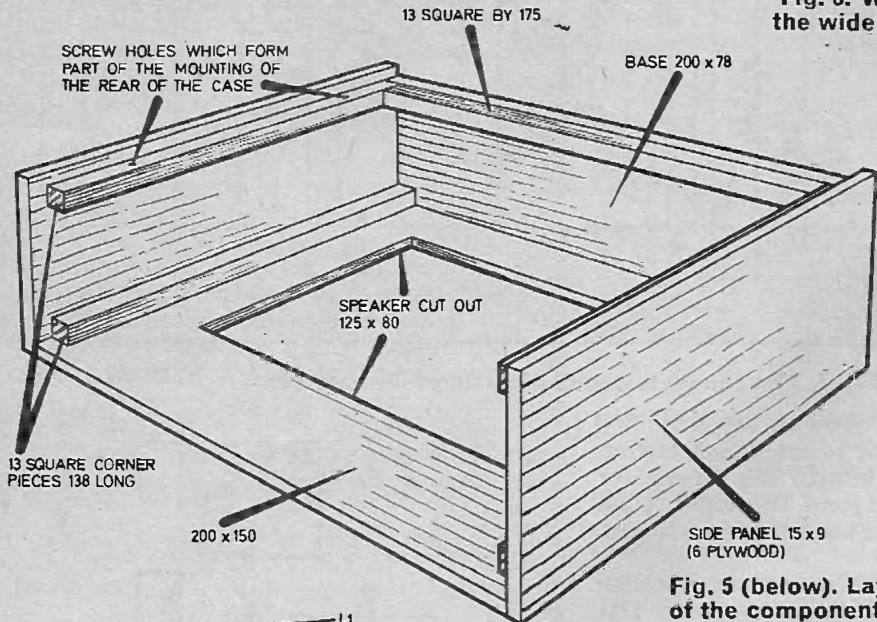
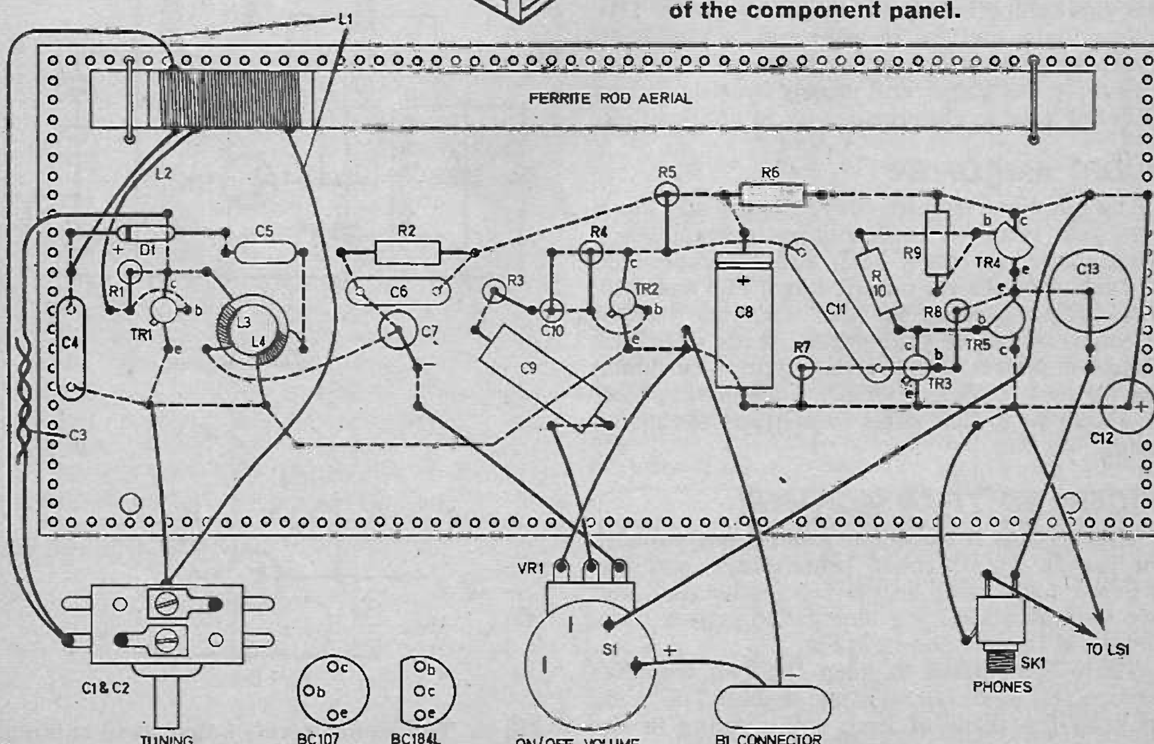


Fig. 4. Details of the prototype case and front panel.

Fig. 5 (below). Layout and wiring details of the component panel.



Components....

Resistors

R1	1MΩ	R6	470Ω
R2	2·2kΩ	R7	10kΩ
R3	2·7kΩ	R8	56kΩ
R4	1·5MΩ	R9	1·2kΩ
R5	4·7kΩ	R10	470Ω

All $\frac{1}{4}$W ±10% carbon

Capacitors

C1 Trimmer section of C2
C2 208pF (front part of 208–176 Jackson 00, with trimmers)
C3 See text
C4 0·01μF } Mullard C280
C5 0·047μF } Mullard C280
C6 0·022μF } Mullard C280
C7 1μF elect. 16V
C8 100μF elect. 10V
C9 0·22μF Mullard C280
C10 1nF polystyrene
C11 0·47μF Mullard C280
C12 100μF elect. 10V
C13 220μF elect. 10V

SEE **SHOP TALK**

Semiconductors

D1 OA91
TR1 BC107 silicon *npn*
TR2, 3 BC109 silicon *npn* (2 off)
TR4 BC184L silicon *npn*
TR5 BC214L silicon *pnp*

Miscellaneous

VR1 5kΩ log. pot with switch (S1)
L1/L2 Denco MW/5FR ferrite aerial
L3/4 FX1593 ferrite ring and 38 s.w.g. enamelled copper wire
LS1 25 ohm loudspeaker (150 x 100mm size used in prototype)
B1 9V PP3 battery and clips
SK1 3·5mm jack socket with switch and earphone with plug to suit, control knobs (2 off), 0·1 inch matrix component board 150 x 65mm, materials or ready made plastic case, connecting wire, 6BA fixings.

THE CASE

The case is home made from 6mm plywood and 12mm square timber, Fig. 4 shows constructional details of this, and also details of the aluminium front panel. The various wooden parts of the case can be either pinned or glued together (or both).

It is advisable to make the speaker cut-out before assembly. It can be made using a fret saw. A piece of speaker fret is glued behind this, and then the speaker glued to the fret.

The front panel is glued to the four corner pieces. The back of the case is made from 6mm ply, and is drilled so that four wood screws can pass through this, and into the four corner pieces, so holding the back in place. The case is finished by being covered with a self adhesive plastics material (Contact, Fablon, etc).

A mounting bracket is required for the component panel, and this is made from 18 s.w.g. aluminium. This fits behind the front panel, and is held in place by C2, VR1, and SK1 when these are mounted on the front panel. For the time being these are mounted on the bracket. The component panel is mounted on the bracket by two 6mm long 6BA bolts.

COMPONENT PANEL

A diagram showing the component side of the component panel, and all external connections is given in Fig. 5. The ferrite rod is tied to the board by two tethers made from thin p.v.c. sleeving. The coil former is slid along the rod to one end, as shown in the diagram. The coil assembly L3/L4 can be secured to the panel in the same way as the ferrite rod.

The other components can then be mounted, and their leadouts bent over at right angles on the reverse side of the panel. These are then soldered together, as shown in the diagram, the underside wiring is shown dotted. Where leads pass close to each other, and there is a danger of a short circuit, one of the leads should be insulated with p.v.c. sleeving.

At any points where interconnecting leads are too short to reach one another, extension leads made from thin tinned copper wire (about 22 s.w.g.) are used to join them.

Connections to SK1, VR1, etc. can then be made. The leads to LS1 are about 300 to 450mm long. The two insulated leads forming C3 are each about 8 to 12mm long, and preferably of single core wire. C1 is ready wired across C2.

ADJUSTMENTS

Before mounting the component assembly in the case, the unit should be checked for mistakes, and then turned on.

Initially, the two wires comprising C3 should be kept well apart. Rotating the spindle of C1 should enable several stations to be received. The two wires forming C3 should now be brought together. If this causes an increase in sensitivity, the two lead outs of L2 should be swopped.

It should be checked that the frequency coverage is correct. If this is found to be incorrect, adjusting C1 should enable this to be ammended. The unit can then be mounted in the case. The battery is wedged between two corner pieces.

Capacitor C3 can then be adjusted. The two wires are brought as close together as possible without either quality seriously breaking up, or the circuit oscillating (which is heard as a whistle as the receiver is tuned over a station).

It may be possible to twist the wires together as shown in the diagram, but in many cases they will only be able to be brought to within 25mm or so of each other. They can in this circumstance, be taped to the side of the case to ensure that they are not accidentally moved once correctly adjusted. ■

New products and component buying for constructional projects

SHOP TALK

By Mike Kenward

WHEN is a toy not a toy? That is a question one could ask about the Fischertechnik range of construction kits. We recently received an invitation to the launch of their range in this country (the product is of German origin) and wondered quite why they thought an "electrouic" magazine would be interested. It turned out that they produce electro-mechanical and electronic kits that can be used to control and drive the models made from the basic kits. The electronics are supplied in module form with sensors—light sensitive, heat sensitive etc.—supplied as plug-in parts. A modular relay is also provided to drive the model motors or lights.

The basic construction set (suitable for age 6 upwards) costs £12·05 and to this can be added a motor kit £6·95 and an electronics kit £14·55, however, the range and versatility are vast.

The kits are made of moulded nylon (non-toxic) are guaranteed against breakage—the electronic parts are also said to be protected against damage from wrong connection. They should be available from your local toy shop by the time you read this.

Ultrasonic Remote Controller

The receiver for the *Ultrasonic Remote Controller* requires one or two parts that are not generally available—the TAA 930B integrated circuit and the ultrasonic transducer.

Phoenix Electronics Ltd, can supply the i.c.—they do advertise in our pages—the i.c. costs £1·23 including VAT.

The transducer costs £3·75 and it would be a good idea to get the "R" and "T" versions in one go (receiver and transmitter) since the "T" will be required for the construction detailed next month. Total cost for the two including p. and p. and VAT is £7·00. They come from Hall Electronics, 48 Avondale Rd., Leyton, E17.

Other components in the receiver should not be difficult to get—almost any metal case could be used to house the unit.

M.W. Reflex Receiver

Once again just a couple of unusual components are required for the *M.W. Reflex Receiver*. The ferrite ring is available from Henry's Radio and the ferrite aerial from Denco for 66p plus VAT, plus postage—a total of 85p. Denco are at 355/9 Old Road, Clacton-on-Sea, Essex, CO15 3RH.

The case for the receiver can be home made or the complete unit could be housed in one of the plastic cases that are generally available.

The River

None of the components specified for *The River* should be difficult to get hold of. The 75 or 80 ohm speaker may need looking for, but most of the larger supplies should be able to provide it for you.

The tagboard used to mount the components is becoming rather outdated but does provide a simple and satisfactory base for this unit.

Ignition System

As regular readers of this page will know after the publication of the original *Transistor Assisted Ignition* system A. Marshall ran out of the TIP49 transistors and have still not been able to replenish their stocks. This means that two TIP53 transistors have to be used instead—at an increase in cost.

Once Marshalls receive some more 49's they will resume supply at the lower price (£2·85); until then, the cost of the semiconductors (diode and all transistors) from them is £3·80 including postage and packing and VAT. Since it is very difficult to say quite when supplies from the manufacturers will resume we suggest readers send the larger amount—those who send off in a few months time may get a refund!

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The Extra-ordinary Experi-ments of Professor Ernest Eversure

by Anthony John Bassett

Professor Ernest Eversure, or the Prof. as his friends call him, has been experimenting in electronics for more years than anyone can remember and we thought that you might like to hear of, and perhaps repeat, some of his extraordinary experiments. Anthony J. Bassett will be recounting some of the experiments every month so why not follow the Prof's work and learn along with young Bob, his friend.

As the robot drew even nearer to him, the startled Professor saw that the unusual movements caused by Bob's oscillator seemed to be making the robot perform a strange dance. Despite this, the robot seemed to be keeping to its original instructions. It seemed to dance towards the Prof. in time with Bob's tune. It gently placed the ohm-meter on the work bench, then danced off and disappeared amongst the equipment at the other end of the room.

The Prof. interrupted Bob's musical attempts, which were now taking the form of a series of gently rising and falling notes, rather like the electronic music sometimes heard from the soundtrack of a science-fiction fantasy film, and pointed out to him that the ohm-meter had now arrived.

What the robot had brought was actually a multimeter but Bob picked it up and switched it to a resistance range. He soon found, by applying the test probes of the meter to various pencils, that each one did in fact have a different resistance (as deduced from his experiments described in the last issue) and that by sliding the probes to different distances apart along the pencil line on his piece of Paxolin, different resistance readings appeared on the meter scale.

Meanwhile, the Prof. had prepared a few more experimental resistors similar to the ones described earlier. He had painted graphite paste around the solder tags, but had not yet put a carbon conducting track across from one tag to the other.

"Now," said the Prof., "We can use these to produce a number of different values of carbon resistor."

"Can I do some?" asked Bob. The Prof. gave some of the partly made resistors to Bob and together they began to make a variety of resistors.

Bob painted resistors with wide tracks between the tags, medium tracks, and narrow tracks down to about 1mm. Some of the tracks were made up of several layers of mixture and some consisted of only one thin layer. The Prof. had meanwhile made up another mixture of graphite and quick-drying varnish using more graphite so that the mixture was a thick paste which could be spread like butter. He spread a thick layer of this from one tag to the other about 3mm wide by 3mm deep on some resistors. Bob painted a thin zig-zag line from one tag to another.

After a break for lunch the pair returned to the now dry resistors and Bob began using the multimeter to measure the resistance values of the various resistors they had made.

The resistors covered a really wide range of values. The lowest value was the one with the thickest, deepest track and this measured 12 ohms. The highest value was the one with the thin zig-zag track and this measured about four megohms. Between these were resistors of a variety of values and Bob knew immediately that it should be possible to make any value of resistor from a few ohms up to a few megohms, quite easily.

"Suppose I wanted to make a 15 ohm resistor, Prof?" asked Bob. "Could I alter the 12 ohm resistor sufficiently?"

"Yes," said the Prof. "Just use a craft knife to scrape off some of the mixture and the value will rise."

Bob connected the meter to the 12 ohm resistor and checked the resistance reading. He left the meter leads connected while carefully scraping away thin layers of graphite mixture. As the mixture was removed, the meter reading gradually changed ... 12 ohms ... 13 ohms ... 14 ohms ... 15 ohms ... 15·5 ohms ... "Whoops! I've taken too much off!" said Bob, looking wryly at the meter reading. The Prof. picked up a very soft lead pencil and carefully rubbed the surface of the resistor, using very light pressure. Gradually, the meter reading crept back down to 15 ohms.

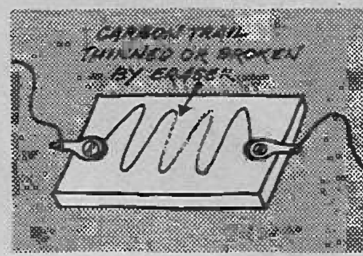
"Now, let's try some high value resistors. We should be able to trim the values of all these resistors to our preferred values," the Prof. stated. He changed the range on the multimeter and connected it to the four megohm resistor. Bob saw that the meter needle moved to the same reading as previously. Using a typist's ink eraser, the Prof. very carefully rubbed the fine carbon track, using very light pressure. The meter reading altered slowly as he did so, until a reading of five megohms was obtained.

"Prof.," said Bob, "The carbon line on that four megohm resistor is very thin and while you were altering it to five megohms suppose you rubbed a little too hard and broke the line?"

"If I broke the line," replied the Prof., "It would break the electrical connection so that no current would flow through the resistor. The meter would then read open-circuit. Let me demonstrate." The Prof. rubbed the line with the eraser and as he did so, the meter needle moved even higher until at one point the carbon track was severed and the meter swung to read open-circuit.

"Now," said the Prof. "We can repair the break in the carbon track quite easily by rubbing it with a hard pencil, or by using more graphite mixture." He selected a 8H pencil and rubbed it carefully across the track at the point of the break. The meter needle began to move and gradually crept back to five megohms.

"If we wanted a lower value resistor, say one megohm, just by continuing to rub with the pencil, the value will become lower." The Prof. demonstrated by continuing to rub with the pencil. The meter reading went back to four then lower, three, two, one megohm. "To go much lower, we would have to use a much softer pencil," observed the Prof. He used the eraser to bring the resistor up once again to five megohms.

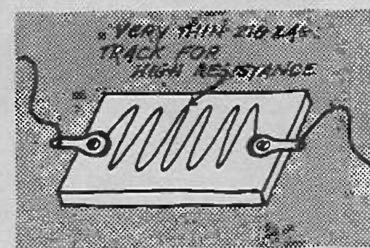


The value of the resistor can be raised by rubbing away the track

"It all looks so simple, Prof.," remarked Bob. "But I'm sure I would not find it so easy to alter such fine lines to the accuracy you have just demonstrated!"

"The higher the value of the resistor you are making and the finer the carbon track which you must produce, the more difficult this becomes," agreed the Prof. "But if you start off by making resistors of a few kilohms, rather than a few megohms, it is much easier to do."

"I see. So if I practice first with some of these other resistors with the wider tracks, I could tackle more difficult ones later."



One of the Prof's experimental resistors. This one uses a zigzag track to obtain high resistance

"Now that we can make resistors of almost any value," said Bob, "we should be able to connect a few of them together to make a simple note selector for my musical note generator. Something similar to a keyboard!"

"Yes," agreed the Prof. I will show you how to build a note selector, using a number of resistors which we can make and connect together on a single piece of printed circuit board or Paxolin. It will enable you to use the oscillator to produce melodies or to produce musical notes which can be tape-recorded to make some electronic sound effects!"

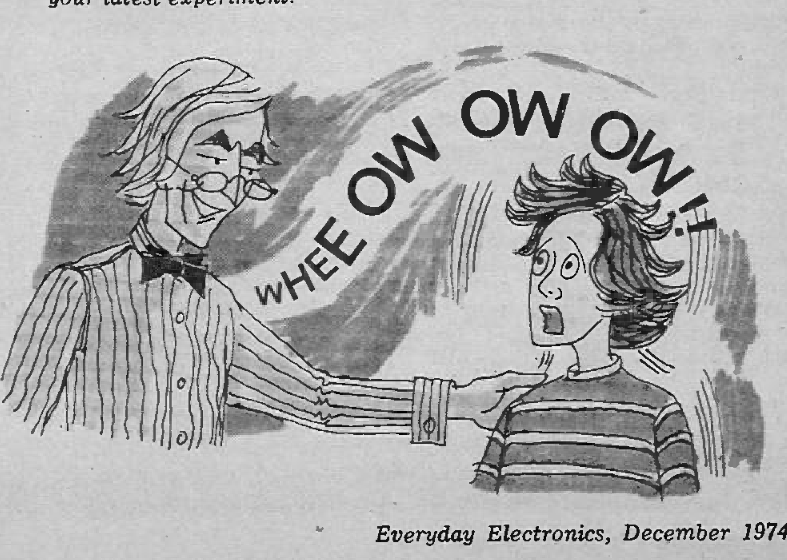
At this moment an amazing sound effect became apparent in the laboratory. An electronic tone rising and falling like a siren.

"Oh, no!" wailed Bob. "I know that sound. It is the alarm signal for your latest experiment. It's out of control and could be dangerous. We cannot go near it and if we don't stop it soon it could synchronise the brain wave patterns of everyone nearby. What can we do, Prof.? "Think of something quickly!"

To Bob's amazement, the Prof. seemed impervious to the blaring alarm signal and completely unaware of the obvious danger. Could it be that the experiment had already begun to affect his brain wave patterns?

Continued next month!

Oh, no! wailed Bob. I know that sound. It is the alarm signal for your latest experiment."



DOWN TO EARTH

By GEORGE HYLTON

"My transistor radio hums when placed close to an electric clock on the bedside table, but only when it's tuned into a station. What is happening?"

Well, here's a deceptively simple question! Hum—mains hum, that is—can get into circuits in at least three ways: leakage through imperfect insulation; capacitive coupling; magnetic coupling. I'm going to stick my neck out and declare in a firm, confident tone that the present case is clearly one of magnetic coupling.

MODULATION HUM

The really clinching clue, as I see it, is the observation that the hum appears only along with a programme. This makes it almost certain that we have a case of what's usually called "modulation hum." Modulation is usually thought of as something that happens at radio transmitters rather than at receivers. It's the term used to describe how the audio programme-signal is impressed on the radio frequency carrier wave which the transmitter broadcasts.

In an amplitude-modulated (a.m.) transmission the strength (amplitude) of the carrier wave is made to vary in sympathy with the programme. In an f.m. transmission it's the frequency of the carrier wave that varies. Either way, some form of modulation circuit is involved. Receivers, oddly enough, also contain bits of circuitry which are quite capable of functioning as modulators, even though that's not their purpose, e.g., frequency changers, amplifiers, and detectors.

If you apply to any of these two signals simultaneously, one a high frequency, the other a low frequency, and at the right relative strengths, then the strength of the high frequency will be made to vary in sympathy with the low one, just as in an a.m. transmission.

In our reader's case, the h.f. signal is the carrier frequency of the incoming station. The low frequency is the 50Hz mains, picked up from the electric clock.

Why am I so confident that it's a case of magnetic pickup? Well, both clocks and transistor radios are usually in well-insulated plastic cases, which more or less rules out leakage. It would be hard to get the clock and radio close enough together to cause an appreciable amount of capacitive pickup. But transistor a.m. radios have a beautifully efficient gadget inside them for picking up magnetic signals, in the shape of a ferrite rod aerial.

AERIAL

It's true that the aerial isn't designed to work at 50Hz, but it does. Not as well as at r.f., of course, but well enough to pick up a good strong signal from the magnetic field of the clock motor. The input circuitry of the average transistor portable is on the lines of Fig. 1. The first transistor is a frequency changer, to which the incoming transmissions are applied via the coupling winding of the ferrite rod aerial (L2) and the local oscillation via the winding of the oscillator coil in the emitter circuit.

The 50Hz signal that does the damage is the one induced in L2. A much bigger one is induced in L1 but the impedance of the aerial tuning capacitor C1 is so enormous at 50Hz that practically no current circulates. A 50Hz signal in L2 on the other hand can get straight to the base of *TR1*.

This 50Hz signal, if strong enough, produces a 50Hz variation in the collector current. Since the gain of a transistor in this sort of circuit is a function of its collector current, any other signals present (including the incoming station) are subject to a gain which varies at 50Hz. The transistor is acting as a modulator.

The h.f. signals which go into the i.f. amplifier are now all modulated not only with the audio programme but with 50Hz. When applied to the detector after i.f. amplification the 50Hz comes out along with the programme. Hence the hum.

Moreover, it's not just the incoming r.f. carriers that get modulated at 50Hz but the modulation sidebands as well, so the 50Hz and the programme get quite inextricably entangled, and every audio tone which emerges from the loudspeaker has a 50Hz wobble on it.

OTHER RECEIVERS

It makes no difference if the first stage of the receiver is a radio-frequency amplifier instead of a frequency-changer. The possibility of hum modulation is still there. So t.r.f. receivers can pick up hum, too. It's less likely in f.m. receivers, but still possible, because the oscillator coil may pick up hum, which pushes the frequency around at 50Hz and so produces a genuine 50Hz frequency modulation on all incoming signals!

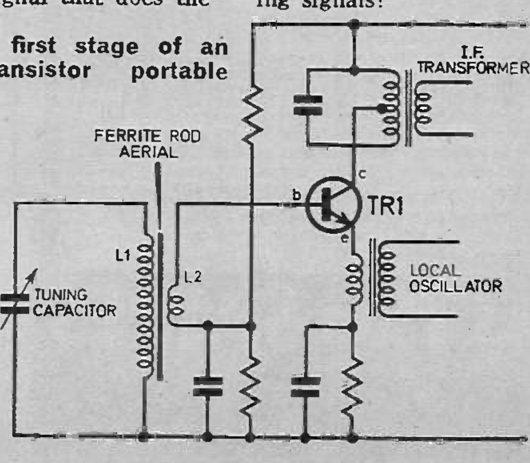


Fig. 1. The first stage of an average transistor portable radio.

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2N918	0·32
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2N1302	0·19
2N1303	0·19
2N1304	0·24
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2N1671B	1·72
2N1671C	4·32
2N1711	0·45
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AC153K	0·25
AC154	0·20
AC176	0·18
AC176K	0·25
AC187K	0·23
AC188K	0·34
ACY18	0·24
ACY19	0·27
ACY20	0·22
ACY21	0·26
ACY28	0·20
ACY30	0·58
AD142	0·59
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AD150	0·63
AD161	0·45
AD162	0·45
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AF116	0·25
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AF127	0·28
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AF170	0·25
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AF239	0·51
AF240	0·72
AF279	0·54
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AL103	0·70
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BC108	0·15
BC109	0·19
BC113	0·15
BC115	0·17
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BFX89	0·45
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BRY39	0·48
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BU105	2·25
C106A	0·46
C106B	0·55
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C106E	0·43
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CD4001	0·51
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14DIL	0·73
LM7805	2·50
MC1303p	1·26
MC1310	2·92
MC1458CPI	0·70
MJ480	0·90
MJ481	1·14
MJ490	0·98
MJ491	1·38
MJE340	0·45
MJE2955	1·12
MJE3055	0·68
MP8111	0·32
MP8112	0·40
MP8113	0·47
MPF102	0·30
MPSA05	0·25
MPSA06	0·26
MPSA55	0·26
MPSA56	0·27
NE555V	0·70
NE560	4·48
NE561	4·48
NE565A	4·48
OC23	1·35
OC28	0·76
OC35	0·60
OC42	0·50
OC45	0·32
OC71	0·20
OC72	0·25
OC81	0·25
OC83	0·24
ORP12	0·55
RS3	1·20
RL54	0·15
SC35D	1·68
SC36D	1·46
SC40D	1·89
SC41D	1·32
SC45D	1·89
SC46D	1·96
SC50D	2·60
SC51D	2·39
SL414A	1·80
SL623	4·59
TAA263	1·00
TAA350	2·10
TAA621	2·03
TAA661B	1·32
TAD100	1·50
Filter	0·70
TBA271	0·64
TBA641B	1·25
TBA800	1·50
TBA810	1·50
TIL209	0·30
TIP29A	0·49
TIP30A	0·58
TIP31A	0·62
TIP32A	0·74
TIP33A	1·01
TIP34A	1·51
TIP35A	2·90
TIP36A	3·70
TIP41A	0·79
TIP42A	0·90
TIP2955	0·93
TIP3055	0·60
ZTX300	0·13
ZTX302	0·20
ZTX500	0·15
ZTX502	0·18
ZTX530	0·21

Integrated Circuits TTL (SN 7400 Series)

SN7400	16p
SN7401	16p
SN7401AN	38p
SN7402	16p
SN7403	16p
SN7404	24p
SN7405	24p
SN7406	45p
SN7407	45p
SN7408	25p
SN7409	33p
SN7410	16p
SN7411	25p
SN7412	28p
SN7413	50p
SN7416	45p
SN7417	30p
SN7420	16p
SN7423	37p
SN7425	37p
SN7427	45p
SN7430	16p
SN7452	45p
SN7437	35p
SN7438	35p
SN7440	16p
SN7441	85p
SN7442	85p
SN7445	1·59
SN7446	2·00
SN7447	1·30
SN7448	1·50
SN7450	16p
SN7451	16p
SN7453	16p
SN7454	16p
SN7460	16p
SN7470	30p
SN7472	38p
SN7473	44p
SN7474	48p
SN7475	50p
SN7476	45p
SN7480	75p
SN7481	1·25
SN7482	87p
SN7483	1·20
SN7484	95p
SN7485	1·58
SN7486	45p
SN7490	65p
SN7491	1·10
SN7492	75p
SN7493	65p
SN7493	65p
SN7494	85p
SN7495	80p
SN7496	1·00
SN74100	2·16
SN74107	43p
SN74118	1·00
SN74119	1·92
SN74121	57p
SN74122	80p
SN74123	72p
SN74141	1·00
SN74145	1·44
SN74150	1·44
SN74151	1·10
SN74153	1·00
SN74154	1·66
SN74155	1·55
SN74157	1·00
SN74160	1·58
SN74161	1·58
SN74162	1·58
SN74164	2·01
SN74165	2·01
SN74167	4·10
SN74174	1·00
SN74175	1·29
SN74176	1·74
SN74180	1·44
SN74181	5·18
SN74190	1·95
SN74191	1·95
SN74192	2·05
SN74193	2·30
SN74196	1·58
SN74197	1·58
SN74198	3·16
SN74199	2·88

Diodes & Rectifiers

PIV	50	100	200	400	600	800	1000
1·5	0·15	0·17	0·20	0·22	0·25	0·27	0·30
3	0·15	0·17	0·20	0·22	0·25	0·27	0·30
10	—	0·35	0·40	0·47	0·56	—	—
35	0·84	0·92	1·18	2·15	2·52	3·05	4·20

Cathode Stud only IN3766 (35 A 800pv) £3·65. IN3768 (35 A 1000pv) £4·20

IN34A	0·10
IN914	0·07
IN916	0·07
AA119	0·07
AA129	0·15
BA100	0·15
BA102	0·25
BA110	0·25
BA115	0·07
BA141	0·17
BA142	0·17
BA144	0·12
BA145	0·17
BA154	0·12
BY100	0·15
BY126	0·15
BY127	0·17½
BY140	1·00
BY237	0·12½
BYZ10	0·35
BYZ11	0·32
BYZ12	0·30
OA9	0·10
OA10	0·20
OA47	0·07½
OA70	0·07½
OA73	0·10
OA79	0·07
OA81	0·08
OA85	0·10
OA90	0·07
OA91	0·07
OA95	0·07
OA200	0·07
OA202	0·10

OPTO & LED's

Red, green and yellow
0·16 diameter 31p
0·20 diameter 33p
DL707 £2·35 or 4 for £8·00
Minitron £1·55

Bridge Rectifiers

Plastic	1A	2A	4A	6A
50	0·24	0·32	0·60	0·62
100	0·36	0·37	0·70	0·75
200	0·30	0·41	0·75	0·80
400	0·36	0·45	0·85	1·10
600	0·40	0·52	0·95	1·25

SCR's	100V	200V	400V	600V
½A	0·43	0·44	—	—
1A	0·45	0·50	0·60	—
1·2A	0·38	0·42	0·53	0·75
3A	0·47	0·53	0·60	0·90
4A	0·50	0·55	0·65	—

PW Teletennis Kit as featured on BBC Nationwide and in the Daily Mail 2 Oct '74. Ideal game for whole family. No need to modify your TV set, just plugs in to aerial socket.

Parts list as follows: A Resistor Pack £1·00 p & p 20p: B Potentiometer Pack £1·25 p & p 20p: C Capacitor Pack £3·10 p & p 20p: D Semiconductor Pack £14·50 p & p 20p: E IC Sockets £4·00 p & p 20p: F Transformer £1·15 p & p 25p: G PCB's £7·50 p & p 20p: H Switches £4·50 p & p 20p: I UHF Modular Kit £7·20 p & p 20p.

Special Prices—complete kit excluding case £42·00 p & p 50p. Sections A-F incl. £23·50 p & p 30p. Assembly instructions with complete kit or 75p on request.

P.C. Marker Pen Dalo 33pc Price 87p. Zeners 400MW 2·7V-43V 11p, 1W 3·3V-120V 17p. IC Sockets 8DIL—16p. 14DIL—17p, 16DIL—20p.

Liquid Crystals—£13·00.
Ex stock S.A.E. for details of CMOS battery operated clock kit using LCD's.

Scorpio Car Ignition Kit—£11·50 + VAT IMF 440V 1 1440V £1·10
BSTB0246 £1·05 Transformer £2·75
Minitron £1·55
DL 707 £2·35 or 4 for £8·00

Resistors W	Tol	Price	Tant Beads Value	
⅛	5%	1p	·1/35	14p
¼	5%	1·5p	·22/35	14p
½	5%	2p	·47/35	14p
1	10%	2·5p	2·2/35	14p
2	10%	6p	4·7/35	18p
2½	5%	7p	10/16V	18p
5	5%	9p	47/6·3V	10p
10	5%	10p	100/3V	20p

Veroboard	Copper ·1	Copper ·15	Plain ·1	Plain ·15
2½x3¾	28p	20p	—	14p
2½x5	30p	30p	—	14p
3¾x3¾	30p	30p	—	—
3¾x5	34p	35p	—	24p
3¾x17	£1·21	95p	76p	69p
Pins x 36	24p	24p		
x 200	89p	92p		

Trade and Retail Supplied

Potentionmeters
Linear or Log

	Single	Double
Rotary Pots	18p	45p
Rotary Switched	28p	—
Sliders	50p	80p

Full range of Capacitors stocked. See catalogue for details

Presets Horizontal or Vertical
·1W 6p ·2W 6p ·3W 6p

Construction Kits

AV7	Aerial Amps	£2·04
UHS70	Transmitter	£2·74
MUE7	Receiver for above	£3·22
EW18	Electronics dice	£6·53
EW20	Electro. Dice +Sen.	£7·79

OUR NEW GLASGOW SHOP IS NOW OPEN

VAT all prices exclusive
p & p p20 Mail Order

FIRST TIME EVER! *SAVE £15·12!

BRAND NEW AC/DC BATTERY/MAINS

Cassette TAPE RECORDER & PLAYER

With remote control microphone.

FIRST CLASS MAKERS

WE COULD CHARGE UP TO £26·97! OUR PRICE £11·85 POST ETC. 50p

Due to price we cannot name makers—but rest assured you're getting one of the BEST! Expensive "PIANO KEYBOARD" CONTROL PANEL (or latest MASTER SWITCH control) and AUTOMATIC LEVEL CONTROL. No fiddling with awkward tape and reels, just "slap-in" a cassette. Superb taping & reproduction! Takes 30, 60 or 90 minute standard cassette tapes. Beautiful tone from a whisper to a roar! Remote control microphone! Rapid rewind! Fast forward! Complete—record anywhere, indoors or out! Runs on standard batteries AND 220/240v. A.C. mains. Separate jacks for remote-control microphone, etc. 9½in. x 5in x 2½in. approx. Designs can vary slightly. With carry handle. WRITTEN G'TEE and instructions. (Importers recommended selling price £26.97!) OUR PRICE £11.85, post, etc., 50p. ★ Send quickly, test on mail order 7 days' approval from receipt of goods. Refund if not delighted. BONUS OFFER: Cassette tape, batteries and microphone stand 55p if required. ALSO Super de luxe model with VHF AM/FM radio (recommended retail price £44!), only £22.15, carr. 50p (batteries and cassette tape 45p extra if required)

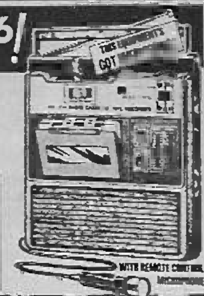
CALLERS: ACCESS & BARCLAYCARDS ACCEPTED AT STORES.

SAVE £21·56!

FABULOUS BRAND NEW

SOLID STATE AC/DC MAINS/BATTERY

COMBINED V.H.F. AM/FM RADIO AND CASSETTE TAPE RECORDER AND PLAYER



IMPORTERS RECOMMENDED SELLING PRICE £44·51! OUR PRICE £22·95 carr. etc. 50p

Latest sensation in the world of sound! First class makers! Fabulous VHF AM/FM RADIO and CASSETTE TAPE RECORDER & PLAYER combined! Runs off standard batteries or Mains (simply plug in mains 220/240v. A.C. line cord supplied)—NOW you can record & play back anything, anywhere! IMPORTERS RECOMMENDED SELLING PRICE £44.51! WE OFFER AT ALMOST HALF PRICE! Fantastic specification:- *Automatic recording level control! *Monitor switch! Expensive calibrated "slider" volume and tone controls! *Latest 'MASTER SWITCH' fast forward, stop, play & rapid rewind control! *Superb built-in Speaker! *Takes standard 30, 60, or 90 minute Cassette tapes, obtainable everywhere. *Earphone & extension speaker sockets PLUS separate input/output DIN jack socket! *Built-in swivel 7 section telescopic aerial (25" approx.) *Magnificent case (approx. 10ins. high) in luxurious Black & Silver finish with "teak-finish" speaker grille. *Built-in carry handle. *Wonderful VHF AM/FM Radio with instant switch-over waveband selection & pin-point station tuner. Superb clarity and tone. Amazing station selection home & abroad including local reception of city & regional stations in every part of the country (even those scheduled for the future) plus BBC National VHF. Also fabulous in Car! You could pay £££'s more for a Radio or Car Cassette player ALONE! Yes, only £22.95 carr. etc. 50p, complete with remote control microphone, etc., Written Guarantee & simple instructions. BONUS OFFER:- Batteries, Cassette Tape, personal listening earpiece, and microphone stand, all for only 55p extra, if required. Send total £24 (to include Bonus, carr. etc.) and test on 7 days mail order approval from receipt of goods. REFUND IF NOT DELIGHTED. Or call at either Shopertunities store.

Dept. EE/30, 164 UXBRIDGE RD. (facing Shepherds Bush Green), LONDON W12 8AQ. (Thurs. 1, Fri. 7). Also at 37/39 HIGH HOLBORN (opposite Chancery Lane), LONDON, W.C.1. (Thurs. 7 p.m.). BOTH OPEN MON. TO SAT. 9 A.M. TILL 6 P.M.

SHOPERTUNITIES LTD.

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learn how to become a radio-amateur in contact with the whole world. We give skilled preparation for the G.P.O. licence

RAPY

free! Brochure, without obligation to:

BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL Dept EEB 124 P.O. Box 156, JERSEY

NAME: ____________________

ADDRESS: ____________________

____________________ BLOCK CAPS please

QUALITY STEREO SOUND

SOLENT AUDIO SYSTEM

ALMOST ½ PRICE OFFER!

MADE TO SELL AT DOUBLE THE PRICE IN CABINET FORM

OUR PRICE £49·95

£5 down

*Stereo Tuner Amplifier chassis with AM/FM radio covering long medium short and Stereo FM wavebands. Separate Base and Treble controls. Power output 7 watts R.M.S. per channel (frequency response 25-20,00 Hz) Tape record and playback facilities. Dimensions 18" x 8½" x 3¼". The very latest BSR automatic record deck with cue and pause control. Two matching elliptical speaker units.

Order early limited stocks available cash price £49·95. Credit Sale £5·00 deposit 9 monthly payments of £5·75 (Total Credit price £56·75). P. & P. £2·50. Send £7·50 today.

Chassis only available for cash at £35·00.

Full 12 months Guarantee.

CALLERS WELCOME.

Stereo headphones supplied with every order.

LEWIS radio E.E. 12/74. 100 CHASE SIDE SOUTHGATE LONDON N14 5PL Telephones: 01-886 9666/3733

RECORD PLAYBACK HEADS (TRUVOX)

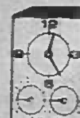
Individual prices of these are:
2 track record playback heads 50p each.
4 track record playback heads 72p each.
Erase heads are also available separately:
2 track 33p; 4 track 55p.
MV metal mounting shields 39p each.
2 track-heads already fixed on heavy mounting plate with shield £1·22.

DRILL CONTROLLER

NEW 1KW 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. £1·95 plus 25p post and insurance. Made up model also available. £2·95 plus 25p post & p.

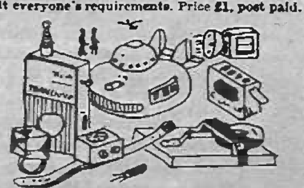
TIME SWITCH



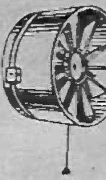
Smith's mains driven clock with 15 amp switch, also notes showing how you can wake up with music playing, kettle boiling or come home to a warm house, warn off burglars, keep pets warm, halve your heating bills, etc. £1·95.

EXPERIMENTER PRINTED CIRCUIT KIT BUILD 60 INTERESTING PROJECTS

CONTENTS: (1) 2 Copper Laminate Boards 4½in. × 2½in. (2) 1 Board for Matchbox Radio. (3) 1 Board for Wristwatch Radio. etc. (4) Resist. (5) Resist Solvent. (6) Etchant. (7) Cleanser/Degreaser. (8) 16-page Booklet Printed Circuits for Amateurs. (9) 2 Miniature Radio Dials SW/MW/LW. Also free with each kit. (10) Essential Design Data Circuits, Chassis Plans, etc. for 60 TRANSISTORISED PROJECTS. Circuits to suit everyone's requirements. Price £1, post paid.

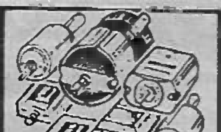


EXTRACTOR FAN



Cleans the air at the rate of 10,000 cubic ft. per hour. Suitable for kitchens, bathrooms, factories, changing rooms, etc., it's so quiet it can hardly be heard. Compact. 5¼" casing with 5¼" fan baldes. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets. £2·75 + 20p P. & P.

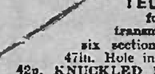
ONLY £1 FOR 7



ELECTRIC MOTORS

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

FREE Details of how to make miniature power station.



TELESCOPIC AERIAL

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

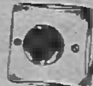
LIGHT DIMMER KIT

For dimming up to 250w without heat sink or 750w with heat sink. This comprises, quadrac, variable control potentiometer, condenser, resistors, tag strip for mounting and data. Price £1·50.

INTEGRATED CIRCUIT BARGAIN

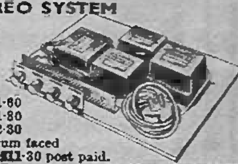
A parcel of integrated circuits made by the famous Plessey Company. A once-in-a-lifetime offer of Micro-electronic devices well below cost of manufacture. The parcel contains 5 ICs all new and perfect, first-grade device, definitely not sub standard or seconds. 4 of the ICs are single silicon chip GP 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.

THYRISTOR LIGHT DIMMER



For any lamp up to 1kw. Mounted on switch plate to fit in place of standard switch. Virtually no radio interference. Price £2·95, plus 20p post and insurance. Industrial model 5A £3·30. Not on plate.

MULLARD UNILEX STEREO SYSTEM



There is no doubt that it is a good system, we believe that for the money it is without comparison. We demonstrate gladly at our Tamworth Road depot. Prices of the individual items for this:—
1 Unilex Amplifier Ref. EP.9000 £1·60
1 Unilex Pre-Amp Ref. EP.9001 £1·80
1 Unilex Power Unit Ref. EP.9002 £2·30
1 Control panel kit with spun aluminium faced knobs £3·30. Or the complete outfit—£11·30 post paid.
Pair of 15 ohm speakers made by E.M.I. are also available if required, £3·30 the pair. No extra postage if ordered with the above, otherwise add 25p.

DISTRIBUTION PANELS

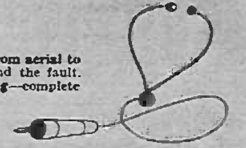
Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work. £2·75 plus 25p P. & P.

THIS MONTH'S SNIP

SOUND TO LIGHT UNIT

Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450w). Unit in box all ready to work. £7·95 plus 95p V.A.T and postage.

RADIO STETHOSCOPE



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

SWITCH TRIGGER MATS

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

SHORTWAVE CRYSTAL SET

Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19.25.31.39 & 49 metre bands. Kit contains chassis front panel and all the parts. £1·25 crystal earphone 83p.

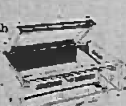
WANT A CHEAP OSCILLOSCOPE

We offer this month a laboratory type instrument made by G.E.C. for their communications laboratory in a steel case with carrying handle. It is mains operated and has its own internal time base and plenty of room to add another base if you wish. Probable cost of this instrument is in excess of £100. We offer this tested and in working order. £17·50 plus £2 carriage for first 200 miles then £1 for each 100 miles after.

MAINS TRANSISTOR POWER PACK

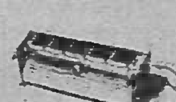
Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer recitifer, smoothing and load resistor, condensers and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

PORTABLE CABINET OFFER



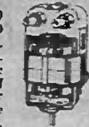
A nicely made portable cabinet, soft padded black finish intended for portable stereo system. Dimensions as sketch. With motor board cut out for Garrard SP 25. This was obviously a very costly cabinet originally made for a de-luxe record player. Offered at £1·95 plus £1 carriage free if bought with the Garrard or BSR record decks.

TANGENTIAL HEATER UNIT



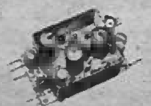
This heater unit is the very latest type, most efficient and quiet running. Is as fitted in Hoover and blower heaters. Comprises motor, Impeller, 2kW. element allowing switching 1, 2kW. and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only needs control switch. £2·75.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

MULTI-SPEED MOTOR



Six speeds are available 500, 850 and 1,100 r.p.m. and 8,000, 12,000 and 15,500 r.p.m. Shaft is ⅛ in. diameter and approximately 1 in. long. 230/240v. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2 in. dia. × 5 in. long. Price £1 plus 30p postage and insurance.

MULLARD AUDIO AMPLIFIERS

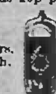


All in module form, each ready built complete with heat sinks and connection tags, data supplied.
Model 1153 500mW power output 72p
Model 1172 750mW power output 94p
Model EP9000 4 watt power output £1·60
EP 9001 twin channel or stereo pre-amp. £1·99

SPIT MOTOR

200-250V induction motor, driving a Carter gearbox with a 1½" output drive shaft running at 5 revs p.m. Intended for roasting chickens, also for driving models—windmills, coloured disc fighting effects, etc. £2·25 plus 20p post and ins.

NUMICATOR TUBES



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SEALED RELAYS

STC sealed relays. Makers type ref. 6945. These are metal encased plug in with two pairs changeover contacts. Approx. size 1½" high × 1" × ⅞". We understand these are vacuum, sealed. Two types available 6v (45 ohms coil) price £1·50; 24v (700 ohms coil) price £1·75.
STC sealed relay. Again, type 6945, sealed metal case plug in but for 12v operation (170 ohms coil) and with 2 pairs normal open contacts. £1·25.

AM/FM TUNER

Unit made by the American GEC company. 8 transistor, all-wired ready to work. Complete with tuner condenser, needs only scale and pointer. Tunes AM range 540 to 1620 KHz, FM range 88 to 108 MHz. Switches for on-off and AFC. Output for MXP or direct. Special snip price £5 plus 30p post. Three or more post free.

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Also makes good car emergency light. This uses a standard 2 foot 20 watt tube and operates from a 12v. car battery drawing approx. 1A. This gives illumination per amp/hour of battery life far in excess to filament lamps and in fact to the miniature 8-13 watt camping lights often offered. Complete unit ready to operate, in strong white enamelled metal frame. These would normally sell at £6, are unused but slightly soiled and we offer these at £4·50 plus 40p post and packing.

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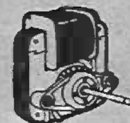

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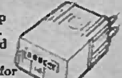

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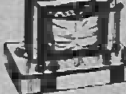

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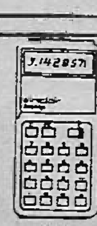

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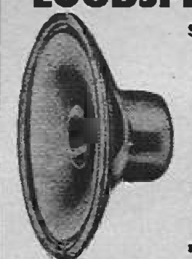

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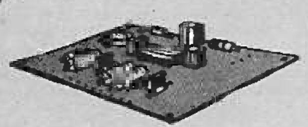

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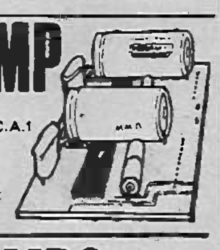

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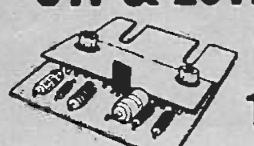

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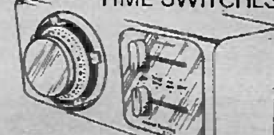

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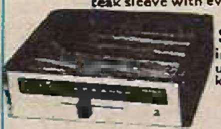

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EAO38	9 volt 1½ + 1½ watts 8 ohms, Stereo	6·95
CAO68	12 volt 3 + 3 watts 8 ohms, Stereo	10·50

FM Modules	
Mullard LP 1186 FM tuner (front end) with data 10·7 MHZ O/P	4·85
Mullard LP 1185 10·7 MHZ IF unit with data	4·50
Gorler Permability FM tuner (front end) 10·7 MHZ O/P	4·20

FM and AM tuners and decoders	
FM 5231 (Tu 2) 6 volt fm tuner	7·95
TU3 12 volt version (FM use with Decoder)	7·95
SD4912 Stereo Decoder for Tu 3, 12 volt	7·95
SP62H 6 volt stereo FM tuner	14·95
A1007 9 volt MW-AM tuner	11·95
Sinclair 12/45 volt FM tuner stereo recorder for above	7·45
A1018 9 volt FM tuner in cabinet	13·95
A1005M (S) 9–12 volt Stereo decoder FM for above	7·50
1062 12 volt Stereo decoder general purpose	6·50

PREAMPLIFIERS		
Sinclair	Stereo 60 Preamplifier	6·75
E1300	Cart/Tape/Mic Inputs 9 volt	2·85
E1310	Stereo 3–30 mV mal cart 9 volt	4·75
FF3	Stereo 3 mV tape head 9 volt	4·95
3042	Stereo 5–20 mV Mag. cart. mains	5·95
EQ25	Mono 3–250 mV Tape/Cart/Flay 9 volt	5·95

Power Supplies Mains input (* chassis-rest cased)

470C6/7½/9V300MA with ad'rs	2·25	*P1081 45V 0·9A	7·88
P500 9 volt 500MA	3·20	P12 4½-12V. 0·4–1 amp	7·15
HC244R 3/6/7½/9v. 400 MA stabilised	5·50	SE101A 3/6/9/12V. 1 amp stabilised	12·75
*P11 24v. ½ amp. 3·30	3·30	P1076 3/4½/6/7½/8 12V. ½ amp	4·20
*P15 28V. ½ amp	3·30	SE800A 1-15 VOLT 0-½A stabilised	17·50
*P1080 12V 1A 4·70	7·8		

SINCLAIR MODULES & KITS

SINCLAIR PROJECT 80			
ST80 Stereo preamplifier	11·95	FM TUNER	11·95
Audio Filter Unit	6·95	STEREO DECODER	7·95
Z40 15 Watt Amplifier	5·45	IC20 power amp kit	7·95
Z60 25 Watt Amplifier	6·95	PZ20 power supply for 1 and 2IC20	5·45
PZ5 Power Supplies for 1 or 2Z40	4·98	PACKAGE DEALS (carr./packg 35p)	
PZ6 Power Supplies (S Tab) for 1 or 2 Z40	7·98	2 x Z40 ST80 PZ5	25·00
PZ8 Power Supplies (S Tab) for 1 or 2 Z60	7·98	2 x Z60 ST80 PZ6	27·75
TRANSFORMER FOR PZ8	3·95	2 x Z60 ST80 PZ8 PZ8-trans	34·40

Sinclair Special Purchases
***Project 60 stereo preamp £6·75 (post 20p)**
***Project 605 Kit £19·95 (post 25p)**

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AF305	Intercom	7·68
AF310/2	Mono Amplifier (for Stereo use two)	7·56
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M1302	Transistor Tester	8·34
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AT65	Psychedelic Light Control. 3 Chan.	16·53
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AT30	Photo Cell Switching Unit	6·69
AT50	400w Triac Light Dimmer Sp. Cont.	5·19
AT56	2·200w Triac Light Dimmer Sp. Cont.	6·75
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HF65	Frequency Modulated FM Transmitter	3·21
HF75	FM Transis. Receiver	3·66
HF310	FM Tuner Unit	16·31
HF325	De-luxe FM Tuner Unit	26·34
HF330	Stereo Decoder for use with HF310/325	10·56
GP310	Stereo Pre-amp (for use with 2 AF310)	22·98
GP312	Basis Circuit Board	10·02
GP304	Basis Circuit Board	5·33
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HF395	Broadband Aerial Amp	2·10
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NT310	Power Pack 2 x 15 volt 2A	5·64
NT305	Voltage Converter	5·64
NT330	Power Pack AF310/GP304	6·27
NT315	P/S 240V ac to 4·5–15V dc. 500m/a	12·06
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