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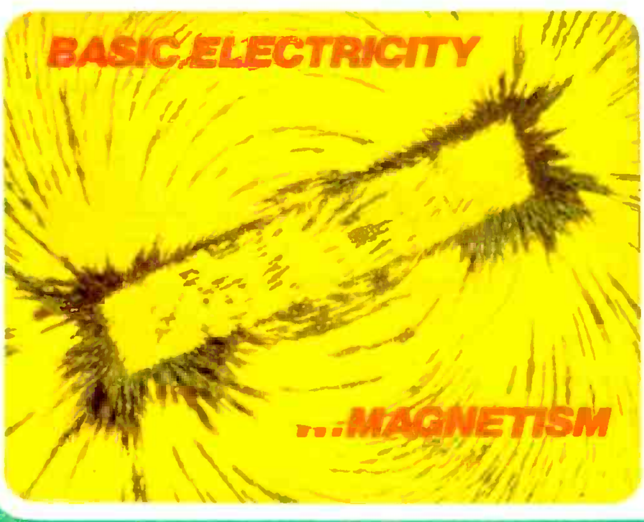

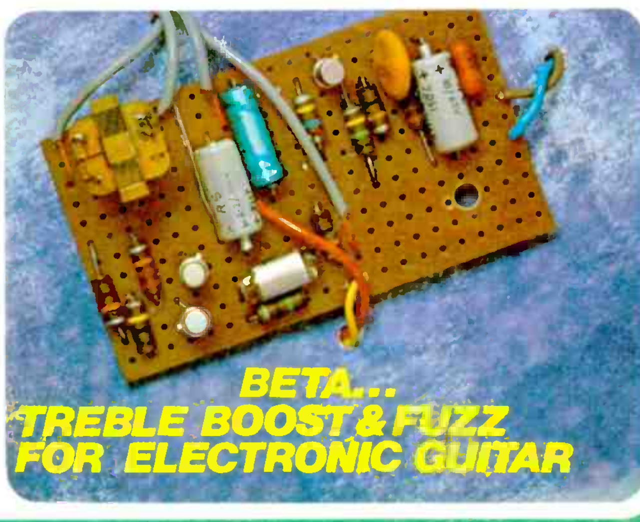

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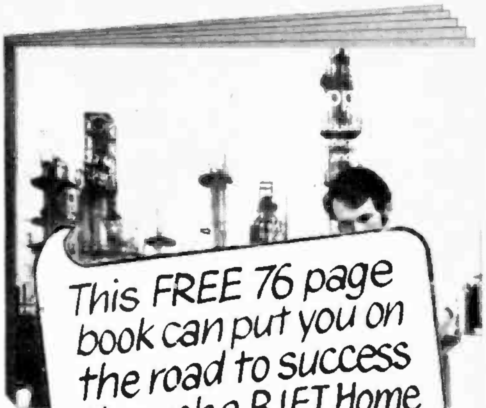

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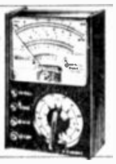

5,000 O.P.V. 0/3/15/150/300/1200 V. D.C. 0/6/30/300/600 V. A.C. 0/300μA/300 MA 0/10K/1 meg Ω Decibels −10 to +16db £2·75 each +15p P. & P.

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

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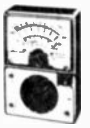

30,000 O.P.V. Overload protection. 6/30/60/300/600/1200 VDC. 12/60/120/600/1200 VAC. 60μA/30 mA/300 mA. 2K/200K/2 megohm. −10 to +63db. £6·50. P. & P. 15p.

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20,000 O.P.V. 0/0 6/6/30/120/600/1,200/3,000/6,000v. D.C. 0/6/30/120/600/1,200v. A.C. 0/60μA/6/60/600mA. 0/6K/600K/6 Meg./60 Meg. Ω 50pF. 0 2mFd. £5 97½. P. & P. 17½p.

MODEL TE-200

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MODEL 500

30,000 O.P.V. with overload protection mirror scale 0/.5/2.5/10/25/100/250/500/1,000v. D.C. 0/2.5/10/25/100/250/500/1,000V. A.C. 0/50μA/5/50/500mA. 12 amp. D.C. 0/60/K/6 Meg./60 Meg Ω £3 87½. Post paid.

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50,000 o.p.v. 43 ranges 0 0·3 to 1,200v D.C. 0-3 to 1,200v A.C. 0-30μA/300mA. 0 3k/30 meg ohms. −10 to +17dB. £8·97. Post 20p.

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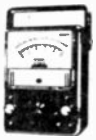

Features A.C. current ranges. 100,000 o.p.v. Mirror Scale Overload protection. 0/.5/2.5/10/50/250/500/1000 V D.C. 0/2·5/10/50/250/1000 V. A.C. 0/10/250μA/2·5/25/250 MA/10 Amp. D.C. 10 Amp A.C. 0/20K/200K/2 MEG/20 MEG. −20 +62db. £12 50. P. & P. 25p.

370 WTR MULTI-METER

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

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

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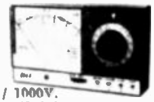
Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V AC and DC at 2,000 o.p.v. Resistance 0-20K ohms. ONLY £1·97 P. & P. 13p.

LT601 MULTIMETER



New style 20,000 o.p.v. pocket multimeter. 5/25/50/250/500 / 2500 V. D.C. 10 / 50 / 100 / 500 / 1000V. A.C. 50μA / 250mA. 6K / 6 meg ogms. −20 to +22dB. £3·57. Post 20p.

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

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

TMK MODEL TW-50K

46 ranges, mirror scale. 50K/Vol. D.C. 5K/Volt A.C. D.C.: Volts ·125, ·25, 1·25, 2·5, 5, 10, 25, 50, 125, 250, 500, 1000V. A.C. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1000V. D.C. Current: 25, 50μA, 2·5, 5, 25, 50, 250, 500mA, 5, 10 amp Resistance: 10K, 100K, 1 MEG, 10 MEG Ω. Decibels: −20 to +81·5db £8 50. P. & P. 17½p.

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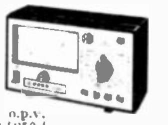

Taut band suspension. Overload protection. Polarity reversing switch. 30,000 o.p.v. 0/·5/2·5/15/50/250/500/1000/2500V. D.C. 0/15/50/150/500/1000V. A.C. 0/50μA/5/50/150/500mA/5A D.C. 0/3K/300K/3 meg. £8·95. Post 20p.

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

MODEL C-7080 EN

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

U4312 MULTIMETER

Extremely sturdy instrument for general electrical use. 667 o.p.v. 0/·3/1·5/7·5/30/60/150/300/600/900 VDC and 75mV. 0/ 3/1·5/7·5/30/60/150/300 600/900 VAC. 0/300μA/1·5/6/15/60/150 600MA/1·5/6 AMP. D.C. 0/1·5/6/15/60/150/600MA/1·5/6 AMP. AC. 0/200 Ω/3K/30K Ω. Accuracy DC 1%. AC 1·5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. £9 50 plus P. & P. 25p.

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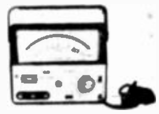
Full capabilities for measuring A, B and ICO. NPN or PNP. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads. £7·50. Post 20p.

Model S-100TR MULTIMETER TRANSISTOR TESTER

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

MODEL 449A IN CIRCUIT TRANSISTOR TESTER



Checks true A.C. beta in/out. Checks icbo. Checks diodes in / out. Checks SCR, etc. Beta H1 10-500, LO2-50. Icbo 0-5000μA. 220/240 V A.C. operation. £17·50. Post 25p.

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Accurate wide range signal generator covering 120 Kc/s 500 Mc/s on 6 bands. Directly calibrated Variable R.F. attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions £15. Carr. 37½p. Size 140 × 215 × 170 mm.

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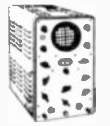
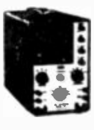
Input impedance 10 meg ohms. 0 / ·3 / 1·2 / 6 / 30 / 120 / 600V. D.C. 0 / 3 / 12 / 60 / 120 / 600V. A.C. 0 / 120μA / 120mA D.C. 0 / 1K / 100K / 10 meg / 100 meg ohms. £15·97. Post 15p.

CI-5 PULSE OSCILLOSCOPE



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

TO-3 PORTABLE OSCILLOSCOPE

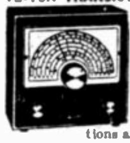


3in. tube, Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps-1·5 MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9v. p-p/CM Bandwidth 1·5cps-800kHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps 300 kHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½lb. 220/240V.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

RUSSIAN CI-15 DOUBLE BEAM OSCILLOSCOPE

5 mc/s Pass Band. Separate Y1 and Y2 amplifiers. Rectangular 5in. × 4in. C.R.T. Calibrated triggered sweep from ·2 u/sec. to 100 milli-sec. per cm. Free running time base 50 c/s-1 mc/s. Built-in time base calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manual. £67. Carr. Paid.

TE-16A TRANSISTORISED SIGNAL GENERATOR



5 ranges 400kHz–30mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide easy to read scale, 800kHz modulation. 5¼ × 5¼ × 3½in. Complete with instructions and leads. £7·97. Post 25p.

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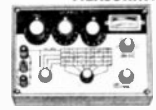

A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω 11·1 meg Ω 6 Ranges ±1% L.1 μ H − 111 HENRYS 6 Ranges 2 − % C.10pF ±110mFd 6 Ranges ± 2%. TURNS RATIO 1 : 1/1000-1 : 1/100. 6 Ranges ± 1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7¾ × 5 × 2in. £20. P. & P. 25p.

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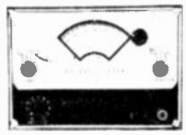
Transistorised. Operates as Grid Dip, Oscillator, Absorption Wave Meter and Oscillating Detector. Frequency range 440Kc/s–280Mc/s in 6 coils. 500μA Meter. 9V battery operation. Size 180 × 80 × 40mm. £12·50. Post 20p.

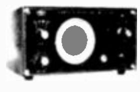
BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR

Sine 18 × 200,000 Hz; Square 18 × 50,000 Hz



Output max. + 10 dB. (10 K ohms) Operation internal batteries Attractive 2-tone case 7½" × 5" × 2". Price £17·50. Carr. 17½p.

MODEL MG-100 SINE SQUARE WAVE AUDIO GENERATOR

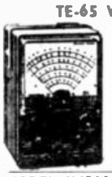


Range 19–220,000Hz Sine Wave 19–100,000 Hz Square Wave. Output Sine or Square wave 10v. P. to P. Size 180 × 90 × 90mm. Operation 220/240v. A.C. £17·50. Post 37p.

MODEL AT201 DECADE ATTENUATOR

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

TE-65 VALVE VOLTMETER



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

MODEL U4311 SUB-STANDARD MULTI-RANGE VOLT AMMETER

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

G. W. SMITH & CO (RADIO) LTD.

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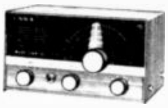
UNR-30 RECEIVER

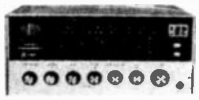


4 Bands covering 550kc/s – 30mc/s. B.F.O. Built-in speaker 220/240v A.C. Brand new with instructions. £15·75 Carr. 37½p.

UR-IA SOLID STATE COMMUNICATION RECEIVER

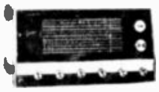
4 Bands covering 550kc/s–30Mc/s. FET S Meter. Variable BFO for SSB, Built-in Speaker, Bandspread, Sensitivity Control. 220/240v. A.C. or 12v. D.C. 12½" × 4½" × 7" Brand new with instructions. £25. Carr. 37½p.

SKYWOOD CX203 COMMUNICATION RECEIVER



Solid state. Coverage on 5 bands 200-420 KHz and ·55 to 30 MHz. Illuminated slide rule dial. Bandspread. Aerial tuning BFO, AVC, ANL, 'S' meter. AM/CW/SSB. Integrated speaker and phone socket. Operation 220/240v AC or 12v DC. Size 325 × 266 × 150 mm. Complete with instructions and circuit. £28·50. Carr. 50p.

LAFAYETTE HA-600 SOLID STATE RECEIVER



General coverage 150–400kc/s. 550 Kc/s–30Mc/s. FET front end. 2 mech. filters, product detector, variable B.F.O., noise limiter. S. Meter, Bandspread, RF Gain. 15" × 9¼" × 8½". 18 lbs. 220/240v. A.C. or 12v. D.C. Brand new with instructions. £50. Carr. 50p.

TRIO 9R59DS COMMUNICATION RECEIVER

4 band covering 550Kc/s. to 30 Mc/s. continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW. ANL. Variable BFO. S meter. Sep. bandspread dial. IF frequency 455 Kc/s. audio output 1·5w. Variable RF and AF gain controls 115/250v. A.C. Size: 7" × 13" × 10" with instruction manual. £49·50. Carr. Paid

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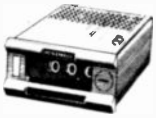
HONEYWELL DIGITAL VOLTMETER VT.100



Can be panel or bench mounted. Basic meter measures 1 volt D.C. but can be used to measure a wide range of AC and DC volt. current and ohms with optional plug in cards. Sepcification: Accuracy: ± 0·2, ±1 digit. Resolution: 1mеV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999). Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100v. D.C. Input: Fully floating (3 poles). Input power: 110–230v. A.C. 50/60 cycles. Overall size: 5⅝in. × 2 13/16in. × 8 3/16in. AVAILABLE BRAND NEW AND FULLY GUARANTEED. £85·50. Carr. 50p.

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OUR PRICE £1·80

P. & P. 10p

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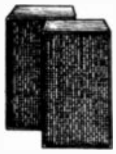

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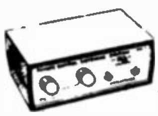

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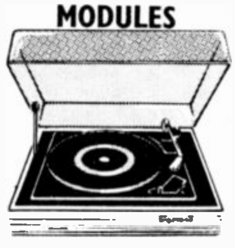

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	Our Price
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HOSIDEN DH-08S DE-LUXE STEREO HEADPHONES

Features unique mechanical 2 way units and fitted adjustable level, controls. 8 ohm impedance 20–20,000cps Complete with spring lead & stereo jack plug £7·97½. P. & P. 12½p.

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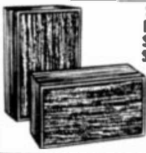
Top quality Hi-Fi Low Noise in Library cases.

C60	3 for 75p.	10 for £2·25
C90	3 for £1·05	10 for £3·30
C120	3 for £1·35	10 for £4·20

Tape Head Cleaner 30p each. P. & P. 10p extra.



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TE 1018 DE-LUXE MONO HIGH IMPEDANCE HEADSET

Sensitive, soft earpads, adjustable headband. Magnetic, impedance 2,600 ohms. £1·97, P. & P. 15p.

G. W. SMITH & CO (RADIO) LTD.

Also see previous pages and opposite page

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

THE FABULOUS

ASTRAD 17

PORTABLE RADIO & COMMUNICATIONS RECEIVER

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

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

28 TRANSISTORS AND DIODES!

WAVEBANDS: STANDARD LONG and MEDIUM *Plus* 5 SHORT WAVEBANDS *Plus* ULTRA SHORT WAVES (V.H.F. AM. FM. MW. LW. USW.)

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

MAINS/BATTERY ELIMINATOR £1·48 extra

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

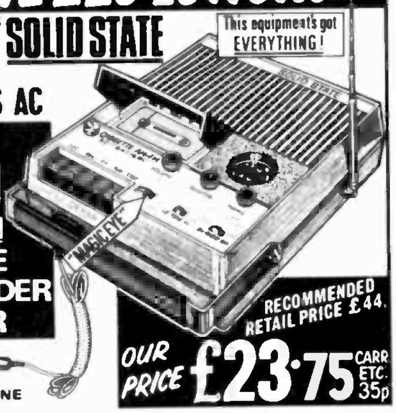
ALMOST UNBELIEVABLE! Think of the year 1984 and what might be produced then—now get the fantastic ASTRAD 17 and SEE for yourself that the incredible Russians have done it all NOW! It's the radio perfectionist's dream come true! THIS ONE SUPERSEDES ALL EARLIER MODELS! It will probably make your present radio seem like a "crystal set"! Complete with optional battery eliminator for both battery and mains use! We're almost giving them away at only £20·75—**a mere fraction of even today's Russian miracle price!** We challenge you to compare performance and value with that of £80 radios! *Test 7 days, we'll refund instantly if you are not astounded! **Elegant black & chrome finish facia, set in fabulous Cabinet built case—constructed of fine Russian hardwood in beautiful Teak Veneer finish—prevents vibration, ensures purer & sweeter tone than ever!** Volume controlled from a whisper to a roar that would fill a hall! **Much wider band spread, for absolute "pin-point" station selection! Plus "MAGIC EYE" tuning level indicator for ultra perfect tuning sensitivity!** Yes, the Russians have surpassed themselves, proving again their fantastic ability in the field of electronics and brilliantly reflecting their advanced micro-circuitry techniques in the field of spaceship and satellite communications. **Yes, EVERY WAVEBAND instantly at your fingertips including Standard Long, Medium, Short and Ultra Short Waves to cover the four corners of the earth 24 hours a day including all normal transmissions. VHF, AM, FM, MW, LW, USW, plus local & new stations not yet operational, and messages from all over the world! Expensive TURRET TUNER** side control waveband selection unit (as used on expensive T.V.'s!). Every waveband clicks into position giving incredible ease of station tuning! Genuine push-pull output! ON/OFF volume and separate Treble and Bass tone controls for utter perfection of reproduction and tone! **Press-button dial illumination! Take it anywhere**—runs economically on standard batteries (obtainable everywhere) or direct through battery eliminator from 220/240v AC mains supply. Internal ferrite rod aerial plus built-in "rotatable" telescopic aerial extending to 39ins approx. **It's also a fabulous CAR RADIO. Can also be used through extension amplifier, tape recorder or public address system. SIZE 14ins x 10½ins x 4½ins** overall approx. Magnificently designed, made to give **years of perfect service.** (U.K. service facilities & spares available for years & years to come, if ever necessary!). With WRITTEN GUARANTEE manual with simple operating instructions & circuit diagram. **ONLY £20·75** (with mains/battery eliminator £1·48 extra) **BOX, POST, ETC. 50p. *BUT WAIT,** for **only 55p extra** you get the sensational **"COMPUTERISED" WORLD TUNING GUIDE** (It enables you to time, pinpoint & get transmissions the whole world over—even a child can do it in a flash—it even **lets you know when to tune into the U.K. when abroad.** NO GUESSING! NO MESSING!) **PLUS** Standard **'longlife' batteries PLUS ultra sensitive earphone for personal listening.** (Sorry—We cannot change these new radios for any earlier model purchased.) HURRY! Send today and test 7 days—refund if not delighted or call.

SAVE £20·25 NOW!

BUY ONE FROM US! fabulous BRAND NEW SOLID STATE

This equipment's got EVERYTHING!

BATTERY/MAINS AC *Combined* V.H.F AM/FM RADIO and CASSETTE TAPE RECORDER & PLAYER



WITH REMOTE CONTROL MICROPHONE

RECOMMENDED RETAIL PRICE £44

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Shopertunities "thunder" ahead with an offer that's FANTASTIC (even by our standards!). We've snapped up 500 magnificent machines. **Latest sensation in the world of sound!** First-class makers! Fabulous **VHF, AM/FM Radio AND Cassette Tape Recorder & Player combined and it also runs off standard batteries or mains.** (Simply plug in the 220/240V. AC line cord.) Record and play back **anything, anywhere! Even tape direct from the radio as you listen! RECOMMENDED RETAIL PRICE GENUINELY £44! WE OFFER AT ALMOST HALF PRICE!** Wonderful features: **★ Press-button Keyboard Control Panel or latest MASTER SWITCH CONTROL! ★ "MAGIC EYE" Visual Battery check recording level indicator or built-in automatic Leveller! ★ Separate ON/OFF and HI-LO volume controls! ★ Heavy duty built-in speaker! ★ Earphone** (for personal listening or "monitoring") **and extension speaker sockets! ★ Remote control microphone! ★ Built-in swivel telescopic extension aerial (24in. approx.)! Magnificently made case with carry handle. (DESIGNS VARY SLIGHTLY.)** Takes standard 30, 60, 90 or 120-minute Cassette Tapes obtainable everywhere. **AND the amazing built-in full circuit VHF, AM/FM Radio** gives you superb clarity of tone, incredible station selection. Unique rotating Station Selector Dial—get all local city and regional stations in every part of the country plus B.B.C. National, VHF. Picks up dozens of foreign stations. **Fabulous in your car!** You could pay £ £ £'s more for a Car Radio or Car Cassette player **ALONE! OUR FANTASTIC PRICE ONLY £23·75, CARR., ETC. 35p. Complete with simple instructions, remote control microphone with on/off switch and microphone stand. WITH WRITTEN GUARANTEE.** *Send today*—test 7 days, refund if not delighted. Or call at either of our stores. **BONUS OFFER: Batteries and Cassette Tape 25p extra if required.**

FIRST TIME EVER! *SAVE £14·48!

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With remote control microphone

FIRST CLASS MAKERS

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THE ONE STEP FORWARD EVERYONE HAS WAITED FOR! **NOW** a superb de-luxe portable **BATTERY/MAINS** tape recorder and player—and incredible **Shopertunities** bring it to you for ONLY £12·49! Due to our cut price we cannot name first-class 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 and off you go!** (Takes 30, 60, or 90 minute standard cassette tapes obtainable everywhere). **Amazing** performance ensures perfect tapings and superb reproduction! Remote control microphone. Rapid Rewind! Fast forward! Beautiful tone from a whisper to a roar! Completely self contained—**record anywhere,** indoors or out! **Runs on standard batteries AND 220/240v. AC mains.** Separate jacks for remote control microphone, etc. Size 9½in. x 5in. x 2½in. approx. Design can vary slightly. With carry handle. WRITTEN GUARANTEE and full instructions. **ONLY £12·49 post, etc., 31p.** ★Refund if you don't agree we could charge up to £26·97! **BONUS OFFER (one per customer)—Cassette tape, set of standard batteries, AND microphone stand all for 50p extra, if req.**

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everyday electronics

PROJECTS...
THEORY......

IN RETROSPECT

With the first 12 issues already behind us and a new year almost here, it is a good time to look around and take stock.

Since EVERYDAY ELECTRONICS first appeared, many thousands from all walks of life and of many different age groups must have gained their first insight into the workings of mysterious electronics. For them formidably looking barriers have been demolished and the fundamentals of electronics laid bare.

Our first course of painless initiation into the theory and practice of this technology was recently concluded. *Teach-In* has given a great start to many newcomers, and on these foundations they can continue to build: through further study plus active participation in the form of practical experiments, as described in our current series entitled *Demo Circuits*.

Valuable experience is of course also acquired through constructional work. Our projects provide good variety and should go a long way towards satisfying all tastes. It will have been noted that EVERYDAY ELECTRONICS has no inhibitions about the uses of electronics. This technology is ideally suited for simple uncomplicated down-to-earth applications, as is proved by the many projects of decidedly homely character which have already appeared in these pages.

NATURAL PROGRESSION

Their appetite whetted, some readers are bound to be eager now to pursue their studies even further, and to widen their practical experience through building more advanced, more ambitious, and more thought-provoking pieces of electronic equipment.

Having been responsible for starting so many off in the first instant, we feel duty bound to assist by suggesting the next move. If such enthusiasts do follow our advice, we shall have a continuing interest in their progress, because the most logical next step is for them to get acquainted with our associate and parent publication PRACTICAL ELECTRONICS. This is a well established meeting ground for the keen amateur, the serious student, and the professional technician and engineer.

EASY DOES IT

EVERYDAY ELECTRONICS will continue to provide the ideal introduction to this all important subject. Within these pages anyone completely unfamiliar with electronics will always find helpful easy-to-follow articles dealing with elementary theory, as well as simple practical designs for building at home.

And now, at this time, we would like to offer seasonal greetings to all our readers. To those who have supported us from the beginning of volume one, a special thank you.

Fred Bennett.

Our February issue will be published on Friday, January 19

EDITOR F. E. Bennett • ASSISTANT EDITOR M. Kenward • B. W. Terrell B.Sc.
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..EASY TO CONSTRUCT
..SIMPLY EXPLAINED

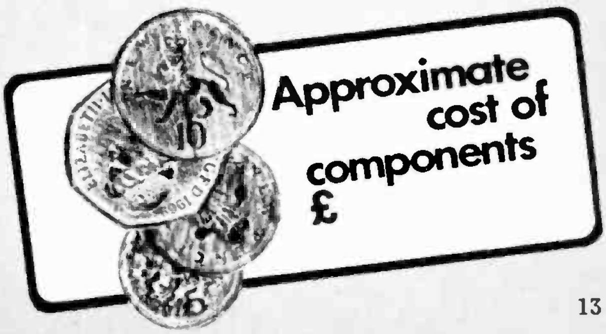
VOL. 2 NO. 1 JANUARY 1973

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

The approximate cost of components given, for constructional articles, in the box shown opposite is an estimated cost compiled from suppliers current catalogue and advertised prices. Parts for some projects may work out more expensive while others may be cheaper than our quoted price, depending on where the components are purchased.

We would like to point out that we, as publishers, cannot supply kits of parts or individual items for any of the published designs.



ICE WARNING DEVICE

BY C. HODGES

A simple device for detecting a remote temperature fall

WITH the winter coming on, many householders and motorists find the need to know when the temperature falls below a certain level. This simple device is designed to be used to check if the temperature sensed by a remote thermistor has fallen below a set level.

The device can be powered by a small 9V battery for portability and, provided it is not left on but used as a regular quick check, the battery will last for quite some time. The unit may also be powered from a car battery by using a simple stabilizer and it will provide the motorist with a check when ice may be forming.

Approximate cost of components £1·40 inclusive

CIRCUIT OPERATION

The circuit is basically a Schmitt trigger (Fig. 1) which is switched from one mode to the other by the variation in resistance of the thermistor RTH1. The temperature at which the Schmitt will switch is set by VR1 and, when the resistance of RTH1 rises with a fall in temperature TR1 is caused to turn off and TR2 to turn on, thus causing LP1 to light. The backlash or hysteresis inherent in this circuit will prevent the lamp from extinguishing until the temperature has risen to a few degrees above the pre-set level. (For a full description of the Schmitt trigger action, see *Demo Circuits* next month.)

To set the level required it is necessary to arrange for the thermistor to be at the temperature level at which the Schmitt must switch, then adjust VR1 until LP1 lights and turn VR1 back very slightly. To check this level switch off the unit, allow the thermistor to warm up, switch on the unit and cool the thermistor, checking the temperature at which LP1 lights.

CONSTRUCTION

Commence construction by cutting the Veroboard to the size shown and drilling the mount-

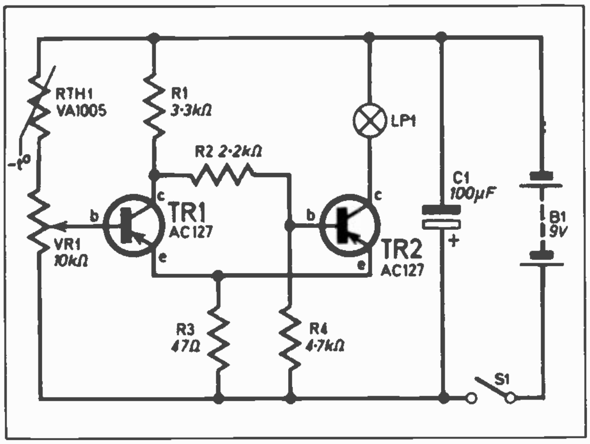


Fig. 1. Complete circuit diagram of the Ice Warning Device.

ing hole. Next solder the components to the board as in Fig. 2. Solder the transistors last, using a heat shunt on each lead as it is soldered. No breaks are necessary in the copper strips. Next connect the flying leads making sure that they are long enough to allow the case lid to open fully.

Connect the negative lead to the battery connector and the positive lead to the switch (Fig. 2), another lead should be connected from the switch to the positive battery terminal. The two leads from TR2 and R1 can be connected to the lamp and the other three leads can be connected to VR1 and RTH1 (as in Fig. 2).

Components.... SEE SHOP TALK

Resistors
- R1 3·3kΩ
- R2 2·2kΩ
- R3 47Ω
- R4 4·7kΩ
- All ± 10% ¼W carbon

Capacitor
- C1 100μF elect. 12V

Thermistor
- RTH1 VA1005 rod type

Transistors
- TR1 AC 127 germanium *pnp*
- TR2 AC 127 germanium *pnp*

Miscellaneous
- VR1 10kΩ carbon potentiometer
- S1 S.p.st. toggle switch or push to make, push to break button
- LP1 6V 0·06A bulb and panel mounting holder
- B1 9V PP3 battery
- Veroboard 1½in × 1½in × 0·1in matrix, control knob, case (see text), 4BA fixing, battery connector, wire, two way connector for RTHI

CASE

The case of prototype is constructed from an empty tobacco tin, the components and battery fit snugly into this box and it is also very cheap. Remember to insulate the Veroboard if a metal box is used. Lamp LP1 and its holder are available in many shapes and sizes therefore the method of fixing will vary.

The complete Ice Warning Device, housed in a tobacco tin case.

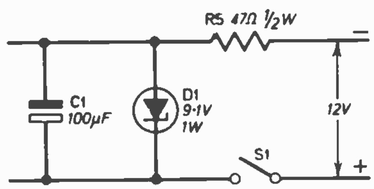
CAR SUPPLY

As previously stated the unit may be powered by a car battery, Fig. 3 shows a suitable arrangement for a simple Zener stabilizer for 12V systems. When connecting the unit to the car wiring make sure that the polarity is correct.

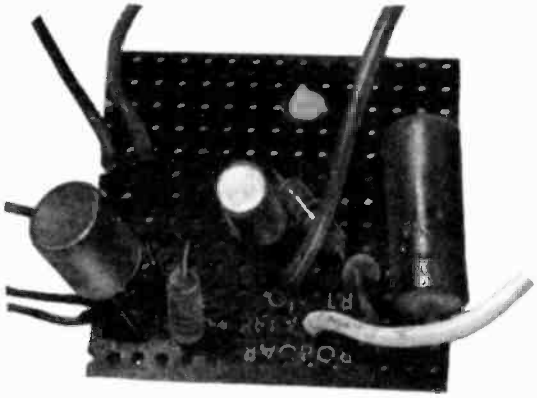
To finish the complete unit the case can either be painted or covered with Fablon, or similar material, and lettered to indicate the control functions.

If RTH1 is to be left outside at the mercy of the elements it should be protected by a coat of paint or by enclosing it in Araldite or one of the plastic fillers sold for use on car bodies, etc. ▣

Fig. 3. Simple stabilizer circuit for use with a 12V car supply.



ICE WARNING DEVICE



Photograph of the completed circuit board.

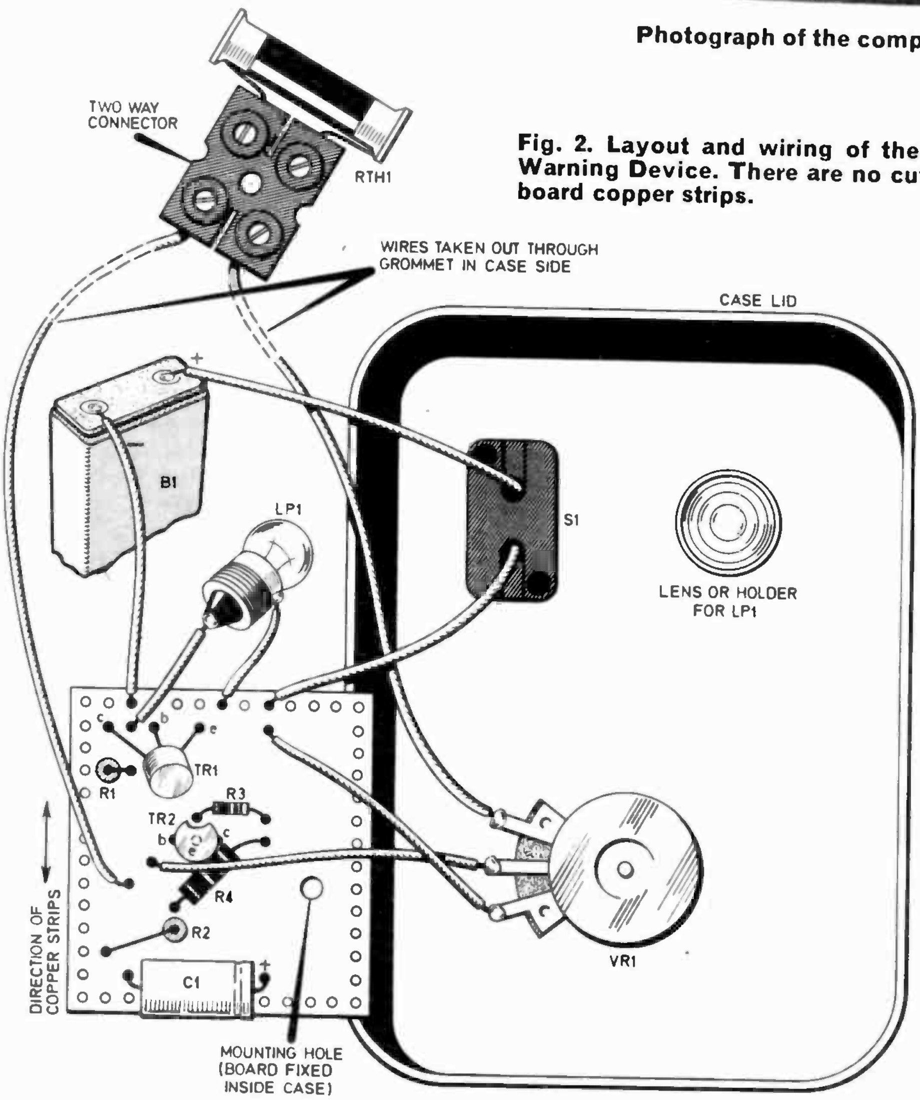
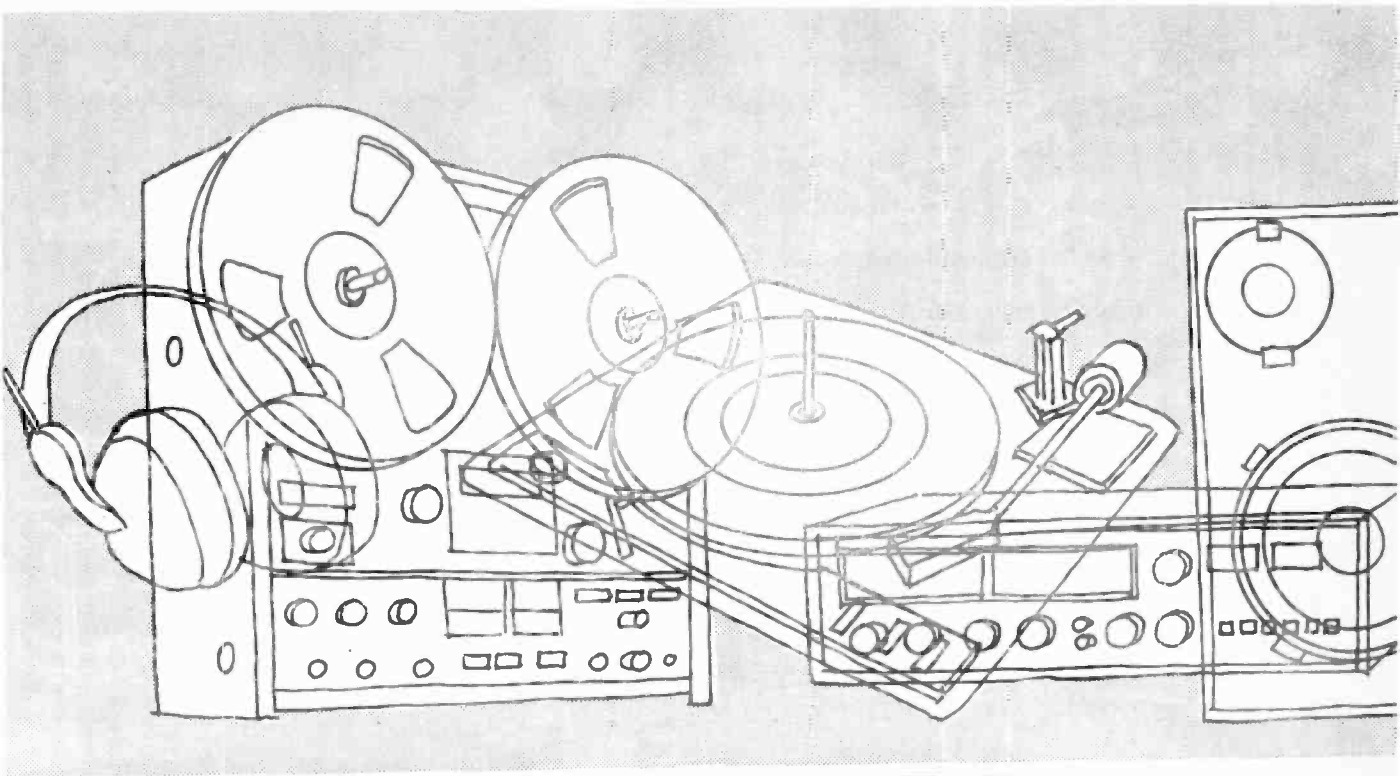


Fig. 2. Layout and wiring of the complete Ice Warning Device. There are no cuts in the Veroboard copper strips.



Selecting Hi Fi Equipment...

By Terence Mendoza B.Sc.

To many people high fidelity is a term which covers a bewildering array of complex looking boxes with complicated sounding names. While these people may wish to get rid of their old record player for something better, they are deterred by the multiplicity of hi fi gadgetry available.

This article is intended to give guidance to such people and, if you class yourself within this group, don't get disheartened—the most fanatical hi fi enthusiast at some stage knew just the same as you do now.

HOW HI FI CAME ABOUT

The sound medium, which achieved popularity after Edison's cylinder phonograph, was the 78 r.p.m. shellac disc. In the early days discs were recorded on one side only but, with the advent of mechanization due to electricity, the "one-siders" gave way to discs recorded on both sides. The era of the mechanical "wind-up" gramophone came to an end and the electric gramophone seized the market with advantages which included efficient volume control, a reasonably consistent running speed and a necessity for less expenditure of elbow grease!

The status symbol syndrome appeared at this stage and audio has never fully recovered—the cabinet swelled in size, acquiring a wireless, an ornate contemporary appearance and price to match and thus the majestic radiogram was born. There is no doubt that these immense items sounded impressive—with material available at the time. This material consisted of discs with background crackle and hiss, and medium and longwave radio, also rather noisy and prone to radio interference.

Radiograms were designed principally as elegant items of furniture and secondly as reproducing equipment that would give a pleasing sound by cutting down the unpleasant background noise—accomplished by constructing the cabinets to absorb the (mainly high frequency) hiss, and noise. Nowadays we would politely call the sound muffled but at the time it was referred to as "mellow toned."

Major improvements in the quality of available sources, the 33 r.p.m. disc with a much lower background noise and v.h.f.-f.m. radio with a virtual absence of interference, set the equipment manufacturers the task of building radiograms which would handle new material to its best advantage.

The hiss of the equipment became important for the first time and so did the unwanted hum which could now be differentiated from the source material. The cabinet resonance, formerly used to disguise the shortcomings of disc and radio, were no longer needed and the concept of high fidelity became established.

True high fidelity *implies* the "closest approach to the original sound"—with the eyes closed it should not be possible to differentiate between a live musician playing and a recording of the musician.

Individual hi fi units made by Goodmans. The units are a.m./f.m. tuner, amplifier and record deck.

TECHNICAL PROBLEMS

Problems occurred with the overall improvement in reproduction equipment. If a better radiogram was used at high volume, the speakers would make the cabinet vibrate. This vibration, when mechanically transmitted through the disc, caused the pickup (sensitive to vibration) to respond and this vicious circle of events resulted in a whistle called feedback. The speaker had to be separated from the rest of the cabinet to alleviate this effect and this allowed for more control over the shape and size of speaker cabinet which in turn affected the fidelity of the resultant sound.

Magnetism and electricity, as readers will be aware, are closely linked and, under suitable conditions, each can generate the other. There was a tendency for the electrified coils of the amplifier transformer to set up powerful alternating magnetic fields which the record pick-up, generally a magnetic transducer, would detect. This signal would then be amplified along with the wanted signal from the disc, to be heard as "mains hum." The cure was to remove the amplifier from the vicinity of the pick-up. Thus the radiogram had now become three separate units—record deck, plus arm and pick-up cartridge, amplifier with preamplifier and power supply circuitry and a loudspeaker.

Accurate spatial localization as well as fidelity of reproduction was still needed to realize the ideal of the "closest approach to the original sound."

It is our brains that determine the direction from which sounds come, an extremely complicated process analyses the signals received by each ear comparing them for differences in loudness, phase and delay. Variations in these factors when equated against the external aural environment, enable the brain to localise the direction of a sound source.

STEREO

Stereophony, or stereo, is the hi fi process that provides the ears with enough additional information to give the subjective impressions of specific sound loci positioned in space between the two (or more) speakers of the reproducing system. Grooves in a stereo record are cut in such a fashion that two sets of information can be derived from a single groove (Fig. 1)—this information is then amplified by a pair of amplifiers (incorporated in one unit in the modern stereo amplifier) to give the signals power enough to drive two loudspeaker units placed some distance apart.

When the same signal is fed with equal power to each speaker it will appear to emanate from a point in space midway between the two speakers. Increasing the power to one speaker will subjectively appear to move this localization point more towards the speaker in question. The localizing mechanism of the brain is efficient only in the horizontal plane and not in the vertical plane (we don't have ears on top of our heads or beneath our chins!) so a two speaker system is adequate for recreating the full spread and depth of an orchestra in front of us.

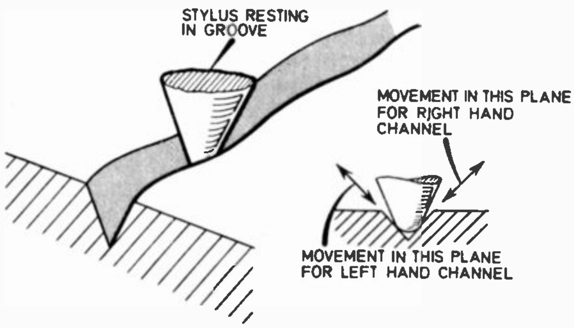
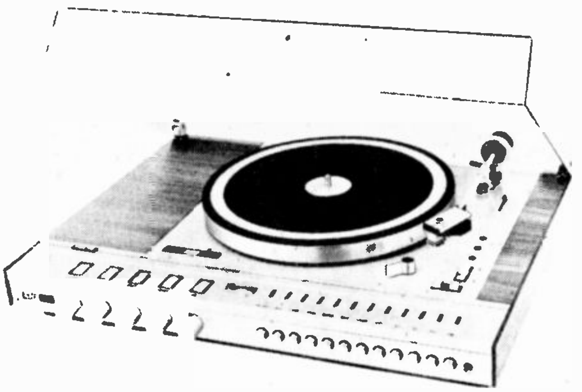


Fig. 1. Showing how a stereo signal is obtained from the record.

PLANNING YOUR SYSTEM

A newcomer can benefit by planning for his "ultimate system" from the beginning. Bearing in mind that he need not buy all the units at one time, he can budget for fewer, better quality components, e.g., by not buying a radio tuner in the first instance, he can initially afford slightly better record deck, amplifier and



A Philips "compact" system, containing tuner, amplifier and record deck.

speakers—thus the hi fi can improve at the same pace as the ear becomes discriminating and the pocket can afford, a choice of sources being added when finances will allow.

SPECIFICATION

Hi fi equipment fulfils stringent specifications which guarantees that it will faithfully reproduce all the subtleties of musical sounds without coloration or distortion. An understanding of hi fi specifications allows one to assess the expected performance of different items of equipment before hearing them. In particular, the following points are important:

1. There should be a low noise level throughout the system. Noise is defined as unwanted sound and this covers hiss, rumble (low frequency sound mechanically originating from record turntables) and hum (due to induced magnetised fields). It is quoted as a **signal to noise ratio** and is measured in decibels (dB).

Construction of an EMI loudspeaker kit. This simple to assemble complete kit is a cheap way of obtaining speakers.

The ratio compares the unwanted noise with a predetermined output power—this output is usually the maximum power an amplifier will deliver without distortion. The first stage of amplification, the pre-amplifier, deals with the smallest voltages as delivered directly from the sources. Different sources deliver different size voltages and hence have to be amplified by different amounts to give sufficient energy to drive the power amplifier. Because of this, different noise figures may be quoted for various sources, e.g., radio 62dB, tape 65dB (the higher the figure the better).

One may sometimes see the signal to noise ratio quoted for the pre-amplifier, amplifier system with all the input gain (volume) controls set to maximum sensitivity (turned right up). This gives an idea of how the noise level would behave under the hypothetically poorest possible conditions.

2. The equipment should respond in exactly the same fashion to whatever audio frequency is fed to it, e.g., the frequency range should be very wide and smooth. This range should extend from the deepest bass notes to the highest overtones. For this reason manufacturers aim to equal at least the range detected by a young person's ear, e.g., 20Hz to 20,000Hz (20kHz).

This range is only useful if it is smooth so that it does not colour the sound, hence a **frequency response** is quoted within stated limits, i.e., 30Hz-20kHz ±1dB, this particular specification indicates that over the stated frequency range the amplifier will not amplify any one frequency more or less than 1dB against any other frequency; 1dB loudness difference is less than most people are able to detect. The ear is most critical to loudness differences that occur around 1,000Hz and this frequency is taken to be on the 0dB mark to standardize graphical representations of frequency response (see Fig. 2).

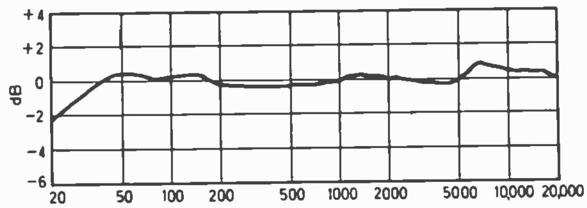


Fig. 2. A frequency response graph. The response is 30Hz-20kHz ±1dB.

3. Distortion must be low; if it is not the sound will be "gritty" and unpleasant. 0·5 per cent **total harmonic distortion** and less is reasonable and less than 0·1 per cent is considered excellent.

4. There should be enough amplifier **power** in reserve to handle **transients** (sudden loudness increase, as in fortissimo passages) cleanly and without distortion. For a good system about 15 watts per channel is considered a reasonable minimum.

5. **Cross-talk**, the level at which the sound from one channel leaks on to the other channel—should be low throughout the system. An average figure is 40dB beneath a signal of equivalent power fed to the other channel, although the minimum recommended value differs with different audio units.

6. The speed at which tape or disc recordings have been made should be produced accurately during replay or the pitch will fluctuate and music sound unpleasant particularly on long sustained notes, short term fluctuation is termed **flutter** and slower speed changes **wow**.

Wow and flutter is quoted as a percentage and a reasonable average for a tape recorder is 0·15 per cent and for a turntable is 0·1 per cent.

FIRST UNITS

The first units to consider for the basic system are the speakers and stereo amplifier. The amplifier is usually integrated with the pre-amplifier which is responsible for increasing the minute signals from the record pick-up, tape head or tuner so that there is enough power to drive the loudspeakers.

Stereo amplifiers provide flexibility in the control of sound so that it can be tailored to suit various types of recorded quality, room acoustics (which influence what the hi fi sounds like) and individual personal taste. Judicious use of the tone controls can reduce obnoxious record crackle and/or distortion.

The prime controls are bass and treble, the former affecting the deep sounds to enhance or reduce them and later having similar effects on the high notes. Filters to remove turntable rumble and record scratch are often provided; these are similar to tone controls in that they affect a band of frequencies, reducing the output of the amplifier over the narrow range in which the unwanted sound is produced. Amplifier prices in the hi fi category range from about £30 to £300 or more.

SPEAKERS

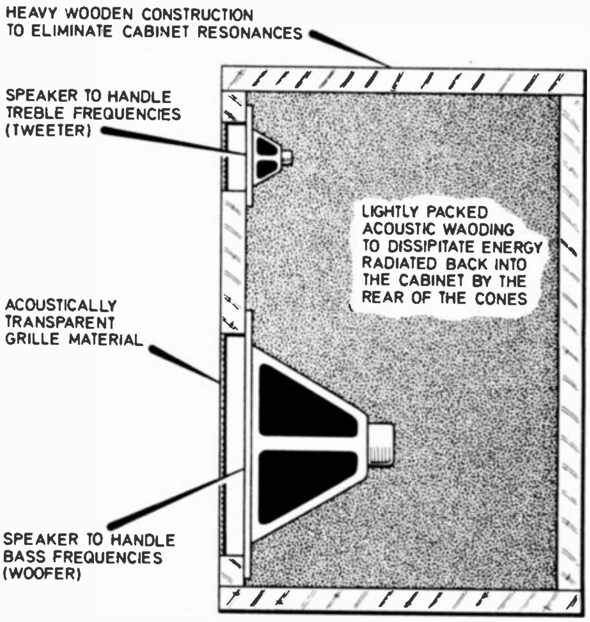
Once amplified the signals pass on to the loudspeakers. Desirable qualities of loudspeakers can be listed as follows.

1. The two speakers should be of the same design and housed in identical enclosures (boxes) to ensure that the stereo image (the ears subjective placing of the sound between the speaker) remains stationary. If dissimilar speakers are used the sound will veer towards one or other speaker at those frequencies which the particular speaker reproduces more loudly—this is called the **colouration** of the speaker.

2. Aesthetic appearance and size must also be taken into account, speaker cabinets are fronted with **acoustically transparent** grille material and some firms offer a choice of both grille material and wood finish. The wood finish should be chosen to suit the room for which the hi fi is intended and the same finish is normally used for all the units in the chain.

Speaker prices range from £25 to over £300 per pair. Despite the fact that loudspeakers for hi fi have been designed to be relatively free from both distortion and colouration each unit nevertheless has its own sound. This is due to the many interacting compromises of size and shape of speaker cone, of the cabinet and its construction and many related factors so it is advisable to compare a selection of models in the same price range, listening to well known material in a familiar environment—many dealers will bring speakers round to a potential customer's house so that he may make his final judgment under favourable conditions.

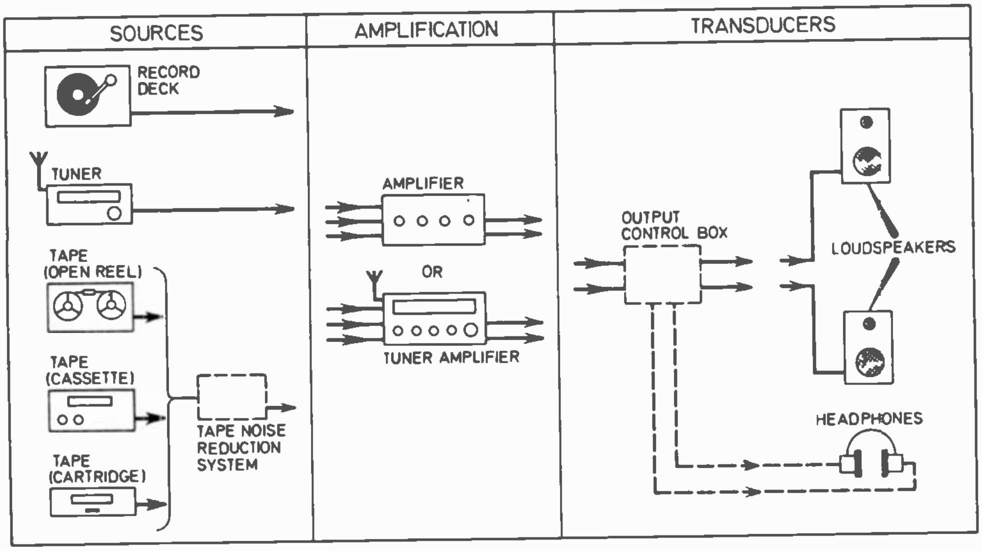
The smaller bookshelf speakers best suit small rooms and the floorstanding ones suit rooms with larger areas—the larger the speaker, the more faithfully it can reproduce the bass end of the spectrum. However, a bookshelf speaker will still handle bass well, despite definitive size due to the cabinet being constructed in the form of an "infinite baffle," i.e., completely sealed except for an aperature for the speaker cone. It thus approximates to a baffle board of infinite dimensions; air moving behind the baffle cannot flow round to the front, either in a true (if hypothetical) infinite baffle or in the compact type of enclosure.



Cross sectional view of a basic speaker system employing two speaker "drive" units.

SPEAKER POSITION

Speakers should be placed fairly symmetrically in relation to the room and its furnishings; the positions should be experimentally deter-



Diagrammatic representation of the units available to build up a stereo hi fi system.

mined to give a good stereo spread in the listening area which should encompass the seating arrangements; generally this means a speaker separation of more than six feet.

As a guide, bass response is enhanced if speakers are stood in corners and/or on the floor; small speakers should be placed on shelves to give a more direct path to the listeners ears. If there is an abundance of soft furnishings in the room the treble may have to be boosted at the amplifier to compensate for absorption losses which occur at the higher frequencies.

HI FI SOURCES

If radio is to be the source, then a tuner will be required and, for reasons already stated, it should be capable of receiving f.m. transmissions on v.h.f. F.M. tuners require special aerials to be fitted to the roof or in the loft hence due consideration should be given to the aerial-to-tuner wiring.

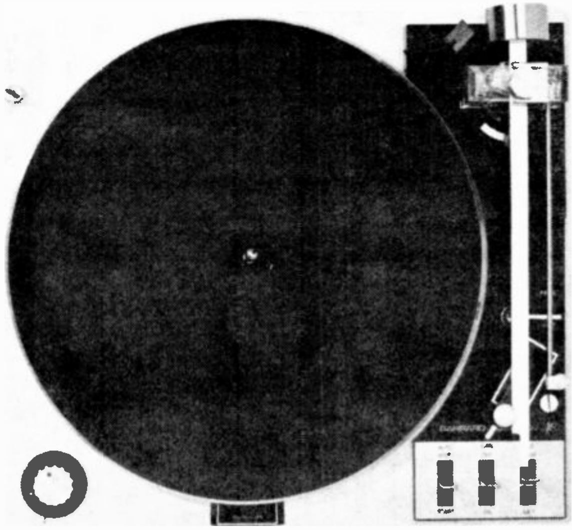
At present BBC Radio 3 and Radio 2 carry many stereo transmissions and plans are under way for Radio 4 to also "go stereo."

Stereo tuner prices extend from about £30 to £150 or more. One common approach is to combine the tuner with the amplifier—the larger unit looks neater yet has all the facilities to be expected from the two as discrete components. Tuner-amplifier prices are from about £50 to £800 or more.

For discs, a record deck will be needed. It consists of a turntable, arm and pick-up cartridge. The turntable should be heavy to give it a flywheel-type momentum to overcome slight speed variation and it should be free from mechanical vibration. Also mounted on the wooden platform, or plinth, with the turntable, is the arm which should be of low mass, well balanced (to cut down effects due to inertia) and frictionless. The cartridge, carried by the pickup arm, itself carries a cantilever which is tipped with an accurately made, microscopically small stylus (the modern-day counterpart of the needle).

Diamond styli are to be preferred as they wear very slowly and hence considerably reduce the risk of accidentally damaging a collection of records by playing them with a worn stylus. The stylus has the immense and incredible task of remaining in the groove of a record following the most minute directional variations whilst at the same time being subjected to terrific velocities and pressures. In addition it must rest so lightly in the groove that it does not distort the plastic material of the disc and, as is to be

The Garrard Zero 100 record deck.

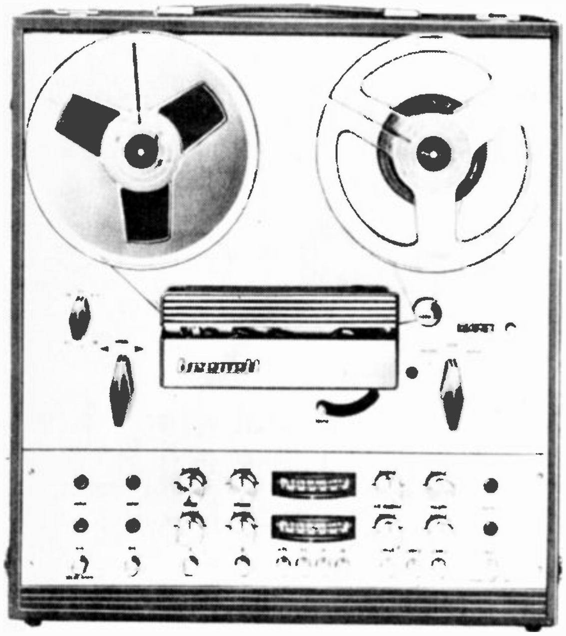


expected, the cartridges are expensive, relative to their size—from about £4 to £60 or more.

Although some decks come complete with arms, many firms make separate arms with weights to counterbalance the weight of the cartridge and inevitable side thrust effects. Devices may be incorporated which lower the arm slowly onto the record, protecting both record and stylus from damage. Prices of arms span the approximate bracket from £10 to £50.

TAPE

The use of tape as a source really requires an article to itself. Three principal types of tape unit exist — open reel machines using tape spools, cassette players and tape cartridge players. Cassettes and cartridges have the advantage of simplicity over open reel machines although the open reel machine is the obvious choice if any "creative" recording is to be done. Good quality cassette decks incorporating noise reduction systems go from about £40 and open reel hi fi stereo decks from around £60.



The Brenell Mk 6 stereo tape deck complete with pre-amplifiers but not power amplifiers or loudspeakers. This is a high quality hi fi tape unit.

INTEGRATED SYSTEMS

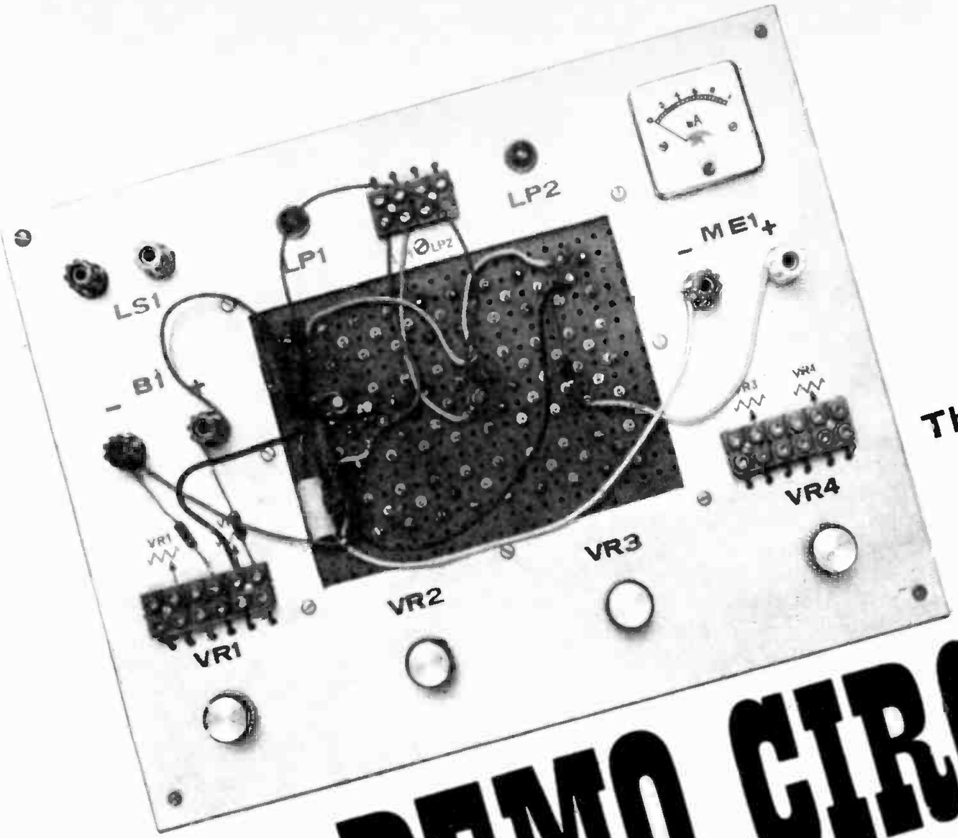
It is important that all items in a proposed system match in respect of input/output impedances and, in the case of pickup cartridges, amplification and equalization. Dealers are happy to advise on such matters and most offer complete "unit audio" systems matched throughout. If the impedance of chosen speakers is less than that of the amplifier output it is possible to overload the amplifier, the converse also applies, e.g., an amplifier with 8 ohm outputs powering 15 ohm speakers will not give so much output.

Although it has already been stated, it is important to hear units before purchase to determine whether the standard will match up to that of the equipment already owned, if any. The guide that I personally find useful is that the price of the pair of speakers should be slightly more than that of the amplifier. Highly acceptable hi fi is obtained from units one third the way up the price brackets and, near the top end, the law of diminishing returns comes into play and more money has to be spent to realise any noticeable increase in quality or available facilities. Careful buying can give a hi fi to be proud of for £250 with tape, disc and tuner.

RULES

To conclude, rules to remember are: pre-plan for the final system in stages if it cannot all be purchased at one time. Check that the quality, impedances, voltages and wattages of the different items match. Quality is best judged with material familiar to the listener in a domestic setting. Sustained piano notes will reveal wow, and transient response (and hence reserve power) can be judged on orchestral music with a wide dynamic range. Don't get so bogged down that you are spending all your time listening out for hiss and hum on your equipment. Once you've got your hi fi learn the facility of turning off your technical criticisms so you can just sit back and enjoy the music. Happy listening! ▣

The Danasound Dynamic headphones produced by Danavox. These headphones are lightweight for comfort and are available wired for stereo or mono.



2

The Relaxation Oscillator

DEMO CIRCUITS

By MIKE HUGHES

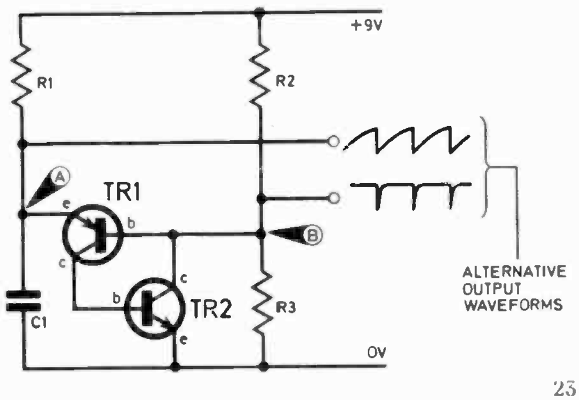
THIS month's circuit—shown in Fig. 2.1—belongs to a group called **relaxation oscillators**. The principle of operation is that C1 is allowed to charge up to a pre-determined value and then transistors TR1 and TR2 rapidly discharge the capacitor. The potential at point A thus rises from nearly zero to the pre-determined level following the characteristic capacitor charge curve and then reverts rapidly back towards zero.

The cycle is made to be repetitive and the signal waveform at point A resembles a sawtooth. Strictly speaking the rise in voltage is not directly proportional to time so the upward going ramp is not what we call linear unless the voltage level at which discharge commences is low compared with the total range of charging voltage (i.e. our battery voltage).

CIRCUIT ACTION

The important circuit action occurs between TR1 and TR2. Assume that R2 and R3 are the same value and that TR2 is not conducting; the potential at point B will be exactly half the supply voltage i.e. 4·5V. Also assume that C1 initially has no charge on it so that the potential at A is zero. The emitter of TR1 is now more negative than its base so no base current can flow (it is a *pnp* type). In the absence of base current no current can flow between its emitter and collector and this, in turn, prevents base current flowing in TR2 which is an *npn* type. Because of this no current flows between collector and emitter of TR2 and the potential at B will stay exactly as we have already described (4·5V).

Fig. 2.1. The basic circuit diagram of the relaxation oscillator.



Capacitor C1 immediately starts charging towards 9V but when the potential at A reaches 5·1V we arrive at the situation when the emitter of TR1 is now 600mV more positive than the base and TR1 turns on (we are assuming silicon transistors are being used). Current flows from the charge held in C1 and from the positive rail through R1 into the emitter of TR1 out of its collector and into the base of TR2. Transistor TR2 thus switches on and current is drawn between its collector and emitter; this current flows through R2 and the potential at B starts to fall.

The fall in potential at B makes it easier for base current to flow in TR1 therefore TR1 passes heavier collector current which drives TR2 further into conduction. This causes the potential at B to decrease even further and again this makes TR1 conduct harder. We can go round this loop over and over again; each time the transistors switch on more and more until they are fully conducting (we say they reach saturation). This process occurs very rapidly.

The main current flowing into the emitter of TR1 comes from the charge held on C1 and, provided R1 has a high value compared with the effective resistance of the emitter/collector and base/emitter paths of TR1 and TR2, the potential at A will fall towards zero very rapidly. When the voltage at A reaches a level slightly more than 600mV, TR1 will start to switch off because base current can no longer be maintained; this reduces the base current in TR2 and the latter starts to switch off. This makes the potential at B start to rise and again we have a cyclic effect in the loop between TR1 and TR2. Eventually both transistors are back to a non-conducting state and C1 starts to charge up at the beginning of a new major cycle.

OUTPUT AND FREQUENCY

The interaction we have described between the two transistors is called regenerative positive feedback and is characteristic of many types of oscillators. This circuit has a bonus because apart from the sawtooth waveform produced at A we get, as a by-product, a repetitive series of very fast negative going spikes at point B.

In practice R1 is usually of a high value so we are not able to draw much current from the waveform at A before we start to alter voltage levels; this means we will have to use a current amplifier after that stage if we want to make use of the signal—this is described in the experiment which follows. Resistors R2 and R3 can be of quite low values hence there is not so much of a problem in this respect if we wish to make use of the pulses at point B.

The frequency of the sawtooth is controlled by the charging rate of C1 through R1 and the potential at which discharge starts—this could be called the trigger level. If the latter is set to be half the supply voltage the frequency is approximately $\frac{1}{0 \cdot 7 \times C1 \times R1}$ where C and R are measured in Farads and Ohms respectively. It is thus a simple matter to alter the frequency by substituting different values for C1; R1 could be varied as well but this is not desirable as its value can affect the critical potentials that are necessary to maintain oscillation.

PRACTICAL CIRCUIT

A practical circuit that can be made up on Demo Deck is shown in Fig. 2.2. It will be noticed that TR3, TR4 and TR5 have nothing to do with the main circuit and are there to enable the operation to be monitored on a meter and on a lamp. Transistors TR4 and TR5 are two emitter followers in cascade (called a **Darlington pair**); they enable us to use the very small current available at point A to drive a bulb. Transistor TR3 is an emitter follower driving the 1mA meter of Demo Deck (ME1) as a high input impedance voltmeter.

The flying leads from both these indicating circuits can be connected to either point A or point B (Fig. 2.3). Use VR2 of Demo Deck (5 kilohm) to see the effect of altering the triggering level—however, start with point B at +4·5V. If this voltage is set lower than mid-rail the amplitude of the sawtooth and negative going

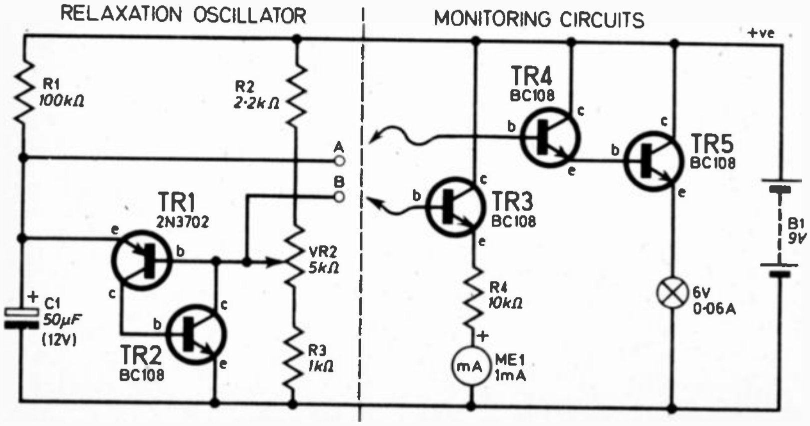
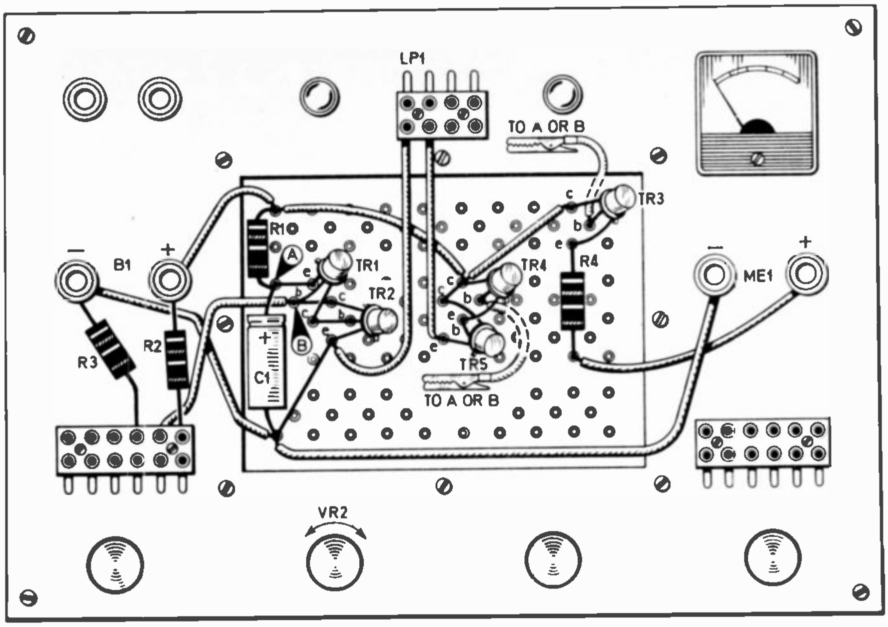


Fig. 2.2. The practical oscillator circuit. Transistors TR3, TR4 and TR5 do not affect the oscillator, they are used for monitoring purposes only.



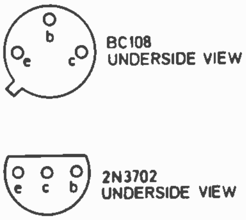


Fig. 2.3. The circuit of Fig. 2.2 built up on the Demo Deck. VR2 controls the triggering level.

pulses will decrease but the frequency increases—also the linearity of the sawtooth improves.

Remember that the sawtooth amplitude is never more than 600mV more positive than the setting of point B so do not expect to get full brilliance from the bulb (the situation is made worse by the forward base emitter drops of TR4 and TR5); this could be improved by increasing the supply voltage to 12V. Try different values for C1; if C1 is reduced to less than about 1μF it will be difficult to monitor oscillation because the measuring system does not respond quickly enough.

Next month: Schmitt Trigger

Ruminations

By Sensor

Any Old Iron

While out in the countryside, last Sunday, I came across one of those "unofficial" rubbish dumps—the country dweller's only way of disposing of his empty bottles and cans, and other waste of our consumer society. The dump was pleasantly situated near a little stone bridge which took the lane over a stream, and I stopped for a while and looked down into the water below.

The autumn sun glinted on some metal in the rubbish and I noticed an old radio lying there. It was a model I knew well, a five valve superhet with long, medium and short waves, built about 1946. The bakelite cabinet lay broken into many pieces, amongst the empty beer cans but the steel chassis was complete and the glass dial was unbroken.

At some time in the past the valve rectifier had been removed, together with the transformer, and a selenium rectifier and mains dropping resistor had been fitted, I could not see the speaker anywhere and did not feel inclined to dig for it, but I know that the original loudspeaker for this set was a mains energised type with a 1000 ohm field winding which also served as a smoothing choke.

When the transformer and valve rectifier were removed it would have been necessary to fit a permanent magnet speaker and modify the smoothing arrangements, as the rectified mains voltage would not be sufficient to cope with a volt drop in the field winding of around 100 volts plus the required h.t. line voltage.

The set had been lying there for some time but I had no doubt that it could be made to work again without too much difficulty—unlike many of our present day miniature radios, which defy any attempt at repair!

A Good Old'un

Apart from the use of frequency modulation, the contemporary domestic radio performs no better than did my old friend on the rubbish dump. The improvements in the last twenty-six years have been in materials, components and methods of production; steel chassis and hand wiring have given way to printed circuits, capacitors have become smaller, resistors are less than half the size they used to be. A watt is still a watt but the resistor manufacturers have quietly managed to produce components that will dissipate the power much more efficiently with a consequential decrease in physical size.

Magnetic steels and ferromagnetic materials have been improved so that loudspeaker magnets can be made smaller and more powerful and the frame aerial has been superseded by the efficient ferrite rod. Transistors have taken over from valves and the "bakelite" cabinet has been replaced by a stronger, less brittle plastic moulding. What we need now is a miniature loudspeaker that doesn't sound like a "strangling chipmunk."

A single channel super-regenerative receiver for model control.

THE transmitter was described last month. This concluding part deals with the receiver, and gives a few useful tips on installing and operating the equipment.

RECEIVER CIRCUIT

The detector used in the receiver circuit of Fig. 1 is of the super-regenerative type. Transistor TR1 is maintained in a highly sensitive condition, just on the verge of oscillation, at 27 MHz, by a secondary oscillation of "quench" frequency of about 25kHz. Although the action of a super-regeneration receiver can seem complicated, it does offer good sensitivity with minimum size and cost.

A difficulty common to all high gain radio receiver circuits is instability caused by small amounts of stray capacitance existing between components and wiring. Slight instability is difficult to identify, and it does have an adverse effect on receiver performance.

In the present case, instability can be prevented by placing a resistance R3 across the radio frequency choke L2. The actual value of R3 will depend on individual circuit differences, such as the high frequency gain of TR1 and the physical spacing of components. It might be thought more convenient to use a sub-miniature variable resistor instead of a fixed resistor for R3, but the variable resistor could shake out of adjustment when subjected to engine vibration and crashes. Details will be given later on the correct selection of R3.

Looking at the other detector circuit components in Fig. 1, Zener diode D1 prevents a drop in receiver sensitivity by holding the detector supply voltage constant until the battery is exhausted. Coil L1 is tuned to the 27MHz carrier, while C2, C5 and C6 govern the quench frequency.

RECEIVED SIGNAL

When a signal is picked up by the receiver aerial, consisting of a tone modulated carrier from the transmitter, the carrier portion of the signal is removed by the filtering action of L2 and C5, to leave an audio tone signal plus quench frequency at the junction of L2 and R4, and this combination is fed to the base of TR2 by C7. Positive half-cycles of the quench frequency serve to bias TR2 on.

The collector load of TR2 consists of the primary winding of T1 tuned by C8, which offers a high impedance to a signal of 500Hz and a low impedance to signals of other frequencies, thus rejecting the quench frequency and any interference from electric motors while passing on the 500Hz tone to TR3.

The amplified a.c. signal appearing at TR3 collector is converted into a steady d.c. current —at the collector of TR4—after rectification by D2 and smoothing by C11. The d.c. current is then further amplified by TR5 to a level of

Radio Control Receiver

by D.Bollen

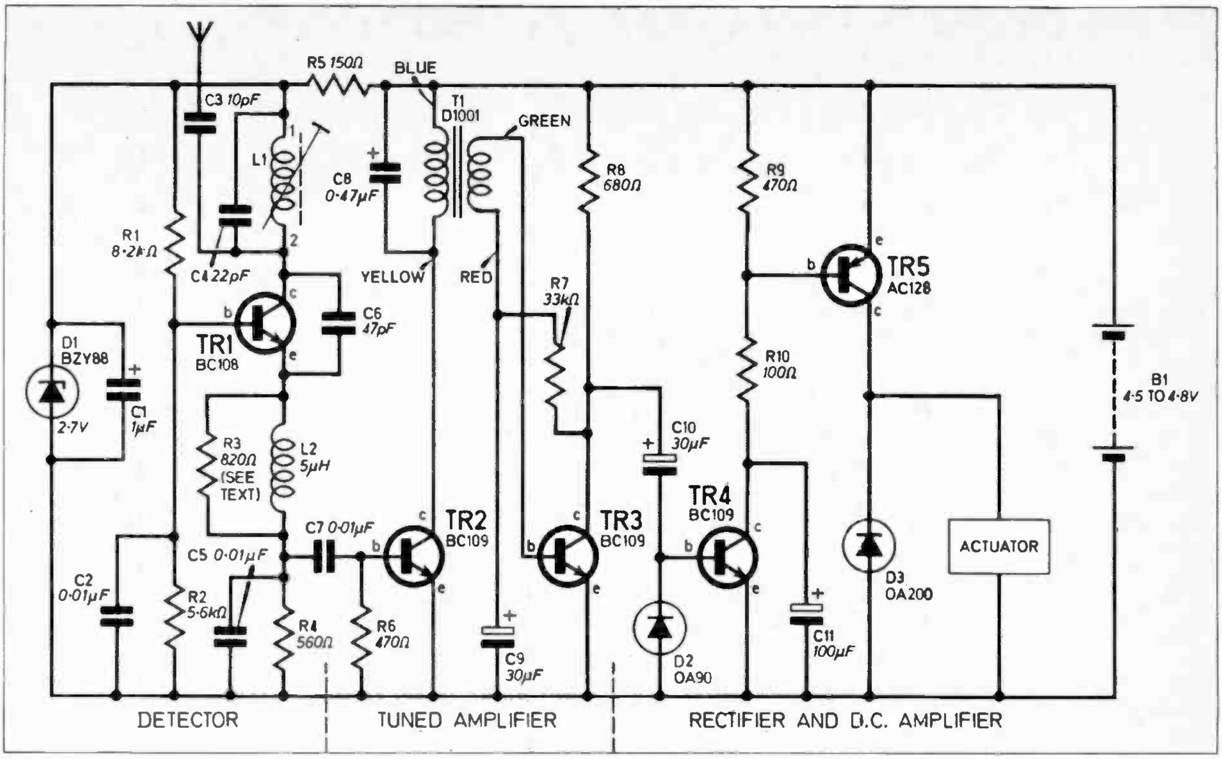


Fig. 1. The complete circuit diagram of the Radio Control Receiver.

Components....

SEE **SHOP TALK**

Resistors

R1 8·2kΩ
R2 5·6kΩ
R3 820Ω (see text)
R4 560Ω
R5 150Ω
R6 470Ω
R7 33kΩ
R8 680Ω
R9 470Ω
R10 100Ω
All ¼ watt ± 10% carbon

Capacitors

C1 1µF tantalum bead type
C2 0·01µF miniature tubular polyester
C3 10pF polyestyrene
C4 22pF polystyrene
C5 0·01µF miniature tubular polyester
C6 47pF polystyrene
C7 0·01µF miniature tubular polyester
C8 0·47µF tantalum bead type
C9 30µF elect. 6V printed circuit type
C10 30µF elect. 6V printed circuit type
C11 100µF elect. 10V printed circuit type

Transistors

TR1 BC108 silicon *npn*
TR2 BC109 silicon *npn*
TR3 BC109 silicon *npn*
TR4 BC109 silicon *npn*
TR5 AC128 germanium *pnp*

Diodes

D1 BZY88 2·7V 400mW Zener diode
D2 OA90
D3 OA200

Miscellaneous

T1 Ardente D1001 transformer (see note 1)
L2 5µH radio frequency 1A TV choke
B1 HP7 (3 off) or 4·8V Deac
Coil former for L1, 5mm diameter with ferrite or high Q core (see note 2); Veroboard size 2·4in. x 0·7in. x 0·1in. matrix; 28 s.w.g. enamelled copper wire; 3·5V 0·3A bulb; non-reversible plug and socket; standard insulated wire.
Note 1: Home Radio Henry's are currently supplying a much larger transformer under the same type number.
Note 2: Henry's Radio type 1 with 1f ferrite core.

Relayless Motorised actuator

R11 100Ω
R12 100Ω
R13 100Ω
All ¼ watt ± 10% carbon
TR1 AC128 germanium *pnp*
D1 OA200
M1 d.c. motor with reduction gearbox
S.r.b.p. board for switching disc

Interference suppressor

C12 0·1µF
C13 0·1µF
L3, L4 2A TV choke (2 off)

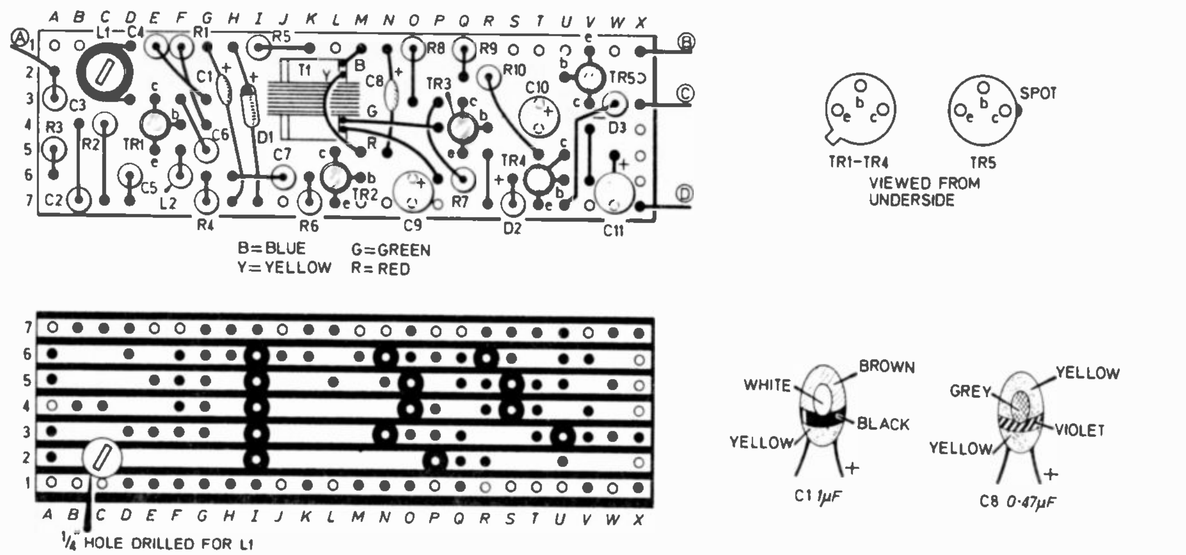


Fig. 2. The layout of the components on the top side of the Veroboard. Vertical mounting is employed; component sizes have been reduced for clarity. Also shown is tantalum capacitor identification.

approximately 0·5A, sufficient to energise an escapement or small electric motor. Diode D3 prevents large voltage surges from inductive loads damaging TR5.

If an accidental short circuit occurs across the actuator load, TR5 can sustain a current of about 0·8A for several minutes before overheating. but this will only occur with a continuous signal from the transmitter or a receiver fault.

RECEIVER CONSTRUCTION

To get the receiver down to a small size it is necessary to place components as close together as possible, and for this reason bare leads should be insulated with sleeving to prevent touching.

Before construction, check that the dimensions of T1 are $\frac{1}{2}$in x $\frac{3}{8}$in x $\frac{1}{2}$in. Much larger transformers are sometimes offered by suppliers, under the same type number, and these would not fit into the space available.

Commence construction by cutting and drilling a piece of 0·1in matrix Veroboard (to size, 2·4in x 0·7in), and break the copper strips with a spot-face cutter, Fig. 2.

Drill a $\frac{1}{4}$in hole in the circuit board, position

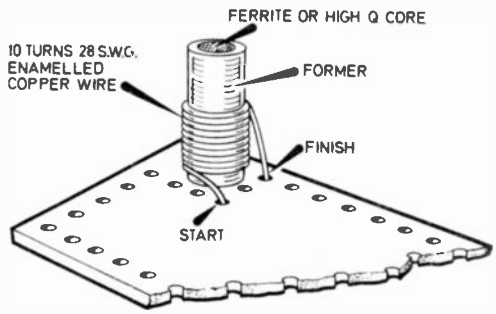


Fig. 3. Winding details for coil L1.

C2, to accept L1 coil former. The former can be of the same type as that used for the crystal oscillator coil in the transmitter, with the square mounting base removed with a fine saw. Glue the L1 former flush with the copper strips in the hole in the receiver circuit board.

To wind L1, see Fig. 3. Solder the end of a reel of 28 s.w.g. enamelled copper wire to location *D3* on the Veroboard then close wind 10 turns on the former and anchor the end of the coil to location *D1* on the Veroboard. Smear some polystyrene glue on L1 windings to hold them secure.

Components can now be mounted on the receiver circuit board, starting at the L1 end. but omit R3 for the time being. Transformer T1 is glued to the board. Check that all electrolytic capacitor and diode polarities are correct.

Flexible insulated wire about 18 inches long will serve for the receiver aerial, and leads B, C and D can be of similar wire about 6 inches long.

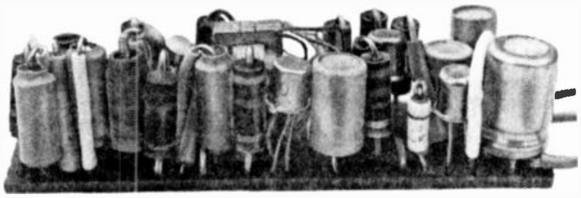
TESTING AND ALIGNING THE RECEIVER

Temporarily solder an 820 ohm resistor to the *underside* of the circuit board for R3, and a 3·5 volt 0·3 amp bulb as an output load across leads C and D. Adjust the core of L1 so that it is just entering the coil.

For initial testing the receiver can be wired to a large 4·5 volt battery, such as a 126 or PP11, with lead B to the positive terminal.

If, on connecting the battery, the bulb load glows and remains alight, reduce the value of the temporary R3 resistor to, say, 560 ohms. Alternatively, if the bulb load does not continue to glow, see if it will light up when the core of L1 is screwed almost out of its former, this will indicate the correct detector working point. In the event of no glow, even after adjustment of L1, increase the R3 value to 1 kilohm, or omit the resistor completely.

Two views of the completed receiver component board.



RANGE CHECK

When it is considered that the correct value for R3 has been determined, the receiver can be range checked. Place the receiver, together with its bulb load and battery on a small insulated tray or wooden board, and get a friend to key the transmitter at a distance of several yards with aerial retracted. Tune L1 in the receiver so that the bulb load glows only when the transmitter is keyed. If there is any tendency for the bulb to remain alight after the transmitter key is pressed, reduce the value of R3 slightly.

Now have the transmitter aerial extended and start walking away with the receiver until the bulb no longer responds to transmitter keying. Slight adjustment of the receiver coil core will be necessary to obtain maximum range.

In built-up areas the working range will be much less than that obtained in open country, or when the receiver is operating in a flying model.

If range testing is satisfactory, L1 core can be secured with a dab of cellulose paint, and R3 soldered permanently in position on the upper side of the circuit board.

INSTALLING THE RECEIVER

For small model aeroplanes, the battery pack can consist of three HP7 cells in a plastic holder, which has short leads terminated by a non-reversible two-way plug. A matching socket is soldered to receiver leads B and D. It is advisable to have two or three quick-fit battery packs to interchange between flights, so that each has time to recover.

As an alternative to the HP7 pack, a 4·8 volt rechargeable Deac pack can be employed to advantage, and this is available from good model shops, complete with charging instructions.

If the receiver is to be operated in a model boat, or large aeroplane, it may be possible to use bigger batteries, such as three HP2's in a holder wired straight to the receiver with an on-off switch in the positive lead.

Receiver circuit board and battery pack should be separately housed in foam lined balsa or plastic boxes, for protection against engine fuel, water, and hard knocks.

Where electric motors are in use in the model, it is advisable to fit interference suppressor chokes and capacitors, see Fig. 6.

SINGLE CHANNEL MECHANISM

A typical example of a single channel control system is shown in Fig. 4, using an escapement or actuator with four crank positions, and operated one step at a time (sequentially).

In the initial position (Fig. 4a), the actuator crank and rudder linkage holds the rudder straight with the engine control lever biased towards fast speed. Pressing the transmitter keying switch once causes the crank to move one step anti-clockwise, thus pulling the rudder to the right (Fig. 4b).

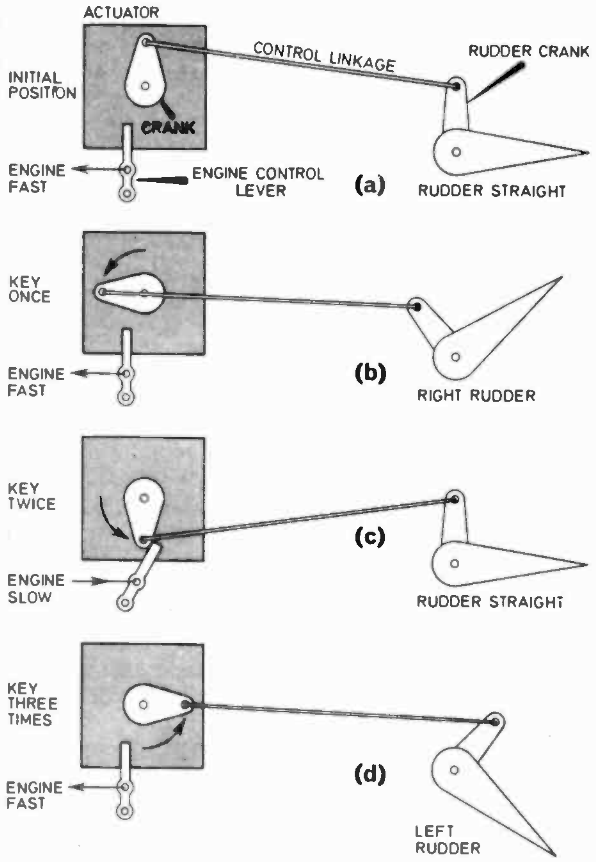
When the keying switch is pressed again, the crank moves on one step to engage with the engine lever (Fig. 4c) thus giving straight rudder and slow speed. Left rudder at fast speed (Fig. 4d) results when the transmitter key is pressed three times, and finally the crank is returned to its initial position after four keyings.

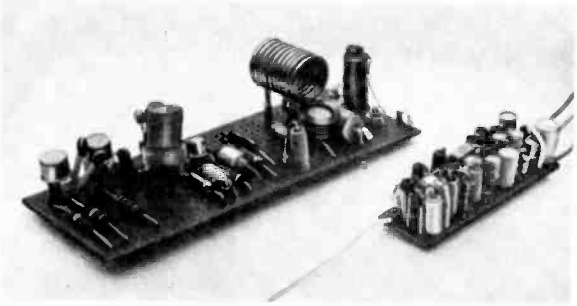
If the transmitter keying switch is operated rapidly, the model does not respond—apart from a slight wobble in some cases—to intermediate steps in the Fig. 4 sequence, and so it is possible, for example, to obtain left rudder almost immediately after the initial position by keying three times in quick succession.

REFINEMENTS

Possible refinements which may be found on commercial escapements and actuators, or obtained by modifying existing equipment, is automatic selection of the initial position by holding down the transmitter keying switch for several seconds. Alternatively, some escapements and actuators offer intermediate steps (half

Radio Control Receiver





Above photograph of the transmitter and receiver.

Fig. 4 (left). A typical single channel control system.

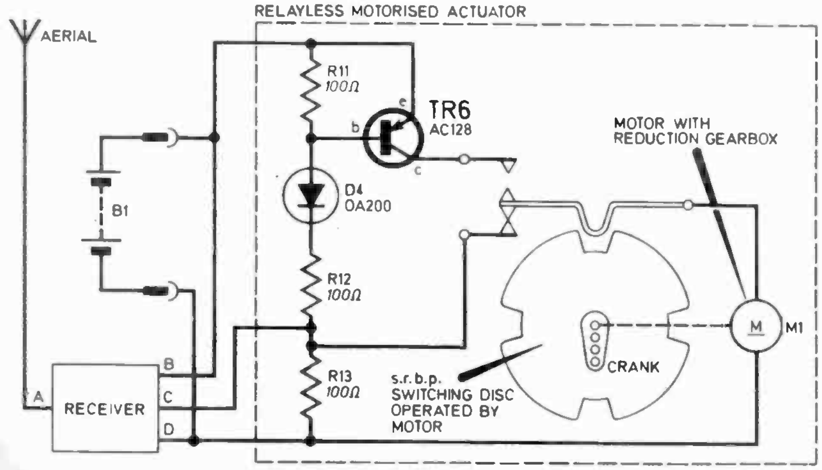


Fig. 5. Details of a circuit of a relayless motorised actuator.

rudder) when the transmitter key is held closed.

A fail-safe mode (engine-off, rudder straight) can be initiated if no signal is received after a pre-arranged time lapse, and this will operate if the model goes out of range, or if the transmitter batteries go flat.

Escapements and actuators can be obtained from model shops, or constructed at home if suitable tools are available. A fuller description of the electromechanical side of model control is beyond the scope of this article.

ACTUATORS

The output from a relayless receiver is primarily intended to drive a rubber or clockwork escapement directly, thus saving the weight and cost of a miniature relay. However, there are a number of single channel actuators (motorised servos) available which are generally more powerful and economical of battery current than an escapement, without being much heavier. Some actuators are intended for use with the manufacturer's own receivers, but they can be purchased separately.

Actuators can be divided into two categories, relay operated and relayless. The former are normally used with receivers having a single-pole changeover relay, but they may be modified quite easily for relayless operation with the addition of a few components, see Fig. 5.

If a relayless actuator is purchased, this will already incorporate a switching transistor, but check that the unit is intended for 3 volt to 4·5 volt operation from a receiver having a negative earth.

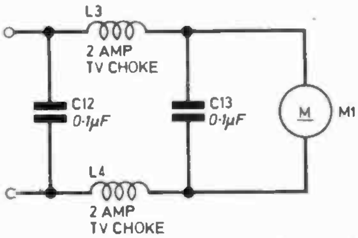
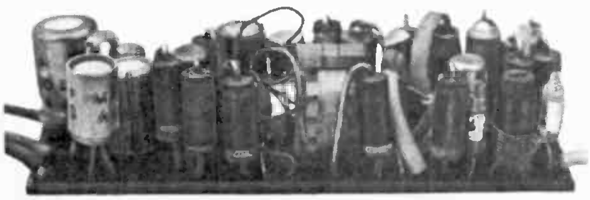


Fig. 6. Interference suppressor circuit for small electric motors.

The mechanically minded reader will be able to construct his own actuator using Fig. 5 as a guide. Electric motor stall current should not exceed 500 milliamps at 3 volts, and the reduction gearbox ratio should be about 36 to 1. It is advisable to fit the suppressor circuit of Fig. 6 to the actuator motors.

Cover photograph: model aircraft kindly loaned by Radio Modeller



BASIC Electricity

3 Magnetic Effect of Current

By Maureen Birch

If we pass an electric current through a coil of wire, we can make an electromagnet. Electromagnets have many uses in everyday life and electronics; this month we describe how to make a magnet and will use it to carry out a few simple experiments.

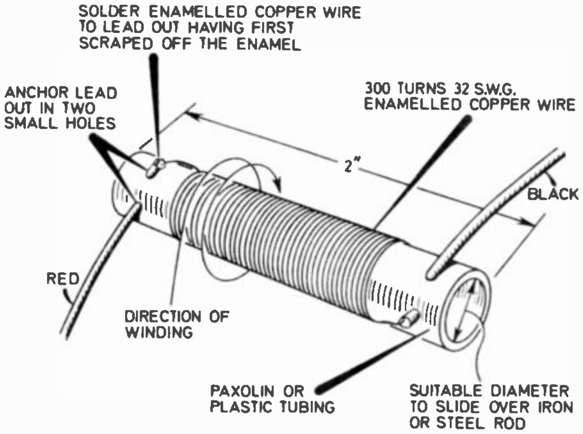
ELECTROMAGNET—CONSTRUCTION

Obtain about 9in. of $\frac{1}{4}$in. diameter steel reinforcing rod and bend it into the shape of a "U" keeping about $1\frac{1}{2}$in. between the legs of the "U". Pure iron rod would be better to use—and easier to bend—but this is not so easy to find. You will also need two 2in. lengths of plastic or paxolin tubing that will just slide over the steel rod—metal tubing should *not* be used. These tubes are to be used as formers on which we can wind coils of wire.

Use 32 s.w.g. enamelled copper wire to wind 300 turns on each former; keep the winding as neat as possible—preferably having three layers each of 100 turns. These coils, which will carry the current, are called solenoids. The ends of the windings should be connected to plastic-covered connecting wires—red at one end and black at the other, making sure that both solenoids have the same "sense" i.e. if you hold the solenoid so that the red wire is at the left then the enamelled wire coming from that termination should start by going over the top of the tube and away from you, see Fig. 3.1.

Slip one solenoid over one leg of the steel U then *reverse* the other coil and place it in position on the other leg. Connect the red and black wires from the solenoids together as shown in Fig. 3.2 so that the coils are effectively series connected and then connect the remaining pair of wires to a 9 volt battery.

Fig. 3.1. Winding details of the solenoids described in the text. Two identical solenoids are required.



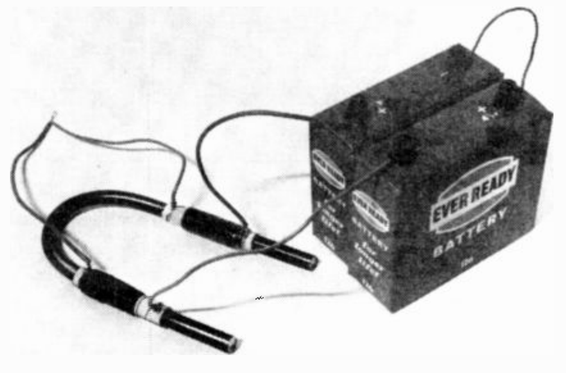


Fig. 3.2. Details of making the U-shaped electromagnet. A convenient supply is obtained by connecting two 4½ volt bell batteries in series.

CORE MATERIALS

The steel rod becomes a fairly strong electromagnet and you should be able to pick up other objects containing iron. These are called **ferromagnetic** materials unlike non-magnetic substances such as wood, paper, glass etc. Incidentally some materials such as pure nickel —which do not contain any iron—are also called ferromagnetic.

If you had used an iron rod in the experiment then as soon as the battery is disconnected, any objects formally attracted to the magnet will fall off. Because we have used steel some magnetism remains after the current has stopped flowing. This is called **remanance** and is one of the disadvantages of using a steel core for an electromagnet—although it is the principle by which all permanent magnets can be made. You will see why remanance is an embarrassment to us a little later.

NORTH-SEEKING POLE

If you put a short straight length of steel through our solenoid and then freely suspended it from cotton (Fig. 3.3) so that it is free to swing in a horizontal plane you will find that our "straight" electromagnet will swing round so that its long axis is pointing in a roughly geographic north-south direction.

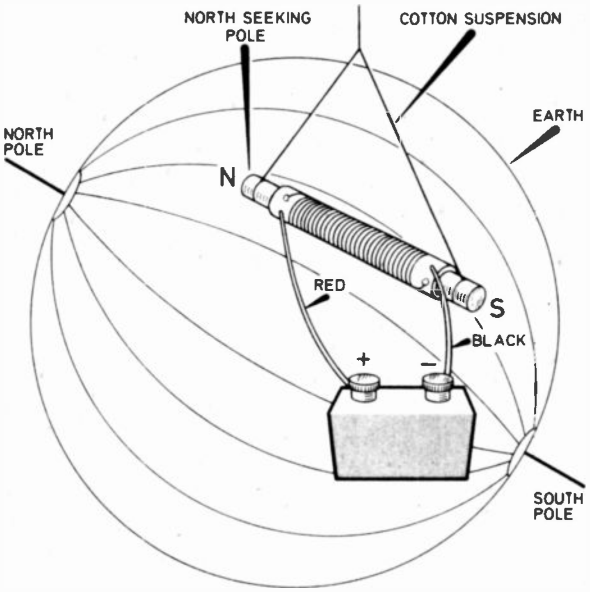


Fig. 3.3. A straight magnet will line up along the earth's magnetic axis.

What happens is that our magnet gets attracted in a preferential direction by the earth's magnetism. Provided we keep our battery connection the same, one end of the magnet will always point in the northerly direction. We call this the north-seeking pole.

You can carry out a simple experiment by making two such straight magnets (use the solenoids we have already made), and connect them in series as before, but make sure the free red lead goes to the positive terminal of the battery. The red end of each magnet will be the north pole (to keep to our geographic description we shall call the other end of each magnet the south pole).

Now suspend one of the magnets on a thread and hold the other in your hand as in Fig. 3.4. Bring the north pole (red end) of the one you hold close to the north pole of the suspended magnet. If you are lucky and have a very free suspension you should see the suspended magnet try and swing away—it is repelled; now let the south pole of the one you are holding approach the north pole of the other and you will find a strong attraction between them. This demonstrates one of the fundamental rules of magnetism—like poles repel each other, unlike poles attract.

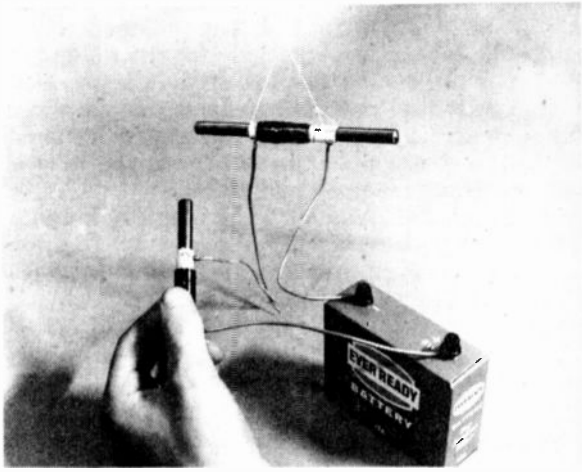


Fig. 3.4. Experiment for showing that like poles repel, unlike poles attract.

RULE OF THUMB

Obviously, suspending an electromagnet on a piece of cotton is not a very convenient way of finding which pole is which. Fortunately there is a much easier and less cumbersome method.

If you imagine you are holding the solenoid in your right hand so that your fingers wrap round it, pointing in the same direction that conventional current is flowing (i.e. from positive to negative) then your thumb will point to the north-seeking pole, see Fig. 3.5.

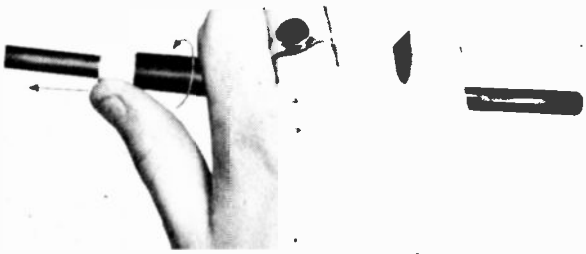


Fig. 3.5. A simple way of determining the north-seeking pole of an electromagnet.

LINES OF FORCE

We have seen that the electromagnet exerts a force on, and will pick up magnetic objects placed near it. Any such objects that respond to the magnet are within what we call the **field** of the magnet. This field is often represented by imaginary **lines of force** which are close together where the field is strong and further apart where the field is weak.

These, so called, lines of force run from the north pole of the magnet through the air to the south pole. Let's make it quite clear that these lines are purely imaginary and are only a convenient way of showing the shape and distribution of the field around the magnet. A single line of force represents one unit of what is called **magnetic flux.** A strong magnetic field produces flux lines very close together and we say we have a high **flux density**. It is stressed again that the concept of lines is simply a convenient way of trying to put a rational explanation to a phenomenon that even now is not fully understood by scientists.

If you place a magnet underneath a piece of paper and sprinkle iron filings over the top of the paper you will see them link up with each other under the influence of the magnetic field and set themselves in the general direction of these flux lines (see cover photo). Try this with the straight and U-shaped electromagnets.

ATTRACTIVE TERMS

Just as an electric current flows more readily in a good conductor so magnetic flux passes more readily through iron than through air. We say iron has a higher **permeability** than air; alternatively we could say that air has a higher resistance towards transmitting flux, i.e. it does not have the ability to carry such a high flux density and the lines of force have to spread out to pass through a larger area, we call this resistance to carrying flux **reluctance.** Air has high reluctance and for iron it is low.

If you hold a piece of iron or steel across both poles on your "U" magnet you will find it is held on with quite a strong force. Moving the steel away you will notice that the attraction lessens with increasing distance. The reason for the strong force holding the steel to the magnet in the first instance is that the lines of force easily pass through the low reluctance path of the steel (it in effect closes the **magnetic circuit)** and as you try and pull it away, the magnetic forces caused by the flux try to maintain the low reluctance path by resisting the pull. As soon as you break the magnetic circuit you introduce an air gap that has high reluctance (the wider the gap the higher this reluctance) and at the same time the steel is moved into a lower magnetic field area; hence the force pulling on the steel gets less and continues to reduce as you move further away.

The natural thing is for flux to pass through the path of least resistance. Hence, if you have a magnet and a loose piece of steel or iron nearby, it will get pulled in towards the magnet producing a lower reluctance path between the pole pieces.

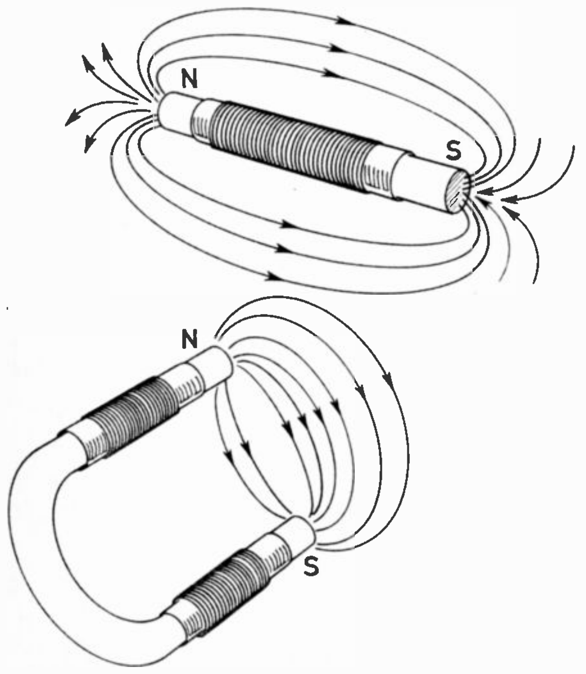


Fig. 3.6. Imaginary lines of force around (1) straight magnet (2) U-shaped magnet.

RELAYS

This effect is put to use in electronics in the form of relays. The relay is basically an electromagnet with a piece of iron held off the poles by a spring. This piece of iron is called an armature because it will move when the magnet is activated by a current in the coil.

An electric contact is fixed to, but insulated from, the armature in such a position that when the armature is pulled in towards the pole to close the magnetic circuit, the contact touches a second contact, the pair acting as a switch that can be used to operate other electrical equipment. Most commercial relays have several contacts arranged to open or close when the coil is activated.

The main application of a relay is to control a circuit that is handling very high voltages or currents from a circuit with a low current that is just sufficient to pull in the armature.

BUZZER

It is difficult to make a home-made relay that works satisfactorily but we can use our electromagnet to make a similar type of thing—an electric buzzer.

Mount the magnet on a wooden base as shown in Fig. 3.7 and make an armature by

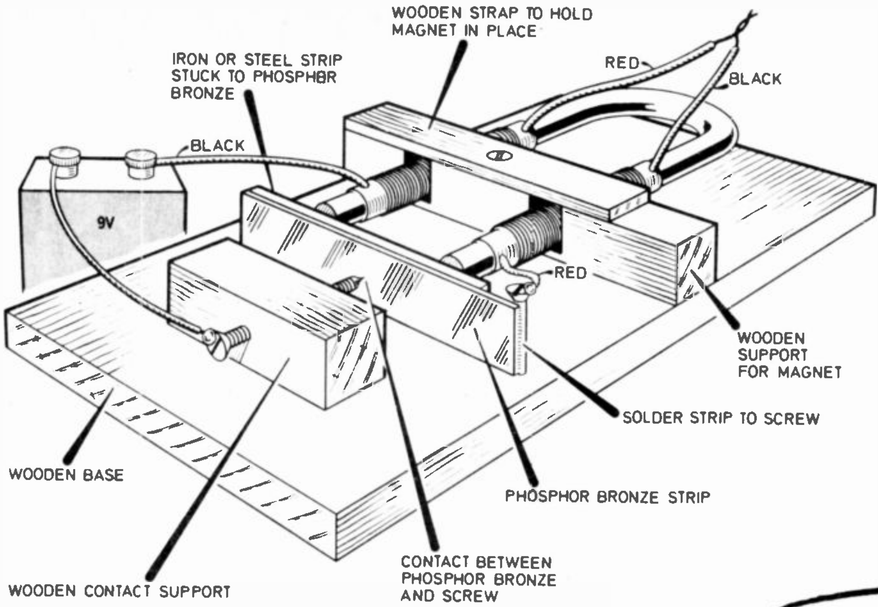


Fig. 3.7. Assembly details of a "home made" buzzer.

sticking a $1\frac{1}{2}$in. length of steel or iron strip on to a 2in. length of phosphor-bronze draft excluder strip. A $1\frac{1}{2}$in. steel screw is used as a mounting for the armature; solder one end of the phosphor-bronze strip onto the screw and arrange the position of the armature so that it extends over both poles of the magnet but is not quite touching them (about $\frac{1}{8}$in. separation would be ideal). Next use another wood screw that passes through a block to make a contact with the phosphor-bronze side of the armature. Finally connect up as shown—preferably using soldered joints.

One end of the magnet's windings should be connected to the screw holding the armature and the other end to one terminal of a 9 volt battery; the second battery connection is taken to the screw making contact to the reverse side of the armature.

When you connect up like this the electrical circuit is closed and the magnet is activated; this causes the armature to be pulled towards the magnet and the contact on the reverse of the armature is broken—the magnetic effect is lost and the armature flies back because of the springiness of the phosphor bronze; this remakes the circuit and the cycle is repeated. The armature moves backwards and forwards very rapidly and produces a buzzing sound.

You may need to experiment with the width of the gap between the magnet and the armature and also the return spring tension (adjusted by turning the supporting screw in the wood).

If the gap is too narrow and the armature touches the magnet and there is insufficient return tension you may find the armature "sticks" to the magnet. This is because of remanance and is the problem we mentioned earlier; using pure iron alleviates this problem.

Next month: meters

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

A very simple and valuable "third hand" when soldering small components is a pair of pliers with an elastic band once or twice around the handles to close the jaws gently but firmly.

One step further, if necessary, is to clamp the pliers to a block of wood with another one or two thick elastic bands.

G. Bartholomew,
Buckhurst Hill.

I have found an alternative method of attaching the leads of the transistor that is being tested, to the *Transistor Tester* by using small one pin midget sockets, as sold at model shops for plugging together radio control units. These can be fastened into holes in the lid of the tester and the transistor leads pushed into them. This way is far neater than the crocodile clips that were suggested.

T. J. Felmingham,
Berkshire.

BETA TREBLE BOOST and FUZZ

By Brian W. Terrell B.Sc.

THIS third and final part of the Beta electronic guitar article describes the electronics to be installed within the body of the guitar—namely fuzz, treble boost, treble cut and volume.

BLOCK DIAGRAM

The block diagram of the electronic system is shown in Fig. 17.

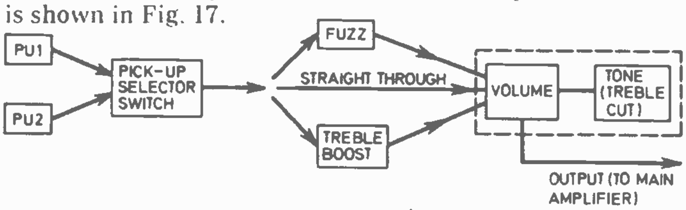


Fig. 17. Block diagram of the complete system installed in the guitar body.

There are two pick-ups which can be selected in three operational modes by use of the selector switch: (1) PU1 alone—bassy sound; (2) PU2 alone—treble sound; and (3) PU1 and PU2 to give a balanced sound. This switch is therefore a means of quick, coarse tone control.

The signal from the pick-ups is then passed straight through to the tone and volume section of the circuit and thence to the amplifier input, or made (by switching) first to pass through either fuzz or treble boost.

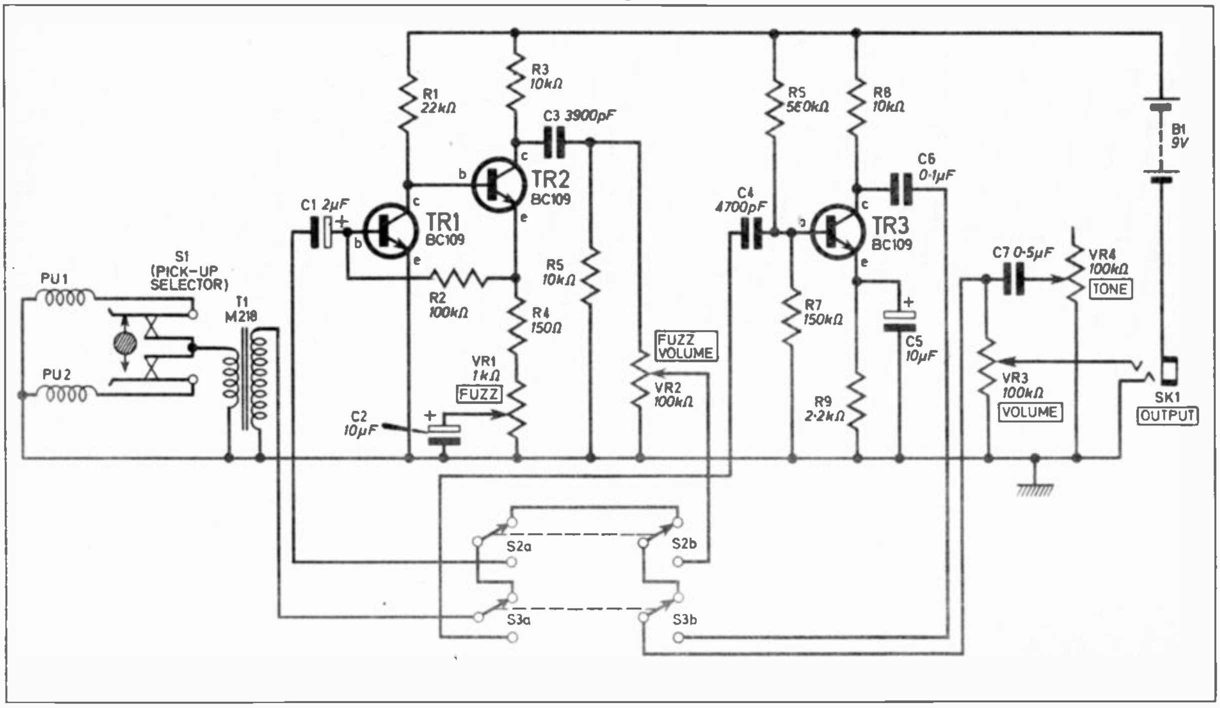
CIRCUIT DIAGRAM

The complete circuit diagram of the Beta electronics is shown in Fig. 18.

The two home-built pick-ups (described last month) have low impedances, so to make them suitable for inputting to commercially available guitar amplifiers a transformer T1 is used that serves a dual purpose. Besides matching the 5 ohm pick-ups to 50 kilohm inputs, it steps up the voltage produced by the pick-ups by a factor of approximately 15.

If you are using ready made (commercial) pick-ups (usually high impedance types) there is no need for T1 and this should be omitted.

Fig. 18. The complete circuit diagram of the Beta "electronics".



The two switches S2 and S3—both double-pole two-way types—are used for passing the resultant signal from the transformer through either fuzz or treble boost effects. For position of switches as shown, the signal passes straight to the output jack socket.

FUZZ

The fuzz effect is derived from the circuitry around transistors TR1 and TR2. The circuit employed is a two-stage amplifier using feedback biasing with a differentiator across its output.

This arrangement of TR1 and TR2 is known as a d.c. feedback pair. The bias for TR1 is derived from the emitter of TR2 via R2.

The d.c. feedback pair configuration provides a high gain with stability and at the same time increases the input impedance of the amplifier.

The combination of VR1 and C2 form what is known as a decoupler; the d.c. resistance of the emitter leg of TR2 will remain constant, but the a.c. resistance (and hence a.c. gain of the stage) will vary according to the position of VR1 wiper.

For bottom E fundamental on the guitar about 160Hz), the a.c. resistance offered by the capacitor will only be about 100 ohms and will *decrease* with rising frequencies.

Ignoring R4 for the moment, the resistance to a.c. will be given by the parallel combination of the wiper resistance (with respect to ground) and C2. As VR1 wiper moves towards TR2 emitter, a.c. resistance falls, consequently a.c. gain increases.

As a.c. gain is increased, clipping of the input signal is seen at TR2 collector, maximum clipping occurring with VR1 completely shunted by C2.

The clipped signal is then fed to the differentiator and spikes are formed across R5, the degree of "spikiness" depending on the amount of clipping. Thus VR1 acts as a "fuzz control."

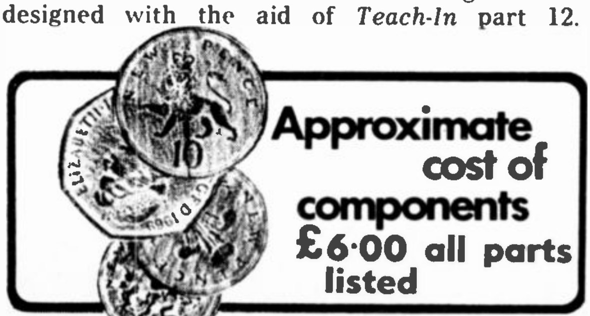
The resistor R4 was found to be necessary to prevent oscillation when VR1 is set for maximum fuzz. If oscillation is experienced, R4 should be replaced with a 500 ohm preset and adjusted for maximum fuzz without oscillation.

TREBLE BOOST

The treble boost unit shown in Fig. 18 was designed with the aid of *Teach-In* part 12. Basically it consists of a low-value capacitor, C4, at the input of a single-stage amplifier using potential divide bias (R6 and R7) with a.c. decoupled emitter.

The function of C4 is to present a very high resistance to low frequencies and thus attenuate them while allowing higher frequencies to pass through to the amplifier stage with little attenuation. Typical impedance values for C4 are: 3 megohms for 100Hz input signal to 30 kilohm for a 10kHz signal (and less for higher frequencies).

Therefore at the output we see the original signal but with its treble content (higher frequencies) substantially increased in volume—i.e. boosted.



VOLUME AND TONE

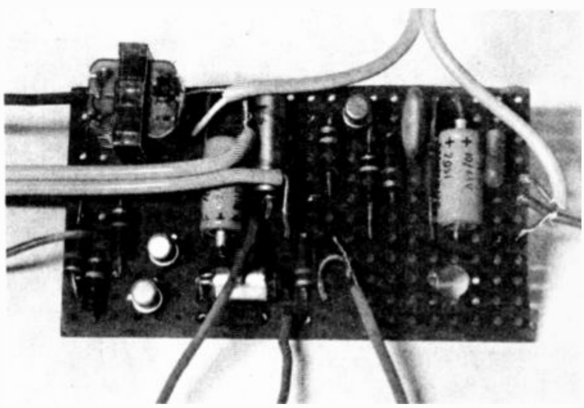
The volume control is nothing more than a potentiometer, VR3. The signal from the pickups (or fuzz or treble boost units) is placed across VR3 and the wiper used to tap off the desired amount of signal—volume.

Connected to one side of VR3 is capacitor C7 which is also connected to the wiper of VR4, the tone control. This capacitor presents a high resistance path to low frequencies and a relatively low resistance path to high frequencies.

With VR4 wiper at the ground end of its track, C7 effectively shunts high frequency signals to ground i e. they do not appear across VR3 since VR3 resistance is much greater than that offered by C7.

The degree of shunting—or treble cut as it is—is determined by the setting of VR4 whose resistance between wiper and ground adds to the a.c. resistive effect of C7.

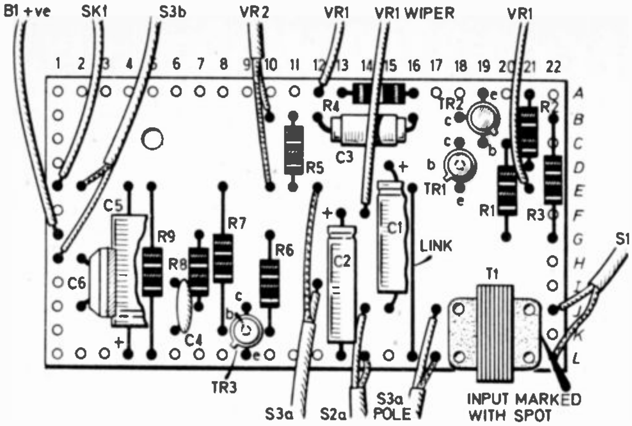
Photograph of the completed component board. Note the use of screened cable.



CONSTRUCTION

The layout of the components on the Veroboard is shown in Fig. 19. The components are to be mounted on the Veroboard that was used last month in the temporary wiring up.

Remove the screened cable connecting the board to the pick-ups and then make the



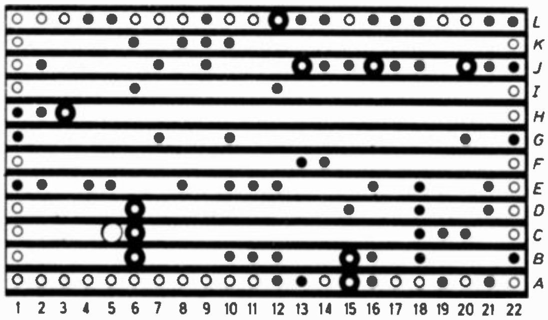


Fig. 19. Layout of the components on the top side of the Veroboard and the regions of copper strip to be removed from the underside. Do not attach the flying leads until installing in guitar body.
To wire up the flying leads refer to Fig. 20 which shows connections to the controls and output.

remaining cut-outs on the underside of the board as detailed in Fig. 19.

Begin by fixing and soldering all the capacitors in position, paying attention to the electrolytic capacitor polarities. Now solder in the resistors and the link wire *E*16 to *L*16.

The transistors should now be soldered in position. A heat shunt must be used when soldering each leg of the transistor otherwise permanent damage may result to the transistors.

Do not connect any flying leads to the component board at this stage. Leave the board to one side.

INSTALLATION

With the pick-ups, switch covers, scratch plate control recess back panel and jack socket cover removed, undertake the installation.

Fix the switch cover to switches S2 and S3 with the two earthing solder tags as shown, and wire up as indicated in Fig. 20. For this you will need two lengths of screened stereo cable and two lengths of single screened cable. The cables should be long enough to reach to the control section with a few inches to spare.

Thread these cables through the plastic tube in the body and the channel to the control section (all cables must be thin).

On the underside of the switches used in the prototype, the connecting tags were labelled 1 to 6 as shown in Fig. 20. It is advisable to mark these cables (from S2 and S3) to the control section accordingly for easy recognition later.

Now place the pick-ups in position and thread the screened cable from each pick-up into the control section and solder these to the selector switch S1 (pushed through from the topside of the guitar). Screw down the pickups and S1 cover.

Screw the four potentiometers on the aluminium securing bracket (details Fig. 21) and then screw this bracket in position. Note that one end of each potentiometer is soldered to its casing. Do this and then solder a piece of tinned copper wire across each potentiometer case as shown.

Solder in capacitor C7 between VR3 and VR4 and wire VR3 to jack socket as detailed. Secure battery in position with fixing bracket (details Fig. 21) and connect the negative side of the battery clip to the jack socket, SK1, as detailed.

Fix the jack socket to its cover and screw in place. Now lay the component board in position and connect up the remainder of the wiring as shown in Fig. 20 using minimum lengths of cable.

Fix the board to the control section base with

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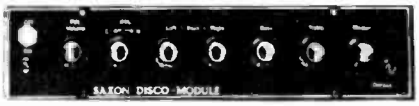

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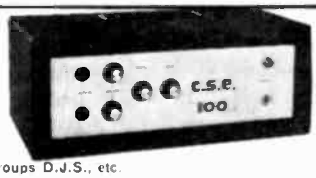

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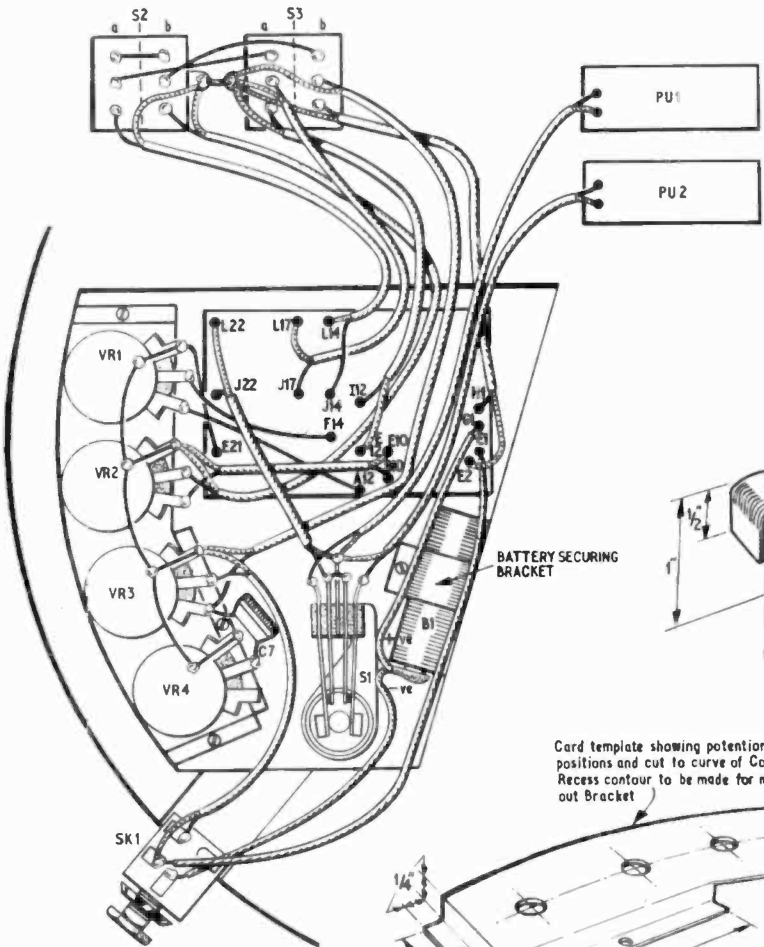

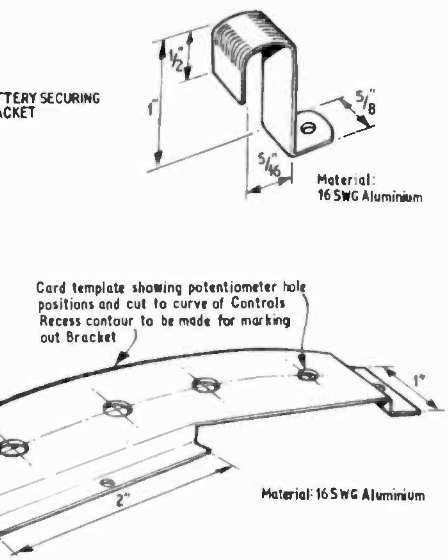

Fig. 20. The complete wiring details of the Beta "electronics". Screened cable *must* be used where indicated. The units are switched on by inserting the jack plug.

Fig. 21. Details of the potentiometer fixing bracket and the battery securing bracket.

a small woodscrew through location C5.

Next screw on the control section backplate, scratch plate, attach knobs to the controls and the installation is complete. Both units will be connected to the battery on insertion of the jack plug.

It is imperative that the wiring is carried out as detailed and screened cable used where indicated.

As shown, all parts of the system are earthed, and touching the pick-ups or switch toggles when plugged into a main amplifier should produce no hum. If there is hum, the system should be completely checked out and remedied.

Components....

SEE SHOP TALK

Resistors
- R1 22kΩ
- R2 100kΩ
- R3 10kΩ
- R4 150Ω
- R5 10kΩ
- R6 560kΩ
- R7 150kΩ
- R8 10kΩ
- R9 2·2kΩ

All ¼ watt ±10% carbon

Potentiometers
- VR1 1kΩ carbon linear
- VR2 100kΩ carbon log.
- VR3 100kΩ carbon log.
- VR4 100kΩ carbon log.

Capacitors
- C1 2μF elect. 10V
- C2 10μF elect. 10V
- C3 3900pF
- C4 4700pF
- C5 10μF elect. 10V
- C6 0·1μF
- C7 0·5μF

Transistors
- TR1 BC109 silicon *npn*
- TR2 BC109 silicon *npn*
- TR3 BC109 silicon *npn*

Switches
- S1 Pick-up selector switch (Re-an Products Ltd.) as listed last month
- S2 D.p.d.t. miniature toggle
- S3 D.p.d.t. miniature toggle

Miscellaneous
- T1 Matching transformer (5 ohm to 50 kilohm) type M218 (Zeta Windings Ltd.) as listed last month
- SK1 Jack socket type R26/1 (Re-an Products Ltd.) as listed last month
- B1 9V battery PP3

Veroboard 24 x 12 holes 0·15in matrix as listed last month; screened cable; stereo screened cable; battery clip for PP3; 1/16in. aluminium plate: 5½in x 1¾in. and 2in. x ½in.; small wood screws.

USING THE INSTRUMENT

The Beta guitar can be used with most commercially available guitar amplifiers.

To recap, the switch located alongside the four control knobs, is the pick-up selector switch for front, rear or both pick-ups together. The treble boost unit has no adjustment, it is either in or out of circuit by the operation of switch S3. The fuzz effect on the other hand has two controls—for amount of fuzz and volume of fuzz output, VR1 and VR2 respectively. The fuzz is operated by S2. Only one effect unit can be used at a time.

When the jack plug is inserted both units draw current from the battery; current consumption is very small, in the order of 3mA, so the PP3 battery will last for some time before needing replacement.

Since the fuzz gives considerable amplification, a volume control, VR2 has been added to enable a balance between "straight through" volume and fuzz volume to be made. This should be set as follows: With the master volume VR3 set to maximum, switch S2 and adjust VR2 to give the required balance.

A final couple of notes: when using the treble boost, it is advisable, for maximum effect, to have VR4 turned fully up, since in effect VR4 is a treble cut control. The lead connecting the guitar to the main amplifier should be screened cable—not the television aerial type.

FINISHING OFF

If you have not already painted your guitar here are a few hints.

Make sure that all the screw holes etc. are made for attaching the fitments and then remove all the fitments. Unscrew the neck.

Thoroughly clean up all the woodwork with sandpaper and fill in all "digs and chips" there may be with a filler such as Polyfilla or Plastic Wood. Allow to dry and sand again. When satisfied a suitable undercoat should be applied to the woodwork. Fill and sand again if necessary.

By far the best painting method is spraying and if done well will give a really professional result. If spraying, cellulose paint is ideal since it dries hard in a very short time and can be "cut-back" easily to give an immaculate shine. If using a brush, a hard gloss enamel such as Valspar is recommended as was used on the prototype; use a 1 inch brush. Painting should be carried out in a warm dust free room.

On the prototype the fretboard was coloured black using a black leather dye, and when dry after a few coats, coated with a *thin* layer of clear varnish. Masking tape was used to mask the fretboard whilst painting to obtain a straight edge along the neck.

Wait until the paintwork is *completely* dry before final assembly. ▣

Modifications to build a bass guitar will be described shortly.

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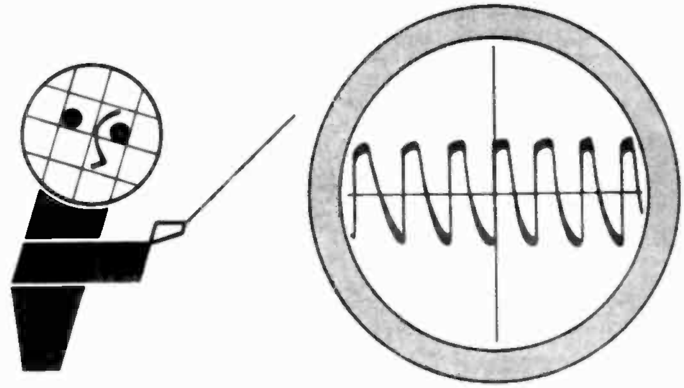

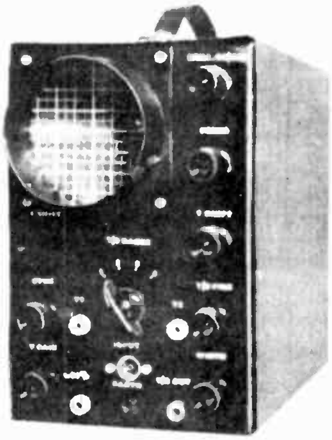

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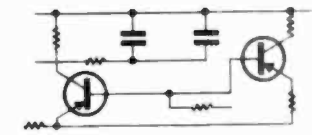

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THIS edition of *E.E.* is No. 1 Volume 2 and during the past fourteen months (Volume 1 started in November 1971) we have endeavoured to keep you, the reader, reasonably happy and free from component buying problems. In the beginning (of *E.E.*) we suggested that you could help yourself avoid any frustration—concerning component buying—by getting together a few catalogues from some of the firms that advertise regularly in our pages. This information is of course still pertinent and at this time of the year many suppliers are reprinting and issuing new catalogues or supplements to old ones. So if you feel you need some more information or your old catalogues, like ours, are falling apart through over use, now is the time to look for new editions.

SHOP TALK

By Mike Kenward

Two buying problems have come to light concerning components for previous projects. The first concerns the *Radio Tuner* that was described in the September 1972 issue (now unavailable); the problem component being the Repanco DRR2 coil. Only a limited number of these coils are manufactured for the retail market and the demand created by the tuner was such that the coil became unobtainable—even from Repanco.

So if you have had to wait for the coil the reason is that Repanco have had to make some more.

The second buying problem has been with the wood for Beta, many people have been unable to obtain the wood or have been quoted high prices. We have been informed by Montague and Collard, of 123 Southlands Road, Bromley, Kent, that they can supply all the wood for £3·09 plus 80p for postage—a hard type of mahogany is supplied for the body (this is quite suitable). Also an incorrect size for the neck/head assembly was given in the article—the correct size is 30 x 2 x $3\frac{1}{2}$ inches—this size is supplied by the above firm.

Beta Treble Boost and Fuzz

The treble boost and fuzz unit described in this issue for use inside the *Beta Electronic Guitar* can of course be used with almost any electric guitar, or with standard pick-ups simply by omitting T1 from the design. For this reason the effects unit is likely to prove more popular than the actual Beta—which is already being built by a large number of readers.

However, since all the parts, excepting perhaps the two miniature d.p.d.t. switches, are generally available there should be no troubles. For the switches you can contact Henry's Radio or Home Radio if your normal supplier cannot help. The switches are fairly expensive—about 50p each—but look good and operate positively; they also fit in the space available. There is one point to watch with these switches, if pressure is applied on the end of the lever, directly towards the base of the switch there is a danger of breaking the mechanism inside. So take care, and do not lay the guitar on its face.

The potentiometers used for the control of the various effects on the Beta are special in that they are smaller than the usual types. These pots are about $\frac{7}{8}$ inch in diameter and, if you have difficulty in obtaining them, they are available from Electrovalue 28 St Judes Way, Englefield Green, Egham, Surrey TW20 0HB (type P.20). This firm can also supply the miniature switches (type 7201) and produce a comprehensive catalogue for 25p post free.

Radio Control Receiver

Once again some notes on supply of parts for the *Radio Control Receiver* are given in the components list.

Two possible buying problems may occur with components, the first is the Zener diode; the 2·7V type is not generally available but Electrovalve can supply them—see above. The other problem is concerned with the printed circuit type capacitors, these are available from G. W. Smith—only in packs of five—or your local supplier may have them.

With regard to the supply of actuators, no doubt many readers will construct their own units and there are many types of motor available from model shops that will be suitable, you will have to go to the nearest one and ask. If you intend buying a ready made actuator then the model shop is also the best place to enquire.

Ice Warning Device

As far as we can see there are no "difficult" components in the *Ice Warning Device*. The thermistor is the only unusual part and is available from most of the large London based suppliers, should you have difficulty locally.

The author has used a push-on push-off switch in the prototype device but it may be better to use a toggle switch since it will then be easier to tell if the unit is on or off.

New Products

An interesting soldering product has come our way this month. This is a new thermostatically controlled 70 watt iron from Litesold. The iron, called the Litestat, is eminently suitable for our type of work; although the power may appear high, remember that the temperature is controlled so overheating of the bit is prevented (we use a similar iron in our workshop).

The heating element is protected by a tough stainless steel binding, and the handle is a one-piece moulding in unbreakable nylon. A detachable hook is fitted for hanging the iron.

An internal indicator lamp shines through the translucent handle when the supply is switched on and pulses with the operation of the thermostat.

Interchangeable bits are screw mounted using a special thread to prevent seizure, and are supplied in three sizes. Bits are of high grade copper and are available in standard chromium or long-life iron plated finishes.

The price of the Litestat is £4·80 and it is available for 24 V, 100/120 V and 220/250 V operation.

Photograph: Science Museum, London

THEY MADE THEIR MARK

No8 Hertz

By J. E. Gregory

FOR the final article in the series, we return to Germany to meet the man who discovered the existence of wireless waves, and whose name has been adopted as the official unit of frequency. (See Table 1.)

Table 1: HERTZ (Hz)

The Hertz, symbolised by the letters Hz, has gained world recognition as the official unit of frequency, and is equal to 1 cycle per second. It is often used with the prefix k (1kHz = one thousand cycles per second), and with the prefix M (1MHz = one million cycles per second).

The number of complete wavelengths that pass any point in one second is the frequency of the waves. The frequency of radio waves varies from thousands to many thousand million Hz. All electromagnetic waves travel at a speed of approximately 186,000 miles per second. The Hertz was adopted by the International Electrotechnical Commission in October 1933.

Heinrich Rudolph Hertz, was born in Hamburg on February 22, 1857. Heinrich's father was a lawyer and senator, and his mother the daughter of a physician. Hertz received every encouragement from his parents, and lived in a comfortable, cultural and academic atmosphere. Unlike so many of the other early pioneers he did not have to struggle against poverty. but he did suffer with ear trouble from an early age.

After leaving school he went, in 1878 at the age of 20, to Munich to pursue an engineering career which he later abandoned in favour of physics.

In 1878 Heinrich enrolled in the Berlin University, where he specialised in the study of natural science, mathematics and magnetics. Here he came under the influence of the German philosopher and physicist Hermann L. Von Helmholtz who had contributed to the development of the electromagnetic theory of light and indicated its general possibilities.

WIRE-LESS

In 1879 the Berlin Academy of Science offered a prize for research on the problem of establishing experimentally a relation between electromagnetic forces and the dielectric polarization of insulators. Helmholtz drew the attention of Hertz to the problem. Hertz started to tackle it by studying the mathematical theories of Maxwell that electricity and light are fundamentally a single phenomenon; that both are waves of the same kind, differing only in wavelength. He also reasoned that if a moving electric charge could broadcast electromagnetic waves, a device similar to that which produced the waves should be able to receive them and change them back to an electric charge.

In 1885 Hertz married Elizabeth Doll, daughter of a professor, and was himself appointed professor of experimental physics at the Technical High School at Karlsruhe. It was here that he started his experiments of trying to generate radio waves by means of an electric spark.

Hertz constructed a transmitter that could make a strong electric spark jump between the knobs on the ends of two metal rods. He then placed a metal ring with a spark gap in it a few feet away. There were no wires between the transmitter and the metal ring, which was in fact, the first "wireless" receiver.

Hertz held his breath, switched on the appartus, and made a spark jump across the spark gap between the knobs. Immediately a spark jumped across the spark gap of the metal ring. Electromagnetic waves, produced by the first spark gap, travelling to the ring had caused the spark to jump across the ring's spark gap. By such means Hertz produced electromagnetic waves with wavelengths from a few metres to 30 centimetres (ultra short waves).

WAVE PROPERTIES

Hertz lived for his work and continued his experiments. Having proved that these waves existed, he proceeded to show that they could be reflected, and polarised just as light can; he measured the velocity of propagation and found it to be of the same order as that of light and radiant heat.

In 1889 Hertz was appointed Professor of Physics at the University of Bonn; at the age of 32 he had achieved a position in the academic world not ordinarily attained until much later in life. He continued his work and carried out research into the discharge of electricity in rarified gases and also produced his treatise on the principles of mechanics; this was to be his last work.

In the summer of 1892 Hertz suffered an illness which developed into chronic blood poisoning. He died on New Year's day 1894, at the age of 37; a premature death had robbed the world of the accomplishments of a man who has been called the Grandfather of Radio.

POST SCRIPT

Hertz's experiments were described in a paper called "Electromagnetic Waves in Air and Their Reflection", and were published in an electrical journal. An Italian teenager vacationing in the Alps happened to read the story. For him it contained the germ of an idea. Why not use the sparks for signalling? The young man was so excited by the prospect he cut short his holiday and rushed back to his home to try his first experiment. His name Guglielmo Marconi, the first man to make use of Hertzian waves.

Colour Television I.C.'s

TBA500	£2.00	TBA550	£3.00	SL436B-E		£3.86
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I.C. Sockets

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5KΩ	50KΩ	500KΩ
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log or lin less switch (& 1KΩ lin)	12p
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Capacitors

Ceramic – plate 63V (C333)

1·8pf	8·2pf	33pf	120pf
2·2pf	10pf	39pf	150pf
3·3pf	12pf	47pf	180pf
3·9pf	15pf	56pf	220pf
4·7pf	18pf	68pf	270pf
5·6pf	22pf	82pf	330pf
6·8pf	27pf	100pf	

all 5p. each

mylar film 100V

1000pf	2p	·01μF	3p	·068μF	4p
2000pf	2p	·02μF	3p	·1μF	4p
5000pf	2p	·04μF	3p	·2μF	5p
		·05μF	3p		

metallised polyester 250V (C280)

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

metallised polyester 400V (C281)

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

mixed dielectric 600V

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

mixed dielectric 1000V

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

Ceramic

12KV.d.c.		8KV.d.c.		HI-K 750V.	
10pf	9p	200pf	9p	1000pf	5p
15pf	9p	220pf	9p	1500pf	5p
22pf	9p	250pf	9p	2000pf	5p
68pf	9p	270pf	9p	3000pf	5p
82pf	9p	300pf	9p	5000pf	5p
100pf	9p	750V DISC		10,000pf	5p
120pf	9p	470pf	5p	feed-	
140pf	9p	1000pf	5p	through	
150pf	9p	5000pf	5p		
180pf	9p	10,000pf	5p	1000pf	5p

Slider Pots

Single	Dual	log
10K	10 + 10K	or
25K	25 + 25K	lin
50K	50 + 50K	
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2 W	10% Carbon Composition	6p each
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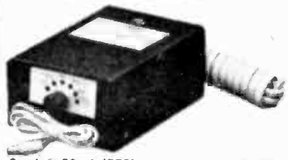
plus p. & p. 7p for up to 25 resistors plus 1p for each additional 25.

Eliminators



9 volt @ 20mA (PP3)	£1.25
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6 + 6 volt, 50mA	£2.50
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BA145	20p	OA200	10p	IN4004	8p
BA148	20p	BY100	15p	IN4005	10p
BA154	13p	BY126	15p	IN4006	12p
BA155	14p	BY127	15p	IN4007	15p

Power Sections

ohms		
7, 9, 10, 12, 14, 17·5, 20	@	700mA 20p
22, 25, 28, 30, 33, 36	@	700mA 25p
40, 47, 52, 56, 60, 63, 66	@	300mA 20p
75, 87, 100, 120, 140, 160	@	300mA 25p
180, 200, 220, 250, 270	@	300mA 25p
300, 350, 400, 470, 560	@	120 mA 20p
726	@	150mA 25p
1KΩ	@	100mA 20p
2KΩ	@	70mA 25p

plus p. & p. 7p per section.

EHT Rectifier Trays

(5 stick version) for BRC Chassis i.e. Ferguson, Ultra, Marconiphone & HMV – 950 Mk II, 960, 970 & 1400 chassis

Our Price £3·50 plus p. & p. 20p

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0·1 watt 5p		0·25 watt 7p		
100	1K Ω	10K Ω	100K Ω	1M Ω
250	2·5K Ω	25K Ω	250K Ω	2·5M Ω
500	5K Ω	50K Ω	500K Ω	5M Ω

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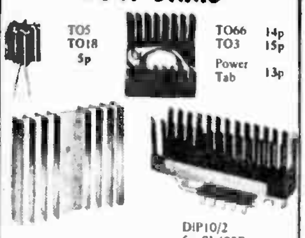

TO5 TO18 5p

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AC107	25p	BC147	10p	BF196	15p	OC81	18p	2N1304	22p	2N5172	15p
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AD140	40p	BD132	70p	MPF102	40p	ZTX303	20p	2N3705	10p	MC1351	£1.00
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AF139	28p	BF184	25p	OC45	15p	ZTX531	25p	2N3903	15p	μA709C	45p
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BC109	10p	BF195	15p	OC76	15p	2N708	15p	2N3906	12p	μA741C	50p

Mullard & Siemens Electrolytics

CAP μF	VOLTAGE 4	6·3	10	16	25	40	63
1	—	—	—	—	—	—	8p
1·5	—	—	—	—	—	—	6p
2·2	—	—	—	—	—	—	6p
3·3	—	—	—	—	—	—	6p
4·7	—	—	—	—	—	—	6p
6·8	—	—	—	—	—	8p	6p
10	—	—	—	—	6p	—	6p
15	—	—	—	6p	—	6p	6p
22	—	—	6p	—	6p	—	6p
33	—	6p	—	6p	—	6p	—
47	6p	—	6p	—	6p	6p	6p
68	—	6p	—	8p	—	—	10p
100	6p	—	6p	—	8p	6p	12p
150	—	8p	—	6p	6p	10p	12p
220	6p	—	6p	6p	10p	12p	18p
330	6p	—	6p	10p	—	—	21p
470	—	6p	10p	—	12p	18p	40p
680	—	10p	—	12p	18p	21p	—
1000	10p	—	12p	18p	21p	40p	60p
1500	—	12p	18p	21p	—	—	—
2200	—	18p	21p	40p	45p	55p	93p
3300	—	21p	—	—	—	—	—
4700	21p	—	—	60p	75p	93p	—

CAP μF	VOLTAGE 16	25	40	64
500			33p	40p
1250			50p	
1600			—	75p
2000	40p	50p	—	—
2500	—	—	75p	93p
3200	50p	—	—	—
4000		75p	93p	—
6400	75p	93p	—	—

We still have large stocks of Mullard C426 and C437 series capacitors and will continue to supply these upon request until stocks become exhausted

Veroboard

	Copperclad 0.1"	Copperclad 0.15"	Plain 0.15"
2½" x 1"	6p	6p	—
2½" x 3¾"	20p	16p (9)	10p
2½" x 5"	24p	21p (7)	12p
3¾" x 3¾"	24p	21p (8)	—
3¾" x 5"	27p	27p (10)	17p
17" x 2½"	67p	50p	37p
17" x 3¾"	90p	70p	52p
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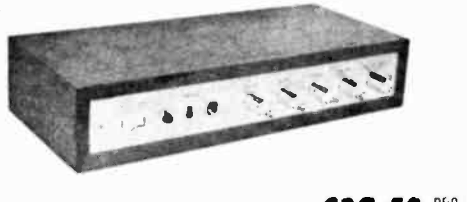
(9)	4"	x 2¾"	x 1½"	35p	8p
(10)	4"	x 5¼"	x 1½"	40p	8p
11	4"	x 2½"	x 2"	35p	8p
12	3"	x 2"	x 1"	32p	9p
13	6"	x 4"	x 2"	50p	10p
14	7"	x 5"	x 2½"	58p	12p
15	8"	x 6"	x 3"	75p	18p
16	10"	x 7"	x 3"	85p	20p

THE TEXAN



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20 Watts per channel integrated stereo amplifier developed by engineers of Texas Instruments Ltd. This designer approved kit, has a state-of-the-art specification, including distortion of only 0.09% at 20 Watts into 8 ohms and a bandwidth of 5 – 35,000 at –3db. The semiconductor compliment of this superb kit includes no less than 6 Integrated circuits, 10 Silicon transistors, 4 rectifiers and 2 zeners. Controls include: bass; treble; volume; balance; on/off; 'on' indicator; headphone sockets; scratch filter; rumble filter; Inputs for magnetic phono; tuner; aux or tape; tape head etc; input; selector; mono/stereo switch. The construction of this kit was featured in 'Practical Wireless' May - Aug 1972.

TV Electrolytics

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

16 + 100 + 100 + 300μF : 275 V.W	£1.23
32 + 100 + 125 + 200μF : 275 V.W	£1.23
32 + 100 + 200 + 200μF : 300 V.W	£1.23
100 + 100 + 100 + 150 + 150μF : 320 V.W.	£1.66
100 + 100 + 200 + 300μF : 275 V.W.	£1.23
60 + 100 + 200μF : 300 V.W.	93p
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Transistorised Treasure Locator

This fully portable transistorised metal locator detects and tracks down buried metal objects—it signals exact location with loud audible sound (no phones used)—uses any transistor radio which fits inside—no connections needed. FINDS GOLD, SILVER, COINS, JEWELLERY, ARCHAEOLOGICAL PIECES ETC. ETC. *Extremely sensitive will signal presence of certain objects buried several feet below ground.* No knowledge of radio or electronics required. *Can be built with ease in one short evening by anybody from nine years of age upwards,* with the clear, easy to follow, step-by-step, fully illustrated instructions—Uses standard PP3 battery. No soldering necessary. Kit includes nuts screws, wire, etc. ONLY £2·85 + 25p. p. & p. (Sectional handle as illustrated 86p. extra). Parts available separately. Made up looks worth £15.

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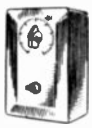
SOOTHE YOUR NERVES RELAX WITH THIS AMAZING RELAXATRON



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READY BUILT AND TESTED TREASURE LOCATOR MODULE

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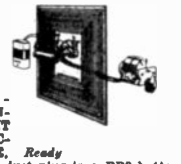

FULLY TRANSISTORISED PRINTED CIRCUIT METAL DETECTOR MODULE. *Ready built and tested*—just plug in a PP3 battery and phones and it's working. Put it in a case, screw a handle on and YOU HAVE A PORTABLE TREASURE LOCATOR EASILY WORTH ABOUT £20! Extremely sensitive—penetrates through earth, sand, rock, water, etc.—EASILY LOCATES COINS, GOLD, SILVER, JEWELLERY, HISTORICAL RELICS, BURIED PIPES, ETC. *So sensitive it will detect certain objects buried* SEVERAL FEET BELOW GROUND! GIVES CLEAR SIGNAL ON ONE COIN £4·95 + 30p carr. etc.

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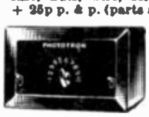
now *YOU* can CATCH SHOALS OF BIG FISH with new electronic miracle

special introductory offer **£2·50**

First time marketed in England, this exciting electronic instrument the "Decoytronic" is the one responsible for starting the electronic fish-lure rage in the U.S.A. just recently. Uses ingenious double-action method of attracting all kinds of fish from hundreds and hundreds of feet away . . . saltwater or freshwater. Why this device is so fantastically successful is because it *actually imitates the sound of wet insects milling about the surface.* These sound waves spread out hundreds of feet in all directions. Although this peculiar sonic frequency won't sound like much to you—to all the fish in the area it's their dinner bell! But that's not all . . . *electroluminescence neon tubes cunningly flicker intermittently,* penetrating the area for hundreds of feet around, at a frequency fish are unable to resist. The fish mistake this flickering glimmer for the soft phosphorescence glow given off by Plankton . . . a favourite delicacy of most fish!!! All you do is switch on, lower into the water (it's completely water resistant) allow around 5 minutes—then start reeling 'em in. We'll bet you won't be able to reel 'em in fast enough. Self-contained batteries last ages—cost pence. Kit of all parts including special easy as a.b.c. directions only £2·50 + 25p. P. & P. (Parts available separately).

the amazing "Phototron" SOUND OPERATED FLASH



ONLY £4·50

Take flash pictures at the exact instant of the bursting of a balloon. A champagne cork leaving the bottle. The split second a hammer strikes a light bulb. *The mind boggles at the possibilities of the "Phototron" . . . the only limit is your imagination.* Now that inexpensive flash guns are on the market in quantity, it has made possible, with the help of electronics the production of a wide variety of exciting photography effects, once strictly limited to the professionals. The duration of an electronically produced flash is extremely brief and normally measured in Milliseconds. Now, providing the camera shutter is left open in a dark or subdued light, it is the timing of the flash that determines what is imprinted on the film—not necessarily anything done by the camera. As electronic flash guns are fired by making a switched connection then it becomes obvious that one of the latest Silicon Controlled Relay's can be used. If we make this S.C.R. operate by sound (with variable sensitivity control (for soft/loud sounds) some real "way out" photography effects can be captured forever on film. Easily built in a couple of hours or so, the "Phototron" is fully solid sate, uses self contained PP3 battery. No soldering necessary using our special printed circuit terminal board (pat. Applied for). All parts including special pictorial step-by step plans, transistors, microphone, S.C.R., potentiometers, switches, test lamp, case, nuts screws, etc. etc., ONLY £4·50 + 25p P. & P. *Made up must be worth at least £10.* (parts available separately).

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SI units are used throughout and brief notes on other systems of units are given at the end of appropriate chapters to help the reader when consulting older books and data.

'. . . this textbook is exceptionally good and is a useful addition to both teachers' and students' bookshelves. It is highly recommended.'
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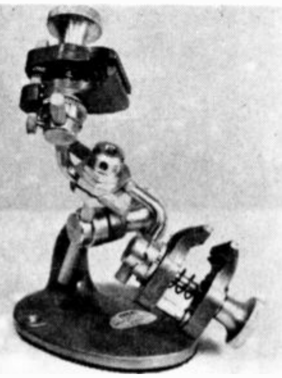

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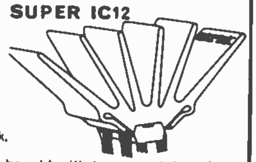

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with lids and screws

Type	L.	W.	D.	Price	p. & p.
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GB9 *	4in	2½in	1½in	38p	13p
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GB11	4in	2½in	2in	38p	13p
GB12	3in	2in	1in	33p	13p
GB13	6in	4in	2in	52p	18p
GB14	7in	5in	2½in	63p	19p
GB15	8in	6in	3in	81p	26p
GB16	10in	7in	3in	92p	26p

* These sizes fit standard veroboards

EQUIPMENT CASES in plain aluminium with sloping front panel.

Type	H.	W.	D.	Price	p. & p.
SF1	2in	5¼in	2½in	45p	12p
SF2	2in	7¼in	3½in	60p	16p
SF3	2in	9¼in	4½in	75p	19p

Stove - enamelled silver-grey hammer finished, 25p extra.

CONSOLE CASES

in plain aluminium, ideal for mixers, instruments, etc.

Type	W. in	A in	B In	C in	D in	Price	p. & p.
GB20	8	9	3½	2	3	£1·42	30p
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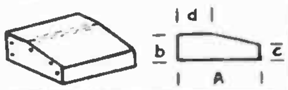
GB22	12	9	3½	2	3	£1·72	30p



PRE-AMPLIFIER

for microphones or guitars. Mounted on printed circuit panel and complete with ¼ inch jack socket. Requires 9V battery. Input 50kΩ. Complete with connection data. 65p.

ELECTROLYTICS

1μF	450V	19p	1,000μF	25V	27p
2μF	450V	20p	1,000μF	50V	42p
4μF	350V	14p	2,000μF	25V	39p
8μF	450V	17p	2,000μF	50V	53p
16μF	450V	18p	2,500μF	25V	45p
25μF	25V	7p	2,500μF	50V	60p
25μF	50V	10p	3,000μF	25V	48p
32μF	450V	27p	5,000μF	25V	60p
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100μF	25V	10p	8–8μF	450V	18p
100μF	50V	11p	8–16μF	450V	20p
250μF	25V	14p	16–16μF	450V	27p
250μF	50V	17p	16–32μF	450V	63p
500μF	25V	18p	32–32μF	450V	49p
500μF	50V	25p	50–50μF	350V	38p

MINIATURE ELECTROLYTICS

1μF	63V	6p	47μF	16V	7p
2·2μF	63V	6p	47μF	25V	6p
3·3μF	63V	6p	68μF	16V	6p
4·7μF	63V	6p	100μF	10V	6p
8μF	40V	7p	220μF	16V	7p
10μF	25V	6p	330μF	16V	11p
10μF	64V	7p	470μF	10V	11p
16μF	40V	7p	1,000μF	16V	19p
33μF	16V	6p	1,500μF	16V	23p

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For Philips and similar cassette recorders.

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Single, less switch, 15p
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5kΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ

SLIDER CONTROLS, 87mm.

complete with knobs.
Single, 44p; Tandem, 55p. 10kΩ, 25kΩ, 50kΩ, 100kΩ, log. or lin.

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All 5%, high-stability, E12 values. ¼W, 1p; ½W, 1½p; 1W, 4p; 2W, 6p

Wire-wound

5W, 10p; 10W, 12p

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Size	0·1 Matrix	0·15 Matrix
2½in × 3¾in	22p	16p
2½in × 5in	24p	25p
3¾in × 3¾in	24p	25p
3¾in × 5in	27p	29p
17in × 2½in	75p	57p
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16 way, 0·15 (2½in)—23p
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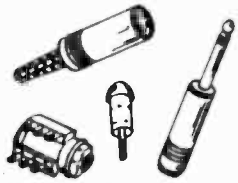
PLUGS

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



SOCKETS

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

LINE SOCKETS

Car aerial	14p
Co-axial	17p
D.I.N. 2 pin (speaker)	15p
D.I.N. 3 pin	16p
D.I.N. 5 pin, 180°	16p
D.I.N. 5 pin, 240°	16p
Jack, 3½mm	15p
Jack, ¼in screened	49p
Jack, stereo, screened	34p
Phono, plated metal	14p

CAPACITORS

2·2pF	500V	S/M	7½p
3·3pF	500V	S/M	7½p
5pF	500V	S/M	7½p
10pF	125V	P.S.	5p
10pF	500V	S/M	7½p
15pF	125V	P.S.	5p
15pF	500V	Cer.	4p
18pF	500V	S/M	7½p
22pF	125V	P.S.	5p
22pF	500V	S/M	7½p
25pF	500V	S/M	7½p
27pF	500V	Cer.	4p
33pF	125V	P.S.	5p
33pF	500V	S/M	7½p
39pF	500V	S/M	7½p
47pF	125V	P.S.	5p
47pF	500V	Cer.	4p
50pF	500V	S/M	7½p
56pF	500V	S/M	7½p
68pF	125V	P.S.	5p
68pF	500V	S/M	7½p
75pF	500V	S/M	7½p
82pF	500V	S/M	7½p
100pF	125V	P.S.	5p
100pF	500V	S/M	7½p
100pF	500V	Cer.	5p
120pF	500V	S/M	7½p
150pF	125V	P.S.	5p
150pF	500V	S/M	7½p
150pF	500V	Cer.	5p
180pF	500V	S/M	7½p
200pF	500V	S/M	7½p
220pF	125V	P.S.	5p
220pF	500V	Cer.	5p
250pF	500V	S/M	8p
270pF	500V	Cer.	5p
300pF	500V	S/M	8p
330pF	125V	P.S.	5p
330pF	500V	S/M	8p
390pF	500V	S/M	8p
470pF	125V	P.S.	5p
470pF	750V	Disc	5p
500pF	500V	S/M	8p
560pF	500V	S/M	8p
680pF	125V	P.S.	6p
680pF	500V	S/M	8p
820pF	500V	S/M	8p
0·001μF	100V	Mylar	3p
0·001μF	125V	P.S.	6p
0·001μF	400V	Poly.	3p
0·001μF	500V	S/M	10p
0·001μF	500V	Cer.	5p
0·001μF	1,000V	MDC	6p
0·0015μF	400V	Poly.	3p
0·0015μF	500V	S/M	10p
0·0015μF	500V	Cer.	5p
0·0018μF	500V	S/M	10p
0·002μF	100V	Mylar	3p
0·002μF	500V	Cer.	5p
0·0022μF	125V	P.S.	6p
0·0022μF	500V	S/M	10p
0·0022μF	1,000V	MDC	6p

0·0027μF	500V	S/M	15p
0·003μF	500V	Cer.	5p
0·0033μF	125V	P.S.	6p
0·0033μF	500V	Poly.	6p
0·0033μF	1,000V	MDC	6p
0·0036μF	500V	S/M	15p
0·0047μF	125V	P.S.	9p
0·0047μF	500V	Poly.	6p
0·0047μF	500V	S/M	20p
0·0047μF	1,000V	MDC	6p
0·005μF	100V	Mylar	3p
0·005μF	500V	Cer.	5p
0·0068μF	125V	P.S.	10½p
0·0068μF	500V	S/M	30p
0·0068μF	500V	Poly.	6p
0·0082μF	125V	P.S.	10½p
0·0082μF	500V	S/M	30p
0·01μF	18V	Disc	4p
0·01μF	125V	P.S.	10½p
0·01μF	160V	Poly.	4p
0·01μF	250V	M.F.	3p
0·01μF	400V	Poly.	3p
0·01μF	500V	Cer.	5p
0·01μF	500V	S/M	30p
0·01μF	600V	MDC	7p
0·01μF	1,000V	MDC	9p
0·015μF	160V	Poly.	3p
0·015μF	400V.	Poly.	3p
0·02μF	100V	Mylar	3p
0·022μF	18V	Disc	5p
0·022μF	250V	M.F.	3p
0·022μF	400V	Poly.	3p
0·022μF	600V	MDC	7½p
0·022μF	1,000V	MDC	10p
0·033μF	250V	M.F.	4p
0·033μF	400V	Poly.	4p
0·047μF	12V	Disc	6p
0·047μF	160V	Poly.	3p
0·047μF	250V	M.F.	3p
0·047μF	400V	Poly.	4p
0·047μF	600V	MDC	8p
0·047μF	1,000V	MDC	10p
0·1μF	30V	Disc	6p
0·1μF	250V	M.F.	4p
0·1μF	400V	Poly.	5p
0·1μF	600V	MDC	10p
0·1μF	1,000V	MDC	14p
0·15μF	250V	M.F.	5p
0·22μF	160V	Poly.	6p
0·22μF	250V	M.F.	5p
0·22μF	400V	Foil	10p
0·22μF	1,000V	MDC	15p
0·33μF	250V	M.F.	8p
0·47μF	250V	M.F.	8p
0·47μF	400V	Foil	15p
0·47μF	1,000V	MDC	25p
1·0μF	250V	M.F.	15p

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

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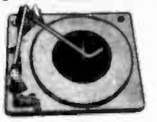
STEREO AND MONO



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Impedance Standard	8 ohms
Maximum Power	12 watts
Useful Response	35 to 18,000 cps
Base Resonance	45 cps

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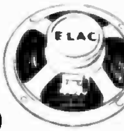

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Bass resonance 55 cps
8 ohm coil
8in. 10 watt
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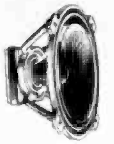

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16/450V	15p	100/50V	47p	32+32/450V	33p
32/450V	20p	8+8/450V	18p	350+50/325V	50p
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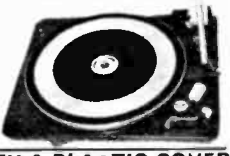

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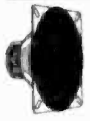

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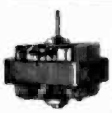

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RADIO & TELEVISION AERIAL BOOSTERS £2·95p, five television valves 45p. 50p bargain transistor packs, bargain £1 resistor and capacitor packs. UHF-VHF televisions £7·50, carr. £1·50p. S.A.E. for 3 leaflets. VELCO ELECTRONICS, Bridge Street, Ramsbottom, Bury, Lancs.

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because this Ministry Approved transmitter/receiver kit does not use R.F. Your transmissions will be virtually SECRET since they won't be heard by conventional means. Actually it's TWO KITS IN ONE because you get the printed-circuit boards and components for both the transmitter AND receiver. You're going to find this project REALLY FUN-TO-BUILD with the EASY-TO-FOLLOW instructions. An extremely flexible design with quite an AMAZING RANGE—has obvious applications for SCHOOL PROJECTS, LANGUAGE, LABORATORIES, SCOUT CAMPS, etc.
GET YOURS! SEND £5·50 NOW
S.A.E. for details
To: **BOFFIN PROJECTS**, DEPT. KEE, 4 CUNLIFFE ROAD, STONELEIGH, EWELL, SURREY.

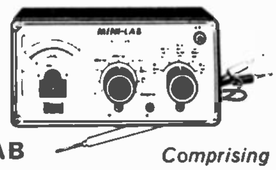
KITS BUILT

Radio, Hi-Fi, Test Gear, etc.

Also equipment built to published designs or your specification.

A. Woodrow, 31 Crowland Walk, Morden, Surrey.

Versatile
10 in ONE
MINI-LAB



Comprising

● AC & DC Voltmeter ● Audio Generator ● Ohm Meter ● Resistance Substitution ● Capacitance Substitution ● DC Ammeter ● Battery Supply ● RF Signal Generator ● RF Field Strength Indicator

This new, unique instrument combines all you need for testing. Guaranteed, money back if not satisfied.

£11.25
+25p. p&p

Cash with order or send s.a.e. for illustrated data sheet to:

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Crickelfield Lane, Bishop's Stortford, Herts.

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100 sq ins (min) packs of mixed veroboard only £1·15p, post/packing free. C.W.O. To—

LAWRENCE ELECTRONICS

5 Rialto Buildings, Salford 7. Tel. 061-773-3953

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EVERYDAY ELECTRONICS
WHEN REPLYING TO ADVERTISEMENTS

WANTED

WANTED to borrow or buy, the first five issues of Everyday Electronics. Cost price paid either way. Box 4.

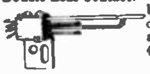
DRILL CONTROLLER
NEW 1KW MODEL

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. £1·50 plus 13p post and insurance. Made up model also available. £2·25 plus 13p post & p.

MAINS OPERATED CONTACTOR

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

NEED A SPECIAL SWITCH?



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

MAINS TRANSISTOR POWER PACK

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

MICRO SWITCH

5 amp changeover contacts. 10p each. 10 for 90p. 15 amp. Model 12p each or £1·08 doz.

MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 20p each £1·80 for ten, your assortment.

KITS FOR PREVIOUS PROJECTS

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

Reprints of projects available 1 for 20p, 3 for 60p or 6 for £1·00, post paid.

HOME SENTINEL INTRUDER ALARM	£3·75
SNAP INDICATOR	75p
WINDSCREEN WIPER CONTROL	£2·25
RECORD PLAYER (amplifier components only)	£5·50
DEMO DEC	£7·00
FUZZ BOX	£1·85
PHOTOGRAPHIC COLOUR TEMPERATURE METER	£2·65
ASTRON RADIO	£3
REMOTE TEMPERATURE COMPARATOR	£4·25
ELECTRO LAUGH	£2
RAIN WARNING ALARM	£1·80
WA-WA PEDAL	£2·90
SIGNAL INJECTOR	80p
SOIL MOISTURE METER	£3·00
SIMPLE CALCULATOR	£2·20
DC POWER SUPPLY	£5·00
BABY ALARM	£4·00
AUDIO TONE GENERATOR	£2·60
METAL LOCATOR	£4·00
LIGHT TO SOUND CONVERTER	£1·70
THRU LENS LIGHTMETER	£3·50
DRILL SPEED CONTROLLER	£2·00
ELECTRONOME	£1·75
SHAVER INVERTER	£3·75
I.R. BURGLAR ALARM	£3·50
L & M RADIO TUNER	£2·50
TAPE POWER SUPPLY MAINS	£2·00
,, ,, ,, CAR	£1·10
ELECTRONIC MOUSE-TRAP	£2·75
REACTORMATIC	£3·00
RADIO CONTROL TRANSMITTER	£5·50
BIT SAVER	£1·50

BAKELITE INSTRUMENT CASE

Size approx. 6½" × 3½" × 2" deep with brass inserts in four corners and bakelite panel. This is a very strong case suitable to house instruments and special rigs, etc. Price 45p each.

HONEYWELL PROGRAMMER

This is a drum type timing device, the drum being calibrated in equal divisions for switch setting purposes with trips which are infinitely adjustable for position. They are also arranged to allow 2 operations per switch per rotation. There are 15 changeover micro switches each of 10 amp type operated by the trips thus 15 circuits may be changed per revolution. Drive motor is mains operated 5 revs per min. Some of the many uses of this timer are Machinery control, Boiler firing, Dispensing and Vending machines, Display lighting animated and signs, Signalling, etc. Price from makers probably over £10 each. Special snip price £5·75 plus 25p post and insurance. Don't miss this terrific bargain.

ICE WARNING
RADIO CONTROL RECEIVER

To receive components for these projects send the quoted approx. price. Any cash difference will be made up.

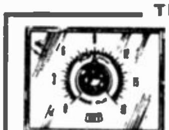
THYRISTOR LIGHT DIMMER

For any lamp up to 600 watt. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price £2·95 plus 20p post and insurance.

MULLARD AUDIO AMPLIFIERS

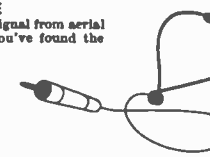
All in module form, each ready built complete with heat sinks and connection tags, data supplied.
Model 1153 500m watt power output 75p.
Model 1172 750m watt power output 85p.
Model EP9000 4 watt power output £1·65.
EP9001 Stereo preamp £1·85.
10% discount if 10 or more ordered.

THIS MONTH'S SNIP
PROCESS TIME CONTROLLER



Made by Smiths. Motorised and mains driven in metal case with glass front and chrome surround. Covers a period of 18 hours. During this 18 hours the controlled device can be made to switch on for a period of 15 minutes to 3 hours. Probable cost from Smiths over £6. Special snip price £1·60 plus 20p post and insurance.

RADIO STETHOSCOPE

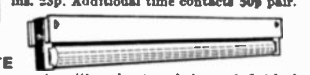


Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV amplifier, anything — complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2—twin stethoset instead of earpiece 75p extra—post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

ELECTRIC TIME SWITCH

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

ATLAS TWENTYLITE



Fluorescent lighting units with polyester choke and finished white enamel. 2ft model, ideal kitchen, bedroom, hallway, porch, loft etc. With tube assembled ready to instal, £1·99.

STANDARD WAFER SWITCHES

Standard size 1½" wafer—silver-plated 5-amp contact, standard ¼" spindle 2" long—with locking washer and nut.

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

CENTRIFUGAL BLOWER

Miniature mains driven blower centrifugal type blower unit by Woods. Powerful but specially built for quiet running—driven by cushioned induction motor with specially built low noise bearings. Overall size 4½" × 4½" × 4". When mounted by flange, air is blown into the equipment but to suck air out, mount it from centre using clamp. Ideal for cooling electrical equipment or fitting into a cooker hood, film drying cabinet or for removing flux smoke when soldering etc. etc. A real bargain at £1·85.

BATTERY CONDITION TESTER

Made by Mallory but suitable for all batteries made by Ever Ready and others, most of which are zinc carbon types but also mercury manganese—nicad—silver oxide and alkaline batteries may be tested. The tester puts a dummy load on the battery and the meter scale indicates the condition depending upon which section the pointer rests. The section reads "replace" "weak" or "good". The tester is complete in its case, size 3½" x 6½" x 2" with leads and prods. Price £2·50 plus 20p postage.

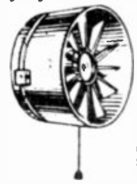
BATTERY CHARGER KIT

Comprising 5 amp 12V mains trs. and rectifier with wiring diagram. £1·75 + 25p P. & P.

BLACK HEAT ELEMENTS

Ideal for making convectors and similar devices Two joined in series approx. 1KW. Price 75p per pr.

EXTRACTOR FAN



Cleans the air at the rate of 10,000 cubic ft. per hour. Suitable for kitchens, bathrooms, factories, changing rooms, etc., it's so quiet it can hardly be heard. Compact, 5½" casing with 5½" fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets. £2·50 + 20p P. & P.

CD CAR IGNITION

This system which has proved to be amazingly efficient. We offer kit of parts as P.W. Circuit £5·95 plus 20p p. & p. Deluxe model with pre pared circuit board £6·95. When ordering please state whether for positive or negative systems.

POWER PACKS

Made for driving racing cars, meccano models and battery motors etc. direct from the mains. Fully insulated and tamper proof. Standard model £2·50, ditto with reversing switch £3·50 or with reversing switch and speed controller £4·25.

SPIT MOTOR

200–250V induction motor, driving a carter gearbox with a ¼" output drive shaft running at 5 revs p.m. Intended for roasting chickens, also for driving models—windmills, coloured disc lighting effects etc. £1·85 plus 20p post and ins

AUTO TRANSFORMER

Primary 220–240V. Secondary 110–120V, well built and varnish impregnated. 250 watt intermittent rating. 150 watt continuous rating. Size approx. 3½" × 3" × 3". £1·00+20p post & ins

SOLDER GUN

A must for every busy man, gives almost instant heat also illuminated job. 100 watt £2·25 plus post and ins. 20p. BIG JOB 250 watt model £4·75 plus post and ins. 40p.

0-5 AMMETER

2in square full vision for flush mounting. Moving iron instrument. Ideal for charger. Price 60p each. 10 for £5·40.

TELESCOPIC AERIAL

for portable, car radio or transmitter. Chrome plated—six sections, extends from 7½ to 47in. Hole in bottom for 6BA screw. 28p. KNUCKLED MODEL FOR F.M. 50p.

TREASURE TRACER

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

IMMERSION HEATERS BY REMPLOY

Standard fitting for domestic water tanks, made by the famous Remploy Company. Complete with sealing washers suitable for 200–240 volts A.C. Depth into tank 11". 2kw. £1·50 plus 20p each post and insurance.

MAINS OPERATED SOLENOIDS

Model 772 — small but powerful 1" pull —approx. size 1½ × 1½ × 1¼" 60p.

Model 400/1 ½" pull Size 2¼" × 2 × 1½" 75p.

Model TT10 1½" pull size 3 × 2½ × 2" £1·80 plus 20p post and insurance.

RESETTABLE FUSE

How long does it take you to renew a fuse? Time yourself when next one blows. Then reckoning your time at £1 per hour see how quickly our resettable fuse (auto circuit breaker) will pay for itself. Price only £1 each or 10 for £9·00 specify 5, 10 or 15 amp—*simply fit in place of switch.*

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

J. BULL (ELECTRICAL) LTD.

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

Callers to: 102/3 Tamworth Road, CROYDON.

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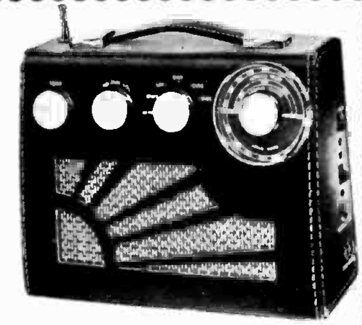
Build yourself a TRANSISTOR RADIO

WITH AFTER SALES SERVICE



ROAMER 10 WITH VHF INCLUDING AIRCRAFT

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

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

Total building cost **£8·50** P. P. & Ins. 50p (Overseas P. & P. £1)

ROAMER EIGHT Mk I

NOW WITH VARIABLE TONE CONTROL

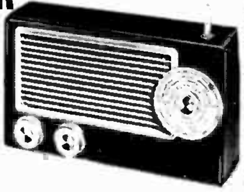
7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mW transistors. Car aerial and Tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts Price List and Easy Build Plans **25p** (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

Total building cost **£6·98** P. P. & Ins. 45p. (Overseas P. & P. £1)

ROAMER SEVEN MK IV

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for MW and LW. Retractable 4 section 24in. chrome plated telescopic aerial for SW. Socket for Car Aerial. Powerful push-pull output. 7 transistors and 2 diodes, fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning and wave change controls. Attractive case with carrying handle Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts price list and easy build plans **15p** (FREE with parts). Earpiece with plug and switched socket or private listening 30p extra.

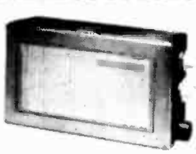
Total building costs **£5·98** P. P. & Ins. 45p. (Overseas P. & P. £1)



ROAMER SIX

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3, Trawler, band plus an extra Medium waveband for easier tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Easy build plans and parts price list 15p (FREE with parts).

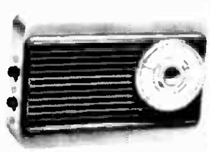
Total building costs **£3·98** P. P. & Ins. 30p (Overseas P. & P. £1)



POCKET FIVE

3 Tunable Wavebands: MW, LW, Trawler Band with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5½ × 1½ × 3½in. Easy build plans and parts price list 10p (FREE with parts).

Total building costs **£2·29** P. P. & Ins. 23p (Overseas P. & P. 63p)

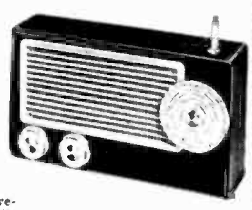


TRANSONA FIVE

5 TRANSISTORS AND 2 DIODES

3 Tunable Wavebands: MW, LW and Trawler Band. 7 stage—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6¼ × 4½ × 1½in. Easy build plans and parts price list 10p (FREE with parts).

Total building costs **£2·50** P. P. & Ins. 24p (Overseas P. & P. 63p)



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 easy build plans 25p (FREE with parts).

Total building costs **£4·48** P. P. & Ins. 32p (Overseas P. & P. £1)

NEW! "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: 3 inch Speaker: Terminal Strip: Ferrite Rod Aerial: 3 Plugs and Sockets: Battery Clips: 4 Tag Boards: Balanced Armature Unit 10 Transistors: 4 Diodes: Resistors: Capacitors: Three ½" 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

All parts including Case and Plans **£5·50** P. P. & Ins. 32p (Overseas P. & P. £1)

FULL AFTER SALES SERVICE
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RADIO EXCHANGE CO

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I enclose £.................. please send items marked

ROAMER TEN	☐	ROAMER SEVEN	☐
ROAMER EIGHT	☐	TRANS EIGHT	☐
TRANSONA FIVE	☐	ROAMER SIX	☐
POCKET FIVE	☐	EDU-KIT	☐

Parts price list and plans for ....

Name ....

Address ....

.... (Dept. E.E.15.)

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NOW OPEN!

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354-356 HIGH FIDELITY & TAPE EQUIPMENT 01-402 5854/4736
309 PA - DISCO LIGHTING HIGH POWER SOUND 01-723 6963
303 BARGAIN STORE SPECIAL OFFERS All Mail to: 303, Edgware Rd., London, W2 1BW

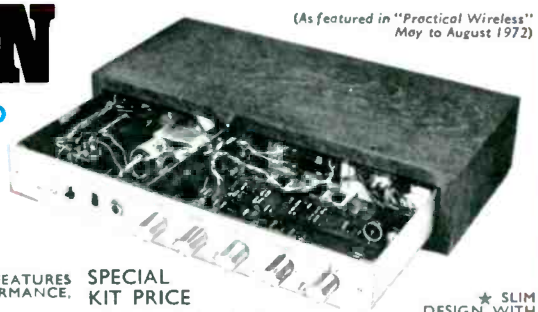
ALL YOUR ELECTRONIC REQUIREMENTS WITHIN 200 YARDS. CALL IN AND SEE FOR YOURSELF.

BUILD THE TEXAN

(As featured in "Practical Wireless" May to August 1972)

20 + 20 WATT INTEGRATED I.C. STEREO AMPLIFIER

★ FREE TEAK CABINET with complete kits!



FEATURES. New slim design with 6 - IC's, IC Sockets, 10 silicon transistors, 4 rectifiers, 2 zeners. Special Gardeners low field slim line transformer. Fibre glass PC panel. Complete chassis work.

HIGH QUALITY & STABILITY ARE PREDOMINATE FEATURES—DEVELOPED BY TEXAS ENGINEERS FOR PERFORMANCE, RELIABILITY AND EASE OF CONSTRUCTION.

FACILITIES. On/off switch indicator, headphone socket, separate treble, bass, volume and balance controls, scratch and rumble filters, mono/stereo switch, Input selector; Mag. P.U. Radio Tuner, Aux. Can be altered for Mic., Tape, Tape-head, etc (Parts list Ref. 20 on request).
Constructional details Ref. No. 21 30p

SPECIAL KIT PRICE **£28·50** P & P 45p

★ SLIM DESIGN WITH SILVER TRIM
Overall chassis size 14½" x 6" x 2" high

COMPLETE WITH FREE TEAK CABINET

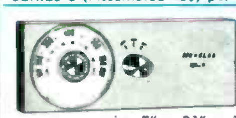
Designer approved kits distributed by Henrys!

LOW COST HI-FI SPEAKERS

E.M.I. Size 13½" × 8½". Large Ceramic Magnet.
TYPE 150 6 watt, 3, 8 or 15 ohms £2·20. Post 22p.
TYPE 150 TC Twin cone version £2·75. Post 22p.
TYPE 450 10 watt with twin tweeters and crossover. 3, 8 or 15 ohms. £3·85. Post 25p.
TYPE 350 20 watt with tweeter and crossover. 8 and 15 ohms. £7·70; Post 28p.

POLISHED CABINETS 150, 150TC 450 £4·60. Post 30p.
ASSEMBLED IN POLISHED CABINETS (8 ohms)
SERIES 6 (Assembled 150 T/C) per pair £16·50. Post 70p
SERIES 8 (Assembled 450) per pair £18·95. Post 70p

ML-3 MW/LW TUNER to BUILD



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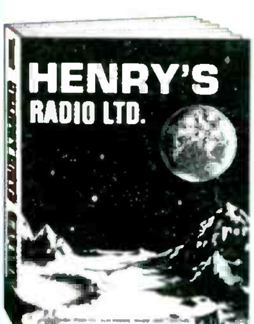

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