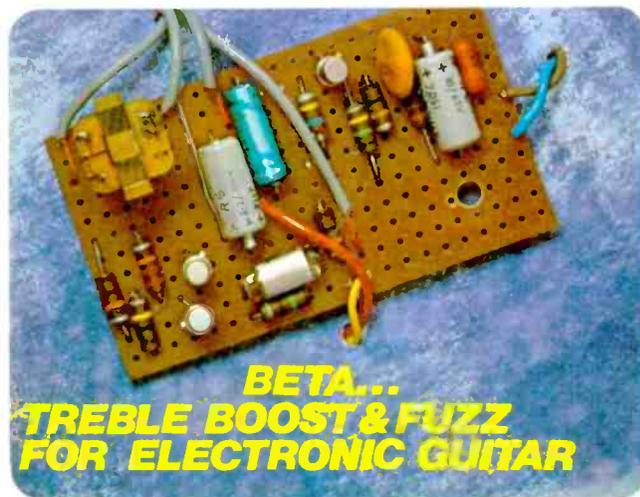
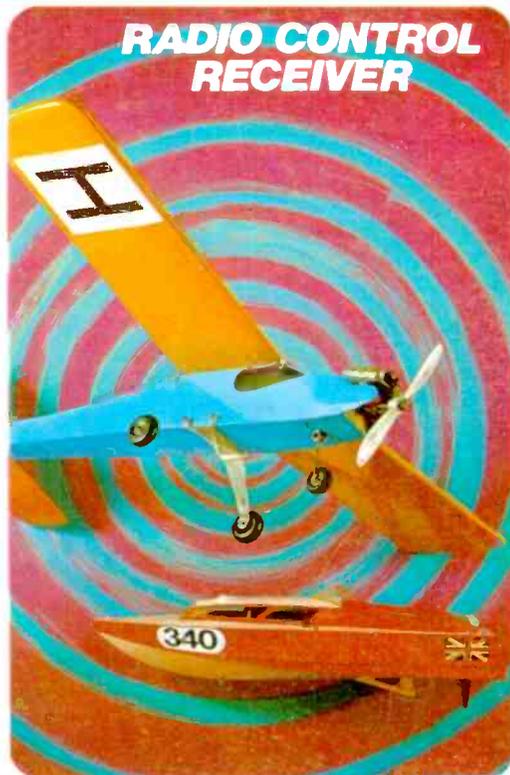


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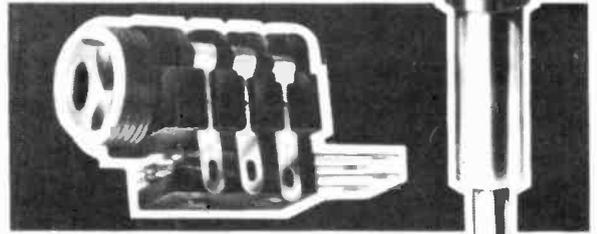
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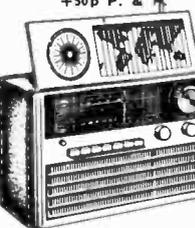
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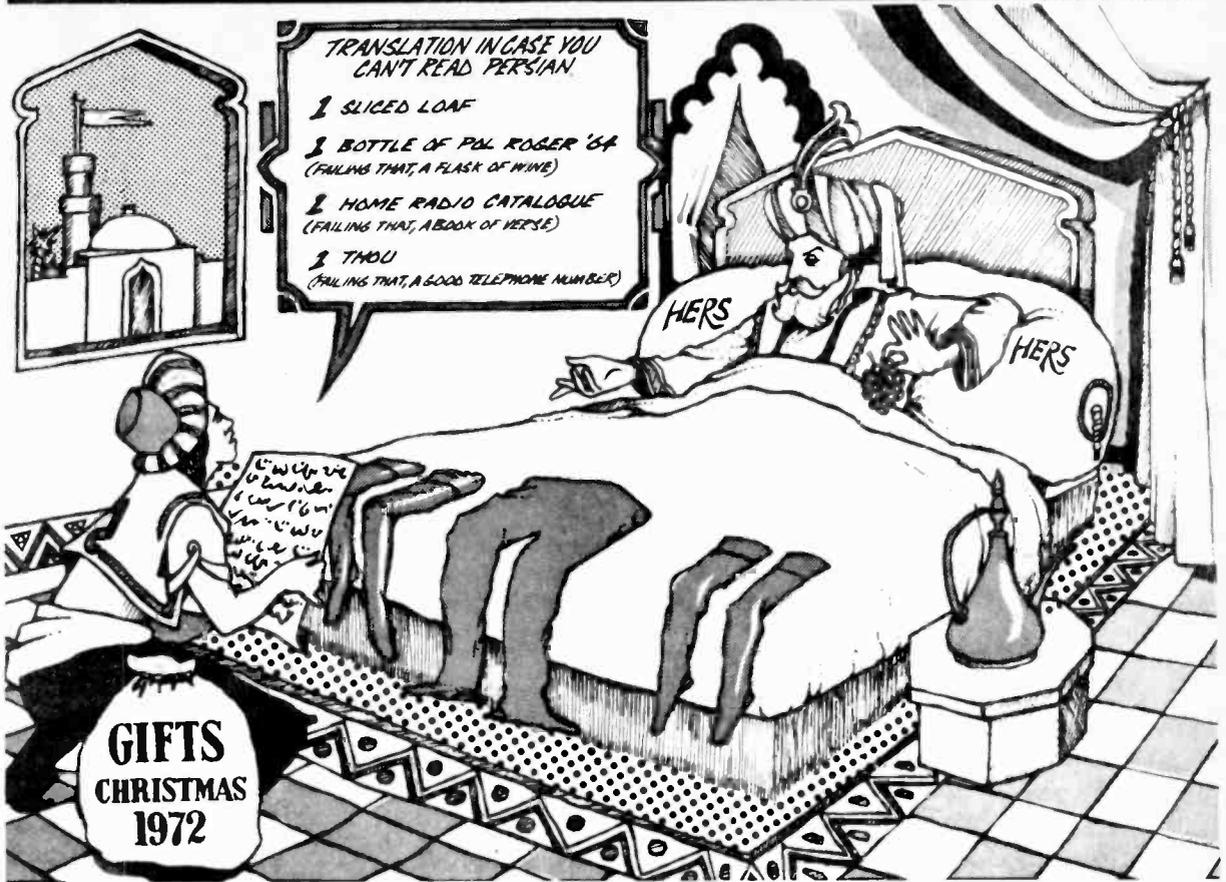
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One of the best known verses runs as follows:
*Here with a loaf of Bread beneath the Bough,
 A Flask of Wine, a Book of Verse and Thou
 Beside me singing in the Wilderness
 And Wilderness is Paradise enow.*

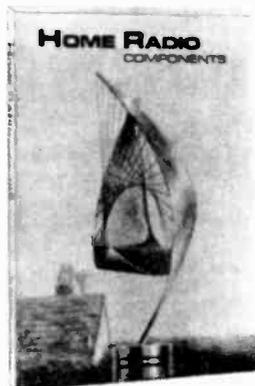
We hope that throws some light on our cartoon. If you read the poem you are bound to come to the conclusion that O.K. liked his tittle—obviously a thoroughly "good type".

What's all this to do with Electronics? You may well ask!!!

Nothing really, but after all, this is the Christmas Number, so we should be able to let our hair down. In any case we are sure you must already know that we produce an excellent Components Catalogue which will make interesting holiday reading for you, listing as it does some 6,785 items (over 1,750 illustrated) and costing only 75p including postage and packing (only 55p if you collect it). It also contains 10 vouchers (each worth 5p when used as directed). Are you convinced? No? Well you'd better go out and buy Omar's "Rubaiyat" instead!

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68/16, 100/4, 100/10, 100/25, 100/40, 150/6.3, 150/16, 150/25, 220/4, 220/10, 220/16,
330/4, 330/10, 470/6.3, 5p each. 68/63, 150/40, 220/25, 330/16, 470/10, 680/6.3,
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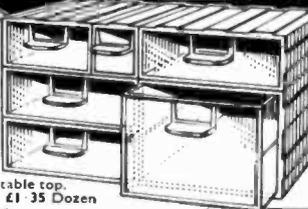
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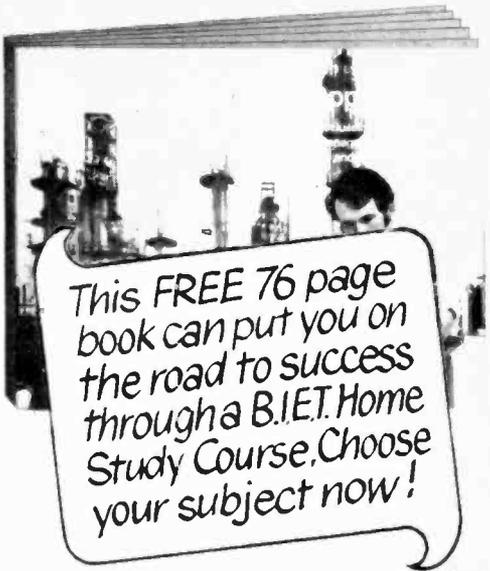
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\$6.50. P. & P. 15p.



MODEL TE-12
20,000 O.P.V. 0/0.6/6/30/120/
600/1,200/6,000/60,000. D.C.
0/1/5/10/20/60/1,200V. A.C.
0/1/3/15/30/60/600V. 0/6K/
600K/6 meg Ω . -20 to +62db.
0.2mV. \$2.97. P. & P. 17p.

MODEL TE-200
20,000 O.P.V. Mirror scale,
overload protection. 0/1/25/125/
1,000V. D.C. 0/10/50/250/
1,000V. A.C. 0/50/150/250/500/
600K/6 meg Ω . -20 to +62db.
\$3.95. P. & P. 15p.

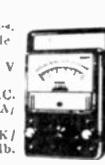


MODEL 500
30,000 O.P.V. with over-
load protection mirror scale
0/5/2.5/10/25/100/250/500/
1,011V. D.C. 0/2.5/10/25/
100/250/500/1,000V. A.C.
0/50/150/250/500mA. 12
80 meg Ω . -20 to +62db.
\$3.97. P. & P. 15p.

HIOKI MODEL 750X
50,000 O.P.V. 43 ranges 0.3 to
1,200V. D.C. 0.3 to 1,200V.
A.C. 0.30A/300mA. 0.5K/30
meg ohm. -10 to +17db.
\$8.97. Post 20p.



HT100B - MULTI-METER
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.
0/10/250/500A/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 A.C.
0/300A/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.



RUSSIAN 22 RANGE MULTIMETER
Model U437 10,000 o.p.v.
A first class versatile in-
strument manufactured in
U.S.S.R. to the highest
standards. Range: 2.5/10/
50/250/500/1000V. D.C. 2.5/
10/50/250/500/1000mA. A.C.
DC Current 100mA/1/10/
100mA/1A. Resistance
300 ohms/3/30/300K/3m Ω .
Complete with batteries,
test leads, instructions and
sturdy steel carrying case.
O.T.R. PRICE \$5.97. P. & P. 25p.



ROUND SCALE TYPE PENCIL TESTER

MODEL T.S.68
Completely portable, simple
to use pocket size 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 multi-
meter. 5/25/50/250/
500 / 2500 V. D.C.
10 / 50 / 100 / 500 / 1000V.
A.C. 60mA / 250mA. 6K / 6
meg ohms. -20 to +22dB.
\$3.97. Post 20p.



MODEL TH-12

20,000 o.p.v. Overload protection.
Slide switch selector
0 / 25 / 2.5 / 10 / 50 / 250 /
1000V. D.C. 0 / 15 / 50 / 250 /
1000V. A.C. 0 / 50mA / 25
250mA. D.C. 0 / 3K / 30K /
300K / 3 meg -20 to +60dB.
\$4.97. Post 15p.

MODEL TE-300

30,000 O.P.V. Mirror scale,
overload protection 0/4/3/15/60/
300/1,200V. D.C. 0/6/30/120/600/
1,200V. A.C. 0/30/60/300/600/
60mA/300mA/600mA. 0/8K/
80K/800K/8 meg. ohm -20 to
+63 db. \$5.97. P. & P. 15p.



MODEL PL436

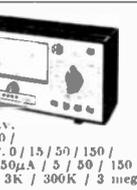
20k Ω /Volt D.C. 8k Ω /
Volt A.C. Mirror scale.
0/3/12/30/120/600 V
D.C. 3/30/120/600 V
A.C. 50/600/6A/60/600
mA. 10/100K/1 Meg/10
Meg Ω -20 to +46db.
\$6.97. P. & P. 12 p.

TMK MODEL TW-50K

66 ranges, mirror scale,
50K Ω /V. D.C. 5K/Volt A.C.
D.C. Volts: 125, 25, 125,
25, 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,
50mA, 2.5, 5, 25, 50, 250,
500mA, 5, 10 amp Resistance:
10K, 100K, 1 MEG, 10 MEG;
0.2 decibels: -20 to +81.5db
\$8.50. P. & P. 17p.

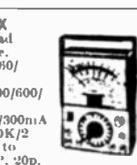
MODEL K228A

Transistor 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. 0/50/150/500/150/
500mA. 5A D.C. 0/3K/300K/3 meg.
\$8.95. Post 20p.



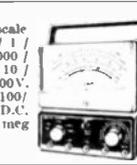
HIOKI MODEL 700X

100,000 O.P.V. Overload
protection. Mirror scale.
3/1/2/1/2.5/12.5/30/60/
120/300/600/1200V DC
1.5/3/6/12/30/60/150/300/600/
1200 V. A.C.
15/30/60/30/60/150/300mA
6/12 AMP. 1K, 2K/200K/2
Meg/20 Meg ohm -20 to
+63db. \$18.50. P. & P. 20p.



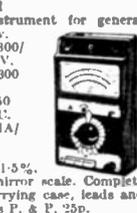
MODEL C-7080 EN

Giant 87 mirror scale
20,000 o.p.v. 0 / 25 / 1 /
2.5 / 10 / 60 / 250 / 1000 /
5000V. D.C. 0 / 2.5 / 10 /
50 / 250 / 1000 / 5000V.
A.C. 0 / 50mA / 1 / 10 / 100 /
500mA / 10 amp. D.C.
0 / 2K / 200K / 20 meg
-20 to +50 dB.
\$18.95. 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. 0/300mA/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. \$9.60 plus P. & P. 25p.



Selected TEST EQUIPMENT

FTC-401 TRANSISTOR TESTER

Full capabilities for measuring
A, B and 100. NPN or PNP.
Equally adaptable for check-
ing 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/
600/6A/ 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.



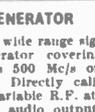
MODEL 449A IN CIRCUIT TRANSISTOR TESTER

Checks true A.C.
beta in/out. Checks Ico.
Checks diodes in / out. Checks
SCR, etc. Beta
H1 10-500, LQ2-50.
Ico 0-5000 μ A. 220/240 V A.C. operation.
\$17.50. Post 25p.



TE-20D RF SIGNAL GENERATOR

Accurate wide range sig-
nal generator covering
120 Kcs 500 Mc/s on
6 bands. Directly cali-
brated Variable R.F. at-
tenuator, audio output.
Xtal socket for calibration.
220/240V. A.C. Brand new
with instructions \$18. Carr. 371p.
Size 140 x 215 x 170 mm.



MODEL L-55 FET V.O.M.

Input impedance 10 meg
ohms. 0 / 3 / 12 / 60 / 30 /
120 / 600V. D.C. 0 / 3 /
12 / 60 / 120 / 600V. A.C.
0 / 120 μ A / 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. Band-
width 10MHz. Sensi-
tivity at 100KHz VRMS/
mm. 1-25; HOR. AMP. Bandwidth 500KHz
Sensitivity at 100KHz V RMS/mm. 3-25;
Preset triggered sweep 1-3,000uSec; free
running 20-200,000Hz in nine ranges.
Calibrator pps. 220 x 360 x 430mm.
115-230V. AC operation.
\$39.00. Carr. paid.



TO-3 PORTABLE OSCILLOSCOPE

3m. tube, Y amp. Sensitivity
0.1v p-p/CM. Bandwidth
1-5 cps-1.5 MHz. Input imp.
2.5 meg Ω 250P X amp.
sensitivity 0.9v. p-p/CM.
Bandwidth 1.5cps-80KHz.
Input imp. 2 meg Ω 20P.F.
Time base. 5 ranges 10 cps
300 kHz. Synchronization.
Internal/external. Illuminated
scale 140 x 215 x 330 mm. Weight 15lb.
220/240V. A.C. Supplied brand new with
handbook. \$40.00. Carr. 60p.



RUSSIAN CI-15 DOUBLE BEAM OSCILLOSCOPE

5 mc/s Pass Band. Separate
Y1 and Y2 amplifiers.
Rectangular 5in. x 4in.
C.R.T. Calibrated trig-
gered sweep from .2 uSec.
to 100 milli-sec. per cm.
Free running time base 50 cps-1 mc/s. Built-
in time base calibrator and amplitude
calibrator. Supplied complete with all
accessories and instruction manual.
\$87. Carr. Paid.



TE-16A TRANSISTORISED SIGNAL GENERATOR

8 ranges 400KHz-30mHz.
An inexpensive instrument
for the handyman.
Operates on 9V battery.
Wide easy to read scale.
800KHz modulation.
81 x 61 x 31mm.
Complete with instruc-
tions and leads. \$7.97. Post 25p.



TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE

A new portable
bridge offering excel-
lent range and
accuracy at low
cost. Ranges: R.
1 Ω 11-1 meg Ω
6 Ranges \pm 1%
L μ H - 111
HENRY8 6 Ranges 2-
6 Ranges \pm 2%. TURN RATIO 1:1/1000-
1:1/100. 6 Ranges \pm 1%. Bridge voltage at
1,000 cps. Operated from 9 volts, 100mA.
Meter indication. Attractive 2 tone metal
case. Size 7 1/2 x 5 1/2 in. \$20. P. & P. 25p.



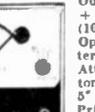
MODEL TE-15 GRID DIP METER

Transistorised. Operates as
Grid Dip, Oscillator, Absorp-
tion Wave Meter and Oscil-
lating Detector. Frequency
range 440Kcs-280Mc/s in
6 coils. 500 μ A Meter. 9V
battery operation. Size 180 x
80 x 40mm. \$12/240 V A.C. operation.
\$20. Post 20p.



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

Size 18 x 200,000 Hz; Square 18 x 50,000 Hz
Output max.
+10 dB.
(10 K ohms)
Operation in-
ternal batteries
Attractive 2-
tone case 7 1/2 x
5 x 2".
Price \$17.50.
Carr. 171p.



MODEL MG-100 SINE SQUARE WAVE AUDIO GENERATOR

Range 19-200,000Hz
Sine Wave 19-100,000
Hz Square Wave.
Output Min. or Square
wave 10v. P. to P.
Size 180 x 90 x 90mm.
Operation 220/240V. A.C.
\$17.50. Post 37p.



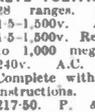
MODEL AT201 DECADE ATTENUATOR

Frequency range 0-
200KHz. Attenuator
0-111db. 0.1db step.
Impedance 600 ohms.
Max. input power
30dbm. Size 180 x 90 x 55mm.
\$12.50. Post 37p.



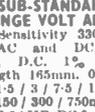
TE-65 VALVE VOLTMETER

25 ranges. 10.5 volts
15-500V. 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 avail-
able: R.F. \$2.12; H.V.
\$2.50.



MODEL U4311 SUB-STANDARD MULTI-RANGE VOLT AMMETER

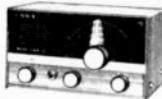
Sensitivity 330 ohms/Volt
AC and DC. Accuracy
5% D.C. 1% AC. Scale
length 165mm. 0/300/750/1500/
15/3/7.5/15/30/75/
150/300/750mA/1.5/3/
7.5AMP DC 0/3/7.5/15/
30/75/150/300/
750mA/1.5/3/7.5/
AMP AC 0/7.5/150/
300/750mV/1.5/.3/3/
7.5/15/30/75/150/300/750V DC
0/750mV/1.5/3/7.5/15/30/75/150/300/
750V AC. Automatic cut out. Supplied com-
plete with test leads, manual and test certifi-
cates. \$49.00. Post 60p.



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

UNR-30 RECEIVER

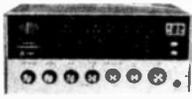
4 Bands covering 550kc/s - 30Mc/s. B.F.O. Built-in speaker 220/240v A.C. Brand new with instructions. £15.75 Carr. 37½p.



UR-1A SOLID STATE COMMUNICATION RECEIVER

4 Bands covering 550kc/s-30Mc/s. PET 8 Meter. Variable BFO for 8SB. Built-in Speaker. Bandspread, Sensitivity Control. 220/240v. A.C. or 12v. D.C. 12½" x 4½" x 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 alidie dial. Bandspread. Aerial tuning BFO. A.V.C. ANL. 18" meter. AM/CW/8SB. Integrated speaker and phone socket. Operation 220/240v AC or 12v DC. Size 325 x 266 x 180 mm. Complete with instructions and circuit. £28.50. Carr. 50p.

LAFAYETTE HA-600 SOLID STATE RECEIVER



General coverage 180-400kc/s. 550 Kc/s-30Mc/s. PET front end. 2 mesh filters, product detector, variable B.F.O., noise limiter. 8 Meter. Bandspread, RF Gain. 15" x 9½" x 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 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. 8SB-CW. ANL. Variable BFO. 8 meter. Sep. bandspread dial. IF frequency 455 Kc/s. audio output 1.5w. Variable RF and AF gain controls 115/220v. A.C. Size: 7" x 13" x 10" with instruction manual. £49.50. Carr. 16½p.



EMI LOUDSPEAKERS

Model 350. 13" x 8" with single tweeter/crossover. 20-20,000 Hz. 15 watt RMS. Available 8 or 15 ohms. £7.25 each P. & P. 37p.
Model 450. 13" x 9" with twin tweeter/crossover. 55-13,000 Hz. 8 watt RMS. Available 8 or 15 ohms. £8.62 each. P. & P. 25p.

HONEYWELL DIGITAL VOLTMETER VT.100

Can be panel or bench mounted. Basic meter measures 1 volt D.C. but can be used to measure a wide range of AC and DC volt. current and ohms with optional plug in cards. Specification: Accuracy: ± 0.2, ± 1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1.999). Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100v. D.C. Input: Fully floating (3 poles). Input power: 110-230v. A.C. 50/60 cycles. Overall size: 5½in. x 3 13/16in. x 8 3/16in. AVAILABLE BRAND NEW AND FULLY GUARANTEED. £26.50. Carr. 50p.



SINCLAIR IC-12



List Price £2.98

OUR PRICE £1.80 P. & P. 10p

SINCLAIR EQUIPMENT

Project 60. Package offers. 2 x Z30 amplifier, stereo 60 pre-amp. PZ5 power supply. £15.95 Carr. 37½p. Or with PZ6 power supply £18.00 Carr. 37½p. 2 x Z20 amplifier, stereo 60 pre-amp. PZ8 power supply. £20.25. Carr. 37½p. Transformer for PZ6. £5.97 extra. Add to any of the above £4.45 for active filter unit and £13.00 for pair of Q16 speakers. All other Sinclair products in stock. 2000 Amp £21.95 Carr. 37½p.; 3000 Amp £28.50 Carr. 37½p.; Neoteric Amp £43.95. Carr. 37½p. IC12 £1.80 p. & p. 10p. NEW PROJECT 605 - £20.97. Carr. 37p.

WHARFEDALE-MID-RANGE HI-FI UNITS

As used in world famous system. 5" dia. Impedance 4/8 ohms. High flux ceramic magnet, 20 watts rms. Brand new £1.50. Carr. 37p.



SPECIAL OFFER! GOODMANS AXIOM 301

Hi Fi 12" 20 watt twin cone full range speaker. 30-16,000 Hz. 16,500 gauss. 8 ohm impedance. Brand new and boxed. (List price £21.72) OUR PRICE £12.50 each. Carr. 50p.



EA-41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated. Simply plug in microphone, etc., and output into your amplifier. Volume control, depth of reverberation control. Beautiful walnut cabinet. 7½ x 3 x 4½in. £5.97. P. & P. 15p.



SPECIAL OFFER! ROTEL RH700 STEREO HEADPHONES

20-20,000Hz. 8-16 ohm. (List £9.95). OUR PRICE £6.75. P. & P. 25p.



SPECIAL OFFER! STEREO SPEAKERS

Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size 14½" x 9" x 7½". 8 ohms. 8 watt RMS. 16 watt peak. Complete with DIN lead. £18.95 pr. Carr. 50p.



HA-10 STEREO HEADPHONE AMPLIFIER

All silicon transistor amplifier operates from magnetic ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9v battery. Inputs 5MU/100MU. Output 50MW. £5.97. P. & P. 15p.



SPECIAL PURCHASE! NEAT G30J STATIC BALANCE PICK-UP ARMS



Identical specification to NEAT G30 arm but with two-tone chrome and black finish. Complete with head shell, pick up rest and plug in phono leads. BRAND NEW—FULLY GUARANTEED ONLY £8.95. P. & P. 25p.

AKAI BARGAINS

SUPER MONEY SAVING OFFERS—BUY NOW WHILE STOCKS LAST! ALL BRAND NEW AND FULLY GUARANTEED



1720 Tape Rec.	£58-75	GXC40 Cassette Rec.	£58-25
1721 Tape Rec.	£73-95	GXC40D Cassette Deck	£66-95
X5000 Tape Rec.	£99-95	GXC40T Cassette/Receiver	£123-95
GX355 Tape Rec.	£237-90	GXC45D Cassette Deck	£95-95
4000D Tape Deck	£81-50	GXC46D Cassette Deck	£103-50
4000D8 Tape Deck	£73-95	GXC60D Cassette Deck	£111-25
X200D Tape Deck	£99-95	GXC85D Cassette Deck	£29-50
GX220D Tape Deck	£164-95	AA9200 Receiver	£74-95
GX240D Tape Deck	£249-40	AA6300 Receiver	£109-00
X19008D Tape/8 track Rec.	£101-95	AA8500 Receiver	£175-00
X20008D Tape/Cass/8 track Rec.	£229-30	CS88 Speakers (Pair)	£15-95
CR81 8 track Rec.	£90-95	ADM11 Microphones (Pair)	£7-50
CR81D 8 track Rec.	£65-95		
CR81T 8 track/Receiver	£118-90		
CR81R 8 track system	£145-00		
CS85 Cassette Rec.	£79-00		
CS85D Cassette Deck	£74-95		

Carriage 50p extra. (Recorders & Decks 75p)

GENUINE BARGAIN!

KOSS 3P 3XC STEREO HEADPHONES
Response 10-15,000Hz. Impedance 4-6 ohms. Brand new, Boxed & fully guaranteed. (List £9.50). OUR PRICE £6.50. P. & P. 25p.



1021 STEREO LISTENING STATION

For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. 2 gain controls, speaker on-off slide switch, stereo headphone sockets. 6" x 4" x 2½". £9.95. P. & P. 15p.



MP7 MIXER PREAMPLIFIER

5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9½" x 5" x 3" Input Mics: 3 x 3mV 50K; 2 x 3mV 600ohm. Phono meg. 4mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K. £8.97. P. & P. 20p.



TE-1035 STEREO HEADPHONES

Low cost high performance stereo headphones. Foam rubber ear cups. Adjustable head-band, 8 ohm impedance 26-18,000 Hz. With lead and stereo jack plug. ONLY £1.97! P. & P. 12½p.



NEW GARRARD MODULES



Popular range of Garrard decks with Shure cartridge fitted in deluxe plinth with hinged lid.

BP25 III Module/M75-6	Our Price £22-50
AP76 Module/M75-6	£23-50
AP96 Module/M75-6	£23-75
Zero 1006 Module/M93E	£23-50

Carr. 50p extra any item.

HOSIDEN DH-08S DE-LUXE STEREO HEADPHONES

Features unique mechanical 3 way onite and fitted adjustable level controls. 8 ohm impedance 20-20,000cps. Complete with spring lead & stereo jack plug £7.97! P. & P. 12½p.



DOLBY SYSTEM NOISE REDUCTION UNIT

Improves the performance of cassette and semi-professional recorders. Reduces tape hiss by 3dB at 600Hz, 6dB at 1200Hz and 10dB for all frequencies above 3000Hz. Controls for input levels and noise reduction on record and replay. 3 meters for Dolby level. Off tape monitoring. Frequency response: 20Hz to 10kHz ± 1dB 10kHz ± 3dB. Size 15½" x 9" x 3½". AC 200/250V OUR PRICE £32.50 Carr. 50p.



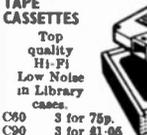
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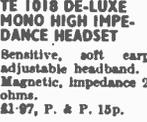
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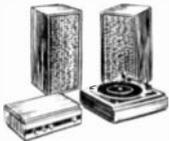
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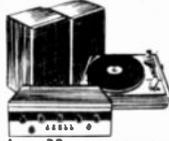
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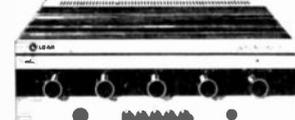
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SN7408	0.30	0.27	0.25	SN7473	0.40	0.37	0.35	SN74158	2.60	2.40	2.25
SN7409	0.45	0.42	0.35	SN7474	0.40	0.37	0.35	SN74161	2.80	2.40	2.25
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PROJECTS...
THEORY.....

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.



Our February issue will be published on Friday, January 19

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..EASY TO CONSTRUCT ..SIMPLY EXPLAINED

VOL. 2 NO. 1

JANUARY 1973

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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.

Everyday Electronics, January 1973



**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.



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 Vero-board to the size shown and drilling the mount-

**ICE
WARNING
DEVICE**

BY G. HODGES

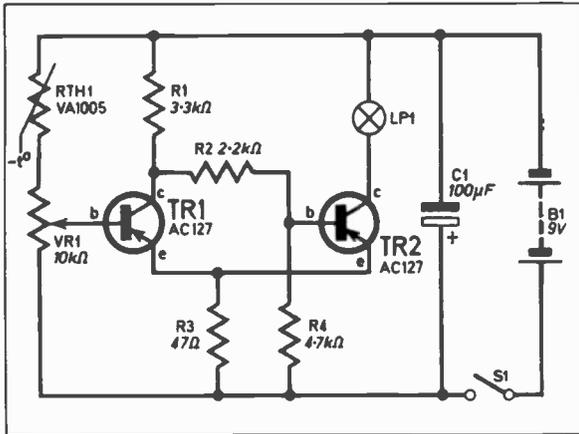


Fig. 1. Complete circuit diagram of the Ice Warning Device.

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).

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.

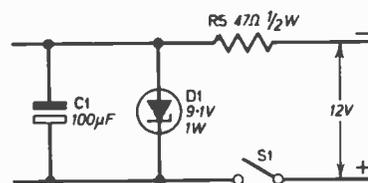
CAR SUPPLY

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 carsupply.



Components SEE SHOP TALK

Resistors

- R1 3.3kΩ
- R2 2.2kΩ
- R3 47Ω
- R4 4.7kΩ

All ± 10% 1/4W carbon

Capacitor

- C1 100µF elect. 12V

Thermistor

- RTH1 VA1005 rod type

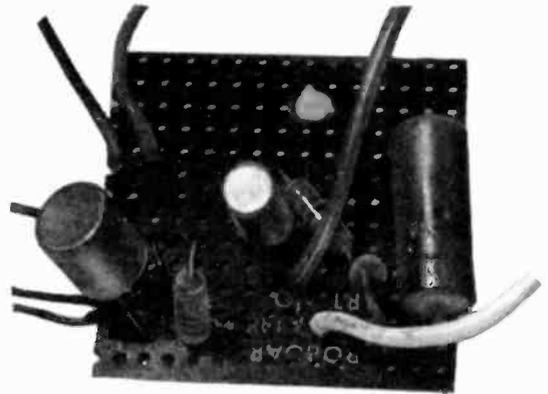
Transistors

- 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 RTH1

ICE WARNING DEVICE



Photograph of the completed circuit board.

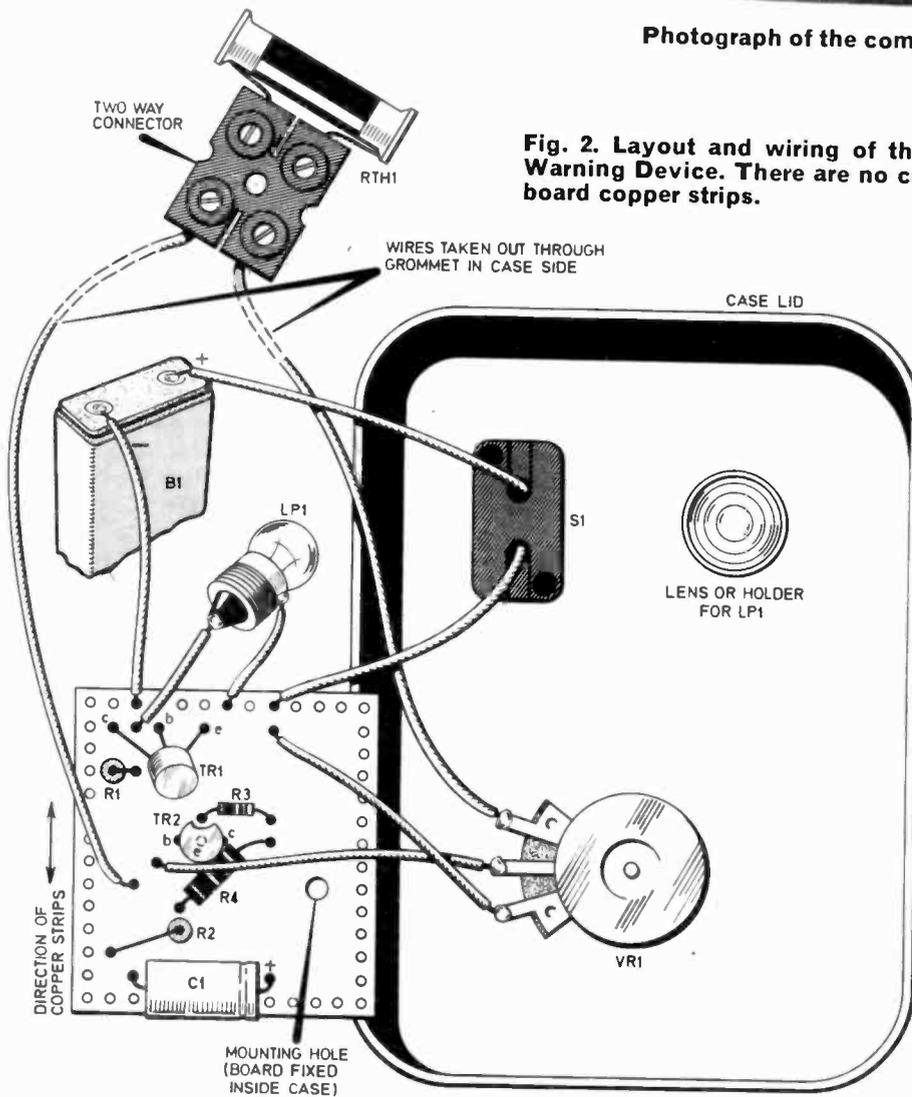
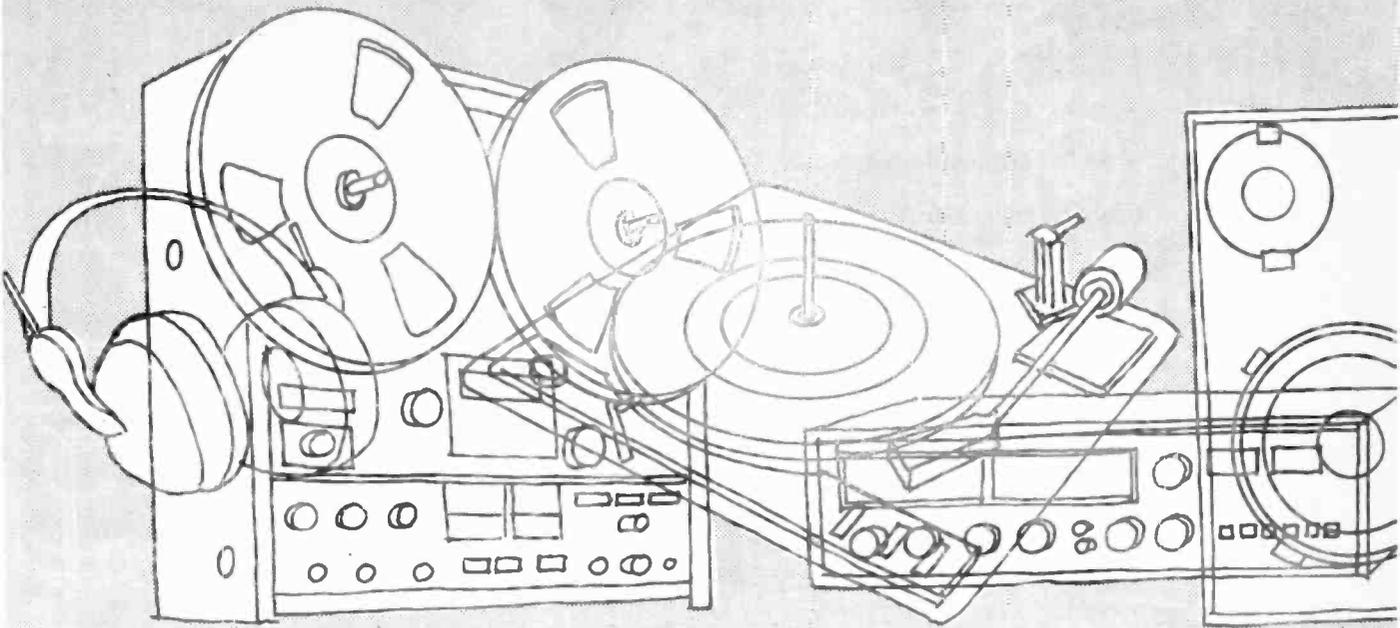


Fig. 2. Layout and wiring of the complete Ice Warning Device. There are no cuts in the Vero-board copper strips.



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.

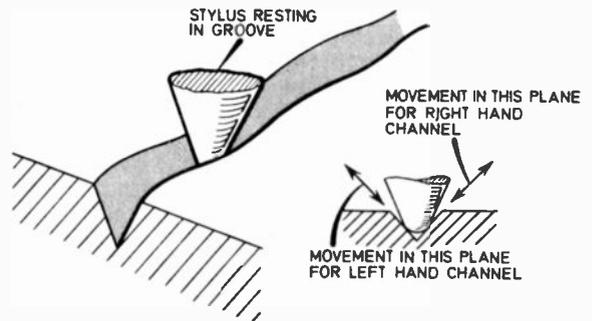
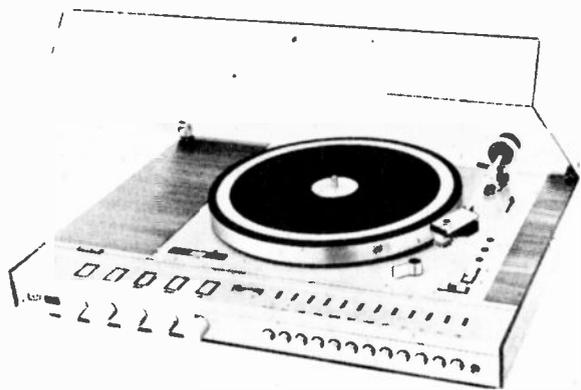


Fig. 1. Showing how a stereo signal is obtained from the record.

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 ± 1 dB, 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).

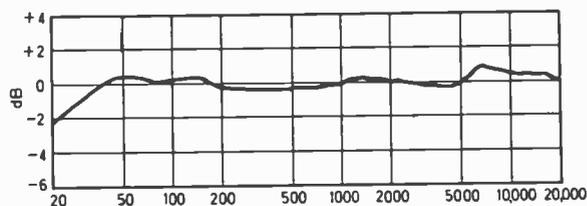


Fig. 2. A frequency response graph. The response is 30Hz-20kHz ± 1 dB.

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.

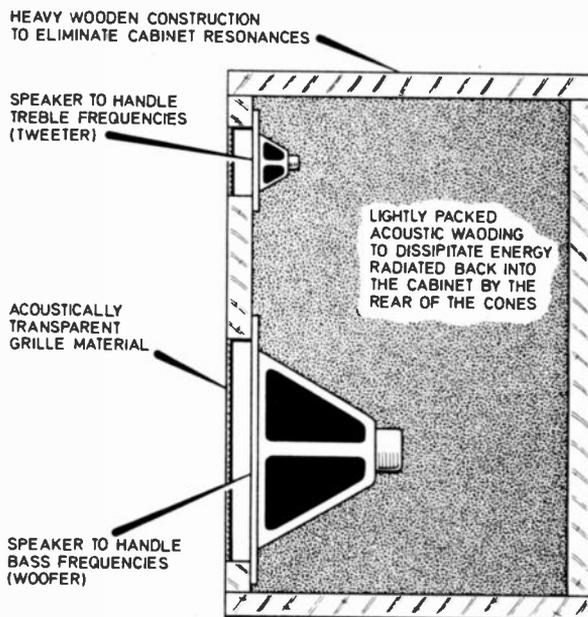
1. The two speakers should be of the same design and housed in identical enclosures (boxes) to ensure that the stereo image (the ears subjective placing of the sound between the speaker) remains stationary. If dissimilar speakers are used the sound will veer towards one or other speaker at those frequencies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

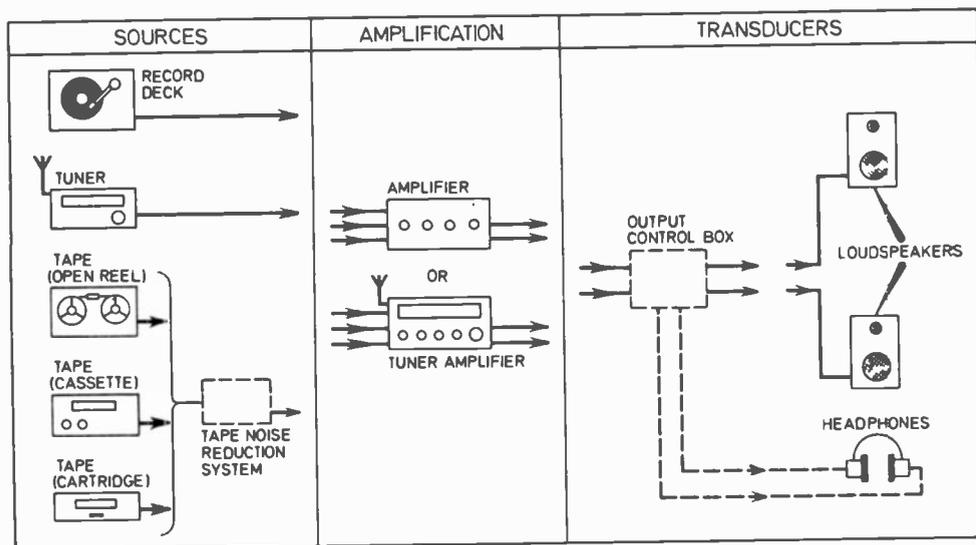
The smaller bookshelf speakers best suit small rooms and the floorstanding ones suit rooms with larger areas—the larger the speaker, the more faithfully it can reproduce the bass end of the spectrum. However, a bookshelf speaker will still handle bass well, despite definitive size due to the cabinet being constructed in the form of an "infinite baffle," i.e., completely sealed except for an aperture 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."

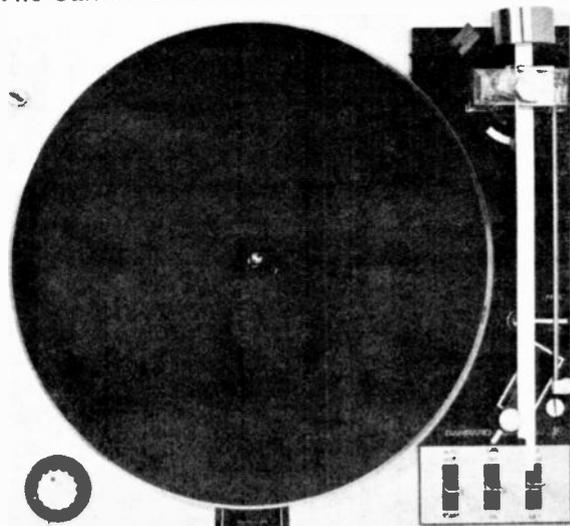
Stereo tuner prices extend from about £30 to £150 or more. One common approach is to combine the tuner with the amplifier—the larger unit looks neater yet has all the facilities to be expected from the two as discrete components. Tuner-amplifier prices are from about £50 to £800 or more.

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.

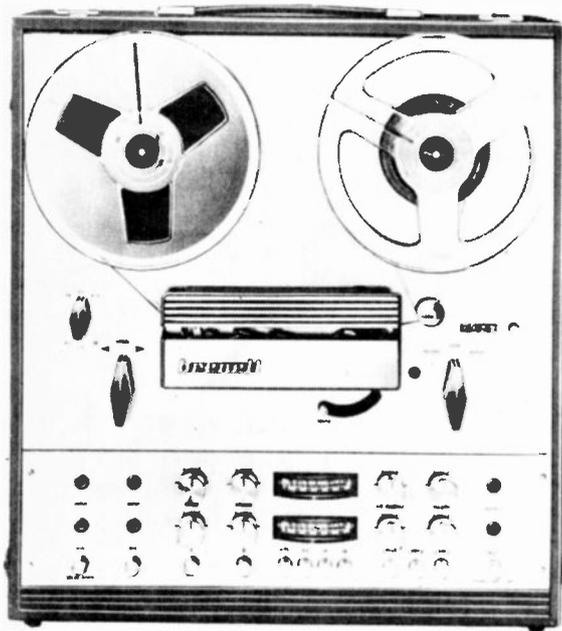


expected, the cartridges are expensive, relative to their size—from about £4 to £60 or more.

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 advan-



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.

tage 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.

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 through-

out. 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.

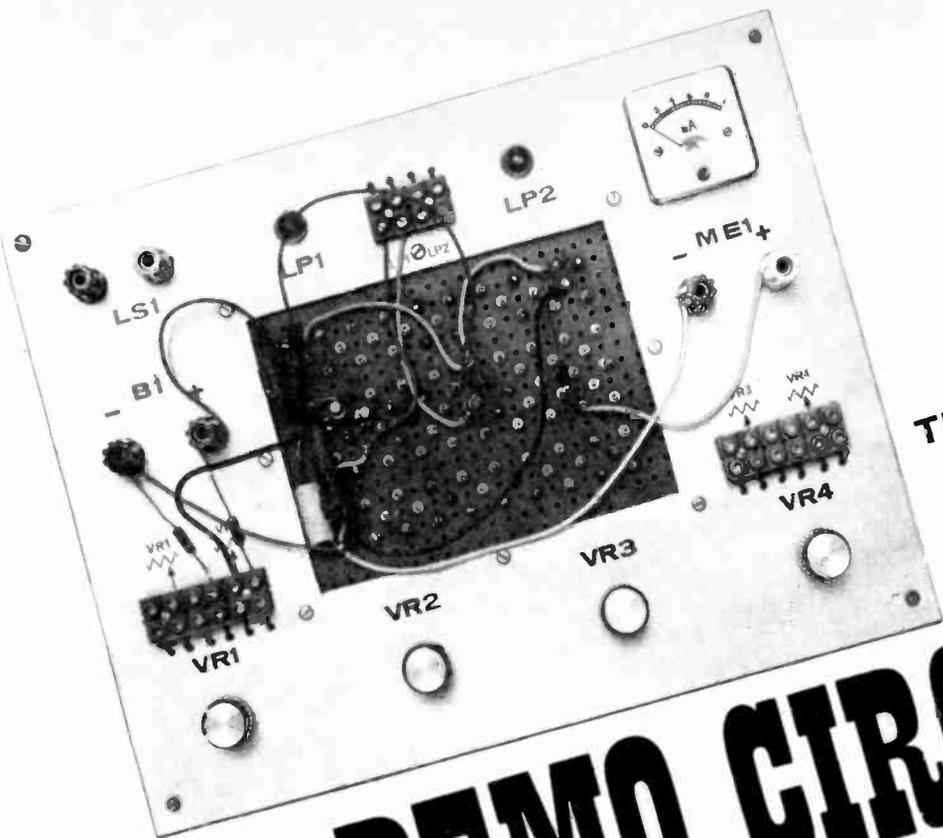
Although it has already been stated, it is important to hear units before purchase to determine whether the standard will match up to that of the equipment already owned, if any. The guide that I personally find useful is that the price of the pair of speakers should be slightly more than that of the 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.

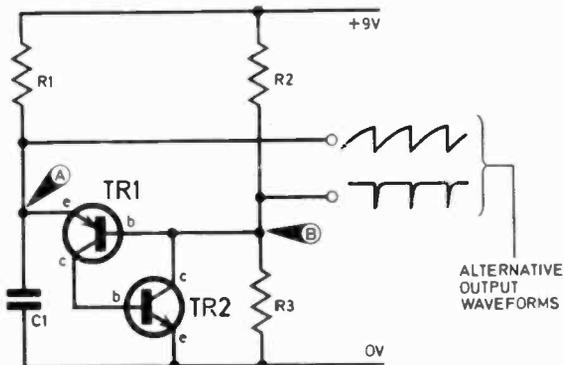
The cycle is made to be repetitive and the signal waveform at point A resembles a sawtooth. Strictly speaking the rise in voltage is not directly proportional to time so the upward going ramp is not what we call linear unless the voltage level at which discharge commences is low compared with the total 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 *pn*p 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 *np*n 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 $\frac{1}{0.7 \times C1 \times R1}$ 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

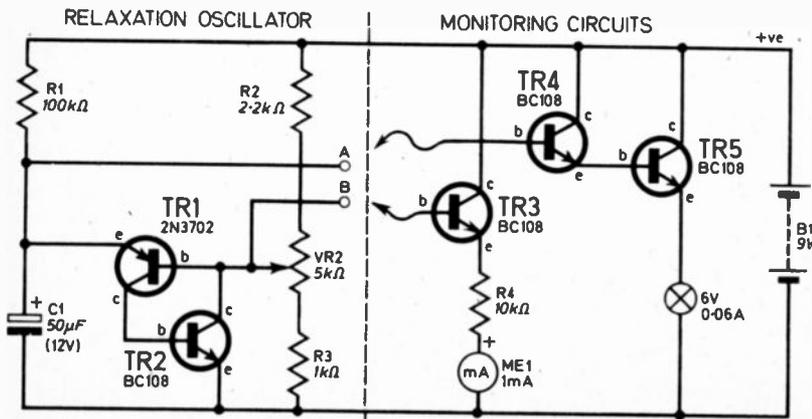


Fig. 2.2. The practical oscillator circuit. Transistors TR3, TR4 and TR5 do not affect the oscillator, they are used for monitoring purposes only.

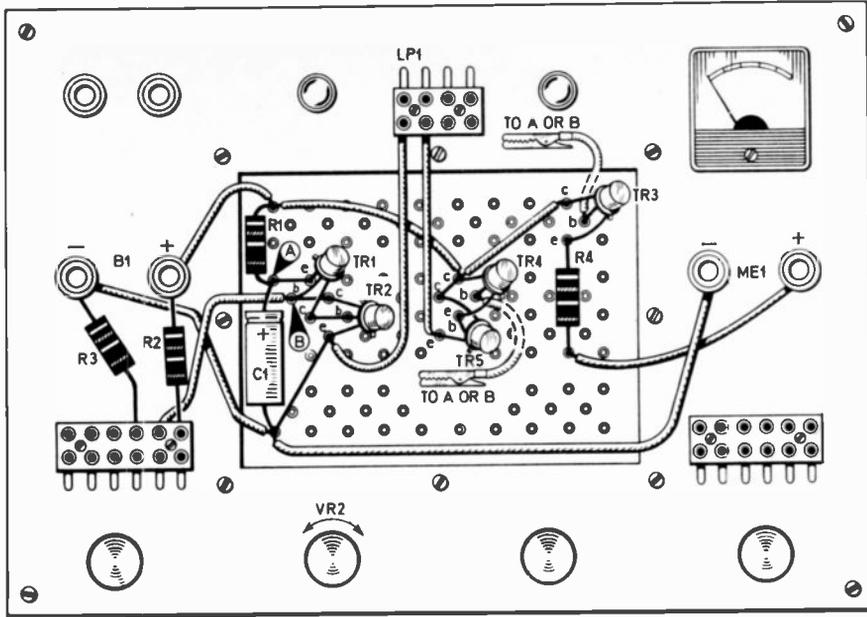


Fig. 2.3. The circuit of Fig. 2.2 built up on the Demo Deck. VR2 controls the triggering level.

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 1 μ F 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 fre-

quency 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. Ccil 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



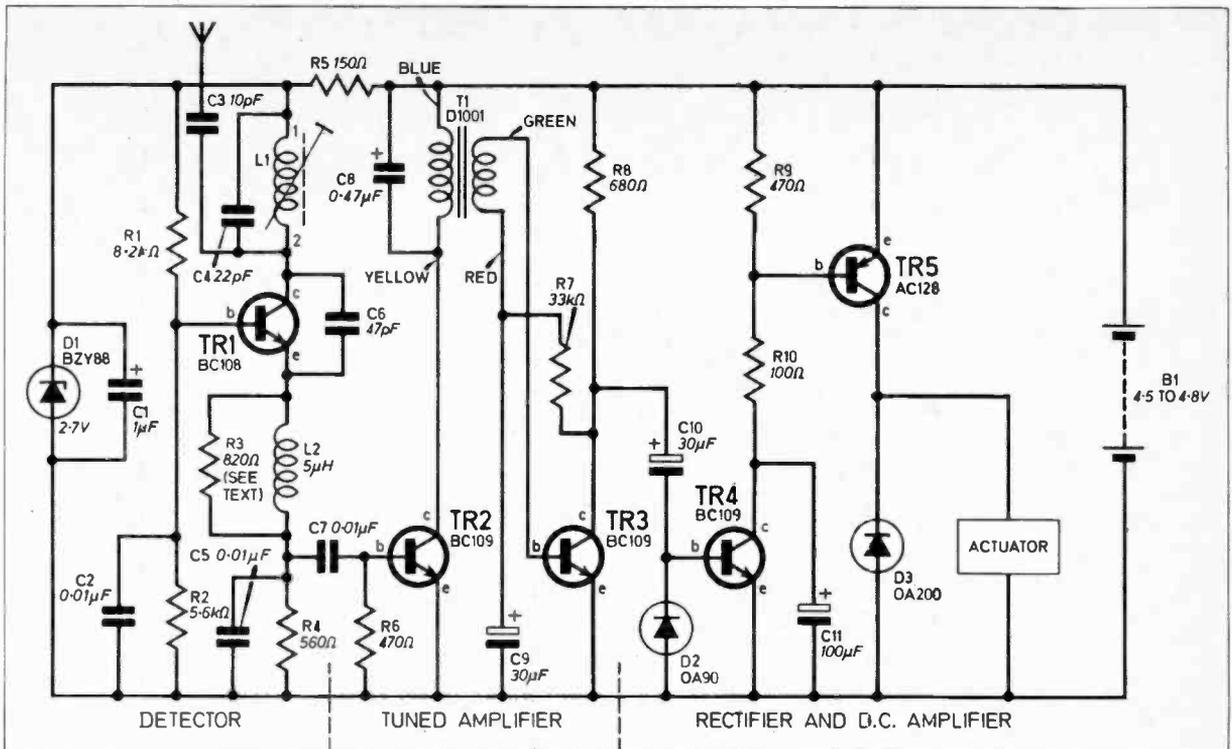


Fig. 1. The complete circuit diagram of the Radio Control Receiver.

Components . . .

Resistors

- R1 8.2k Ω
 R2 5.6k Ω
 R3 820 Ω (see text)
 R4 560 Ω
 R5 150 Ω
 R6 470 Ω
 R7 33k Ω
 R8 680 Ω
 R9 470 Ω
 R10 100 Ω
 All $\frac{1}{4}$ watt $\pm 10\%$ carbon

Capacitors

- C1 1 μ F tantalum bead type
 C2 0.01 μ F miniature tubular polyester
 C3 10pF polystyrene
 C4 22pF polystyrene
 C5 0.01 μ F miniature tubular polyester
 C6 47pF polystyrene
 C7 0.01 μ F miniature tubular polyester
 C8 0.47 μ F tantalum bead type
 C9 30 μ F elect. 6V printed circuit type
 C10 30 μ F elect. 6V printed circuit type
 C11 100 μ F 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 Ardenite D1001 transformer (see note 1)
 L2 5 μ H radio frequency 1A TV choke
 B1 HP7 (3 off) or 4.3V 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 100 Ω
 R12 100 Ω
 R13 100 Ω
 All $\frac{1}{4}$ watt $\pm 10\%$ 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 0.1 μ F
 C13 0.1 μ F
 L3, L4 2A TV choke (2 off)

SEE
**SHOP
 TALK**

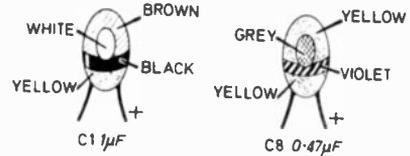
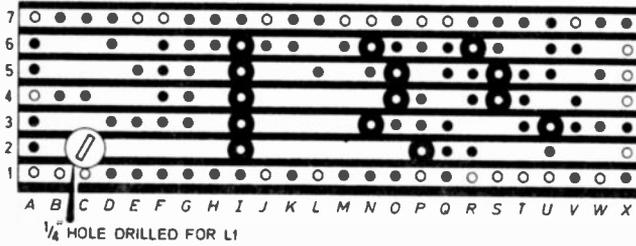
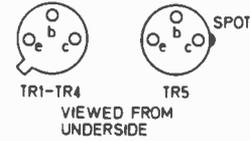
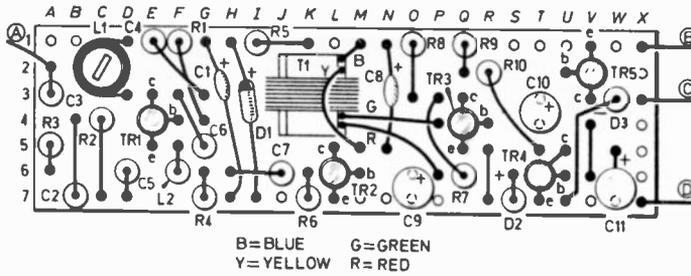


Fig. 2. The layout of the components on the top side of the Veroboard. Vertical mounting is employed; component sizes have been reduced for clarity. Also shown is tantalum capacitor identification.

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 1/2in x 3/8in x 1/2in. 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 1/4in hole in the circuit board, position

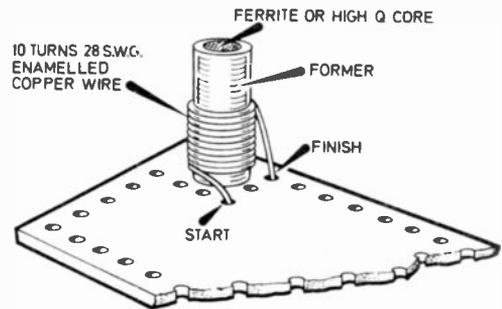


Fig. 3. Winding details for coil L1.

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

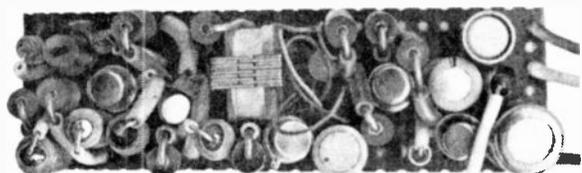
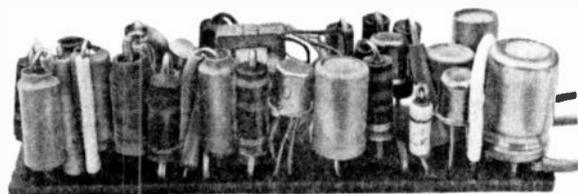
Temporarily solder an 820 ohm resistor to

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).

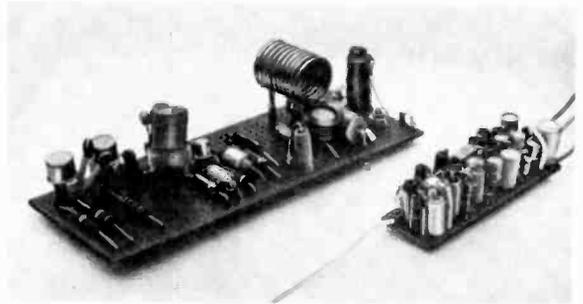
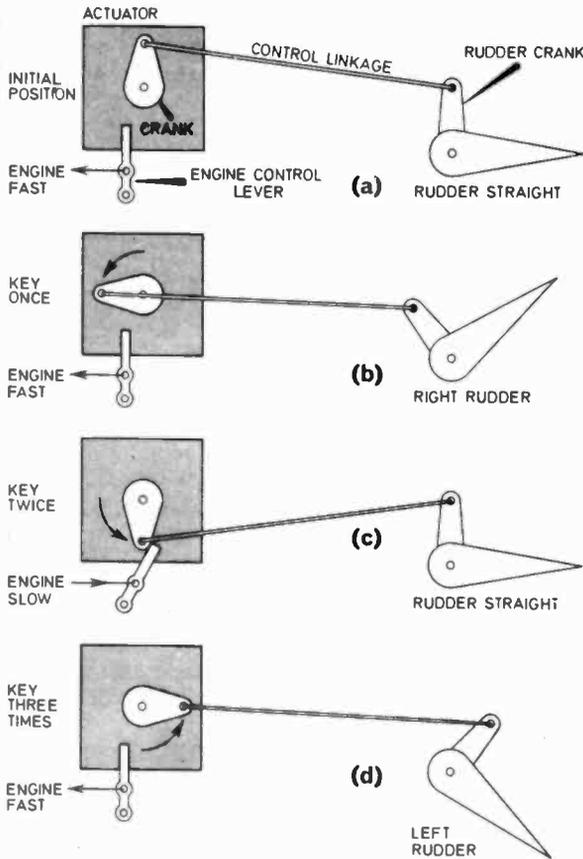
When the keying switch is pressed again, the crank moves on one step to engage with the engine lever (Fig. 4c) thus giving straight rudder and slow speed. Left rudder at fast speed (Fig. 4d) results when the transmitter key is pressed three times, and finally the crank is returned to its initial position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

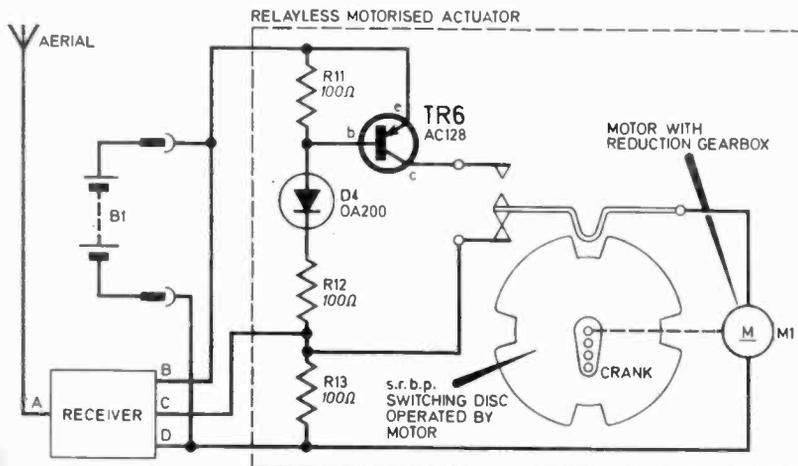


Fig. 5. Details of a circuit of a relayless motorised actuator.

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.

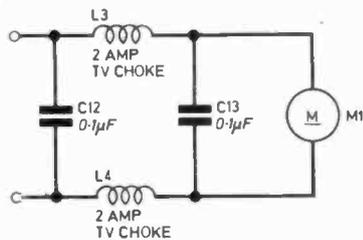
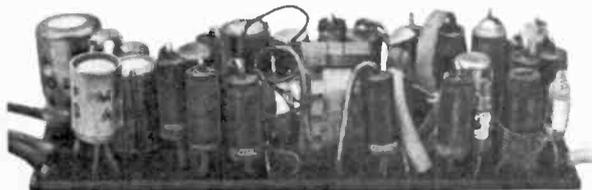


Fig. 6. Interference suppressor circuit for small electric motors.

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



Everyday Electronics, January 1973

Next Month

Audio Colour unit

Add a colour dimension to your audio equipment. This three channel colour unit modulates the light level of three different coloured lamps in time with the bass, middle and treble notes of any music.

Damp Locator

Buying a new house or just renovating your own? The damp locator gives a quick check on walls and floors. Easily carried in the pocket it "spots" damp, and not just cold walls.

UHF TV Aerial

Are you now able to receive all television programmes on U.h.f. 625 lines from a local transmitter, but do not have a proper aerial? Then you must not miss next month's issue which shows how to build a simple u.h.f. aerial very cheaply.

All in the Feb. 73 issue of



On Sale Friday Jan 19th.

BASIC

3

Electricity

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.

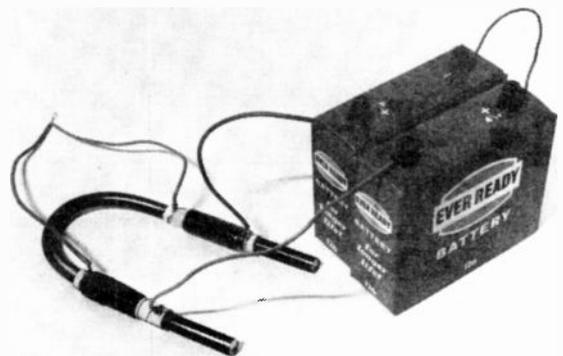
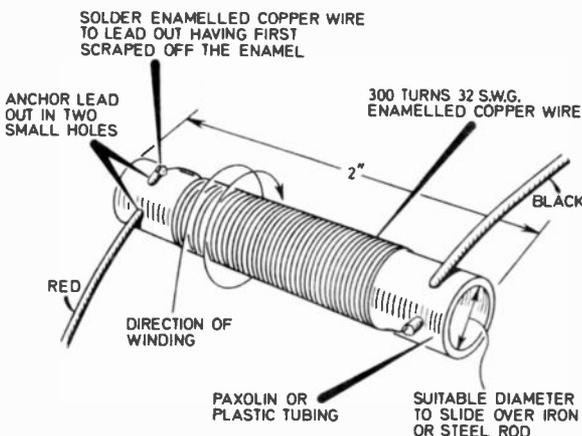


Fig. 3.2. Details of making the U-shaped electromagnet. A convenient supply is obtained by connecting two $4\frac{1}{2}$ volt bell batteries in series.

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 sub-

stances 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 formerly attracted to the magnet will fall off. Because we have used steel some magnetism remains after the current has stopped flowing. This is called **remnance** 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 remnance 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.

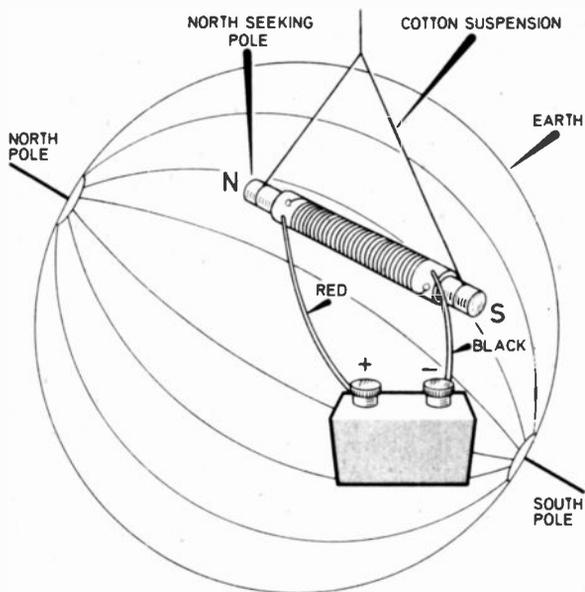


Fig. 3.3. A straight magnet will line up along the earth's magnetic axis.

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.

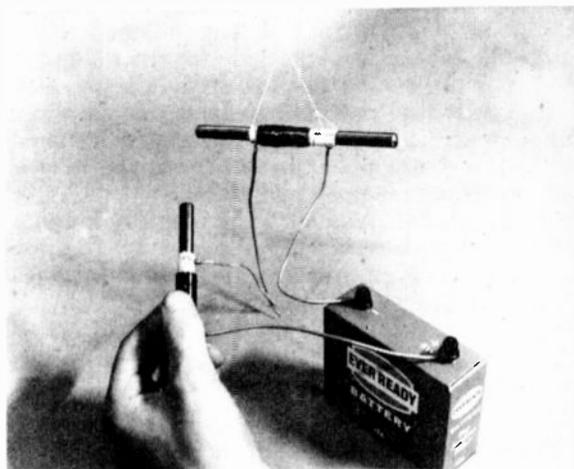


Fig. 3.4. Experiment for showing that like poles repel, unlike poles attract.

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

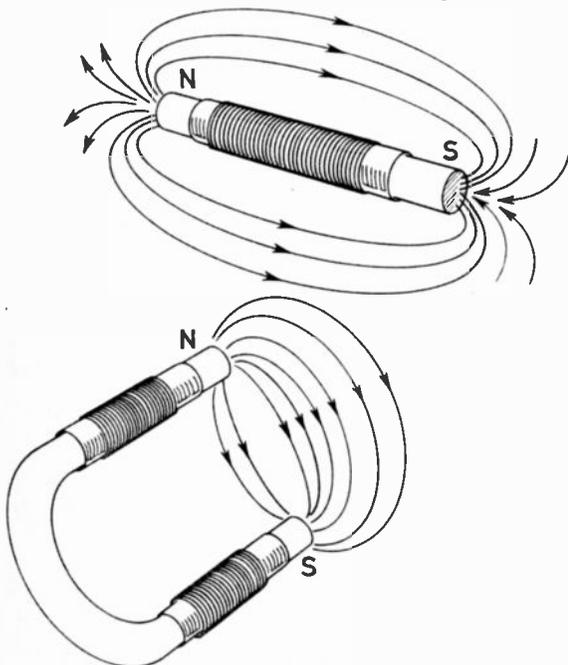


Fig. 3.6. Imaginary lines of force around (1) straight magnet (2) U-shaped magnet.

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.

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

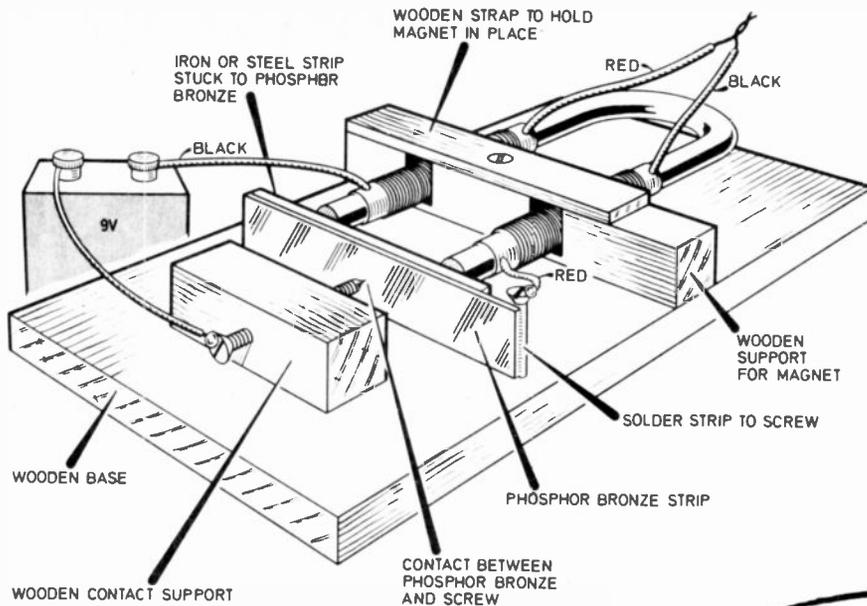


Fig. 3.7. Assembly details of a "home made" buzzer.

sticking a 1½ in. length of steel or iron strip on to a 2 in. length of phosphor-bronze draft excluder strip. A 1½ 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 ⅛ 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.

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.

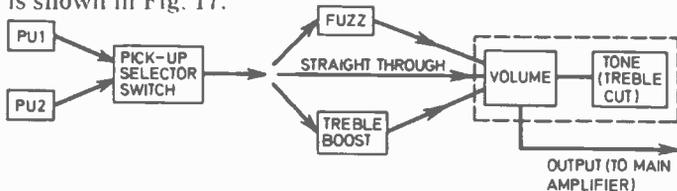


Fig. 17. Block diagram of the complete system installed in the guitar body.

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

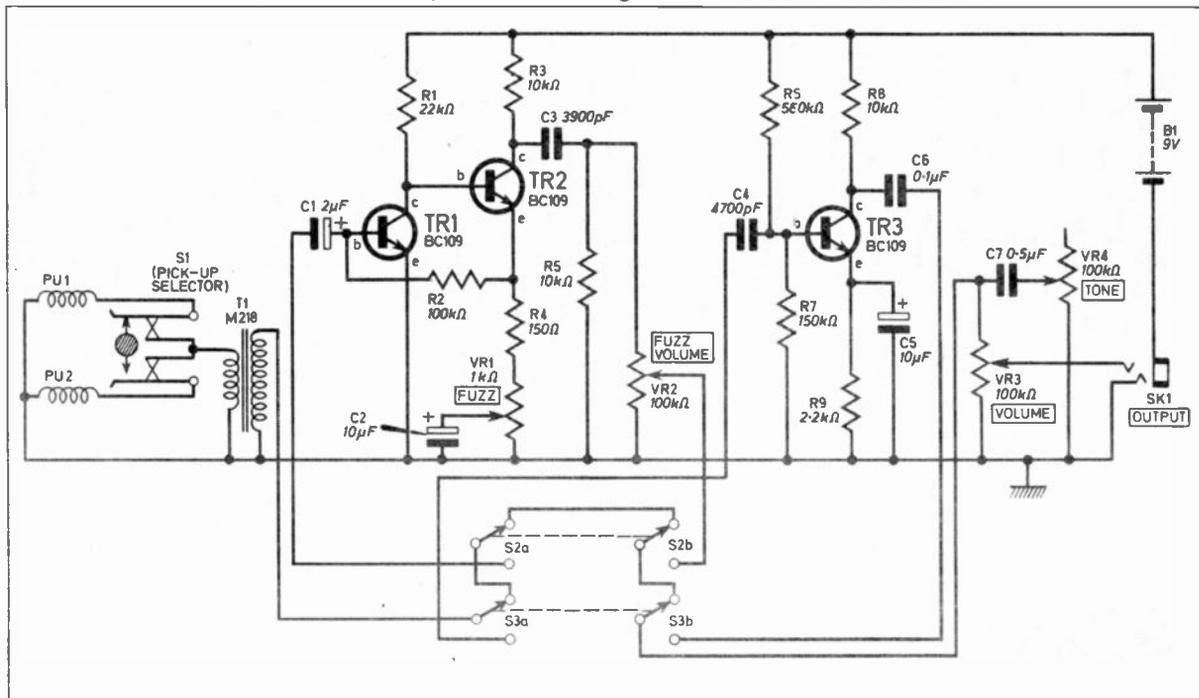
BETA TREBLE BOOST and FUZZ

By Brian W. Terrell B.Sc.

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.



**Approximate
cost of
components
£6.00 all parts
listed**

Everyday Electronics, January 1973

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 megaohms 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

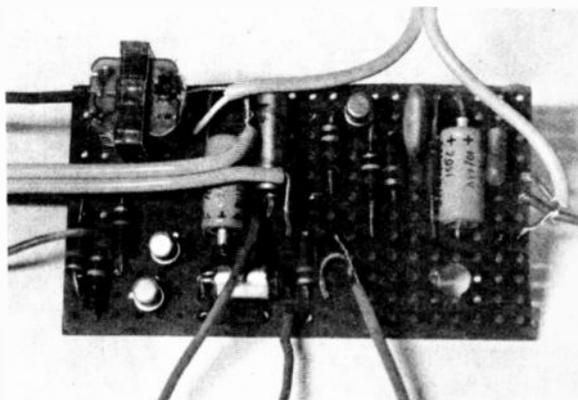
The volume control is nothing more than a potentiometer, VR3. The signal from the pickups (or fuzz or treble boost units) is placed across VR3 and the wiper used to tap off the desired amount of signal—volume.

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 pickups and then make the

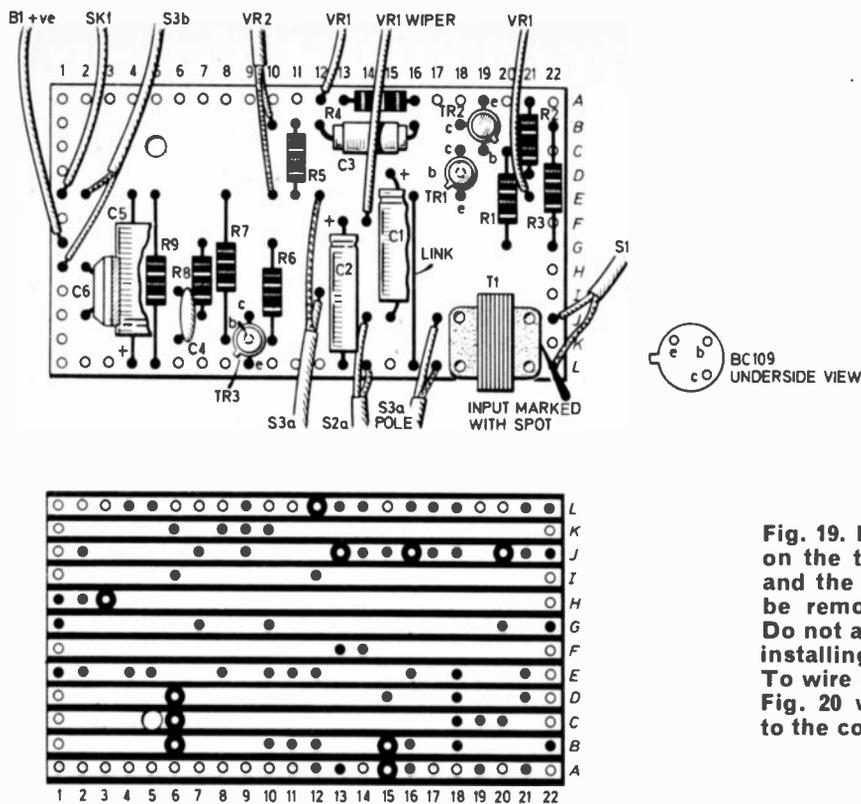


Fig. 19. Layout of the components on the top side of the Veroboard and the regions of copper strip to be removed from the underside. Do not attach the flying leads until installing in guitar body. To wire up the flying leads refer to Fig. 20 which shows connections to the controls and output.

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 E16 to L16.

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.

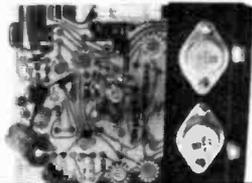
Fix the board to the control section base with

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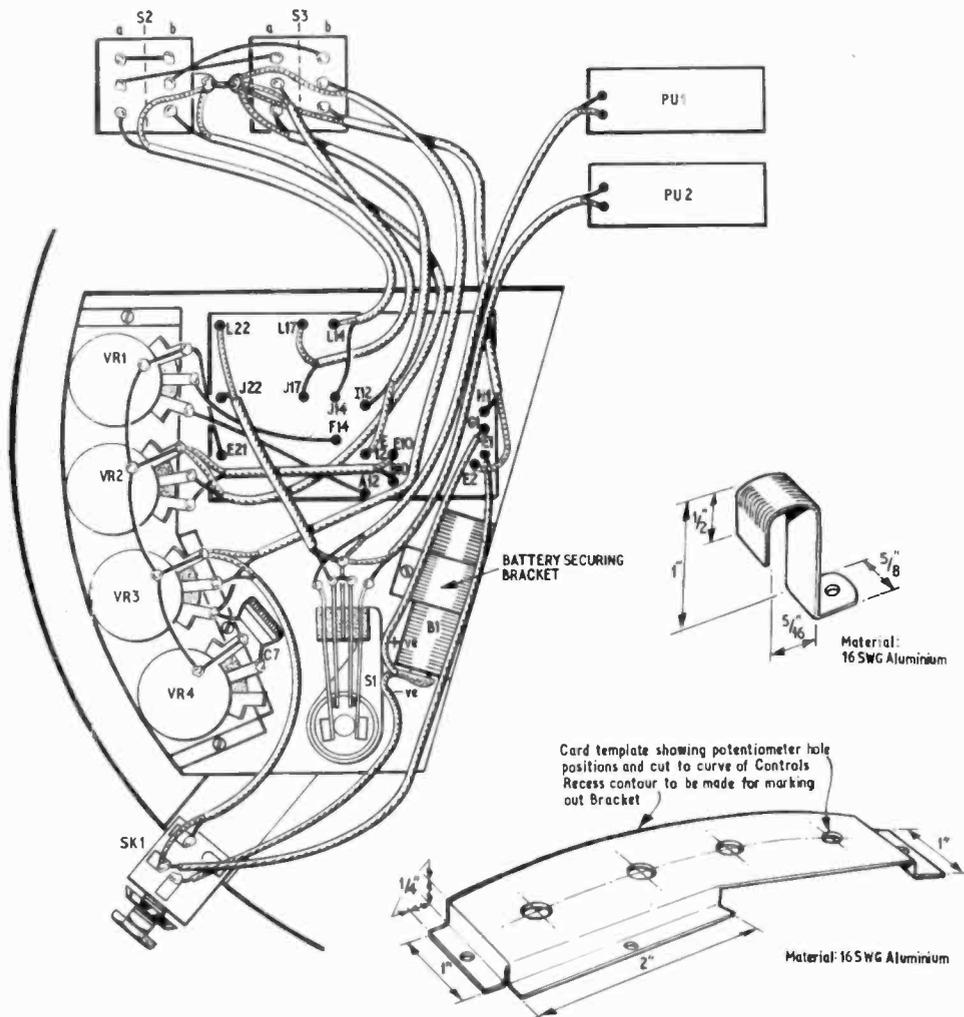


Fig. 20. The complete wiring details of the Beta "electronics". Screened cable *must* be used where indicated. The units are switched on by inserting the jack plug.

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

Resistors

- R1 22k Ω
- R2 100k Ω
- R3 10k Ω
- R4 150 Ω
- R5 10k Ω
- R6 560k Ω
- R7 150k Ω
- R8 10k Ω
- R9 2.2k Ω

All $\frac{1}{2}$ watt : 10% carbon

Potentiometers

- VR1 1k Ω carbon linear
- VR2 100k Ω carbon log.
- VR3 100k Ω carbon log.
- VR4 100k Ω carbon log.

Capacitors

- C1 2 μ F elect. 10V
- C2 10 μ F elect. 10V
- C3 3900pF
- C4 4700pF
- C5 10 μ F elect. 10V
- C6 0.1 μ F
- C7 0.5 μ F

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; $\frac{1}{8}$ in. aluminium plate; 5 $\frac{1}{2}$ in x 1 $\frac{1}{2}$ in. and 2in. x $\frac{1}{2}$ in.; small wood screws.

SEE
**SHOP
TALK**

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.

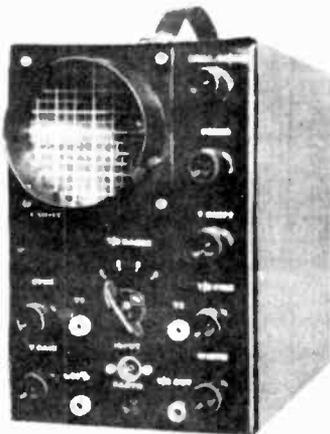
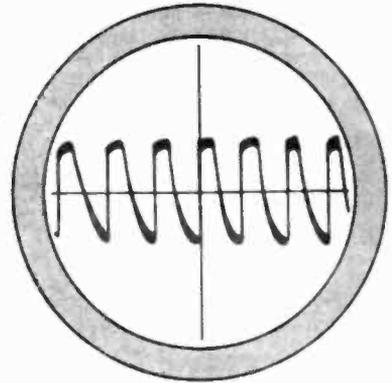
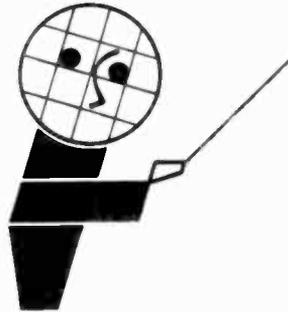
Wait until the paintwork is *completely* dry before final assembly. ☐

Modifications to build a bass guitar will be described shortly.

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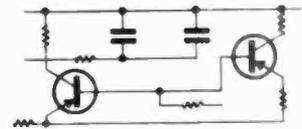
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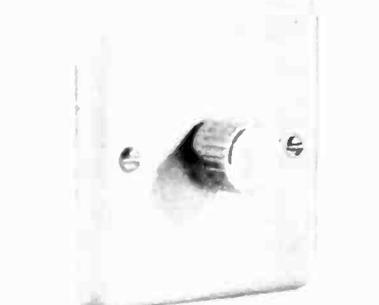
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THIS edition of *E.E.* is No. 1 Volume 2 and during the past fourteen months (Volume 1 started in November 1971) we have endeavoured to keep you, the reader, reasonably happy and free from component buying problems. In the beginning (of *E.E.*) we 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



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 3½ 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 7/8 inch in diameter and, if you have difficulty in obtaining them, they are available from Electrovalve 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 thermostat 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 No 8 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.)

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 magnetism. 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

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.

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 apparatus, 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.

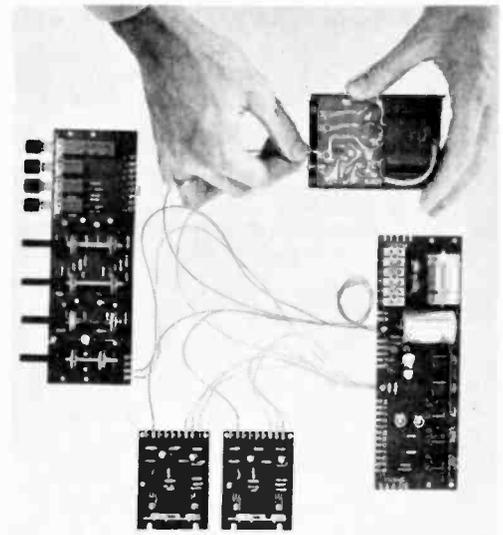
In the summer of 1892 Hertz suffered an illness which developed into chronic blood poisoning. He died on New Year's day 1894, at the age of 37; a premature death had robbed the world of the accomplishments of a man who has been called the Grandfather of Radio.

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.

Everyday Electronics, January 1973

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

plus p. & p. 7p per section.

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plus p. & p. 7p per dropper.

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5K Ω	50K Ω	500K Ω
10K Ω	100K Ω	1M Ω
25K Ω	250K Ω	2M Ω

log or lin less switch (& 1K Ω lin) 12p
log or lin with switch 24p
dual less switch 40p
dual with switch 10K, 100K & 1M log only 52p
10K log 10K antilog less switch 40p

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	1M Ω
	2.5M Ω
	5M Ω

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Ceramic - plate	63V (C333)
1-8pF	8.2pF
2-2pF	10pF
3-3pF	12pF
3-9pF	15pF
4-7pF	18pF
5-5pF	22pF
6-6pF	27pF
all 5p. each	82pF

mylar film	100V
1000pF 2p	0.1μF 3p
2000pF 2p	0.2μF 3p
5000pF 2p	0.5μF 3p
	1μF 4p
	2μF 4p
	5μF 5p
	10μF 5p

metallised polyester	250V (C280)
0.1μF 3p	0.68μF 3p
0.15μF 3p	1μF 4p
0.22μF 3p	1.5μF 4p
0.33μF 3p	2.2μF 4p
0.47μF 3p	3.3μF 4p
	4.7μF 4p
	6.8μF 4p
	10μF 4p
	15μF 4p
	22μF 4p
	33μF 4p
	47μF 4p
	68μF 4p
	100μF 4p
	150μF 4p
	220μF 4p
	330μF 4p
	470μF 4p
	680μF 4p
	1000pF 4p
	1500pF 4p
	2200pF 4p
	3300pF 4p
	4700pF 4p
	6800pF 4p
	10000pF 4p

metallised polyester	400V (C281)
0.1μF 4p	0.47μF 6p
0.15μF 4p	0.68μF 6p
0.22μF 4p	1μF 6p
0.33μF 4p	1.5μF 6p
0.47μF 4p	2.2μF 6p
	3.3μF 6p
	4.7μF 6p
	6.8μF 6p
	10μF 6p
	15μF 6p
	22μF 6p
	33μF 6p
	47μF 6p
	68μF 6p
	100μF 6p
	150μF 6p
	220μF 6p
	330μF 6p
	470μF 6p
	680μF 6p
	1000pF 6p
	1500pF 6p
	2200pF 6p
	3300pF 6p
	4700pF 6p
	6800pF 6p
	10000pF 6p

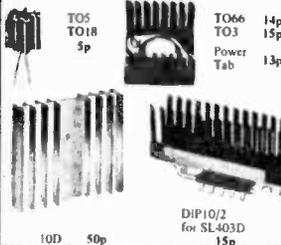
mixed dielectric	600V
0.1μF 7p	0.47μF 7p
0.22μF 7p	0.68μF 7p
0.33μF 7p	1μF 7p
	1.5μF 7p
	2.2μF 7p
	3.3μF 7p
	4.7μF 7p
	6.8μF 7p
	10μF 7p
	15μF 7p
	22μF 7p
	33μF 7p
	47μF 7p
	68μF 7p
	100μF 7p
	150μF 7p
	220μF 7p
	330μF 7p
	470μF 7p
	680μF 7p
	1000pF 7p
	1500pF 7p
	2200pF 7p
	3300pF 7p
	4700pF 7p
	6800pF 7p
	10000pF 7p

Ceramic	8KV d.c.	HI-K 750V.
100pF 9p	220pF 9p	1000pF 5p
15pF 9p	220pF 9p	1500pF 5p
22pF 9p	250pF 9p	2000pF 5p
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82pF 9p	300pF 9p	5000pF 5p
100pF 9p	750V DISC	10,000pF 5p
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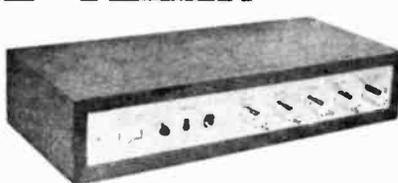
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Mullard & Siemens Electrolytics

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	4	6.3	10	16	25	40
1	-	-	-	-	-	8p
1.5	-	-	-	-	-	6p
2.2	-	-	-	-</		

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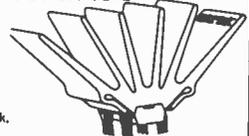
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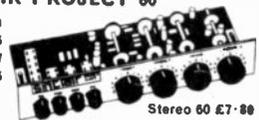
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100μF 50V 11p	8-16μF 450V 27p
250μF 25V 14p	16-16μF 450V 27p
250μF 50V 17p	16-32μF 450V 63p
500μF 25V 18p	32-32μF 450V 49p
500μF 50V 25p	50-50μF 350V 38p

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 63V 6p	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

CASSETTE OWNERS!

For Philips and similar cassette recorders.
 PU12 Power unit for connection to 12V + or - E car electrical systems, giving 7 1/2V, stabilised £3.25 output.
 PU14 As above but switched for 6V, 7 1/2V or 9V output. £5.10
 PP75 Mains power supply, output 7 1/2V d.c. £1.95
 All units are complete with cable and plug.

CASSETTES

Top quality British made, low noise, complete with transparent library cases—
 C60—40p; C90—55p; C120—70p

BATTERY ELIMINATORS

suitable for transistor radios and similar light current equipment
 PP6 Input 240V a.c. Output 6V d.c.
 PP9 Input 240V a.c. Output 9V d.c.
 Price £1.50 plus 12p p. & p.

ILLUSTRATED CATALOGUE

Post Free 15p

CONTROLS, Log. or Lin.

Single, 15p; Tandem, 40p
 Single, D.P. switch, 24p
 Tandem, less switch, 40p
 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.

RESISTORS

Carbon
 All 5%, high-stability, E12 values. 1/4W, 1p; 1/2W, 1 1/2p; 1W, 4p; 2W, 6p
 Wire-wound
 680pF 125V P.S. 6p
 680pF 500V S/M 8p
 820pF 500V S/M 8p

VEROBOARD

Size	Matrix	0-15 Matrix
2 1/2 in x 3 1/2 in	22p	16p
2 in x 5 in	24p	25p
3 1/2 in x 3 1/2 in	27p	29p
3 1/2 in x 5 in	27p	29p
1 7/8 in x 2 1/2 in	75p	57p
1 7/8 in x 3 1/2 in	£1	75p

Spot face cutter—39p
 Pins—either size, packet of 36 18p
 Edge connectors:
 24 way, 0-1 (2 1/2 in)—34p
 36 way, 0-1 (3 1/2 in)—44p
 16 way, 0-15 (2 1/2 in)—23p
 24 way, 0-15 (3 1/2 in)—34p

BONDED ACRYLIC FIBRE

B.A.F. wadding, 18in wide, lin thick. The ideal lining for speaker enclosures. 30p per yard. p. & p. one yard 12p; each extra yard 4p.

PLUGS

Car aerial
 Co-axial
 D.I.N. 2 pin (speaker)
 D.I.N. 3 pin
 D.I.N. 4 pin
 D.I.N. 5 pin, 180°
 D.I.N. 5 pin, 240°
 D.I.N. 6 pin
 Jack, 2 1/2mm unscreened
 Jack, 2 1/2mm screened
 Jack, 3 1/2mm unscreened
 Jack, 3 1/2mm screened
 Jack, 4 1/2mm unscreened
 Jack, 4 1/2mm screened
 Jack, stereo, unscreened
 Jack, stereo, screened
 Phono, plastic top
 Phono, plated metal
 Wander, red or black
 Banana 4mm, red or black



SOCKETS

Car aerial
 Co-axial, surface
 Co-axial, flush
 D.I.N. 2 pin (speaker)
 D.I.N. 3 pin
 D.I.N. 5 pin, 180°
 D.I.N. 5 pin, 240°
 Jack, 2 1/2mm
 Jack, 3 1/2mm
 Jack, 4 1/2mm
 Jack, 4 1/2mm unscreened
 Jack, 4 1/2mm screened
 Jack, stereo, switched
 Phono, single
 Phono, 2 on a strip
 Phono, 3 on a strip
 Phono, 4 on a strip
 Wander, single, red or black
 Wander, twin strip
 Banana 4mm red, or black

LINE SOCKETS

Car aerial
 Co-axial
 D.I.N. 2 pin (speaker)
 D.I.N. 3 pin
 D.I.N. 5 pin, 180°
 D.I.N. 5 pin, 240°
 Jack, 2 1/2mm
 Jack, 3 1/2mm
 Jack, 4 1/2mm
 Jack, 4 1/2mm screened
 Jack, stereo, screened
 Phono, plated metal

CAPACITORS

2.2pF 500V S/M 7 1/2p	0.0027μF 500V S/M 15p
3.3pF 500V S/M 7 1/2p	0.003μF 500V Cer. 5p
5pF 500V S/M 7 1/2p	0.0033μF 125V P.S. 6p
10pF 125V P.S. 5p	0.0033μF 500V Poly. 6p
15pF 125V P.S. 5p	0.0036μF 1,000V MDC 15p
15pF 500V Cer. 4p	0.0047μF 125V P.S. 9p
18pF 500V S/M 7 1/2p	0.0047μF 500V Poly. 6p
22pF 125V P.S. 5p	0.0047μF 500V S/M 20p
22pF 500V S/M 7 1/2p	0.0047μF 1,000V MDC 6p
22pF 500V P.S. 5p	0.005μF 100V Mylar 3p
25pF 500V S/M 7 1/2p	0.005μF 500V Cer. 5p
27pF 500V Cer. 4p	0.0068μF 125V P.S. 10 1/2p
33pF 125V P.S. 5p	0.0068μF 500V S/M 30p
33pF 500V S/M 7 1/2p	0.0068μF 500V Poly. 6p
39pF 500V S/M 7 1/2p	0.0082μF 125V P.S. 10 1/2p
47pF 125V P.S. 5p	0.0082μF 500V S/M 30p
47pF 500V Cer. 4p	0.01μF 18V Disc 4p
50pF 500V S/M 7 1/2p	0.01μF 125V P.S. 10 1/2p
56pF 500V S/M 7 1/2p	0.01μF 160V Poly. 4p
68pF 125V P.S. 5p	0.01μF 250V M.F. 3p
68pF 500V S/M 7 1/2p	0.01μF 400V Poly. 3p
75pF 500V S/M 7 1/2p	0.01μF 500V Cer. 3p
82pF 500V S/M 7 1/2p	0.01μF 500V S/M 30p
100pF 125V P.S. 5p	0.01μF 600V MDC 7p
100pF 500V S/M 7 1/2p	0.01μF 1,000V MDC 9p
100pF 500V Cer. 5p	0.01μF 1,600V Poly. 3p
120pF 500V S/M 7 1/2p	0.015μF 400V Poly. 3p
150pF 125V P.S. 5p	0.02μF 100V Mylar 3p
150pF 500V S/M 7 1/2p	0.022μF 18V Disc 5p
150pF 500V Cer. 5p	0.022μF 250V M.F. 3p
180pF 500V S/M 7 1/2p	0.022μF 400V Poly. 3p
200pF 500V S/M 7 1/2p	0.022μF 600V MDC 7 1/2p
220pF 125V P.S. 5p	0.022μF 1,000V MDC 10p
220pF 500V Cer. 5p	0.033μF 250V M.F. 4p
250pF 500V S/M 8p	0.033μF 400V Poly. 4p
270pF 500V Cer. 5p	0.047μF 12V Disc 6p
300pF 500V S/M 8p	0.047μF 160V Poly. 3p
330pF 125V P.S. 5p	0.047μF 250V M.F. 3p
330pF 500V S/M 8p	0.047μF 400V Poly. 4p
390pF 500V S/M 8p	0.047μF 600V MDC 8p
470pF 125V P.S. 5p	0.047μF 1,000V MDC 10p
470pF 750V Disc 5p	0.1μF 30V Disc 6p
500pF 500V S/M 8p	0.1μF 250V M.F. 4p
560pF 500V S/M 8p	0.1μF 400V Poly. 3p
680pF 125V P.S. 6p	0.1μF 600V MDC 10p
680pF 500V S/M 8p	0.15μF 1,000V MDC 14p
820pF 500V S/M 8p	0.15μF 250V M.F. 5p
0.001μF 100V Mylar 3p	0.22μF 160V Poly. 6p
0.001μF 125V P.S. 6p	0.22μF 250V M.F. 5p
0.001μF 400V P.S. 3p	0.22μF 400V Poly. 10p
0.001μF 500V S/M 10p	0.22μF 1,000V MDC 15p
0.001μF 500V Cer. 5p	0.33μF 250V M.F. 8p
0.001μF 1,000V MDC 6p	0.47μF 250V M.F. 8p
0.0015μF 400V Poly. 3p	0.47μF 400V Foil 15p
0.0015μF 500V S/M 10p	0.47μF 1,000V MDC 25p
0.0015μF 500V Cer. 5p	1.0μF 250V M.F. 15p
0.0015μF 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	

Note:
 S/M=silver mica 1% tol.
 P.S.=polystyrene 2 1/2% tol.
 MDC=a.c. rating=300V.
 M.F.=Mullard min. foil.
 Cer.=ceramic.

MAIL ORDERS: Some items have a post and packing charge shown against them. Where p. & p. is not shown the charge is 12p for any selection. When both classes of goods are ordered the charge is 12p plus any p. & p. charges shown. (Overseas extra.) Telephone 01-692 4412

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100 Micro Amp
Balance/level meters.
Size $1\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{2}$ deep 75p
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AMMETERS NEW!

DC amps 1, 5, 15, 20, AC Amps 1, 5, 10, 15, 20. £1-75. incl. P. & P.
0-300V a.c. £1-90 incl. P. & P.

PARVALUX TYPE SD2. 200/250 VOLT A.C. D.C. HIGH SPEED MOTOR

Speed 9,000 r.p.m.
approx. or 3,200 r.p.m. if
used with built in governor,
or variable speed over a wide
range if used in conjunction with
our Dimmer Switch, illustrated
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600 WATT DIMMER SWITCH

Easily fitted. Fully guaranteed
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rescent at mains voltage.
Complete with simple instruc-
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Easy to build. Solid State. Two full
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Complete set of parts, including:
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In response to numerous requests, we
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four of our Hy-Light or Super Hy-Light
Strobes in either 1, 2, 3, 4 sequence;
2+2; or all together. Fantastic effects
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up to 50 yards, so that your Strobes can
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separate case. Thoroughly tested and
reliable. Complete with full connection
instructions. Price: £18-50 plus 25p
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450 Watt. Mercury vapour
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Complete with oil
filled colour
wheel. 100 watt
lamp. 200/250V
A.C. Features ex-
tremely efficient
optical system. £18-50 + 35p P. & P.



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100 WATT. 1 ohm, 10A; 5 ohm, 4-7A;
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100 ohm, 1A; 250 ohm, 0-7A; 500 ohm,
0-45A; 1 kΩ, 280 mA; 1-5 kΩ, 230mA; 2-5 kΩ, 0-2A; 3-5kΩ,
165mA 5 kΩ, 140mA. Diameter 3½in Shaft length ½in, dia. ½in.
All at £1-65 each. P. & P. 7½p.
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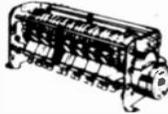
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Three sets c/o contacts rated at 5 amps.
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240V A.C. 5 r.p.m. motor. Each cam
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SIMPLE 12 CAM PROGRAMMER with 4 adjustable cams avail-
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Build a Strobe Unit, using the latest type Xenon white
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circuit. 230/250V a.c. operation. Plastic thyristor.
EXPERIMENTERS' ECONOMY KIT
Speed adjustable 1 to 36 flash per sec. All electronic
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Ideally suitable for schools, laboratories, etc. Roller tin
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Designed and produced for use in large halls and utilises a
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Light output approx. 4 joules. £12-00. P. & P. 50p.
SPECIALLY DESIGNED. FULLY VENTILATED
METAL CASE. Including reflector. £4-00 P. & P. 45p.
Post paid with kit.

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Approx. four times the light output of our well proven
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Never before a Strobe Kit with so HIGH an output at so
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ATTRACTIVE, ROBUST, FULLY VENTILATED
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10,000µ 75v, 33,000µ 40v, 4½ x 2½ in. dia.,
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LARGE ELECTROLYTIC: 500/25, 10p, 500/50, 12p
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5000/50, 85p, 2500/50, 55p.
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0-1/30, 4p, 0-1/100, 5p, 22pF-0-01µF, 50V, 2p.
(E12 series).
CARBON FILM RESISTORS, 1W, 5%, 10 ohms-22M
1p, each, or 100 for 85p.
SPECIAL RESISTOR KITS (1W, 5%, Carbon Film)
E10E12KIT, 10 each E12 value, 100ohms-1M
A total of 610. £8-80 net
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2½" x 5" 25p 5K 2M Log and Lin
2½" x 5" 25p 17p +single 18p, single
3½" x 5" 29p 30p with SW, 24p, dual
3½" x 3½" 25p 25p 42p.
Pins, Pkt, 25 8p 8p SCREENED WIRE
Xenon Bulb 11N Plug 12p, 8kt, 10p Single 5p/yd., twin
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5 Pin 11N Plug 14p, 10p, 8kt, 12p 19p
Red Panel Neon 240V. 15p
RF Chokes (µH) 0-22, 2-2, 12, 22 8p
PVC Wire 7/0078, 5 x 10 yds. 30p
PVC Wire 14/0078, 5 x 10 yds. 30p
Neon Bulb 90V, wire ended 5 for 30p
Min. Push button, push to make 10p
Mains Transformer 32-0-32 at 150mA 50p
1N4001, 8p, 1N4002, 7p, 1N4003, 8p, 1N4004, 8p
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Above motor board 3 1/2 in. below motor board 2 1/2 in. with STEREO and MONO XTAL MONO-COMPATIBLE Plays all records

£8.75 Post 25p.
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BSR JUNIOR

Heavy duty 4-speed motor with separate pick-up arm fitted LP/78 turnover motor cartridge.

£4.50



E.M.I. WOOFER AND TWEETER KIT

Available separately
Wooler 24-25 Tweeter £1.90
Comprising a fine example of a Woofer 10 1/2 x 6 1/2 in. with a massive Ceramic Magnet, 44oz. Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter 3 1/2 in. square has a special lightweight paper cone and magnet flux 10,000 lines. Crossover condenser and full instructions supplied.

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For any lamp up to 600 watt. Mounted on switch plate to fit in place of standard switch. Virtually no noise interference. 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 EP9001 4 watt power output £1.65. EP9001 Stereo preamp £1.85. 10% discount if 10 or more ordered.



THIS MONTH'S SNIP

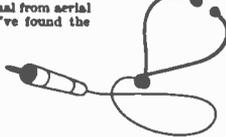
PROCESS TIME CONTROLLER

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. £3—twin stetho-set instead of earpiece 75p extra—post and ins. 25p.



ELECTRIC TIME SWITCH

Made by Smiths these are A.C. mains operated. EOT 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. 25p. 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 install, £1.99.

STANDARD WAFER SWITCHES

Standard size 1 1/2" wafer—silver-plated 5-amp contact, standard 1" spindle 2" long—with locking washer and nut.

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

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 4 1/2" x 4 1/2" x 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, flem drying cabinet or for removing flux smoke when soldering etc. etc. A real bargain at £1.65.

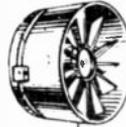


BATTERY CONDITION TESTER

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 3 1/2" x 6 1/2" x 2" with leads and prods. Price £3.50 plus 20p postage.

BATTERY CHARGER KIT

Comprising 5 amp 12V mains tra. and rectifier with wiring diagram. £1.75 + 25p P. & P. BLACK HEAT ELEMENTS Ideal for making convector 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, bath-rooms, factories, changing rooms, etc., it's so quiet it can hardly be heard. Compact, 6 1/2" casing with 6 1/2" 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 it of parts as P.W. Circuit £5.95 plus 20p P. & P.

ELECTRONIC IGNITION

Deluxe model with pre pared circuit board £6.95. When ordering please state whether for positive or negative systems.

POWER PAGES

Made for driving racing cars, mecano 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 1 1/2" 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. 3 1/2" x 3" x 5". £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.



0-8 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 7 1/2 to 47in. Hole in bottom for 6BA screw. 85p. KNUCKLED MODEL FOR F.M. 50p.



TREASURE TRACER

Complete Kit (except wooden batens) to make the metal detector as the circuit in Practical Wireless, August issue. £2.95 plus 20p post and insurance.

IMMERSION HEATERS BY REMPLY

Standard fitting for domestic water tanks, made by the famous Remply 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 773—small but powerful 1" pull—approx. size 1 1/2 x 1 1/2 60p. Model 400/1 1" pull Size 2 1/2 x 2 x 1 1/2 75p. Model TT10 1 1/2" pull size 3 x 2 1/2 x 2 1/2 £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. B.A.E. with enquiries please.

J. BULL (ELECTRICAL) LTD.

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

Callers to: 162/3 Tamworth Road, CROYDON.

PREMIER 800 STEREO AMPLIFIER



(As used in SYSTEM '800')

A truly high quality stereo amplifier—compare the specification, compare the price. Output: 5 watts per channel. Frequency response: 30-20,000 Hz = 2 db. Distortion: 1% Output Impedance 8 ohms nom. Inputs equalised to R.I.A.A. Magnetic 4mV. Ceramic 100mV. Tuner 100mV. Tape 100mV. Tape out 150mV. Bin sockets for inputs and outputs. Controls: Bass, Treble, Volume, Balance, Selector. Mono/Stereo switch. Stereo headphone socket. Attractive slim line design black leatherette cabinet with aluminium front panel. Size 12½" x 6½" x 2½".

ONLY £15.00 Carr. 50p.

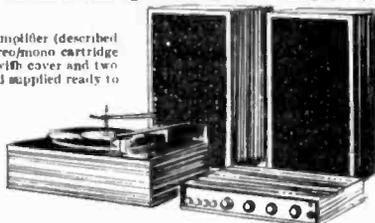
Mk. 11 Version available with Teak Finish Cabinet. £16.25. Carr. 50p.

PREMIER HI-FI STEREO SYSTEMS

SYSTEM "800"

Consists of the Premier 800 Mk II all transistor stereo amplifier (described left) Garrard auto/manual record player unit fitted stereo/mono cartridge with diamond stylus and mounted in teak finish plinth with cover and two cloth front loudspeaker systems. Absolutely complete and supplied ready to plug in and play. The 800 Mk II amplifier has an output of 5 watts per channel with inputs for ceramic and magnetic pick-up, tape and tuner also tape output socket and headphone socket. Controls: Bass, Treble, Volume, Balance, Selector. Mono/Stereo switch. Headphone socket. Power on/off. Teak finish cabinet with aluminium front panel. Size: 12½in x 6½in x 2½in.

£35.00
Carr. £1.75



SYSTEM "TWO"

as above but with slotted front teak finish loudspeakers. Garrard SP25 Mk. III and magnetic cartridge.

£45.00
Carr. £1.75

SYSTEM "THREE"

This consists of KLINGER KC903 stereo amplifier giving 6 watts rms per channel with Bass, Treble, Volume and Balance Controls. Inputs for Magnetic and Ceramic pick-up, tuner, tape in and out. Stereo headphone socket. Garrard SP25 Mk. III in teak finish plinth with cover and fitted Sonotone 9TAHCD diamond stereo cartridge. A pair of 11MF Speakers size 16½" x 10" x 9" fitted EMI units complete the matching system.

£57.75
£1.75

FREE

LEADS AND PLUGS SUPPLIED WITH ALL SYSTEMS

PREMIER PARAGON STEREO HI-FI AMPLIFIER



Gives the best possible reproduction of records, radio and tape at a reasonable price. Fitted with all the controls and facilities you're ever likely to want, the Paragon gives you a degree of sophistication that is usually only found with amplifiers costing twice its price. It has bass and treble slide controls, volume and balance knobs, and eight push-buttons. There's also a standard stereo jack socket on the front panel, plus a ceramic/magnetic cartridge switch and a mains outlet socket on the back panel.

Specifications 10 + 10 watts into 8 ohms. Power/frequency response: 0dB 10 watts into 8 ohms—3dB 20Hz - 25KHz. Distortion typically less than 0.25%. Inputs for Magnetic phono (4mV) Ceramic phono (66mV) Radio/Tape (100mV). High and low filters. Teak finish cabinet. Size: 12½" x 5½" x 10½".

£32.00 P. & P. 50p.

Premier Stereo System '89'

Consists of the Premier Paragon Stereo Amplifier, Garrard SP25/III in teak finish plinth with cover and fitted Goldring G800 stereo magnetic cartridge plus a pair of Marsden Hall Annex 100 Loudspeaker Systems.

£69 Carr. & Insurance £1.75

Complete with Free leads and plugs.



WELLER "EXPERT" SOLDER GUN. Saves time and simplifies soldering in the home and service dept. Two position trigger gives instant dual heat. 100/140 watt. £3.95 P. & P. 50p. 240 volt A.C.

"Litesold" Soldering Iron. Lightweight ½" pencil bit. Ideal for regular bench use and around the home. 25 watts. 240 volt A.C. £1.50 P. & P. 10p.



E.M.I. 13x8in. HI-FI SPEAKERS
Fitted two 2½in tweeters and crossover network. Impedance 8 or 15 ohm. Handling capacity 10W. Brand new.
£3.47 P. & P. 50p

PREMIER HI-FI OFFERS

- Rogers Ravensbrook II Stereo Amplifier teak £38.50
- Rogers Ravensbourne Stereo Amplifier teak £55.00
- Metrosound ST20E Stereo Amplifier teak £25.50
- Goldring GL72 less cartridge £22.00
- Garrard SP25 III with Goldring G800 cartridge £15.00

P. & P. 50p extra any of above



GARRARD SP25 MK III SINGLE RECORD PLAYER FITTED GOLDRING 800 MAGNETIC STEREO CARTRIDGE. COMPLETE IN TEAK FINISH WITH COVER.
Total list price over £34.

PREMIER PRICE £17.95 P. & P. £1

Garrard AP76 with G800, ready wired to 5 pin Din in plinth with cover £29.50 P. & P. £1

Garrard AP76 less cartridge P. & P. 60p. £18.80

Garrard 401 Transcription Unit P. & P. 60p. £26.60

Garrard 2025 T/C with Stereo Ceramic Cartridge £8.50 P. & P. 60p

Garrard 2025 T/C with Stereo Ceramic Cartridge ready wired in teak plinth with cover P. & P. £1. £12.45

CARTRIDGE BARGAINS!
Goldring G800H £5.00; G800 £5.50; G800E £9.50; P. & P. 10p



METER BARGAIN

MODEL OT-800 MULTIMETER

A precision made pocket sized test meter, ideally suited for testing electronic circuits or electronic appliances. Supplied complete with test lead and batteries. RANGE—DC Voltages: 10, 50, 250, 1,000V (1,000 opV). AC Voltage: 10, 50, 250, 1,000V (1,000 opV). DC Current: 1mA, 100mA. Resistance: 0-150K ohms. Decibel—10 to +22dB (at AC 10V range) £2.47, P. & P. 25p.



HI-FI STEREO HEADPHONES

Designed to the highest possible standard. Fitted 2½in. speaker units with soft padded ear muffs. Adjustable headband. 8 ohms impedance. Complete with 6ft lead and stereo jack plug.
£2.47 P. & P. 25p.

VERITAS V-149 MIXER

Battery operated 4-channel audio mixer providing four separate inputs. Size 6 x 3 x 2½in. suitable for crystal microphone low impedance microphone, with transformer, radio, tape, etc. Max. input 15v. Max. output 2.5v. Gain 6 db. Standard jack plug socket inputs, phono inputs. Attractive teak wood grain finish case.



MONO MODEL £3 STEREO MODEL £3.47 P. & P. 15p

E.M.I. LOW NOISE CASSETTES in Library cases



C60 (List 71p) 45p
C90 (List 98p) 65p
C120 (List £1.49) 85p
P. & P. 10p

LOW-NOISE COMPACT CASSETTES

Screw fixing—fully guaranteed. In Library cases.

	EACH	3 for	6 for	10 for
C60	29p	81p	£1.56	£2.50
C90	40p	£1.11	£2.16	£3.50
C120	52p	£1.40	£2.76	£4.50

P. & P. 10p each (3 and over 15p)

"VERITONE" RECORDING TAPE

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

TT3	3'	450'	POLYESTER	87p	DT8	5½'	1800'	POLYESTER	£1.12
DT3	3½'	600'	POLYESTER	57p	TT8	5½'	2400'	POLYESTER	£1.87
SP5	5'	900'	P.V.C.	42p	SP7	7'	1200'	P.V.C.	62p
LP6	5'	900'	ACETATE	50p	LP7	7'	1800'	ACETATE	75p
DT5	5'	1800'	POLYESTER	75p	DT7	7'	2400'	POLYESTER	£1.25
LP6	5½'	1200'	ACETATE	75p	TT7	7'	3600'	POLYESTER	£2.50

TAPE SPOOLS 3' 5p, 5½' 7p, 7' 9p.
Post and Packing 3' 5p, 5½' 7p, 7' 10p (3 reels and over Post Free).



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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 Telescope 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" x 7" x 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 Telescope 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 x 7 x 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.

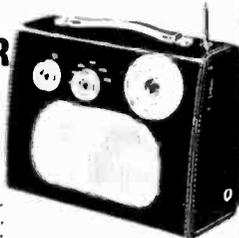
Total building cost **£6-98** P. P. & Ins. 40p. (Overseas P. & P. £1)



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 x 7 x 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.

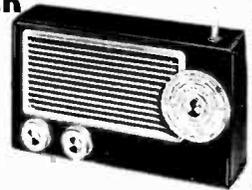
Total building costs **£5-98** P. P. & Ins. 45p. (Overseas P. & P. £1)



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 x 5 1/2 x 2 1/2in. approx. Easy build plans and parts price list 15p (FREE with parts).

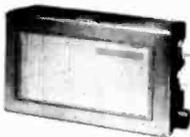
Total building costs **£3-98** P. P. & Ins. 30p. (Overseas P. & P. £1)



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, super-sensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5 1/2 x 1 1/2 x 3 1/2in. Easy build plans and parts price list 10p (FREE with parts).

Total building costs **£2-29** P. P. & Ins. 25p. (Overseas P. & P. 65p)



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, condenser volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6 1/2 x 4 1/2 x 1 1/2in. Easy build plans and parts price list 10p (FREE with parts).

Total building costs **£2-50** P. P. & Ins. 24p. (Overseas P. & P. 65p)

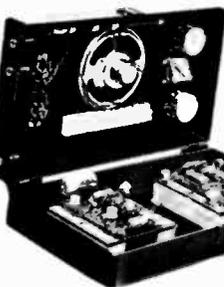
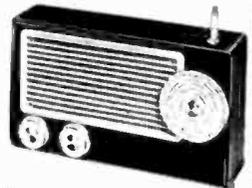


TRANS EIGHT

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 x 5 1/2 x 2 1/2in. 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)



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BUILD RADIOS, AMPLIFIERS, ETC., FROM EASY TO FOLLOW 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 1/2" 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)

RADIO EXCHANGE CO

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

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ROAMER EIGHT TRANS EIGHT
TRANSONA FIVE ROAMER SIX
POCKET FIVE EDU-KIT

Parts price list and plans for

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Address

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U.K.'s LARGEST ELECTRONICS CENTRES!

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

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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 PREDOMINANT 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



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

SPECIAL KIT PRICE
£28.50 P & P 45p

★ SLIM DESIGN WITH SILVER TRIM
 Overall chassis size 14 1/4" x 6" x 2" high

COMPLETE WITH FREE TEAK CABINET
 Designer approved kits distributed by Henrys!

RECORD DECKS

CHASSIS (POST 50p)	
SP25 £10.25 HT70	£14.50
MP60 £9.95 MP610	£12.95
AP76 £17.95 GL75	£28.30
PLINTH/COVERS (State Model)	
SP25/MP60/610 £3.30 post 40p	
AP76 £4.50 post 40p	
CART PLINTH/COVER (Post 70p)	
(HL) MP60/G800H/PC	£18.50
MP610/SC5MD/TPD2/PC	£19.95
AP76/M756SM/PC	£32.50
AP96/M756SM/PC	£39.95
(HL) AP76/G800/PC	£28.95
(HL) SP25/G800H/PC	£18.95
HT70/G800/TPD1/PC	£24.50
(HL) 2025/9TAHCD/PC	£13.95
MP60/SC5MD/PC	£17.25
(HL) GL75/G800E/PC	£42.95
(HL) GL75/G800/PC	£38.95

ULTRASONIC TRANSDUCERS

Operate at 40kc/s up to 100 yds. Ideal remote switching and signalling. Complete with data and circuits.
£5.90 per pair. Post 10p

MARRIOTT TAPE HEADS 4 TRACK MONO or 2 TRACK STEREO

17" High Impedance	£2.00
18" Med. Impedance	£2.00
36" Med. Low Imp.	£3.50
Erase Heads for above 75p	
63" 2 track mono - Hi Imp.	£1.75
43" Erase Head for above 75p	

POWER INTEGRATED CIRCUITS

Plessey SL403D—3 watt with 8-page data, layouts and circuits £1.50. P.C. Board 60p. Heat Sink 14p. Sinclair IC12—6 watt with data and circuits £1.80. TH9013P—20 watt Power Amp Module £4.57. TH9014P—IC Preamp £1.50. Data/Circuits for above No. 42 10p

7 SEG & NIXIE TUBES

(Post 15p per 1 to 6)
 XN3, XN13, GN6 0-9 side view with data, 85p.
 GNP-7, GNP-8 0-9 side view with decimal points and data, 95p.
 3015F 7 seg £2 each. £7 per 4 with data.
 12 and 24 hour clock circuits Ref. No. 31 15p.

Miniature Amplifier

S transistor. 300mW o/p. Fitted volume and sensitivity control, 9 volt operated. £1.75 each P/P 15p.

Quality Slider Controls

60mm stroke singles and ganged. Complete with knobs. 5K, 10K, 25K, 100K, 250K, 500K, 1 meg, Log and Lin. 40p each, 10K, 25K, 50K, 100K, 250K, Log and Lin ganged. 60p each.

Hi-Fi & Tape Equipment

Acknowledged as U.K.'s Largest Stockists with Lowest Prices Plus 12 months Guarantee. Write or call for FREE 16 page lists (Ref. N. 17)

Transistors - IC's - SCR'S - Rectifiers - Triacs, etc. LATEST BROCHURE Ref. No. 36 on request, or see our earlier page

LOW COST HI-FI SPEAKERS

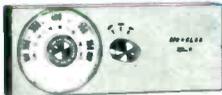


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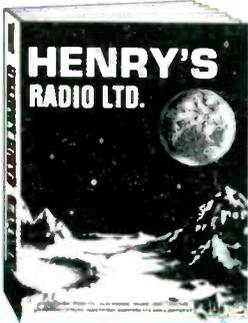
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