Practical projects to build at home

everyday electronics

JAN. 75
20p

PLUS!
THEORY
PRACTICE
POPULAR FEATURES
Electronics made easy!

The largest selection

EX COMPUTER BOARDS
Packed with transistors, diodes, capacitors and resistors—COMPONENT VALUE £1·50. 3 for ONLY 55p + p & p 30p

SPECIAL One as above PLUS Power Transistors ONLY 55p each + p & p 15p

PAXOLINE BOARDS 7½ × 9" approx. 4 for 30p + p & p 20p.

FIBRE-GLASS PRINTED CIRCUIT BOARDS
16½ × 4" approx. 2 for 55p

DECON-DALO 33PC Marker
Etch resistant printed circuit marker pen 99p each

VEROBOARDS
Packs containing approx. 50sq. ins. various sizes, all ·1 matric 55p

REPANCO CHOKES & COILS
RF Chokes
CH1. 2·5mH 29p CH2. 5·0mH 30p
CH3. 7·5mH 31p CH4. 10mH 33p
CH5. 1·5mH 28p
COILS
DRX1 Crystal set 31p DRR2 Dual range 45p

COIL FORMERS & CORES
NORMAN ¼" Cores & Formers 8p
⅜" Cores & Formers 10p

SWITCHES
DP/DT Toggle 36p SP/ST Toggle 30p

FUSES
1¼" and 20mm. 100mA, 200mA, 250mA, 500mA, 1A, 1·5A, 2A
QUICK-BLOW 5p ea.

EARPHONES
Crystal 2·5mm plug 42p
Crystal 3·5mm plug 42p
8 ohms 2·5mm plug 22p
8 ohms 3·5mm plug 22p

DYNAMIC MICROPHONES
B1223. 200 ohms plus on/off switch and 2·5mm and 3·5mm plugs £1·85

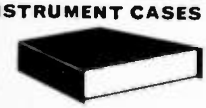
3-WAY STEREO HEAD-PHONE JUNCTION BOX
H1012 £1·87

2-WAY CROSSOVER NETWORK
K4007. 80 ohms Imp. Insertion loss 3dB £1·21

CAR STEREO SPEAKERS
(Angled) £2·85 per pair.

BI-PAK
CATALOGUE AND LISTS
Send S.A.E. and 10p.

INSTRUMENT CASES



(Black Vinyl covered)

No.	Length		Width		Height	Price
BV1	8"	×	5¼"	×	2"	£1·10
BV2	11"	×	6"	×	3"	£1·45

ALUMINIUM BOXES

BA1	5¼"	×	2¼"	×	1½"	42p
BA2	4"	×	4"	×	1½"	42p
BA3	4"	×	2¼"	×	1½"	42p
BA4	5¼"	×	4"	×	1½"	50p
BA5	4"	×	2½"	×	2"	42p
BA6	3"	×	2"	×	1"	84p
BA7	7"	×	5"	×	2½"	70p
BA8	8"	×	6"	×	3"	90p
BA9	6"	×	4"	×	2"	58p

P & P 10p on each box

BIB HI-FI ACCESSORIES

De Luxe Groov-Kleen
Model 42 £1·95
Chrome Finish
Model 60 £1·50

Ref. B Stylus & Turntable Cleaning Kit 34p
Ref. 36A. Record/Stylus Cleaning Kit 33p
Ref. 43. Record Care Kit £2·42
Ref. 31. Cassette Head Cleaner 58p
Ref. 32. Tape editing Kit £1·68
Model 9. Wire Stripper/Cutter 83p
Ref. 46. Spirit level 62p
Ref. P. Hi-Fi Cleaner 31p
Ref. 32A. Stylus Balance £1·37
Ref. J. Tape Head Cleaning Kit 62p
Ref. 56. Hi-Fi Stereo Hints & Tips 42p
Ref. 45. Auto changer groove cleaner £1·08

ANTEX SOLDERING IRONS
X25. 25 watt £2·05
CCN 240. 15 watt £2·48
Model G. 18 watt £2·26
SK2. Soldering Kit £3·25
STANDS: ST3. Suitable for all models £1
SOLDER: 18SWG Multicore 7oz £1·61
22SWG 7oz £1·61. 18SWG 22ft 51p
22SWG Tube 23p

ANTEX BITS and ELEMENTS

Bits No.		
102	For model CN240 3/32"	42p
104	For model CN240 3/16"	42p
1100	For model CCN240 3/32"	42p
1101	For model CCN240 3/16"	42p
1102	For model CCN240 ¼"	42p
1020	For model G240 3/32"	42p
1021	For model G240 1/8"	42p
1022	For model G240 3/16"	42p
50	For model X25 3/32"	48p
51	For model X25 1/8"	48p
52	For model X25 3/16"	48p

ELEMENTS
ECN 240 £1·30 ECCN 240 £1·32
EG 240 £1·07 EX 25 £1·16

ANTEX HEAT SINKS 10p

V.A.T. Included in all prices. Please add 10p P. & P. (U.K. only). Overseas orders—please add extra for postage.

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C1	200	Resistors mixed values approx. count by weight	0·55
C2	150	Capacitors mixed values approx. count by weight	0·55
C3	50	Precision Resistors 1%, 2% mixed values	0·55
C4	75	⅛th W Resistors mixed preferred values	0·55
C5	5	Pieces assorted Ferrite Rods	0·55
C6	2	Tuning Gangs, MW/LW VHF	0·55
C7	1	Pack Wire 50 metres assorted colours	0·55
C 8	10	Reed Switches	0·55
C 9	3	Micro Switches	0·55
C10	15	Assorted Pots & Pre-Sets	0·55
C11	5	Jack Sockets 3 × 3·5m 2 Standard Switch Type	0·55
C12	30	Paper Condensers preferred types mixed values	0·55
C13	20	Electrolytics Trans. types	0·55
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets etc.	0·55
C15	5	Mains Slide Switches	0·55
C16	20	Assorted Tag strips & Panels	0·55
C17	10	Assorted Control Knobs	0·55
C18	4	Rotary Wave Change Switches	0·55
C19	2	Relays 6—24V Operating	0·55
C20	1	Pack sheets of Copper Laminate 20 sq. ins	0·55

PLUGS AND SOCKETS

PLUGS

PS 1	D.I.N. 2 Pin (Speaker)	0·11
PS 2	D.I.N. 3 Pin	0·12
PS 3	D.I.N. 4 Pin	0·15
PS 4	D.I.N. 5 Pin 180°	0·16
PS 5	D.I.N. 5 Pin 240°	0·16
PS 6	D.I.N. 6 Pin	0·17
PS 7	S.I.N. 7 Pin	0·18
PS 8	Jack 2·5mm Screened	0·18
PS 9	Jack 3·5mm Plastic	0·12
PS 10	Jack 3·5mm Screened	0·18
PS 11	Jack ¼" Plastic	0·15
PS 12	Jack ¼" Screened	0·22
PS 13	Jack Stereo Screened	0·36
PS 14	Phono	0·10
PS 15	Car Aerial	0·22
PS 16	Co-Axial	0·15

INLINE SOCKETS

PS 21	D.I.N. 2 Pin (Speaker)	0·14
PS 22	D.I.N. 3 Pin	0·20
PS 23	D.I.N. 5 Pin 180°	0·20
PS 24	D.I.N. 5 Pin 240°	0·20
PS 25	Jack 2·5mm Plastic	0·16
PS 26	Jack 3·5mm Plastic	0·16
PS 27	Jack ¼" Plastic	0·30
PS 28	Jack ¼" Screened	0·35
PS 29	Jack Stereo Plastic	0·30
PS 30	Jack Stereo Screened	0·38
PS 31	Phono Screened	0·18
PS 32	Car Aerial	0·22
PS 33	Co-Axial	0·22

SOCKETS

PS 35	D.I.N. 2 Pin (Speaker)	0·08
PS 36	D.I.N. 3 Pin	0·11
PS 37	D.I.N. 5 Pin 180°	0·11
PS 38	D.I.N. 5 Pin 240°	0·11
PS 39	Jack 2·5mm Switched	0·12
PS 40	Jack 3·5mm Switched	0·12
PS 41	Jack ¼" Switched	0·20
PS 42	Jack Stereo Switched	0·30
PS 43	Phono Single	0·08
PS 44	Phono Double	0·10
PS 46	Co-Axial Surface	0·10
PS 47	Co-Axial Flush	0·20

LEADS
LS 1 Speaker lead 2 pin D.I.N. plug to open ends approx. 3 metres long (coded) 0·20

CABLES

CP 1	Single Lapped Screen	0·07
CP 2	Twin Common Screen	0·11
CP 3	Stereo Screened	0·12
CP 4	Four Core Common Screen	0·23
CP 5	Four Core Individually Screened	0·30
CP 6	Microphone Fully Braided Cable	0·10
CP 7	Three Core Mains Cable	0·09
CP 8	Twin Oval Mains Cable	0·07
CP 9	Speaker Cable	0·05
CP 10	Low Loss Co-Axial	0·18

CARBON POTENTIOMETERS
Log and Lin
4·7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M

VC 1	Single less Switch	0·15
VC 2	Single D.P. Switch	0·28
VC 3	Tandem Less Switch	0·48
VC 4	1K Lin Less Switch	0·15
VC 5	100K Log anti-Log	0·46

HORIZONTAL CARBON PRESETS
0·1 watt 0·06 each
100, 220, 470, 1K, 2·2K, 4·7K, 10K, 22K, 4K7, 100K, 220K, 470K, 1M, 2M, 4·7M

IT'S NEW IT'S POWERFUL
(15 + 15w R.M.S.) ***AND—***
IT LOOKS GOOD!

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ORDER NOW—
ONLY £39.95 p & p 50p.
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WORLD SCOOP
JUMBO SEMICONDUCTOR PACK
Transistors – Germ. and Silicon Rectifiers Diodes – Triacs – Thyristors – I.C's and Zeners ALL NEW AND CODED.
APPROX 100 PIECES
Offering the amateur a fantastic bargain Pak and an enormous saving—identification and data sheet in every Pak.
Only £2 p. & p. 20p

RECORD STORAGE/ CARRY CASES
7" EP. 13½" x 7" x 8". (50 records) £3·10
12" LP. 13¼" x 7¼" x 12¼". (50 records) £3·95

CASSETTE CASES
Holds 12. 10" x 3½" x 5". Lock & Handle. £1·30

SPECIAL PURCHASE
2N3055. Silicon Power Transistors NPN. Famous manufacturers out-of-spec devices free from open and short defects—every one able! 115w. T03. Metal Case.
OUR SPECIAL PRICE 8 for £1

LOW COST CAPACITORS
·01µF 400v. 3p. each
500µF 50v. Elect. 10p each

REPANCO TRANSFORMERS
240v. Primary. Secondary voltages available from selected tappings 4v, 7v, 8v, 10v, 14v, 15v, 17v, 19v, 21v, 25v, 31v, 33v, 40, 50 and 25v-0-25v.

Type	Amps.	Price	P & P
MT50/½	½	£1·93	30p
MT50/1	1	£2·42	35p
MT50/2	2	£3·30	40p

CARTRIDGES
ACOS
GP91-1SC 200mV at 1·2cm/sec £1·35
GP93-1 280mV at 1cm/sec £1·85
GP96-1 100mV at 1cm/sec £2·80
TTC
J-2005 Crystal/Hi Output £1·05
J-2010C „ „ „ Compatible £1·20
J-20068 Stereo/Hi Output £1·75
J-2105 Ceramic/Med Output £1·95
J-2203 Magnetic 5mV/5cm/sec, including stylus £4·95
J-22038 Replacement stylus for above £3·00
AT-55 Audio-technica magnetic cartridge 4mV/5cm/sec £3·30

CARBON FILM RESISTORS
The E12 Range of Carbon Film Resistors, 1/8th watt available in PAKS of 50 pieces, assorted into the following groups:—
R1 50 Mixed 100 ohms–820 ohms 50p
R2 50 Mixed 1K ohms–8·2K ohms 50p
R3 50 Mixed 10K ohms–82K ohms 50p
R4 50 Mixed 100K ohms–1 Meg. ohms 50p
THESE ARE UNBEATABLE PRICES JUST 1p EACH INCL. V.A.T.

BI-PAK SUPERIOR QUALITY LOW - NOISE CASSETTES
C60, 36p C90, 48p C120, 60p

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18 BALDOCK ST., WARE, Herts. (A10)
Open Mon.–Sat. 9 5.30 p.m. Tel. 61593

ASK LASKYS

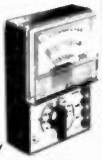
and make no mistake

TMK 200 MULTIMETER KIT

Build yourself a quality 20000 opv. multimeter and save money. Complete kit with meter scale, movement and rotary range selector ready mounted in cabinet. All parts, batteries, test prods and instructions. Ranges: 0/0.6/6/30/120/600/1200V D.C. 0/6/30/120/600/1200V A.C. Current: 0/0.6/6/60/600mA. Resistance: 0/10/100K/1/10 Meg ohms. Decibels: —20 to +63db. Size: 90 x 150 x 35mm.
OUR PRICE £7.95 P&P 30p.

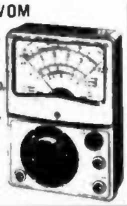
AUDIOTRONIC Model ATM1

Top value 1,000 opv pocket multimeter. Ranges: —0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistance: 0/150k ohms. Decibels: —10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.
OUR PRICE £3.25 P&P 15p

AUDIOTRONIC Model ATM5

Jewel movement, attractively moulded case with edgwise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC, (2500 opv). 0-6/30/300/600V DC, (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. —10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.
OUR PRICE £3.95 P & P 20p

MODEL TH12

20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. 0/50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. —20 to +50dB.
OUR PRICE £5.95 P&P 30p

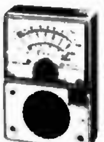
HIOKI 720X VOM

A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10/50/250/1000V AC. 0—50uA/250mA. 0—20k/2 Megohms.
OUR PRICE £5.97 P&P 30p

MODEL PL436

20,000 opv DC. 8000 opv AC. Mirror scale. 0/3/12/30/120/600V DC. 3/30/120/600V DC. 60/600μA/60/600mA. 10/100K/1 Meg/10 Meg Ohm. —20 to +46dB.
OUR PRICE £6.97 P&P 30p.

U4323 MULTIMETER

20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: x 10, x 100, x 1,000, x 10,000 (50Ω, 500Ω, 5kΩ, 50kΩ centre scale). Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.
OUR PRICE £7.70 P&P 30p

HIOKI 730X

30,000 opv. Overload protection. 0/6/30/60/300/600/1200V DC. 12/60/120/600/1200V AC. 60/μA/30mA/300mA. 2K/200K/2 Meg Ohm. —10 to 63dB.
OUR PRICE £7.50 P&P 30p

U4324 MULTIMETER

High sensitivity, overload protected. 20,000opv. Ranges: 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/3/30/300mA/3A AC. Resistance: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: —10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.
OUR PRICE £9.25 P&P 30p

U435 MULTIMETER

20,000opv. Ranges: 75mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.
OUR PRICE £8.75 P&P 30p

U4312 MULTIMETER

extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/150/60/600mA/1/1.5/6A DC. 0/1.5/6/15/60/150/600mA/1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.
OUR PRICE £10.25 P&P 50p

U91 Clamp VOLT AMMETER

For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.
OUR PRICE £13.50 P&P 30p

MODEL 500

30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms.
OUR PRICE £13.95 Carr. paid
Case for above £1.75

HIOKI 750X VOLT-OHM-MILLIAMETER

43 ranges: 0—0.3/0.6/1.5/3/6/12/30/60/150/300/600/1,200V DC. 0—3/6/15/30/60/120/300/600/1,200V AC. Current: 0—30/60uA/1.5/3/15/30/150/300mA/6/12A. Resistance: 0—3/300k/3/30Mohms. Decibels: —10 to +17dB. Output: —0—3/6/15/30/60/120/300V. Accuracy ± 3% DC, ± 4% AC. Sensitivity: 50,000 opv DC, 5,000 opv AC. 4 inch meter. Built in protection. Size: 57 x 102 x 153mm.
OUR PRICE £11.95 P&P 40p

TMK MODEL TW50K

46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistance: 10k/100k/1 Meg/10 Meg ohms. —20 to +81.5dB.
OUR PRICE £12.50 P&P 20p

HIOKI MODEL 700X

100,000opv. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC. 2k/200k/2M/20MOhms. —20 to +63dB.
OUR PRICE £14.95 P&P 30p

Model HT100B4 MULTIMETER

Overload protected, shock proof circuits. 9.5uA Meter with mirror scale. Sensitivity 100kV. Polarity change switch. Ranges: 0.5/2.5/1/-/50/250/500/1,000 Volts DC. 2.5/10/50/250/1,000 Volts AC. DC resistance 0—20/200k/2/20 Meg. ohms. DC current: 0—10/250uA/2.5/25/250 mA/10A. AC current: —0—10A. —20 to +62dB. Operates from 2 x 1.5V batteries. Size: 180 x 134 x 79mm.
OUR PRICE £17.50 P&P 40p

MODEL AS.1000 VOM

100,000 opv. Mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600V AC. 0/10μA/6/60/300mA/12 Amp. 0/2K/200K/2M/200 Meg Ohm. —20 to +17dB.
OUR PRICE £17.50 P&P 30p.

MODEL C7202EN

20,000 o.p.v. DC. 10,000 o.p.v. AC Mirror Scale. 5/25/50/250/500/1000/2500 V. DC. 10/50/100/500/1000 V. AC. DC Resistance x10, x1000 (30Ω centre scale) DC Current 50uA/2.5mA/250mA. —20 to +68 dB.
OUR PRICE £6.50 P & P 30p

KAMODEN HM720B FET VOM

Input impedence 10 Megohms. Ranges: —0/.25/1/2.5/10/50/1000V DC. 0/2.5/10/50/250/1000V AC. 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms
OUR PRICE £21.00 P & P 40p

KAMODEN 360 MULTIMETER

High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale, overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC. 5/10/50/250/1000V AC. Current: 0.01mA/0.5/5/50/500mA/10A. Resistance: 0.1/1/10/100 ohms/1/10/100k ohms/10/100M ohms. Decibels —20 to +62dB. Battery operated. Size: 180 x 140 x 80mm. Supplied complete with, test leads etc.
OUR PRICE £17.50 P & P 40p

TMK MODEL 117 FET ELECTRONIC VOLTMETER

Battery operated. 11 Meg Input, 26 ranges. Large 4¾" mirror scale. Size: 149 x 117 x 60mm. 0.3—12000V DC. 3—300V RMS AC. 8—800V P.P. DC current 0.12—12mA. Resistance up to 2000MOhms. Decibels: —20 to +51dB. Supplied complete with leads and instructions.
OUR PRICE £18.50 P&P 20p

TMK 100K LAB TESTER

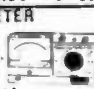
100,000opv. 6½" scale. Buzzer short circuit check. Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.5/2.5/10/50/250/1000V AC. 3/10/50/250/500/1000V DC. current 10/100uA/10/100/2.5/10A. Resistance: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: —10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.
OUR PRICE £19.95 P&P 30p

370WTR MULTIMETER

Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/250/500/1000V DC. 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: —20 to +62dB.
OUR PRICE £19.95 P&P 30p

KAMODEN 72.200 Multitester

High sensitivity tester. 200,000 opv Overload protected. Mirror scale. Ranges: —0/.06/.3/3/30/120/600/1200V DC. 0/3/12/60/300/11200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. —20 to +63dB. 0/2k/200k/2 Meg/200 Megohms.
OUR PRICE £22.50 P&P 30p

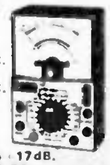
U4317 MULTIMETER

High sensitivity instrument for field and laboratory work. Knife edge pointer, mirror scale, overload protection. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: —5 to +10dB. Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.
OUR PRICE £16.50 P&P 40p

MODEL C7208FM

30,000 opv DC. 15,000 opv AC. 6/3/15/60/300/600/1200 V. DC. 6/30/120/600/1200 V. AC. OC Resistance x 1, x 10, x 100, x 1000 (50Ω centre scale) OC Current 30uA/3/30/600mA. —20 to +63dB.
OUR PRICE £8.95 P & P 30p

MODEL U4311 Sub-standard Multi-range Volt-Ammeter

Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC, 1% AC. Scale length: 165mm. 0/300/750uA/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A AC. 0/75/150/300/750mV/1.5/3/7.5/15/30/75/150/300/750V DC. 0/750mV/1.5/3 /7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.
OUR PRICE £52.00 P&P 50p

MODEL AF.105 VOM

50,000 opv. Mirror scale. Meter protection. 0/.3/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600/1200V DC. 0/30μA/6/60/300 mA/12 Amp. 0/10K/1m/10m/100 Meg Ohms. —20 to 17dB.
OUR PRICE £12.50 P&P 30p.

L83 TRANSISTOR TESTER

Tests ICO and B. PNP/NPN. Operates from 9V battery. Instructions supplied.
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L84 TRANSISTOR TESTER

Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.
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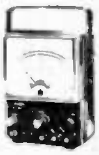
KAMODEN TT35 TRANSISTOR TESTER

High quality instrument to test reverse leak current and DC current. Amplification factor of NPN, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads carrying handle.
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U4341 Multimeter & Transistor Tester

27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.
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S100TR MULTIMETER TRANSISTOR TESTER

100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA/6/12A DC 0/10k/1 Meg/100 Meg. —20 to +50dB. 0.01—0.2 MFD Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.
OUR PRICE £19.95 P&P 25p

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Also see following pages

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

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

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RUSSIAN CI16 Double Beam OSCILLOSCOPE
5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2usec to 100 milli-sec/cm. Free running time base. 50Hz–1MHz. Built-in time base Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.

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

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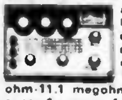
TRANSISTORISED L.C.R. A.C. BR/8 MEASURING BRIDGE

A new portable bridge offering excellent range and accuracy at low cost. Resistance: 6 ranges: 0.1 ohm-11.1 megohm ± 1% Inductance: 6 ranges: 1 microhenry-111 henries, ± 2% Capacity: 6 ranges: 10pf-1110 mfd ± 2% Turns Ratio: 6 ranges: 1:1/1000-1:11100 ± 1% Bridge Voltage at 1,000cps. Operated from 9-volt battery. 100 microamp meter indication. Size 7½" x 5" x 2"
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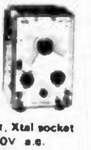
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Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedence 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.

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

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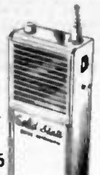
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High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating.

Single hole fixing. ¼" diameter shafts. Bulk quantities available.

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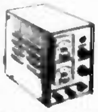
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AUDIOTRONIC LE-102A INTERCOM

Beautifully made and finished in two tone ivory/buff, the LE-102A is useful in the home, office or shop and is suitable for use as baby alarm. Wall or desk mounting 57mm speaker/mic gives clear 2-way communication with on/off and volume control on master unit. Operates on 9V batt. Approx. 60ft lead.
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TRITON 4318 PORTABLE 8 TRACK CARTRIDGE PLAYER WITH MW/LW RADIO
Will play 8 track stereo cartridge monaurally. Channel selector switch. Covers medium and long wave bands. Volume and tone controls. Earphone socket. Battery/Mains operation.

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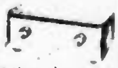
EA41 REVERBERATION AMPLIFIER
Self contained, transistorised, battery operated. Simply plug in microphone, guitar etc. and output to your amplifier. Volume control and depth of reverberation control. Beautiful walnut cabinet. 184 x 77 x 108mm.

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SPECIAL PURCHASES! RECORD DECK PACKAGE by Famous Manufacturer
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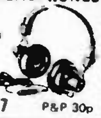
LH02S STEREO HEADPHONES
Light weight head phones with padded ear pieces. 4/16 ohms 20–20,000Hz. Complete with 6' lead and plug.

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

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

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

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Moving coil. Ideal for language teaching, communications etc.

Headphone impedence 16 ohms. Microphone impedence 200 ohms.
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Covers Medium and FM wave-bands. Slider volume and tone controls. Battery/Mains operation. Will record direct from radio or through built in condenser microphone. Complete with batteries, earphone, and cassette.

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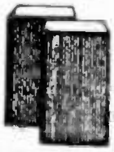
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FM TUNER CHASSIS
6 transistor high quality tuner. Size only 153 x 101 x 63mm 3 IF stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Covers 88–108MHz. Ready built, ready for use. Fantastic value for money.

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Stereo Multiplex Adaptor £5.95 extra

SPECIAL OFFER! SAVE OVER 50%

AMSTRAD 8000/2 Stereo amplifier 7 watts per channel rms. Inputs for tuner tape, phono. Headphone socket. List price £29.95.
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SPECIAL OFFER! CONVERT YOUR STEREO SYSTEM TO 4D SOUND FOR UNDER £16.

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

Model A1018 FM TUNER
6 transistor high quality unit—3 IF stages and double tuned discriminator. For use with most amplifiers. Covers 88—108MHz. Powered by 9V battery.

OUR PRICE £13.50 P&P 30p
Stereo multiplex adapter £5.95 extra.

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Spanning nearly two octaves, including semi-tones. This instrument will give hours of enjoyment to all the family. Beautifully finished. The Keyboard range can be adjusted to be in tune with any instrument. Operates from internal 9V battery. Fitted with on/off switch, vibrato switch, earphone socket and external 9V D.C. socket.
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BINATONE DIGITAL CLOCK
Attractive ivory case. Large clear numbers for hours, minutes and seconds. A.C. 240V operation. Size approx. 6½ x 3 x 3½ inches.

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SINCLAIR IC12 INTEGRATED CIRCUIT AMPLIFIER
complete with printed circuit mounting board.

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Transformer for PZ8	£4.05	P & P 50p
IC 20 Stereo Amp. kit	£7.95	P & P 15p
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SINCLAIR Project 80 Packages

2xZ40/Stereo 80/PZ5	£28.80	P & P 35p each
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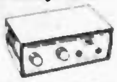
2xZ60/Stereo 80/PZ8	£33.55	

TE1021 Stereo Listening Station
For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. Two gain controls, speakers on—off slide switch, stereo headphone socket.

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AUDIOTRONIC LOW NOISE CASSETTES

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

P&P 3p each. 10 and over Post Free

MP7 MIXER-PREAMPLIFIER
5 Microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. Size: 235 x 127 x 76mm. Inputs: Mics. 3 x 3mV 50k; 2 x 3mV 600 ohms. Phono. Mag. 4mV 50k; Phono Ceramic 100mV 1 Meg. Output 250mV 100k.

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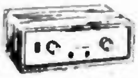
AUDIOTRONIC AHA101 Stereo Headphone Amplifier
All silicon, transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. INPUTS: 5mV and 100mV. OUTPUT: 50mV per channel.

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Amateur Electronics by Josty-Kit, the professional book for the amateur—covers the subject from basic principals to advanced electronic techniques. Complete with circuit board for AE1 to AE10 listed below.
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500uA	£3.65
50-0-50uA	£3.75
100-0-100uA	£3.70
1mA	£3.65
5mA	£3.65
10mA	£3.65
50mA	£3.65
100mA	£3.65
500mA	£3.65
1A DC	£3.65
5A DC	£3.65
10A DC	£3.65
5V DC	£3.65
10V DC	£3.65
20V DC	£3.65
50V DC	£3.65
300V DC	£3.65
15V AC	£3.75
300V AC	£3.75
VU Meter	£3.90

CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm

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

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Size: 90 x 34mm

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200uA	£4.05
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50-0-50uA	£4.10
100-0-100uA	£4.05
1mA	£3.85
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Size: 100 x 90 x 150mm including terminals

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

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50-0-50uA	£7.90
1mA	£7.60
1-0-1mA	£7.60
1A DC	£7.60
5A DC	£7.80
5V DC	£7.60
10V DC	£7.60
15V DC	£7.60
20V DC	£7.60
50V DC	£7.60
300V DC	£7.60
500mA/5A DC	£8.60
5V/50V DC	£8.60
5V/15V DC	£8.60
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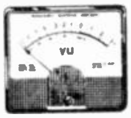
1A/15A DC	£8.60

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



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

CLEAR PLASTIC MODEL SD830
Size: 110 x 83mm

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

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

50uA	£3.20
100uA	£3.15
200uA	£3.10
500uA	£3.00
50-0-50uA	£3.15
100-0-100uA	£3.10
500-0-500uA	£2.95
1mA	£2.95
5mA	£2.95
10mA	£2.95
50mA	£2.95
100mA	£2.95
500mA	£2.95
1A DC	£2.95
5A DC	£2.95
10V DC	£2.95
20V DC	£2.95
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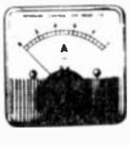

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50-0-50uA	£3.05
100-0-100uA	£3.00
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1mA	£2.80
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2mA	£2.80
5mA	£2.80
10mA	£2.80
20mA	£2.80
50mA	£2.80
100mA	£2.80
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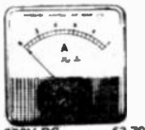

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500-0-500uA	£3.70
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1-0-1mA	£3.70
5mA	£3.70
10mA	£3.70
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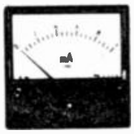

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100-0-100uA	£3.45
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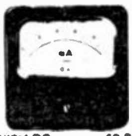
10mA	£3.30
50mA	£3.30
100mA	£3.30
500mA	£3.30
1A DC	£3.30
5A DC	£3.30
10V DC	£3.30
20V DC	£3.30
50V DC	£3.30
300V DC	£3.30
15V AC	£3.40
300V AC	£3.40
S Meter 1mA	£3.30
VU Meter	£3.80
1A AC	* £3.30
5A AC	* £3.30
10A AC	* £3.30
20A AC	* £3.30
30A AC	* £3.30

BAKELITE MODEL MR 65
Size: 80 x 80mm



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1-0-1mA	£3.60
5mA	£3.60
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PROJECTS... THEORY......

BRIGHT INTERVALS—WE HOPE

As many readers will have noticed, yet another prototype "self-supporting house" has been unveiled for our amazement. The idea is good and sensible of course, the only problem is the siting. A roof-ful of solar cells is likely to be very rewarding in Bulawayo, Bomba, or Brasilia. But in Ballachulish, Burnley, or Basingstoke the prospect seems rather less encouraging.

From our own recent dampening experience of deluge following deluge, what we in the UK *do* urgently need is a system for converting rain into electric power. A rainmill for example. The thought of all those gallons of that most abundant natural resource falling to waste is simply horrific. No doubt technology will catch up with this, one damp day—hopefully before we local inhabitants assume submariner status.

Those continuous downpourings have scarcely required any electronic aid to announce their oncoming. Actually we blush a little when mentioning one of this month's projects—the Rain Alarm. Yet in the course of time, this extremely simple device will come into its own—mark our words. It is really intended for those crafty intermittent showers that have a habit of appearing out of the blue (remember?) when least expected.

So, to you lads in particular among our readers, here's a bit of advice. Don't overlook this chance to get the right side of mum. For when this rain alarm has had a chance to demonstrate it's value as a "laundry protector" your squatter's rights on the kitchen table for constructional purposes should be amicably conceded.

ANOTHER SOLID STATE?

Rain, rain. But what price mere rain when the 21st Ice Age is upon ! ! EVERYDAY ELECTRONICS could surely claim a world scoop with this month's Ice Warning Device. But it's still a trifle premature to prepare for *that* catastrophe. As a matter of fact it is the motorist we have in mind on this occasion. And what could be more timely as winter begins to get its cold and treacherous grip on things—roads in particular.

Sorry that two of the main attractions in this issue bring attention to some of the least agreeable aspects of the weather. Perhaps, to be more seasonable we should have included a snow detector. But at any rate we have covered the two extremes, the liquid and the solid state of H_2O.

Best wishes to all our readers this Christmastide, and may the outlook be set fair.

Our February issue will be published on Friday, January 17

Everyday Electronics Fleetway House, Farringdon Street, London, E.C.4. Phone: *Editorial* 01-634-4452; *Advertisements* 01-634-4202.

.EASY TO CONSTRUCT
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VOL. 4 NO. 1 JANUARY 1975

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

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ICE WARNING

CIRCUITS which respond to changes in air or liquid temperature are easy to build because of the ready availability of thermistors.

This project describes how to use a thermistor as a transducer in a circuit which repeatedly flashes a lamp when the temperature of the thermistor has fallen to a preset temperature—in this case 0 degrees C. Thus the circuit can be used to provide a warning that the temperature in a greenhouse, for example, has reached frost point. Or, as described for this project, the circuit could be used to warn the driver of a car that icy roads are likely.

Apart from two bipolar transistors, an *npn* and a *pnp* type, the circuit also uses three other types of semiconductor devices. Firstly, the *thermistor*, consisting of a bead of semiconducting material, is a glass-encapsulated negative-temperature-coefficient (n.t.c.) type. Its small size enables it to respond rapidly to temperature changes and the glass encapsulation protects the bead from the electrical effects of conducting liquids which might come into contact with it. Note that an n.t.c. thermistor has an electrical resistance which increases with temperature fall.

Secondly, an integrated circuit operational amplifier (op amp)—the general purpose 741 type—is used as a sensitive detector of voltage change across a Wheatstone bridge, one arm of which contains the thermistor.

Thirdly, a light-emitting diode (l.e.d.) is the solid state lamp which flashes the warning signal. This lamp is small, robust and requires very little current to light compared with a tungsten filament lamp.

THE CIRCUIT

The complete circuit of the "frost" alarm is shown in Fig. 1. The design shown is powered by a 12V car battery, although should the circuit be used for other applications a 9V battery would suffice to operate the circuit.

The circuit may be considered to consist of two parts divided by the dotted line. To the left of this line is the temperature-sensitive Wheatstone bridge, the output from which is sensed by the op amp acting as a differential amplifier. To the right of the dotted line is the two-transistor oscillator which flashes the l.e.d. when the thermistor reaches a predetermined temperature.

The Wheatstone bridge consists of resistors R1 and R2 which set the voltage at the inverting terminal of the op amp at about 8V with respect to the negative line (for a 12V supply). The preset resistor VR1 and the thermistor RTH1 form the other arms of the bridge.

Since the thermistor is an n.t.c. type, as its temperature falls its resistance increases, and the voltage at pin 3 rises. As this voltage just exceeds that at pin 2, the voltage at the output of the op amp goes from near zero to a few volts positive. The temperature at which the output goes sharply positive can be selected by adjustment of the preset resistor VR1.

The sudden rise of voltage at the output of the

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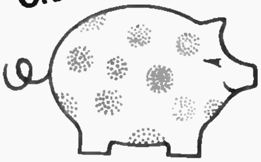

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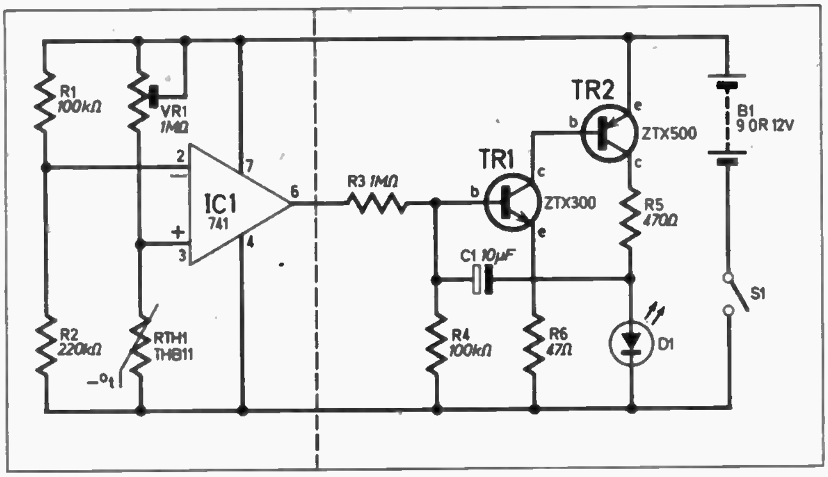


Fig. 1. The circuit diagram of the Ice Warning device.

op amp switches on the oscillator to the right of the dotted line, resistor R3 coupling this voltage change to the base of transistor TR1. The capacitor C1 provides the positive feedback which is necessary to maintain the low-frequency oscillations.

The *pnp* transistor TR2 has the l.e.d. in its collector circuit as well as a suitable series resistor R5 which restricts the current passing through the l.e.d. to below its maximum rated value. The frequency of the flashes of the l.e.d. are determined partly by its own resistance but can be adjusted to the required rate by selecting a suitable value for C1.

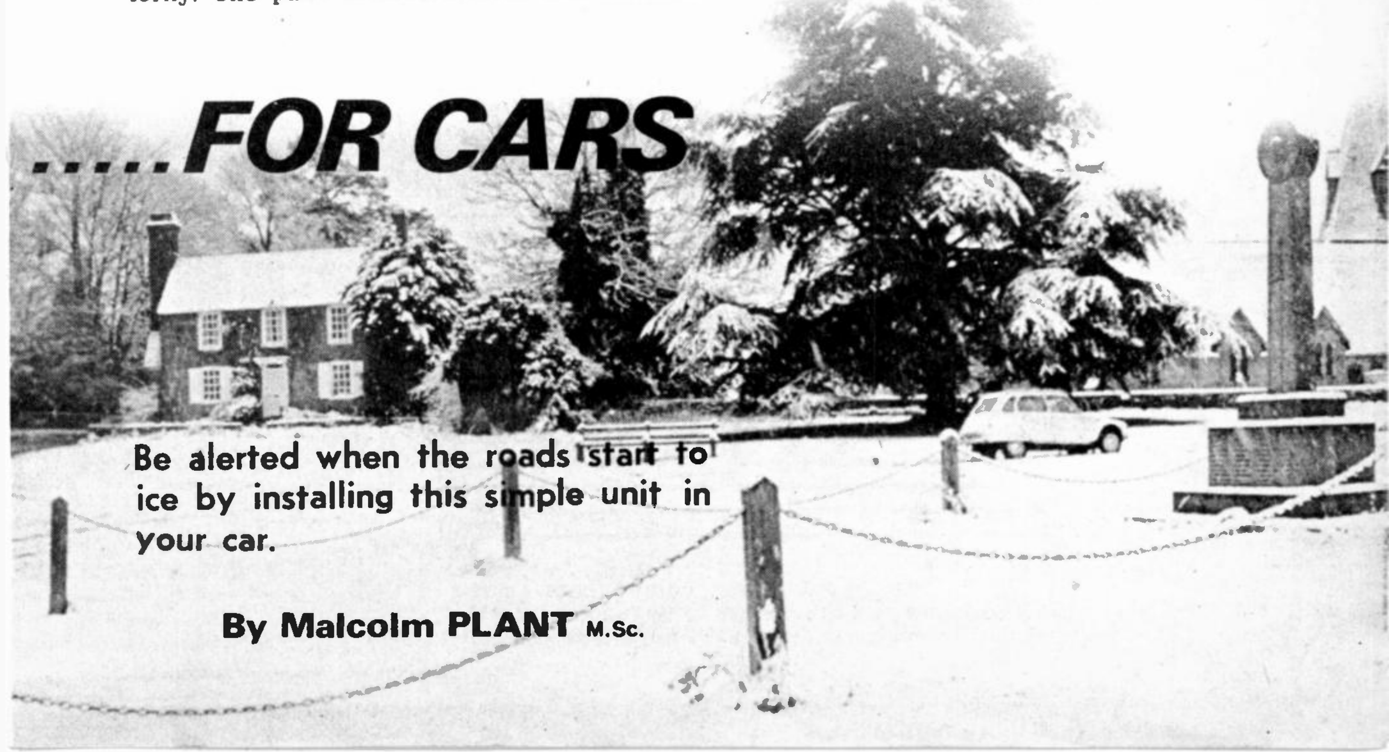
Transistors TR1 and TR2 should be a complementary pair if the circuit is to work satisfactorily. The pairs 2N2926/2N3702 and BC182L/BC212L are suggested alternatives to the types in the circuit.

CIRCUIT ASSEMBLY

All of the components, excepting battery, switch and l.e.d., can be mounted on 0·1 inch matrix Veroboard as shown in Fig. 2 although the actual layout may depend upon the physical size of the components which are obtained by the constructor.

The thermistor must be sited in a position where it cannot receive heat from the engine. It must be close to the ground since the conditions for ground frost, giving icy patches on roads, cannot be predicted a few feet above the ground.

The thermistor must be protected from con-



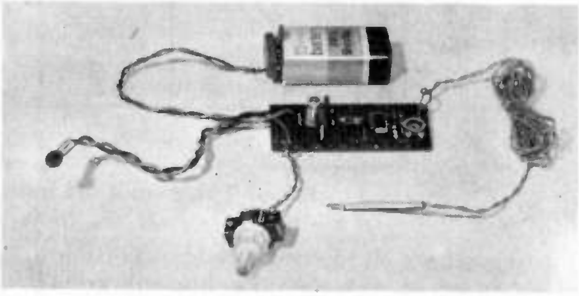
.....FOR CARS

Be alerted when the roads start to ice by installing this simple unit in your car.

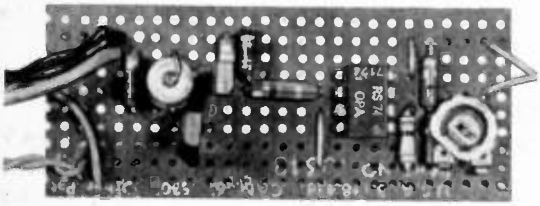
By Malcolm PLANT M.Sc.

ICE WARNING

FOR CARS



The prototype unit wired up and ready for installation.



Photograph of the completed prototype component board.

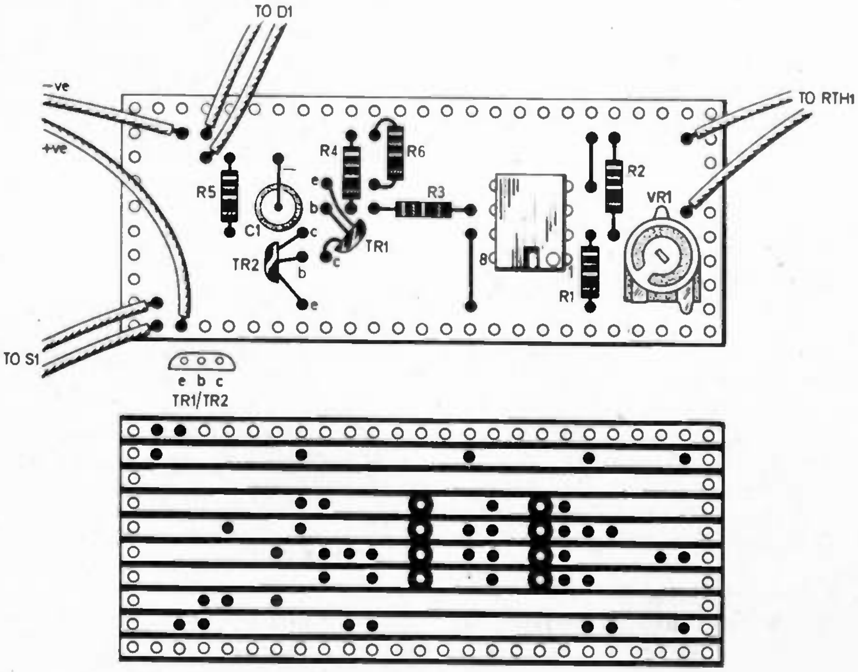


Fig. 2. The layout of the components on the Veroboard and the breaks to be made along the copper strips on the underside.

Components....

Resistors

R1	100kΩ
R2	220kΩ
R3	1MΩ
R4	100kΩ
R5	470Ω
R6	47Ω

All ¼W ± 10% carbon

SEE SHOP TALK

Capacitor

C1 10μF elect. 15V

Semiconductors

ICI	μA 741C or similar 741 type with holder
TR1	ZTX 300, 2N2926 or BC182L silicon *npn*
TR2	ZTX500, 2N3702 or BC212L silicon *pnp*
D1	red light emitting diode, any type
RTH1	THB11 thermistor

Miscellaneous

B1 9V battery or 12V car supply
S1 s.p.s.t. switch or car ignition switch
Veroboard 25 holes x 10 strips, 0·1 inch matrix, connecting wire, suitable small plastic case approx 75 x 30 x 30mm.

tact with water splashes and rain, for the cooling produced by water evaporating from the thermistor will cause it to fall to a temperature below the true air temperature. A good position for the thermistor is behind the front bumper although the best position will be determined by the type of car.

Having decided the position for the thermistor, you will need to estimate the length of flex required between the thermistor and the circuit. Care should be exercised in soldering the flex to the thermistor since the soldered joints should be insulated with sleeving to prevent them coming into contact with water; heat-shrinkable sleeving is ideal for this purpose. The thermistor should be glued into the end of a short length of plastic tubing so that although air can circulate round it, it is protected from water splashes.

Any small plastic box can be used to house the circuit and to locate it unobtrusively behind the dashboard of the car. Three pairs of leads should leave the box through a grommet: two leads to the battery, two to the thermistor, and two to the light-emitting diode. Choose a position on the dash where it is easy to see the flashing of the l.e.d. Drill a hole to take the l.e.d. so that it can be fixed by pushing it through a plastic grommet.

The l.e.d. must be connected correctly to the circuit so that it is forward-biased by TR2 switching on. It is easy to find the anode of an l.e.d. by means of a multimeter switched to its ohms range. Indeed, when the diode is forward biased (giving a low resistance reading), the l.e.d. will often light, being energised by the internal battery of the multimeter. Before finally fixing the circuit to the car, it must be set to respond to an air temperature of 0 degrees C in the following way.

CALIBRATION

Crush some ice in a container until it is a "slush". Ensure that the ice is melting, for then it is at 0 degrees C (the ice point) but check the temperature with a thermometer if you have one available. Immerse the thermistor in the melting ice and adjust the preset resistor until the l.e.d. just begins flashing. Take the thermistor out of the iced water and as it warms up the l.e.d. will cease to flash.

Of course, you may decide to choose an alternative temperature for the l.e.d. to start flashing. The circuit is relatively immune to changing supply voltages which might cause the l.e.d. to flash at temperatures other than that set. Incidentally, resistor R5 has been included in the circuit to prevent the l.e.d. from occasionally flashing when the thermistor is above the set level This resistor provides a slow discharge path for the capacitor.

MODIFICATION

Should it be required to convert the circuit to one which provides an audible warning rather than a visible alarm, the following alteration may be made. Change C1 to about 0·1μF (select its value for the desired frequency), and replace R5 and the l.e.d. by an 80 ohm miniature speaker, C1 now being connected directly to the collector of TR2. For an audio-visual indication, make this modification but also replace R4 by the l.e.d.

In use it is interesting to note, as one drives along during a frosty evening, the indication given by the device. The likely conditions for ice to form on the road is clearly indicated—under trees or other sheltered places, in hollows where cold air collects and even a change from cloudy to clear sky. ▣

PLEASE TAKE NOTE

Windscreen Wiper Controller (Nov. 74). **In Fig.3, diode D1 is drawn the wrong way round. The circuit diagram and Fig.2 show the correct polarity.**

M. W. Reflex Receiver (Dec. 74). **Under the heading Adjustments, in the last sentence of the second paragraph "increase" should be changed to "decrease".**

We would like to apologise for an error on the Data Check Card given free with the December issue of E.E. The formula for the net value of two capacitors wired in series should read

$$C_{total} = \frac{C1 \times C2}{C1 + C2}$$

New products and component buying for constructional projects

SHOP TALK

By Mike Kenward

By the time this issue hits the bookstalls it will be nearly Christmas—it seems very far away at the time of writing (early November) and one wonders how it will be upon us so quickly. No doubt many readers will be getting soldering irons or small multimeters for Christmas and excellent presents they make too.

One of the smaller meters costing about £10 should last a lifetime if carefully looked after and will soon prove itself invaluable to any constructor. The available range is vast and it would be necessary to choose the one you want instead of leaving the choice to some well meaning, but electronically unaware, relative. The things to go for are high sensitivity (ohms/volt), about 20,000Ω/V is required, and a good number of ranges with reasonable accuracy.

Ice Warning Device

Few if any components for the *Ice Warning For Cars* should cause problems. The author has provided alternative transistor types should the Ferranti ZTX ones not be available in your area. The thermistor could prove difficult but the larger suppliers should have it and if not they may able to offer a device with similar characteristics.

To enhance the finished unit an l.e.d. with chrome mounting case can be purchased although this will add to the cost. The prototype unit was housed in a plastic photographic slide box providing excellent protection within the car. The case can be packed with foam rubber inside to protect the board from shocks, and the lid held on with Sellotape.

2 Band Superhet Tuner

A fairly complex project and not one recommended for the new constructor, the *2 Band Superhet Tuner* is the first superhet design that we have published. Readers will notice that it is fairly expensive when compared with a complete Japanese superhet receiver and these days it is simply not possible to make a superhet receiver more cheaply than a similar one can be purchased for.

However this does not detract from the knowledge gained and the satisfaction of producing ones own unit and this design will make an excellent "add on" for the hi fi enthusiast who wants to listen to an a.m. station occasionally and only has an f.m. receiver.

One or two of the components are rather special, in particular all the Denco parts. These are available from some retailers or direct from Denco at 357/9, Old Road, Clacton-on-Sea, Essex. The combined cost of all their parts plus post, packing and V.A.T. is £3·40. The parts must be specified individually as shown in the components list. Add 20p if the trimming tool is required.

Another component which may cause some difficulty is the Jackson 00 capacitor (208/176pF with trimmers) that forms C1, C2, C6 and C7. This should be available from the larger retailers—again give the full specifications when ordering.

Rain Alarm

Certainly the most simple *Rain Alarm* we have ever published and probably one of the most simple designs possible. The few parts for this device should not cause any problems. Doram are the suppliers of the audible warning device (12V version), they do advertise in our pages. The cost of this item including post, packing and V.A.T. is £1·70.

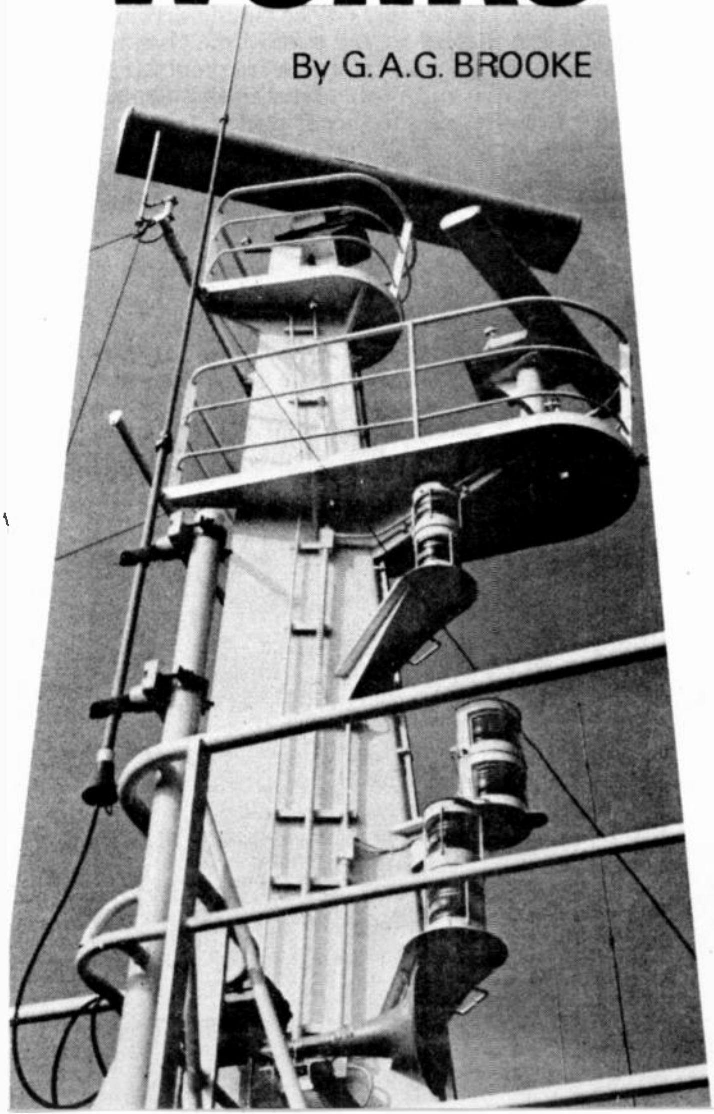
Ultrasonic Remote Control

The parts for the ultrasonic transmitter are all readily available except possibly the transducer which comes from Hall Electronics. The cost of this item including post, packing and V.A.T. is £3·75. Hall are at 38 Avondale Rd., Leyton E17.

If you have any difficulty in getting the diecast case shown, write to Doram who can supply it for £1·23 inclusive (type 994).

HOW RADAR WORKS

By G.A.G. BROOKE



RADAR in some form—for ships, airports, speed traps, weapons—is now so commonplace that manufacturers and others in the business are inclined to take for granted that everyone else knows exactly how it works. The reverse is often the case and this article sets out to explain the salient points, mainly with reference to marine equipment.

DEVELOPMENT

Although it took the pressures of impending hostilities to produce a practical design some years before World War II, Hertz had proved that radio waves can be reflected by metallic bodies as much as 50 years before. Marconi alluded to the possibilities of obtaining reflections from targets in 1922 and, although much money and effort had to be expended, it is hard to see why radar took so long in gestation at a period when advances were being made in many other technical directions.

Modern radar really has its roots in the works of scientists in the mid-twenties and early thirties, mainly in England and the U.S.A. who were concerned with the heights above the earth of the electrically conductive layers of the atmosphere which reflect radio waves. Sir Edward Appleton, M. A. F. Barrett and R. A. (later Sir Robert) Watson Watt were prominent in this country.

Sir Robert, who died only recently, became of course the great pioneer and it was under him that the development of radar was concentrated prior to and during the last war. Randall and Boot are two names almost as significant, as it was they who produced the cavity magnetron at Birmingham University in 1940. It elevated radar from v.h.f. to microwave frequencies, and made possible a much smaller and highly directional aerial that provided greater power by concentrating it in a narrow beam.

The magnetron is still with us, though it and the cathode ray tube are the only valves to be found in modern solid-state equipment.

BASIC PRINCIPLE

The basic principle of radar is simplicity itself: if radio energy at high frequency (usually between 1GHz and 40GHz) is emitted with high power, it will be reflected off hard objects in much the same way as audible sound. Since the speed of both the emitted and reflected energy is known, it is only necessary to construct an electronic timing device for the range of the object returning an echo to be measurable.

This sounds easy, but accounts for one of the intricate parts of a standard marine radar (the whole costing from £600 for the simplest yacht model to £10,000 for the largest standard big ship set). The position of the echo in azimuth (its bearing) is much more easily determined, of which more later.

In practice a radar consists of a transmitter to generate pulses of radio-frequency energy; a rotating aerial for sending these out into space as a narrow beam of radio waves; a receiver for accepting the echoes returned (via the aerial) from any suitable target; and a display for presenting them visually so that range and bearing are evident. (There also has to be a power supply for converting the electricity available into the special form required by the radar.)

TRANSMITTER

Ranging by radar is very analogous to making use of echoes of the human voice. If one shouts in order to time the echo, the best results are obtained if "transmission" consists of short, sharp sounds. The shortness ensures that the transmission will have ceased before the echoes return and the sudden rise to full power will make the instant of return immediately perceptible.

Similarly, the radar transmission which must operate for ranges varying from 25 yards to, say, 48 miles, has to produce a short pulse of oscillation rising rapidly to full amplitude, which it maintains until cut off. The duration of the pulse is called the pulse length and its frequency, the pulse repetition frequency (p.r.f.).

If, for instance, the target is only 50 yards from the transmitter, the pulse will have to be cut off before the beginning of the wave has had time to travel to the target and back; a total distance of 100 yards. A radio wave travels 328 yards in one microsecond so that the pulse, in this case, must not be longer than 0·3 microseconds.

If it is also desired to receive echoes from targets up to, say, a 30 mile range, the interval between pulses must be long enough to enable the wave to travel twice this distance, i.e. 370·4 microseconds. This gives a maximum p.r.f. of 2700 pulses per second. (The pulse has to be further shortened in order to separate echoes of the same bearing and of very small difference in range. With too long a pulse, the echoes would be merged.) In practice a choice of two or three p.r.f.s may be provided for use at different ranges.

OPERATION

It will be noticed that in the case mentioned the transmitter is required to oscillate for 0·3 microseconds and then to rest for 370·1 microseconds. Because of this, a small valve (the magnetron) may be used to generate very high power since it has relatively long intervals in which to cool. In practice the p.r.f. is usually between 500 and 4,000 pulses per second. In these circumstances a magnetron no bigger than 250 watt lamp can give a peak power of 60kW.

The "firing" of the magnetron (an apt description) is the last action from a chain of four basic circuits in the transmitter. Traditionally—in the latest solid-state equipment there is some variation—these and their functions are:

1. The sync. trigger, which synchronises the display with the transmitter;
2. The sub-modulator, which is a timing device determinging pulse width;
3. The modulator, which stores energy and then releases it to the magnetron on command from the sub-modulator;
4. The magnetron itself which converts electrical energy into electromagnetic waves.

These circuits are so designed that, after the sudden initial rise, the discharge is as near as possible at a constant rate and is completed in the time of the desired pulse length; that is to say, it takes the form of a short square pulse. The magnetron bursts into oscillation when the energy is released and ceases to oscillate when the supply is cut off.

Though it has but two electrodes, the action of the magnetron is complex. Suffice it to say that it is known as a cavity resonator and operates between the poles of a very strong magnet.

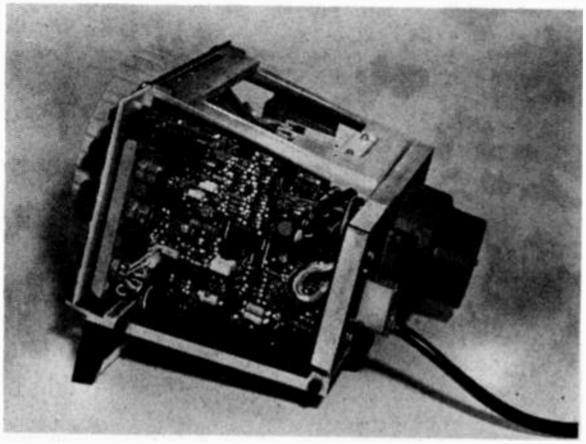
As described earlier, the key to range measurement by radar is the time interval between transmitted pulse and returning echo. To measure this, the sync. trigger sets off the timing arrangements in the display at the same time that the magnetron is fired and the radio frequency (r.f.) pulse begins. We will return later to the display.

The r.f. pulse, so produced, passes from the transmitter to the aerial via a waveguide, simply a tube (usually of copper) of rectangular section and engineered to high limits. Its internal dimensions are critically dependent on the frequency used and must be uniform.

THE AERIAL

There have been several types of aerial over the years but in marine practice the most usual

One side of a Decca small boat radar display showing virtually all the display electronics mounted on one board.



A sophisticated anti-collision display that indicates risk of collision with any echoes investigated. The separate anti-collision component is being lifted out.

these days is the slotted waveguide design. This virtually consists of a length of waveguide mounted horizontally on a turntable so that it can be revolved. The front face has a series of slots cut in it, again engineered to very high limits in both pitch, angle and depth.

The aerial has an electric motor which drives it at about 30 r.p.m., the whole assembly being known as the scanner. The beam radiated is narrow in the horizontal plane—usually less than three degrees—an important factor in bearing discrimination, the ability to separate adjacent echoes. In marine radar the vertical beamwidth is about 27 degrees. to allow for the roll of the ship.

It is in fact difficult to concentrate all the energy into a single narrow beam; some of it is radiated at various angles on either side. These fractions are known as side-lobes and, though weak, can produce unwanted echoes on the display in certain close range conditions.

The advantages of the slotted waveguide design (others being the tilted parabolic cylinder and the cheese) are in the realms of weight, wind resistance and side-lobe performance. Construction is, however, expensive and the other types are sometimes found in the cheaper small boat equipment. Double aerials exist where one is used for transmission and the other for reception. Usually, however, the reflected energy is made to return through the same aerial and is passed down the waveguide to the receiver.

THE RECEIVER

The transmitted pulse is extremely powerful—anything up to 60kW in marine radar—and the returning pulse naturally very small (much of it having been scattered in unsuitable directions); so the sensitive receiver must be protected from the transmitted pulse. The usual protective method is to use a transmit receive cell which blocks the transmitter pulse from the receiver input.

The receiver's function is to amplify the minute returning echo pulses while retaining their distinctive shape so that they will be capable of employment in the display. Since it is expensive to amplify the returning pulses at their own radio frequency (e.g. 9MHz), the first duty of the receiver is to change the frequency to a more suitable one. This change is effected in the mixer, the main components of which are the local oscillator and the mixer crystals.

The principle is the same as in superhetrodyne radio receiver, i.e. mixing of the received signal with one of different frequency produces another of intermediate (difference) frequency; this, after suitable amplification, is detected to produce video pulses suitable for acceptance by the video amplifier of the display. (A major problem is in keeping down the level of noise generated by the receiver mixer and input circuits. Noise appears as a speckled background on the radar display and must be kept to a minimum if weak legitimate echoes are to be seen.)

THE DISPLAY

The display is the name given to the entire unit, including screen, electronics, controls and in some modern sets an integral power supply. The proper description for the screen itself is the plan position indicator (p.p.i.). This is a cathode ray tube (c.r.t.) which, as the name implies, presents the same picture of the area around the transmitting aerial as would be seen by a helicopter flying so as to remain always immediately over "own ship". The object of the display designer is thus to provide echoes on the p.p.i. which are as near as possible in the correct positions relative to the centre spot, which represents own ship.

Taking range first, consider the situation with the scanner stopped. It is sending out pulses and receiving echoes from another ship. Now the magnetron's trigger also starts a spot on the p.p.i. moving out from own ship to the circumference, at a predetermined speed. (This spot is actually moving at such a rate that it appears as a solid line, known as the timebase or "trace", in practice dimmed to a barely visible level.)

When the receiver picks up the returning echo, it causes the spot to increase in brightness. Because the spot is travelling at a predetermined speed, its distance from the centre when brightened can be measured in time. This time is the same as that taken for the radar pulse to go out and its echo to be received. We know the speed of the pulse and so we can assess the distance away of the ship returning the echoes.

In fact, to paint the echo on the p.p.i., the momentary increase of spot brightness calls for variation of one of the voltages applied to the c.r.t. For the echo pulse to provide this variation, it must (after being processed in the receiver as described) receive a final amplification by the video amplifier. The video amplifier is also responsible for the painting of measuring marks on the p.p.i.

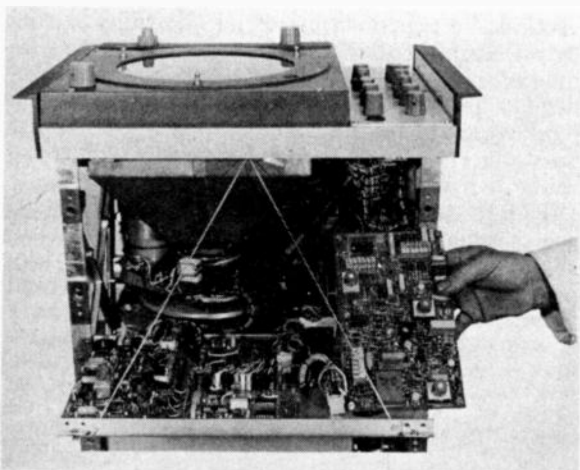
Still considering range only, a choice of scales is provided so that at the turn of a control, the radius of the p.p.i. can be altered to represent, say, 24, 12, 6, 3, 1½, or ½ mile. (As implied earlier, it is often necessary to vary pulse repetition frequency with range and this is affected automatically by the same control.) If the display is on the six mile scale and a ship three miles off, the echo will of course appear exactly half way to the circumference.

To facilitate judgment, range rings are provided at set intervals. If an echo exactly cuts a ring, its range is clear but, if not, interpolation is necessary by eye or with a ruler (except with the more sophisticated sets; these have a variable range marker which provides the answer in digits on completion of a simple measuring action).

BEARING

What of bearing? The receiver will only register an echo when the aerial is pointing at a target. Therefore, if we rotate the trace in the display exactly in synchronisation with the aerial, the spot going out along the trace will be momentarily brightened at the exact moment the aerial is pointed at a target; and therefore the echo will show up on exactly the right bearing.

Main components of a Decca medium sized radar display (the power supply is out of picture below).



In practice the face of the c.r.t. is coated with phosphor which ensures that the echo continues to glow after the trace has passed and it can be arranged that all targets within range glow all the time, renewed in brightness at each revolution of the trace. A bearing cursor is provided (a sheet of glass or Perspex over the face of the p.p.i.) which is revolved until a line thereon—the bearing marker—cuts the echo in question. The bearing can then be read off either side.

The bearing will of course be purely relative to the ship's head. (As with the variable range marker, in some cases the bearing may appear digitised in a "window" as the bearing marker is aligned.)

ACTUAL UNITS

In practice, the transmitter and receiver are combined in one unit, often called the transceiver. Thus with the scanner, the display and the power unit, there are four components to the standard radar system. In some small craft sets, the transceiver is located integrally with the scanner, not only simplifying installation by reducing the number of separate units to three, but improving performance by obviating the loss-making waveguides that would otherwise join the two.

Very small boat radars usually have the aerial enclosed in a radome to save cost and electrical power by permitting the use of a smaller turning motor (due to reduced wind resistance and a lighter aerial). A radome simplifies weatherproofing and usually has room for the power unit so that in these instances the number of separate components is further reduced to two.

TRUE MOTION

Since we have been considering marine radar in particular, it is worth mentioning an alternative form of presentation—true motion. This was introduced by Decca in 1956. Simple displays, as described above, are relative motion where the p.p.i. shows you what a helicopter would see flying so as to remain permanently over own ship. In true motion our helicopter is hovering perpetually *in space*, and everything below that is on the move—including own ship this time—passes beneath it.

The effect is produced by actually moving the centre spot about the p.p.i.—via inputs from compass and log—with the same course and speed as own ship's. The advantages are considerable: instead of all courses, etc. being only relative and needing a further (plotting) operation to be changed to true courses, etc., these can now be read direct off the p.p.i.

Put another way, everything happens as in real life; when going up a river in relative motion everything (be it a hovercraft doing 60 knots) appears stationary and the river banks slide past, but in true motion the river banks stay put and own ship moves up between them. Of course own ship eventually comes to the edge of the p.p.i.. whence it is quickly reset. True motion does involve greater complexity and is seldom found in small craft.

ALTERNATIVES

Another alternative frequently encountered is that of wavelength. The standard marine wavelength is 3cm but, in large vessels carrying two radars, the second is often of 10cm because of superior performance in rain, other forms of precipitation and "sea clutter".

"Rain clutter" and "sea clutter" are perpetual bugbears needing special circuits to nullify them as far as possible. Sea clutter produces a cotton-wool effect on the p.p.i. in the vicinity of own ship, caused by the echoes from wave-tops in choppy weather; rain clutter is similar, though at any position, and caused by the myriad reflections from rain drops.

The pulses of 10cm wavelength have a considerable though by no means total ability to ignore such unwanted targets. A disadvantage of the 10cm wavelength is the larger size of the equipment necessary, particularly the aerial which is 3·5m long. This makes it difficult to fit on smaller craft, some of which (such as fishing vessels that frequent northern waters) could benefit greatly thereby.

Where radars for special purposes are concerned, there are several variations in the general description above. For instance, in the case of the airfield surface movement indication, radar which needs very high definition and discrimination over a short range, the wavelength is only 8mm and the aerial rotation rate 750 r.p.m. But the basic principles still apply.

As far as future developments are concerned. it is likely that the magnetron valve will be replaced by solid-state devices as improved low-noise receiver innovations continue to reduce the transmitter power required (e.g. one new 48 mile radar requires only 3kW, where its predecessor needed 10kW. Another set with a range of 12 miles requires only $1\frac{1}{2}$kW and has an input of only 75 watts).

Aerials of the phased array type, which do not rotate, are already in use for military purposes but are still many years away from commercial application. The solid-state display is in a very similar category.

Miniaturisation will continue with attendant advantages but it is presumed that separate aerials and displays will always be required. Marine radar at any rate is about static in value, inevitable increases in manufacturing costs being offset by very real advances in performance. ▣

...Counter Intelligence

BY PAUL YOUNG

A retailer discusses component supply matters.

JUST after the Second World War, my brother and I had a small radio business. Life was hard for many reasons. New radio receivers were non-existent and all we had to offer for sale were re-conditioned second-hand ones. Consequently we would tackle anything! We would re-wire your house, or convert your favourite vase into a table lamp. One day, just before Christmas, a tall highly perfumed Indian gentleman in a rainbow coloured turban walked into our shop and asked us to make him a talking kettle ! ! !

Well we had the rent to pay and children to feed and presents to buy, so we agreed. We did however, admit our ignorance as to the form this particular kitchen utensil took. He then produced an American catalogue of conjuror's equipment, and sure enough on one of the pages was listed a talking kettle. It appeared that this gentleman, "Ashraf" I think he was called, had a small stand at a nearby department store, from which he sold scent. To pep up sales, he decided that every customer who purchased a bottle, would get a free glimpse into the future. Having smelt the concoction we reckoned a free gas mask would have been more appropriate!!

To intrigue his customers still further, Ashraf would ask them what they wanted to know, and then tell them to pick up the kettle and put the spout in their ear. To their utter astonishment they would hear the answer! We had to produce the kettle and necessary electronics! The electronics were fairly straightforward. We had a small speaker in the lid of the kettle, fed from a coil of heavy gauge wire in the base. Another coil of wire was concealed under a table top and this was fed from the output of a 20 watt amplifier.

One snag was, that the screening effect of the bottom of the kettle prevented any pick-up. We needed a non metallic kettle. Rather than risk personal injury by asking the local ironmonger for a wooden kettle, we cut the bottom out of our existing one, and it appeared quite normal. The finished product was very satisfactory, and with the kettle lifted off the table, up to a distance of three feet speech was audible.

In operation, small hidden microphones in the edge of the table would pick up the customers voice and relay it to the "fortune teller" in a back room. He would give his prognostication, which would arrive via the kettle spout.

In those days our workshop was just a bench near the wall. Imagine the dismay of a potential customer entering the shop and seeing my brother apparently talking to himself and then picking up a kettle and sticking the spout in his ear! !

By way of compensation, it gave us many laughs. Our friend Ashraf seemed delighted with the result and said, "You must come over to my house and have a real Indian dinner." I still have the scars on my tongue, of second degree burns, caused by the Curry!! Well a merry Christmas to you all and a successful 1975.

Physics is FUN!

By Derrick DAINES

THE TORCH BATTERY

If a run-down torch battery is taken to pieces it will be found to consist of a carbon rod held in the centre of a zinc tub. Between the rod and the walls of the tub is white "goo" or paste made of ammonia solution thickened by starch or gelatine.

Sometimes the zinc tub is surrounded by a cardboard tube with the maker's name on it, but sometimes the outer sheath is of steel for strength and to prevent the "goo" leaking out, Fig. 1.

Now we cannot make the battery as good as new, but we can get some more life out of it quite simply. Discard the steel sheath and thoroughly wash the carbon rod and zinc tube free of ammonia paste.

You will need two or perhaps three old batteries to light a torch bulb. You also need some paper-clips and wire.

Solder a piece of wire to each of the brass caps at the end of the carbon rods and at the other end of the wire fasten a paper-clip. Now make a simple frame of wood or Meccano and hang the carbon rods in their zinc tubs, making sure that they do not touch the tub walls.

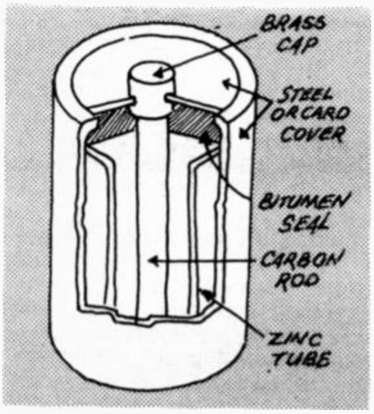


Fig. 1. Details of the inside of a dry cell.

The circuit of Fig. 2 can now be completed by clipping the wires to the zinc tub next to it, etc., making a circuit or circle of wires.

Now mix some ordinary common salt with warm water, stirring in more salt until no more will dissolve. Pour this salt water into the tubs. The bulb will light.

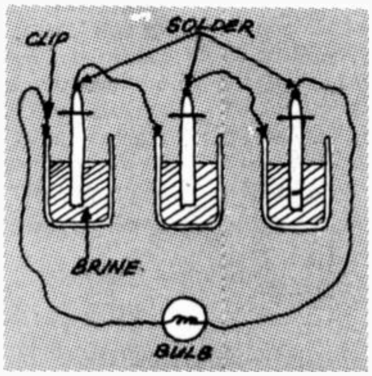


Fig. 2. The remains from three old batteries to make a new one.

What is happening? The carbon terminal is called positive, the zinc negative and the liquid (salt solution) is called an electrolyte. Electrons—remember these are parts of atoms—float across the electrolyte from the positive to the negative terminal. They then bustle along the wire, through the lamp back to the positive terminal again, doing work on the way—heating the wire of the bulb to white-hot brightness. This is one type of simple electric cell, caused by chemical action.

An Italian called Galvani hung up some frogs' legs expecting them to jerk with the approach of a thunderstorm. It so happened that he used a copper hook and hung the legs near an iron balcony.

He was amazed to see that the frogs' legs jerked every time the wind blew them against the iron grill. (You might try this yourself!) Galvani thought that the electricity was produced by the frogs' legs, but it was left to another chap Volta to show that the real cause lay in the *dissimilarity* of the metals used—copper and iron—with a weak acid between them.

Any two dissimilar metals with a weak acid between them will make a source of electricity.

Volta used copper and zinc with sulphuric acid between. The car battery uses lead and zinc—there are many combinations.

If the reader has a voltmeter he can conduct a series of experiments using different metals and find out which gives the best results. For the electrolyte—a citrus fruit can be used! Fig. 3.

Put an iron nail in one side of a cut lemon and a copper nail in the other side. The voltage will be low, but the method *has* been used to light a torch bulb!

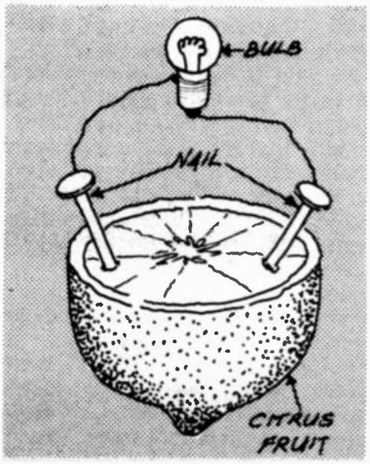


Fig. 3. A "fruit battery". The nails must be of dissimilar metals.

BEGIN HERE

PART TWO SEMICONDUCTOR DEVICES

By DONALD MAYNARD

In Part One we looked at the basic components found in electronic circuits. This month we are concerned with semiconductor devices. The most common of these are diodes, thyristors, transistors and integrated circuits and as before the information will mainly be aimed at those wishing to construct circuits but feel themselves lacking in knowledge.

JUNCTION DIODES

The junction diode is a device with two leads having the property that it will ideally pass a current through it in one direction but not in the other. In practice there is a very small reverse current, but in most applications this can be ignored. The symbol for a diode is shown in Fig 2.1a.

Logically one would expect that a positive voltage applied to B would cause the diode to conduct i.e. a current would flow through the diode. Unfortunately, because the early discoverers of electricity were not aware of the existance of electrons, this is not the case. Consider the convention that current flows from positive to negative.

The arrowhead in the symbol shows the direction of the "conventional" current. We sometimes talk about the anode (A) and cathode (B) of the diode, comparing it with its thermionic valve counterpart. In this instance the cathode is the positive *marked* end of the device.

If we should measure the diode's resistance with a multimeter we are in for another surprise. Despite what has been said above, connecting the positive lead to B and the negative lead to A produces the lowest reading of resistance showing that the current is much larger with that polarity. This is because the voltage on the positive lead is in fact negative and vice versa. Two wrongs do make a right sometimes!

There is a small voltage drop across the diode when it conducts i.e. it is forward biased—Fig. 2.2a. This is of the order of 0·2 volt for a germanium diode or around 0·8 volt for silicon types. When the diode is off i.e. it is reverse biased (Fig. 2.2b), a large voltage may be present across the device. If the voltage is increased beyond a certain point however, the diode will be destroyed. This is called the breakdown voltage. The peak inverse voltage (p.i.v.) quoted is slightly less than the breakdown voltage to avoid damage if used "on the limit".

When considering a replacement for a specified diode it is important to consider the peak

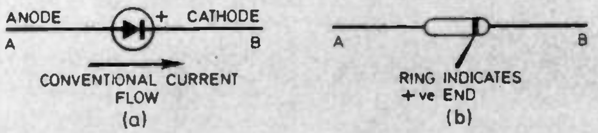


Fig. 2.1. The junction diode (a) diode symbol (b) a small junction diode.

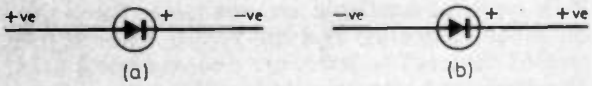


Fig. 2.2. Biasing of a diode (a) forward biased (b) reverse biased.

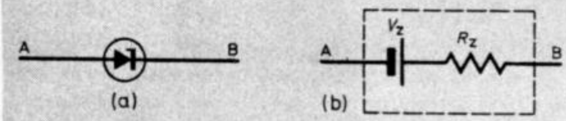


Fig. 2.3. The Zener diode (a) symbol (b) equivalent circuit.

inverse voltage and the maximum forward current. In addition it is usually important to keep to the same type as that stated e.g. silicon junction, or germanium point-contact.

ZENER DIODES

Strictly speaking the heading should read "Zener and avalanche diodes". The difference between them is in the internal action of electrons which produce different reference voltages and also different temperature coefficients. For our purposes we can consider them both to be voltage reference diodes.

The diodes operate in their reverse biased state at the breakdown voltage. While in junction diodes this would prove disasterous, by limiting the current through the Zener diode we can use it as voltage reference. The symbol for such a diode is shown in Fig. 2.3a, while Fig. 2.3b shows its equivalent circuit, which helps us to see how the device operates.

The battery voltage V_z gives us a voltage reference while the internal Zener resistance R_z tells us that as we draw more current through the diode the overall voltage across A to B will vary. This variation will only be slight as R_z is quite small.

The figures quoted for voltage reference diodes in advertisements usually show the nominal Zener voltage (V_z) and the maximum power dissipation (P_z). From this it is easy to determine the maximum Zener current (I_z) because:

$$P_z = I_z \times V_z$$

Therefore a 7·5 volt, 400mW Zener diode has a maximum Zener current of 0·053 amps or 53mA. A series resistor is always used with a voltage reference diode to bias it and also to limit the Zener current.

THYRISTORS

The thyristor, or controlled semiconductor rectifier, is a device with three leads. It has both anode and cathode like a diode but it then has a third connection called the gate or grid. The purpose of the gate is to cause the thyristor to "fire", i.e. to produce a short-circuit between its anode and cathode.

Symbols for the thyristor are shown in Fig. 2.4. Two types of thyristor are available, the *n*-gate or anode controlled and the *p*-gate, cathode controlled device. The latter are almost always used, the thyristor being operated with the anode more positive than the cathode.

These devices are mainly used as semiconductor switches so as to control the voltages reach-

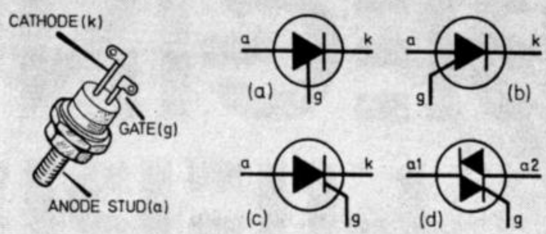


Fig. 2.4. The thyristor and thyristor symbols (a) general (b) ***n*** **gate (anode controlled) (c)** ***p*** **gate (cathode controlled) (d) triac.**

ing a load. Bi-directional thyristors can be obtained and they are then usually called triacs (Fig. 2.4d). These devices "fire" in the same way as a thyristor but can pass current in both directions.

BIPOLAR TRANSISTORS

Bipolar transistors come in two main configurations—*pnp* and *npn*. The first type is usually operated with a positive earth and the second with negative earth. Older transistors tend to be made from germanium although silicon is now generally preferred for reasons to do with stability, gain and low leakage currents. The three leads are called the emitter (e), base (b), and collector (c). There may be a fourth lead connected to the transistor's case acting as a screen (s).

The *pnp* transistor is shown schematically in Fig. 2.5a together with the voltage polarities. The double negative on the collector shows that normally its voltage is much more negative than the base which in turn is slightly more negative than the emitter.

The action of the base is to "turn on" the current flowing from emitter to collector. If the current in the base lead is I_b then the current flowing in the emitter and collector leads will be approximately βI_b where β is the common emitter amplification factor (sometimes known as h_{fe}). The value of β may vary from ten up to a few hundreds. The operation of the transistor is complex and its uses numerous, the devices will not be covered in more detail in this series.

The *npn* transistor operates in exactly the same way, except that the voltage polarities are reversed (Fig. 2.6b). In addition, all currents will flow in the opposite direction. Note that it is only the arrow in the emitter lead which shows whether the transistor is *npn* or *pnp*. The base-emitter voltage under normal conditions is about

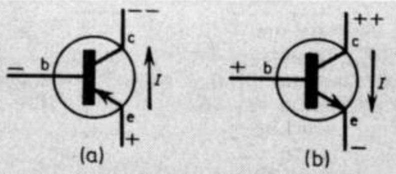


Fig. 2.5. Bipolar transistors (a) ***pnp*** **transistor (b)** ***npn*** **transistor.**

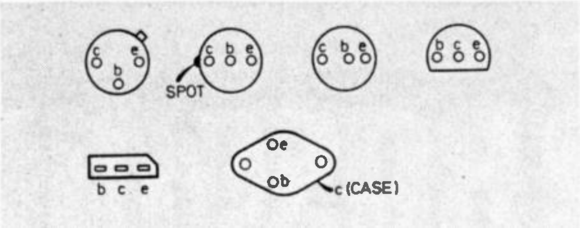


Fig. 2.6. Some transistor lead-outs.

0·2 for germanium, and 0·7 for silicon. This applies to both *pnp* and *npn* types.

Transistors come in a variety of shapes and sizes, and some of the lead arrangements are shown in Fig. 2.6. For accurate substitution of different types of transistor a good substitution book is desirable, but for general purposes one should allow for maximum collector current, maximum collector/emitter voltage, maximum power dissipation and common emitter amplification factor.

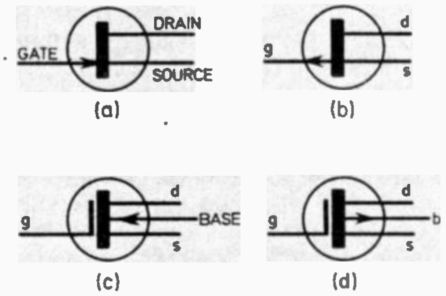


Fig. 2.7. Field effect transistors (a) *n* channel (b) *p* channel (c) *n* channel junction gate f.e.t. (d) *p* channel junction gate f.e.t.

UNIPOLAR TRANSISTORS

There are various types of unipolar transistor but they can all be lumped under the title, field effect transistors (f.e.t.). They can have the characteristic of an extremely high input impedance and they exhibit characteristics associated more with valves than with bipolar transistors. Because of low inter-electrode capacitances these devices are ideal for use at high frequencies.

A few different types of f.e.t. are shown in Fig. 2.7. The insulated gate f.e.t. is also known as the metal-oxide-silicon transistor (M.O.S.T.). Constructors are most likely to come across these devices used in applications requiring a high input impendance and low noise amplification. Lead-out arrangements vary but two common types are shown in Fig. 2.8.

Next month: Integrated circuits.

Fig. 2.8. Two f.e.t. lead-outs.

Ruminations

By Sensor

Adding it up

"Who has got a calculator?" Perhaps the question ought to be "Who has not got a calculator?", for I seem to be one of the few who still relies upon mental arithmetic, slide rule, or pencil and paper. I find, increasingly, that my traditional methods of calculation are too slow when compared with even quite a modest electronic calculator. This fact was brought home to me when I was watching the last general election broadcast on TV.

A few years ago one had time to calculate percentage swings and to forecast the number of seats likely to be lost and won by the various parties, working from the results as they were displayed. I used to try to beat the cephologists (I think that's the right word) at arriving at these analysis figures, but no longer. The programme has become much too slick and polished. There is no room now for the amateur.

"Swingometer" and "slideometer" fed by experts aided I suspect, by dozens of electronics calculators, display the forecasted results before I can get my slide rule moving. One becomes just a passive observer; the "audience participation" of election programmes years ago has disappeared, it's hardly worth staying up any more!

Working it out

I welcome the calculator, it takes the sheer drudgery out of calculation, we ought to have had them years ago. Mercifully, decimalisation has simplified many previously tedious arithmetical tasks; do you remember the long division of money sums that we were taught at school? What a grind that was! And anyone who studied electrical or mechanical engineering before S.I. units came into use had to cope with a host of different units and umpteen conversion factors. Those brought up under the old system tend to cling to it because it is familiar, but even the most diehard must admit that it is quite illogical.

I wonder if we shall see a time when those who know how to do traditional arithmetic or work in Imperial units will be as rare as thatchers and drystonewallers. I can imagine them working in industrial museums translating old drawings and specifications, being called upon by the archeologists and historians of the future to demonstrate how to extract a cube root in the manner of the 19th Century.

But I must admit that one unit in particular has always intrigued me, perhaps because it has three names, this is the good old "rod, pole or perch". What a fine strong, upright and honest unit that is! It is sad to see these old units go, for they are part of our history and heritage. But we must accept the new, with its many advantages, in the interest of progress.

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

ULTRASONIC

LAST month details were given to build the ultrasonic receiver. This month the article is concluded with the transmitter.

THE TRANSMITTER

The transmitter circuit is shown in Fig. 4, and uses the NE555V integrated circuit wired as an astable multivibrator. This is an eight pin dual-in-line device, but a similar device can also be obtained in a metal-can encapsulation.

The output at pin 3 switches between a potential just above that of the negative supply line to a value just below that of the positive supply. The capacitor C1 alternately charges and discharges through VR1 and R1, the frequency being set by VR1.

Each time the potential at pin 6 rises to two-thirds of the positive supply potential, the output at pin 3 is switched to the low voltage state. Similarly, whenever the potential at pin 2 falls to one-third of the positive line potential, the output at pin 3 is switched to its high voltage state.

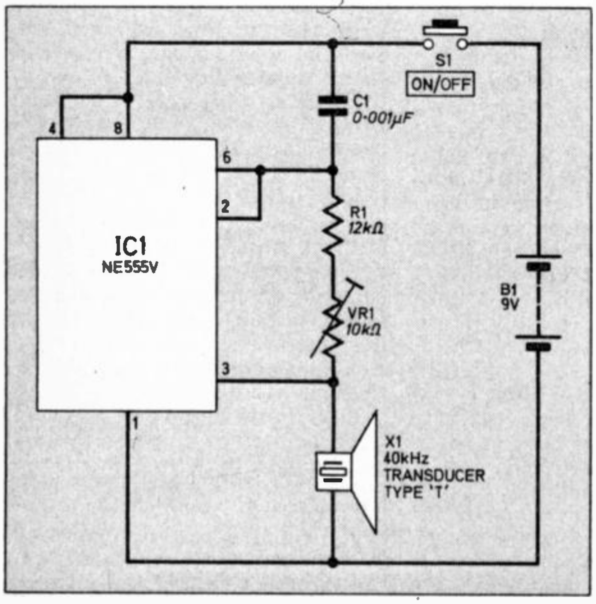


Fig. 4. The circuit diagram of the Ultrasonic Transmitter.

The maximum permissible power supply voltage to the NE555V is 16 volts, but it is wise to regard 15 volts as the maximum so as to allow some margin of safety.

The circuit will operate from a 6 volt supply, but the power output and the range are then very limited. A 9 volt PP3 battery is very convenient for operating the transmitter unit, but the maximum distance for satisfactory operation will be increased by a few yards if the supply voltage is increased to 15 volts.

The power supply current is quite small, being typically 4 milliamps at 6 volts and 10 milliamps at 15 volts.

The capacitor C1 should be a mica or polystyrene type, the smaller polystyrene type having been used in the prototype.

The type of ceramic capacitors intended for decoupling purposes are unsuitable for this application, since they have a very wide tolerance in their value and this may prevent the correct frequency from being obtained.

TRANSMITTER CONSTRUCTION

In the prototype the transmitter circuit was constructed in an Eddystone die-cast box size approximtely 120 x 95 x 55mm. Plenty of space is available for either a large battery or mains power supply.

The transmitter circuit was built on a piece of 0·1inch plain matrix board size 85 x 48mm approximately.

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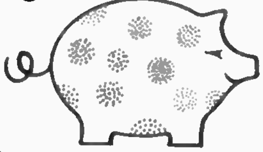
ESTIMATED COST* OF COMPONENTS
including V.A.T.



£5.50
excluding case

*Based on prices prevailing at time of going to press

work for you — (No licence required!)

REMOTE CONTROL

PART 2 TRANSMITTER

By J.B. DANCE

Begin construction by cutting the board to size and drilling the fixing holes. Now insert the transducer (T type), the 8-pin socket and the components in the board as shown in Fig. 5 and wire up as detailed. Insert the i.c. in the socket paying attention to polarity. Note that components are mounted on both sides of the board.

The trimmer potentiometer VR1 must be fixed in such a position that it can easily be adjusted when the circuit board is fitted inside the box.

Drill a 12mm diameter hole in the box along one of the short sides in such a position that the ultrasonic transducer grille is directly behind this hole when the board is fitted in the box. Now secure the board to the case with three 6BA nuts, bolts, spacers and washers, such that the transducer does not touch the case.

Components....

R1	12kΩ ¼W carbon ± 10% resistor
VR1	10kΩ lin. skeleton preset potentiometer
C1	0·001µF mica or polystyrene capacitor
IC1	NE555V timer integrated circuit
S1	s.p.s.t. push button type to suit
X1	96D-40(T) ultrasonic transducer (Hall Electronics)
B1	9V battery type PP3

SEE SHOP TALK

0·1in. plain matrix board size 85 x 48mm (approx.); 8-pin d.i.l. socket for IC1; diecast aluminium case size 120 x 100 x 55mm; battery clips to suit B1; 6BA fixings; connecting wire.

TESTING AND ADJUSTMENT

Thoroughly check out the circuit construction and when completely satisfied, the power supply (battery or other) may be connected to the receiver and current consumption monitored. The relay may close each time the power is first applied.

Place the two boxes such that the two transducers are facing each other about 10cm apart and apply power to the transmitter circuit. The receiver relay will probably close, but if it does not do so, VR1 should be adjusted fairly coarsely until the relay closes.

If the relay still does not close, a high resistance meter should be connected across points XX in Fig. 1. If the part of the circuit containing the TAA 930B and the diode pump is functioning correctly, a reading of over 5 volts will be obtained. This reading should decrease as the transmitter and receiver are separated and as the transducers are moved so that they no longer face one another.

The positions of the units should be adjusted so that only a small reading is obtained on the meter; VR1 of the transmitter should now be adjusted for the maximum meter reading.

It is possible to adjust VR1 without a meter by adjusting it for the greatest sensitivity of relay closing.

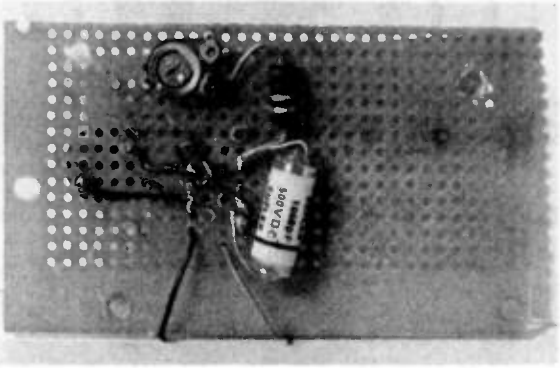
PERFORMANCE

The maximum range of the prototype equipment was about 12 metres (40 feet) in the open air. It is possible that a unit could have been designed with a somewhat greater range, but it would then have been more sensitive to stray vibration.

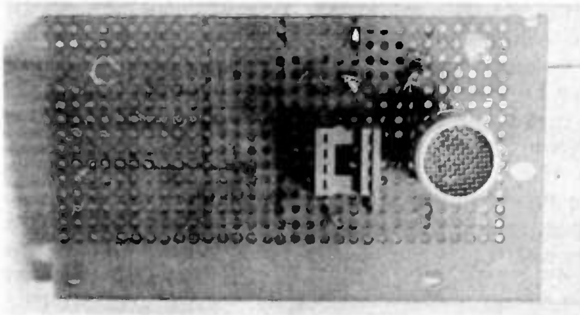
In the prototype the relay may close if the grille of the receiver transducer is tapped, but the time constants have been chosen so that the equipment is fairly insensitive to transient vibrations.

If the equipment is operated in a corridor, an increased range may be expected, since the walls will reflect some of the ultrasonic energy towards the transducer in the receiver. The waves are also readily reflected from the walls of a room or from a ceiling.

The 40 kilohertz ultrasonic waves are fairly directional. If the transmitter and receiver are taken into the open air, the transducers can be placed fairly near to one another without the relay being operated if they are facing in opposite directions or have an angle of over 90



Photographs, above and below of the prototype component board.



ULTRASONIC REMOTE CONTROLLER

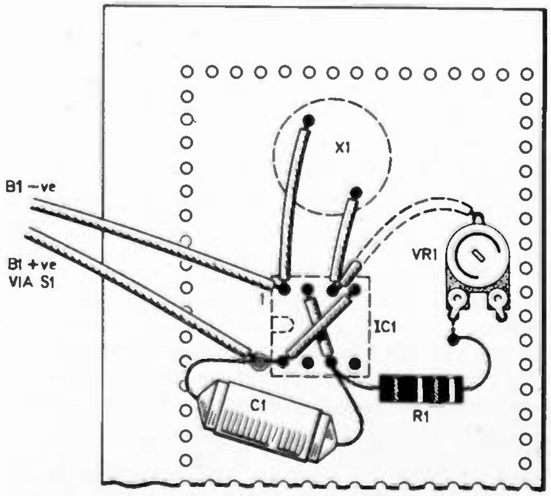


Fig. 5. Layout of the components and wiring up details on the plain matrix board. Wiring on the top of the board is shown dotted.

degrees of arc between them.

In a small room one may find that the relay will close whenever the transmitter is switched on irrespective of position; this is due to reflection.

The mechanical resonance of the transducers causes them to "ring" for a millisecond or so after the transmitter waveform has ceased and it would seem that this effect and the limited bandwidth would prevent speech being conveyed as a modulated ultrasonic wave using these techniques.

APPLICATIONS

Ultrasonic waves can be used for a variety of applications, but unfortunately they are attenuated fairly strongly in air and therefore their range is fairly limited in all applications. The following applications are typical ones for a transmitter-receiver system, but readers will doubtless find many other applications.

Remote Control

A small transmitter unit carried by a person can be employed to switch any other piece of equipment to which the receiver is connected. For example, channel changing in a television or radio receiver may be accomplished using an ultrasonic link. A pulse from the transmitter can be employed to cause the relay to rotate a switch or coil turret in the receiver.

One can thus rotate the channel selector switch from one's chair with repeated pulses until one returns to the same channel as was first being received if one wishes. In this type of equipment the transmitter could be battery driven, whilst the ultrasonic receiver (which is always switched on when the equipment is in use) could be driven from the equipment supply.

Ultrasonic beams are also useful for garage door opening or closing. When a driver reaches his home, he can press a button in is car to switch on an ultrasonic transmitter mounted under the car's front bumper. This signal operates a receiver mounted by the side of the garage door so that a relay closes and provides power to the door operating mechanism. When the motorist takes his car out again, a similar ultrasonic signal can be used to close the door.

An elderly or infirm person could carry a small ultrasonic transmitter which could be used to switch on an illuminated sign in the window calling for help. The sign could be switched on from anywhere within the room or even from the next room if the door between the rooms was open.

The range of ultrasonic waves is too limited for them to be used to control model aircraft. However, they can be used to control many types of children's toys. They are suitable for the remote control of small model boats provided that the range is reasonable. It will be necessary to fit more than one transducer on the boat so that the waves can be received no matter in which direction the boat is travelling at the time.

Ultrasonic waves are also used by the police to switch motorway fog warning lights without stopping their cars.

Communication

The Post Office Act of 1969, Section 24(1) confers the exclusive privilege of running systems for the conveyance, through the agency of electric, magnetic, electro-magnetic, electro-chemical or electro-mechanical energy of speech, music, other sounds, visual images, etc. In view of the fact that the repulsive forces between the air molecules in an ultrasonic wave are electrical in nature, the writer did check with the Post Office that an ultrasonic communication system would not infringe their monopoly and received their confirmation that no licence is required.

One can therefore communicate with one's neighbour by means of an ultrasonic beam, but it is not permissible to adopt the much simpler method of throwing a wire over the fence between the houses!

The transmitter could be modulated by switching it on and off to produce a morse signal, but the receiver time constant may have to be reduced.

Intruder Alarm

If the transmitter is placed at one side of a corridor and the receiver at the opposite side, any intruder interrupting the beam will cause the relay to open. This could be used to sound an alarm. If the alarm does not sound in the corridor or room, the intruder will not know he has been detected.

If the intruder rotates either the transmitter or receiver or switches either of them off, it can be arranged that the alarm will sound. In this application it is best to reduce the transmitter supply voltage so that it is only slightly above the level at which the relay keeps closed.

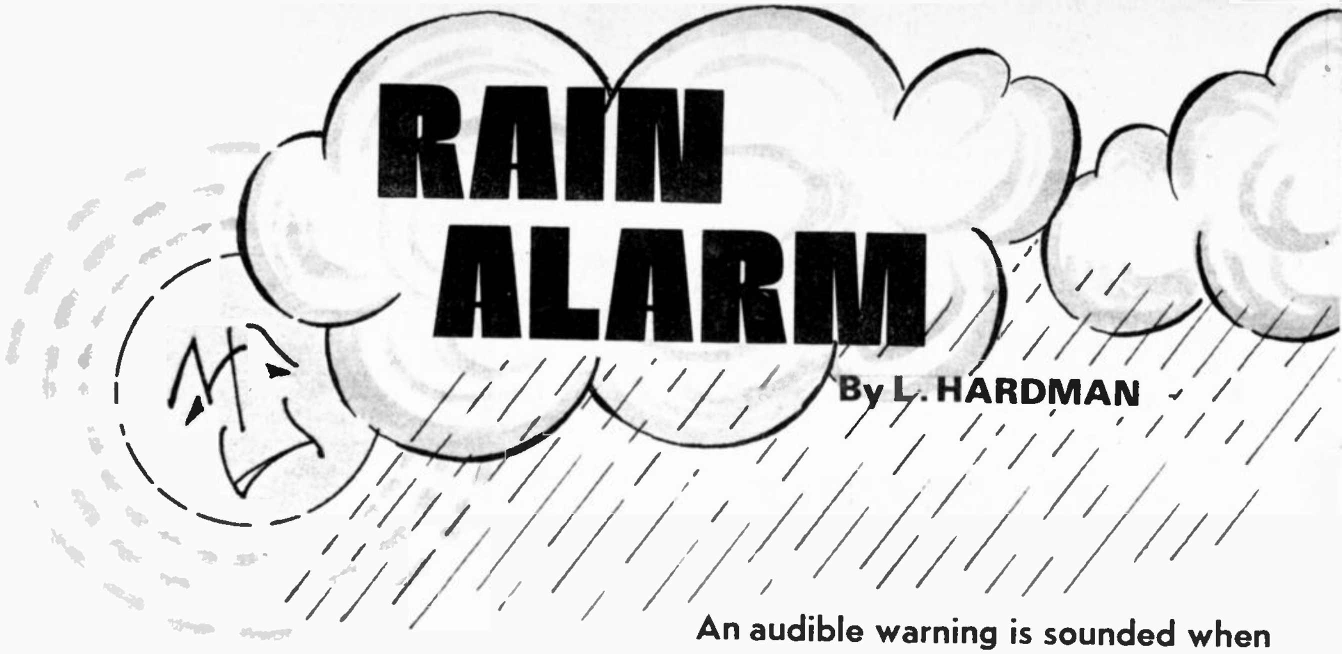
Leak Testing

If the transmitter is placed inside a car, the interior of the vehicle is filled with ultrasonic waves. One can then pass the transducer in the receiver around the edges of the doors and windows and find any small leaks.

Leaks in the sealing rubber of refrigerator doors can be found in a similar way. It is better to use a receiver employing a voltmeter, as indicated in Fig. 1, rather than a relay for leak testing.

Leaks in pressure pipes can also be found using a receiver with a meter, since such leaks generate ultrasonic waves. ▣

RAIN ALARM



By L. HARDMAN

An audible warning is sounded when it rains or snows.

THIS is a particularly useful device for the housewife. With this unit she does not have to keep a watchful eye on the state of the weather if clothes are drying on the garden clothes line. As soon as rain (or snow) falls on the sensor an audible alarm sounds drawing ones attention to the fact that it is raining.

CIRCUIT

The circuit diagram of the Rain Alarm is shown in Fig. 1 and is seen to be extremely simple. With S1 in the "on" position, 12 volts is placed across the series combination of the thyristor CSR1 and audible warning device WD1.

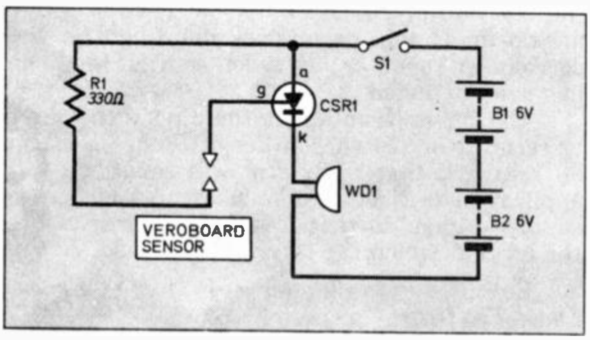


Fig. 1. The circuit diagram of the Rain Alarm.

When the sensor is dry, the gate of the thyristor is not connected, hence CSR1 is "off", i.e. no current flows. Now when the strips of the sensor are shorted, or rain bridges any two adjacent strips, a positive voltage is applied to the gate of CSR1, thus turning it "on". Current then flows through the thyristor and alarm device producing an audible tone.

The alarm can only be muted by switching off at S1. Resistor R1 is included to limit the gate current to a safe level.

Components....

R1	330Ω ¼ watt carbon resistor
CSR1	CRS1/05 or any similar thyristor
SI	on/off toggle switch
WD1	12V audible warning device (Doram)
B1, B2	PP1 6V battery (2 off)

Veroboard: 0·1in. matrix, 100 x 100mm (see text); aluminium for case; rubber grommet; length of twin-cable; battery clips for PP1 (2 pairs); tag strip.

CONSTRUCTION

The protoype unit was housed in an aluminium case, dimensions and front panel layout shown in Fig. 2. The rear panel of the case is to be made removable.

Begin construction by making the case and the cut-outs to suit S1, WD1 and the lead-out to the sensor.

The circuit is built on a short length of tag strip. Begin by soldering R1 and CSR1 to the tag strip and fix to the case as detailed in Fig. 3. Secure S1 and WD1 to the case and wire up according to Fig. 3.

Pass the two external wires through the grommet and place the two batteries in position, and

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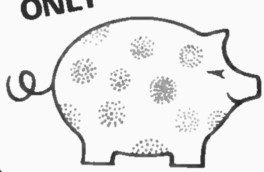

£3.00 less cable

*Based on prices prevailing at time of going to press

RAIN ALARM

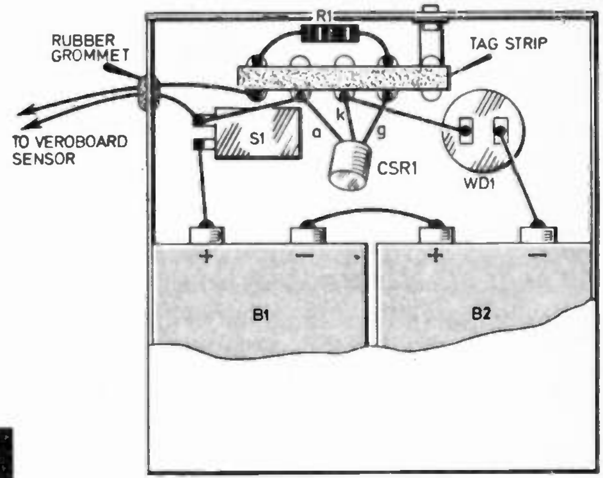

Fig. 3. Wiring up details.

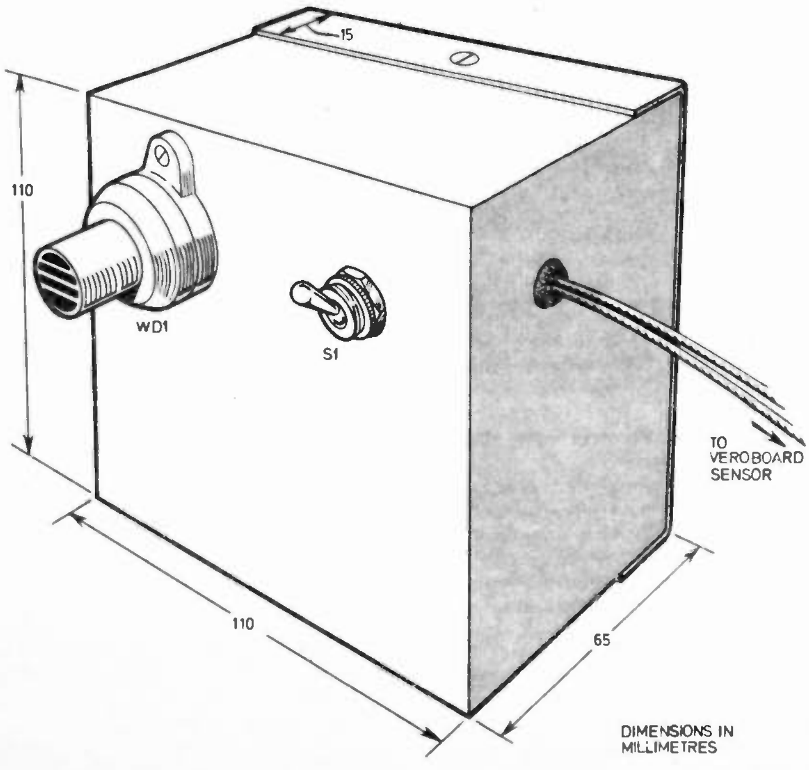

Fig. 2. Details of the aluminium case used to house the prototype showing positioning of components on the front panel.

screw on the back panel. The case has been designed so that the batteries fit snugly into the base of the case, eliminating the need for a fixing bracket.

SENSOR

The sensor should be made from a piece of 0·1in. matrix Veroboard. The size of this board is not critical, but the larger it is the more sensitive. A suitable size is about 100×100mm.

Make the board by simply soldering a length of wire across all the strips at each end of the board and then make breaks at each end to alternate tracks as shown in Fig. 4.

INSTALLATION AND USE

The Veroboard sensor should be located in the garden in an unsheltered position out of reach of the wet washing, on top of the line pole for example. It is advisable to mount the sensor at an angle so that rain falling on the sensor can run off more easily.

The case itself should be mounted inside the house (e.g. kitchen) so that the alarm can be easily heard from all parts of the house. The two units should be joined with a suitable length of twin cable.

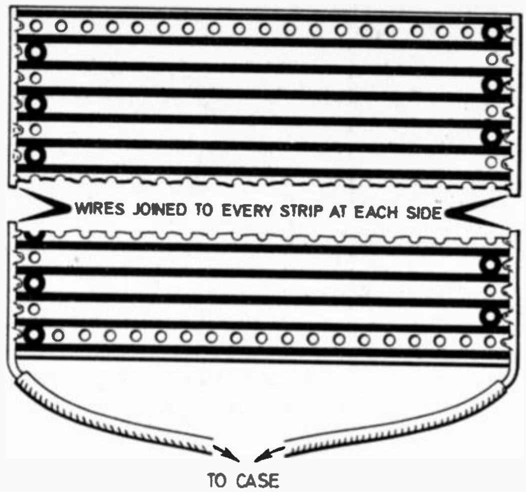

Fig. 4. Details of the sensor board.

Normally, the unit should be switched off and only turned on when washing is on the line. If the alarm sounds, due to falling rain, switch off at S1. When the unit is next switched on it may be necessary to wipe the sensor board with a dry cloth. ▣

BOOK REVIEWS

ELECTRONICS: AN ELEMENTARY INTRODUCTION FOR BEGINNERS
By L. W. Owers, C.Eng. M.I.E.R.E.
Published by Publication Mailing Services, P.O. Box 6, Crawley, Sussex RH10 6LH
Size: 119 pages perfect bound, 21 x 15 cm.
PRICE: £1·45 including post and packing from above address.

This book has been written for students and is not intended to teach the constructor the basics of electronic circuit theory. The first third of the book in concerned exclusively with static electricity, fundamental particles and electron theory.

We are then led quickly through current, and passive components before meeting the valve and its derivations which are again dealt with very briefly. Semiconductor devices take up 12 pages, most of which is used to describe semiconductor theory and the action of electrons and holes in diodes and transistors. There is no introduction to actual circuits or circuitry.

The explanations are good and the maths is kept to the minimum. The drawings are clear and uncluttered but tend to take up larger areas than necessary. For the convenience of teachers the illustrations are available as 35mm colour slides.

A good grounding for the "O" level student but not much else, most readers would very quickly require more information. M.K.

BEGINNERS' GUIDE TO ELECTRONICS (Third Edition)
By T. L. Squires and C. M. Deason
Published by Newnes-Butterworths
Size: 240 pages, 20 x 12cm.
PRICE: £1·90

This is a somewhat old-fashioned style of book that crams in as many different topics (areas of application) of electronics as possible. There is not one photograph in the whole 240 pages, although photographs would have been much better in some cases than some of the line drawings.

However, illustrations are clear and many circuit diagrams are supplemented by pictorial schematic diagrams of the physical circuit set-up. This is a great help for the beginner.

First published in 1964, this third edition has been updated (!) to include a chapter on the digital computer and a chapter on microminiature electronic components—18 pages each chapter.

A quick scan through the book can be off-putting through the number of valve drawings and symbols one will see. Clearly this third edition has not been updated sufficiently.

In this age of integrated circuits, a book published in 1974, containing as many valve references as this one, is coming it a bit.

The authors say this book is intended for those thinking of a career in electronics. It has been written without the use of mathematics, which makes for easy reading for those with no technical knowledge in the electronics field. It would prove most useful on the shelf of a school library. B.W.T.

NEXT MONTH...

A high power stereo amplifier designed using modules for ease of construction. Providing 20 watts r.m.s. per channel (40 watts total), this amplifier has the added facility of a guitar input.

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FEBRUARY ISSUE ON SALE FRIDAY JANUARY 17

2 BAND SUPERHET TUNER

BY F. G. RAYER

You can plug this tuner into almost any audio amplifier, to obtain radio reception with all the power the amplifier is capable of giving. The tuner is completely portable and self-contained, operating from its own internal battery.

A superhet circuit has a greater number of components than the simpler type of "local station" tuner, but is much more selective and sensitive. This circuit has only two transistors and a diode, but will be found to give excellent results. Some simplification is possible by constructing the tuner for medium wave reception only, and long wave reception can be provided later if required.

OPERATION

The circuit diagram is shown in Fig. 1. Signals are picked up by the ferrite rod aerial, producing a signal voltage in the coil L1, which is tuned by the variable capacitor C2. Signals reach the base of TR1 from the coupling winding L2. This transistor also has emitter and collector coupling windings to the oscillator coil L3, which is tuned by C7. Capacitor C7 is the second section of the ganged tuning capacitor.

Throughout the tuning range a constant frequency difference of 465kHz is maintained between circuit L1 and L3. As a result, of the mixing of received signals with the oscillator frequency to which L3 is tuned, all signals provide a 465 kHz output from TR1. Both windings of the intermediate frequency transformer IFT1 are permanently tuned to 465kHz. Signals pass to the intermediate frequency amplifier TR2, and to the second intermediate frequency transformer IFT2, also tuned to 465kHz.

Diode D1 operates as a detector and by its demodulator action makes available the audio signal, or programme, at VR1. Potentiometer VR1 is a volume control, the wanted level of signal being taken from the slider, via C12, to the output socket and hence the audio amplifier being used.

Diode D1 also produces bias for TR2, through resistor R6. This provides automatic volume control. Strong signals produce more bias to reduce the gain of TR2, but when signals are weak, gain is allowed to rise .This results in a more equable volume from signals of widely different strength, and helps counteract fading, or variations in signal strength.

No values are shown for trimmers C1 and C6 because these are integral with the tuning capacitor. Should a capacitor without trimmers be used, extra trimmers, each of 30pF or 60pF, must be added. The capacitors associated with the IFT windings are also present inside these components already. The IFTs listed are pre-tuned to 465kHz by the maker, so the cores should be left untouched, except for possibly small adjustments made as described later.

It is convenient to have the individual volume control VR1 on the tuner. Any volume and tone controls on the amplifier can be left in those positions found most suitable.

CIRCUIT BOARD

Most components are mounted on a plain perforated board measuring about 20 by 17 holes (0·15 inch matrix), Fig. 2. Begin by drilling holes for the pins of L3, IFT1 and IFT2. If these items do not fit easily, the holes can be enlarged with a small round file. Also drill holes for the brackets and paxolin strips X-X which will support the ferrite rod.

The metal sub-panel is 90 × 50 mm with a flange to which the board is fixed with two 6BA bolts. It can be bent in a vice, or a ready-angled "universal chassis" flanged member can be used. This panel allows the tuner to be mounted to the case panel by the screws which will secure C2/C7.

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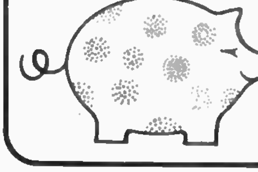
ESTIMATED COST* OF COMPONENTS including V.A.T.



£6.60 excluding case

*Based on prices prevailing at time of going to press

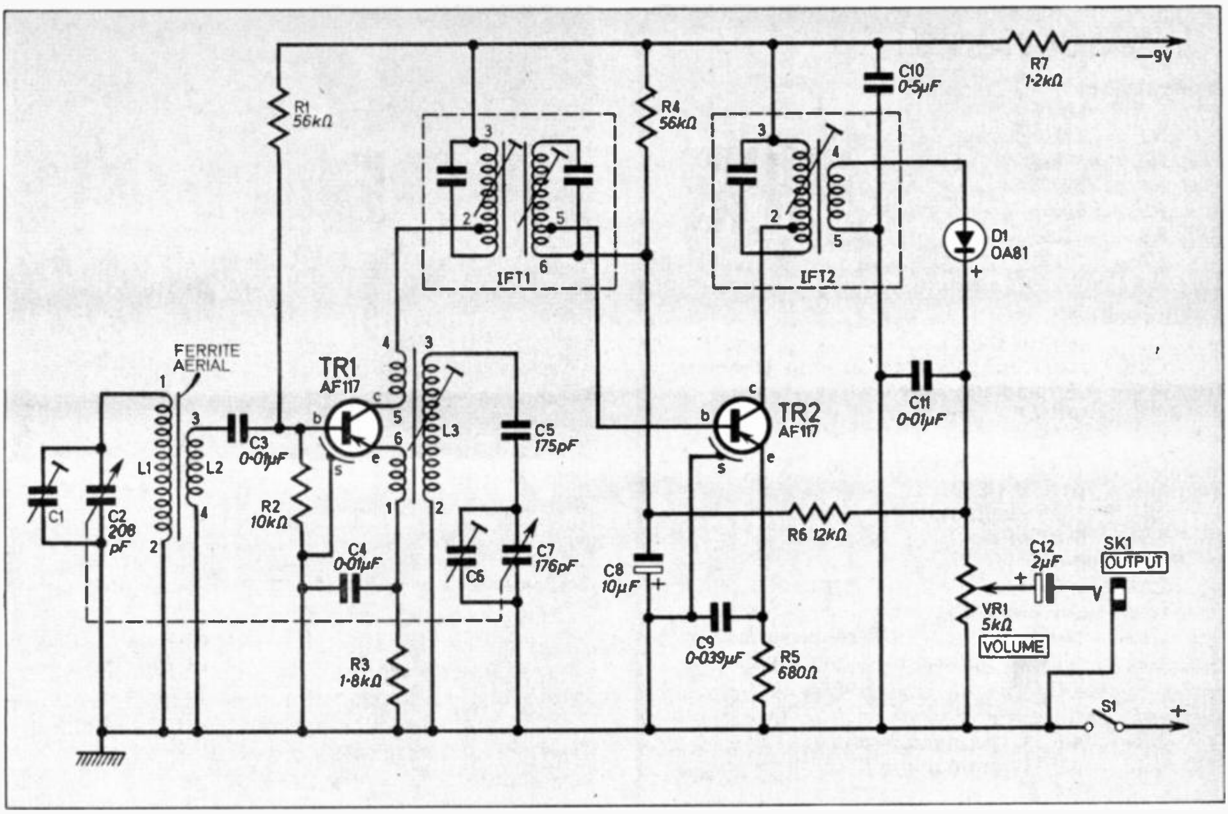


Fig. 1. The circuit diagram of the 2 Band Superhet Tuner.

Components are placed as in Fig. 2, temporarily omitting the aerial, transistors, and tuning capacitor. Underneath wiring is also shown in Fig. 2.

Two tags form an earth return to the sub-panel and frame of C2/C7 when this is fixed. Secure L3 and the IFTs by bending out the can tags, and note that these are wired to the earth line.

The wire ends of resistors and capacitors come through the holes as in Fig. 2, they are bent over, soldered to the correct points, and cut off. In a few places some 22 s.w.g. or other connecting wire will be required. Put insulating sleeving on any leads which come near other leads or joints.

Note that C8 has positive and negative ends, and that positive goes to earth. In the same way, when C12 is wired, its positive lead is taken to the slider or centre tag of VR1.

GANGED CAPACITOR

The tuning capacitor is fixed to the sub-panel with three short 4BA bolts, which run into holes provided in the front plate of the capacitor. These bolts must be short, so that they will pass through the case panel, sub-panel and capacitor without projecting and thereby shorting or damaging this item. Alternatively, sufficient washers can be put between the capacitor and sub-panel, provided the spindle projects enough for the control knob.

Solder C5 to the back tag (C7), as in Fig. 2.

TRANSISTORS

Arrange the transistor leads so that they emerge as in Fig. 2, allowing about 10 mm of lead above the board. The wires must be positioned so that they cannot touch each other, or short lengths of insulated sleeving can be put on before inserting the transistors.

Emitter e, base b, collector c and screen s leads can then be cut to length and soldered as in Fig. 2. If the iron has reached its proper temperature and is removed immediately the joint is made, these joints can be soldered in the usual manner without danger.

Diode D1 can also be fitted now, noting its polarity as shown.

FERRITE AERIAL

The two strips X-X, Fig. 2, are about 50 mm high and 12 mm wide, and can be Veroboard (plain type), Paxolin, wood, or similar material. Cut a "V" shaped notch in the top of each, and drill a small hole below this.

The rod rests across the strips, and is held by thread or thin string passing round it and through the small holes. Place the centre of the rod about level with the spindle of the tuning capacitor so that the tuner can fit into its case.

Place the medium wave section on as in Fig. 2. Solder (1) the beginning of L1 to C2, and the end (2) to the metal frame tag of C2/C7 as in Fig. 2. Take (3) of L2 to C3, and (4) of L2 to earth on the tuning capacitor.

Components....

Resistors

R1	56kΩ
R2	10kΩ
R3	1·8kΩ
R4	56kΩ
R5	680Ω
R6	12kΩ
R7	1·2kΩ

All ¼W ± 10% carbon

SEE SHOP TALK

Capacitors

C1	part of C2/C7
C2/C7	208/176pF Jackson 00 with trimmers (C1 and C6)
C3	0·01μF
C4	0·01μF
C5	175pF ± 1% silver mica
C6	part of C2/C7
C8	10μF elect. 6V
C9	0·039μF
C10	0·5μF
C11	0·01μF
C12	2μF elect. 6V
C13	150pF } required for long wave only
C14	60pF compression trimmer } required for long wave only

Semiconductors

TR1	AF 117 germanium *pnp*
TR2	AF 117 germanium *pnp*
DI	OA 81

Inductors

L1/L2/L4	Denco MW/LW/5FR ferrite rod aerial
L3	Denco TOC.1 oscillator transformer
IFT1	Denco IFT 18/465
IFT2	Denco IFT 14/465

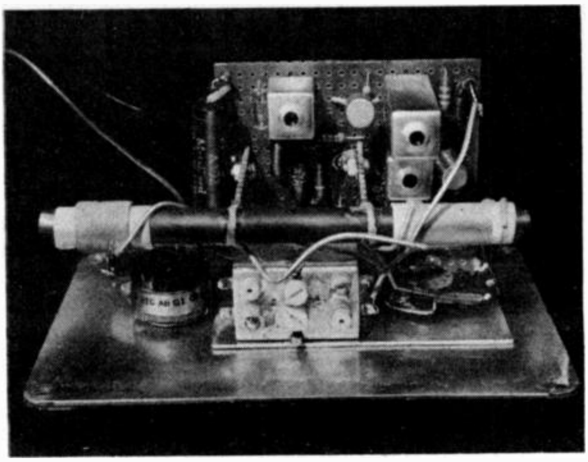
Miscellaneous

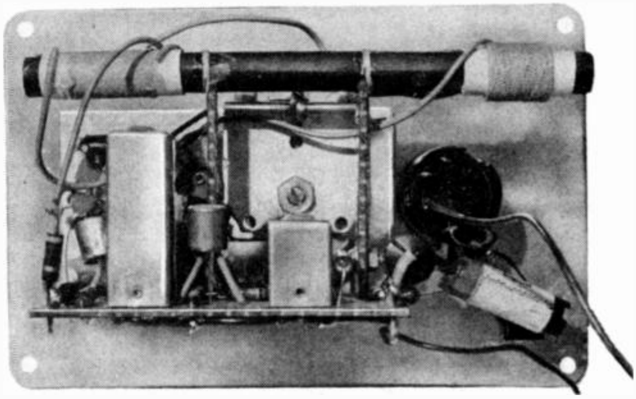
VR1 5kΩ log. potentiometer with s.p.s.t. switch (S1)
S2 s.p.d.t. rotary switch—required for long wave
SK1 3·5mm output jack socket with plug to suit
Plain perforated Veroboard 20 x 16 holes, 0·15 inch matrix, sub panel 100 x 50mm
Universal Chassis flanged member (CU133, Home Radio), case approx 150 x 100 x 100mm, three knobs, battery connecting clips, connecting wire, 4BA fixings.

OTHER CONSTRUCTION

Potentiometer VR1 fits to the panel as in Fig. 2, with the jack outlet (SK1) near. The associated connections can now be made. As the tuner only requires about 2mA, a PP4 battery is adequate and there is no point in using a larger battery. Solder a lead with positive clip to S1. The negative lead runs to R7, or to a Veropin inserted here as an anchor point.

The tuner can be tested if wished by plugging in headphones. High-impedence phones (about 2 to 4 kilohms) are most suitable, but many headsets other than low-impedence units will operate satisfactorily.





Photographs of the completed prototype front panel assembly.

To connect the tuner to an amplifier, fit a 3·5 mm jack plug to one end of a screened lead. The jack tip goes to the inner conductor, and the jack sleeve to the outer, braid conductor. At the other end of the lead, fit a plug of the type required by the amplifier, using the outer braid as the "earthed" side of this circuit, in the usual manner.

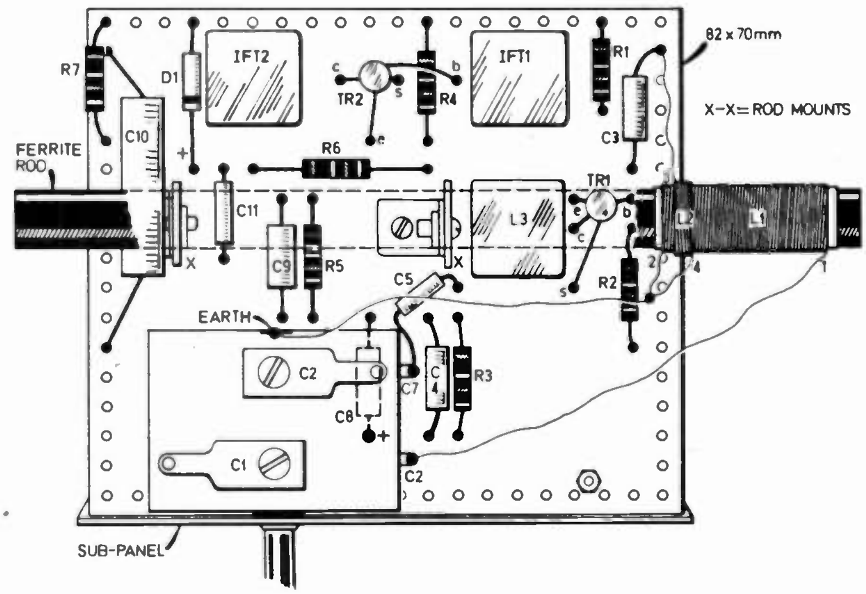
ADJUSTMENTS

A properly shaped tool is necessary to adjust the cores of L3, IFT1 and IFT2. A steel blade is not suitable, and a screwdriver or other wedge-shaped tool may break the cores. A suitable adjusting tool (TT5) is available from the IFT manufacturer.

Assuming that no signal generator is available. first screw C1 and C6 nearly fully down, and place L1/L2 about 3mm from the end of the rod. Rotating the tuning control should bring in a local station. Tune this in correctly.

The two cores of IFT1 and single core of IFT2 can now be adjusted for best results. Only a small rotation of any core is likely to be needed. A meter, on a range to read around 2mA, may be connected in one battery lead, and these and other adjustments can then be for *minimum* battery current. This corresponds to maximum a.g.c.

2 BAND SUPERHET TUNER



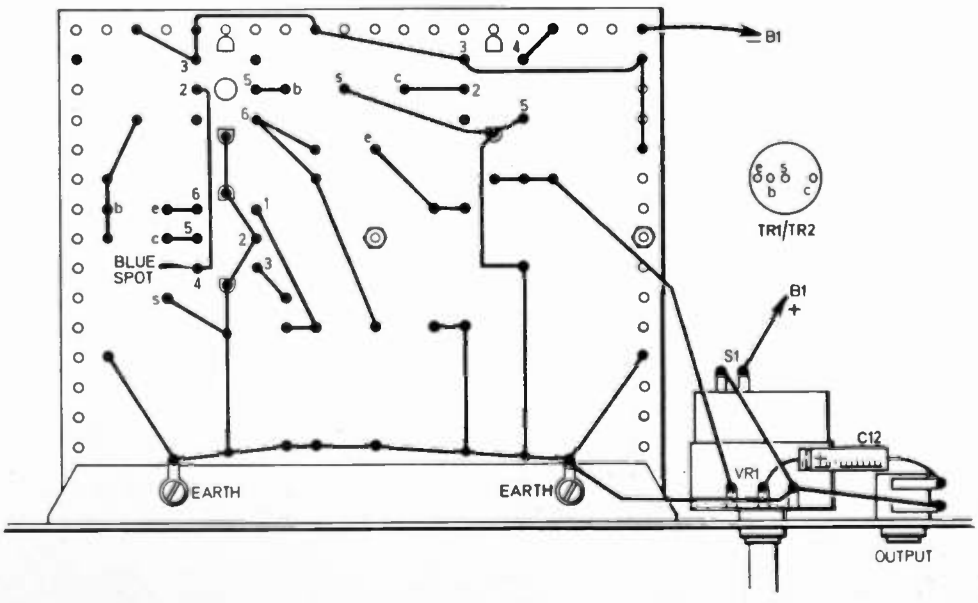


Fig. 2. Complete wiring up and layout details on both sides of the component panel and case front panel.

voltage and optimum adjustment of circuits, and small changes are more easily seen than heard with phones or an amplifier. However, if adjustments are made by ear, check them with a very weak signal tuned in.

Once the IFT cores are peaked for best results, they should be left as they are and they need no further adjustment.

It is now necessary to align L1 and L3 so that they track suitably throughout the tuning range. This is done by adjusting C1 for best results near the high frequency end of the band (C2/C7 nearly fully open) and by adjusting the position of L1 on the rod near the low frequency end of the band (C2/C7 nearly closed).

Tune in a signal near the high frequency end, and rotate C1 with a screwdriver, for best volume (or minimum reading on the meter). Then find a signal near the low frequency end of the band, and slide L1 along the rod, to peak up the signal. As adjustments influence each other, return to the h.f. end of the band, to check C1, then to the l.f. end of the band, to check the position of L1. Continue until no further improvement can be obtained.

BAND COVERAGE

If it is necessary to adjust the coverage of the band, this is done by adjusting C6 and the core of L3. With C2/C7 fully closed, the dial reading should be that of the maximum clockwise mark. A BBC or other known frequency can then be tuned in, and the core of L3 can be adjusted until the actual dial reading agrees with that of the station received. For adjustment of L3 core, the station should be near the l.f. end of the band.

A signal can then be tuned in near the h.f. end of the band, and C6 can be adjusted to secure good agreement with the frequency shown on the dial. Repeat h.f. and l.f. band end adjustments (e.g., C6 and L3) a few times. After this, tuning should agree closely with the dial. It is necessary to touch up the positions of C1 and L1, as mentioned earlier, after adjusting C6 and L3.

If a superhet circuit has not been made before, this may seem rather complicated. However, the procedure, which was given in detail, is easily summarised and carried through:

(1) Adjust all IFT cores for best results.

(2) If necessary, adjust C6 at the h.f. end of the band, and L3 at the l.f. end of the band, to secure suitable tuning coverage.

(3) Adjust C1 near the h.f. end of the band, and L1 near the l.f. end of the band, for best reception.

LONG WAVES

In some areas in particular, l.w. reception is very useful. The circuit is adapted for m.w./l.w. reception by adding a l.w. coil to the rod, with wavechange switch, and an additional trimmer and parallel fixed capacitor.

The details for this modification are shown in Fig. 3; L4 is the long wave section on the ferrite rod. When the bandswitch S2 is in the medium wave position, L4 is shorted out, and m.w. tuning is obtained as originally. When the switch is moved for long wave reception, L4 is in series with L1, so that the ferrite aerial covers long waves. In addition, C13 and C14 are introduced across L3, so that the oscillator coil coverage is suitably changed.

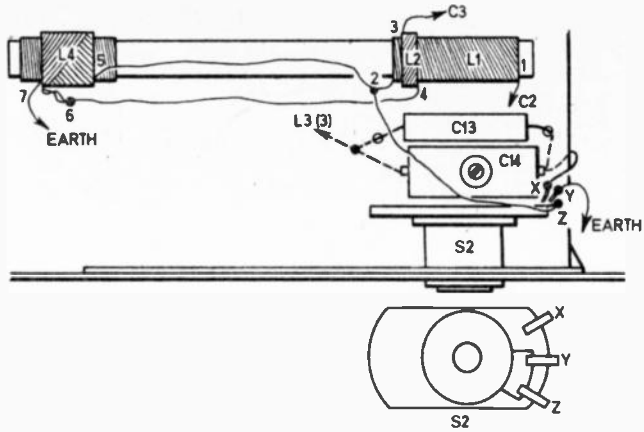


Fig. 3. Modification to the construction to enable long wave reception.

Fit S2 to the right of the tuning capacitor. Disconnect 2 of L1 from earth, and join it to the beginning of L4, wiring both to the new switch as in Fig. 3. Also disconnect 4 of L2 from earth, and take this to the tapping 6 on L4. Wire the end 7 of L4 to earth.

Drill the board to clear the tags and centre screw of C14, and place this and C13 as in Fig. 3. Wire to X on the switch, and pin 3 of L3, as shown. Wire Y of the switch to earth at one of the tags underneath the board. All other connections remain as before.

After this change, a little re-adjustment of m.w. alignment and trimming will be required, due to stray capacitance in the switch and new wiring, etc. Do this with the switch at m.w. Only when this is done switch to l.w. and with the dial set at 200kHz adjust C14 and the position of L4 on the rod for best reception. If L4 has no definite position, take it off and turn it over (to bring its windings into the same "sense" as those of L1). Subsequently, L4 may be moved on the rod for best reception at the l.f. end of this band.

CASE

The case used is fully insulated, and it should be noted that **a metal case cannot be used.** The battery rests to the left of the circuit board, and four screws secure the panel.

Provided component values in the tuned circuits are as given, with the components listed, the tuning dial in Fig. 4 may be fixed to the front of the panel. The whole panel can be covered with transparent material as used for book covers, to protect the paper scale.

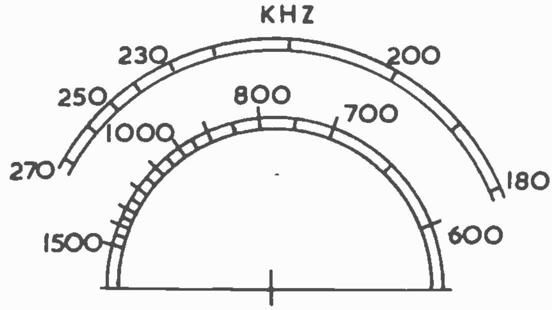


Fig. 4. The tuning dial, drawn actual size, as used on the prototype.

MW OSCILLATION

Due to the high gain of TR1, it *may* be found that oscillation and continuous whistles arise at the *extreme* high frequency end of the medium wave band (that is, with C2/C7 nearly fully open). This depends on the actual transistor fitted for TR1, and on the exact adjustments of C1 and C6, which limit the highest frequency which can be tuned. This defect is easily corrected either by removing a turn or two from L2, or by placing a resistor between C3 and 3 of L2. A suitable value is 470 ohms, but the value only need be high enough to prevent oscillation, and may well not be required in any case.

Danger!

Neither Mr. Hartley nor yourselves appear to be aware of the danger presented by the *Bright Ideas* article in the October edition of EVERYDAY ELECTRONICS.

I strongly urge readers not to use benzene for the cleaning of printed circuit boards, or for any other purpose during which it is allowed to come into contact with skin.

This chemical is believed carcinogenic; i.e., it could cause cancer. It is absorbed through the skin and its effects may take years to become apparent. However, it usually only induces cancer after many occasions of contact with it; its effects are cumulative and only build up during regular contact. However, the precise amount that could be dangerous is unknown as it varies from person to person.

There must be many safe organic solvents available that would do the job equally well (has anyone tried surgical spirit—available at chemists' shops?) So it does not seem worth the risk in using benzene.

G. L. Manning,
Edgware.

Nuts!

Could you please tell me how the distances between frets on a guitar, such as the *Delta Guitar* described in the October issue of E.E., are worked out. Could you also please tell me why the O fret on the *Delta Guitar* is so near the nut. Normally with a guitar the nut would be in the same position as the O fret on the Delta, and the first fret would be approximately in the same position as the first fret on the Delta. Does this mean that for some reason the strings rest on the fret in the Delta guitar and if so why not put the nut at the O fret position?

P. J. Arden,
Sheffield.

You readers are hard to please! When, with the Beta guitar (November '72), we used the nut as the O fret as suggested, we got letters asking why no separate fret was used—now you want it as before! In fact both methods are used on commercial guitars. With no O fret, the nut would have to perform two functions (1) a guide for the strings and (2) to keep all the strings at a set distance above the fingerboard. This means it would have to be precision made. The O fret on the Delta Guitar *keeps all the strings at the same distance above the fingerboard and other frets. Therefore the guide cuts on the nut can be made to any depth below the O fret height.*

To work out the distances between the frets, a very good approximation (to within carpenters accuracy) is to divide by 18 the distance between nut and bridge to give first fret dimension from nut. For next fret, divide by 18 distance from first fret to bridge. This process is repeated for number of frets required.

Wiper Control

I've just completed and installed the *Windscreen Wiper Controller* by Eric Moore in November EVERYDAY ELECTRONICS. I tested the device prior to installation actually using a 12 volt car battery. As a result I have had to modify the circuit by using a 500 kilohm in place of 1 megohm for VR1. Also I increased C1 to 220 microfarad. This gave a delay of from normal to about 45 seconds.

A most peculiar and inexplicable phenomenon has occurred since installation. At very short delay setting the relay actually latches onto the frequency of the normal wiper speed. There is then no delay obtainable between normal and about 10 seconds, i.e. you can't get a five second delay for example.

One would have thought that there could be no connection at all between the timing of the NE 555 and the normal frequency of the wipers as there is no electrical connection—only mechanical via the relay. I have very carefully checked the wiring of the relay and the rest of the circuit. Nevertheless, it is impossible to obtain a brief (i.e. under 10 secs delay) as any setting below 10 secs "latches on" to the normal frequency of the wipers.

Do you have any thoughts on the matter?

B. R. Sanders,
Cheadle Hulme.

We suspect that a small voltage pulse caused by the wiper motor turning off is triggering the sensitive i.c. Try putting a 220 ohm resistor in the supply line to the i.c. and potentiometers and a 100 microfarad 25V electrolytic capacitor across the i.c. supply.

Voltage Flow!

Reference school boy howler, "How many volts will pass through a relay coil?" (*Electronics At School* Oct. '74). I thought you might be interested in the following quotes from recent newspapers.

"The new class 87 engines (railway) operate on 25,000 volts of current."

"Somehow he slipped (off a pylon). His hand clawed through empty air and instinctively clutched the nearest object—a live cable with 33,000 volts of electricity flowing through it."

Perhaps the pupil left school to become a journalist?

Terence Davey,
Stoke on Trent.

Repeats?

First of all, having recently started getting EVERYDAY ELECTRONICS, I must say how I enjoy it—very suitable for a beginner in electronics like myself. However I would like to make a suggestion.

Over the last few years E.E. must have printed many very good projects and there must be many people like myself who have only recently started subscribing to E.E. How about reprinting some of the more popular projects you have printed in the past, I'm sure this would be appreciated by a lot of your readers.

J. P. Cross,
Frailingham,
Suffolk.

It is not our policy to reprint articles, however we have repeated various projects employing different or updated circuitry and over the years will continue to do this.

Simple Sums?

You really have some nitpickers! In fact Adrian Hope does himself an injustice since the expression $11-2+4\times2$ is not a well formed formula of arithmetic any more than $+-3$ is. This being so he is entitled to mean by it just what he likes and what this is the context makes clear.

Your readers may be amused to learn that the Polish notion was originated by one Lesniewski (less-nee-eff-ski) in Warsaw before the last war. It is an alternative way of writing logical formulae, the other one being Bertrand Russell's (Russellian or Russellese).

Formulae like CCCK*pqrst* appear where the big letters are logical operations and the little ones sentences. Thus, save us, we get: If if if both *p* and *q* then *r* then *s* then *t*. Reverse Polish (I guess) puts numbers before the arithmetical operations. Then the true "reverse polish" for $(11-2+4)\times2$ should be 2, 4, 2, 11, $-$, $+$, $\times$.

Lesniewski had some followers: Lukasiewicz, Sobocinski, and my old teacher Lejewski. But for those with shorter names it is all toomuchski.

P. Moll,
Department of Philosophy,
University of Lancaster.

On the subject of calculators, *For Your Entertainment* (September 1974), and taking the example given $11-2+4\times2$, the answer (26) is correct for full flow arithmetic which discounts bracketing rules. Taking each operation in turn the operation $\times2$ might not have yet occurred. Thus the calculation as your critics would have it would appear as $11-2+(4\times?)$, not very solvable if one does the brackets first.

Further a calculation involving sum of the products e.g. $(2\times3)+(4\times5)+(6\times7)$ would need partial results to be written down then added.

To solve this on a calculator using full flow one would use the expression:

$$2\times3-4+5\times4-6+7\times6.$$

If the usual brackets were included it would make nonsense.

I hope this clears up some doubts on full flow compared with conventional arithmetic, both of which can be done on a calculator. It depends what you want.

A. M. Coppin,
Feltham, Middlesex.

It must now be much more clear to someone! See For Your Entertainment *for more on this subject.*

Stereo Noise!

With reference to the *Tape Noise Limiter* in your November issue. Would you advise me whether it is possible to use this with a stereo cassette deck, e.g. by using two tape noise limiters one for each channel, and where in my system would I fit it—between the cassette deck and amplifier?

K. Kirk,
Welwyn Garden City.

Two noise limiters can be used for stereo and fitted as you surmise, between the deck preamplifiers and the power amplifier.

Soldering

Your article *Soldering For Beginners* recommends a conventional electric soldering iron, but I understand that whether or not such irons are earthed is important when soldering transistors or i.c.s which can be destroyed by voltage at the bit.

I, and probably many other beginners, would appreciate any available information on the effects of earthed or unearthed electric irons whether we need one of each and if so, when and how to use them on transistors or i.c.s.

S. Coward,
Durham.

It is normal not to earth a soldering iron so that "live" circuitry can be soldered without shorting (only do this on low voltage circuits). However when soldering to m.o.s. (metal oxide semiconductor) devices — some i.c.s. and mosfets etc.—it is best to unplug the iron and earth the contact of the device. Most i.c.s and semiconductors can be soldered with an unearthed iron in the normal way.

Please note: We cannot undertake to answer readers' letters that do not concern published articles and not enclosing an s.a.e.

The Extraordinary Experiments of Professor Ernest Eversure

by Anthony John Bassett

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

PROFESSOR Ernest Eversure appeared quite calm and collected. He pursed his lips and emitted a series of clicks and whistles. The robot immediately appeared, approaching one of the control-panels at the other side of the laboratory. It made some adjustments to the controls, and the alarm signal immediately ceased.

"What a relief" sighed Bob.

"We can leave the robot to take care of that experiment," remarked the Prof., "While we get on with the musical note-selector for your oscillator."

The Prof. began to draw a number of diagrams. The first was a sketch of one of the experimental resistors described in last month's issue.

"Now," said the Prof., "If we wish to connect a number of these resistors together in series, it could be done like this—."

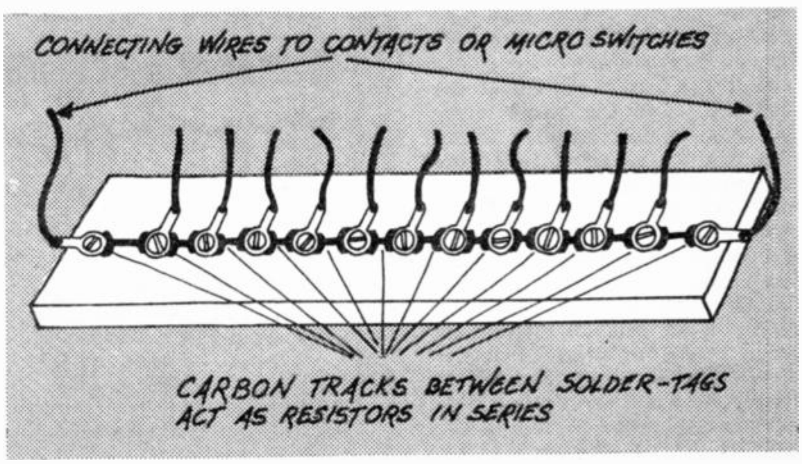
He drew a diagram of a longer piece of Paxolin with several nuts, bolts and solder tags joined by graphite lines (Fig. 1).

"Another method would be to use a piece of printed circuit-board, copper clad plastic or fibre-glass sheet. If you remove some of the copper, either with a craft knife and tweezers, or by etching, to produce a pattern like this (Fig. 2), it is quite easy to put either short or long carbon tracks on the board, between the remaining pieces of copper, to produce either low-value or high-value resistors. Connections can easily be made to each resistor by soldering wires to the copper."

"These wires could be connected to microswitches or contacts placed under keys from an old piano or wind-organ!" remarked Bob, "Or even built into an accordion!"

"If it were built into an accordion," the Prof. observed shrewdly, "When the accordionist played a chord, the top note of the chord would be generated electronically. It would automatically accompany the chord! I have been told about an instrument like this, which was built by an electronics experimenter, and had a separate oscillator for bass notes!"

Fig. 1. The Prof's basic resistors joined up in series.



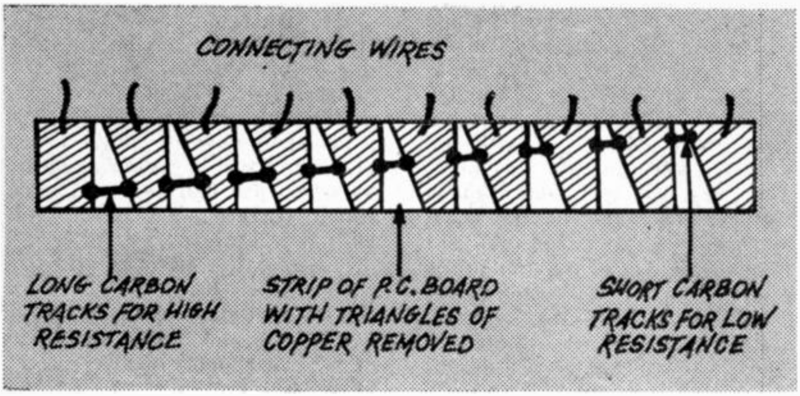


Fig. 2. The resistors formed on a printed circuit board.

The Prof. continued to draw, and soon produced another sketch which is shown in Fig. 3.

"Here is a design we could use to fit the tuning resistors and also copper 'keys', all on one printed circuit board," he said, "and notes can be played by touching the 'keys' with a metal rod connected by a piece of wire to the note generator."

"This board can be made by standard printed-circuit techniques, or by removing the unwanted copper with a craft knife and tweezers."

Assisted by the Prof., young Bob set to work busily, and soon he had made a printed circuit board to the Prof's design. He soldered a wire from it to the connection previously used to join VR1 to the emitter of TR2 in the oscillator.

Then he used a fine artist's paintbrush to apply a mixture of fine graphite powder and thin, quick-drying varnish between the copper sections at the places shown in the diagram. Near the right hand end of the board, used for high notes, he applied the mixture where the copper sections approached closest, to give low-value resistors.

Near the left hand end of the keyboard, used for lower notes, Bob applied the mixture where the copper sections did not approach so closely, to give higher value resistors. Then he put an extra quantity of the mixture on the board, to provide a graphite "pad" near the right-hand end of the note selector.

The note selector was now nearly ready for use; Bob left it for the varnish to dry, and looked around for a suitable keyboard instrument to assist in tuning the selector. He could have tuned it to a piano, an organ, accordion, or a guitar. But there appeared to be nothing suitable.

"Prof.," he queried, "Is your sound-synthesizer keyboard ready for use yet? The note-selector is nearly ready for tuning, and I will need a reference instrument to tune it to."

"No," replied the Prof., "It is not finished yet. But robots can do almost anything."

He summoned the robot, which came and stood near to the workbench on which were Bob's note selector and oscillator.

"You will need to tune the selector from the top note downwards," observed the Prof., "And I see that the first note you will require is an 'F'!"

Pursing his lips, he gave the robot some more instructions in a code of clicks and whistles. The robot whistled back, a continuous musical note 'F'.

"Wow!" exclaimed Bob in amazement, "Now I'll have a robot-tuned note selector!"

Young Bob quickly connected up his oscillator and switched it on. He used a crocodile-clip to attach the other tuning wire from the oscillator to the top 'F' note on the selector. The printed resistor at the top end of the keyboard now replaced VR1 in the oscillator circuit, but the note produced was higher than that produced by the robot. Young Bob used a typist's eraser to remove a small quantity of the graphite mixture.

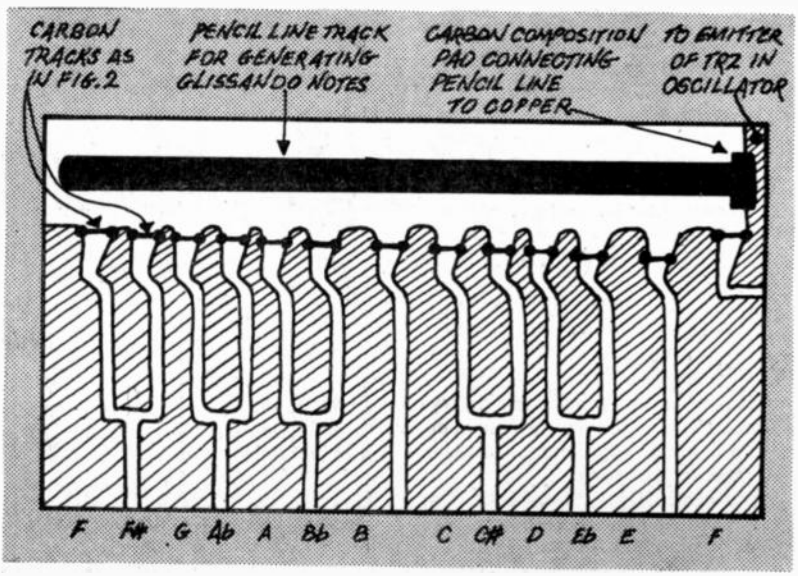
As he rubbed the resistor carefully, with the eraser, the note from the oscillator gradually became lower, until it was very nearly in tune with the 'F' note produced by the robot.

"Just a little bit more, and it'll be in tune," thought Bob.

But he rubbed just a little too much of the mixture away, and the note from his oscillator went below the note he was aiming for. Bob exchanged his eraser for a medium graphite pencil, and, by carefully rubbing the surface of the resistor with the tip of the pencil, gradually brought the pitch of the note exactly to 'F'!

Moving the crocodile clip on to the next note, which was 'E', Bob was amazed to find that the Robot automatically began to whistle an 'E' note! He quickly adjusted the next resistor so that an 'E' note

Fig. 3. The "keyboard" and "glissando strip" produced by Bob.



was produced by the oscillator, and went on to tune the remaining notes on the selector the same way, each with its own resistor.

Then he drew a thick black pencil line on the printed circuit board, joining up with the pad of graphite mixture at the right hand end of the keyboard. He went over the line several times with a soft graphite pencil until the line was about 10mm.

By sliding the crocodile clip connected to the oscillator along the line, Bob found that he could obtain interesting glissando sound-effects, whilst melodies could be obtained by touching the copper "keys" with the clip!

"Look Prof!" he exclaimed, "I've made a two-in-one instrument now! It doesn't just play notes like a keyboard instrument; it can be used to give sliding glissando effects as well!"

Whilst Bob demonstrated, Professor Eversure examined the instrument carefully.

"Now," he said, "I can think of quite a few improvements which we could make. First, if you continue to use that crocodile-clip on your pencil-line track, it will quickly scratch the track away. I suggest you replace it with a spare multimeter probe. Either round-off the end of the probe with a file and polish it perfectly smooth, or solder a small shiny ball-bearing onto the end."

"Another improvement would be to carefully trim the pencil-line track so that points along the track each correspond with the nearest note on the keyboard. That way, you will know that if you put the probe on the track near the 'A' note, an 'A' will sound, and if you put the probe near 'C', a 'C' will sound, yet you will be able to slide the probe gradually from one note to another, and the pitch will gradually alter!"

"Just as you tuned the 'keyboard' part of the selector by starting with the top notes, so it will be necessary to trim the pencil-line track by starting at the high end."

The Prof. found a meter-probe with a worn, rounded end, and connected it in place of the crocodile clip. Then he compared the note obtained by touching the upper 'F' note on the note selector, with that obtained by touching the centre of the pencil-line track nearest the same note. The note obtained from the pencil-line track was too low, so the Prof. used a soft graphite pencil to rub more graphite onto the paxolin near the 'F' note, and to the right of it, until the correct note was obtained.

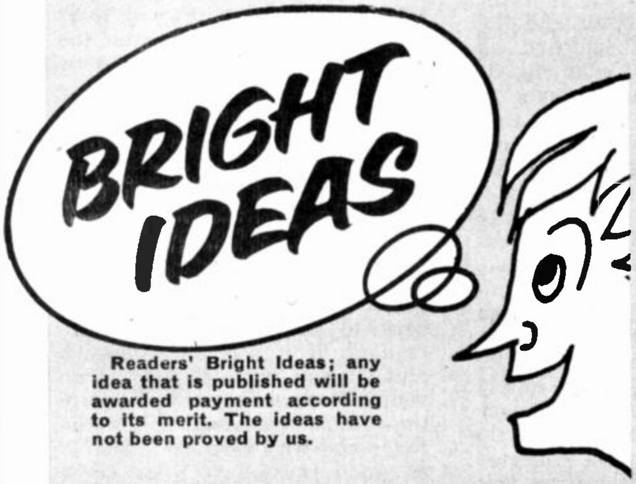
He then continued down the scale, comparing the note produced on the track with the nearest note on the keyboard, and correcting them by using either a pencil to raise the pitch, or an eraser to lower it, until a smoothly varying track had been produced which corresponded quite well with the "keyboard" section.

"Now, Bob," said the Prof., "I think that's about as far as we can go for today, as it's becoming quite late, and there are some other experiments which I want to do. But I'm sure your friends from school will be very interested in your note selector, and would like to practise tunes and sound-effects on it. Why not take it and show them?"

"Thanks, Prof.", said Bob gratefully, "and if I come round again soon, will you have time to show me how I can make my own experimental microphones?"

"Yes," said the Prof., "and we have planned to try experimental gramophone pickups as well, so it should be quite an interesting session! "'Bye Bob," he said as Bob carefully carried his oscillator and note selector towards the Laboratory exit.

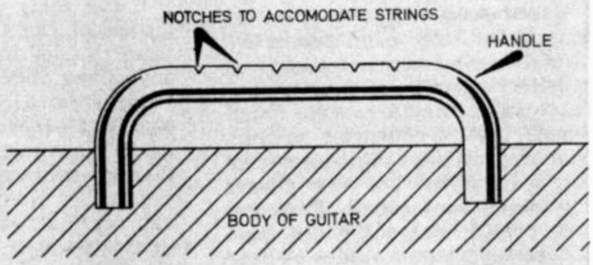
"Bye, Prof; see you soon!" called Bob, setting off happily to show his note selector to some of his friends.



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

With reference to the *Delta Electric Guitar* featured in the October issue, I have found a very cheap and effective way of making a bridge. All one needs is an old chrome plated brass drawer handle, one only has to drill two holes in the body of the guitar.

The notches can be cut with a small hacksaw or a triangular file. The height of the bridge is semi-adjustable



in that one can drill the holes fairly deep and get them to the right depth by inserting small washers. This bridge will be held in by the tension of the strings.

A. T. Scaramanga,
Reading, Berks.

Capacitors

I am thoroughly confused by the different types of capacitors available — plastic foil, polystyrene etc. What are the differences and are they interchangeable?

The different names describe their construction and the type of insulator used for the dielectric. Some insulators are of good quality, others are not so good and can be "leaky" under high voltage stress and when radio frequencies are applied.

Polystyrene and silver mica devices show very good properties at high radio frequencies—and as they are usually of low capacitance value they are to be found where high frequencies prevail. You can usually substitute mica for polystyrene but not always the other way round. Polyester and polycarbonate devices have higher capacitance values as have paper capacitors and plastic foil.

Unless specifically stated with a good reason one can usually substitute one for another amongst this group but remember that paper capacitors (these are very good quality) are much more bulky than the others. In the capacitance range of $0{\cdot}47\mu F$ to about $2{\cdot}2\mu F$ you can always substitute polyester capacitors for electrolytics but not vice versa. NEVER use an electrolytic capacitor as a substitute for a non polarity sensitive device. This is particularly important if you ever think of using a polarity sensitive tantalum capacitor instead of a polyester device.

Transformer Identification

Is there any simple way of finding the values of transformers that are unmarked?

We appreciate that it is most frustrating to be in possession of an expensive looking unmarked transformer and one feels duty bound to use it rather than buy one having a more certain pedigree. Unfortunately there are many different types of transformer—mains, auto, coupling, output, etc., and they may have inductances to suit certain specific frequencies; e.g. transformers from aircraft—even though they may have voltage transformation markings on them they should not be used on the mains because they are designed to operate at 400Hz. Applying the correct voltages at 50Hz would cause them to overheat.

We feel we should dissuade readers from using transformers of dubious origin simply because of the safety angle and in any case the techniques for carrying out the requested tests can be extremely complex.

Back e.m.f.

In some of your circuits that use relays you show a diode connected across the relay's coil and say this is for "protection purposes". What is it protecting from what?

If the relay is in the collector circuit of the transistor and the transistor is being switched on and off by very fast edge signals —e.g. from a Schmitt trigger or such like—there is a danger that when the transistor goes non-conducting very rapidly (the relay's current is quickly broken) you can get a very high voltage generated as a back e.m.f. across the relay coil—caused by inductive action.

The polarity of this voltage tends to make the potential at the collector of the transistor go very much higher that the supply rail voltage and there is a danger of exceeding the reverse breakdown voltage between collector and base. The diode catches this "over swing" and shorts any voltage straight back to the power rail.

Microwaves

Is there any way I can check if there is any escape of microwaves from a microwave oven. Also are microwaves harmful?

We do not know of any sure way of checking your oven for leakage but would think that holding a small neon tester close to the unit should give some indication. If the neon lights up when held close to (but NOT in contact with) the oven there is certainly an escape of microwave energy. If, however it does not light up we cannot say for sure that there is no escape, but if there is it is unlikely to be harmful.

Under certain circumstances high energy microwaves are extremely harmful—otherwise the meat would not cook in the oven —but it is unlikely that there is any hazard external to a commercial oven as they are heavily screened. Fine steel wool is an excellent absorber of stray microwaves but we do not recommend you stuff this into any potential gaps in the casing of your oven!

If you are particularly concerned over this point we suggest you contact the manufacturers who, we are sure, would be only too pleased to advise you and set your mind at rest.

Hum

I have purchased a commercial v.h.f. tuner unit but when connected up and switched on it emits a hum irrespective of whether the amplifier is switched to record player or radio. The hum does not seem to come from my loudspeaker but from the tuner itself.

Is there any possible reason for this? I have had the electricity board along to check the house wiring for interference but they found nothing wrong.

More than likely the hum is caused by the laminations of the mains transformer inside the tuner unit. This is most aggravating and should really be referred back to the manufacturer—particularly if it was an expensive unit. If you want to have a go yourself we suggest you locate the mains transformer in the tuner and with care use a length of wood pressed to your ear—the other end touching the metalwork of the transformer. If you hear a pronounced hum then you have confirmed our guess.

The only thing you can do is tighten up any mechanical fixing screws and squeeze the laminations clamp together with a Mole Wrench if the transformer is of the open lamination type.

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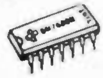

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SN7421N	0·33	SN74118N	0·90	CA3036	1·08
SN7422N	0·25	SN74119N	1·68	CA3046	1·03
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SN7441AN	0·92	SN74154N	2·00		
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SN7448N	1·27	SN74163N	1·38	MFC4000P	0·46
SN7450N	0·16	SN74164N	1·76	MFC4010P	0·56
SN7451N	0·16	SN74165N	1·76	MFC6040P	1·00
SN7453N	0·16	SN74166N	1·60	**Others**	
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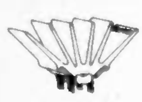

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BFX50	0·21	TIP29A	0·49	40408	0·50
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SC40D	1·20
SC40E	1·50
10 Amp	
SC45A	1·09
SC45B	1·12
SC45D	1·50
SC45E	1·65
15 Amp	
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SC50B	1·57
SC50D	1·80
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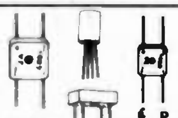

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B025/05	0·16
1 Amp	
B1/05	0·20
B1/10	0·21
B1/20	0·24
B1/60	0·25
B1/100	0·30
2 Amp	
B2/05	0·30
B2/10	0·35
B2/20	0·40
B2/40	0·44
B2/60	0·45
B2/100	0·55
4 Amp	
B4/05	0·45
B4/10	0·48

	£ p
B4/20	0·54
B4/40	0·60
B4/60	0·70
B4/80	0·90
6 Amp	
B6/05	0·50
B6/10	0·58
B6/20	0·68
B6/40	0·75
B6/60	0·87
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for your Entertainment...

By Adrian Hope

THE correspondence on calculator logic and the sum $11-2+4\times2$ is especially welcome because it neatly sums up what I see this column is all about—namely, electronics as the servant of man rather than vice versa. It also neatly reminds us that most computer mistakes (for instance in accounts and statements) are not machine mistakes at all, they are the fault of the machine operator.

Of course, using legitimate mathematics, the correct answer to the sum $11-2+4\times2$ is 17 and not 26, because multiplication and division take precedence over addition and subtraction.

Legitimately the answer 26 can only be arrived at by writing the sum as $(11-2+4)\times2$. A chain flow logic calculator automatically puts the brackets into the sum to produce the answer 26.

If the operator (either through ignorance or by subconsciously regarding the brackets as implied) would move from left to right through the sum to produce the answer 26, then a chain flow calculator will follow his train of thought and produce the same answer. So the calculator becomes a simple human tool, neither introducing errors nor correcting those made by the operator.

This is why I suggest that a chain flow logic calculator is more likely to be of practical domestic use than a reverse logic machine. But of course those who prefer reverse logic machines are in luck, because, as previously pointed out, it is just these machines that are now going cheap.

SPOT CHECK

I did a spot check round a cross section of my friends and acquaintances, see below, to see just how people working and earning their living with figures would work out the sum $11-2+4\times2$, in that form.

Every one of them obviously realised that the question must have a catch, because I was, after all, phoning them up one evening out of the blue and asking them to write out and solve a simple sum!

Housewife	26
BBC bandleader (paying musicians, handling VAT and tax)	26
Company secretary	26
Lecturer in Economics	26
Insurance Broker	26
Director of firm manufacturing and selling commercial vehicles (dealing in large quantities of money and crucial chassis and body measurements)	26
Professor of Physics	17
Schoolteacher	17
University Lecturer in Technology	26
Practising doctor	26
Architect	26
Book-keeper (handling the books of a large firm)	26
Pharmacist	26
University Lecturer in Maths	17
University Maths graduate	17
Ten-year-old child	21

(Yes, 21: he half knew what to do but ended up using the 4 twice)

I don't say this proves anything but I do say it is interesting. I also say it suggests that the average man and woman in the street would not only work out the sum incorrectly but also would write it incorrectly if they wanted the answer 26, i.e. it is natural for some educated people to move left-to-right through a sum and subconsciously add brackets.

Yes, I know this is wrong and there are very good arguments for preserving correct form at all times. But there are also equally good arguments in favour of admitting an abuse into the language when it is more confusing to exclude it.

Take, for example, the word "sophisticated." Many of us use it to describe complicated or advanced circuitry and some modern dictionary definitions are beginning to acknowledge this—but try looking the word up in an older dictionary and you may have a surprise.

Also, try looking up the word "nearby". It is used almost daily by the BBC newsreaders as an adjective (eg. "nearby trees") and the modern Penguin dictionary lists it as such. But try looking in an older dictionary and if you can find it at all you are quite likely to see it listed as an adverb.

TALKING MACHINE

By the way—

If you want to feel you are one up on a computer, try fooling your pocket calculator by making it talk.

These machines all have digital read out figures, some of which happen to look like letters of the alphabet when viewed upside down. For instance 0=O, 1=1, 2=Z, 3=E, 4=h, 5=S, 7=L, 8=B and 9=G.

See how this works out in practice try punching in $1{\cdot}1601\times4\div6$. Then turn the calculator round and read out the answer upside down.

"How come I'm always £1 short on my housekeeping since you got that calculator?"

DOWN TO EARTH

By GEORGE HYLTON

"I read that, in the circuit of Fig. 1, maximum output is obtained when R_b is h_{FE} times R_c. Is this true, and if so, why?"

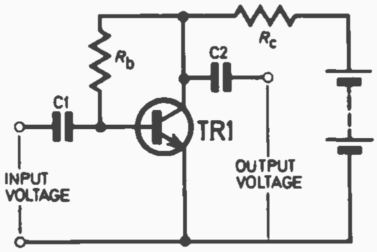

Fig. 1. A simple one-stage amplifier with feedback biasing.

Here we are concerned with *voltages*. The important ones are shown in Fig. 2. The *output* voltage is produced by changes in the collector current flowing in R_c, changes which are governed by the input signal, which we can take to be a small a.c. voltage applied to the base-emitter junction. Its effect is to impress small to-and-fro variations on the steady base-emitter voltage V_{be}.

The corresponding small variations in the collector current I_c produce corresponding changes in the voltage drop across R_c. These variations are the a.c. output voltage and they are taken out of the circuit, without upsetting the d.c. conditions, via a capacitor (C2 of Fig. 1).

PEAK SWING

If the input is an audio signal, made up of mixtures of sine waves, then on average it swings just as far positive as it does negative. For this reason V_{be} is made such that the circuit overloads at the same peak voltage, positive or negative. A peak positive swing then just increases the collector current to the point where R_c drops all the supply voltage V_{cc}.

Any further increase of input cannot increase the output because the transistor is turned on as hard as the circuit will allow; it is "bottomed"; i.e. its collector voltage is zero, or very nearly so.

A peak negative swing just cuts off the collector current; there is now no current in R_c and the collector voltage is the full supply voltage V_{cc}. Once again, no further increase is possible since the transistor is already cut off and the output at a maximum.

Common sense says that to allow equally large swings of collector voltage in either direction, the collector voltage V_{ce} should have a steady, d.c. value of half the supply voltage, V_{cc}. If V_{cc} is 12V d.c., and V_{ce} is 6V d.c., the peak a.c. output is 6V positive or 6V negative. The peak-to-peak a.c. output is 12V, the same as V_{cc}, and we can't do better than that. If the collector were sitting at 4V, the peak output would be only 4V in the negative direction before distortion set in.

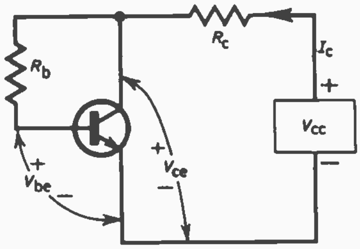

Fig. 2. D.C. conditions only for Fig. 1.

APPLICATION

So the problem is to set up the d.c. conditions so that V_{ce} is half V_{cc}. The rule for doing this is to make $R_b = h_{FE} \times R_c$. Here h_{FE} is what the data sheets call the "large-signal current gain". However, like most practical rules, it is only an approximation. It gives good results for high values of V_{cc} but not when V_{cc} is small.

First, why does the rule work, at all? Well, the form of biasing of the transistor shown here involves some d.c. negative feedback. When R_b passes current into the base, the collector current which then flows pulls down the collector voltage. This leaves less voltage to drive base current through R_b, with the result that the circuit settles down with V_{ce} *somewhere* between 0 and V_{cc}.

The exact voltage depends on how much collector current flows for a particular base current, i.e. on the gain of the transistor. But, obviously, it depends also on the resistances in the circuit. It turns out that, approximately anyway, the collector voltage adjusts itself to half V_{cc} when $R_b = h_{FE} \times R_c$.

What prevents the rule from being completely accurate is that not all of the collector/emitter voltage is available for driving current through R_b. The voltage across R_b is not V_{ce} but V_{ce} minus V_{be}. In a silicon transistor V_{be} is around 0·7V, which makes quite a difference when V_{ce} is not very large, as in circuits worked from 3V batteries.

The value of h_{FE} used in calculating R_b should be the true large-signal current amplification factor for the particular transistor you are using at the particular collector current. Since transistors vary, even though nominally of the same type, and since h_{FE} varies with I_c, the only *certain* way to get the right R_b is by experiment. This can be tedious.

If the limits of h_{FE} for the transistor type are known, at the collector current to be used in your circuit, then an average value of R_b can be calculated which will be all right for an average transistor and, hopefully, not too far out for a non-average one. Thus if h_{FE} is 100-200 you can take it as 150 with good results.

Unfortunately some transistor types have a much greater "spread" than this 2:1 ratio. A type with $h_{FE} = 80\text{-}500$ will give less repeatable results. The best average value for h_{FE} is not the simple arithmetic mean which I just used but the "geometric mean", found by multiplying the upper and lower limits of h_{FE} together and then taking the square root. For the 100-200 transistor this gives 140 instead of the 150 I used, which hardly makes any difference. But in the 80-500 transistor the geometric mean h_{FE} of 200 is very different from the simple average of 290.

To allow for low V_{cc}, calculate R_b as before then multiply by

$$\left(\frac{1-2V_{be}}{V_{cc}}\right)$$

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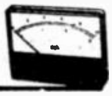

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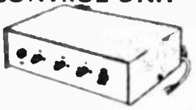

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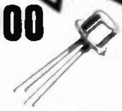

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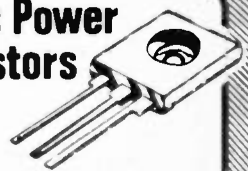

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2N1305	0·24	2N3440	0·59	2N5459	0·49	AF239	0·51	BC261	0·20	BF178	0·35	CD4011	0·51	RS3	1·20
2N1306	0·31	2N3441	0·97	40361	0·48	AF240	0·72	BC262	0·18	BF179	0·43	CD4015	2·66	RL54	0·15
2N1307	0·22	2N3442	1·69	40362	0·50	AF279	0·54	BC263	0·23	BF180	0·35	CD4016	1·02	SC35D	1·68
2N1308	0·25	2N3414	0·10	40363	0·88	AF280	0·54	BC300	2·12	BF181	0·34	CD4017	2·66	SC36D	1·46
2N1309	0·36	2N3415	0·10	40389	0·46	AL102	0·75	BC301	0·34	BF182	0·40	CD4020	2·96	SC40D	1·89
2N1671	1·44	2N3416	0·15	40394	0·56	AL103	0·70	BC302	0·29	BF183	0·40	CD4023	0·51	SC41D	1·32
2N1671A		2N3417	0·21	40395	0·65	BC107	0·16	BC303	0·54	BF184	0·30	CD4024	1·90	SC45D	1·89
	1·54	2N3638	0·15	40406	0·44	BC108	0·15	BC307	0·10	BF185	0·30	CD4027	1·56	SC46D	1·96
2N1671B	1·72	2N3638A		40407	0·33	BC109	0·19	BC307A	0·10	BF194	0·12	CD4028	2·34	SC50D	2·60
2N1671C			0·15	40408	0·50	BC113	0·15	BC308	0·09	BF195	0·12	CD4029	3·79	SC51D	2·39
	4·32	2N3639	0·27	40409	0·52	BC115	0·17	BC308A	0·12	BF196	0·13	CD4041	2·11	SL414A	1·80
2N1711	0·45	2N3641	0·17	40410	0·52	BC116	0·17	BC308B	0·09	BF197	0·15	CD4044	2·11	SL623	4·59
2N1907	5·50	2N3702	0·11	40411	2·25	BC116A	0·18	BC309	0·10	BF198	0·18	CD4047	1·65	TAA263	1·00
2N2102	0·50	2N3703	0·12	40414	3·55	BC117	0·21	BC309A	0·10	BF199	0·18	CD4049	0·90	TAA350	2·10
2N2147	0·78	2N3704	0·14	40430	0·85	BC118	0·11	BC309B	0·10	BF200	0·40	CD4050	0·90	TAA621	2·03
2N2148	0·94	2N3705	0·12	40583	0·23	BC119	0·29	BC237	0·21	BF225J	0·19	LM301A	0·48	TAA661B	
2N2160	0·60	2N3706	0·09	40601	0·67	BC121	0·23	BC238	0·19	BF237	0·22	LM304A	2·03		1·32
2N2192	0·40	2N3707	0·13	40602	0·46	BC125	0·16	BC337	0·19	BF238	0·22	LM309K	1·88	TAD100	1·50
2N2192A		2N3708	0·70	40603	0·53	BC126	0·23	BC338	0·19	BF244	0·21	LM702C	0·75	Filter	0·70
	0·40	2N3709	0·11	40604	0·56	BC132	0·30	BCY30	0·64	BF245	0·33	LM709T099		TBA271	0·64
2N2913	0·40	2N3710	0·12	40636	1·10	BC134	0·13	BCY31	0·64	BF246	0·58		0·48	TBA641B	
2N2193A		2N3711	0·11	40669	1·00	BC135	0·13	BCY32	1·15	BF247	0·23	8DIL	0·38		1·25
	0·61	2N3712	0·96	40673	0·70	BC136	0·17	BCY33	0·45	BF254	0·16	14DIL	0·40	TBA800	1·50
2N2194	0·73	2N3713	1·20	AC107	0·51	BC137	0·17	BCY34	0·49	BF255	0·17	LM723C	0·90	TBA810	1·50
2N2194A		2N3714	1·33	AC113	0·16	BC138	0·24	BCY38	0·55	BF257	0·46	LM741T099		TIL209	0·30
	0·30	2N3715	1·50	AC117	0·20	BC140	0·34	BCY39	1·50	BF258	0·59		0·40	TIP29A	0·49
2N2218A		2N3716	1·80	AC126	0·20	BC141	0·29	BCY40	0·87	BF259	0·55	8DIL	0·40	TIP30A	0·58
	0·22	2N3771	2·20	AC127	0·20	BC142	0·23	BCY42	0·28	BFS21A	2·30	14DIL	0·38	TIP31A	0·62
2N2219	0·24	2N3772	1·80	AC128	0·20	BC143	0·25	BCY58	0·21	BFS28	0·92	LM747	1·00	TIP32A	0·74
2N2219A		2N3773	2·65	AC151V	0·25	BC145	0·21	BCY59	0·22	BFS61	0·27	LM7488DIL		TIP33A	1·01
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2N2220	0·25	2N3790	2·40	AC153	0·25	BC148	0·13	BCY71	0·22	BFX29	0·30	LM7805	2·00	TIP35A	2·90
2N2221	0·18	2N3791	2·35	AC153K	0·25	BC149	0·12	BCY72	0·13	BFX30	0·27	14DIL	0·73	TIP36A	3·70
2N2221A		2N3792	2·69	AC154	0·20	BC153	0·18	BCY87	3·54	BFX44	0·33	LM7805	2·50	TIP41A	0·79
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Readers are advised that Messrs. Electrospares have temporarily withdrawn this service.

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