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JUNE 74

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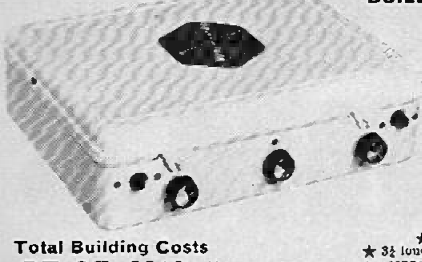


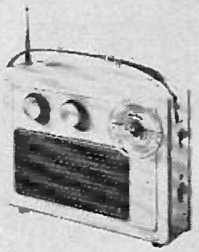
★ 4 Transistor Earpiece Radio ★ Signal Tracer ★ Signal Injector ★ Transistor Tester NPN-PNP ★ 4 Transistor Push Pull Amplifier ★ 5 Transistor Push Pull Amplifier ★ 7 Transistor Loudspeaker Radio MW/LW ★ 5 Transistor Short Wave Radio ★ Electronic Metronome ★ Electronic Noise Generator ★ Batteryless Crystal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

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

Total Building Costs £7·23 P P & Ins. 44p. (Overseas P & P £1·85p.)
(+ 10% VAT 72p)

NEW ROAMER NINE

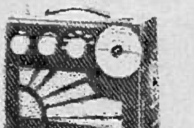
WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors. 9 Tunable wavebands as Roamer Ten, built in ferrite rod aerial for MW/LW. Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600 mw transistors. 9 Transistors and 3 diodes, tuning condenser with V.H.F. section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange control. Attractive all white case with red grille and carrying strap. Size 9¾" x 7" x 2¼" approx. Parts Price list and Plans 30p (FREE with parts)

Total Building Costs £6·95 P P & Ins. 44p.
(Overseas P & P £1·85p)
(+ 10% VAT 69p)

ROAMER TEN



with VHF including aircraft. 10 Transistors. Latest 4" 2 watt Ferrite Magnet Loudspeakers, 9 Tunable Wavebands. MW1, MW2, LW, SW1, SW2, SW3, Trawler Band, VHF and Local Stations also Aircraft Band. Built in Ferrite Rod Aerial for MW/LW. Retractable, chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600 mw Transistors. Car Aerial and Tape Recording Sockets. 10 Transistors plus 3 Diodes. Ganged Tuning Condenser with VHF section. Separate coil for Aircraft Band. Volume on/off. Wave Change and tone Control. Attractive Case in black with silver blocking. Size 9" x 7" x 4". Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts).

Total building costs £8·50 P. P. & Ins. 62p
(Overseas P. & P. £1·85)
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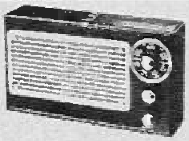
NEW EVERYDAY SERIES



Build this exciting New series of designs

E.V. 5 5 Transistors and 2 diodes. MW/LW Powered by 4½ volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9" x 5¼" x 2¼" approx.
Parts price list and Plans 15p. Free with parts.

Total Building Costs £2·73 P P & Ins. 30p
(Overseas P & P £1·25p)
(+ 10% VAT 27p)

E.V. 6 Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt battery. Ferrite rod aerial, 3" loudspeaker, etc., MW/LW coverage. Push Pull output. Parts price list and Plans 15p. Free with parts.

Total Building Costs £3·60 P & P Ins. 30p
(Overseas P & P £1·25p)
(+ 10% VAT 36p)

E.V. 7 Case and looks as above. 7 Transistors and 3 diodes. Six wavebands. MW/LW, Trawler Band, SW1, SW2, SW3, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. 3" loudspeaker. Parts price list and easy build plans 20p. Free with parts.

Total Building Costs £4·08 P P & Ins. 31p
(Overseas P & P £1·85)
(+ 10% VAT 40p)

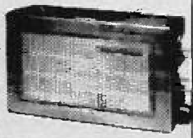
"EDU-KIT"

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

Components include: Tuning Condenser: 2 Volume Controls: 2 Slider Switches: Fine 3" Tone Moving Coil Speaker: Terminal Strip: Ferrite Rod Aerial: Battery Clips: 4 Tag Boards: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three ½" Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction.
Parts price list and plans 25p (FREE with parts).

Total Building Costs £5·50 P P & Ins. 33p
(Overseas P & P £1·85)
(+ 10% VAT 55p)

POCKET FIVE

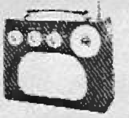


3 Tunable wavebands. M.W./L.W. and Trawler Band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, moving coil loudspeaker, attractive Black and Gold Case. Size 5½" x 1¼" x 3½" approx. Plans and parts price list 15p. (Free with parts).

Total Building Costs £2·28 P P & Ins. 26p
(Overseas P & P 1·25p)
(+ 10% VAT 22p)

ROAMER EIGHT Mk 1

NOW WITH VARIABLE TONE CONTROL



7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mW transistors. Car aerial and Tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Latest 4" 2 watt Ferrite Magnet Loudspeakers. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9 x 7 x 4in. approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

Total Building Costs £6·98 P P & Ins. 47p
(Overseas P. & P. £1·85)
(+ 10% VAT 69p)

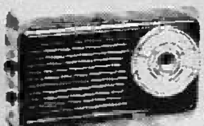
ROAMER SIX

Case and looks as Trans-Eight

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3, Trawler band plus an Extra Medium waveband for easier tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 x 5½ x 2½in. approx. Plans and parts price list 25p (FREE with parts).

Total Building Costs £3·98 P P & Ins. 31p
(Overseas P. & P. £1·85)
+ 10% VAT 39p)

TRANSONA FIVE

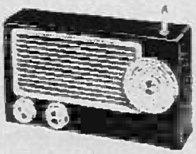


Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial.
Plans and parts price list 15p (Free with parts).

Total Building Costs £2·50 P P & Ins. 26p
(Overseas P & P 1·25p)
(+ 10% VAT 25p)

TRANS EIGHT

8 TRANSISTORS and 3 DIODES



6 Tunable Wavebands; MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 3in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 x 5½ x 2½in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).

Total Building Costs £4·48 P P & Ins. 33p
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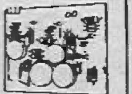

Components galore for the experimenter Ex computer boards with: Resistors, Capacitors and useful Transistors—at least 4 transistors per board.

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A control unit which when connected to twin decks makes a disco of professional quality. We supply a smart front panel which incorporates controls, switch and input sockets. The control module, I.C. construction, incorporating, mixing, pre-amp and head-phone listening amplifier. The power pack enables this unit to work from the standard mains. • Inputs include Mic. Tape/Cassette and Twin Decks. • Controls include Mic. Tape. Each Deck and P.F.L. Full instructions are included with every Pack. MONO = £14 plus 20p PP. STEREO = £17 plus 20p PP. Send a S.A.E. for more information.

STEREO / MONO HEADPHONE VOLUME CONTROL BOX

Plug Stereo phones into this control box and you then incorporate a right and left hand volume control and a stereo/mono switch. Complete with stereo jack plug and 2 m cable.
A Bargain at £1. Plus 10p P. & P.

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Stereo jack plug to two stereo line sockets complete with 110 mm of cable. For plugging two stereo inputs into one. A Bargain at 65p plus 5p P&P.

LOW VOLTAGE AMPLIFIER

Few only at £1·75 plus 13p P. & P.

5 transistor amplifier complete with volume control, is suitable for 9V d.c. and a.c. supplies. Will give about 1W at 8 ohm output.
With high IMP input this amplifier will work as a record player, baby alarm, etc., amplifier.

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Please include 6p. P. & P. up to 3 Mini-Loudspeakers

TRI-VOLT BATTERY ELIMINATOR

Enables you to work your transistor radio, amplifier, or cassette, etc. from A.C. mains through this compact eliminator. Just by moving a plug you can select the voltage you require — 6v, 7½v or 9 volts. This means all your transistor power pack applications can be handled by this one unit. Approx. size: 2¼" x 2½" x 3¼". OUR PRICE — £2·75p + 10p. P. & P. Same model suitably wired for the Philips Cassette — £3·00 + 10p. P. & P.

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We supply the three modules for you to build this Disco-Group-P.A. amplifier into the cabinet of your choice.

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170W. r.m.s. eq. wave 300W instantaneous peak into 8 ohm (60W into 16 ohm). £14·28, carr. 45p.

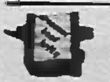
★ **THE PRE-AMP MODULE**
Four control pre-amp. Vol. Bass. Treble. Middle controls. Designed to drive most amplifiers using F.E.T. first stage. £3·96 carr. 25p.

★ **THE POWER SUPPLY MODULE PS100**
Is supplied complete with the mains transformer. £9·66, carr. 50p. Complete fixing instructions are supplied and no technical knowledge is required to connect the three ready wired modules. A fantastic bargain. If you purchase all three modules. £25, carr. 75p. Send S.A.E. for further details on this or our ready built amplifiers

200/250V MAINS RELAY

Heavy duty contacts. 2,500 Ω coil. All new and unused D.P.D.T. mains relays 50p + V.A.T. Carr. Free. Special quantity price: £40 per 100 relays.

"CRESCENT BEAT BRITE" SINGLE CHANNEL SOUND TO LIGHT UNIT



This fantastic little box approx. 4" × 3" × 2½" when connected to the output of a sound source from 1 to 100 watts produces a psychedelic light display of up to 1000 watts. Complete with a sensitive level control the unit is fused and can not harm your amplifier.
A Bargain at £7·50 plus 10p P. & P.

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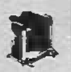
Fused Primary 240V. Secondary 220V @ 50mA. 6·3V @ 1A. This transformer is made to a very high standard and is a small size: 2in × 2½in × 2½in. 63p plus 15p P. & P.



TRI-VOLT CAR CONVERTER

Enables you to work your Transistor Radio, Amplifier or Cassette etc. from the 12 volt car supply positive or neg. earth.
This converter supplies 6, 7½ or 9 volts and is transistor regulated. Approx. size 2½" × 3½" × 2". Very easy to fit and a real money saving device for £2·50 + 10p. P. & P.

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1 pole 12 way
2 pole 2 way
2 pole 3 way
2 pole 4 way
2 pole 6 way
3 pole 4 way
4 pole 3 way
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5K	Log or	5K	
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100K		100K	40p.
250K	Double	250K	each
500K	Pole	500K	
1M	Switch	1M	
2M	24p ea,	2M	

Up to 3 Pots. Please add 5p. P. & P.

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160V: 0·01μF, 0·015μF, 0·022μF, 3p. 0·047μF, 0·068μF, 3½p. 0·1μF, 4½p. 0·15μF, 5p. 0·22μF, 5½p. 0·33μF, 6½p. 0·47μF, 8½p. 0·68μF, 12p. 1μF, 14p.

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⅛	MF	10-2M7	2	1·54	1·32	1·1	3×7
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3·3μF	63V	6½p	100μF	25V	6½p
4·0μF	40V	6½p	100μF	63V	14p
4·7μF	63V	6½p	150μF	16V	6½p
6·8μF	63V	6½p	150μF	63V	15p
8·0μF	40V	6½p	220μF	6·4V	6½p
10μF	25V	6½p	220μF	10V	6½p
10μF	63V	6½p	220μF	16V	8p
15μF	16V	6½p	220μF	63V	21p
15μF	63V	6½p	330μF	16V	12p
16μF	40V	6½p	330μF	63V	25p
22μF	25V	6½p	470μF	6·4V	9p
22μF	63V	6½p	470μF	40V	20p
32μF	10V	6½p	680μF	16V	15p
33μF	16V	6½p	680μF	40V	25p
33μF	40V	6½p	1000μF	16V	20p
32μF	63V	6½p	1000μF	25V	25p
47μF	10V	6½p	1500μF	6·4	15p
47μF	25V	6½p	1500μF	16V	25p
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Insertion tool	59p	59p
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Pins. Pkt. 25	10p	10p

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AC128	22p	BC213L	12p
BC107	11p	BC214L	17p
BC108	12p	OC44	18p
BC109	13p	OC71	13p
BC148	12p	OC81	16p
BC149	12p	OC170	23p
BC182L	12p	TIS43	33p
BC183L	12p	2N2926	11p
BC184L	13p	2N3702	11p

POTENTIOMETERS

Carbon Track 5K Ω to 2M Ω, log or lin. Single, 16½p Dual Gang 46p. Log Single with switch 26p
Slider Pots. 10K, 100K, 500K. 30mm, 34p. 45mm, 47p. 60mm, 55p.

DIODES

1N4001	6½p
1N4002	7½p
1N4003	9p
1N4004	9½p
1N4005	12p
1N4006	14p
1N914	7p
1N916	7p
BA100	10p
OA5	42p
OA47	9p
OA81	11p
OA200	8p

PLUGS

DIN 2 Pin	12p
3 Pin	13p
5 Pin 180°	15p
Std. Jack	14½p
2.5mm Jack	11p
Phono	5½p

SOCKETS

DIN 2 Pin	10p
3 Pin	10p
5 Pin 180°	12p
Std. Jack	14½p
2.5mm Jack	11p
Phono	5½p

ELECTROLYTIC CAPACITORS. Tubular & Large Cans

(uF/V): 1/25, 2/25, 4/25, 4·7/10, 5/25, 8/25, 10/10, 10/50, 16/25, 22/63, 25/25, 25/50, 32/25, 50/25, 100/10, 100/25, 6½p. 50/50, 8p. 100/50, 200/25, 11p. 250/50, 18p. 500/10, 11p. 500/25, 15p. 500/50, 18p. 1000/10, 15p. 1000/25, 22p. 1000/50, 40p. 2000/10, 20p. 1000/100 90p. 2000/25, 30p. 2000/100, 95p. 2500/25, 38p. 2500/50, 62p. 3000/50, 80p. 5000/25, 66p. 5000/50, £1·10.

HI-VOLT: 4/450, 14p. 8/350, 19p. 8/450, 20p. 16/350, 22p. 16/450, 23p. 32/350, 33p. 50/250, 20p. 100/350, 60p.

METALLISED PAPER CAPACITORS

250V: 0·05μF, 0·1μF, 6p. 0·25, 6p. 0·5μF, 7½p. 1μF, 9p. 500V: 0·025, 0·05, 6p. 0·1, 6p. 0·25, 7½p. 0·5, 9p. 1000V: 0·01, 11p. 0·022, 13p. 0·047, 0·1, 15p. 0·22, 23p. 0·47, 28p.

Integrated Circuits

μA709C	30p
μA741C	55p
μA723C	£1
ZN414	£1·32

Screened Wire, Metre	6½p
Twin Screened Wire, Metre	12p
Stereo Screened Wire, Metre	12p
Connecting Wire, All colours, Metre	2½p
Neon Bulb, 90V Wire Ended	5 for 24p
Panel Neon, 240V Red, Amber, Clear	20p

NEW KIT

5E12½W Metal Film 5% Ultra Low Noise New Resistors with full colour coding. 5 each E12 value 10ohm/1M total 305 £2·75 Nett.

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WE ARE APPOINTED STOCKISTS AT ALL BRANCHES

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AF30 Mono pre-amplifier	£2.61
AF35 Emitter amplifier	£2.27
AF80 0.5W mic. amplifier	£4.22
AF305 Intercom	£9.52
AF310 Mono amplifier	£5.91
AT5 Automatic light control	£2.58
AT25 Window wiper robot	£5.82
AT30 Photo cell switch unit	£5.70
AT50 400W triac light dimmer/speed control	£4.80
AT56 2,200W triac light dimmer/speed control	£6.90
AT60 1 channel light control	£7.80
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GP304 Circuit board	£4.94
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HF75 FM receiver	£2.87
HF310 FM tuner	£15.81
HF325 Deluxe FM tuner	£24.12
HF330 Decoder (HF310/325)	£9.96
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M192 Stereo balance meter	£4.97
M1302 Transistor tester	£8.46
NT10 Stabilised power supply 100mA, 9V	£6.16
NT300 Stabilised p. supply	£12.51
NT305 Voltage converter	£4.50
NT315 Power supply 240V AC to 4,5/15V DC, 500mA	£9.57

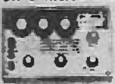
Amateur Electronics by Josty-Kit, the professional book for the amateur —covers the subject from basic principals to advanced electronic techniques. Complete with circuit board for AE1 to AE10.

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

AE1 100mW output stage	£1.50
AE2 Pre-amplifier	£1.15
AE3 Diode receiver	£1.82
AE4 Flasher	99p
AE5 Astable multi-vibrator	95p
AE6 Monostable multi-vibrator	93p
AE7 RC generator	97p
AE8 Bass filter	90p
AE9 Treble filter	90p
AE10 CCIR filter	90p

Also see previous page

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



A new portable bridge offering excellent range and accuracy at low cost. Resistance: 6 ranges 0.1 ohm-11.1 megohm ± 1% Inductance. 6 ranges: 1 microhenry 111 henries ± 2% Capacity: 6 ranges: 10pf-1110 mfd ± 2% Turns Ratio. 6 ranges: 1:1/1000-1:11100 - 1% Bridge Voltage at 1,000cps. Operated from 9-volt battery. 100 micro-amp meter indication. Size 7¼" x 5" x 2"

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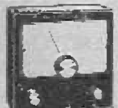
TE16A TRANSISTORISED SIGNAL GENERATOR



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

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MODEL TE20 RF SIGNAL GENERATOR

Six bands. 120kHz—260MHz. Dual output RF terminals. Separate variable audio output. Accuracy ± 2%. Audio output to 8V. Power requirements: 105—125V, 220—240V AC. Size: 193 x 265 x 150mm. Complete with test leads etc.

OUR PRICE £17.50 P&P 40p

TE-200 RF SIGNAL GENERATOR

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

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ARF 300 AF/RF SIGNAL GENERATOR

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

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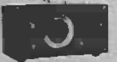
MODEL MG100 SINE SQUARE WAVE AUDIO GENERATOR



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

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MCA220 Automatic Voltage Stabiliser

Input 88—125V AC or 176—250V AC. Output 120V AC or 240V AC. 200V/A rating. P&P 50p

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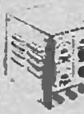
PS100B Regulated POWER SUPPLY UNIT

Solid state. Output 6, 9 or 12V DC up to 3 Amp. Meter to monitor current. Input 220/240V AC. Size: 100 x 82 x 159mm.

OUR PRICE £11.97 P&P 25p

PS200 Regulated POWER SUPPLY UNIT



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

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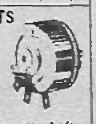
POWER RHEOSTATS



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

25 WATT 10/25/50/100/250/500/1000/2500 Ohms **£1.15** P&P 10p

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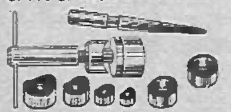
AUTO TRANSFORMERS

0/115/250V. Step up or step down. Fully shrouded.

80 WATTS	£2.75	P&P 18p
150 WATTS	£3.50	P&P 18p
300 WATTS	£4.50	P&P 23p
500 WATTS	£6.95	P&P 33p
1000 WATTS	£9.50	P&P 38p
1500 WATTS	£12.50	P&P 43p
2250 WATTS	£20.95	P&P 50p
5000 WATTS	£44.95	P&P £1

CP110 CHASSIS PUNCH SET



Carefully machined top grade steel. Contains 1/2", 5/8", 3/4", 1" and 1 1/8" punches complete with gripper and accessories.

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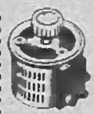
YAMABISHI VARIABLE VOLTAGE TRANSFORMERS

Excellent quality at low cost. Input 230V 50/60Hz. Output 0—260V.

MODEL S260 BENCH MOUNTING

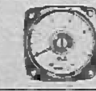


		P&P
1A	£10.50	30p
2.5A	£12.00	35p
5A	£17.50	37p
8A	£30.35	50p
10A	£33.75	75p
12A	£29.50	75p
20A	£85.00	125p
25A	£95.00	130p
40A	£120.00	150p

MODEL S260B PANEL MOUNTING

1A	£10.00	30p
2.5A	£12.00	35p

240° Wide Angle 1mA METERS



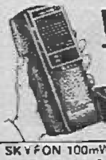
MW 1—6 60x60mm
£6.50 P&P 15p
MW 1—8 80x80mm
£6.90 P&P 15p

BVD5 Vernier TUNING DIAL

App. 7:1 ratio planetary drive vernier dial. Log scale 0—180 degrees. Blank scales 1—5. Dial size 128 x 76mm. Overall size 190 x 117 x 41mm. deep including knob and coupling. ¼" diam. shaft

OUR PRICE £1.62 P&P 15p

WALKIE TALKIES



SKYFON 100mW
OUR PRICE £24.95 per pair
P302 Two Channel 300mW
OUR PRICE £52.50 per pair
P1003 Three Channel 1 Watt
OUR PRICE £71.25 per pair
P&P 50p per pair
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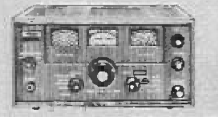
RUH6 Reflex Horn Speaker

Built-in driver unit. Impedence 16 ohms. Power rating 10W. Response 380—7000Hz. Size app. 6" x 6". Weather and shock protected.

OUR PRICE £4.97 P&P 30p

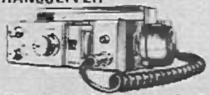
TRIO 9R59DS RECEIVER



Four bands covering 550kHz to 30 MHz continuous and electrical bandspread on 10, 15, 20, 40,and 80 mtrs. 8 valve plus 7 diode circuit. 4 to 8 ohm output and phone jack. SSB-CW, ANL, variable BFO, S Meter and separate band spread dial. IF frequency 445kHz, audio output 1½ watt. Variable RF and AF gain controls. 115/250V AC, with instructions.

Our Price £42.50 CARR. PAID

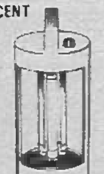
BELTEK W5400 CAR TRANSCEIVER



Solid state mobile transceiver for 12 volt DC neg. Transmits and receives on any 12 of 28 channels between 144 and 146MHz. Power output 10W and 1W switchable. Controls: On/off/volume, squelch and channel selector. Internal 3" speaker. Complete with dynamic mic. PTT switch, three sets of crystals for 144.48, 144.6 and 145MHz, mounting bracket and instructions. Size 150 x 70 x 220mm.

OUR PRICE £75.00 P&P 50p

HITACHI FLUORESCENT LANTERN L1901



A portable battery operated lantern ideal for home, motoring, camping etc. Approx 10" tall. Provides brilliant light from 9 1.5v batteries (not supplied)

OUR PRICE £7.90
P&P 25p

OT55G DIGITAL CLOCK MECHANISM

Features 24 hour alarm setting, on/off and auto alarm 'sleep' switch. Illuminated rotary dial with hours, minutes and seconds. Automatically turns off radio, TV, light etc. and with auto switching will turn on again when required. 240V AC operation. Switch rating 250V—3 Amp.

OUR PRICE £5.95 P&P 30p

KE630 3 Station INTERCOM

Master and two sub stations. Can be used on desk or wall mounted. Complete with cable and batteries

OUR PRICE £5.25 P&P 50p

LH02S STEREO HEADPHONES

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

OUR PRICE £1.97 P&P 30p

TE1018 Deluxe Mono High Impedence Headset.

Sensitive magnetic headset with soft ear pads. Impedence 2,600 ohms (600 ohms DC). Frequency response: 200—4,000Hz.

OUR PRICE £2.25 P&P 30p

DH02S STEREO HEADPHONES

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

OUR PRICE £2.50 P&P 30p

TE1035 Stereo HEADPHONES

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

OUR PRICE £2.60 P&P 30p

SH8DV MONO/STEREO HEADPHONES

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

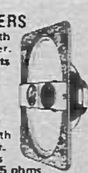
OUR PRICE £4.97 P&P 30p

BH001 HEADSET and Boom Microphone

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

OUR PRICE £5.95 P&P 30p

EMI LOUDSPEAKERS



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

OUR PRICE £7.50 each P&P 37p

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

OUR PRICE £3.62 each P&P 25p

SPECIAL PURCHASE LIMITED QUANTITY!

Tannoy 12" DR/8 Bass Speakers

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

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SPECIAL BARGAIN !! STEREOSOUND SPEAKERS

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

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SPECIAL BARGAIN! FERGUSON 3406 HI-FI SPEAKERS

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

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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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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.

ALL PRICES EXCLUDE VAT

SEW CLEAR PLASTIC PANEL METERS

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

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

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

CLEAR PLASTIC MODEL SO640
Size: 85 x 64mm

50uA	£3.80		
100uA	£3.75		
200uA	£3.70		
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	10V DC	£3.65
100mA	£3.65	20V DC	£3.65
500mA	£3.65	50V DC	£3.65
1A DC	£3.65	300V DC	£3.65
5A DC	£3.85	15V AC	£3.75
10A DC	£3.66	300V AC	£3.75
5V DC	£3.65	VU Meter	£3.90

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	10V DC	£4.10
100mA	£4.10	20V DC	£4.10
500mA	£4.10	50V DC	£4.10
1A DC	£4.10	300V DC	£4.10
5A DC	£4.10	15V AC	£4.20
10A DC	£4.10	300V AC	£4.20
5V DC	£4.10	VU Meter	£4.40

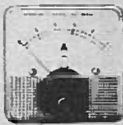
CLEAR PLASTIC MODEL MR 65P
Size: 86 x 78mm

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

CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm

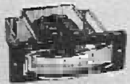
50uA	£4.60		
100uA	£4.50		
500uA	£4.30		
50-0-50uA	£4.50		
100-0-100uA	£4.45		
1mA	£4.30		
1A DC	£4.30		
5A DC	£4.30		
20V DC	£4.30	150V AC	£4.45
50V DC	£4.30	300V AC	£4.45
300V DC	£4.30	VU Meter	£4.90

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



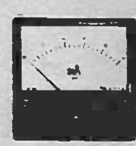
50uA	£3.20		
100uA	£3.15		
200uA	£3.10		
500uA	£3.00		
50-0-50uA	£3.15		
100-0-100uA	£3.10		
500-0-500uA	£2.95		
1mA	£2.95		
5mA	£2.95		
10mA	£2.95		
50mA	£2.95		
100mA	£2.95		
500mA	£2.95	300V AC	£3.05
1A DC	£2.95	S Meter 1mA	£2.95
5A DC	£2.95	VU Meter	£3.40
10V DC	£2.95	1A AC	* £2.95
20V DC	£2.95	5A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

EDGWISE MODEL PE70
Size: 90 x 34mm



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

BAKELITE MODEL S80 Enlarged Window
Size: 80 x 80mm



50uA	£4.60
100uA	£4.45
500uA	£4.20
50-0-50uA	£4.45
100-0-100uA	£4.40
1mA	£4.20
1A DC	£4.20
5A DC	£4.20
20V DC	£4.20
50V DC	£4.20
300V DC	£4.20
300V AC	£4.30
VU Meter	£4.70

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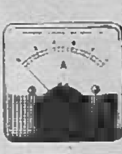
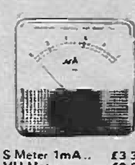
100uA	£7.90		
50-0-50uA	£7.90		
1mA	£7.60	20V DC	£7.60
1-0-1mA	£7.60	50V DC	£7.60
1A DC	£7.60	300V DC	£7.60
5A DC	£7.60	500mA/5A DC	£8.60
5V DC	£7.60	5V/50V DC	£8.60
10V DC	£7.60	5V/15V DC	£8.60
15V DC	£7.60	1/5A DC	£8.60
		1A/15A DC	£8.60

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



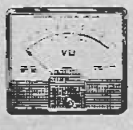
50uA	£3.10		
100uA	£3.05		
200uA	£3.00		
500uA	£2.85		
50-0-50uA	£3.05		
100-0-100uA	£3.00		
500-0-500uA	£2.80		
1mA	£2.80		
1-0-1mA	£2.80		
2mA	£2.80		
5mA	£2.80		
10mA	£2.80		
20mA	£2.80		
50mA	£2.80	20V DC	£2.80
100mA	£2.80	50V DC	£2.80
150mA	£2.80	100V DC	£2.80
200mA	£2.80	150V DC	£2.80
300mA	£2.80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

CLEAR PLASTIC MODEL MR 52P
Size 60 x 60mm



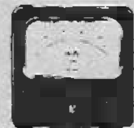
50uA	£3.70		
100uA	£3.50		
500uA	£3.35		
50-0-50uA	£3.50		
100-0-100uA	£3.45		
1mA	£3.30		
5mA	£3.30		
10mA	£3.30		
50mA	£3.30		
100mA	£3.30		
500mA	£3.30		
1A DC	£3.30		
5A DC	£3.30	S Meter 1mA	£3.30
10V DC	£3.30	VU Meter	£3.80
20V DC	£3.30	1A AC	* £3.30
50V DC	£3.30	5A AC	* £3.30
300V DC	£3.30	10A AC	* £3.30
15V AC	£3.40	20A AC	* £3.30
300V AC	£3.40	30A AC	* £3.30

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



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

BAKELITE MODEL MR 65 Size: 80 x 80mm



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

CLEAR PLASTIC MODEL SO460
Size: 59 x 46mm

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

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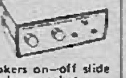

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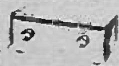

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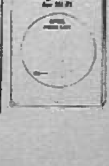

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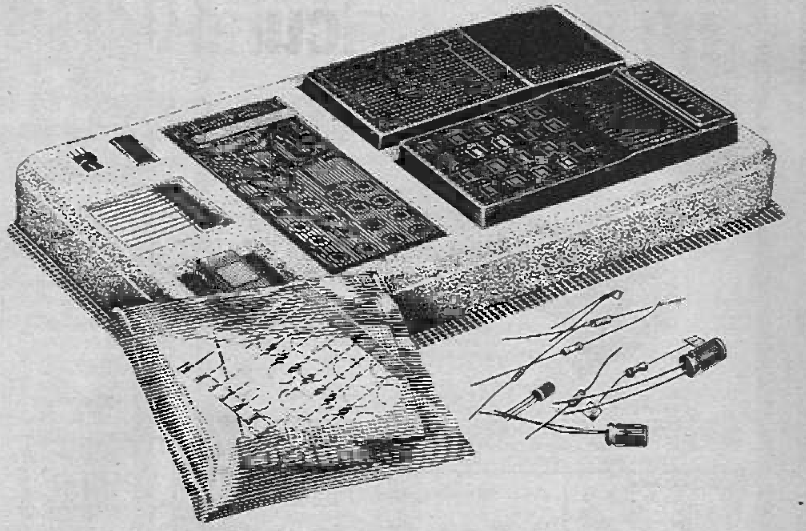
10. Soft wallet.



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* Uniquely handy package. $4\frac{1}{2}" \times 2" \times \frac{11}{16}"$, weight $3\frac{1}{2}$ oz.
* Standard keyboard. All you need for complex calculations.
* Clear-last-entry feature.
* Fully-floating decimal point.
* Algebraic logic.
* Four operators (+, –, x, ÷), with constant on all four.
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everyday electronics

PROJECTS...
THEORY.....

POCKETS AND PROJECTS

The tide of rising prices and inflation does not look like subsiding, yet. All we can hope for in our most optimistic mood is that the peak of the flood has now been experienced (and suffered) and that the tide will soon be on the ebb. At any rate, most of us will have to continue to consider very carefully any proposed expenditure in the immediate future.

Whether hobbies and leisure pursuits in general suffer or prosper in times of financial difficulty is an interesting debating point. One cannot generalise, of course, since a lot depends upon the nature of the hobby and the personal circumstances of the individual.

Some leisure pursuits are entirely recreational and possibly extravagant in outlay for services or equipment. Of a different nature are the many traditional crafts that can be taken up for fun but provide an additional permanent bonus in the form of some tangible result from the effort expended.

To the list of established traditional crafts, we must now include electronics. With the introduction of simple-to-use circuit devices, most of the old terrors of electronics have disappeared. The average man in the street can be as happily engaged in building and experimenting, as the technically trained expert. The nature of this subject allows useful and interesting involvement at all levels. One can restrict one's interest to quite a modest level; or one can progress practically without limitation—save that of the depth of pocket—to the highest heights, by building ambitious and technically complex projects.

Among electronics magazines for hôme constructors, Everyday Electronics is unique in covering the modest end of the business *exclusively*. This means we devote much of our attention to the absolute beginner and help him (or her) on the way, by explaining in plain language the basic facts of life: about both the theory of electronic circuits and the practice of assembling electronic projects from readily available, and generally inexpensive, components.

Now that we have come back to "money," this is a good opportunity to mention another Everyday Electronics exclusive feature—The Cost Box. Desirable as a particular design may be, the expenditure involved is likely to be a decisive factor in determining whether or not to go ahead. So we ensure that readers have a good idea as to the probable cost of each and every constructional project we present.

The shrewd contructor will appreciate the good investment our projects provide!

Fred Bennett.

Our July issue will be published on Friday, June 21

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EASY TO CONSTRUCT
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VOL. 3 NO. 6 JUNE 1974

CONSTRUCTIONAL PROJECTS

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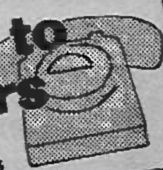
A special call to all subscribers



see page 337 for more details

The position for effective operation of a deep freeze unit is usually outside and remote from the kitchen or lounge and very often it is situated in the garage and may only be visited once a day or less. If the deep freeze unit develops a fault it may be sometime before this is discovered and by that time the contents may be spoiled.

The unit to be described here will help to prevent this spoiling by giving an audible and visual alarm when the temperature in the freezer compartment varies by more than plus or minus 1·5 degrees. In this way the fault is brought to your attention, and repairs and/or other arrangements can be made immediately, such as lagging the freezer until repairs are carried out or moving the contents to another freezer.

CIRCUIT DESCRIPTION

The circuit diagram of the Freezer Temperature Alarm is shown in Fig. 1. The unit uses a differential amplifier IC1 whose voltage output, pin 6, is proportional to the difference in voltage between the two inputs, pins 2 and 3.

The voltage on pin 3 is held constant by the potential divider effect of resistors R7 and R8, the potential at their junction being set at half the supply voltage i.e. 6V. The voltage applied to pin 2 is controlled by the potential divider effect of the resistance chain R9, VR1 and RTH1.

Potentiometer VR1 is a preset control, wired to act as a variable resistor for setting up purposes. At a given temperature, VR1 can be adjusted so that the voltage appearing on pin 2 is the same as that at pin 3, in this instance there will be no voltage at the output (pin 6).

Now a thermistor is a component whose resistance varies in a known way with temperature so that when the temperature changes the voltage at pin 2 changes, and thus an output voltage is produced. The unit has been designed such that a 1·5 degree temperature change (with G14 thermistor) produces sufficient output voltage to operate relay RLA.

When the relay contacts, RLA1, close, power is available to operate the astable multivibrator composed of TR1, TR2 and associated components. The frequency of the multivibrator is 1Hz (approximately) determined by the timing components R1, C6 and R4, C5. Therefore the output from the collector of TR2 is a train of positive pulses and these are fed via R5 to the

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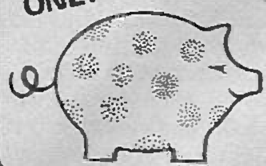


£7.10

excluding case

*Based on prices prevailing at time of going to press

FREEZER TEMPERATURE ALARM

BY T.P. MANNING & R.D. HIDER

Gives an audible and visual alarm if the temperature inside the freezer varies.

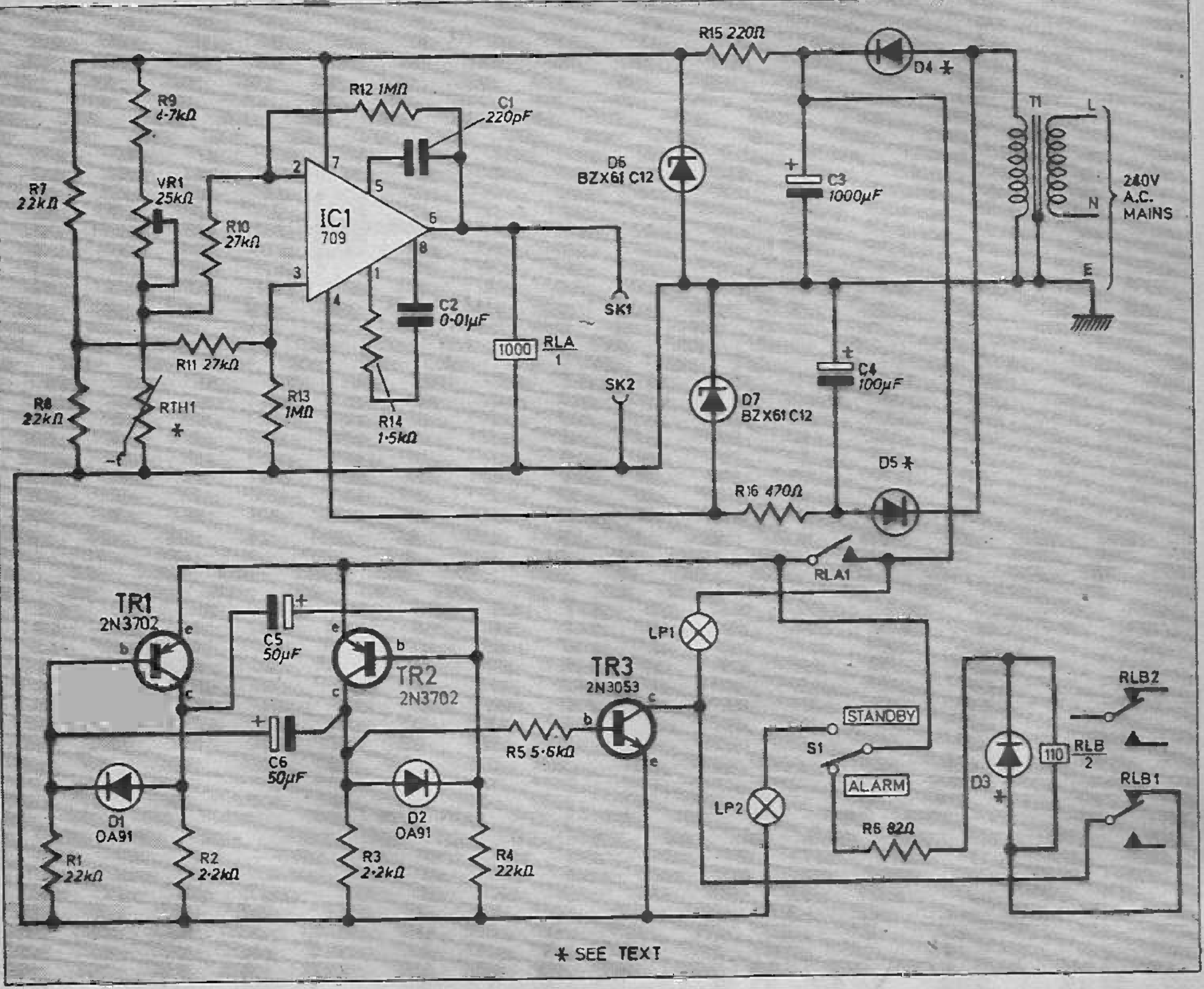


Fig. 1. The complete circuit diagram of the Freezer Temperature Alarm.

base of TR3.

Each time a positive voltage is applied to the base of TR3, it is biased into conduction and TR3 collector falls to almost zero volts causing almost 20 volts to be placed across the lamp LP1 causing the latter to be illuminated. The net result of the pulse train is to cause LP1 to flash on and off thus giving the visual alarm.

With S1 in the position shown, RLB is in parallel with LP1 and is energised each time LP1 is illuminated. Contact RLB1 is wired so that when the relay is energised, the contact is pulled in and breaks the circuit causing the relay to become de-energised. As this happens, RLB1 springs back and makes the circuit again and the cycle is repeated.

This process happens very quickly and the relay contact is made to "buzz" thus giving the audible alarm. This is the principle on which the simple bell works.

With S1 in its other position the buzzer is taken out of circuit and this is indicated by the illumination of LP2. This is useful in setting up the unit as the buzzer can be annoying.

Resistor R6 is incorporated in series with RLB to drop the voltage across the relay to 12V.

If desired, the audible and visual alarm can be omitted and another alarm of your choice, e.g., a buzzer can be employed, contact RLA1 switching it on (the contacts are rated at 200mA maximum). In this case all circuitry below relay contact RLA1 in Fig. 1 is not required.

P.C. BOARD

The component board used in the prototype was a home made printed circuit type, the full-size drawing of which is shown in Fig. 2.

The easiest way of making the board is to thoroughly clean a piece of copper clad board, size 140 x 90mm and then with either enamel paint or a Dalo pen (etchant resist) cover in the areas shown in black on the master drawing —these are the areas of copper to remain after etching.

When the etchant resist has completely dried, check the board for mistakes, ragged edges and uncovered areas and when completely satisfied, the board should be immersed in a dish of dilute

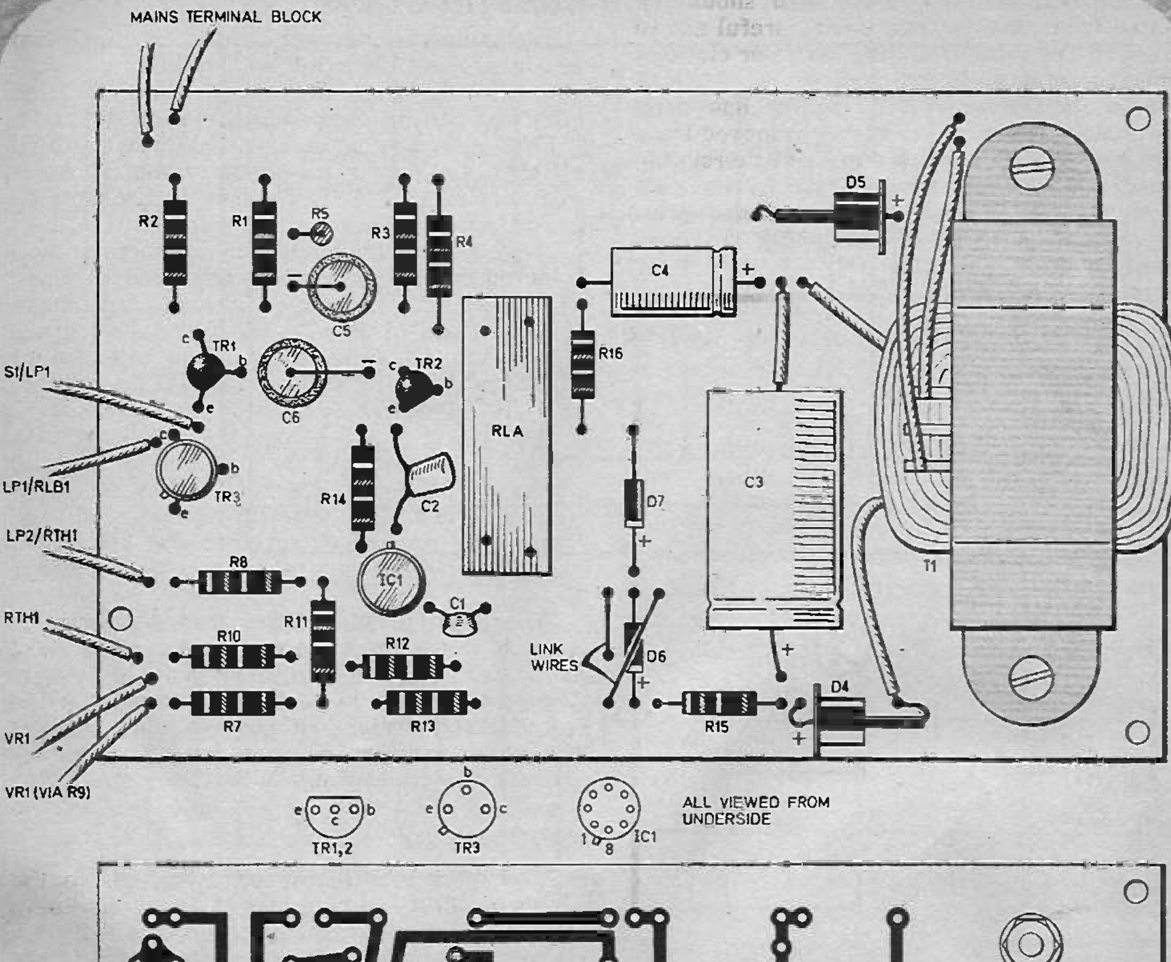


Fig. 2 (top). The layout of the components on the top side of the printed circuit board and (below) the full-sized master drawing of the copper pattern on the underside of the board.

ferric chloride solution. The board should be agitated from time to time being careful not to get any of the solution on the hands or clothing as it is poisonous and corrosive.

When all the unwanted copper has been etched away, the board should be removed from the dish with a pair of tweezers and thoroughly washed under running tap water.

Now clean off the resist and drill all the necessary holes. The board is now ready for component assembly.

Components....

Resistors

R1	22kΩ
R2	2·2kΩ
R3	2·2kΩ
R4	22kΩ
R5	56kΩ
R6	82Ω
R7	22kΩ
R8	22kΩ—see text
R9	4·7kΩ
R10	27kΩ
R11	27kΩ
R12	1MΩ
R13	1MΩ
R14	1·5kΩ
R15	220Ω
R16	470Ω

All ½W ±10% carbon

SEE SHOP TALK

Capacitors

C1	220pF
C2	0·01μF
C3	1000μF elect. 25V
C4	100μF elect. 25V
C5	50μF elect. 25V
C6	50μF elect. 25V

Semiconductors

TR1, 2	OC71 germanium *pnp* (2 off)
TR3	2N3053 silicon *npn*
D1, 2	0A91 (2 off)
D3	BY234
D4, 5	IN92 or any 1A 50V diode (2 off)
D6, 7	BZX61, 12V 1W Zener (2 off)
IC1	709 differential amplifier TO-99 case
RTH1	G14 thermistor—see text

Miscellaneous

VR1	25kΩ carbon preset TV type
S1	single-pole changeover toggle
SK1, 2	4mm insulated sockets, one red, one black (2 off)
T1	mains/15V 500mA secondary
LP1, 2	m.e.s. 20V 100mA lamps and panel mounting lampholders, one amber lens, one clear lens (2 off)
RLA	9–12V reed relay with coil resistance greater than 200 ohms (type RR (9-12) colour blue)
RLB	12V with changeover contacts and coil resistance 110 ohms (Omron)

Copper clad board size 140 x 90mm; 2A terminal blocks, 2-way and 3-way; length of three core mains cable; 4BA nuts, bolts, washers and stand off spacers; metal case.

CONSTRUCTION

The prototype unit was built in an aluminium box measuring 150 x 100 x 65mm with a removable lid. This should be the minimum size used otherwise all the components will not fit inside.

First, obtain or build a suitable box and drill all the fixing and components mounting holes as indicated in Fig. 3. The box should now be painted or covered.

The components should now be mounted and soldered in position on the printed circuit board as detailed in Fig. 2 paying special attention to the polarities of the diodes, capacitors, integrated circuit and transistors. Use a heatshunt when soldering the semiconductors. Do not connect the flying leads at this stage.

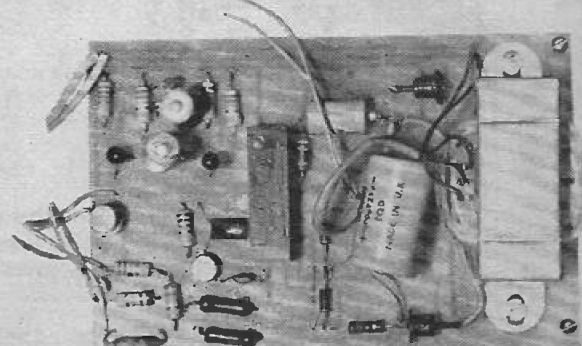
Next position and secure the components to the lid of the box and the two sets of terminal blocks to the bottom half of the box as shown in Fig. 3, and then wire up as indicated. The mains lead should be let into the box via a rubber grommet and a cable clip used to anchor it.

When completely satisfied that the wiring is correct, secure the component board to the base of the box with 4BA fixings and stand-off spacers and place the lid in position **ensuring that the lid mounted components do not touch any of the board mounted components and more important, the transformer.**

SETTING UP

Disconnect the thermistor, switch S1 to the alarm position and plug in and switch on. Lamp LP1 should flash and the buzzer sound. Switch S1 to the standby position and LP2 should light up and the buzzer cease to operate; LP1 should still flash.

If all is satisfactory, switch off the unit and insert the thermistor in its terminal block on a length of twin cable and place the thermistor inside the deep freeze cabinet. It will depend on the model of the freezer how access is obtained, but in chest type freezers it is sufficient to lay the thermistor on the seal so that



Photograph of the completed prototype component board.

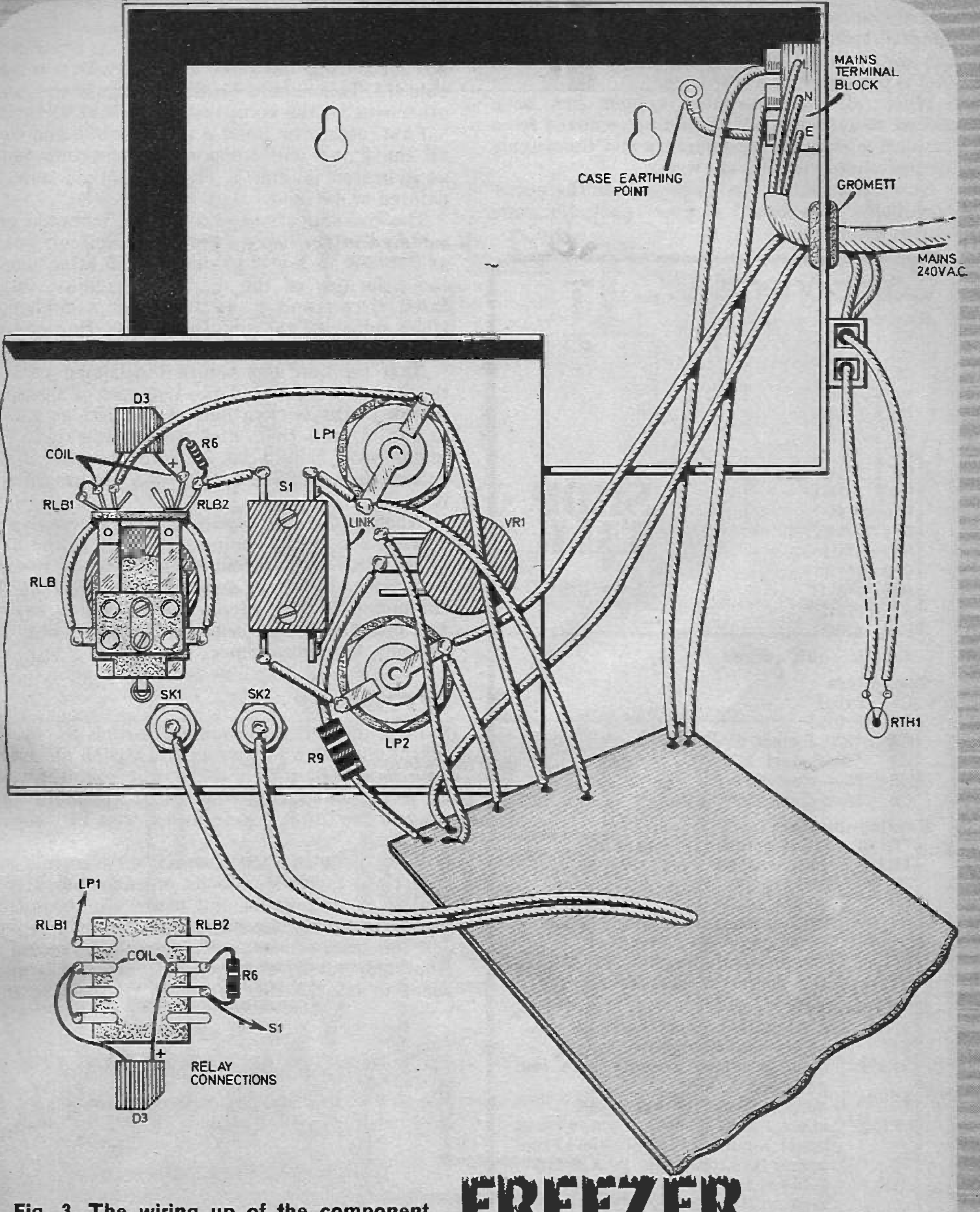


Fig. 3. The wiring up of the component board to the case mounted components. Also shown is the wiring around the buzzer relay.

FREEZER TEMPERATURE ALARM

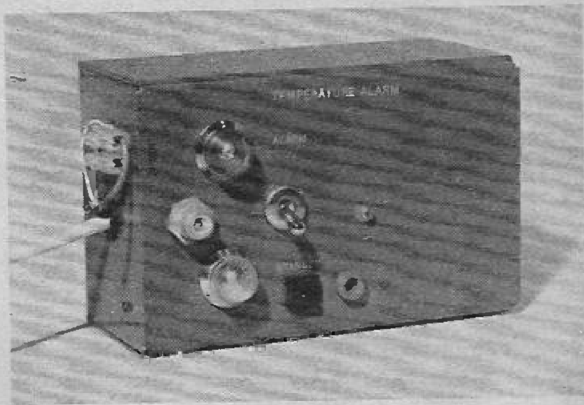
the lid closes down on the wires, the thermistor hanging in the freezer compartment.

With the freezer working normally, and set to "0" degrees centigrade, allow the thermistor to stabilise at the working temperature and then switch on the unit with S1 at alarm. Now connect a d.c. voltmeter set to read 10V in SK1 and SK2 and adjust VR1 to read zero volts. The lamp should stop flashing and the buzzer should cease to operate.

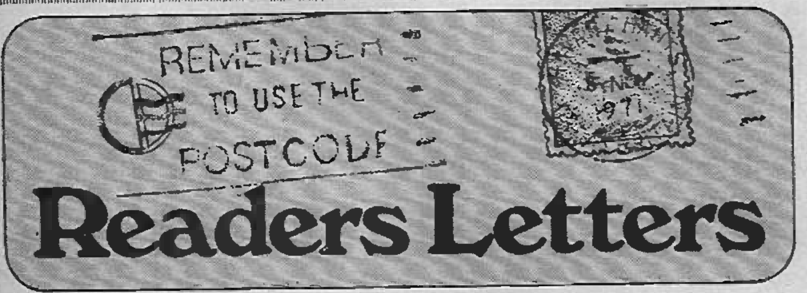
The Freezer Temperature Alarm will now trigger if there is a change of plus or minus 1·5 degrees centigrade. The length of the cable between the thermistor (in the freezer) and the unit adjacent to a convenient power point in the room of your choice can be as long as necessary (within reason).

THERMISTOR

The foregoing setting up procedure is applicable where a type G14 thermistor is used, however, it is not essential that this particular type is used as any other type can be used providing its resistance is known or can be identified at 0, +2 and −2 degrees centigrade in which case the following procedure should be used: (1) Replace R8 with a resistor of the value of the thermistor at 0 degrees centigrade. (2) With a resistor of the same ohmic value as the thermistor at +2 degrees centigrade fitted in place of the thermistor, adjust R12 and R13 until the alarm just comes in. (3) Remove this resistor and refit the thermistor and set up as described above. ▣



Photograph of completed unit.



Current Flow

I purchased the March '74 issue of E.E. today just to see how you were getting on as I have often recommended to friends that reading E.E. was a good introduction to the subject.

However having studied page 163 I am sorry to say that I will think twice before doing so again. How A. P. Stephenson can, in the space of two inches reverse the direction of current flow without a single word of explanation is beyond me. The effect of this rubbish on a person trying to grasp how a transistor works is confusing to say the least, and can only make the subject more difficult to understand.

Perhaps Mr. Stephenson would like to note that electron flow and current flow are the same thing, moving in the same direction (We only need "holes" wandering backwards, or is it forwards, to add to the confusion and mumbo jumbo which exists.)

Please realise that your publication is read by school children who can ill afford to be mixed up by those who should know better.

Alexander C. Young,
Director, Wilton Electronics
(Scot.) Ltd.,
Glasgow.

Your confusion over the difference between conventional current and electron flow is understandable because years ago I had the same trouble. The mix up started in the years of the pioneers, Kirchhoff, Ohm and Faraday when it was arbitrarily decided that "current" flowed from positive to negative and arrows showing directions have traditionally followed this convention. "Electrons" (which came later) were found to flow in the opposite direction—hence the confusion.

Regarding your specific criticism, perhaps you might care to re-examine the offending "two inches of my article" and note that Fig. 7.1 is labelled "Electron-Flow" and Fig. 8.1 is labelled "Current Flow." The difference between electron flow and current flow was pointed out in the November 1973 issue of E.E.—A. P. Stephenson.

Transistor Assisted Ignition

I have read with great interest in this month's magazine (April '74) of the *Transistor Assisted Ignition*. As I have a 6V system on my car, please could you tell me if this is suitable or would I need different components.

M. Steeden,
Faversham, Kent.

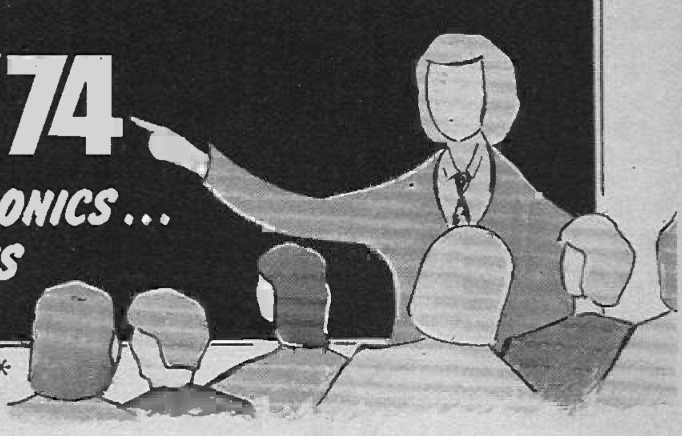
We are looking into the suitability of the unit and we hope to publish some comments on the Transistor Assisted Ignition *for 6V cars in the near future.*

Please Take Note

In the *Semiconductor Primer* page 281 last month. It was stated that h_{FE} was $\frac{\text{base current}}{\text{collector current}}$ this should have been $\frac{\text{collector current}}{\text{base current}}$

TEACH-IN '74

FOR BEGINNERS IN ELECTRONICS ... THEORY AND EXPERIMENTS



TUTOR: PHIL ALLCOCK*

LESSON 9 Inductance and the Transformer

INDUCTANCE is measured in terms of a basic unit known as the "henry" and it is a fundamental property that inductance can be related to the voltage across a coil and the rate of change of current through it. The symbol for a coil or inductor is given on the wall chart and the usual sub-divisions of the basic unit of one henry can be used e.g. $1\text{mH} = (^1\!/_{1000})$th of one henry.

If a coil has an inductance (L) of one henry and the current through it is made to change at a rate of 1 amp/sec., then a voltage difference of one volt will be present between the ends of the coil due to electromagnetic induction. The changing current sets up a changing magnetic field or flux and the voltage exists only whilst the current is changing.

A *constant* current of say one ampere would give zero voltage since the magnetic field and flux would be fixed. Obviously this is another example of a component that depends on the rate of change of a quantity. The voltage variation that would occur from the given current waveforms are shown in Fig. 9.1, it can be seen that in each case the coil voltage is given by

Voltage = L × (Rate of change of current).

Consistent units are volts, henries and amps./second.

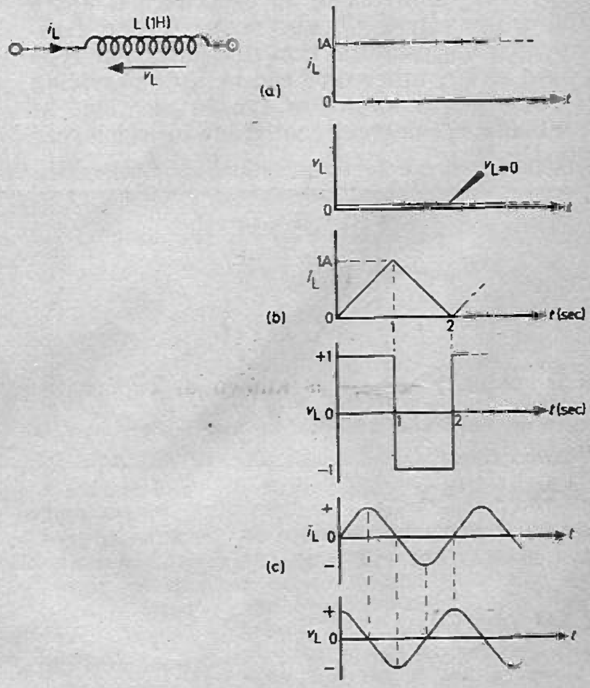


Fig. 9.1. Voltage and current waveforms for an inductor.

REACTANCE

The sine wave variation, of current or voltage, will always have the standard shape and so it is possible to work out the maximum value of the rate of change which occurs each time the sine-waves passes through the zero axis. For the instantaneous current i, we can write

$$i = I_m \sin(2\pi ft).$$

Where I_m is the *peak* value of the wave and f is the frequency in Hz. The *maximum* rate of change is given by $2\pi fI_m$ whilst at the peaks of the wave, the rate of change is always zero. Using these facts we can write the *peak* voltage across the coil L as:

$$\text{peak voltage} = L \times (2\pi fI_m)$$
$$= (2\pi fL) \times (\text{peak current}).$$

The quantity $2\pi fL$ is shown as the inductive reactance of the coil and is a measure of its

* North Staffordshire Polytechnic *.Any communications arising from the Teach-In '74 series must be addressed to Everyday Electronics, Fleetway House, Farringdon Street, London E.C.4).*

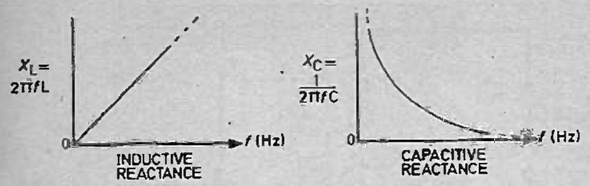


Fig. 9.2. Variation of reactance with frequency.

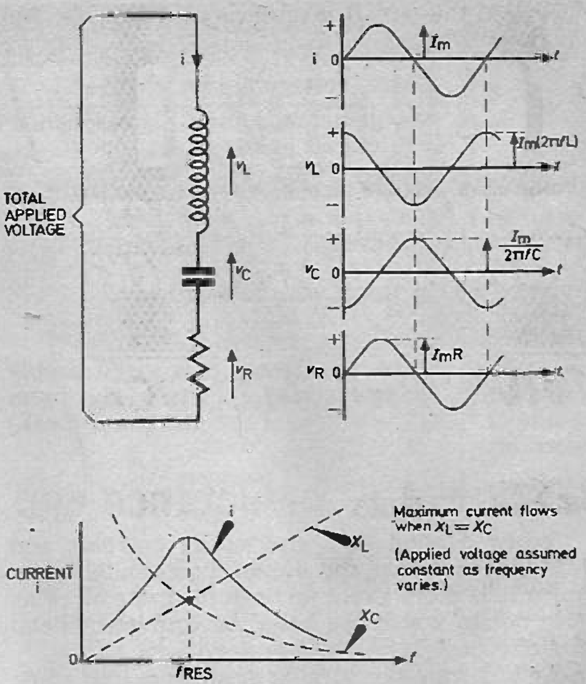


Fig. 9.3a (top) Voltage waveforms for an *LCR* series circuit. (b) Variation of current in a series resonant circuit.

ability to limit alternating current flow. It is measured in ohms, just like resistance, but does not depend in any way on the resistance of the wire used for the coil. An ideal (perfect) coil would have no wire resistance but would have a reactance that depends on frequency f and inductance L, Fig. 9.2 shows how inductive reactance varies with frequency for a given value of L. A similar result can be obtained for the capacitor. If the voltage is written as $V_m \sin(2\pi ft)$ then:

$$\text{peak current} = C \times (\text{maximum rate of change of voltage})$$

$$I_m = C \times 2\pi f V_m$$

$$\text{hence} \quad V_m = I_m \times \left(\frac{1}{2\pi fC}\right)$$

The quantity $\dfrac{1}{2\pi fC}$ is known as capacitive reactance and the variation with frequency is also given in Fig. 9.2. It is important to realise that a 90 degree phase displacement also occurs with the inductor, but in this case the current lags the voltage by 90 degrees (i.e. the voltage leads the current this time).

RESONANCE

It is possible to produce some very interesting and useful effects by combining inductance and capacitance together. Since practical coils invariably have resistance we can simulate a real coil by studying an ideal resistor in series with an ideal inductor. Thus a series *LCR* circuit could be represented by the circuit of Fig. 9.3a.

If the current is assumed to be sinusoidal, the voltage across each element can be obtained using the ideas previously discussed and the total instantaneous voltage can then be obtained by addition of the individual voltage waveforms. The waveforms are shown in Fig. 9.3a and it is easy to see that the variations of voltage across L and C are in the opposite sense and therefore tend to cancel each other.

If the peak values are equal the cancellation will be perfect and this condition is known as series resonance. For cancellation, we must make the peak values of v_L and v_C equal and this requires that

$$2\pi f I_m = I_m\left(\frac{1}{2\pi fC}\right)$$

$$\text{rearranging terms gives } f^2 = \frac{1}{(2\pi)^2 LC}$$

$$\text{hence } f\,(\text{resonance}) = \frac{1}{2\pi\sqrt{LC}}\,\text{Hz}.$$

Thus, at this frequency (which depends on the L and C values) the voltages v_L and v_C completely cancel each other out, and the voltage across the complete L C R circuit is exactly the same as the voltage across the resistor. In fact at this one frequency the circuit behaves as a simple resistor of value R.

At other frequencies the total voltage (for a given current) will increase since the cancellation of v_L and v_C will be incomplete. If we apply a constant voltage at various frequencies to a series L C R circuit the current will vary as shown in Fig. 9.3b. Note that at the resonant frequency the current is at its maximum value.

CIRCUIT MAGNIFICATION

At resonance the voltage across either L or C can be considerably greater than the voltage applied to the circuit. The ratio of these voltages is called the circuit magnification factor Q_o and is given by

$$Q_o = \frac{\text{Max. voltage across whole}}{\text{Max. voltage across } L \text{ (or } C\text{) at resonance circuit at resonance}}$$

Since the voltage across the whole circuit at resonance equals that across R we have

$$Q_o = \frac{(2\pi f L)\ I_m}{R\ I_m} = \frac{2\pi f L}{R}$$

Note that the voltage across R is given simply by Ohm's law and therefore has a maximum value of $I_m \times R$, where I_m is the maximum (peak) current.

R.M.S. VALUES

When dealing with alternating currents and voltages that have the standard sinusoidal waveform it is more usual to work in terms of *effective values* which are based on equivalent heating effects.

To illustrate this idea let us suppose that when we pass an alternating (sinusoidal) current, of peak value I_m amps, through a resistance of value R ohms, the *average* power dissipation is given by P_{AV}. (The instantaneous power will be fluctuating throughout each cycle as the current varies.) If we set up an equal value resistor with a *steady* current I and adjust I to give the *same average power dissipation* as in the first resistor, then I is defined as the effective or root-mean-square (r.m.s.) value of the alternating current. For sinusoidal currents the relationship is

$$I\,(\text{r.m.s.}) = \frac{\text{peak current}}{\sqrt{2}} = \frac{I_m}{\sqrt{2}}$$

Since $\frac{1}{\sqrt{2}} = 0{\cdot}707$, the r.m.s. value of the current is approximately 71 per cent of the peak current. A similar proportionality exists between r.m.s. and peak voltages providing the waveform is sinusoidal.

MEASUREMENT OF ALTERNATING CURRENT/VOLTAGE

All the measurements made so far in the series have been possible using a 0-1V or 0-10V voltmeter. The moving coil of the 100μA meter carries the current and rotates due to the interaction of the magnetic field of the coil and the permanent magnet system which surrounds the moving coil. The coil also experiences a restoring force provided by the fine "hair springs" and thus rotates until all the forces balance.

If we apply an alternating voltage to our 0-10V voltmeter the coil will try to rotate one way,

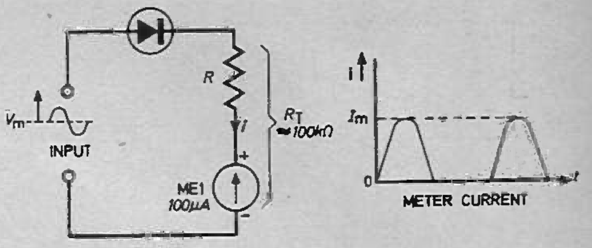


Fig. 9.4 "Halfwave" voltmeter circuit.

then the opposite way and the net deflection will be zero. Only if the applied waveform has a non-zero average value (over one cycle) will the meter respond.

To make a simple voltmeter for alternating voltages we can use a diode in series with the usual meter circuit so that current can flow only for one half cycle of the input. If we neglect the forward voltage drop across the diode the meter will respond to the *average* value of the half-wave voltage variation as shown in Fig. 9.4. The current in the meter consists of a series of unidirectional half-sinewave pulses having a peak value of V_m/R_T where R_T is the total resistance of R and the meter together. The average value of this current can be shown to be I_m/π i.e. $0{\cdot}318(I_m)$. Thus a sinusoidal voltage of say 10 volts (r.m.s.) would have a peak value of $10\sqrt{2}$ volts and since R_T is approximately 100 kilohms the peak current can be found.

$$I_m = \frac{14.14}{100{,}000} = 141.4\mu\text{A}.$$

For this input, the meter will indicate a current of $141{\cdot}4 \times 0{\cdot}318 = 45\mu$A.

In practice the forward voltage drop across the diode would give a reading somewhat less than this. Assuming that $0{\cdot}6$ volts is "lost" across the diode the actual reading will be about 43μA.

By using four diodes it is possible to get almost double this deflection, for the same voltage input, by passing current through the meter for each half cycle in the *same* direction.

The circuit for this full-wave rectifier meter is shown in Fig. 9.5. When A is positive with respect to B, diodes D1 and D2 conduct and D3 and D4 are reverse biased. When B is positive with respect to A, the roles of the diodes are changed and D3, D4 now conduct. Note that current flow in the meter is always in the same direction. Since the number of current pulses/sec. is now doubled, the average current and therefore the meter reading is doubled.

The improvement is not exactly a factor of two since the circuit now introduces two diodes in series each half cycle and the voltage drop is therefore increased. The meter will indicate approximately 80μA for a 10 volt r.m.s. input.

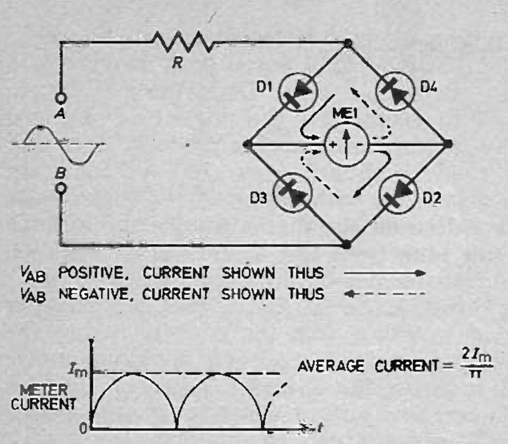


Fig. 9.5 "Full-wave" voltmeter circuit.

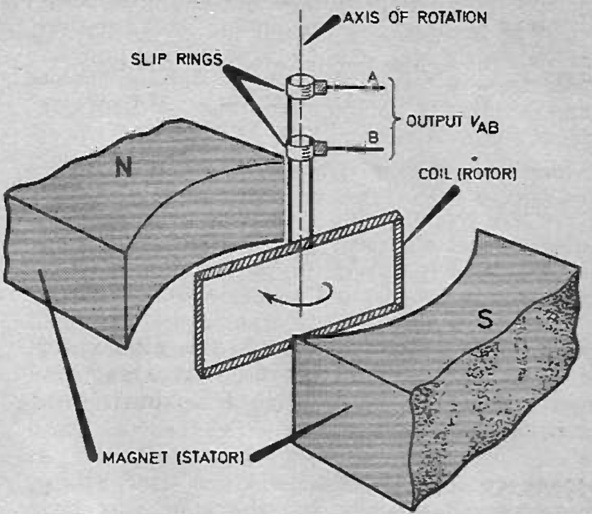


Fig. 9.6. A diagram of a simple alternator.

THE ALTERNATOR

We have introduced the idea of alternating voltage and current and also examined the behaviour of resistance, capacitance and inductance in situations involving alternating current. The usual household mains supply is generated at a power station by an electrical machine known as an alternator. (Yes, you are right! A smaller version of the same device is used in the electrical system of the modern car.)

In its simplest form a coil of wire (the rotor) is turned between the poles of a magnet. See Fig. 9.6. Connections are made to the ends of the coil by contacts which press on two slip rings. When the coil rotates in the magnetic field produced by the (stator) magnets a voltage is induced in the coil by electromagnetic action.

The voltage is found to depend on the rate of change of magnetic flux linking the coil and the situation is illustrated in Fig. 9.7. The **rate of change of flux linkage** is seen to be a maximum when the coil sides are actually moving across the magnetic field lines (which merely represent the actual magnetic field in our diagram) and is a minimum when the coil sides are moving along the field lines.

The generation of one complete cycle of the sine waveform that is produced by this alternator is shown in Fig. 9.7 and it can be seen that the voltage V_{AB} measured between the two slip rings reverses polarity every half revolution of the coil.

In the power station the rotor coil is driven by a steam turbine and the speed of rotation is held fairly constant. Since each revolution gives one complete cycle a constant alternator speed will produce an output having a constant frequency (number of cycles per second). Use is made of this constant frequency feature in the household (mains) electric clock which employs a synchronous motor that revolves in step (i.e. synchronism) with the mains supply frequency.

TRANSFORMER PRINCIPLE

It is not necessary to use a permanent magnet and a moving coil to utilise the electromagnetic induction effect. The essential requirement is a **flux linkage** which can be changed with time and the resulting voltage will always depend on the rate of change of the flux linkage. A transformer is simply a set of two or more coils that share a common core of magnetisable material, such as soft iron, and in use one coil is used to set up a time varying magnetic field which links with the other coil or coils to generate an output voltage.

It will be apparent from what we have said so far that the transformer can only work if the magnetic field in the core is made to change and because of this a transformer cannot be

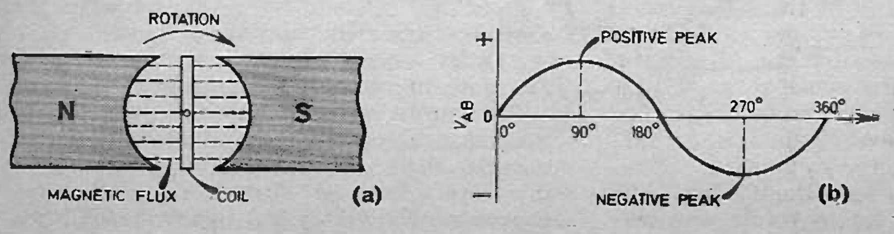


Fig. 9.7a. Coil position for zero output voltage (b) Variation of V_{AB} with coil angle for one complete cycle.

usefully employed with direct (steady) current.

One of the greatest attractions of alternating current is that it can be used in conjunction with transformers to change voltage levels (magnitudes) either up or down without significant loss of power. The efficiency of a well designed transformer is usually in excess of 95 per cent.

We will examine the transformer in more detail since it is obviously a very useful component and is widely used in electronic systems, especially in power supplies derived from mains.

One of the coils of the transformer is called the **primary** and may consist of many thousands of turns of fine insulated wire (for mains inputs). The other coil, which is wound on the same magnetic core, but is electrically insulated from the primary coil, is known as **secondary** coil. Transformers can have one or more secondary coils and the coils may have different numbers of turns.

Next month: More on transformers, plus the reed relay, and loudspeaker.

TUTOR BOARD EXPERIMENT

Test No. 19

The Friedland bell transformer can supply 3, 5 or 8 volts (r.m.s.) from normal 240 volt mains supplies. The low voltage output is quite safe but the windings should never be short circuited. The mains (primary) coil must be connected to a suitable lead and plug, to fit the outlets in use in the home. **Under no circumstances should any connections be made, or changed, with the mains plug connected to the household supply.**

Where possible use a fused plug fitted with a low current fuse (1 amp). Do not use a 13 amp fuse as this cannot give the protection required with low power consumption devices. If in any doubt, readers should seek the assistance of someone familiar with mains wiring techniques. **Always switch off the mains supply and remove the mains plug from the socket before connecting the transformer to any Tutor Board circuit.**

Using two leads to the 3 volt transformer secondary winding, join the transformer to the half-wave voltmeter circuit (Fig. 9.4). The meter should indicate the average value of the low voltage rectified output when the mains is connected. The diode can be a 1N4001 or similar type. Repeat the test using the 5 volt and 8 volt output of the transformer in turn.

Always disconnect the mains before altering the transformer connections. Check that the readings agree with the theory. The 3, 5 and 8 volt markings are only approximate (r.m.s.) values and the results may be affected by mains voltage variation from the nominal 240V.

Restore the connections to the 3 volt transformer winding and repeat the measurement with a 250μF capacitor connected across the meter and its 100kΩ resistor. The positive side of the capacitor should be connected to the diode cathode and the negative side to the meter negative terminal. The circuit can be set up on the Tutor Board, as shown in Fig. 9.9, which uses the switch S1 to connect the capacitor as required.

In this test the voltmeter responds to the *peak* voltage when S1 is closed. Check your results to see if they are consistent.

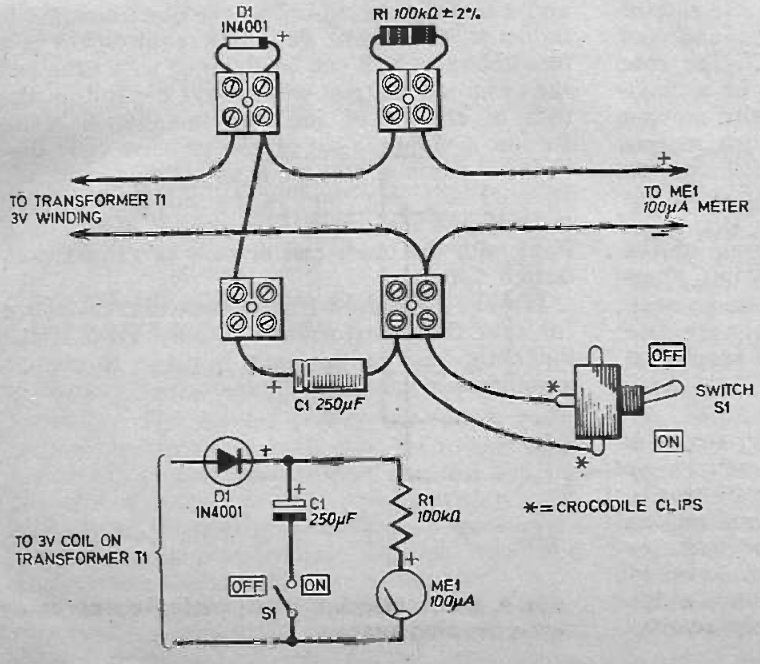
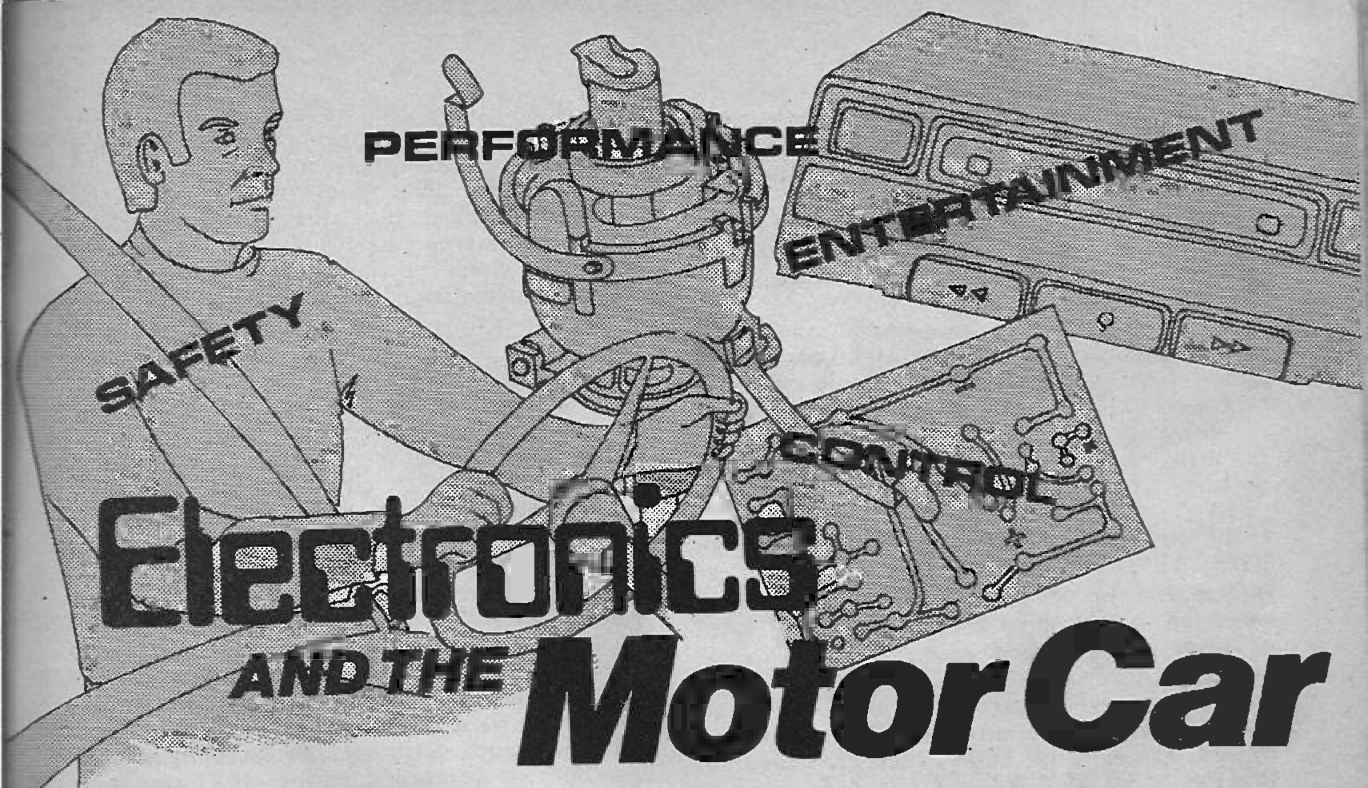


Fig. 9.9. Test circuit and wiring on the Tutor Board for Test No. 19.



Electronics AND THE Motor Car

By C. S. POINTER

Having dealt with electronics related to diagnosis, performance and safety last month we now move on to control and security.

CONTROL AND VEHICLE SECURITY

Electronic control may be applied to many systems and units in the car. With custom built thick film integrated circuits which are now being used throughout the electronics industry, electronic control is becoming more practical. Electronic intermittent wiper controls have been available for some time and are now being fitted to some modern cars.

Electronic control of electrical cooling fans uses a thermistor sensor and a Schmitt trigger to switch a relay or power transistor in the fan motor circuit.

Light sensors together with amplifiers and power switching circuits are used in systems which dip the interior mirror when the light from the following cars falls on the mirror light sensor, or systems which detect the light from on-coming vehicles and then dip the headlamps, Fig. 6 shows the block diagram of a headlamp dipping unit.

Car alternator voltage regulators use electronics to control alternator output voltage and limit current output. The regulator units monitor the rectified output from the alternator and regulate the output by varying the field produced by the field winding thus providing constant voltage output. The three-phase output from the alternator being rectified by semiconductor diodes mounted on a suitable heatsink. The various regulator units vary from printed circuit assemblies to thick film integrated circuits.

There are under development several vehicle speed control systems either using roadside transmitter units or cables under the road sur-

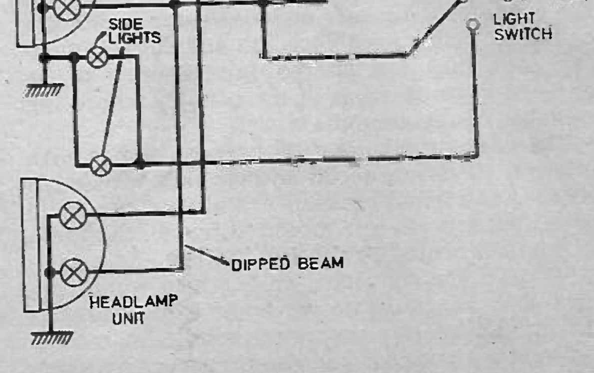


Fig. 6. Block diagram of an automatic car headlamp dipping system.

The Heathkit engine analyser, a useful instrument for the practical man.

face to transmit information to vehicle mounted receivers connected to the speed control unit, or using a dashboard mounted control unit enabling the driver to select a cruising speed and the unit will control the vehicle speed at the set value until any of the normal car controls, accelerator, brakes, etc. are operated thus reverting speed control to the driver.

Vehicle security systems include alarms and immobilising systems. Alarms switching the car horn on and off, or operating a siren are triggered by various sensors mounted on the car, door switches, mercury switches detecting vibration caused by an intruder or triggered from the ignition switch if the alarm has not been reset.

ENTERTAINMENT

The car radio is probably the most common item of electronic equipment fitted to cars on the road today. The car radios produced today are transistorised or contain integrated circuits and range from simple manual tuned or push button single and dual waveband sets to station seeking, multiwave band sets.

Most car radios receive medium wave and long wave stations but there are available sets which receive short wave and f.m./v.h.f. stations, the range of v.h.f. sets includes some which are equipped with stereo decoders and stereo amplifiers enabling f.m. stereo programmes to be enjoyed in some areas of the country where the signal is strong enough.

There are available dual purpose radios with internal batteries, aerial and speaker which can be used as normal portable radios until the radio is pushed into the car mounted frame, the radio is then connected to the car battery and aerial; also there are converter units which when connected to any medium wave car radio converts the radio to receive shortwave bands.

Together with car radios, increasing numbers of tape players and record players are being fitted to cars. Tape players are becoming very popular and there are two main systems in use today, these are compact cassette units and eight-track cartridge stereo units.

The cassette units range from simple mono player units which play through the car radio amplifier to stereo cassette players with built in amplifiers, mono recorder and f.m. stereo radio.

A new development in the cassette player field is the auto-reverse stereo player shown in Fig. 7. This unit is fitted with small magnets on each take-up turntable which switch reed switches. When the end of cassette tape is reached and the take-up turntable stops revolving, the drive clutch slips. The absence of an output signal from the reed switch circuits due to the turntable stopping, trigger, via a control circuit, a solenoid which reverses the cassette drive direction and switches from one pair of tape head windings to another. The unit gives continuous music without the need to remove and turn over the cassette at the end of the track; the direction of play can be reversed at any time by pressing a panel mounted button. Also fast forward/ fast reverse facility is available.

The compact cassettes can be bought prerecorded or recorded using the standard domestic cassette recorders which are in wide use today.

The eight track cartridge player uses a cartridge which contains an endless loop of tape with eight tracks which are pre-recorded with four stereo programmes. There are available eight track cartridge players with radio and for some units there is available a converter which slots into the unit in place of the cartridge giving f.m./v.h.f. stereo radio reception.

Modified versions of the cartridge player which take cartridges recorded with quadrophonic programmes, two programmes each of four channels played through four speakers mounted at each of the four corners of the car.

One or two of the more expensive cars have as optional equipment television receivers mounted out of the driver's view, but these are few and far between.

COMMUNICATION

Car communication using transmitter/receiver has been in use for a long time, used by police, fire brigade, ambulance, taxis and many large

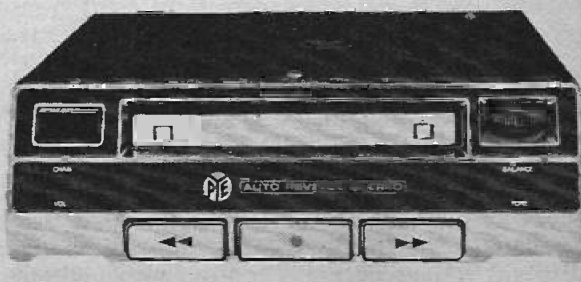


Fig. 7. The Pye auto reverse stereo tape player.

companies for communication between base and cars on the road. The private motorist and the company executive can now in some areas have fitted to his car a GPO radio telephone or a transmitter/receiver hired from a company running a radiophone service.

Under development is a system which is intended to relay traffic information and warnings to the driver through the car radio. Roadside transmitters being used to transmit local information when conditions arise requiring warnings to be given, a receiver mounted in the car picks up the signals and interrupts the normal programmes with the warnings. The receiver may be a separate unit connected to the car radio or it may be part of the radio itself.

CONCLUSIONS

In order to power some electronic equipment from a car electrical system it may be necessary to include a power unit to convert the 12V or 6V d.c. supply to a higher or lower voltage or to a.c. voltage, such as the d.c./a.c. inverter in E.E. July 1972. (*No longer available.*)

By use of these various power supplies a wide range of electronic equipment may be powered from the car electrical supply.

As the electronics industry develops new and more advanced techniques many of these may benefit the motorist indirectly in making available more items of electronic equipment to the motorist and motor manufacturers.

In general electronic units fitted to production cars are of the plug-in type making replacement fairly simple. The majority of electronic equipment is very reliable and should last for the life of the car.

Large electronic digital computer systems are used in production control, car design, spares distribution by the large manufacturers and in some countries used car testing is computer controlled.

This article has covered some of the applications of electronics connected with cars and motoring, which is a very wide field. ▣

A compact m.w. and l.w. car radio complete with fixings and speaker from Bosch Ltd.

Ruminations
By Sensor

Anyone for Tennis?

An ingenious variation on the pin table theme is getting around the country. The apparatus looks like a large table model TV but its circuits probably have more in common with radar than with television. When the appropriate coins are put into the slot, a spot of light begins to bounce across the "court" and short vertical lines, which represent racquets, can be moved vertically by the players' controls in order to intercept the "ball".

The apparatus emits a realistic echoing "plunk" when the "ball" hits the racquet and the "ball" bounces back to the opponents on the other side of the "court". If the ball goes out of court the player is admonished by a suitable "brrp" noise and the score points on the screen record the error.

Apart from enjoying my game of electronic tennis—even though I lost, I got a lot of fun from speculating how the thing works. No doubt many readers will have a shrewd idea of what lies behind the electronic court—indeed, I would not be surprised to see something of this nature appear as a constructional project in the future.

On Load

I read recently that one of Britain's fast breeder reactors is now producing power, a whole 100 watts of it! This is just a start of course, the reactor output will be in megawatts when things really get going.

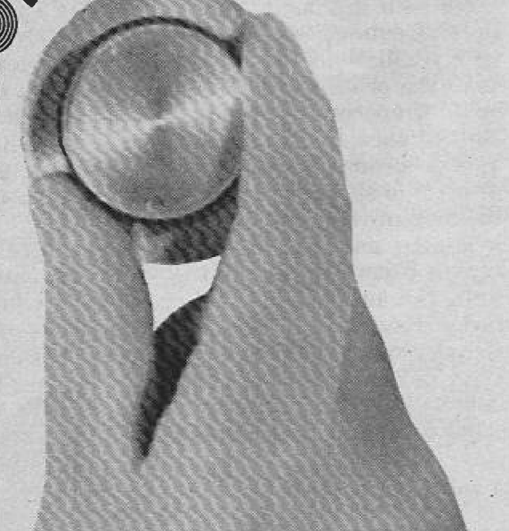
My own knowledge of nuclear power generation is minimal and I ought to refrain from comment, but the thought of this huge and highly complex and expensive plant somehow sweating away to generate 100 watts seems ludicrous—like the mountain labouring and giving forth a mouse.

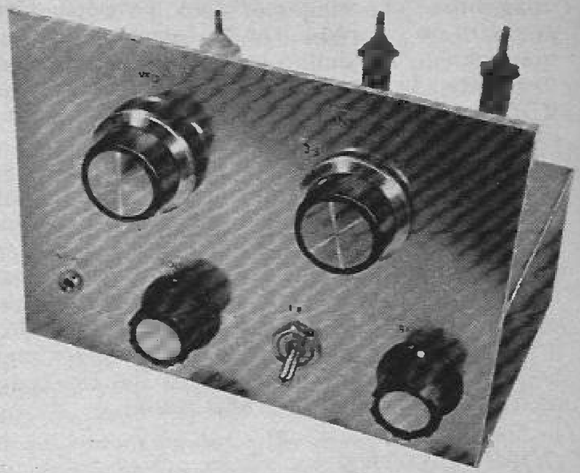
Britain led the world in nuclear power generation but the suggestion made some weeks ago that the CEGB were thinking of buying American built reactors leads one to suppose that we may be falling behind. I hope that this is not the case.

This country has been accused of being very good at research but poor at production, and there is certainly some measure of truth in the accusation. I have known many engineers and physicists who had an aversion for production and "sordid commercialism" and wished only to spend their lives "playing" in the laboratory. Certainly, a research laboratory can provide a comfortable, sheltered environment where one can work happily doing one's own thing, but is this the best way of getting things done?

Perhaps the root of most of the problems lies in our educational system, is it too academic?

80m & 160m





AMATEUR BANDS RECEIVER

BY R.A. PENFOLD

A direct conversion receiver that will receive s.s.b. and c.w. transmissions.

Although some years ago a.m. (amplitude modulation) was probably the main form of transmission used on the amateur bands, this is no longer the case, and a form of transmission known as s.s.b. (single sideband) has now almost entirely replaced a.m. The main advantage of s.s.b. is that it makes full use of the output power of the transmitter, as unlike an a.m. transmission, only part of the signal that contains the information to be sent is transmitted, and the rest is suppressed. This is especially important when one considers the low transmitter power limit enforced on the amateur bands.

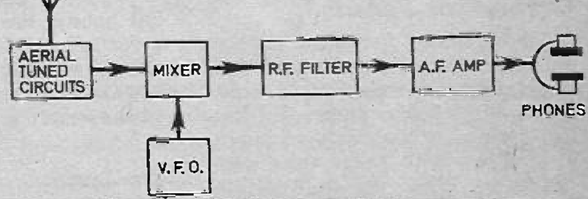
Another advantage is that an s.s.b. signal occupies less than half the band space occupied by an equivalent a.m. signal, which helps to ease the problem of overcrowding on the bands.

Ordinary a.m. receivers are unsuitable for s.s.b. reception, and for the other main mode used, c.w. (continuous wave—morse code). The circuitry used in amateur receivers is therefore rather specialised. The most simple type of receiver suitable for amateur band reception is the direct conversion type. The receiver described here is of this type, and covers two amateur bands, 80 metres (3·5 to 3·8MHz), and 160 metres (1·8 to 2MHz). The receiver is battery powered, and the output is for high impedance headphones.

DIRECT CONVERSION OPERATION

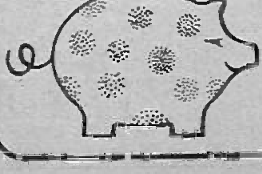
A direct conversion receiver is so called as it converts the received r.f. (radio frequency) signal direct to an a.f. (audio frequency) signal, using a mixing process; Fig. 1 shows a block

Fig. 1. Block diagram of a direct conversion receiver.



FOR GUIDANCE ONLY

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



£8.20 plus chassis and headphones

*Based on prices prevailing at time of going to press diagram of the stages of such a receiver. The mixer forms the heart of the receiver. The output of this is equal to the two sets of input frequencies, plus their sum and difference frequencies.

Supposing for instance that a 3·7MHz c.w. signal is to be resolved, by tuning the v.f.o. (variable frequency oscillator) to 3·701MHz, and the aerial tuned circuits to peak the signal, the output will be: 3·7MHz and 3·701MHz (the input frequencies), the sum of the two, 7·401 MHz (3·7+3·701), and the difference between the two, 1kHz (3·701−3·700).

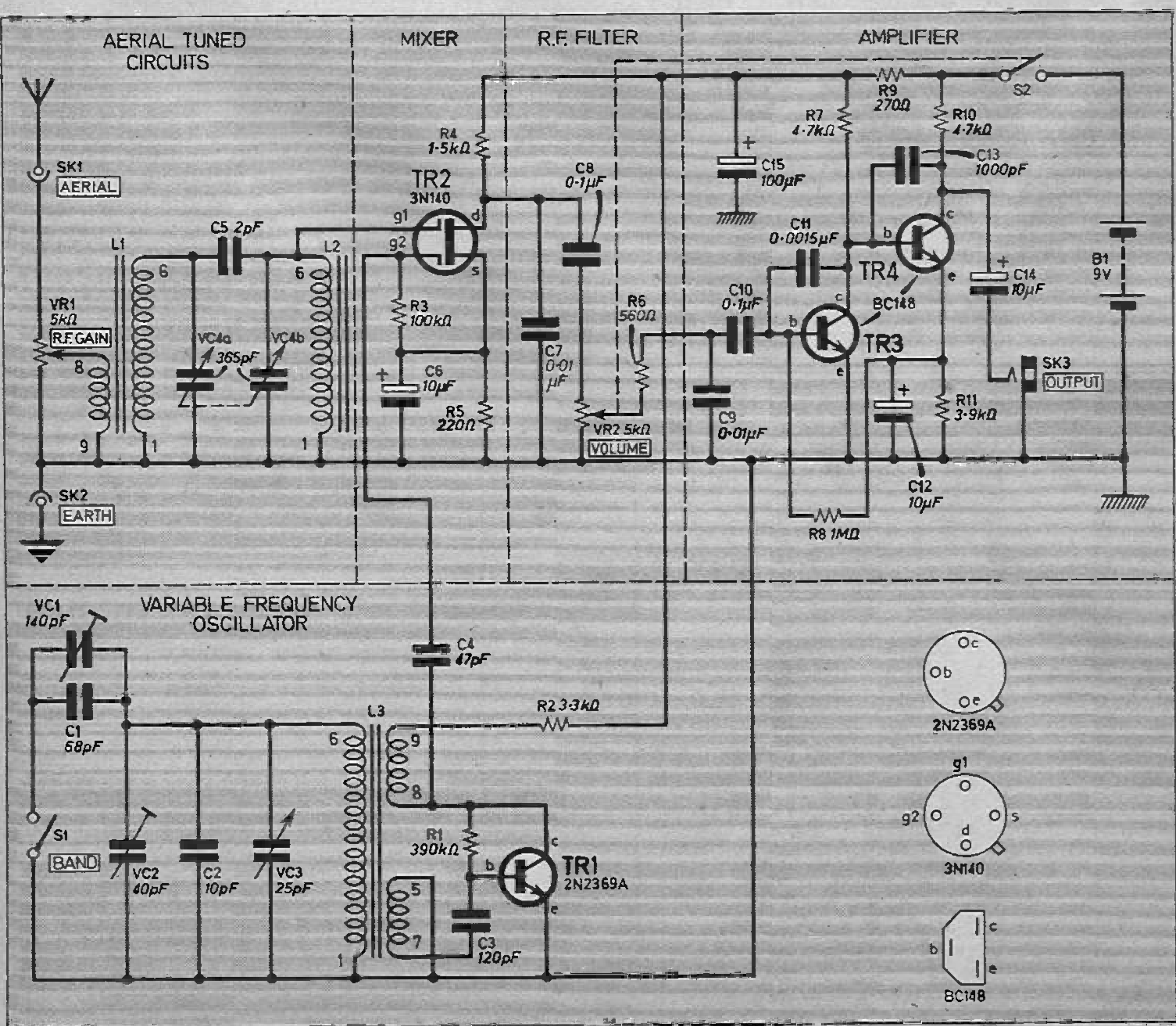
The r.f. filter will remove the r.f. part of the output signal, and only allow the audio frequencies to pass to the audio amplifier. In our example the 1kHz signal is the only audio signal.

The v.f.o. frequency can be either just above or just below the transmission frequency (3·700-3·699 also equals 1kHz). In practice the oscillator would be tuned to whichever side gives the most interference free signal. The audio signal does not have to be at 1kHz, and the v.f.o. is adjusted to give the frequency that the operator finds most acceptable.

An s.s.b. transmission consists of a variety of radio frequencies, which when properly mixed with oscillations of the correct frequency, produce the original audio frequencies. The mixing process operates in the same way as for a c.w. signal, except that instead of one radio frequency producing one audio frequency, a complex radio signal produces the complex sound of the human voice.

Tuning an s.s.b. signal is more critical than tuning a c.w. one as, if the v.f.o. is slightly off tune, the audio signal will sound rather high, or rather low pitched. There are two types of s.s.b. signal, lower sideband, and upper sideband. With lower sideband the v.f.o. is tuned just above the signal frequencies, and with upper sideband it goes just below them.

Fig. 2. Complete circuit diagram of the 80 and 160m Amateur Bands Receiver.



CIRCUIT

A circuit diagram of the receiver is shown in Fig. 2, TR1 is used in a simple v.f.o. This is tuned by VC3. With S1 open this tunes the 80 metre band, and with S1 closed the additional capacitance of VC1 and C1 allow the 160 metre band to be tuned.

Transistor TR2 is the mixer, and uses a special type of transistor, a dual-gate MOSFET. The aerial signal couples via the r.f. gain control, VR1, and the input tuned filter to one input of TR2. The input filter can be tuned to either band by adjusting VC4. The v.f.o. couples to the other input of TR2, and it modulates the aerial signal, the mixed output appearing at the drain of TR2.

Capacitor C7, C9 and R6 form the r.f. filter, TR3 and TR4 form a high gain two stage audio amplifier, feeding a pair of high impedance headphones. Potentiometer VR2 is the volume control, and is ganged with the on/off switch S2. Low frequencies are attentuated by the low value of the coupling capacitors, C8 and C10, and the two feedback capacitors, C11 and C13 give high frequency attentuation. This gives a considerable reduction in noise, and reduces adjacent channel interference.

CHASSIS AND PANEL

A ready made 150×100×50mm aluminium chassis is used. The front panel is made from 18 s.w.g. aluminium, and measures 150×115mm. This will probably have to be cut from a larger piece.

The three coils are mounted in ordinary B9A valveholders. The 20mm diameter cut outs for these are most easily made using a 20mm chassis punch. The coil holders are each mounted by two 6BA bolts. A 6BA solder tag is mounted on one of the mounting bolts of the holder for L1, and another on one of those for L3 (see Fig. 5). Control VC4 is mounted by two short 4BA bolts which pass through the appropriate holes in the chassis from underneath, and screw into the two threaded holes on the underside of the capacitor.

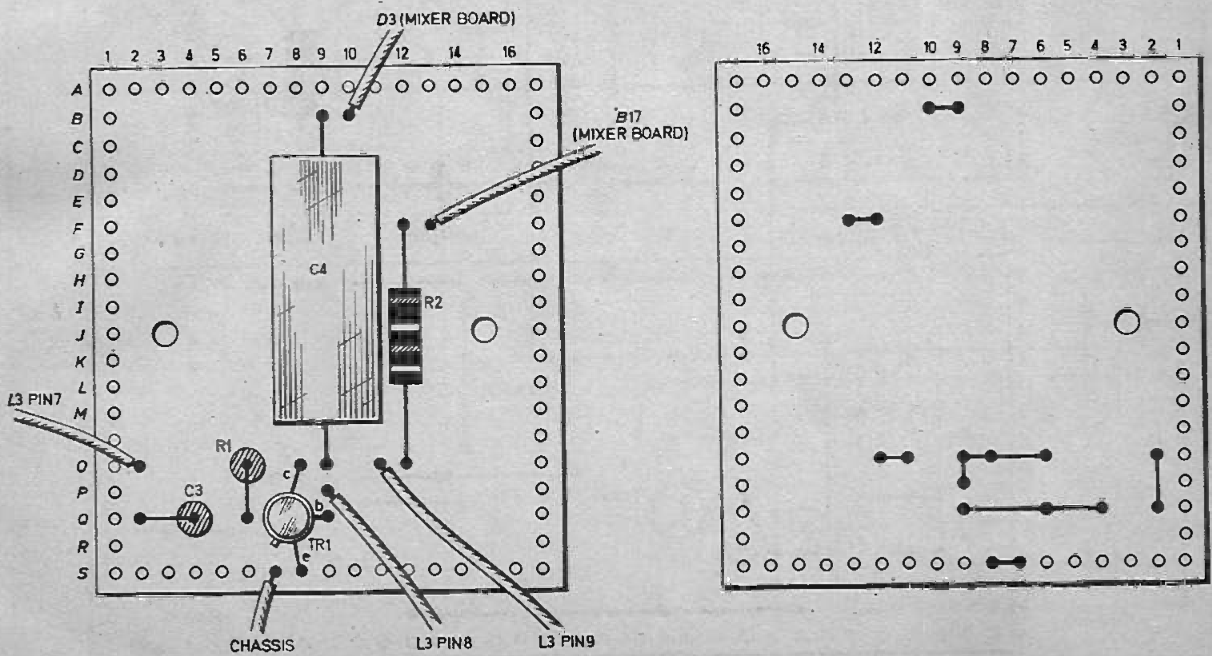
Mounting holes for SK1 and SK2, must be made to suit the particular make of socket used. The positions of the mounting holes for the component panels are marked using the panels themselves as templates. The chassis and panel are held together by SK3, VR2, S1 and VR1.

COMPONENT PANELS

The bulk of the circuitry is contained on two component panels, one for the v.f.o., and the other for the mixer and audio stages. These are made using 0·1 inch matrix plain board. Construction of these is illustrated in Fig. 3 (oscillator), and Fig. 4 (mixer). The boards are cut to the sizes shown from the larger size in which the board is sold, using a small hacksaw.

The components are mounted in the positions shown, and their lead outs are bent over at 90 degrees on the reverse side of the panel. These are then soldered together, this wiring also being shown in the respective figures. In most cases the component leads are long enough to

Fig. 3. Layout and wiring of the variable frequency oscillator board.



facilitate this, but in a few cases it will be necessary to use short lengths of tinned copper wire as extension leads.

For anyone new to this method of construction, it is advisable to start with the v.f.o. panel, as this is simpler. Transistors TR3 and TR4 have special lead outs which "plug" into the board, TR2 is supplied with a wire clip which shorts all the leads to its case. **This must not be removed until all the wiring has been completed, and checked, otherwise the device could be damaged.**

Where leads emanate from the panel, thin insulated leads are soldered in place. The approximate length of these can be judged by reference to the unit itself, and the complete wiring diagram of the receiver, Fig. 5. These can be made slightly on the long side so that the free ends of these can be cut to length, and connected up when the panels have been mounted.

The completed panels are mounted by two 6BA bolts for each. Two extra nuts are placed over each bolt between the chassis and the board, in order to hold the underside wiring of the board slightly clear of the chassis.

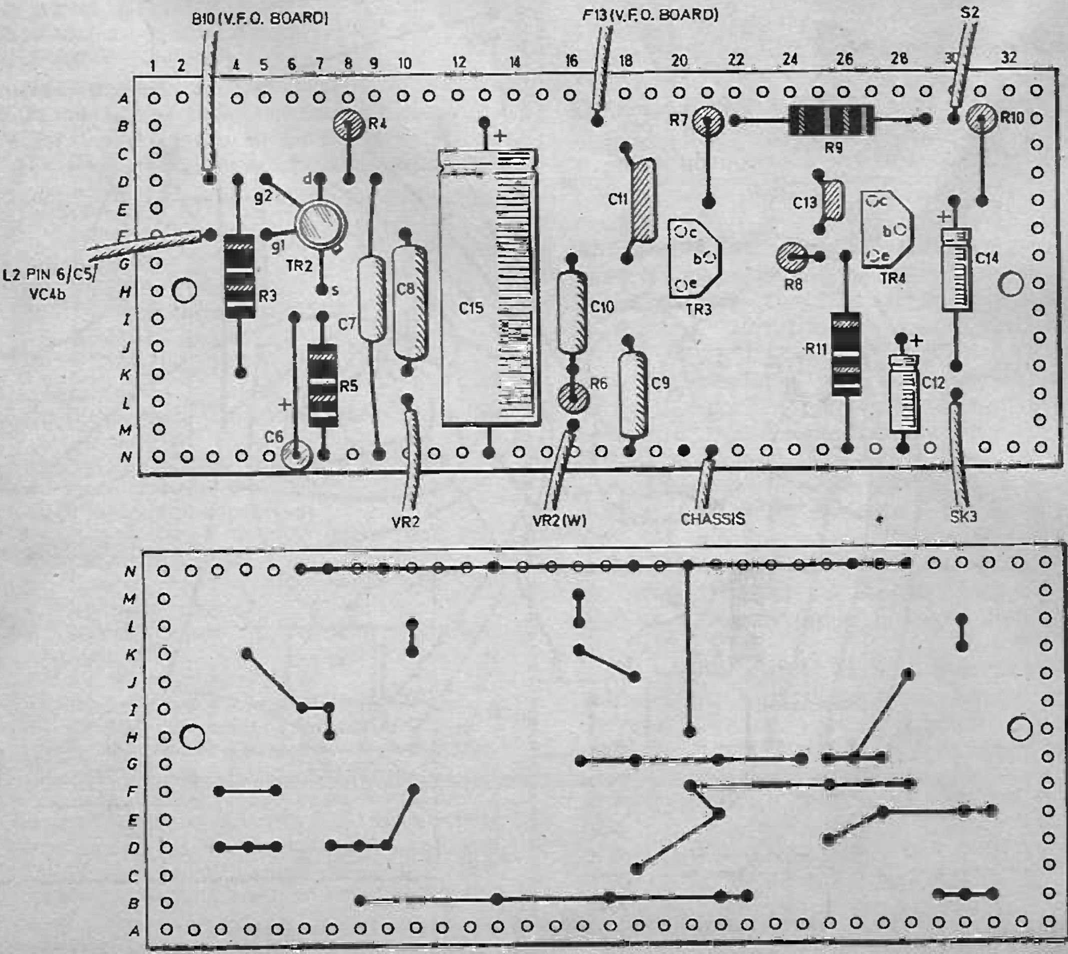
The wiring diagram, Fig. 5, is largely self explanatory, and the main points to bear in mind are that all wiring should be as short as possible, and to make sure that VC1 and VC2 are mounted so that they can be easily adjusted. The battery is mounted on a small aluminium bracket glued on one side of the chassis. This can be seen in the photographs.

SETTING UP

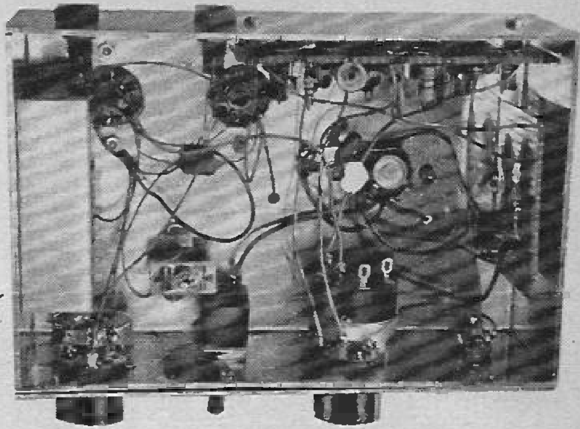
The receiver has no internal aerial of any kind, and a long wire aerial is required. A short indoor aerial will probably provide reception of a few stations, but for serious listening a proper aerial is essential. This consists of a long length of wire (16 s.w.g. or 7/22) insulated and set as high as possible. The ideal length is 40m (132ft), but 20m (66ft) should be quite adequate.

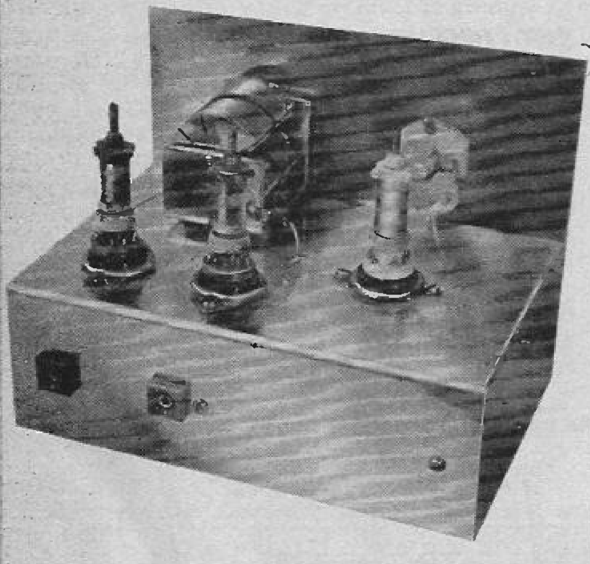
An earth connection may improve reception, this can be made with a buried metal plate or pipe connected to SK2, which connects to the receiver.

Fig. 4. Layout and wiring of the mixer and amplifier board.



AMATEUR BANDS RECEIVER





Above. Photograph of the underside layout and wiring.

Left. Photograph of the back of the completed receiver.

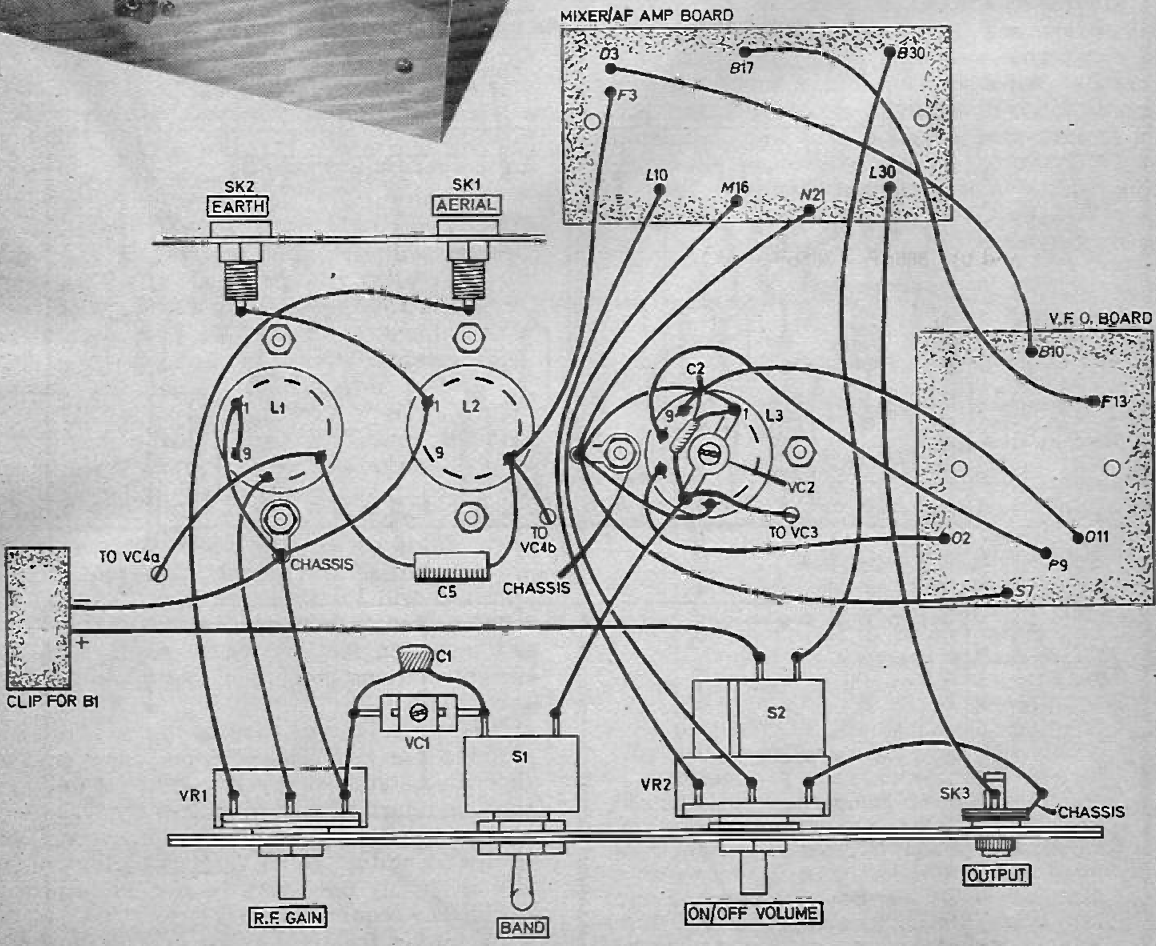


Fig. 5. Layout and wiring of the underside of the receiver.

Components....

Resistors

R1	390 kΩ	R7	4·7kΩ
R2	3·3 kΩ	R8	1MΩ
R3	100kΩ	R9	270Ω
R4	1·5kΩ	R10	4·7kΩ
R5	220Ω	R11	3·9kΩ
R6	560Ω		All ¼W ± 10% carbon

SEE SHOP TALK

Potentiometers
VR1 5kΩ lin carbon
VR2 5kΩ log. carbon with switch (S2)

Capacitors
C1 68pF ceramic or silver mica
C2 10pF ceramic or silver mica
C3 120pF polystyrene
C4 47pF silver mica
C5 2pF silver mica
C6 10μF elect. 10V
C7 0·01μF Mullard C280
C8 0·1μF Mullard C280
C9 0·01μF Mullard C280
C10 0·1μF Mullard C280
C11 0·0015μF ceramic disc
C12 10μF elect. 10V
C13 1,000pF ceramic
C14 10μF elect. 10V
C15 100μF elect. 10V

Variable Capacitors
VC1 30/140pF mica compression trimmer
VC2 10/40pF ceramic trimmer
VC3 25pF air spaced variable (Jackson C804)
VC4 (a and b) 365pF +365pF dual gang air spaced variable (Jackson type O)

Semiconductors
TR1 2N2369A silicon *npn*
TR2 3N140 dual gate MOSFET
TR3 BC148 silicon *npn*
TR4 BC148 silicon *npn*

Miscellaneous
SK1 Single wander socket with plug for aerial
SK2 Single wander socket with plug for earth
SK3 3·5mm jack socket
L1 Denco range 3 blue aerial coil (for transistor usage)
L2 Denco range 3 blue aerial coil (for transistor usage)
L3 Denco yellow r.f. coil (for transistor usage)
S1 s.p.s.t. toggle switch
S2 s.p.s.t. switch incorporated in VR2
B1 9V PP3 type battery and connector
150mm × 100mm × 50mm aluminium chassis, front panel, B9A valveholders (3 off for coil mounting), 4000Ω impedance headphones fitted with 3·5mm jack plug, 0·1 inch matrix plain perforated Veroboard, two small and two large control knobs, 4BA and 6BA fixings, connecting wire, wire for aerial and earth.

Before the set is ready for use, VC1 and VC2 must be adjusted to give the correct frequency coverage, and the cores of the coils have to be peaked. The cores of L2 and L3 are adjusted so that the metal threaded portions protrude about 10mm. The core of L1 is similarly adjusted for a protrusion of 13mm.

Having given the set a final check for mistakes, remove the clip on TR1 and turn on, switch S1 should be set to the 80 metre band. Assuming that no test gear is available, the only way to find the correct setting of VC2 is to try various settings until one is found which allows VC3 to tune the whole of the band. The 80 metre band is usually fairly crowded (especially at weekends), and this makes it quite easy to locate the limits of the band.

When VC2 has its final adjustment, VC1 can be adjusted for correct coverage of the 160 metre band. This is likely to be more difficult, since this band is shared with marine transmissions, and a lower transmitter power limit is enforced. This makes it less popular than other bands, and it is mainly used for local contacts. In some areas there may be very little activity on this band at all.

If there are two closely spaced settings of VC4 which will peak signals, the core of L1 is adjusted slightly (probably inwards) to give a single setting which produces a single peak.

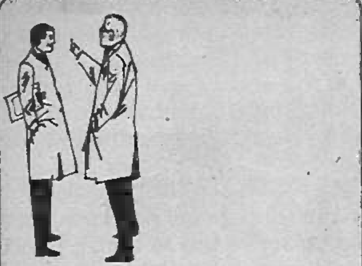
OPERATING NOTES

The output is suitable for high impedance headphones (4000 ohms) which plug into SK3. Results will probably be best if the volume control (VR2) is kept at a fairly high setting, and the r.f. gain (VR1) is advanced no further than is necessary to provide an adequate signal. It is essential that the aerial trimmer (VC4) is always adjusted to peak the incoming signal, so as to give the proper sensitivity, and to reject unwanted signals. Remember that this control works independently of the wavechange switch (S1), and needs totally different settings for the two bands.

As stated earlier, the 160 metre band is used mainly for local contacts and most stations received will be no more than about 50 miles distant. Many British and European stations will be heard on the 80 metre band, with more distant stations coming in when conditions are favourable.

It is worth bearing in mind that most 80 metre stations use l.s.b. (lower side band), and it is therefore standard practice when scanning the band to start at the high frequency end (the vanes of VC3 unmeshed). This way, as one tunes towards a station, it will sound very high pitched, and it is only necessary to further adjust VC3 to give the required pitch.

By tuning from the other end of the band it would be necessary to tune through the station, and then readjust, which is less convenient. ▣



SHOP TALK

By Mike Kenward

THIS month we have been taking another look at our approximate cost box and in view of the changeable state of the market, have felt it prudent to modify somewhat the wording. Obviously there must be some "give and take" in such matters, but we believe most readers appreciate the general guidance the cost box offers.

One item that is usually omitted from the approximate cost is the case for any particular project. This is mainly, because most suppliers offer various cases at various prices and quite often readers are able to construct their own cases either from wood or metal.

R.F. Signal Generator

Still continuing on the case theme, we promised to supply the name and address and cost for the Olsen case again and also a supplier for knobs for the *E. E. Test Gear Five* series.

The Olsen case type 25A with louvres is available in light green, dark green, blue and silver grey with front panels in light green, white or cream for £3·45, including postage packing and V.A.T. from Olsen Electronics Ltd, 5 Long Street, London, E.2.

Similar knobs to those shown, with a skirt and indicator line (type R62) are available from Re-An Products, Burnham Road, Dartford, Kent. Top cap colours available are red, blue, green, yellow and black—state which when ordering. The knobs cost 14p each plus 20p post and packing pus V.A.T. on the total.

The dial and pointer used on the *R. F. Signal Generator* are available from Home Radio Components. The Denco coils are available direct from Denco (Clacton) Ltd., 355/7/9 Old Road, Clacton-on-Sea, Essex CO15. The "red" types cost 44p each and 8p should be sent with each order to cover post packing. Add 10 per cent V.A.T to total.

A. F. Oscillator

The Wima capacitors for the *A.F. Oscillator* can no longer be obtained from Combined Electronic Services as mentioned in our March issue.

However Trannies are able to supply Mullard C281 types which they have selected for less than ±5 per cent tolerance. The total cost for the six capacitors required including selection, V.A.T. and postage is £1·46—about the same as from the previous supplier.

Freezer Alarm

Most of the components for the *Freezer Temperature Alarm* should be readily available. The pre-set control should be a T.V. type—that is a panel mounting enclosed type, as opposed to a skeleton pre-set.

The reed relay used in the prototype is an R. S. Components device and should be available through most component suppliers who can order it from them. Readers are not able to buy direct—a situation about which we have heard a few rumours, and we hope to see a retail outlet in the future.

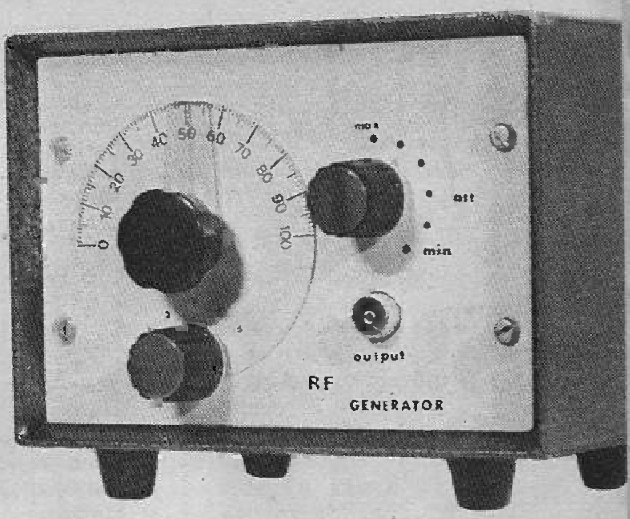
The reed relay can in fact be replaced by almost any type with a coil resistance of more than 200 ohms and the correct working voltage but, of course, this would be unlikely to fit on the board.

Amateur Bands Receiver

The *Amateur Bands Receiver* also uses Denco coils (see *R.F. Signal Generator* above) and these are also available direct from Denco. The Range 3 blue, two are required, and the yellow r.f. cost 44p each, once again include 8p for post and packing and add 10 per cent V.A.T to the total. The 3N140 MOSFET can be obtained from either Arrow Electronics or Marshall's. The addresses and prices are: Arrow Electronics Ltd., 7 Coptfold Road, Brentwood, Essex. CM14 4BN, 92p plus V.A.T., no charge for post and packing. A. Marshall and Son (London) Ltd., 42 Cricklewood Broadway, London, NW2 3HD, £1·00 including V.A.T., post and packing.

TEST GEAR FIVE

R.F. SIGNAL GENERATOR



THIS project is the last and most difficult of the *E.E. Test Gear Five* series. However, readers who have already built one or more of the other instruments will have gained sufficient experience to make a success of this project.

An r.f. signal source is essential for work with radio receivers. With the aid of a signal generator, circuits can be tested and aligned from the detector, back through the receiver to the aerial socket. It is very difficult to carry out any serious work or repairs to radio receivers using only signals picked up from broadcast transmissions.

The actual circuit itself is quite simple, but the necessity to switch ranges, to have a reasonable attenuator and the care needed in wiring means that the mechanical layout of the instrument is more critical than the previous projects. The instrument covers frequencies from 200kHz to 30MHz in five ranges.

For work with f.m. receivers, the fourth harmonic of range 5 may be used to provide signals in the f.m. band (80 to 120MHz).

The generator is amplitude modulated (a.m.), but useful signals can be picked up by f.m. receivers nevertheless.

THE R.F. OSCILLATOR

Previous instruments in this series have featured an integrated circuit as the main active component. This instrument employs a field effect transistor (f.e.t.).

A field effect transistor is very much like an *npn* transistor but with a very high base impedance. The source, gate, drain electrodes are similar in function to the emitter, base, collector or, for those who remember valves, cathode, grid and anode. The field effect transistor is so much like a valve that many valve circuits can be readily adapted to work with them.

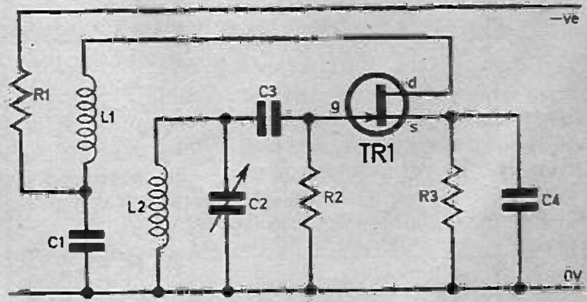


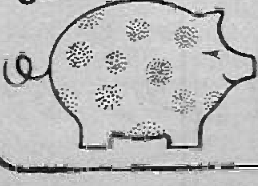
Fig. 1. The basic r.f. oscillator circuit.

The basic r.f. oscillator circuit is shown in Fig. 1. Coil L2 and variable capacitor C2 form a highly selective tuned circuit, signals being passed from this circuit via C3 to the gate input of the transistor. These signals are amplified at the drain output of the transistor and coupled via L1 back to the tuned circuit.

When the circuit is switched on, oscillations build up until limited by other components in the circuit; R1 and C1 provide decoupling which ensures that the end of L1 is connected to earth through C1. Components C3 and R2 form an automatic bias circuit which controls the amplitude of the oscillation, whilst R3 and C4 work in conjunction with R1, R2 and C3 to set the working current in the transistor.

FOR GUIDANCE ONLY

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



£7.10

Excluding Case

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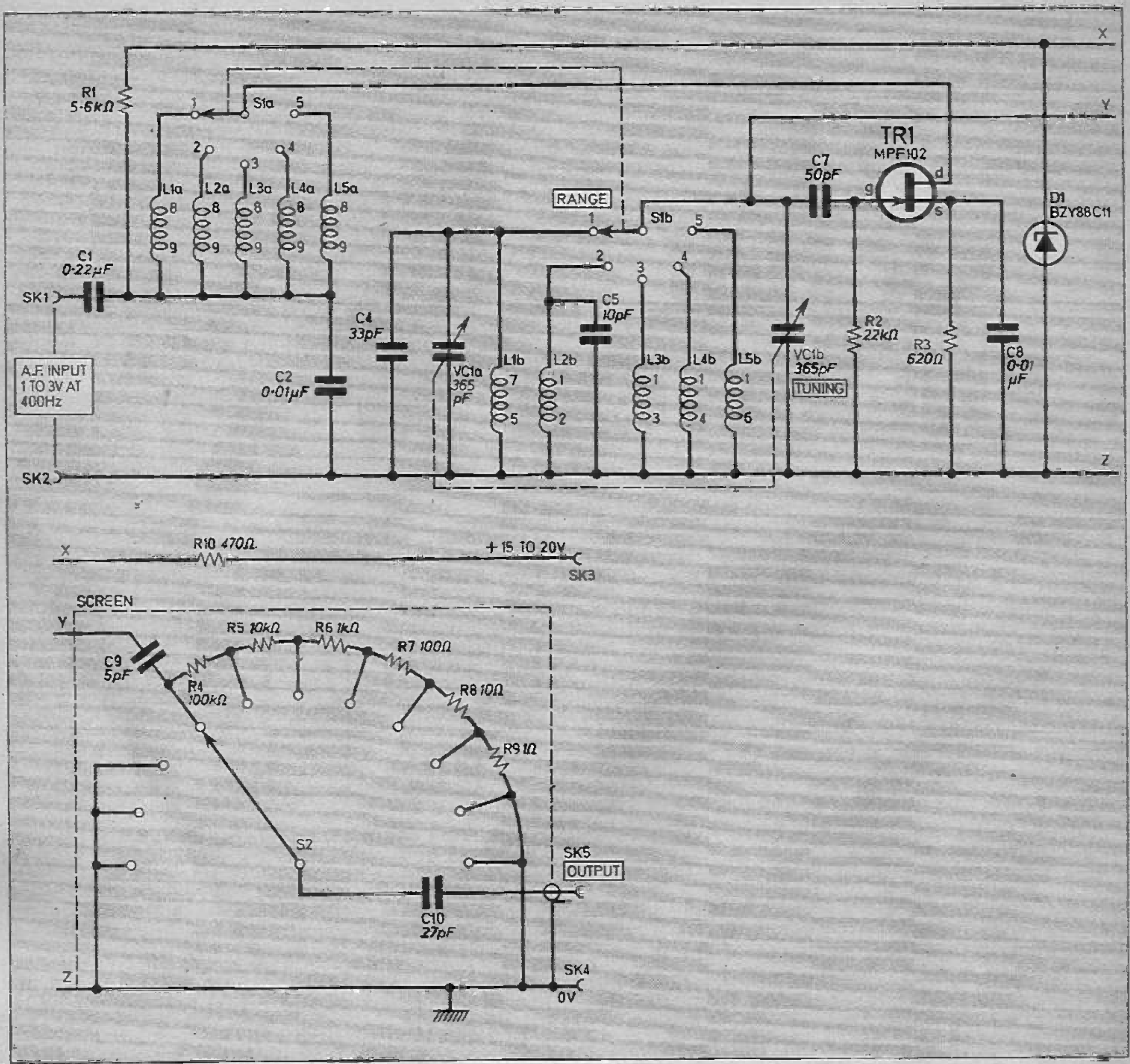


Fig. 2. The complete circuit diagram of the R.F. Signal Generator.

This basic circuit is used in many signal generators and as the local oscillator of superhet receivers.

THE SIGNAL GENERATOR

The full R.F. Signal Generator circuit is given in Fig. 2. Although this circuit looks rather large, with many long wires connecting the components, it is only drawn this way for clarity. In fact, when the instrument is wired the very minimum of wire must be used.

The similarity between this and the basic circuit of Fig. 1 is quite evident. However, the differences are important. For example an input of 400Hz is fed to the r.f. generator from an audio oscillator. This is the modulation.

Signal generators can be used without modulation for some work, but in the majority of applications a modulated signal is necessary.

The *A.F. Oscillator*, the second project in the *E.E. Test Gear Five* series (March 1974) makes an ideal modulator. Set the a.f. oscillator to 400Hz with its output voltage set to 2 volts and this will modulate the r.f. carrier properly. The main function of resistor R1 should now be clear, it enables the voltage supply to TR1 to be moved up and down in response to the *modulating* input signal, thereby modulating the carrier. Capacitor C1 is chosen to couple an adequate signal at 400Hz, whilst C2 is chosen to provide sufficient r.f. decoupling without seriously affecting the modulation.

The main oscillator TR1 is identical to the basic circuit shown in Fig. 1 except that five switched ranges are used via S1a and S1b. To simplify the building of the instrument, readily available oscillator coils designed for superhet local oscillators have been chosen. The use of these means that some trimming is necessary on the two lowest ranges, ranges 1 and 2. Capacitors C4 and VC1a (half of the twin gang tuning capacitor) trim L1b so that it extends down to 200kHz. Coil L2b is trimmed with a simple fixed capacitor C5. The ranges thus covered are:—

Range 1	198kHz to 638kHz
Range 2	600kHz to 2·01MHz
Range 3	1·6MHz to 5·44MHz
Range 4	5MHz to 13·5MHz
Range 5	10·9MHz to 31·2MHz
4th harmonic (Range 5)	80·4MHz to 122MHz

Components....

SEE SHOP TALK

Resistors
- R1 5·6kΩ
- R2 22kΩ
- R3 620Ω
- R4 100kΩ
- R5 10kΩ
- R6 1kΩ
- R7 100Ω
- R8 10Ω
- R9 1Ω
- R10 470Ω
- All ¼W carbon ± 5%

Capacitors
- C1 0·22μF
- C2 0·01μF
- C4 33pF silver mica
- C5 10pF silver mica
- C7 50pF silver mica
- C8 0·01μF
- C9 5pF silver mica
- C10 27pF silver mica
- VC1 365pF twin gang variable (Jackson)

Semiconductors
- TR1 MPF102 *n*-channel f.e.t.
- D1 BZY88 11 volt 400mW Zener

Coils
- L1 Denco Red Range 1
- L2 Denco Red Range 2
- L3 Denco Red Range 3
- L4 Denco Red Range 4
- L5 Denco Red Range 5

Miscellaneous
- S1 two-pole five-way miniature Maka switch
- S2 one-pole eleven-way ceramic type
- SK1, 2, 3, 4 insulated screw terminals, one off each red, black, green, yellow (4 off)
- SK5 panel mounting co-axial socket
- Eddystone die cast box size 98 × 57 × 25mm; 90mm diameter dial calibrated 0-100 through 180 degrees of arc; Perspex pointer to suit dial; transistor socket; knobs (3 off); Olsen type 25A case with louvres.

These ranges are adjusted by the dust core adjuster in the coils, but due to the complete absence of padders (very low value trimmer) and trimmers different layouts and wiring will affect the ranges actually obtained, therefore great care must be exercised in the construction and wiring to ensure that it is as close as possible to the original shown here.

Finally, the output is fed via C9 to a simple attenuator. This attenuator uses an 11-way ceramic switch. The ranges adjacent to the wiper are unused and connected to earth in order to reduce capacitive coupling between the strong input signal and the attenuated output. Some coupling is unavoidable in such a simple arrangement so calibration of this attenuator is not possible, especially at the higher frequencies. It does however give a useful range of attenuation from a maximum output of about 500 millivolts.

CONSTRUCTION DETAILS

As with the previous four instruments, the R.F. Oscillator is housed in a type 25A Olsen case with louvres. However, unlike the others no circuit board is used for the components, everything being mounted on the front panel and other major components.

First it is necessary to make up a simple aluminium bracket as shown in Fig. 3, before bending this bracket, it must be drilled as shown. Secondly, the front and back panels must be drilled as shown in Fig. 4. Finally, a diecast "Eddystone" box must be cut and drilled to house the attenuator switch, Fig. 5.

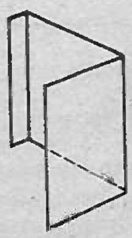
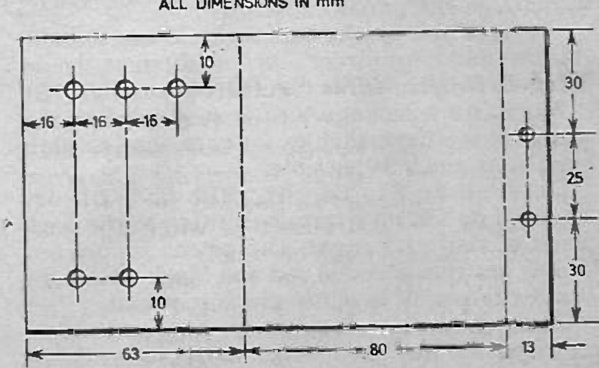
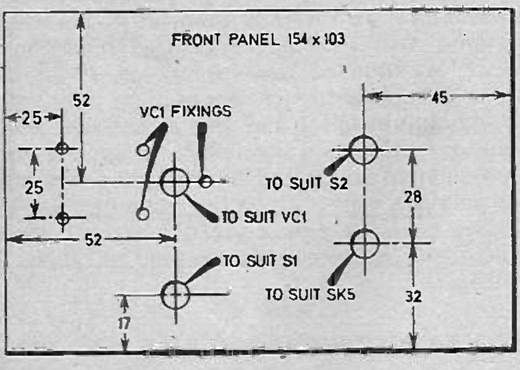


Fig. 3. The aluminium bracket for holding the coils.



Next, mount the variable capacitor and range switch S1 onto the front panel and the coils onto the aluminium bracket bent into shape. When these components are mounted, the switch, coils and tuning capacitor must be very close to each other, as shown in the photograph and Fig. 6. It is essential that the coils of ranges 4 and 5 are as close as possible to the range switch.



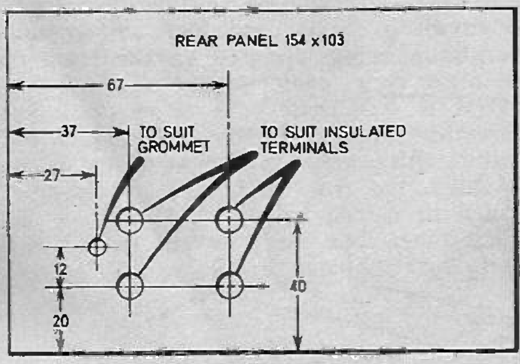


Fig. 4. Front and rear panel drilling details.

The coils, range switch and wiring to components VC1, C7, C5, C8, TR1, R2 and R3 should now be wired using the *shortest possible wiring* according to Fig.6. In particular, the earth wire from pin 5 on coil 5 should go direct to the earth terminal of the tuning capacitor.

The oscillator works best if the wires take the shortest and most direct route, no attempt should be made to loom wires together. Transistor TR1 is fitted into a socket which is suspended in the wiring above the switch in order to shorten path lengths as much as possible.

Components C1, C2, R1, R10 and D1 are mounted on the four terminals fitted to the back panel of the instrument. The power supply terminals are colour coded red and black whilst the modulation input uses two green terminals.

Two wires join the group of components mounted on the back panel to those mounted on the front panel, these are the earth connection and the wire leading to pins 9 on the coils.

The attenuator is wired separately, components R4 to R9, C9 and C10 all being fitted to the attenuator switch. A short wire is led out of the box from C9 to connect the attenuator to the tuning capacitor. The coaxial socket is bolted to the diecast box using countersunk screws so that when the retaining nut is removed from the attenuator switch the whole assembly can be offered up flush to the front panel and held in position by refitting the retaining nut to the switch. Having done this the wire from C9 can be connected using the shortest possible length of wire.

The instrument wiring is now complete, but two or three checks of this wiring is recommended. Transistor TR1 is very delicate and can

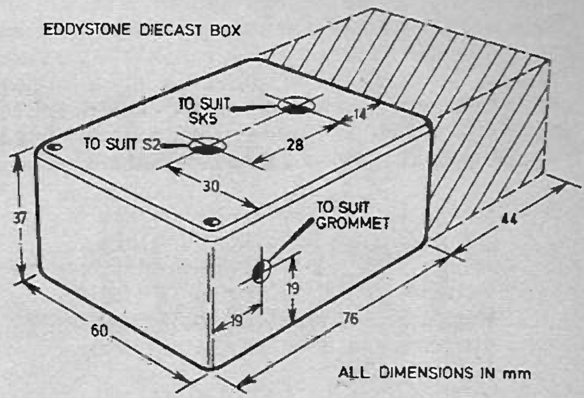
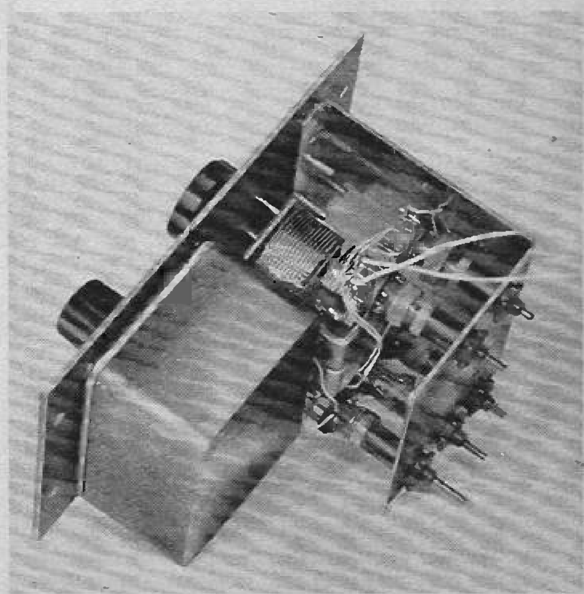


Fig. 5. Drilling and cutting details for the Eddystone diecast box for housing the attenuator.



Photograph of the completed prototype front panel showing mounting of coils to bracket, and bracket to front panel.

R.F. SIGNAL GENERATOR

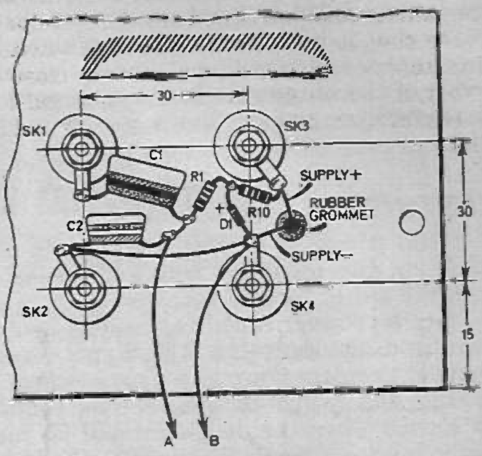
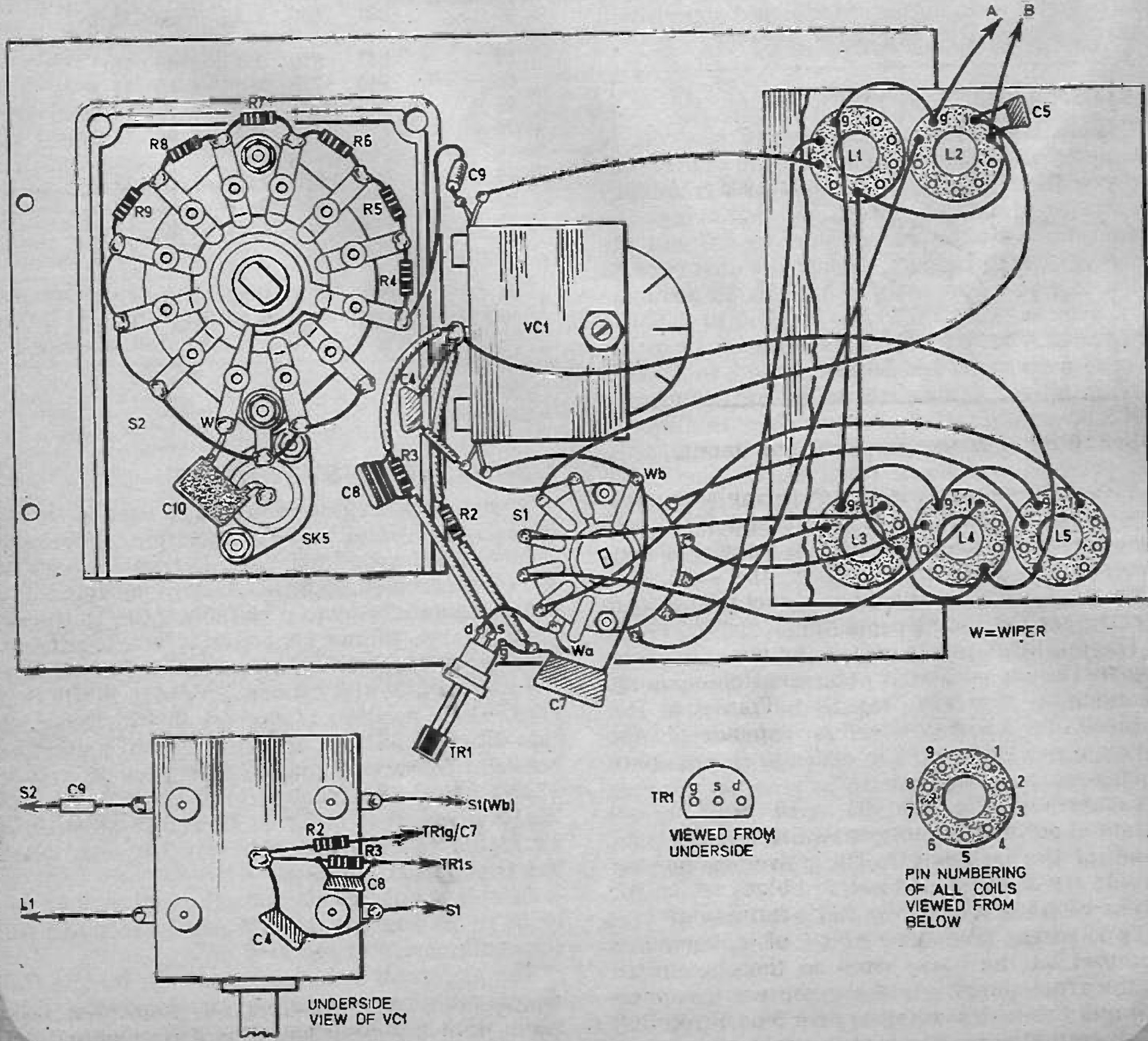


Fig. 6. (below) The layout and wiring up details of the components mounted on the front panel. The coil mounting bracket has been drawn opened up, for clarity, thus showing the bases of the coil formers head on; (above) The layout and wiring of the components on the rear panel.



easily be damaged by an error in the wiring. Finally, the front panel is marked up using letraset and the 0-100 dial and pointer are fitted.

The dial is held in place by cutting a hole in the bottom and trapping it under the retaining screw of the range switch. The pointer is a standard Perspex one cut down in size to suit the dial.

TESTING

If the wiring is correct and TR1 is in good condition the oscillator will work. It is tested with the aid of a radio receiver.

Place a receiver tuned to the long or medium waveband alongside the R.F. Signal Generator. Connect the generator to a power supply set to 18 volts and switch on. The receiver should pick up signals when the dial is rotated on ranges 1 and 2, long and medium wave. These signals will be received as quiet spots on the receiver dial.

Next connect the audio generator to the modulation terminals having first set the controls to 400Hz and 2 volts output. Modulated signals will now be received by the radio receiver.

CALIBRATION

Calibration is simple for those with access to frequency measuring equipment and difficult for those without it. First, for those with frequency measuring facilities. Start by removing the modulation, set the dial pointer to 100 and the range switch to range 1. Adjust the dust core on coil 1 to give a frequency of 198kHz. In a similar way, set range 2 to 600kHz, range 3 to 1·6MHz and range 4 to 5·0MHz. Rotate the dial pointer to read 5 divisions and adjust range 5 to 31MHz. Having set the calibration points for each range make up a calibration chart as show in Table 1.

For those without frequency measuring facilities proceed as follows. First, set all dust cores about half way out on their adjusting screw. The unit must be calibrated against known radio station frequencies by setting the dust core into its correct position.

For example, range 1 can be calibrated against the BBC long wave transmission on 200kHz (1500 metres) as follows: tune a radio receiver to 200kHz then set the dial pointer on the generator to 98; a beat note should be heard in the receiver. The core adjuster on range 1 is now adjusted to give zero beat, (as near as possible), in the receiver. Range one is now as close as possible to the calibration chart. Each range should now be set against a known transmission standard so that every range is as close as possible to the calibration chart.

If a suitable receiver is not available or you don't know the frequency of a station, leave the dust core set half way until an opportunity to calibrate presents itself. Ranges 1 to 4 should be calibrated between pointer position 80 and 100 and Range 5 as near to 5 as possible.

Table 1: Calibration chart for the prototype R. F. Signal Generator

Dial position	Range and frequency (MHz) 1	2	3	4	5	FM
0	·640	1·99	5·53	13·5	31·1	
5	·632	1·95	5·43	13·4	31·0	
7·5	·609	1·86	5·21	13·1	30·5	122
10	·574	1·73	4·88	12·6	29·9	119·6
12·5	·539	1·64	4·54	12·1	28·6	114·4
15	·507	1·56	4·26	11·6	27·5	110
17·5	·475	1·45	3·95	11·1	26·1	104·4
20	·447	1·35	3·70	10·4	24·8	99·2
22·5	·423	1·28	3·49	9·95	23·6	94·4
25	·402	1·22	3·31	9·54	22·5	90
27·5	·383	1·16	3·14	9·16	21·4	85·6
30	·366	1·11	3·00	8·82	20·5	82
35	·338	1·02	2·76	8·22	19·0	76
40	·316	·958	2·57	7·74	17·7	
45	·297	·898	2·42	7·33	16·7	
50	·281	·850	2·29	6·97	15·8	
55	·267	·810	2·17	6·65	15·1	
60	·256	·776	2·08	6·40	14·4	
65	·245	·744	1·99	6·15	13·9	
70	·236	·717	1·92	5·94	13·3	
75	·228	·693	1·85	5·74	12·9	
80	·221	·670	1·79	5·57	12·5	
85	·214	·649	1·74	5·40	12·1	
90	·209	·631	1·69	5·26	11·7	
95	·203	·614	1·64	5·12	11·4	
100	·198	·600	1·6	5·0	11·2	

USING THE INSTRUMENT

A signal generator is normally used with the modulation connected. For example, suppose it is necessary to adjust the i.f. transformers of a radio receiver 465kHz. A wire must be fed from the generator to a suitable input to the i.f. channel, the tuning capacitor is often suitable. The generator is switched on and set to 465kHz.

Inspection of the calibration chart shows that range scale position 17·5 gives 480kHz and position 20 gives 453kHz, therefore, 465kHz must be between these two readings. In fact 465kHz is 12kHz above the frequency at position 20 and 15kHz below that at 17·5. Therefore, 465kHz is estimated to be about half way between these two readings at 18·75.

As this is only an estimate the dial may be set to 18 or 19 and still be sufficiently accurate for the realignment of receiver i.f.'s.

The generator is accurate enough for the full alignment of any receiver providing the final calibration is carried out using a broadcast transmission of known frequency. ■

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FREE ENTRY COMPETITION

...WIN A CHINAGLIA MULTIMETER!

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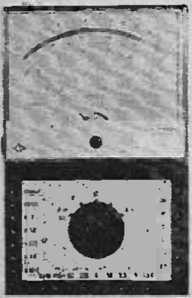
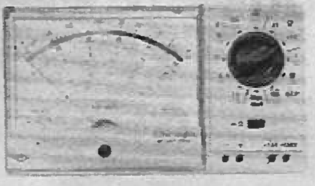
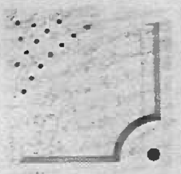


First prize, a Chinaglia Dino electronic multimeter which utilises f.e.t.s. to provide a d.c. input impedance of 200kΩ/V and an a.c. impedance of 20kΩ/V. This instrument has 33 ranges, all with high accuracy and costs over £28.





Second and third prize, a Chinaglia Minor multimeter with a sensitivity of 20kΩ/V on d.c. and 4kΩ/V on a.c. ranges. This instrument is a versatile pocket-sized instrument, having 25 ranges all with high accuracy. It sells for over £13.

Ten runner-up prizes, a Chinaglia Cito pocket multimeter designed specifically to provide a low cost instrument for everyday use. Sensitivity 20kΩ/V on d.c. ranges and 2kΩ/V on a.c. ranges. With 24 high accuracy ranges the Cito sells for over £10.

HOW TO ENTER

Place the eight multimeter features, given below, in what you consider to be their order of importance to the average reader working on typical Everyday Electronics constructional projects.

For example, if you consider that "A.C. current ranges" is the most important of them all, write "C" in the box marked 1st on your entry coupon; the key letter of your choice goes into the second box and so on for all eight.

IMPORTANT

Another free entry coupon will appear in the July issue of Everyday Electronics.

The closing date is Monday 22nd July 1974, to allow plenty of time for you to obtain the second entry coupon from our next issue and post two different attempts in one envelope if you wish.

A Anti-parallax mirrored scale.
B Degree of accuracy.
C A.C. current ranges.
D Resistance ranges beyond 1MΩ.
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FREE ENTRY COUPON

COMPETITION RULES

There is no entry fee, but each attempt must be fully completed in ink on the proper printed coupon cut from Everyday Electronics, and bear the entrant's own full name and address.

Every accepted entry will be examined and the first prize, as described, will be awarded to the entrant who, in the opinion of an expert panel of judges, and in any one attempt, has shown the most skill and judgement in listing the eight features in order of importance. The other prizes will be awarded to the senders of the 12 next best attempts in order of merit. No entrant may win more than one prize.

In the event of a tie or ties for any of the prizes, a further eliminating contest will be conducted by post between the tying competitors to determine such winner/s or winning order.

Any entry which does not comply with the printed instructions or is received after the closing date will be disqualified, as will any received mutilated or illegible, incomplete, bearing alterations, or with more than one key letter in each space. No responsibility will be accepted for entries lost or delayed in the post or otherwise.

The judges' decision, and that of the Editor of Everyday Electronics in all other matters affecting the competition, is final and legally binding. No correspondence can be entered into.

The competition is open to all readers in Great Britain, Northern Ireland, and the Channel Isles except employees (and their families) of IPC Magazines, the printers of Everyday Electronics or of Chinaglia (U.K.) Ltd.

The winners will be notified, and the result announced in the earliest possible issue of this magazine.

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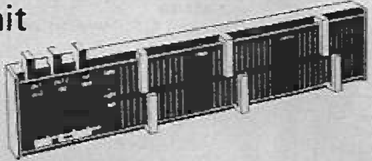
Stereo 80 pre-amplifier and control unit

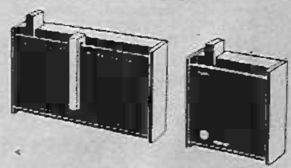


Each channel has independent tone and volume slider controls enabling exceptionally good environmental matching to be obtained. A virtual earth input stage forms part of the up-dated circuitry which includes generous overload margins. Clear instructions with template are supplied.

Size – 260 × 50 × 20mm (10½ × 2 × ¾ ins)
Inputs – Mag. P.U. 3mV RIAA corrected; Ceramic P.U., Radio, Tape
S/N ratio – 60db
Frequency range – 10Hz to 25KHz + 3dB
Power requirements – 20 to 35 volts
Outputs – 100mV + AB monitoring for tape
Controls – Press button for tape, radio and P.U. Sliders for Volume, Bass and Treble.

R.R.P. £11.95 +£1·19 V.A.T.

Project 80 FM tuner and stereo decoder



FM Tuner
Size – 85 × 50 × 20mm
Tuning range – 87.5 to 108 MHz
Detector – I.C. balanced coincidence.
AFC – Switchable
One 26 transistor I.C.
Twin dual varicap tuning
Distortion 0.2% at 1 KHz for 30% modulation
4 pole ceramic filter in I.F. section
Sensitivity – 4 microvolts for 30dB quieting
Output – 300mV for 75 KH deviation

Decoder–
With gallium arsenide tuning beacon and 19-transistor I.C.
Size – 47 × 50 × 20mm

FM tuner R.R.P. £11.95 +£1·19 V.A.T.
Decoder R.R.P. £7.45 +0·45p V.A.T.

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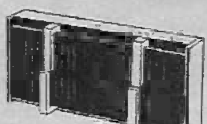

Size – 108 × 50 × 20mm (4¼ × 2 × ¾ ins)
Voltage gain – minus 0·2dB
Frequency response – 36Hz to 22KHz, controls minimum
Distortion – at 1KHz – 0·03% using 30V
HF cut off (scratch) – 22KHz to 5·5KHz, 12dB/oct. slope
L.F. cut off (rumble) – 28dB at 20Hz, 9dB/oct. slope

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Z.40 & Z.60 power amplifiers

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Size – 55 × 80 × 20mm
Input sensitivity – 100mV
Output – 15W RMS continuous 8 Ω (35V).
Frequency response – 10Hz – 100KHz ± 1dB
Signal to noise ratio – 64dB
Distortion – less than 0·1% at 10W into 8 Ω
Power requirements – 12-35 volts

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Z.60
Size – 55 × 98 × 20mm
Input sensitivity – 100-250mV
Output – 25W RMS 8 Ω (45V).
Distortion – typically 0·03%
Frequency response – 10Hz to more than 200KHz ± 1dB
S/N ratio – better than 70dB

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SEMICONDUCTOR PRIMER

By A.P. STEPHENSON

13 ■ THE TRANSITION FREQUENCY

The gain of a transistor is not independent of frequency.

As frequency is increased, h_{fe} remains fairly constant until a certain upper limit is reached.

Beyond this frequency, the h_{fe} falls, and eventually reaches unity.

The **transition frequency** f_T is this limit, where

f_T = frequency at which h_{fe} has fallen to unity.

As an example, the BC107, BC108 and BC109 all have an f_T of 300MHz, providing I_c is held at around 10mA.

A transistor is naturally a useless animal at its transition frequency, but f_T is a useful figure for the following reason:

As frequency is successively *halved,* the gain is *doubled* (which is a convenient method of predicting the gain at high frequencies).

Thus, the BC108 **will** have an h_{fe} of 1 at 300, 2 at 150, 4 at 75, and 8 at 37·5MHz.

This simple relation only holds for about four or five "halvings." Eventually, the figure for h_{fe} reaches its normal **mid-frequency value,** which in most cases will be at about $\frac{1}{10}$**th** f_T.

The BC108 published figures of $h_{fe}=125$ (minimum) which means this figure is valid up to about 30MHz.

14 ■ CHOICE OF COLLECTOR CURRENT

Some humans are said to be highly strung or touchy and sensitive.

All transistors are touchy and sensitive!

Changes in d.c. operating bias, temperature and signal frequency all tend to change the so called contants such as h_{fe} and noise figure.

Detailed data sheets always include numbers of graphs, showing how the constants change I_C, I_B temperature etc. In the absence of these, the following broad rules can be accepted:

(1) h_{FE} h_{fe} — *rises* as d.c. collector current rises. Therefore it is wise to design with fairly high I_C values, (at least 1mA or more). BC108, BC109, BC107 will still operate reasonably with I_C as low as 10μA but with much reduced h_{FE} and h_{fe}.

(2) **Transistor input resistance** (r_{in} **or** h_{ie})
r_{in} *falls* as I_C is increased. Thus for high r_{in} a low I_C should be used

(3) **Highest operating frequency**
This *rises* as I_C is increased, because h_{fe} rises. For very high operating frequencies, 10mA or more is customary.

(4) Noise
Transistors generate some noise. This noise is reduced if I_C is kept very low. Thus for low noise input stages, operate with very low I_C value (10 or 20 μA).

15 ■ PRODUCTION SPREADS

The range of variation expected between the manufacturers published data and the actual values found in a given transistor specimen are often substantial.

Semiconductor manufacture has improved enormously in the last five years but there are still very wide "production spreads" in any given transistor.

h_{fe} is the worst offender of all. Taking the BC109 as a typical example, the user must expect to find any value between 240-900, representing a variation of almost 400 per cent!

Almost every other data item suffers wide variations. Superficially, it would appear that predictable design is impossible, but such is not the case for the following reasons:

(a) Manufacturers quote three figures for most data, called **Typical, Minimum and Maximum.** Thus the **minimum** h_{fe} for BC109 is guaranteed to be 240.

The procedure adopted for design is based on the philosophy of "worst-case conditions" which is nothing more than adopting a pessimistic attitude—expecting all BC109 specimens to be the worst ones in the range. An attitude like this can lead occasionally to elation but never disappointment.

(b) Use of negative feedback in practically every circuit. Negative feedback always tends to reduce the effects of production spreads because the gain of such a stage is *almost independent of the transistor!* To illustrate this point, an equation for the voltage gain of an amplifying stage is

$$A=\frac{R_c}{R_e}, \text{ where } R_c, R_e \text{ are resistors}$$

Without negative feedback, the gain would vary widely with different specimens of transistor.

DOWN TO EARTH

By GEORGE HYLTON

"I've come across the term 'amplified diode voltage stabilizer.' What is this, and what is it used for?"

To begin with, look at a diode stabiliser without any amplification (Fig. 1). This makes use of the fact that, once a junction diode conducts, increasing the current through it doesn't increase the voltage very much. A silicon diode begins to conduct at about 0·5V. At its maximum safe current the voltage drop across it is about 1V.

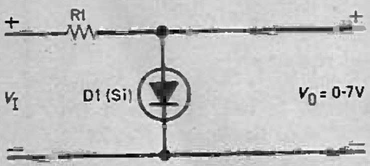


Fig. 1. Simple diode stabiliser circuit.

Both voltages vary from diode to diode, but an average voltage drop at a moderate current is always near 0·7V. (For germanium the voltage is about 0·3V, but remember that this applies only to junction diodes, not point-contact diodes).

In Fig. 1, V_I is the unstabilised input voltage. R1 absorbs the unwanted part, leaving V_O, the stabilised output, at around 0·7V. If V_I is about 2·7V, and an output of 0·7V, 1A is required, then R1 must drop 2V at 1A; i.e., R1 must be 2 ohms. Readers familiar with Zener diode stabilisers will see that the design procedure for this circuit is the same.

Who wants a 0·7V stabilised supply? The usual requirement is for higher voltages. You can increase the voltage by connecting a number of diodes in series: two give 1·4V, three 2·1V and so on. If more than a few volts is needed, it's cheaper to use a Zener, which gives better stabilisation anyway.

AMPLIFICATION

This is where the amplified diode circuit comes in. It will give any voltage you like, using only one diode. The circuit (Fig. 2) seems wrongly named. No diode!

But the base-emitter junction of TR1 is a diode. It begins to pass current (if TR1 is a silicon transistor) at about 0·5V, turning on the transistor in the process, of course. The resulting collector current, flowing through R1, pulls down the output voltage V_O, just as in the simple diode stabiliser.

The difference is that the base voltage V_B is only a *part* of the output voltage, because R2 and R3 form a voltage divider. If V_B is one-tenth of V_O, then TR1 will not begin to conduct until V_O reaches about 5V. To make TR1 conduct strongly calls for a V_O of perhaps 7V, so the circuit is a 7V stabiliser.

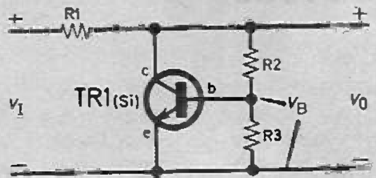


Fig. 2. Stabiliser using amplified diode principle.

By varying the ratio of R2 to R3 the stabilised output can be adjusted to any voltage within the capacity of the transistor. However, if the stabilised voltage is very large the stabilisation is poor, and the circuit is best suited to lowish output voltages.

Amplified diodes are often used in integrated circuits, in the form shown in Fig. 3. Here R2 and R3 are absent because the whole of the output voltage is fed back to the base. A silicon transistor still works as a transistor under these conditions and behaves like a simple diode with sharper turn-on. It is often referred to as a "diode" or a "shorted transistor".

In Fig. 4, an amplified diode (TR1) is used for setting up the base bias of a complementary output pair in a class B amplifier. The adjustability of the arrangement makes it very useful here, and the low voltage needed is just what the circuit can provide.

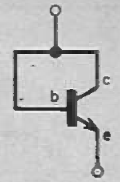
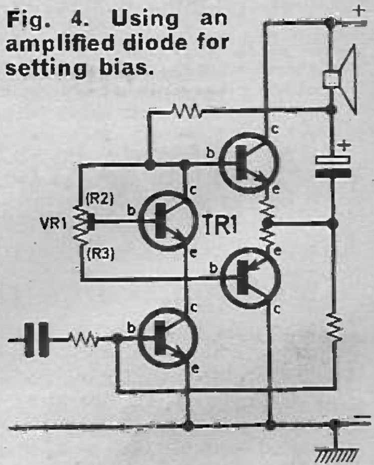


Fig. 3. Amplified diode found in integrated circuits.

Fig. 4. Using an amplified diode for setting bias.



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AC127	20	AF118	39	BC159	13	BD139	61	BF195	13	OC19	39	2G371B	13	2N2221	22	2N3404	31	2N4290	19
AC128	20	AF124	33	BC160	50	BD140	66	BF196	16	OC20	70	2G373	19	2N2222	22	2N3405	46	2N4291	19
AC132	16	AF125	33	BC161	55	BD155	88	BF197	16	OC22	52	2G374	19	2N2368	19	2N3414	17	2N4292	19
AC134	16	AF126	31	BC167	13	BD175	66	BF200	50	OC23	54	2G377	33	2N2369	16	2N3415	17	2N4293	19
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AC141	20	AF139	33	BC169	13	BD177	72	BF257	50	OC25	42	2G381	18	2N2411	27	2N3417	31	2N5294	60
AC141K	32	AF178	55	BC170	13	BD178	72	BF258	66	OC26	32	2G382	18	2N2412	27	2N3525	83	2N5457	35
AC142	20	AF179	55	BC171	16	BD179	77	BF259	94	OC28	55	2G401	33	2N2646	52	2N3614	74	2N5458	35
AC142K	28	AF180	55	BC172	16	BD180	77	BF262	61	OC29	55	2G414	33	2N2711	23	2N3615	82	2N5459	44
AC151	17	AF181	55	BC173	16	BD185	72	BF263	61	OC35	46	2G417	28	2N2712	23	2N3616	82	2N6211	75
AC154	22	AF186	55	BC174	16	BD186	72	BF270	39	OC36	55	2N388	39	2N2714	23	2N3646	10	2S301	55
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AC157	27	AL103	72	BC178	21	BD189	83	BF273	39	OC44	17	2N404A	31	2N2905	23	2N3704	14	2S303	61
AC165	22	ASY26	28	BC179	21	BD190	83	BF274	39	OC45	14	2N524	46	2N2905A	23	2N3705	13	2S304	77
AC166	22	ASY27	33	BC180	27	BD195	94	BFW10	66	OC70	11	2N527	54	2N2906	17	2N3706	13	2S305	86
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AC178	31	ASY54	28	BC184	13	BD205	88	BFX88	24	OC77	28	2N699	39	2N2925	16	2N3819	31	2S323	62
AC179	31	ASY55	28	BC184L	13	BD206	88	BFY50	22	OC81	17	2N706	09	2N2926(G)	14	2N3820	55	2S324	77
AC180	22	ASY56	28	BC186	31	BD207	£1·05	BFY51	22	OC81D	17	2N706A	10	2N2926(Y)	12	2N3821	39	2S325	77
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AC181	22	ASY58	28	BC207	12	BDY20	£1·10	BFY53	19	OC82D	17	2N711	33	2N2926(R)	11	2N3903	31	2S327	77
AC181K	32	ASY73	28	BC208	12	BF115	27	BFX25	94	OC83	22	2N717	39	2N2926(B)	11	2N3904	33	2S701	46
AC187	24	ASZ21	44	BC209	13	BF117	50	BSX19	17	OC139	22	2N718	27	2N3010	77	2N3905	31	40361	44
AC187K	25	BC107	12	BC212L	12	BF118	77	BSX20	17	OC140	22	2N718A	55	2N3011	16	2N3906	30	40362	50
AC188	24	BC108	12	BC213L	12	BF119	77	BSY25	17	OC169	28	2N726	31	2N3053	19	2N4058	13		
AC188K	25	BC109	13	BC214L	16	BF121	50	BSY26	17	OC170	28	2N727	31	2N3054	51	2N4059	11		
ACY17	28	BC113	11	BC225	28	BF123	55	BSY27	17	OC171	28	2N743	22	2N3055	55	2N4060	13		
ACY18	22	BC114	17	BC220	39	BF125	50	BSY28	17	OC200	28	2N744	22	2N3391	16	2N4061	13		
ACY19	22	BC115	17	BC301	30	BF127	55	BSY29	17	OC201	31	2N914	16						
ACY20	22	BC116	17	BC302	27	BF152	61	BSY38	20	OC202	31	2N918	33						
ACY21	22	BC117	20	BC303	35	BF158	50	BSY39	20	OC203	28	2N929	23						
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ACY29	39	BC125	13	BCY30	27	BF157	61	BSY95A	14	OCP71	48	2N1302	16						
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ACY34	23	BC134	20	BCY33	24	BF160	44	C400	33	P21	50	2N1305	19						
ACY35	23	BC135	13	BCY34	28	BF162	44	C407	28	P346A	22	2N1306	23						
ACY36	31	BC136	17	BCY70	16	BF163	44	C424	28	P397	46	2N1307	23						
ACY40	19	BC137	17	BCY71	22	BF164	44	C425	55	ST140	14	2N1308	28						
ACY41	20	BC139	44	BCY72	16	BF165	44	C426	39	ST141	19	2N1309	26						
ACY44	39	BC140	33	BCZ10	22	BF167	24	C428	22	TIS43	38	2N1613	22						
AD130	42	BC141	38	BCZ11	28	BF173	24	C441	33	UT46	30	2N1711	22						
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AD142	53	BC143	33	BD115	68	BF177	39	C444	39	2G301	21	2N1890	50						
AD143	42	BC145	50	BD116	88	BF178	33	C450	24	2G302	21	2N1893	41						
AD149	55	BC147	11	BD121	66	BF179	33	MAT100	21	2G303	21	2N2147	79						
AD161	39	BC149	11	BD123	72	BF180	33	MAT101	22	2G304	27	2N2148	63						
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BA116	23	BYZ13	28	OA95	8
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7411	0·28	0·27	0·26	7476	0·44	0·42	0·42	74160	2·10	2·00	1·90
7412	0·39	0·34	0·31	7480	0·74	0·71	0·64	74161	2·10	2·00	1·90
7413	0·32	0·31	0·30	7481	1·30	1·25	1·20	74162	4·40	4·15	3·85
7416	0·48	0·44	0·42	7482	0·96	0·95	0·94	74163	4·40	4·15	3·85
7417	0·48	0·44	0·42	7483	1·20	1·15	1·05	74164	2·20	2·10	2·00
7420	0·18	0·17	0·16	7484	1·10	1·05	1·00	74165	2·20	2·10	2·00
7422	0·55	0·53	0·50	7485	3·50	3·80	3·30	74166	3·20	3·10	3·00
7423	0·55	0·53	0·50	7486	0·35	0·34	0·33	74174	2·50	2·40	2·30
7425	0·55	0·53	0·50	7489	4·00	8·75	3·50	74175	1·75	1·65	1·55
7426	0·50	0·46	0·44	7490	0·74	0·71	0·64	74176	1·85	1·75	1·65
7427	0·50	0·46	0·44	7491	1·10	1·05	1·00	74177	1·85	1·75	1·65
7428	0·55	0·53	0·50	7492	0·74	0·71	0·64	74180	1·50	1·40	1·30
7430	0·18	0·17	0·16	7493	0·74	0·71	0·64	74181	5·00	4·50	4·00
7432	0·50	0·46	0·44	7494	0·85	0·82	0·75	74182	2·00	1·90	1·75
7433	0·75	0·73	0·70	7495	0·85	0·82	0·75	74184	3·20	3·10	3·00
7437	0·70	0·68	0·65	7496	0·96	0·93	0·86	74190	2·15	2·10	2·00
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7441	0·74	0·71	0·64	74105	1·07	1·04	1·00	74193	2·15	2·10	2·00
7442	0·74	0·71	0·64	74107	0·44	0·42	0·40	74194	2·98	2·86	2·75
7443	1·20	1·15	1·10	74110	0·60	0·55	0·50	74195	2·00	1·95	1·90
7444	1·20	1·15	1·10	74111	1·38	1·27	1·21	74196	1·95	1·90	1·85
7445	1·98	1·95	1·90	74118	1·10	1·05	1·00	74197	1·95	1·90	1·85
7446	1·20	1·15	1·10	74119	1·50	1·40	1·30	74198	5·00	4·75	4·50
7447	1·10	1·07	1·05	74121	0·50	0·48	0·45	74199	5·00	4·75	4·50

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100	0·28	0·37	0·52	0·52	0·55	0·64	0·70	1·54
200	0·39	0·41	0·54	0·54	0 63	0·67	0·83	1·76
400	0·48	0·52	0·62	0·62	0·74	0·83	1·03	1·93
600	0·59	0·63	0·75	0·75	0·85	1·07	1·38	—
800	0·70	0·77	0·88	0·98	0·99	1·32	1·65	4·40

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50	0 04	0·06	0·06	0·08	0·16	0·23	0·66
100	0·04	0·07	0·06	0·15	0·18	0·26	0·83
200	0·06	0·10	0·07	0·16	0·22	0·27	1·10
400	0·07	0·15	0·08	0·22	0·30	0·41	1·35
600	0·08	0·18	0·11	0·26	0·38	0·50	2·05
800	0·11	0·19	0·12	0·28	0·41	0·61	2·20
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UIC04=12×7404	0·55	UIC53=12×7453	0·55	UIC94=5×7494	0·55
UIC05-12×7405	0·55	UIC54-12×7454	0·55	UIC95=5×7495	0·55
UIC06-8×7406	0·55	UIC60=12×7460	0·55	UIC96=5×7496	0·55
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C	1	4·7–10M	3·2	2·5	1·92 nett
MO	1/2	10–1M	4	3·3	2·3 nett
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WW	3	1–10K	7	7	6
WW	7	1–10K	9	9	8

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0·47	—	—	—	—	—	—	11p	8p
1·0	—	—	—	—	—	11p	—	8p
2·2	—	—	—	—	11p	—	8p	9p
4·7	—	—	—	11p	—	8p	9p	8p
10	—	—	—	—	8p	9p	8p	8p
22	—	—	8p	—	8p	8p	8p	10p
47	8p	—	9p	8p	9p	8p	10p	13p
100	9p	8p	8p	8p	9p	10p	12p	19p
220	8p	8p	9p	10p	10p	11p	17p	28p
470	9p	10p	10p	11p	13p	17p	24p	45p
1,000	11p	13p	13p	17p	20p	25p	41p	—
2,200	15p	18p	23p	26p	37p	41p	—	—
4,700	26p	30p	39p	44p	58p	—	—	—
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As designed by P. J. Baxandall and described originally in "Wireless World." Simple to assemble, fantastically good results and a greater money saver. Carries 10 watts RMS, 15 ohms impedance. Size 18in x 12in x 10in. Complete kit, including pack-flat cabinet, £14·90.
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Technical specification:

1.) Output 2.5 watts R.M.S. into 8 ohms. For 12 volt operation on negative or positive earth.
2.) Integrated circuit output stage, pre built three stage IF Module.

Controls Volume, manual tuning and five push buttons for station selection, illuminated tuning scale covering full medium and long wave bands.

Size Chassis 7 ins. wide, 2 ins. high and 4 7/8 ins. deep approx.

NOTE: The ability to solder on a printed circuitboard is necessary to complete this kit successfully. Circuit diagram and comprehensive instructions 55p free with kit.

Car Radio Kit
£6.60 + 55p. postage & packing.

Speaker including baffle and fixing strips
£1.65 + 23p. postage & packing.

Recommended Car Aerial - fully retractable and locking.
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QUALITY SOUND(*) FOR LESS THAN £19·00

Stereo 21 easy to assemble audio system kit, - no soldering required. Includes:—

BSR 3 speed deck, automatic, manual facilities together with ceramic cartridge.
Two speakers with cabinets.
Amplifier module. Ready built with control panel; speaker leads and full, easy to follow assembly instructions.

For the technically minded:—

Specifications:
Input sensitivity 600mV; Aux. input sensitivity 120mV: Power output 2.7 watts per channel: Output impedance 8–15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs – radio, tape, etc., and outputs for taping discs. Overall Dimensions, Speakers approx. 15½" × 8" × 4". Complete deck and cover in closed position approx. 15½" × 12" × 6". Complete only **£18.95** + £1.60 p & p.

Extras if required.
Optional Diamond Styli **£1.37**
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance. **£3.85.**

DISCO AMPLIFIER

Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties.
Outputs 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).
Inputs *5 Electrically Mixed Inputs. *3 Individual Mixing controls. *Separate bass and treble controls common to all 5 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling.

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Size approx. 12½ ins × 6 ins × 3½ ins
**£15.00 + 60p.
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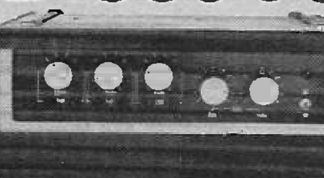
DISCO 50



45 WATT R.M.S. MONO DISCOTHEQUE AMPLIFIER

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Special Offer: Disco 50 plus two 15" E.M.I. speakers type 14A/780 (as illustrated on opposite page). **Complete £57.00 + £4.00 p&p.**

COMPLETE(*) STEREO SYSTEM

£51·00

40 Watt Amplifier.
Viscount III – R102 now 20 watts per channel.
System I includes.
Viscount III amplifier – volume, bass, treble and balance controls, plus switches for mono/stereo on/off function and bass and treble filters. Plus headphone socket.
Specification
20 watts per channel into 8 ohms.
Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K. equalised within _ 1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: ÷ 12dB to –17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble – 12dB to –12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max.) –58dB.
Crosstalk better than 35dB on all inputs.
Overload characteristics better than 26dB on all inputs. Size approx. 13¾" × 9" × 3¾".
Garrard SP25 deck, with magnetic cartridge, de luxe plinth and hinged cover.
Two Duo Type II matched speakers – Enclosure size approx. 17½" × 10¾" × 6" in simulated teak. Drive unit 13" × 8" with parasitic tweeter **Complete System £51.00**

£69·00

System II
Viscount III amplifier (As System I)
Garrard SP. 25 (As System I)
Two Duo Type IIIA matched speakers – Enclosure size approx. 31" × 13" × 11½". Finished in teak veneer. Drive units approx. 13½" × 8½" with 3½" HF speaker. Max. power 20 watts, 8 ohms. Freq. range 20Hz to 20kHz.

Complete System £69.00

PRICES: SYSTEM 1

Viscount III R 102 amplifier	£24·20 + £1 p & p
2 Duo Type II speakers	£14·00 + £2·20 p & p
Garrard SP25 with MAG. cartridge de luxe plinth and hinged cover	£21.00 + £1.75 p & p.
total	£59.20

Available complete for only £51.00 + £3·50 p. & p.

PRICES: SYSTEM 2

Viscount R102 amplifier	£24·20 + £1·00 p. & p.
2 Duo Type IIIA speakers	£39·00 + £4·00 p. & p.
Garrard SP25 with MAG cartridge de luxe plinth and hinged cover	£21·00 + £1·75 p. & p.
total	£84·20

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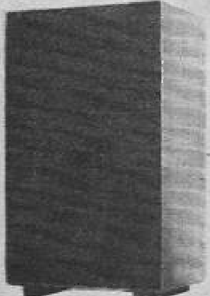
THE ULTIMATE COMPLETE SPEAKER SYSTEM EMI LE 315 listed price £86·00



A professional standard five way speaker system with enclosure giving top quality performance.
Enclosure Dimensions
approx. (3ft. · 2ft. · 1ft.).
Drive Units
Hand built – 15" diameter bass with 3" voice coil. – two 5" diameter Mid Range units. – two 3½" HF. units, plus matching crossover panel with two variable potentiometers for mid and high frequency adjustment.
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Frequency Response
20 Hz 20,000 Hz. Imp. 8 ohms.

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Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts RMS. and is treated to give a smooth frequency response. Resonance 30 Hz. flux density 360,000 Maxwells. Impedance at 1 kHz is 8 ohms. 3" voice coil.

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OUR PRICE £18·70 + £1·50 p & p

950 KIT

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Huge 19" × 14" (approx.) high efficiency Bass-Speaker with 16,500-gauss magnet built on a heavy diecast frame.
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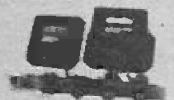

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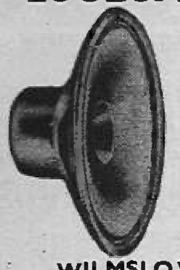

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